The role of Hoogheemraadschap de Stichtse Rijnlanden in urban climate adaptation

Master's Thesis – Water Science and Management

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Abstract

To keep urban areas in the Netherlands inhabitable in the changing climate where extreme rainfall, drought, and heat occur increasingly often, they need to become more climate adaptive.

The *Deltaprogramma Ruimtelijke Adaptatie* (DPRA) requires safety regions to carry out a climate stress test for locations that are at risk of water nuisance, drought, heat stress and flood risk. Based on this test municipalities can create a local adaptation strategy (LAS). Because climate adaptation is such an important and broad topic, different government levels need to collaborate to reach the desired results. Currently, there is no scientific framework on how the relevant government levels: water authorities, provinces and municipalities should collaborate to reach the climate adaptation goals.

This research has focussed mostly on the collaboration between municipalities and water authorities. In depth research on the collaboration of Hoogheemraadschap de Stichtse Rijnlanden (HDSR) and fourteen municipalities within its management area has been conducted with the aim to provide HDSR with a set of actions they can take to assist municipalities in the creation of climate adaptation policy and the implementation of adaptation measures. In order to find this set of actions firstly the available climate adaptation policy of the municipalities was reviewed. Based on those results municipal representatives were interviewed to ask about their policy, difficulties, and what they desire and expect from HDSR. Secondly, possible actions HDSR could take were investigated. This concerned policy, capacity and budgetary aspects. Those possible actions were then linked to the main obstacles mentioned by the municipalities to come to a recommended course of action for HDSR.

From the policy review, it became apparent that only eight of the fourteen municipalities have a clear climate adaptation policy document and for the other six municipalities it is either absent or fragmented over other documents. The most prevalent obstacles that were mentioned in the interviews were capacity, budget, space availability, citizen participation, and uncertainty of requirements.

HDSR can assist municipalities through three different categories: policy, capacity and budget. For the policy category, HDSR can include climate rules in the new *waterschapsverordening*, which makes standards regarding water nuisance and drought enforceable. The second category, capacity, entails both manpower and knowledge provision. For the last category, budget, HDSR has the option to increase the budget of the impulse arrangement and the amount of subsidies available to citizens for climate adaptive measures.

Keywords: urban climate adaptation, regional water authorities, municipal adaptation, multiple level governance

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List of abbreviations

HDSR – Hoogheemraadschap de Stichtse Rijnlanden	(water authority de Stichtse Rijnlanden)
DPRA – Delta programma ruimtelijke adaptatie	(Delta programme spatial adaptation)
NAS – nationale adaptatie strategie	(national adaptation strategy)
RAS – regionale adaptatie strategie	(regional adaptation strategy)
LAS – lokale adaptatie strategie	(local adaptation strategy)
GRP – gemeentelijk rioleringsplan	(municipal sewage plan)
WRP – water- en rioleringsplan	(water- and sewage plan)

1. Background

1.1 Climate change and the related challenges to the urban environment

Climate change is a largely problematic phenomenon that has become more and more prevalent over the past few decades (Poortinga et al., 2019). In the Netherlands, the amount of precipitation during extreme precipitation events with a repetition time of 10 years or more has increased by 15-20% during the past 30 years, and it is expected to increase even further (KNMI, 2021). Additionally, the periods of drought that are experienced during the summer months are expected to increase both in occurrence and severity (KNMI, 2021).

The increasing peak precipitation events in combination with more severe droughts pose huge challenges to the entire water system. Droughts in urban areas are linked to a decrease of the groundwater levels, decrease in surface water levels and (potentially) surface water area, and a decrease in water quality (STOWA, 2022). Another effect of climate change is an increase in temperature, which in urban environments, due to the presence of concrete structures, cause an increase in the presence and severity of urban heat islands (Rizwan et al., 2008). These urban heat islands may increase the experienced temperature in cities up to 7ºC hotter than in the surrounding rural areas (KNMI, 2021; Fowler et al., 2021) and can cause health problems to its inhabitants (Heaviside et al., 2017). One last effect that is linked to an increase in peak precipitation is flood risk. Due to the heavier rainfall events the peak drainage of canals and rivers will also increase, which, in the Netherlands, increases the flood risk of the area around dikes (Paudel et al., 2015; Klijn et al., 2012). While the hazard of flooding does not vastly differ between urban and rural areas, the risk does differ as risk depends on both hazard and exposure and the exposure in urban areas is much higher than exposure in rural areas (Ramsey, 2009). Urban areas are known to experience climate change more extremely than their rural counterparts. Apart from the urban heat island effect, also both the amount and the effects of peak precipitation events are more extreme. In general, the 15 minute and hourly precipitation sum exceeds the higher threshold values relatively more often in urban areas than in rural areas (Overeem, 2014). This is due to the fact that the urban surroundings alter the dynamics and thermodynamics of the atmosphere, which affects both the temperature and the precipitation (Daniels et al., 2016). Thus, especially in urban areas the challenges climate change brings about are huge and range from an increase of heat stress to increased water nuisance during peak precipitation events that are getting more severe (KNMI, 2021; Carter, 2011).

The changing climate of its own is not the only challenge to urban environments, the combination with population growth and urbanisation increases the stress that is put on the urban system (Carter, 2011). Currently, about 74% of the population of the Netherlands lives in an urban area (PBL, 2015). This combination makes that a large part of the Dutch population will experience the negative effects of climate change in urban areas.

In order to make the Netherlands climate adaptive, changes need to be made withing the urban climate to lessen the negative effects of climate change. It is too late now to completely stop the effects of climate change, so the focus needs to partially shift to adaptation. This means that we as a society accept that a certain degree of climate change will happen and change our living environment accordingly so as to not experience too devastating effects. Climate adaptation is an important governance challenge at all spatial and temporal scales (Adger et al., 2001) and the long-term character of climate adaptation forces decisions to be taken at the present time to be prepared for future situations.

The responsibility, therefore, lies not only with the inhabitants, but also largely with the government which can create policies to ensure climate adaptation will be implemented. Whereas mitigation to climate change happens mostly at the global and national level, adaptation mostly concerns local and regional action, with a framework set at the national level (Adger et al., 2001).

1.2 Policy on climate adaptation in the Netherlands

The Dutch national government has several policy documents that serve as guidelines on what challenges the Netherlands faces regarding climate change and what measures they can implement to adapt to the aforementioned change. One of those documents is the *Deltaplan Ruimtelijke Adaptatie* (DPRA) (deltaprogramme spatial adaptation) that has first been introduced in 2018 and has since been integrated in every version of the *Nationaal Deltaprogramma* (Ministerie van Infrastructuur en Waterstaat et al., 2022). The DPRA consists of seven ambitions that should lead to a climate resistant and water robust design of the Netherlands by 2050. The DPRA requires provinces, municipalities, local water authorities and safety regions to together carry out a 'climate stress test' that tests for four categories: 1. Water nuisance, 2. Heat stress, 3. Drought, and 4. Flood risk. This test has first been done in 2018 and is required to be repeated every six years (Ministerie van Infrastructuur en Waterstaat et al., 2022). Based on the results of the stress test, local governments have to develop a climate adaptation plan and strategy to get rid of the bottlenecks that are exposed by the stress test and incorporate climate resilience and water robustness in their governance strategy. However, the stress tests do not provide hard targets for what situations should be avoided at all costs. The results are primarily used as a means to stimulate thinking and acting with climate adaptation in mind (Kennisportaal Klimaatadaptatie, n.d.). Furthermore, the stress standards that are used in the tests, like the extreme precipitation events that are used to analyse water nuisance, are not meant to be the norm to use for spatial design or the design of water systems.

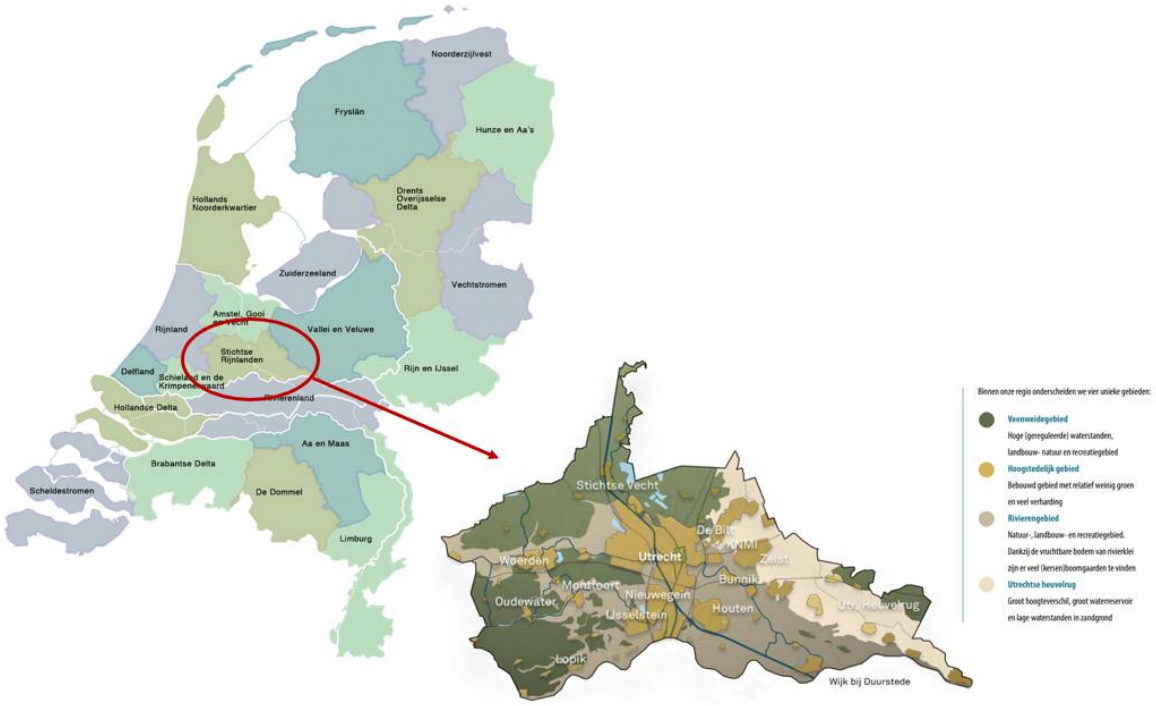
An official government policy that builds upon the DPRA is the *Nationale Adaptatie Strategie* (NAS) which has been created in 2016 according to European Commission guidelines, is a supplementary document to the *Deltaprogramma*. The NAS covers all aspects of climate adaptation and is an overarching Dutch strategy on climate adaptation. It paints a picture of the risks climate change brings about and shows a vision on how to combat these risks. Furthermore, the programme highlights sectors, chains, themes and risks that are not covered in the DPRA.

Where the NAS looks at the country wide challenges, the *Regionale Adaptatie Strategie* (RAS) zooms in on the more local challenges. The goals of the NAS and the RAS are the same: Create a climate resilient and water robust country/region where the area and its inhabitants are adapted to the effects of climate change. Where the documents differ the most is the scale of the posed challenges and proposed measures. Where the NAS sets guidelines for the goals on a national level and is focussed on the role of the national government, the RAS zooms in on a specific region and focusses on the role of the municipalities, water authorities, provinces and safety regions. The RAS connects regional climate- and water related challenges and offers an basis for local, municipal policy (Netwerk Water en Klimaat, 2020).

1.3 Study area regional water authority HDSR

This research zooms in on one particular region in the Netherlands: Region Utrecht Zuidwest. This is done for two reasons, the first is that this area is representative for a larger area of the Netherlands because of its interaction with different landscape types such as low lying peat, river valleys and high laying areas with sandy soils (Netwerk Water en Klimaat, 2020). The second reason is the absence of a framework on how water authorities, municipalities and provinces should collaborate to reach the goals that are set by the DPRA. Birchall et al. (2023) argue that adaptation happens most commonly at the local level through local governments. This is why the municipal and water authority governance levels are the focus of this research.

Region Utrecht Zuidwest consists of 14 municipalities and makes up part of the province of Utrecht and part of water authority HDSR. The entire area can be observed on map 1 (larger version in appendix A). As can be seen on the map, the area is split into four categories: 1. Veenweidegebied (peatlands), 2. Hoogstedelijk gebied (urban area), 3. Rivierengebied (river dominated area), and 4. Utrechtse heuvelrug (hilly area with sandy soils).



Map 1 The study area, Regio Utrecht Zuidwest (adapted from Unie van Waterschappen, n.d. and Netwerk Water & Klimaat, 2020)

Making a distinction between what tasks fall under the authority of the municipality and what tasks fall under the authority of the water authority is difficult because they are mutually dependent on one another and their tasks in urban areas are intertwined. Rainwater discharge that comes from an urban area and is deposited in surface waters shifts very quickly from being a municipal responsibility to being a responsibility of the water authority. This makes a good communication and collaboration between the two governing bodies not only desirable but crucial.

1.4 Problem description, aim and research questions

In the coming decades the amount of houses within the area of HDSR is expected to increase by 120.000 in the scenario with the least population increase, to 330.000 in the scenario with the largest population increase. Most urban development is expected to occur as urban densification until 2070 and urban expansion after 2070. The most prevalent effects on the water system as a result of this urban development are an increase in pressure on water drainage, an increase in drinking water demand and impact on the water quality (HDSR, 2022).
For the regional water authorities a trade-off has to be made between making investment costs upfront to stimulate municipalities to create more blue and green infrastructure, or not making costs now and paying the price (for potential damages) in the coming decades.
Even though it is widely recognised that successful adaptation requires collaboration across multiple scale levels, research mostly focuses either on the municipal or the national level (Dannevig and Aall, 2015). This research sets out to investigate the cooperation between two scale levels, the regional level (water authority) and the local level (municipality), and make a start in filling that knowledge gap.

There are large differences between municipalities, in both budget availability and employee capacity to work on the problem. For the larger municipalities climate adaptation is a separate department and for the smaller municipalities it often falls under an existing department which causes it to become more of an afterthought. This is demonstrated perfectly by the following quote of Özerol et al. (2020) pp. 7: “Due to funding and personnel constraints, climate change adaptation is often part of larger water-related projects, and initiatives remain as ad-hoc or at pilot level.” This also seems to be the case for the study area of the research. There is a wide variety in available budget and available personnel to work on climate adaptation policy ranging from >2.0 FTE in Utrecht to <0.2 FTE in De Bilt, Bunnik, Lopik and Montfoort (personal correspondence with Netwerk Water & Klimaat, 2023). Furthermore, a lack of problem ownership seems to be the most important barrier to action and it is suggested that vagueness of responsibilities is a key barrier to adaptation action (Biesbroek et al., 2010; Carter, 2011; Dovers and Hezri, 2010).

HDSR as of now has no clear overview of what municipalities are actively doing with regards to climate adaptation and which municipalities do have adaptation policy and which do not. Furthermore, the proposed solutions to deal with water nuisance and drought are mostly concentrated on the rural area, because the influence of HDSR is much larger, and too little on what can and should be done in urban areas, even though urban areas can experience a lot nuisance.

The aim of this research is to find out how HDSR can assist municipalities in making urban areas more climate adaptive. Therefore, the main research question that needs to be answered is:

“How can the regional water authority HDSR assist its municipalities in making urban areas more climate adaptive?”

To help answer this question, the following sub-questions will be addressed:

1. What are the main challenges found by each of the 14 municipalities in the urban areas of HDSR through the results of the climate stress test and what is their current adaptation strategy?
2. What are the main obstacles municipalities experience in the creation and implementation of climate adaptation policy and what is the cause of these obstacles?
3. What are the tools available to HDSR and how do these tools relate to the aforementioned gaps in sub-question 2?

1.5 Theory

1.5.1 Dutch water governance

In order to understand the interaction between the different policies and which authority is responsible for each respective policy, it is important to understand the Dutch governmental structure regarding water policies. A broad overview of the existing government structures and how they interact can be seen in figures 1a and 1b.

As can be observed in figure 1a, there are four institutional levels that influence water policy in the Netherlands, starting very broadly at the European level and narrowing down all the way to the municipal level. Each of the different levels has responsibilities and authority related to their scale level. The authorities that carry water management responsibilities in the Netherlands are: the National government, Rijkswaterstaat (National Water Authority in figure 1a), Provinces, Regional Water Authorities, and Municipalities. Figure 1b displays the interaction between regional water authorities and municipalities. Municipalities and regional water authorities have a coordinative and conferral interaction. Responsibilities of municipalities include the collection and transport of waste water, and duties concerning rainwater and groundwater in urban areas. They should take water management into account in their spatial planning practices through the *"watertoets"*, which in short means that if they replace green/blue (nature/water) by grey (build up) surface in one area, they should compensate for that by changing 15% of that surface area from grey to green/blue surface in a different area (OECD, 2014).

Regional water authorities are responsible for regional water systems, flood defence, waste water treatment, and water quality. They are supervised by the province and collaborate with municipalities on urban water management (OECD, 2014).

In urban areas the distinction between the responsibilities of the municipality and the regional water authority is difficult to make. The municipality has the duty to take care of the groundwater level, which means that the municipality has to implement measures to prevent damage caused by groundwater levels that are unfit for the purpose the area is used for (e.g. housing, agriculture, nature area, etc.). In practice, municipalities create an urban groundwater policy and carry this out, however, they are dependent on regional water authorities for the drainage of groundwater surpluses and potentially external water supply in times of drought. The regional water authorities are responsible for regional waters and make water level ordinances. Additionally, they manage the surface water and ground water levels. In urban water management there is also a third actor that has rights and responsibilities, homeowners are responsible for the state of their own house and plot and are responsible for processing rainwater on their plot (Sterk consulting & Colibri advies, 2012: pg 18-19).

As can also be observed in figure 1a and 1b, there are some mismatches between the responsibilities and authority of regional water authorities, municipalities and provinces. These mismatches are mainly noticeable in urban areas where the distinction of who is responsible for which part of the water system is hard to make. For example, the municipalities are responsible for the collection and transport of wastewater, but the regional water authority is responsible for the treatment of the wastewater (Mostert, 2013; OECD, 2014). Furthermore, municipalities are responsible for drainage and infiltration of rainwater in urban areas, which are topics that are also very relevant for water authorities and in which they have high interests (Mostert, 2013).

There is also a difference in political priorities between municipalities and water authorities. The political priorities of municipalities are more short-term focussed and tend to have as motivation the securing of re-election and as a result they opt to favour public opinion over long-term need (Smith

and Mayer, 2018; Wynne, 2010). Water authorities, on the other hand, operate more on the background and tend to have a more long-term vision (Mostert, 2013).

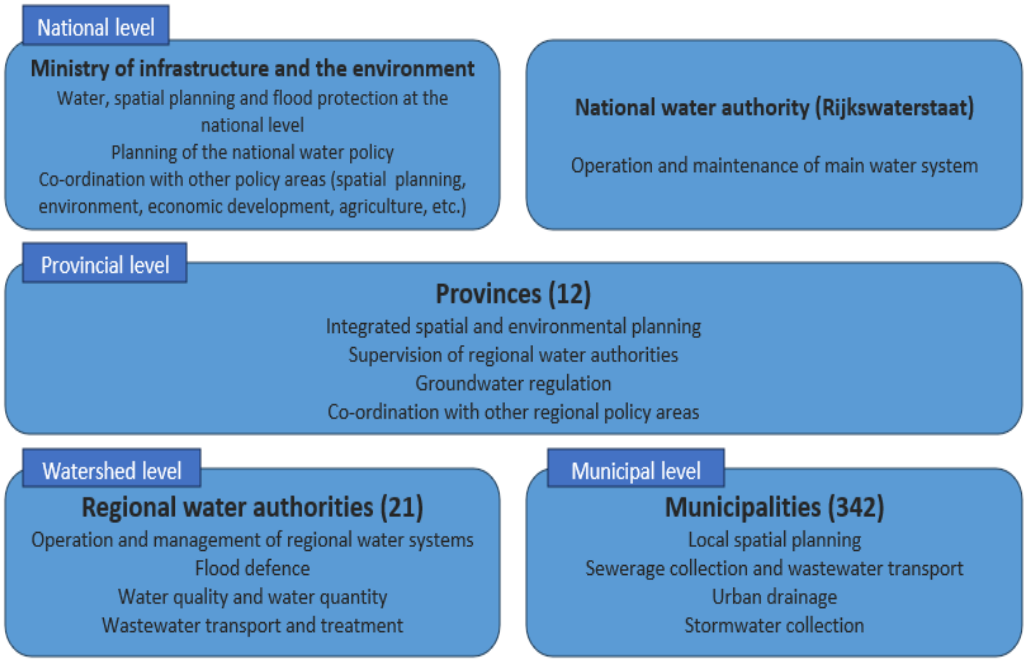
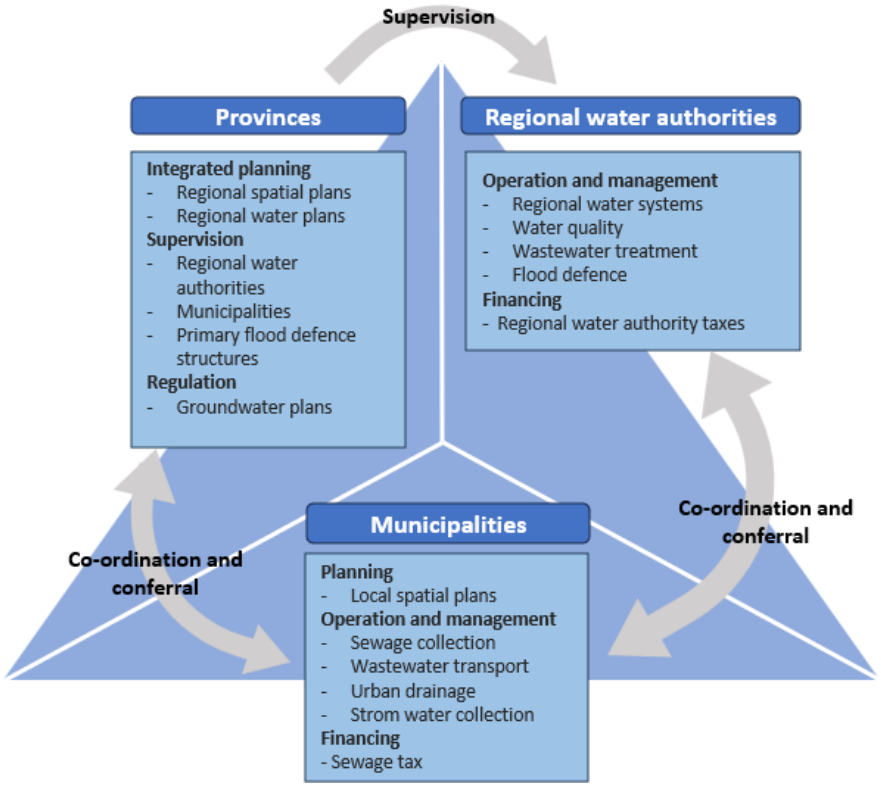


Figure 1 Water governance in the Netherlands.
a) Institutional layers related to water policy in the Netherlands adapted from OECD (2014).



b) The interaction between provinces, Regional water authorities and Municipalities and their respective responsibilities regarding water management adapted from OECD (2014).

1.5.2 Definitions and concepts

The concepts that are used in this research are mostly related to climate change. The first concept is climate adaptation, which in this context is regarded as equipping the urban environment to be able to deal with the extreme weather events caused by climate change. Adaptation is not a single action or approach, and many adaptation plans are now framed around the more general concept of resilience (Birchall et al., 2021; Davoudi et al., 2013).

The IPCC defines resilience as 'the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity of self-organization, and the capacity to adapt to stress and change.' (IPCC, 2007).

Resilient systems differ from an engineering approach to *robust* systems, which rely primarily on hard protective structures (e.g. sea walls) or are designed in ways that emphasize the strength of specific individual components to ensure functionality. Robust systems can consist of both grey infrastructure and green-blue infrastructure, i.e. hard concrete structures and nature based solutions (Chen et al., 2021). *Resilient* systems, in contrast, ensure that functionality is retained and can be rapidly re-instated through system linkages despite some failures or operational disruptions (Bruneau et al., 2003; McBain et al., 2010). Characteristics that are often attributed to resilience include flexibility and diversity, redundancy and modularity, and safe failure (Leichenko, 2011; Ernstson et al, 2010; Andersson, 2006).

Urban climate resilience can be defined based on three elements: systems, agents and institutions. This research will focus on institutions, namely the water authority and municipalities. A resilient urban climate is characterised by being flexible under different conditions. Additionally it should be able to replace certain parts where needed, and be able to absorb sudden shocks to the system. There are three key attributes of urban resilience in relation to climate change, as described by Leichenko (2011). The first one is that climate change is only one of the stressors cities experience and its effects often occur in combination with other effects and stressors such as population growth to which cities should also be resilient. The second attribute is a resilient city should demonstrate certain characteristics, such as flexibility, diversity, adaptive governance and capacity for innovation. The third and last attribute concerns the requirement of urban resilience to be integrated with other plans for urban development.

In this research, a climate adaptive urban area is defined based on the *Staat van je Straat* tool of SWECO (n.d.). This tool labels urban areas based on a scale from A to E, where A (very climate adaptive) is best and E (little climate adaptive) is worst. The tool tests for all four categories of the climate stress test of the DPRA (*delta programma ruimtelijke adaptatie*; delta programme spatial adaptation): water nuisance, drought, heat stress, and flood risk. The full list of indicators that make up the categories and the accompanying values that make up the labels can be seen in appendix B. In this research, a climate adaptive urban area is reached when label B is achieved for each of the respective categories. For flood risk, a broader approach was chosen as the responsibility for the prevention of a flood through a dike breach of the Lekdijk lies fully with the regional water authority, province, and national government. The responsibility for mitigating the consequences of a potential flood, however, does lie with the municipalities and therefore they are responsible for the second and third layer of the multi-layered safety approach (sustainable spatial design of the municipality and a proper preparation for a possible flood (disaster mitigation)) (Van der Most et al., 2013). The presence of evacuation and contingency plans do contribute to the label but it is not clear how (SWECO, n.d.), however, in this research they were still reviewed, as they are essential to have.

2. Methods

2.1 Approach

The first and second sub-questions were answered by doing a thorough review of the policies each municipality has available and by conducting semi structured interviews with each of the municipalities. The semi structured interview format allows for greater flexibility with questioning and enables conversation that progresses over time (Birchall et al., 2006). Semi structured interviews employ a relatively detailed interview guide and can be used when objective knowledge of the subject is present, but subjective knowledge is lacking (Morse & Field, 1995). The framework on which the interview guide is based stems from the analysis of the objective knowledge, in this case the policy document analysis (McIntosh & Morse, 2015). Semi structured interviews are characterised by comparing participants' responses by item. Because all participants are asked the same questions in the same order, the collected data is comparable and quantifiable. The data analysis will consist of two parts, 1. preparing the data for analysis, and 2. conducting the content analysis. Preparing the data for the analysis will happen through transcribing the interviews. It is important that the audio file is transcribed verbatim and not paraphrased. The transcription will be done through Microsoft Office 365 which has an AI tool for transcribing interviews. The transcript was then checked and compared to the tape to ensure reliability, as the accuracy of the programme is not 100% (Huijser & de Liagre Böhl, 2022). The transcripts were then analysed using the narrative approach as done in a similar study by Birchall and Bonnet (2021). During the analysis the relevant key points were identified and categorised. Once all the interviews were analysed the key themes were compared and organised to unify the data within each category and discover emerging themes. The results of the interviews were put into a table that displays the biggest challenges per municipality and in a separate table the main reasons why the gap between policy and action is present.

The fourteen municipalities were categorised (table 1) based on the map of the different soil system areas in map 1 and were compared and contrasted to find out which themes of the DPRA pose the largest problems per area category. Additionally, the size and number of inhabitants per municipality was taken into consideration, because those numbers serve as an indicator of the workload of a municipality. The number of inhabitants is an indicator for the amount of money the municipality receives from taxes and from the national government (Rijksoverheid, n.d.).

Table 1 The categorisation of the 14 municipalities per area type: veenweidegebied (peatland area); Utrechtse heuvelrug (hilly area with sandy soils); Hoogstedelijk gebied (highly urbanised area); and rivierengebied (river dominated area with clay soils). The number of inhabitants and the area size of the municipalities (CBS, 2023) is displayed as well.

Area type	**Municipality**	**Number of inhabitants**	**Area size (in ha)**
Veenweide gebied	Lopik	14.512	7.557
	Montfoort	13.818	3.757
	Oudewater	10.159	3.890
	Woerden	52.882	8.857
	Stichtse Vecht	65.240	9.610
Utrechtse heuvelrug	Zeist	65.987	4.851
	Utrechtse Heuvelrug	49.981	13.201
Hoogstedelijk gebied	Utrecht	361.699	9.383
	Houten	50.323	5.494
	De Bilt	43.508	6.612
	Nieuwegein	64.554	2.351
Rivierengebied	Bunnik	15.590	3.697
	Wijk bij Duurstede	23.921	4.762
	IJsselstein	33.429	2.107

The municipalities were assigned the *Staat van je Straat* label for the current situation (or the situation at the time the climate adaptation policy was created) and for the desired result in 2050. This tool was chosen because the values that belong to the labels are clear and the labels give an easy and quick overview of the situation the municipalities are in. There is variability within the municipalities, especially the larger municipalities. For the purpose of this research the most prevalent label will be chosen and if the distribution between two labels is 50/50, the category were assigned both labels.

The third sub-question was answered through the review of policies that enable HDSR to carry out actions. The main policies that were reviewed are the *Watertoets, Keur/Waterschapsverordening, Landelijke Maatlat*, and the *Afspraken klimaatadaptief bouwen*. To see what policy choices best suit the governing style of HDSR, the NSOB-model (Dutch School for Public Governance) of governing styles was used as shown in figure 2 (Diercks et al., 2020).

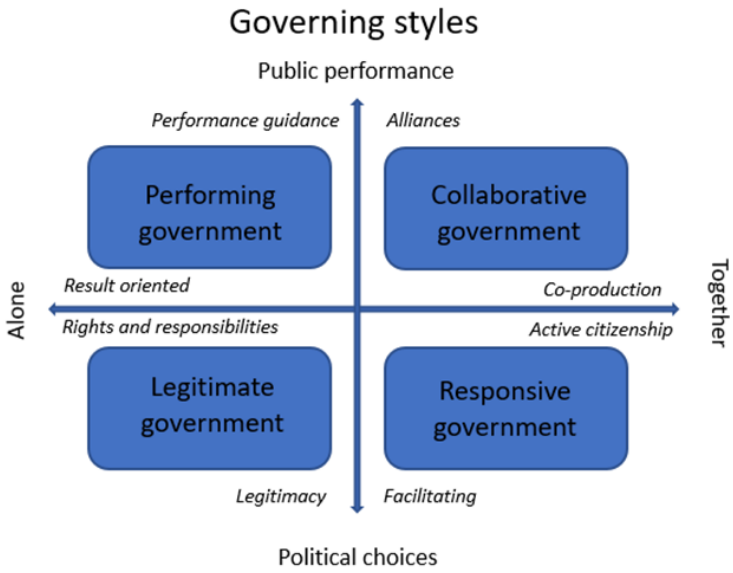


Figure 2 NSOB-model governance styles (adapted from Diercks et al., 2020).

This was then combined by conducting interviews with several HDSR employees to ask what methods and tools are most suitable in different situations. This can give a better overview of what methods and tools are already in use and what/how it can be improved.

2.2 Data collection and analysis

The framework that is used in this research is shown in figure 3. There are two different sides that are included, the municipal side and the side of the water authority. At first, the two sides will be analysed separately after which the insights will be combined and lead to a recommended set of actions HDSR can take to assist municipalities in making urban areas more climate adaptive.

The data was obtained through a qualitative data analysis of official documents regarding climate adaptation plans per municipality and through conducting interviews with municipality representatives. Before conducting the interviews, an interview guide has been created with questions that address their adaptation strategy, how they plan to incorporate that strategy in spatial planning, where the most difficulties occur and how they see the role of HDSR (appendix E). Furthermore, a qualitative document analysis of official documents concerning spatial planning and water laws has been conducted (e.g. *Omgevingswet, waterschapsverordening, watertoets*, etc.).

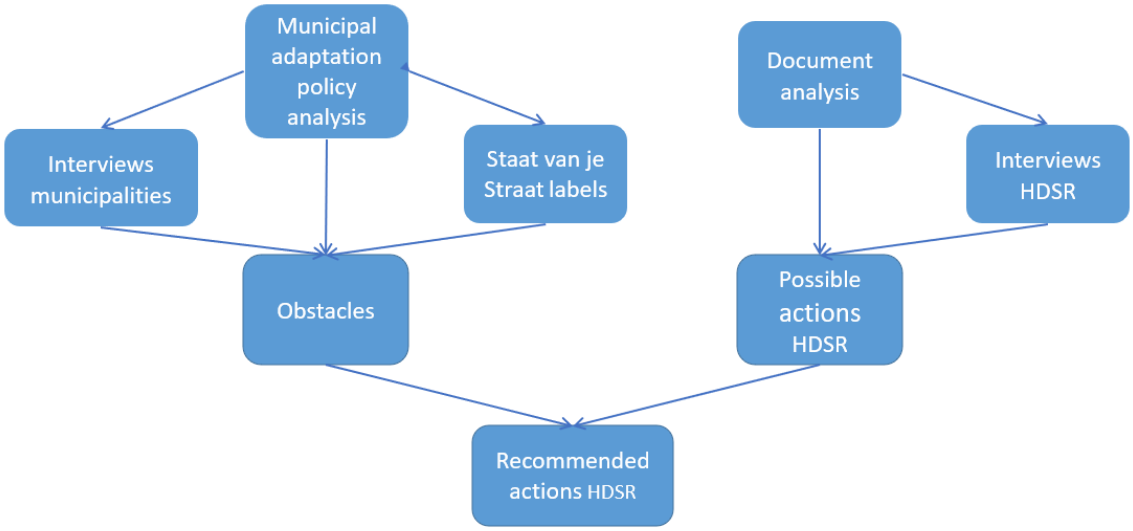


Figure 3 A flowchart showing the data collection and analysis sequence of this research

The data was analysed by using systematic approach for the municipal documents and transcribed interviews for certain keywords and categorises the data. This systematic approach ensures an objective comparison of the fourteen different municipalities.

The qualitative document analysis has been done following the approach of Mayring (2000). There are two possible approaches to qualitative content analysis, inductive and deductive. The inductive approach starts with the determination of data categories and as the data gets analysed new definitions and categories will be formulated. The deductive approach starts with the theoretical based definition of the aspects of analysis, main categories and sub-categories. For this qualitative document analysis no theoretical framework is present, so the inductive approach has been used.

For the analysis of municipal documents a document will be created that contains the current situation, goal situation for 2050 and the strategy on which measures will be implemented to reach the goal.

For the interviews, a summary was made of what is mentioned in the interviews, which was then combined with the documents to create an overview of the current situation, goals, strategy, main obstacles and expected actions of HDSR. For the analysis of the policy documents categories have been made for the different administrative levels and legal status (e.g. binding vs. advisory).

Once the obstacles of the municipalities and the tools and possible actions of HDSR had been identified, the tools were linked to the respective obstacles they could solve or mitigate. Once this has been done, a review was done into the desired course of action of HDSR and what actions best suit their governing style.

2.3 Ethics

Before the interviews, the interviewees have signed an informed consent form. This ensures that the research is in line with GDPR (the general data protection) and the DPA (data protection act). The GDPR has six principles: Lawfulness, purpose limitation, data minimisation, data accuracy, storage limitation, and integrity and confidentiality. The data is be stored in OneDrive as that storage option has a large storage size, the service is provided through Utrecht University. It allows for remote access, and it is a safe option to store sensitive information. The data will be stored for 10 years, as that is the required storage time by Utrecht University (Utrecht University, 2023). The transcription service Microsoft Office 365 that will be used to transcribe the interviews has been approved for the use of sensitive data by the UU (Huijser & de Liagre Böhl, 2022).

3. Results

3.1 Adaptation policy and strategy

3.1.1 Adaptation policy

Not all fourteen municipalities have a local adaptation strategy (LAS) or other clear climate adaptation policy documents, only eight of the fourteen municipalities have a clear climate adaptation document and plan on how to become climate adaptive by 2050 (table 2). Additionally, of the six municipalities without a LAS, only one, Stichtse Vecht, has translated all the results from the climate stress tests from the regional level to the local level (interview G). All municipalities have used the RAS (regional adaptation policy) and the *afspraken klimaatadaptief bouwen* (agreements climate adaptive construction) as umbrella policy documents for their LAS or other climate adaptation policy. The eight municipalities with a LAS have also conducted risk dialogues with relevant stakeholders and experts before creating policy on the municipal level (interviews A, B, E, F, I, K and M).

Two of the municipalities without a LAS, IJsselstein and Wijk bij Duurstede, are currently working on the creation of one and expect it to be ready sometime during the second half of 2023 (interviews C and L).

Table 2 The available policy with regards to climate adaptation in the municipalities. If a Local Adaptation Strategy is available, the other documents are not included as all relevant information is available in the LAS. The policy categories are: Local adaptation Strategy; omgevingsvisie/Integrated vison of public space; and municipal sewage plan/water and sewage plan.

Municipality	**Climate adaptation documents**		
	LAS	**Omgevingsvisie/IVOR**	**GRP/WRP**
Bunnik			x
De Bilt	x		
Houten	x		
IJsselstein		x	x
Lopik		x	x
Montfoort		x	x
Nieuwegein	x		
Oudewater	x		
Stichtse Vecht			x
Utrecht	x		
Utrechtse Heuvelrug	x		
Wijk bij Duurstede			x
Woerden	x		
Zeist	x		
Total	**8**	**3**	**6**

The eight municipalities with a LAS also have an accompanying execution agenda that gives a clear overview of what measures will be implemented and when. Houten, Oudewater, Utrecht, Utrechtse Heuvelrug and Woerden have an execution agenda that is set until 2050 (documents D, E, G, H and J) and De Bilt, Nieuwegein and Zeist have one for five years, after which it will be updated with the results of the new stress tests as input (documents A, B and F). Of the six mu nicipalities without a LAS, two do have an execution agenda: IJsselstein and Montfoort (interviews C and H).

The municipalities that only have a GRP/WRP (municipal sewage plan/water and sewage plan) focus on the themes water nuisance and drought of the DPRA (table 6) (documents C, K, L, M and N). The reason given is that the GRP/WRP only includes policy and measures on the topic of water with the main focus being the prevention of water nuisance, so heat stress is not included in the document.

Furthermore, the GRP/WRP is written by a third party in all municipalities, with the exception of Utrecht, that is specialised in water and sewage related topics and does not have expertise knowledge on the topic of heat stress (interviews B, G and H). The three municipalities that have integrally included climate adaptation in the *omgevingsvisie* also have a vision on how to create more green within the municipality, but the link to combating heat stress is not explicitly made (documents L, M, and N).

In order to get a clear overview of the climate adaptation tasks of the municipalities in order to reach their own climate adaptation goals, the current street labels and goal labels for 2050 are shown in tables 3 and 4.

In table 3, the current *'Staat van je straat'* labels are displayed. Only four municipalities use the SWECO tool: Zeist, De Bilt, Oudewater and Woerden (documents A, B, H and J). The labels for the other ten municipalities are an estimation based on the values mentioned in either the LAS or other policy documents (in italics in table 2). For the municipalities Bunnik, Lopik and Montfoort, there are no data available for the themes heat stress and drought, so no estimations of labels could be made (documents K, M and N).

Table 3 The current climate labels of the municipalities per theme of the DPRA; labels in italics are an estimation based on values mentioned in the LAS, omgevingsvisie or GRP/WRP. When two labels are assigned, the distribution of the labels across the area of the municipality is roughly equal in size.

Municipality	**DPRA Theme**			
	water nuisance	**heat stress**	**drought**	**flood risk**
Bunnik	*C*	*C/D*	?	*C*
De Bilt	C	D/E	D	A/C
Houten	*B/C*	*B/C*	*B*	*C*
IJsselstein	*C*	*C/D*	*B*	*C*
Lopik	*C*	*C/D*	?	C
Montfoort	*C*	*C*	?	*C*
Nieuwegein	*B/C*	*C*	*B*	*C*
Oudewater	C	C/D	C	C
Stichtse Vecht	*C*	*C*	*C*	*C*
Utrecht	*C*	*D/E*	*B*	*C*
Utrechtse Heuvelrug	*B/C*	*B/C*	*D*	*A/C*
Wijk bij Duurstede	*C*	*C/D*	*B*	*C*
Woerden	C	D	C	E
Zeist	B/C	B/C	C	A/C

For the theme water nuisance, almost all municipalities score a C or are split between B and C. There are four municipalities that border label B, those municipalities have a largely robust water system, but experience some bottlenecks that result in nuisance during rainfall of 50mm/h (label C). Those bottlenecks are often located in lower lying paved areas which the water flows towards, such as tunnels.

For heat stress a geographical distinction can be made between the municipalities located on the Utrechtse Heuvelrug and the municipalities in the Hoogstedelijk gebied and Veenweide gebied (map 1), with the municipalities on the Utrechtse Heuvelrug, Utrechtse Heuvelrug and Zeist, scoring B/C and the municipalities in the *Hoogstedelijk gebied* and *Veenweide gebied*, Woerden and Utrecht, scoring D or E.

The labels for drought range from B to D with the worst labels occurring either in municipalities located on sandy soils in the east, e.g. De Bilt and Utrechtse Heuvelrug; or on peaty soils in the west, e.g.

Woerden and Oudewater. The effects of drought differ between the areas, with the municipalities on sandy soils experiencing desiccation of green, and the municipalities situated on peaty soils experiencing subsidence.

For the theme flood risk, most municipalities score a C. There are a few municipalities that are split between label A and C, this is based on the geographical locations of certain neighbourhoods within those municipalities and the elevation differences within the municipality.

*Table 4 The goal labels of the municipalities for 2050 per theme of the DPRA; * = existing area, ** = new construction, labels in italics are an estimation based on values mentioned in the LAS of the respective municipalities*

Municipality	**DPRA Theme**			
	water nuisance	**heat stress**	**drought**	**flood risk**
Bunnik	*C*	-	-	-
De Bilt	A*/B**	C	C	C
Houten	*B*	*B/C*	*B*	*C*
IJsselstein	-	-	-	-
Lopik	*B*	-	-	-
Montfoort	-	-	-	-
Nieuwegein	*B*	*B/C*	*B*	*C*
Oudewater	B	B*/C**	A*/B**	C
Stichtse Vecht	*B*	*B*	-	-
Utrecht	*B*	*C*	*B*	*C*
Utrechtse Heuvelrug	*B*	*B*	*C*	*C*
Wijk bij Duurstede	*B*	-	-	-
Woerden	A*/B**	B*/C**	A*/B**	C
Zeist	B	B	C	A

Table 4 shows the goal labels for 2050 (2040 in the case of Houten) of the eight municipalities with a LAS, for the municipalities without a LAS it was not possible to make an estimation for themes other than water nuisance, as those municipalities do not yet have a vision for 2050. As can be seen in the table, label B and C are the most prevalent.

For water nuisance, all municipalities want to obtain label B, except for Woerden, which wants to obtain label A for new construction projects (document J). The municipalities decided not to choose label A, because the extra amount of money needed to carry out measures would be disproportionate to the extra benefits generated by obtaining label A.

For heat stress, each municipality aims for label B or C. It is important to note that heat stress is scored based on temperature relative to the surrounding rural area, shade percentage and distance to a cool area, so whereas climate change might cause the absolute temperature to increase, the label will not be affected by that. The municipalities Woerden and Oudewater have made a distinction between new construction and already existing urban areas (documents H and J). This has been done because it is more feasible to obtain a higher label in new construction, as heat stress can be taken into account during the design process, this, however, is not possible to do in already existing urban areas. Utrechtse Heuvelrug and Zeist are the only two municipalities that aim to obtain label B (documents A and D). From the interviews with those municipalities it became prevalent that the aim for label B stems from the green character of the municipality. They are both situated on or right on the edge of the Utrechtse Heuvelrug, which provides a cooling effect that can be utilised. Furthermore, these municipalities

already score label B/C (table 3) so only minor changes need to be made to obtain label B. The municipalities that aim for label C mentioned in interviews that C is the highest label that can be reached with the amount of public space that is available to restructure (interviews B, E, F, K and M).

The range in goal labels for drought is larger than for the other themes. This is can partially be explained by the fact that there is a large difference in soil types between the municipalities. The municipalities with sandy soils experience more desiccation of greenery and even with climate adaptation measures this is hard to combat, as drought will become more extreme in both intensity and duration in the future. For this reason De Bilt, Utrechtse Heuvelrug and Zeist aim to obtain label C (documents A, B and D). The municipalities that are located on clay and peat soils aim for label B or, in the case of Oudewater and Woerden, label A for new construction (documents B, E, G, H and J).

The goal for flood risk is label C in almost all municipalities, with the exception of Zeist, where the goal is label A. For this category, the measures that municipalities can take is to employ proper spatial planning (layer 2) and create an evacuation and contingency plan (layer 3) of multilayered safety. As can be seen in table 5, the third layer is present in every municipal policy, whereas the second layer is missing in five municipalities (documents A to N).

Table 5 The presence of the second layer (spatial planning regulations) and the third layer (contingency- and evaluation plans) of the Meerlaagseveiligheid (multilayered safety)

Municipality	**Spatial planning regulations (layer 2)**	**Contingency- and evacuation plans (layer 3)**
Bunnik		x
De Bilt	x	x
Houten	x	x
IJsselstein		x
Lopik		x
Montfoort		x
Nieuwegein	x	x
Oudewater	x	x
Stichtse Vecht	x	x
Utrecht	x	x
Utrechtse Heuvelrug	x	x
Wijk bij Duurstede		x
Woerden	x	x
Zeist	x	x

Table 6 The themes of the Deltaprogramma Ruimtelijke Adaptatie that are present in climate adaptation policy

Municipality	**DPRA Theme**			
	water nuisance	**heat stress**	**drought**	**flood risk**
Bunnik	x			
De Bilt	x	x	x	x
Houten	x	x	x	x
IJsselstein	x		x	
Lopik	x			
Montfoort	x		x	
Nieuwegein	x	x	x	x
Oudewater	x	x	x	x
Stichtse Vecht	x			x
Utrecht	x	x	x	x
Utrechtse Heuvelrug	x	x	x	x
Wijk bij Duurstede	x			
Woerden	x	x	x	x
Zeist	x	x	x	x
Total	**14**	**9**	**10**	**9**

The distribution of attention between the four different themes is not equal among the municipalities (table 6). The focal point of adaptation policy is based on the problems each municipality experiences most. The east side of the study area that contains some elevation differences and has mostly sandy soils experiences more problems as a result of drought than the lower lying west side which has mostly peat and clay soils. On the topic of water nuisance the pattern is reversed, as the west side of the study area experiences more problems and difficulties in the creation of suitable measures because of the high groundwater levels and the poor infiltration capacity of the soils. Heat stress is mostly experienced in municipalities with larger urban centres such as Utrecht, Houten and De Bilt. Several municipalities mentioned in the interviews that heat stress is not prevalent and that the effects of the urban heat island do not occur in the urban centres as a result of either having a very small paved surface and a green and water rich surrounding area to provide a cooling effect, or having a lot of trees in the urban areas to provide a sufficient amount of shade. However, the claims regarding heat stress of the municipalities Lopik, Wijk bij Duurstede and Montfoort are not backed by actual data (documents C, M and N).

3.1.2 Adaptation strategy

The adaptation strategy that is mentioned most often across the interviews is the principle of '*meekoppelen*', which means that climate adaptation measures are carried out during other restructuring projects (interviews A to M). This happens due to a variety of reasons, but the most mentioned ones are that it costs a lot less money and that it only causes a disruption to public space once instead of multiple times which decreases the nuisance to inhabitants (interviews A, B, E, I ,K and M). The most popular *meekoppel* measures are the detachment of rainwater from the mixed sewer system during sewer replacement activities. The aforementioned benefits are very large, but there are also some drawbacks attached to this strategy. The main disadvantage is that the execution is fully dependent on the sewage restructuring projects, which in some cases are not planned for another twenty years because the average lifespan of sewage pipes is quite long (interviews B, F, K and M).

Another strategy that is applied by many municipalities is making subsidies available to inhabitants to stimulate them to take measures on their own plots. In urban areas there is a lot of space that the municipality cannot take measures because that space is privately owned by homeowners, housing corporations, or businesses. In order to involve those private actors in the adaptation process so as to be able to reach the goals of the LAS, several municipalities have made subsidies available for a variety of measures such as replacing paved surface by green surface, detaching the rain pipe from the sewer system, the installation of green roofs and the creation of façade gardens (interviews B, E, F, G, I K and L).

The budget for climate adaptation measures is mostly made available from the GRP/WRP. However, as the GRP/WRP only covers water related measures, heat stress is not covered by that budget. Measures to combat heat stress are mostly financed from the greenery management plan in municipalities that do have budget available for heat stress. Some municipalities have a detailed financing paragraph with budgets assigned to specific measures, whereas other municipalities have a broadly labelled budget for climate adaptation that they can use on climate adaptation as they see fit. Most municipalities also have a separate budget specifically available for subsidies for citizens, and information campaigns to increase citizen participation.

3.2 The main identified obstacles

Through the interviews with the 14 municipalities five main challenges with regards to climate adaptation policy creation and implementation became apparent. These challenges/obstacles are displayed in table 7.

Table 7 The obstacles mentioned in interviews and a description of what the obstacle contains

Obstacle	Description
Budget	All financial aspects, amongst which the budget available for projects, but also the budget available for employees
Capacity	The amount of employees, and the amount of employees with specific and sufficient knowledge on the topic of climate adaptation
Space availability	The above and below ground room that is available for adaptation measures; for example, the planting of trees is not possible in some location because of the below ground infrastructure of cables and pipes.
Citizen participation	The willingness of citizens to take measures on their private property like removing tiles from their gardens and implementing green roofs, but also their acceptance of adaptation measures in public space as unaccepting citizens can cause delays in adaptation measures
Uncertainty of requirements	Uncertainty of which requirements need to be met exactly. This is mainly due to the different requirements and threshold values that are mentioned in different government documents

The obstacles are mostly self-explanatory, however, uncertainty of requirements requires an additional explanation. The letter *Water en Bodem sturend*, for example, mentions different threshold values than the *convenant klimaatadaptief bouwen* Utrecht and the new *landelijke maatlat klimaatadaptatie*, which causes confusion and, in the case of Wijk bij Duurstede, IJsselstein and Bunnik, delays in the creation of municipal policy.

Table 8 The obstacles with regards to climate adaptation mentioned in the interviews with municipality representatives

Municipality	**Mentioned obstacles in climate adaptation policy creation and implementation**					
	Budget	**Capacity**	**Space availability**	**Citizen participation**	**Uncertainty of requirements**	**Total**
Bunnik	x	x			x	3
De Bilt		x				1
Houten				x		1
IJsselstein	x	x				2
Lopik	x	x			x	3
Montfoort		x				1
Nieuwegein		x				1
Oudewater			x			1
Stichtse Vecht		x				1
Utrecht		x	x	x		3
Utrechtse Heuvelrug				x		1
Wijk bij Duurstede	x	x			x	3
Woerden			x			1
Zeist			x	x		2
Total	4	9	4	4	3	

Table 8 displays the experienced obstacles for each municipality. Lack of capacity is mentioned most often, eight times, as an obstacle to climate adaptation policy creation and implementation (table 8). The capacity problems leave municipalities vulnerable, as the representative of De Bilt put it “if I leave or am incapacitated, all expertise knowledge within the municipality is gone” (interview F). A representative of Stichtse Vecht mentioned: “We have the budget for climate adaptation, but we do not have the capacity to realise all our ambitions, so we have had to lower our budget because we have been unable to spend all the money accordingly.” (interview G).

The other obstacles are mentioned by fewer municipalities and are more spread out over the municipalities. Three of the smaller municipalities, Lopik, Bunnik and Wijk bij Duurstede, have mentioned the most obstacles in the interview and also that all mentioned the same obstacles: budget, capacity and uncertainty of requirements (interviews D, J and L). A distinction in the severity of the problems within those municipalities can be made. Lopik does not experience many negative effects as a result of climate change in urban areas, as the municipality only has a few and very small urban centres (interview J). These aforementioned reasons result in the fact that the municipal board does not make money and personnel available for the sole purpose of climate adaptation. Whereas the municipal board of Lopik does not see the necessity, the representative of Bunnik does see the urgency in their municipality, but they simply have too little resources to do anything about it. The topic of climate adaptation is spread out over already existing functions which means that different people are responsible for different themes of the DPRA and they collaborate where possible, but it does not always work out well and they do not have a clear overview of what the others are working on. The capacity problems in Bunnik are so severe that the municipality does not even have the time to apply for subsidies, which in turn causes the budgetary problems to increase (interview D).

The obstacle ‘space availability’ is mentioned by four municipalities: Oudewater, Utrecht, Woerden and Zeist (interviews A and K). Utrecht mentioned that to reach the desired label for heat stress about one

third of the currently paved area needs to be transformed to green space, which would mean a severe decrease in parking spots or other amenities (interview M). The acceptance of decreasing the amount of parking spots or other disturbance of public space is very low, which makes it hard to carry out these measures.

The problem of citizen participation is mentioned in municipalities that already do have clear policy for public space, but now struggle to get their inhabitants on board. Houten, Utrecht and Utrechtse Heuvelrug all have subsidies available to incentivise citizens to take adaptation measures in their gardens (interviews E, I and M). This works well but there is also some resistance to the more ambitious projects that are planned for public space. Houten and Utrechtse Heuvelrug have mentioned that some proposed measures, such as green-blue playgrounds and parking spaces paved with grass tiles generates some resistance from inhabitants because they fear they might get dirty when it is muddy (interviews E and I). Zeist does not have subsidies available to stimulate citizens, which stems from capacity problems because they do not have the capacity to handle the subsidy requests and they fear that the benefits will not outweigh the costs (interview A).

One last obstacle that has been mentioned by Utrecht is the time horizon of 2050. In a municipality the size of Utrecht not every neighbourhood will be restructured before 2050 which makes it harder to use *meekoppel* opportunities and carrying out climate adaptation measures in and of itself is too expensive. Additionally, the lifespan of the current sewer system and other infrastructure in some cases exceeds 2050 which causes replacement work to take place after 2050 (interview M).

3.3 Available tools and their link to the main obstacles

An overview of the relevant policy documents on climate adaptation in urban areas is depicted in table 9 below. There are four different scale levels present in the standard setting of climate adaptation values: national, provincial, municipal and the water authority level. In the Netherlands the subsidiarity principle is used, which means that the national government is only used when necessary and the local governments are used when possible. This also applies to climate adaptation policy, where certain requirements and demands are set on the national level, but local governments have the ability to customise policy to fit their area characteristics.

Table 9 Policy documents that include climate adaptation in urban areas, their scale level, contents, legal status and application

Policy	Scale level	Summary	Legal status
Omgevingswet	National	A legal document that sets values for air quality, water quality (both surface and groundwater), swim water quality, and water safety.	Binding
Landelijke maatlat	National	National agreement on how to implement climate adaptation policy and measures in the urban environment, works with system requirements and measure requirements	Not binding (yet)
Afspraken klimaatadaptief bouwen	Provincial	Agreement between province, municipalities, water authorities and project developers in the province Utrecht on requirements buildings and neighbourhoods have to meet, concerns all four themes of the DPRA	Not binding (yet)
Omgevings-verordening	Provincial	A legal document that sets certain values the physical living environment needs to meet. This also concerns water quality and water safety	Binding
Omgevingsplan	Municipal	A document that sets certain environmental values that the physical living environment has to meet, there can be some overlap with the *omgevingsverordening* of the province and the *waterschapsverordening*	Binding
Keur/ waterschaps-verordening	Water authority	Legal framework, sets requirements municipalities have to meet on the topic of water storage and infiltration mostly	Binding
Handboek water in ruimtelijke plannen	Water authority	Serves as a guide to municipalities, project developers and consultancy agencies on how to include water management in spatial development	Advisory
Watertoets	Water authority	A test that is carried out by the water authority to approve or deny development proposals based on how water management is incorporated	Binding

The main policy available to the water authority to enforce climate adaptation measures in urban areas is the *Waterschapsverordening/Keur* (water authority ordinance) (HDSR, 2023a). The *waterschapsverordening* will go into force on January 1st 2024, which will be an updated version of the *Keur,* and the *waterschapsverordening* will include the new *Omgevingsvisie/wet* (environment vision/law) (Rijksoverheid, 2020) that is coordinated with the provincial *omgevingsverordening* and the municipal *omgevingsplan* (TROWA, 2019). HDSR currently works with a *Keur* and is still in the process of creating a *waterschapsverordening* (interview N).

Another document that is particularly relevant for urban areas is the *afspraken klimaatadaptief bouwen Utrecht* (agreement climate adaptive construction Utrecht) (Provincie Utrecht, n.d.), henceforth called the *bouwconvenant* (construction covenant). This is an agreement between the

province Utrecht, municipalities located within the province, the three water authorities that operate in the province and project developers on how to incorporate the four themes of the DPRA plus land subsidence and biodiversity in construction projects. The *landelijke maatlat* is based on the *bouwconvenant*, but operates on the national level instead of the provincial level (Valkenburg et al., 2022).

Water authorities can adopt an agenda-setting and advisory role on topics outside the frame they usually operate in (where water authorities have no jurisdiction), however, they cannot enforce this in the *Keur/waterschapsverordening.* HDSR can include standards for water nuisance and drought in the *waterschapsverordening* and, once it is in force, municipalities and project developers are required to meet those standards. Currently, there are no hard standards in the *Keur* apart from the compensation rule which entails that for new development of >500m^2 an area 15% of the size in new surface water needs to be created (HDSR, 2019). This might, however, change once the *waterschapsverordening* goes into force.

HDSR has self-assigned their approach on the different themes of the DPRA (table 10), which is enforcing on the theme they have jurisdiction over; advising on the themes that they cannot legally set requirements for, but do have an interest in; and agenda-setting on the theme they have least interest in and control over.

Table 10 The four themes of the Delta programme spatial adaptation and the approach HDSR adopts for each of the themes in urban areas

DPRA theme	Approach/role HDSR
Water nuisance	Enforcing
Drought	Advisory
Heat stress	Agenda-setting
Flood risk (consequence mitigation)	Advisory

HDSR adopts a stimulating and facilitating strategy in their interactions with municipalities rather than a proactive and enforcing strategy. This is apparent from the presence of the *Handboek Water in Ruimtelijke Plannen* (guide water in spatial plans) (Vissers et al., 2023), which informs municipalities, project developers and consultancy agencies on how to include the requirements of the *Omgevingswet, Watertoets, Bouwconvenant* and *Landelijke Maatlat* in spatial developments. Furthermore, their strategy is visible through their presence and role they play within *Netwerk Water & Klimaat* (water and climate network) which includes 14 municipalities, the province, safety region Utrecht, and HDSR. The goal of this network is to make the region Utrecht Zuidwest climate proof and water robust so as to be able to still be an attractive region to live in by 2050. Through this network HDSR is an approachable entity for municipalities if they have water related questions. Several of the municipalities within the network have mentioned, however, that they would like to see HDSR take on a more proactive role and be the driving force on the topic of climate adaptation (interviews D, E, I and J).

Another tool that is available to HDSR is the provision of budget for climate adaptation measures to municipalities. HDSR currently works with the impulse arrangement, which provides municipalities with funding for projects that improve the water quantity and/or the water quality. Officially, the impulse arrangement is not a subsidy because subsidies include a strict set of requirements and the impulse arrangement leaves more room for customisation. The total amount of money that has been allocated in 2023 is €1.475.000 which has been spread over 26 projects (HDSR, 2023b) and the total amount that was requested by municipalities was €2.700.000 (interview O). The arrangement funds a maximum of 50% of the total project costs, the other part is funded by the municipality, which makes

the arrangement have a multiplier effect. In order to be considered for the impulse arrangement, projects have to contribute to the water quality and ecology in urban areas; decrease the effects of extreme rainfall events, long periods of drought and heat in urban areas; or increase the awareness of the importance of water among citizens (HDSR, n.d. a). There is no specific theme of the DPRA that the money has to be spend on, as long as it is in some way related to water, so it can also be used for measures combatting heat stress (interview O).

3.3.1 Linking tools to obstacles

Budget

The tool that best links to the financial problems of the municipalities is the available budget through the impulse arrangement. Furthermore, HDSR has subsidies available for homeowners to take climate adaptive measures on their plot, such as detaching rainwater from the sewer and the creation of green roofs.

Capacity

The capacity problems of the municipalities can be alleviated through the availability of personnel and expertise knowledge of the water authority. This strategy has already partially been used by De Bilt, who hired an employee of HDSR to help in the creation of their LAS (interview F). The same could be done by other municipalities that are still in need of an adaptation policy. Furthermore, the expertise knowledge available at HDSR can help municipalities with the decision of which measures to take and at which location those will be most effective.

Space availability

There is no clear tool that links to this obstacle. However, through policy HDSR already demands a compensation of 15% for every increase in paved surface during urban restructuring projects through the *watertoets* (Vissers et al., 2023). Additionally, HDSR can use the knowledge they have on how to optimally use space and include the water interests. They can take on an advisory role on topics such as drought resistant greenery, which roots do not take up much space in the subsoil.

Citizen participation

Through the *hemelwaterverordening* (rainwater ordinance) municipalities can require citizens to store and infiltrate a certain amount of water on their plot. It is not a popular move and none of the municipalities in this research uses it because it is almost impossible to enforce (interview G). Furthermore, municipalities have indicated that they would rather facilitate and stimulate citizens to take action themselves than to create even more rules (interviews A, G, I).
HDSR has the possibility to share knowledge on how they stimulate citizen participation, how to successfully detach houses from the sewer system, and other adaptation strategies that have been used by the different municipalities within their management area.

Uncertainty of requirements

By creating clear and consistent policy that corroborates with policy from the national and provincial governments, HDSR can increase the clarity for municipalities of what standards they are required to meet. HDSR has already taken the first step by creating the *Handboek water in ruimtelijke plannen* where the requirements and desired goals are listed per theme of the *landelijke maatlat*. Furthermore, HDSR can collaborate with municipalities in creating the *omgevingsvisie* to attune it to the *waterschapsverordening* and thereby match the requirements set in both documents.

4. Discussion

4.1 Most pressing problems of municipalities

Only eight out of the fourteen municipalities in the study area within Hoogheemraadschap De Stichtse Rijnlanden do have a LAS (local adaptation strategy) and the other six currently have included climate adaptation in another municipal policy document. This has made it impossible to assign *Staat van je Straat* labels to all municipalities for every theme of the DPRA (*Deltaprogramma Ruimtelijke Adapatatie*).

For three municipalities, Bunnik, Lopik and Montfoort, it has not been possible to assign a label to the category drought because there was no data available in policy documents. That theme, together with heat stress, has the most ambiguous standards and is the hardest to monitor, which is also given as a reason by Bunnik and Montfoort for the absence of those themes in their policy. Furthermore, there is no clear place in policy for those two themes, whereas water nuisance and flood risk is included in the GRP/WRP (municipal sewage plan/water and sewage plan), there is no such document for heat stress and drought. Because data on water nuisance has been included in the GRP/WRP everywhere, it has been possible to assign a label to all fourteen municipalities.

Currently most municipalities score a C or a B/C on the water nuisance topic. This is mainly a result of the percentage of paved surface that hinders infiltration. This is close to the goal label for all municipalities. However, all the 'low hanging fruit' has already been picked, so while all the straightforward and easy measures have already been taken, HDSR can assist in the last steps that are necessary to reach the goal. The main reason that the theme water nuisance is already close to the goal label in most municipalities is that it has been the main focus of policy and measures for most municipalities and because measures regarding water nuisance are relatively easy to implement and finance. The budget for measures regarding water nuisance is made available through the levy of the municipal sewer tax. This enables municipalities to precisely budget sewer replacements, the creation of wadis and other buffer locations, and other measures regarding the holding, infiltration and drainage of excessive rainwater. A positive spill-over effect of many measures that decrease water nuisance is that they also combat drought.

It is interesting to see how the different goal labels of the different themes are geographically distributed across the study area. The goals for water nuisance do not differ much between the fourteen municipalities, but the differences in goals for drought and heat stress are more prominent. The municipalities in the eastern part of the study area that are located on the Utrechtse Heuvelrug have higher goal labels for heat stress (label B), which is mainly due to the fact that those municipalities (Utrechtse Heuvelrug and Zeist) have a lot of greenery and already have label C, and the effort to reach label B is manageable and affordable. For drought, the geographical distribution is less easy to make because the area categories, as mentioned in paragraph 2.1, experience different drought related problems. The drought related problems in the Utrechtse Heuvelrug area mainly concern desiccation of green, whereas the *Veenweide gebied* experiences more subsidence related problems. This distribution is also found in studies by Brakkee et al. (2022) and Costa et al. (2020). Furthermore, the municipalities that are located on sandy soils, De Bilt, Utrechtse Heuvelrug and Zeist, have low groundwater levels and large elevation differences, which makes it harder to combat drought related problems. The *Rivierengebied* and *Hoogstedelijk gebied* experience less drought related problems because of the water supply from the different rivers that cross the area. At the same time, this leaves those municipalities vulnerable because if water supply from one of those rivers cannot be ensured, there will be water shortages and accompanying drought related problems, which corresponds with the findings of Sterk consulting & Colibri advies (2012).

Another interesting aspect that becomes evident from the results is that the larger municipalities in the study area (>40.000 inhabitants) have a LAS (local adaptation strategy), with the exception of Stichtse Vecht; and the smaller municipalities (<40.000 inhabitants) generally do not have a LAS, with the exception of Oudewater. This is both due to the fact that larger municipalities have more personnel and financial resources available to create a LAS themselves, or to outsource it to a consultancy firm. These findings correspond with the findings of Mees et al. (2018) who found that larger municipalities are more likely to have an adaptation strategy than smaller municipalities.

4.2 Policy

The fact that not every municipality in the management area of HDSR has a LAS or other clear climate adaptation policy document indicates that there still is a long way to go to reach the goal of being climate adaptive by 2050 because without clear cut policy, it is difficult to carry out measures. The analysis to map the challenges of the municipalities, the climate stress test, has been used as input for adaptation policy. However, the stress tests in their current form deliver too little detailed information to municipalities to clearly show the bottlenecks on the local level and in order to gain a clear overview of the locations that might cause trouble in the future, that translation needs to be made by the municipalities themselves. Only one of the six municipalities without a LAS has made the translation to the local level (Stichtse Vecht). The other five have not done this yet, mainly due to budgetary and capacity constraints. They do not have the time and/or knowledge to create a LAS and they do not have the budget to outsource it either. Lopik and Stichtse Vecht have also indicated that they do not see the immediate necessity of a LAS, for Stichtse Vecht because climate adaptation measures are integrally included in the GRP and *omgevingsvisie,* and for Lopik because it does not experience direct negative effects as a result of climate change. The attitude of Lopik suits the description of the 'local government paradox' to climate adaptation by Berke and Ward (2013), where local governments do not implement strong plans to reduce risk despite the loss that would result from inaction. This lack of action is not due to lack of scientific and technological knowledge, but rather due to the low priority it holds among local government officials. Research by Mees et al. (2018) found lack of urgency to be a key barrier in municipal climate adaptation policy in the Netherlands. This phenomenon is not limited to the Netherlands, but proves to be a problem in many different locations around the world (e.g. Canada, Australia, United States) (Lyles et al., 2018; Berrang-Ford et al., 2011; Measham et al., 2011).

An interesting conflict of interest between municipalities and the water authority on the use of buffers came up during the interviews, as the municipality Utrecht has mentioned that they prioritise infiltration over the drainage of buffers, even if that takes more than 60 hours, which has been set by the water authority as the maximum time a buffer can be full. Utrecht sees drought as a larger problem than water nuisance and therefore they disagree with the HDSR on this issue. This difference in priorities challenges HDSR to be flexible and possibly make some compromises with municipalities in order to reach the desired result. This might however change once the legal status of the *landelijke maatlat* changes because then it is not a guideline anymore for buffers to be available again after 60 hours, but a requirement. The official ratification of the *landelijke maatlat* is however expected to take at least several years, so for now it is important for HDSR to be flexible and collaborative, rather than potentially cause a conflict and worsen their relationship with the municipalities.

In the policy category, HDSR has two instruments available to enforce demands from municipalities: the *Keur* and the *watertoets*. Water authorities have the opportunity to include requirements on the amount of water that needs to be infiltrated and the amount of groundwater that can be extracted in the *Keur*. The *watertoets* is mainly used during the spatial planning process to check whether urban developments sufficiently account for the interest of the water. Because of the nature of the *watertoets* it can only be used construction or restructuring plans and cannot be applied to existing urban areas.

The new *waterschapsverordening* that will go into force in 2024 will be a broader and updated version of the *Keur* and therefore poses opportunities to include more climate adaptation requirements. The TROWA (Transition Assistance Envrironment Law Water Authorities), together with the *Unie van Waterschappen* (Union of Water Authorities) and the *Waterschapshuis* (House of Water Authorities), advises water authorities to create the *waterschapsverordening* in accordance and collaboration with the *omgevingsplan* of the municipalities within its management area (TROWA, 2019). By involving the municipalities better agreements can be made and overlap and contradictions can be prevented. This facilitating and collaborative character of HDSR places it on the edge of the collaborative government and responsive government on the NSOB-model of governing styles (figure 2). HDSR is holding back with the enforcing capabilities they have because "we would rather work with the carrot than with the stick, although the stick will be used if the carrot does not work". The *Keur* does include certain requirements municipalities have to meet, mostly concerning the storage and infiltration of water. The content of the *Keur* has to be water related, so HDSR cannot set requirements for heat stress in the *Keur* (or *waterschapsverordening*).

HDSR has several routes it can take to stimulate climate adaptation policy and measures in urban areas of municipalities. The first option is to create strict policy on the water nuisance requirements that need to be met by including ambitious storage and infiltration standards in the *waterschapsverordening*. As this policy instrument is legally binding, municipalities will have to meet those standards, but they can decide on how to do so themselves. This strategy is, however, not preferential for HDSR as they would rather take on a collaborative and facilitating role and work with the carrot rather than the stick. Additionally, including requirements in the *waterschapsverordening* leaves little room for customisation for both the water authority and municipalities. Water authority Rijnland has included "climate rules" in their new *waterschapsverordening* in a way that is both strict and reasonable (if the infiltration norm cannot possibly be met due to, for example, the soil characteristics and groundwater table, an exception can be made) (Hoogheemraadschap van Rijnland, 2023). HDSR can choose to include such requirements and exceptions in their *waterschapsverordening* as well. The inclusion of storage and infiltration requirements also solves the uncertainty of requirements some municipalities struggle with in their creation of adaptation policy and enables employees to justify proposed policy measures to the municipal board.

Another possibility is to continue working with guidelines through the *Handboek water in ruimtelijke plannen* and actively communicate those to the relevant municipal employees. This works in combination with some hard requirements that are included in the *waterschapsverordening*. The combination of hard policy requirements and soft guidelines could work if it is properly communicated and if HDSR collaborates with municipalities on climate adaptation measures and strategies.

4.3 Capacity

What has become apparent from the interviews with municipal representatives is that almost all municipalities are aware of the problems climate change brings about and they are motivated to work on adaptation strategies to minimise the negative effects it brings about. This is in contrast with the findings of Biesbroek et al. (2010); Carter (2011); and Dovers and Hezri (2010), who all stated that a lack of problem ownership seems to be the most important barrier to action. This is an interesting result because capacity problems have a more clear cut solution than a lack of ownership. Capacity problems have already been identified as an obstacle by Özerol et al. (2020) and are also present in other areas of the world, as Birchall and Bonnet (2021) found capacity to be a limiting factor to climate adaptation in Surrey, Canada.

The tools available to HDSR in this category are the outsourcing of employees and the assistance in policy creation and climate adaptation projects. The first tool has already been used as an employee of

HDSR has helped in the creation of the LAS of De Bilt. This could also be used by the other municipalities without a LAS, as the expert knowledge on the creation of a LAS is present at HDSR. The second tool is currently used in a different way through the *watertoets*. During the *watertoets* process development projects of municipalities are reviewed by experts from HDSR on whether they properly include water interests in the project. This reviewing can also be done for climate adaptive measures such as the creation of wadis, the planting of trees, creation of a green strip. Furthermore, HDSR could assist in the monitoring of the effects of the implemented measures as they do have the relevant models and knowledge to do so. HDSR can also implement their knowledge on spatial planning to assist municipalities who have indicated space availability as an obstacle to becoming climate adaptive. HDSR has a good overview of what strategies the different municipalities use to combat that issue and they also have their own ideas on this topic. Another example of a tool HDSR can create is a database with plants and trees that can be used to combat heat stress and the conditions they can best be used in, for example drought resistant greenery that does not take up much room in the subsurface. Additionally, HDSR can use their knowledge on how the water will behave during a possible flood to assist municipalities in taking flood consequence mitigation measures and create an evacuation strategy.

As a possible action HDSR could make one or more employees available for municipalities to assist in the climate adaptation process in the same manner as the area managers or people who carry out the *watertoets* are currently spread out over the different areas. This is, however, not a desired path of action by HDSR because this would increase their workload and they also do not have the capacity to do so. Furthermore, although this does help municipalities, it also might cause future problems as there is no influx or creation of relevant knowledge on the topic of climate adaptation if they outsource it to HDSR. The middle ground on this topic would be a close collaboration between municipalities and HDSR in a way that HDSR assists in the creation, implementation and monitoring of measures, but also increases the relevant knowledge of the municipalities with the aim to enable municipalities to repeat this process on their own in the future. Another set of actions HDSR could take is to create a database with measures that are taken in the fourteen municipalities per DPRA theme in close collaboration with Netwerk Water & Klimaat. The municipalities can then use this database to see what measures other municipalities have taken and if it suits their own situation as well. This ensures that creative solutions can be optimally used and the municipalities can benefit from each other's knowledge as well. It has been mentioned by HDSR that it does not want to do the municipalities' work for them and therefore wants to leave the responsibility as much with the municipalities as possible. This might, however, be a disadvantageous course of action, as it can lead to large delays in the process of creating climate adaptive urban areas.

4.4 Budget

Most of the municipalities that have indicated budget is an obstacle to climate adaptation policy creation and measure implementation mention that it is not the most prominent obstacle, but that they would be able to do more with a higher budget. These budgetary constraints correspond with the findings of Özerol et al. (2020). Furthermore, the budget available in the municipalities mostly comes from the GRP/WRP which means that they can only spend it on water related projects and not on, for example, the planting of trees to combat heat stress. Another aspect that was mentioned across the interviews was that even if the budget of the municipality would increase, climate adaptation would not be the priority and the money would be spend on other projects. This could be because the priorities of municipalities appear to be more focussed on the short term and on favouring public opinion with the motivation of securing re-election (Smith and Mayer, 2018; Wynne, 2010).

HDSR is already assisting the municipalities in its management area through the presence of the impulse arrangement. This allows municipalities to apply for funding for projects easily and with little effort. Because the impulse arrangement does not have the same rules and regulations a standard subsidy brings about, HDSR has the freedom to choose which projects receive funding themselves. They have to make these choices as the demand exceeds the amount available by almost €1 million. In reality, the decision for which projects receive funding is heavily influenced by how dependent the project is on the funding for the implementation. Another benefit of the impulse arrangement is that municipalities are able to spend it on any climate adaptation related project, also heat stress as long as it also has a positive effect on water. The problem is that many municipalities are not aware of this even though HDSR actively communicates this fact.

HDSR does have a subsidy arrangement available for inhabitants to take climate adaptive measures on their own plot. This subsidy can be used for the construction of green roofs, the purchase of rain barrels and "blue citizen initiatives" which increase the water awareness and sustainable water management (HDSR, n.d. b).

Apart from increasing the budget for the impulse arrangement, HDSR cannot assist much in decreasing the budgetary problems of the municipalities. HDSR can, however, stimulate citizen participation by broadening their subsidy arrangement to also include the greening of gardens and the detachment of rainwater. This action would particularly benefit the municipalities without a subsidy arrangement.

4.5 Reliability of results

The results can be considered reliable as they mostly consist of first hand data obtained directly from the relevant organisations through interviews. The results, and interpretation of the results, have been send to the interviewees for approval and to check whether they were interpreted correctly. For the policy review, the most recent versions of each policy have been used. Climate adaptation is, however, a relatively novel field and some of the reviewed policy has not yet been ratified to be legally binding which makes it subject to changes. Furthermore, the absence of a climate adaptation policy document in six of the fourteen municipalities has made it impossible to give all municipalities a goal label for 2050 since they have not explicitly mentioned their goals in policy documents. This has not made it possible to compare the different area types within the study area to investigate if the there is a statistically significant difference between the different areas in goals per theme of the DPRA. This was not a goal of the research, but would have made it possible to extrapolate the results to a broader geographic area than just the study site and would have increased the societal relevance of the research. It is still possible to give an indication of how other areas in the Netherlands experience the climate adaptation process as the study area does provide a good combination of different soil types, municipality sizes (both in area and inhabitants) and its accompanying problems. Moreover, the existing literature shows that other areas in the Netherlands experience similar obstacles in the process of becoming climate adaptive. This overlap in results indicates that the results found in this research and the recommended course of action can be extrapolated and applied to other areas in the Netherlands.

There is little scientific literature on the collaboration between municipalities and water authorities in the Netherlands, especially on the topic of climate adaptation. This has made it difficult to create hypotheses, but it does signify the importance of this research in bridging the current knowledge gap.

Furthermore, there is no clear definition and consensus on what it means to be "climate adaptive". Therefore, the criteria that were chosen for this research may not be the same as the criteria used in other research. This is not a problem in and of itself, but it might cause difficulties in comparing this research to other research that uses different standards. I believe the decision to use '*Staat van je*

Straat' label B to mark an area as climate adaptive is a fair decision because the threshold values that make up that label are ambitious yet obtainable, however, this remains arbitrary. The novelty of this research topic also has as an implication that it is evolving fast. The value for a T=100 rainfall event (an event that has a likelihood of occurring once per 100 years) has changed from 70mm/h to 80mm/h in the last 10 years, this has the implication that this research might need to be updated in a few years once the new climate scenarios have been published. This underlines the difficulties municipalities face as they also have to deal with changing threshold values and their policy cannot keep up with that.

The use of the labelling system in this research does have its limitations. The *Staat van je Straat* tool gives scores on the street level and this research gives scores on the municipality level. The most prevalent label throughout the municipality has been used. This does, however, not account for inter-municipal variability. This inter-municipal variability is on the other hand been included in the interviews that were conducted. All interviews followed the same structure with the same sequence of questions; the only difference between the interviews is present in the follow up questions that were asked if the interviewee said something relevant that was not included in the interview guide. This has made the results from the interviews reliable and comparable so as to be able to draw conclusions from them.

4.6 Policy implications

One of the main recommendations that follows from this research is that all governments of different levels that are involved and have stakes in climate adaptation (national, provincial, municipal and water authority) should collaborate more closely to ensure that the goals of the DPRA will be met. Furthermore, it is important that all policy is attuned to each other and uses the same standards and requirements that need to be met instead of containing contradictory requirements across the different governance levels. For HDSR this means that the new *waterschapsverordening* needs to correspond with the provincial *omgevingsverordening* and the municipal *omgevingsplannen* that are present in the management area of HDSR. Furthermore, this research and previous research by Mees et al., (2018) shows that the smaller municipalities are lagging behind in the climate adaptation process, so the focus should shift more towards those smaller municipalities.
A recommendation for the national government is to set targets on the national level and let the local governments translate it to their specific situation to see what actions can and need to be taken.

4.7 Scientific implications

This thesis has been the first scientific research into the collaboration between municipalities and water authorities to reach the goal of being climate adaptive by 2050 in the Netherlands. It has combined a policy analysis with interviews with municipal representatives to get an in depth overview of the obstacles municipalities face and the possibilities water authorities have to assist municipalities in their management area. This same research methods can be applied to/by other water authorities to find out how they can assist the municipalities in their management area in climate adaptation policy and measures. Once this framework has been applied to multiple water authorities, the results can be compared and contrasted to see if other areas of the Netherlands experience the same obstacles as HDSR.
Further research needs to be done into what it means for an urban area to be “climate adaptive”. Additionally, further research can be done into how other water authorities collaborate with the municipalities in their management area, what different strategies they use and what the different water authorities can learn from each other. It is also interesting to investigate the possible roles of the regional and national governments in the climate adaptation process.

5. Conclusion

The municipalities studied in this research still have a way to go in the climate adaptation process. They cannot do this on their own and collaboration with governments on higher scale levels is a necessity. This research set out to explore how water authority HDSR (Hoogheemraadschap de Stichtse Rijnlanden) can assist fourteen municipalities within its management area to create and carry out climate adaptation policy and measures within urban areas.
The five most pressing obstacles municipalities face in the creation and implementation of climate adaptation are: lack of budget, capacity, space availability, citizen participation and uncertainty of the climate adaptation requirements.

The instruments available to HDSR can be put into three categories: policy, budget and capacity. The most important instrument that can be used by HDSR is capacity not only in the form of manpower, but mostly in the form of expertise knowledge provision. This knowledge provision can help both in the creation of policy and the implementation of specific measures. Furthermore, HDSR can financially assist municipalities by subsidy provision for climate adaptive measures as it already does through the impulse arrangement. The last possibility to actively enforce climate adaptation in urban areas is to include strict requirements in the new *waterschapsverordening*.

The recommended course of action for HDSR is to take on a more proactive approach in the climate adaptation process and include climate rules in the *waterschapsverordening*. Moreover, it is beneficial to assist in the creation and implementation of adaptation policy by making capacity available for proactively assisting municipalities in the climate adaptation process. Additionally, increasing the budget for the impulse arrangement ensures more adaptation measures can be implemented. The investments that HDSR has to make on the capacity and budget side might seem costly now, but are likely to pay off in the future through prevented damage to urban areas and the entire water system. Proper communication and collaboration between all relevant parties remains of the utmost importance to reach the goal of being climate adaptive by 2050.

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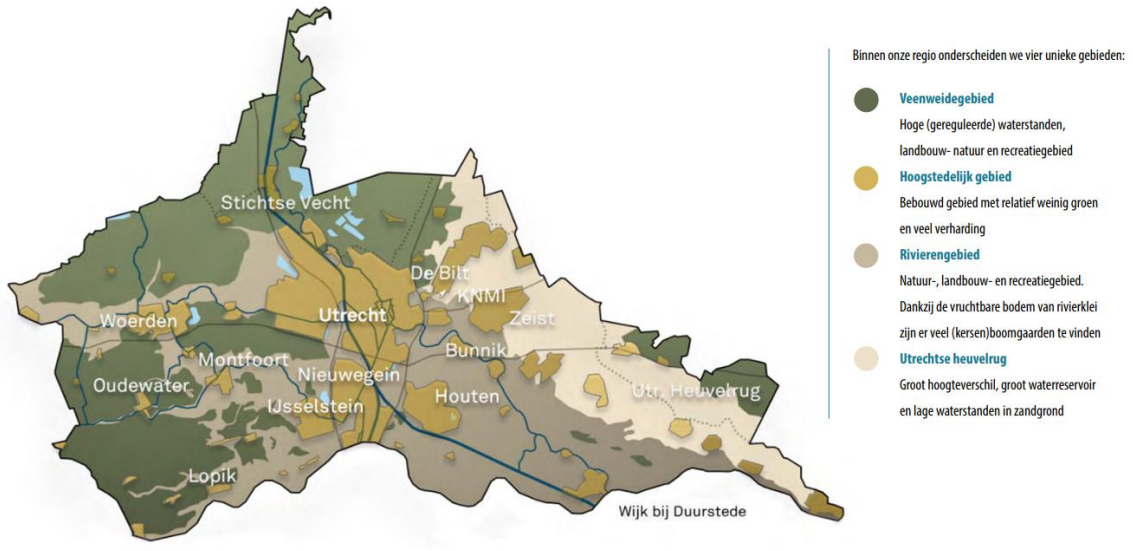
Appendices

A. List and map of municipalities in the management area of HDSR

*Table 10, All municipalities in the management area of HDSR, the municipalities included in this research are displayed in **bold and italics** (HDSR, n.d. c)*

Municipality	
Alphen aan den Rijn	Nieuwkoop
Bunnik	***Oudewater***
Bodegraven-Reeuwijk	Rhenen
De Bilt	***Stichtse Vecht***
Houten	***Utrecht***
Krimpenerwaard	***Utrechtse Heuvelrug***
IJsselstein	***Wijk bij Duurstede***
Lopik	***Woerden***
Montfoort	Woudenberg
Nieuwegein	***Zeist***



Map 2 Study area Utrecht Zuidwest (Netwerk Water & Klimaat, 2020)

B. Staat van je Straat indicators and label requirements (Sweco, n.d.)

Water nuisance:

- Damage to buildings (50% of the label)
  - A: at 90mm/h water depth is lower than building threshold
  - B: at 70mm/h water depth is lower than building threshold
  - C: at 40mm/h water depth is lower than building threshold
  - D: at 20mm/h water depth is lower than building threshold
  - E: at <20mm/h water depth is lower than building threshold
- Traffic nuisance (50% of the label)
  - A: at 90mm/h water depth on the street is less than 10cm
  - B: at 70mm/h water depth on the street is less than 10cm
  - C: at 40mm/h water depth on the street is less than 10cm
  - D: at 20mm/h water depth on the street is less than 10cm
  - E: at <20mm/h water depth on the street is less than 10cm

Drought:

- Subsidence, consisting of:
    - Public space (40% of the label)
        - A: not to very lightly susceptible to subsidence
        - B: lightly susceptible to subsidence
        - C: mildly susceptible to subsidence
        - D: susceptible to subsidence
        - E: very susceptible to subsidence
    - Private space (10% of the label)
        - A: not to very lightly susceptible to subsidence
        - B: lightly susceptible to subsidence
        - C: mildly susceptible to subsidence
        - D: susceptible to subsidence
        - E: very susceptible to subsidence
- Focus area wooden pile foundations (50% of label)
    - A: Not vulnerable
    - B: Little vulnerable
    - C: Vulnerable
    - D: Very vulnerable
    - E: -
- Water quality (does not contribute to the label, because it is monitored on the neighbourhood level)
    - A: Aim vision ecoscan 'natural'
    - B: Aim vision ecoscan 'lively'
    - C: Aim vision ecoscan 'visible'
    - D: -
    - E: Aim vision ecoscan 'low'
- Aerosols (does not contribute to the label, because there is little action perspective)

Heat stress:

- Experienced temperature during the day (33% of the label)
    - A: Experienced temperature is 'a lot cooler' in >40% of the street
    - B: Experienced temperature is 'cooler' in >40% of the street
    - C: Experienced temperature is 'normal' in >40% of the street
    - D: Experienced temperature is 'warmer' in >40% of the street
    - E: Experienced temperature is 'a lot warmer' in >40% of the street
- Distance to cool areas (33% of the label)
    - A: Distance to a cool place is maximum 230m (4 minutes of walking)
    - B: Distance to a cool place is maximum 300m (5 minutes of walking)
    - C: Distance to a cool place is maximum 367m (6 minutes of walking)
    - D: Distance to a cool place is maximum 433m (7 minutes of walking)
    - E: Distance to a cool place is 500m or more (over 7 minutes of walking)
- Warm nights (33% of the label) (a warm night is a night with a minimum temperature of 20°C)
    - A: Less than 7 nights
    - B: 7-14 nights
    - C: 14-21 nights
    - D: 21-28 nights
    - E: more than 28 nights

Flood risk

- Individual risk of dying (100% of the label)
    - A: Risk of dying is 0 per year
    - B: Risk of dying is 1 to 10.000.000 per year
    - C: Risk of dying is 1 to 1.000.000 per year
    - D: Risk of dying is 1 to 100.000 per year
    - E: Risk of dying is 1 to 10.000 per year

C. Summary of municipal climate adaptation policy

Review of climate adaptation plans

General remark: it is difficult to compare the different municipalities because they use different methods to display their challenges and goals and on top of that also adhere to different threshold values.

Document A: Climate adaptation strategy document Zeist

View for 2050 with regards to:

Water nuisance:

- Accept that there could be water on the street temporarily
- Prevent that water can enter dwellings
- Prevent traffic delays on the main roads
- Method:
    1. Catch rainwater at the location it reaches the surface
    2. Contain the rainwater at lower lying locations where it does not cause nuisance

Heat stress

- Every inhabitant has a cool location (playground, park, forest) in close proximity
- Cooling in the streets, foot- and bike paths have shade on the hottest moment of the day
- Green roofs and facades are present throughout the entire municipality
- Dwellings of vulnerable inhabitant groups have extra natural cooling element in close proximity

Drought

- During wet periods as much rainwater as possible is infiltrated into the soil to create a buffer
- opt for trees and plants that are suitable for the surroundings, such as the foundation and availability of (ground)water
- Good maintenance will ensure good water quality

Flood risk

- Lekdijk is strengthened and heightened by the national government and HDSR
- In the unlikely event of dike breach, the effects are limited, Zeist-West can experience flooding of a few decimetres, but viratl and fragile functions are located on the higher parts of the Utrechtse Heuvelrug
- Calamity contingency plans are in place, so actions that need to be taken in case of dike breach are clear

Current problems

- Labelled on municipal and neighbourhood level for all categories of the stress test
- Municipal level
    1. Water nuisance: A: 30%; B: 23%; C 27%; D: 14%; E: 6%
    2. Heat stress: A: 5%; B: 68%; C: 26%; D: 2%; E: 0%
    3. Drought: A: 7%; B: 27%; C: 55%; D: 12% E: 0%
    4. Flood risk: A:73%; B: 0%; C: 21%; D: 6%; E: 0% (problems only in neighbourhood Zeist-West)

Water nuisance

- Problems identified on street level
- Lower lying dwellings are vulnerable

- Origin of rainwater is important, public space versus gardens (tiles and water can flow into homes) -> gardens are the responsibility of the inhabitants, municipality has an informing role
- Prevent water nuisance by replacing grey infrastructure in public and private space, by green infrastructure
- Water nuisance is at the forefront of every new construction (gemeentelijk rioleringsplan 2022-2026)
- Stimulating citizens green up their gardens and disconnect their rain pipes

Heat stress

- Heatwave temperatures 35-40 degrees, length increasing
- Street level analysis
- Extent of shade during the day (of trees and buildings), preferably on foot and bike paths
- Heat during the night, urban areas emit heat during night and don't cool down as much as the rural areas -> urban heat island
- Zeist is a green municipality in comparison with other municipalities and does not experience the urban heat island effect much, point of interest: Zeist city centre and its surrounding older neighbourhoods -> absence of trees
- Aim to create more green on public and private property (trees, façade gardens, gardens and roofs)
- Zeist has enough cool locations, the forested areas that surround the centres provide ample shade, additionally enough parks in urban areas to provide cooling
- 90% of Zeist's inhabitants lives within 5 minutes walking distance to a cool location -> shaded areas should be designed to better accommodate recreation

Drought

- Large areas of Zeist on high sandy soils -> susceptible to drought
- During long periods of drought the groundwater supply runs out and the quality of the green is damaged
- Larger fluctuations in the groundwater level are expected to have a negative effect on the quality of plants and trees
- Infiltrating as much rainwater as possible to combat drought
- Choose for plants and trees that are suitable for the climate in 2050
- Quality of surface water deteriorates because of lack of new supply, solutions sought after together with HDSR
- Negligible subsidence and building foundation problems

Flood risk

- Only Zeist-West at risk
- Meerlaagse veiligheid (multi layered safety) deployed
    1. Prevention: HDSR strengthens dikes so dike breaches are prevented
    2. Spatial planning: In the event of a dike breach, the effects are limited because of smart spatial planning. Vital and vulnerable functions are positioned high and dry. If not otherwise possible, positioning in flood prone areas will happen surrounding robust (essential functions not on the first floor) according to the Omgevingsvisie
    3. Disaster management: optimising crisis management by informing citizens about possible effects of a dike breach and how to act will prevent casualties.

Goals

Water nuisance:

- Accept that there could be water on the street temporarily
- Prevent that water can enter dwellings
- Prevent traffic delays on the main roads
- Method:
    1. Act according to the motto “green, unless….” to ensure the prevention of unnecessary paving
    2. Where possible, place the green in low lying areas to maximise infiltration
    3. Within restructuring projects, infiltrate and store the rainwater at the location it reaches the surface
        - Reconstruction where sewage system is replaced: 100% disconnection of rainwater from sewer system and prevent water nuisance for rainfall of 70mm in 1 hour
        - Reconstruction where only surface is replaced, attempt to infiltrate as much rainwater as possible
    4. Earlier solving of bottlenecks, no nuisance:
        - 2030, rainfall of 30mm in 1 hour
        - 2040, rainfall of 50mm
        - 2050, rainfall of 70mm
    5. Infiltrating rainfall at location it reaches the surface on private properties and not let it drain to sewage treatment plant to prevent sewer overflow
- For new construction:
    1. Prevent damage to buildings in case of extreme rainfall events (90mm/hour)
    2. Every plot can store 45mm of rainwater, 37,5mm in 45 minutes

Heat stress

- Every inhabitant has a cool location (playground, park, forest) in close proximity
- Cooling in the streets, foot- and bike paths have shade on the hottest moment of the day
- Green roofs and facades are present throughout the entire municipality
- Dwellings of vulnerable inhabitant groups have extra natural cooling element in close proximity
- This will be done by
    1. Take the shade requirements into consideration in the spatial planning of parks, playgrounds and forests
    2. Ensure at least 40% in public space in streets, of which slow moving traffic can make use
    3. Informing and helping inhabitants and companies create more green in buildings, parking lots and gardens
    4. Determining how to limit the effects of extreme heat for vulnerable groups and events, in collaboration with GGD (municipal health service)

Drought

- During wet periods as much rainwater as possible is infiltrated into the soil to create a buffer
- opt for trees and plants that are suitable for the surroundings, such as the foundation and availability of (ground)water
- Good maintenance will ensure good water quality
- Reach this goal through:
    1. Infiltrate as much rainwater as possible at locations where it is still connected to the sewer system (goal is to have at least 50% disconnected by 2050)

2. Choose plants and trees that are suitable for the soil and groundwater levels. On top of that, ensure that rainwater drains towards plant patches
3. Keep maintenance of waterways up to standard, if possible create nature friendly embankments instead of timbering

Flood risk

- Lekdijk is strengthened and heightened by the national government and HDSR
- In the unlikely event of dike breach, the effects are limited, Zeist-West can experience flooding of a few decimetres, but vital and fragile functions are located on the higher parts of the Utrechtse Heuvelrug
- Calamity contingency plans are in place, so actions that need to be taken in case of dike breach are clear
- Responsibility lies with Rijkswaterstaat and HDSR
- Employ proper spatial planning

Construction type

- Separate plans and requirements for new construction and restructuring

Finance

- National government €400.000-500.000 -> max 33% of the budget for climate adaptation in the municipality, measures need to be implemented in the period 2021-2027

Document B: Climate adaptation strategy document De Bilt

View for 2050 with regards to:

Water nuisance

- Label B in existing areas, label A in new constructions

Drought

- Label C

Heat stress

- Label C

Flood risk

- Label C (at the very least)

Current problems

- On the street level with staat van je straat

Water nuisance

- Diverse places in De Bilt experience water nuisance during a rainfall event of 70mm/hour, like water entering buildings, traffic obstruction and failure of infrastructure
- Problems are mainly situated in neighbourhoods with a lot of paved surface, like the centre of De Bilt, where water cannot infiltrate properly or Bilthoven where the drainage capacity is limited
- On map, label C is most prevalent

Drought

- High sandy soils are susceptible to drought damage to greenery, mostly in De Bilt and Bilthoven
- Soil subsidence not much of a problem, mostly in peaty soils like Westbroek
- Air quality is impacted during dry periods near busy roads and business parks
- Label D most prevalent on map

Heat stress

- Mostly a problem in De Bilt and to a lesser extent in Maartensdijk and the southern part of Bilthoven
- Also a problem in Westbroek, polder area without shade
- Label D and E most prevalent on map

Flood risk

- In case of dike breach of the river Lek the largest problems occur in Maartensdijk, Westbroek and Groenekan
- Bilthoven and De Bilt (mostly) stay dry
- Impact of possible dike breach is large because utilities like electricity, gas and water provision can experience failure
- It can take a while for the area to be dry, inhabitable and liveable
- Label A and B most prevalent on map

Goals and how to reach them

Water nuisance

- Prevent water nuisance as much as possible
- Aim is to have label B in existing constructions
- New constructions always need to have label A
- Accept that there sometimes is water on the streets, but main roads need to stay accessible, especially for emergency vehicles
- Reach this goal through:

1. Map vulnerable locations through stress tests and real life notifications
2. Give these locations priority for restructuring projects
3. During restructuring projects design public space in a way that prevents water nuisance
4. Detach rainwater from the sewer system and infiltrate it into the soil (preferable) or drain it to surface waters
5. In existing build up area, remove unnecessary paving and replace it by lowered greenery, so more water can be contained and infiltrated
6. In new construction projects, act according to the principle 'green, unless….' Which means only pave the absolute necessary areas
7. Make gardens greener so rainwater does not drain immediately to the sewer or surface waters, but can infiltrate at location

Drought

- Aim to have label C
- Prevent damage caused by drought as much as possible
- Reach this goal through:
    1. Map vulnerable places through stress tests and real life notifications
    2. Give these locations priority for restructuring projects
    3. Restore the natural sponge function of the area as much as possible through:
        - Detach rainwater drainage from roofs and roads of the mixed sewer system and let it infiltrate where possible so as to prevent desiccation, on sandy soils the long term goal is to infiltrate 90%
        - In existing build up area, remove unnecessary paving and replace it by greenery, so more water can be contained and infiltrated
        - In new construction projects, act according to the principle 'green, unless….' Which means only pave the absolute necessary areas
        - Only use trees and plants that are able to withstand dry conditions and preferable evaporate as little water as possible (e.g. use deciduous trees instead of pine trees that stay green year round)
        - Make gardens greener so rainwater does not drain immediately to the sewer or surface waters, but can infiltrate at location

Heat stress

- Aim to have label C
- Prevent damage caused by heat as much as possible
- Take into account the changing frequency and durations of heatwaves as a result of global warming
- Reach this goal through:
    1. Map vulnerable places through stress tests and real life notifications
    2. Give these locations priority for restructuring projects
    3. In existing build up area, remove unnecessary paving and replace it by greenery, so more water is available for plant growth and evaporation (cooling effect)
    4. In new construction projects, act according to the principle 'green, unless….'
    5. Preserve trees as much as possible in spatial developments and when placing new trees, choose for trees that provide a lot of shade and have a large cooling effect
    6. Aim for at least 30% shade in new constructions according to the document climate adaptive construction

7. Provide cooling areas like parks
8. Replace tiles by greenery in gardens
9. Ensure good water quality during the summer in collaboration with HDSR

Flood risk

- Water authorities work together with the national government on the strengthening of dikes
- Regional programme consequence mitigation of floodings constructed together with safety region Utrecht and province Utrecht
- Local level measures
    1. Prevent situating essential functions in basements in flood prone areas
    2. Research (together with region) how to better protect vital and vulnerable functions, or how to mitigate the damage as much as possible

Approach

- Policy and plans
    1. Omgevingsvisie
    2. Leidraad klimaatadaptief bouwen
    3. Water- en Rioleringsplan De Bilt 2022-2026
    4. Local heat plan
    5. Detachment possibilities
- Roadmap Climate adaptive De Bilt 2050
- Collaboration and participation
- Communication
- Evaluation and monitoring
    1. Evaluate and update every 5 years
    2. Act with intermediate goals
        - Water nuisance (goal label B):
            1. Current: 40%; 2030; 60%; 2040: 80%; 2050: 100% Gap: 60%
        - Drought (goal label C):
            1. Current: 25%; 2030: 50%; 2040: 75%; 2050: 100% Gap: 75%
        - Heat stress (goal label C):
            1. Current: 50%; 2030: 65%; 2040: 80%; 2050: 100% Gap: 50%
        - Flood risk (goal label C):
            1. Current: 100% Gap: 0%

Finances

Water nuisance

- Can be found in water- en rioleringsplan
- Financed through rioolheffing

Heat stress

- Groenbeheer- en wegenplan of municipality

Document C: Water- en rioleringsvisie Wijk bij Duurstede

Current problems

- Neighbourhood and street level

Water nuisance

- In neighbourhoods with relatively large height differences between roads, a lot of water can be on the road surface in some places
- In De Geer (neighbourhood) the access roads are elevated which makes it harder for water in residential streets to reach surface waters
- A rainfall event of 60mm/hour causes over 15cm of water to be on the road surface in over 50% of the roads, which can cause traffic obstructions
- Relatively little nuisance on access roads, in some cases, water originating from local roads can flow to access roads and cause nuisance, like the Nieuweweg and the Frankenweg

Drought

- Area is not susceptible to drought thanks to possible water supply from the Kromme Rijn
- There are no large changes expected in the groundwater levels, during longer periods of drought the groundwater level in the entire area will get lower in the entire municipality
- In urban areas, drought is not seen as a large risk

Heat stress

- The places that experience the most heat stress are business parks on the west side of Wijk bij Duurstede and in Cothen, due to the omnipresent pavement and black roofs
- Shopping centres, and to a lesser extent older buildings and care facilities are also at risk of heat stress for the same reasons. Examples are the direct surroundings of supermarkets, partycentrum Cothen and the historical centre of Wijk bij Duurstede
- Urban areas within the municipality are clearly hotter than the surrounding rural areas

Flood risk

- In case of a dike breach, most of the areas within the municipality will be flooded
- In general, the water height ranges from 0 to 1,5m. An exception to this is the area between the ARK and Rijndijk where the height fluctuates from 2 to 5m
- The area between Wijk bij Duurstede and the Utrechtse Heuvelrug is lower lying than its surroundings, which causes the evacuation routes to be flooded

Goals

- There needs to be cohesion between public and private property because the urban area is split about 50/50 public private.

Water nuisance

- Create height differences to protect everything that needs to be protected, locate vital functions higher than its surroundings
- Create more space for water during extreme rainfall events
- Prevent water in buildings during rainfall events of 60mm/hour

Drought

- Damage as a result of drought should be prevented
- Infiltrate water where possible

Heat stress

- The temperature on the hottest places should not increase more than the rural areas as a result of climate change
- The hottest 10% of the heat stress map should be provided cooling measures
- New constructions should be build heat neutral by placing less pavement and take measures against heat

Flood risk

- Make sure that floods do not have disastrous effects
- Provide evacuation and emergency routes for all centres
- Better protect vital infrastructure by heightening them

The how

- Work on climate adaptation integrally
    1. Focus on detaching rainwater from the sewer system (meekoppelen, do this during restructuring projects)
    2. Creating locations where it can be stored temporarily
    3. Where possible let it infiltrate
    4. If not possible to infiltrate, let it flow to a ditch or wadi
    5. Expectations are to tackle 2 project areas per year between 2020 and 2050, budget of €100.000
    6. Install separate sewers in new construction projects
- Stimulate citizens and businesses to make their plot climate adaptive
    1. Through a communication campaign
    2. €10.000 budgeted annually until 2050
    3. Operation ‘Steenbreek’ (national campaign to replace paving by greenery on private properties)
    4. Stimulate the detachment of rainwater, €20.000 budgeted annually

Finances

- €100.000 until 2050 for detaching rainwater during restructuring projects
- €10.000 annually until 2050 to stimulate greenery on private property
- €20.000 annually to stimulate the detachment of rainwater

Document D: Lokale adaptatie strategie Utrechtse Heuvelrug

Current problems

Water nuisance

- Combination of increase in peak precipitation and increase in paved surface causes severe nuisance
- Especially Amerongen and Leersum experience problems
- Increase in precipitation on the southern side of the Heuvelrug poses problems
- Risk of mudslides on Heuvelrug
- Increase in sewer overflow
- Agricultural businesses on the lower laying clay soils experience more and longer water nuisance because the excess water drains to those places
- Financial damages in 2050:
    1. Between €91 and €191 million for just rain
    2. Together with hail between €114 and €155 million

Drought

- The sandy soils of the Heuvelrug are extremely susceptible to drought because of its dependence on rainwater due to the low groundwater levels
- Especially plants and trees that are not fully grown yet are vulnerable

Heat stress

- Experienced on the microlevel, like paved town squares without trees
- Nature and its cooling effects are always in close proximity
- Difficult access to cooler places for vulnerable groups, like elderly

Flood risk

- In case of dike breach of the Lekdijk only the southern part of Driebergen is located in the flood zone
- Water heights will stay between 1 and 1,5m

Goals

- In 2050:
    1. The water system of the Utrechtse Heuvelrug is water robust and climate resilient, water is contained optimally
    2. The water balance is designed in such a way that during periods of extreme drought, there is enough water available for humans, nature and agriculture

Water nuisance

- There will be no structural damage to buildings, infrastructure and vital amenities during rainfall events of 70 mm/hour (label B)
- During a rainfall event of 90 mm/hour, vital functions remain functioning (energy, drinking water, access roads)
- Vital functions and infrastructure is designed in a water robust manner
- The water system is designed robustly, so peaks in wet and dry periods can be managed
- There will be no negative effects on the water quality as a result of combined sewer overflow
- Citizens and companies are aware of the effects of climate change and contain as much water on their own plot as possible

Drought

- Water will be contained as much as possible by locally infiltrating rainwater where possible
- Longer periods of drought do not lead to desiccation or damage to greenery and buildings in the urban environment
- Rural areas, nature and agricultural areas are able to withstand longer periods of drought
- The spatial planning is in tune with the natural groundwater levels and freshwater availability during droughts (natural means without technical measures such as pumps and drainages)
- Citizens and companies are aware of the necessity of taking measures to mitigate the effects of drought

Heat stress

- The difference in experienced temperature between urban and rural areas is 5 degrees max
- The living environment remains liveable during longer periods of extreme heat
- Vital and vulnerable functions are able to withstand the effects of extreme heat
- The water quality of surface water is suitable for its function during longer periods of extreme heat (and drought)
- The urban areas are designed in such a way that heat stress is limited during night times

Flood risk

- The municipality is optimally prepared for extreme weather events
- The evacuation possibilities are optimised
- The resilience regarding reconstruction is increased

The how

Region Utrechtse Heuvelrug

- Increasing infiltration
- Replace pine trees by deciduous trees
- Monitor and regulate groundwater extraction

Municipal level

- Hold rainwater at the location it reaches the surface preferred action sequence:
    1. Hold the water and use it
    2. Above ground infiltration
    3. Below ground infiltration
    4. Drain to surface waters
- Replace combined sewers by separated sewers
- Place wadis and other infiltration provisions
- In places with high groundwater levels, place a rainwater sewer to transport the rainwater to a soil elsewhere or drain it to nearby surface waters
- Limit the amount of paved surface: ‘green, unless….’ Principle
- Analysis of useless paving shows that 7% of the paved area could easily be replaced by green area
- Design areas in such a way that rainwater drains to the green areas
- Include private roofs in infiltration projects in case of small front gardens and if it is cost efficient
- Pump up groundwater to keep the water level at an acceptable level for some waters (with important nature functions), during long periods of drought
- Aim for adequate water quality for surface waters
- Stakeholder facilitation and informing (communication)
- Stakeholder stimulation (financially) and eventually obligation

Water nuisance

- Prevent rainwater from flowing from the higher situated forests into lower lying urban areas. This will be done by holding the water upstream and let it infiltrate there
- Prevent water nuisance in urban areas by employing smart spatial planning
    1. Heightening pavements
    2. Changing the road profile
    3. Drain the rainwater to an area where it can infiltrate
    4. Use appropriate spaces such as public green, parking lots, squares and playgrounds as temporary (green) storage facilities
    5. If there is not enough space to process rainwater, possible make use of third parties
- Account for the relief of the area in taking measures

Heat stress

- Maintain the current amount of shade in villages
- For areas with slow moving traffic (foot and bike paths, town squares and parks), aim for 40% of shade during the highest sun position, and aim for 30% of shade on the neighbourhood
- Maintain the current amount of greenery in the villages and if possible increase the greenery in Amerongen to 50% (is now 44%)
- Make sure there is a cool area at a max distance of 300m from every dwelling.
    1. In most cases this goal is already reached
    2. Provide extra cool areas close to vulnerable inhabitant groups (elderly, children)
- Design the horizontal and vertical surface in accordance with the 'groen-blauwe agenda'

Climate adaptive new construction

- No new constructions in areas where it negatively impacts the water management
- Rainwater should be processed on homeowners' own plots, unless it proves to be absolutely impossible
- A rainfall event of 70 mm/hour should be able to be processed on the plot level
- Aim for a green surface of at least 50% of the total surface
- Green, unless… principle
- At least 40% shade for slow moving traffic and at least 30% shade on the neighbourhood level

Finances

- Annual budget of €198.000 from the municipal sewer plan
- Temporary impulse regulation from national government provides €637.251
- Municipality aims to apply for available subsidies from national government, province and regional water authorities
- The available budget will be spend to get 'quick-wins' with regards to the processing of rainwater in public space
    1. Climate squares Driebergen
    2. Water storage upstream to prevent damage downstream
    3. Neighbourhood focussed approach
    4. Replacing pavement with green
    5. Surface level infiltration projects or optimising the current system by the application of for example wadis
    6. Increasing the water holding capacity of the soil, by planting green and trees

Document E: Klimaatadaptatieplan Houten 2022-2027

Ambition

- To be climate proof in 2040 and have combated the present weaknesses by then

Current situation

- Street and neighbourhood level

Water nuisance

- No major problems in the current situation, only on some extreme occasions have a few locations experienced nuisance
- Water nuisance determined for rainfall events with t=10, t=50, t=100 -> 60mm/hour, and t=500; per repetition time the amount of locations at risk of water nuisance (81, 144, 345, 663) and the amount of buildings at risk (323, 568, 1283, -) are determined
- The town centre of Houten is at risk to experience severe water nuisance for a rainfall event of t=100 possible explanations are:
    1. Accessibility for people in wheelchairs is heavily implemented in the design of the centre, entrances of stores are situated very low in relation to the street level
    2. In some neighbourhoods there are a lot of height differences, which causes water to collect in the lower laying areas
- During a rainfall event of 60 mm/hour, the water height on the roads is over 15cm for one third of the roads; the access roads (Rondweg) are mostly empty of water
- A rainfall event of 90 mm/hour causes all roads of Houten to be covered with water for several hours, it is still possible to drive on the access roads albeit slowly
- The pumps are still operable during such a rainfall event (except the one in a tunnel because that one drains to the sewer and problems will occur due to counter pressure of the water)

Drought

- In urban areas the largest effect of drought is damage to municipal greenery
- Irrigation of newly planted greenery has to go on until autumn
- Grass in wadis also experiences difficulties during dry periods, so far the only real effect is that the grass is yellowish some of the time
- Map of the risks shows about 75% not at risk and 25% at risk of drought damage
- Only dwellings in the Oude Dorp have wooden pile foundations and are therefore at risk of pile rot and foundation damage

Heat stress

- The amount of days exceeding 25 and 30 degrees will increase, as will the amount of successive hot (>25 degrees) days
- Experienced temperatures in the centre and Castellum are up to 15 degrees higher than the rural areas
- In the northern part of Houten, the percentage shade on the highest sun position is mostly over 30%, but in the southern part it ranges between 10 and 30%
- Almost all parts of Houten are within 300m distance of a cool green area, only on business parks the distance is larger than 300m

Flood risk

- In case of a dike breach of the Lekdijk, only small parts of Houten will stay dry

- The water height varies mostly from 0,5 to 1,5m but in the lower laying areas it can reach a height of up to 5m
- Evacuation routes via the A12 and A27 will also be partially flooded

Goals
- To be spatially designed in a climate adaptive way by 2040

Water nuisance
- Public space is designed in such a way that a rainfall event of 70 mm/hour does not cause damage to buildings and does not cause obstruction of roads for emergency services
- It is acceptable for water to be on the street temporarily, up to 2 hours
- The urban water system is designed in a robust and resilient manner, water will be held optimally and stored in soil and water system so nuisance during peak rainfall events and drought is minimised
- Vital objects and infrastructure are designed water robustly
- Citizens and businesses are aware of the effects of climate change and hold as much water as possible on their own plot

Drought
- Longer periods of drought do not lead to structural damage to buildings, foundations, roads, greenery, water, and vital and vulnerable functions
- Longer periods of drought will not lead to desiccation or damage to the built environment, including above and below ground infrastructure and greenery
- Citizens and businesses are aware of the effects of climate change and take measures to limit the effects of drought

Heat stress
- During heat, the built environment offers a healthy and attractive living environment
- The living environment stays liveable during (longer periods of) extreme heat
    1. In order to achieve this, ample of shade is present, at least 40% shade during the highest sun position in places of slow moving traffic and 30% of shade on the neighbourhood level
    2. There are enough locations where inhabitants can find cooling
    3. There are cool and shaded locations within 300m of every house and those places should be freely accessible
- Vulnerable groups are protected against heat stress during longer periods of extreme heat
- Citizens and businesses have designed their plots as heat resistant as possible
- The built environment is designed in such a way that heat stress is limited

Flood risk (2050)
- The built environment is prepared for dike breaches through effect limiting measures
- All vital and vulnerable functions, like energy and head infrastructure, are still available in event of a flood
- The effects of a flood are limited
- The evacuation possibilities are optimised
- The resilience regarding reconstruction is large
- This all happens in collaboration with Netwerk Water & klimaat -> veiligheidsregio Utrecht is leading

The how

- Through 7 steps:
    1. New construction and restructuring climate adaptive
    2. City as a sponge
    3. Liveability during heat
    4. Climate adaptive agriculture and nature development
    5. Consequence limitation climate effects vital and vulnerable function
    6. Strengthening natural water system
    7. Climate awareness and framework for action for citizens and businesses

1. New construction and restructuring climate adaptive
    a. Attainable and clear demands for new construction and restructuring (afspraken klimaatadaptief bouwen)
    b. Mostly focussed on preventing water nuisance
    c. Current minimum storage on private plot will be increased from 15mm to 40mm
    d. Storage agreements
        i. Mandatory climate adaptation paragraph and climate test to measure climate adaptation incorporation in plans
        ii. Legal backing through omgevingsvisie
    e. Policy starting points
        i. Minimum building level threshold of 30cm above street level
        ii. Storage of 40mm on plot level
        iii. Install cables and pipes bundled if possible to create more space for trees and other functions in the subsurface
        iv. 10% less paving than in the previous situation in case of restructuring projects
        v. Green, unless… principle
2. City as a sponge
    a. Detaching rainwater from the sewer system
        i. Detach 7.500m^2 annually, try to combine this with other restructuring projects
    b. Replace pavements by greenery (to increase infiltration capacity)
        i. Replace 3.250m^2 paving annually
        ii. Use the useless paving tool
        iii. Provide subsidies for citizens
        iv. Apart from replacing paving for greenery, replace paving by water permeable paving where no greenery is possible (50 plots of 250m^2 per year)
    c. Policy starting points
        i. Preferred sequence for the handling of rainwater
            1. Hold on roofs and rain barrels and use it in a useful way
            2. Infiltrate it above ground
            3. Infiltrate it below ground
            4. Process it in surface waters
            5. Drain it to a sewage treatment plant
3. Liveability during heat
    a. More shade on routes with slow moving traffic
        i. Allow the trees in Houten-Zuid more time to grow
        ii. Monitor the amount of shade
    b. Monitoring progress climate adaptation

        i. Evaluate the amount of shade created and the effectivity of the created shade
        ii. If necessary adapt strategy
    c. Create a local heat plan
    d. Policy starting points
        i. Create pleasant and cool locations by planting more trees
        ii. Keep optimal greenery for cooling in mind during the design of every adjustment to public space
        iii. Use native trees and plants that add to an optimal cooling effect
4. Consequence limitation climate effects vital and vulnerable functions
    a. Work together with the entire region
    b. Translate insights to measures
5. Climate awareness and framework for action for citizens and businesses
    a. Increase climate awareness with a positive message
    b. Increase the feeling of urgency for businessowners
    c. Provide a good example as a municipality
    d. Stimulate private actors to take climate adaptive measures through the provision of subsidies
        i. “Regeling afkoppelen en infiltreren hemelwater” for detaching rainwater with a max of €30/m^2 and a total max of €750
        ii. “Regeling aanleg groene daken” for the creation of green roofs (max of €25/m^2 and max of €750)
        iii. “Regeling Gratis oude tuintegels laten ophalen” to stimulate citizens to make their garden greener, the municipality will collect tiles for free. In order to qualify for this, the garden should be paved less than 50% in the new situation
        iv. “Regeling ontstenen en zelfbeheer” private actors can submit proposals to increase the green surface in public space around their house (façade gardens in streets without gardens par example)

Finances

- Most activities are funded through the WRP
- This is supplemented with subsidies from the national government, HDSR and the province Utrecht
- Annual available budget:
    1. Tackling at risk locations of water nuisance/damage: € 500.000, WRP
    2. Detaching rainwater: € 90.000, WRP
    3. Swapping paving by permeable paving: € 10.000, WRP
    4. Swapping paving for greenery: € 25.000, WRP
    5. Provision of subsidies to citizens (detaching and green roofs): € 40.000, WRP
    6. Collecting garden tiles: € 3.000, WRP
    7. Subsidies removing pavement and private management: € 75.000, WRP
    8. Communication actions climate adaptation: € 5.000, sustainability budget
    9. Planting of green against heat stress: € 10.000, sustainability budget
    10. € 10.000 from sustainability budget and €27.000 from WRP to Netwerk Water & Klimaat

Document F: Visie klimaatadaptatie Nieuwegein

Current situation

Water nuisance

- The municipal sewer system is not prepared to process a peak rainfall event and has a maximum capacity of 20 mm/hour
- A large area of the municipality is paved (40-60%) which hinders infiltration
    1. 60-70% of the rainwater that falls on paved surface reaches the sewer system
    2. Of an unpaved surface only 10% reaches the sewer
- The flooding of tunnels and roads can lead to traffic obstruction and decrease the accessibility of parts of the city

Drought

- Long periods of drought will occur more often in the future
- Even though the municipality provides plants and trees extra water, there are many shrubs and trees with withered leaves
- Drought occurs mostly from April to October, which overlaps with the growing season
- Drought damage to buildings is unlikely in Nieuwegein
- The maximum decrease of the groundwater level is 10 cm
- The extra projected subsidence (on top of the naturally occurring subsidence) as a result of drought is maximally 10 cm by 2050

Heat stress

- There will be an increase in the amount of hot and tropical days
- The amount of nights where the temperature stays above 20 degrees will increase to 20 a year by 2050
- The experienced temperature in urban areas can be 7-12 degrees higher than in rural areas in 2050
- The liveability of neighbourhoods will decrease as a result of the increased amount of hot and tropical days
- Areas of concern are paved areas with little green, such as the inner city, town squares and business parks

Flood risk

- The impact of a possible dike breach is high, the water height will vary from 1-6m
- Evacuation plans are present
- If the water height reaches 20cm all utility services (electricity, gas, water, internet) will shut down and driving cars is not safe anymore
- There is one neighbourhood that is not protected by the Lekdijk, in the current situation the surface is as high as the Lekdijk and the neighbourhood is built in a water robust way

Goals

- Intermediate goal for 2025 and end goal for 2050

Water nuisance

- Throughout the entire municipality it is possible to infiltrate 45 mm/hour locally
- Larger rainfall events can be drained with a delay without any problems
- Prevent damage to buildings or unsafe situations during peak rainfall events by draining the water to an area where it cannot cause damage

Drought

- Prevent damage to green during periods of drought
- Prevent structural damage due to lower groundwater levels during drought

Heat stress

- Experienced temperature in urban areas max 3-5 degrees higher than in the surrounding rural areas
- Max walking distance to a shaded area of 1 minute

Flood risk

- The Lekdijk is up to standard of the DPRA
- Vulnerable objects and vital infrastructure is designed water robustly
- Evacuation routes are up to standard
- Amenities of utility companies are able to withstand a water height of 30cm

The how

Water nuisance

- Use greenery to 'manage' water nuisance
- Replace paving by greenery
- Create green strips, nature inclusive playgrounds and more green in gardens, there are more possibilities for water to infiltrate
- Collect water in cultivated trenches with a permeable soil, wadis, and let the rainwater flow to surface water through wadis
- Have an infiltration capacity of at least 20 mm/hour (aim is 45 mm/hour) on every plot for new construction and restructuring projects
    1. Any additional rainwater will be buffered with a delayed drainage
- In locations with low traffic intensity, use water permeable paving
- Locate adequate places to temporarily store excess rainwater (parking lots for example)
- Stimulate private parties to practice proper water management
- Create more green and water surface in urban areas
- Stimulate green school playgrounds
- Detach rainwater from sewer system

Drought

- Use drought resistant greenery
- Let water infiltrate into the soil as much as possible to create a buffer for longer periods of drought
- Stimulate private parties to practice proper water management

Heat stress

- Create more green spaces that provide shade
- In the design of new buildings, the sun position will be taken into account so heat stress in bedrooms is decreased
- Create more green roofs to stimulate the cooling effect of evaporation
- Add more green to public and private space
- Create green spaces with different plant/tree heights
- Create local heat plans and 'tropenroosters' for schools

Flood risk

- Finish the development of the ‘meerlaagseveiligheid’ approach
- Collaborate with the safety region, province and HDSR

Construction type

- New constructions
    1. Designed in a climate adaptive way
    2. Positioning of the sun is taken into account to create cool bedrooms
    3. Prevention of water nuisance is included as a leading principle
    4. In investments of municipal real estate, climate adaptation demands will be included
- Restructuring
    1. Prevention of water nuisance is included as a leading principle
    2. Research will be done into how and what climate adaptation measures can be taken and what the consequences of solar panels and green roofs are to the structural integrity of buildings

Finances

- Good budgeting up to 2022, could not find anything newer

Document G: Visie klimaatadaptatie Utrecht

Current situation

Water nuisance

- Sewer system can handle rainfall up to 20 mm/hour
- Risk of water staying on the streets and causing it to be unavailable for traffic, including emergency vehicles
- Expected damage caused by water nuisance between 2018 and 2050 is estimated to be €480-570 million (only damage to buildings, damage to public space and traffic obstruction is not included in this amount)
- Chance of groundwater nuisance increases due to wetter winters which can cause foundation damage, health problems and trees and plants that die due to root rot

Drought

- Utrecht not susceptible for subsidence, except for peaty areas in the rural areas
- To a lesser extent, clayey soils may also cause problems. Clay soils are present throughout the city some known examples of drought damage are the Ringkade in Rijnenburg and the Tjepmaweg in De Meern
- Especially pre-war buildings that do not have foundations or historical buildings that have different types of foundations are at risk to experience drought damage
- Fluctuating groundwater level as a result of drought can also have a negative effect on archaeological structures in the subsurface
- Drought can also lead to damage to urban green especially younger greenery that does not have a full grown root system yet is vulnerable
- Surface water also experiences problems during drought, especially the water quality of (recreational) water deteriorates
- Expected damages between 2018 and 2050 are estimated at €140 to €670 million
    1. The large range in costs is caused by the large range of costs to restore foundation damage
    2. Direct damages to urban greenery in Utrecht in the extremely dry year 2018 were €400.000

Heat stress

- Amount of hot and tropical days will increase, as will the amount of consecutive hot days
- Heat stress is a big problem in the city centre and the surrounding neighbourhoods, where the experienced temperature can be more than 8 degrees higher than the edges of the city on a hot day
- The lack of shade and greenery also causes the night time temperature to be higher which can cause bad sleeping conditions
- In almost the entire city of Utrecht, inhabitants can reach a cool area withing 200m walking distance
- Only in parts of Lombok, Parkwijk Zuid, ‘t Zand and Hoge Weide this is not the case
- Expected damages between 2018 and 2050 are estimated at € 170-200 million
    1. This amount makes up the direct damage, such as decrease in work productivity, death, hospitalisations and controlling of the oak processionary caterpillar
    2. Indirect damage is not accounted for, indirect damage is mostly prevalent in vulnerable groups like elderly, sick people and young children and can consist of an increase in allergies, skin cancer, and respiratory diseases as a result of smog.

Furthermore, damage cause by heat to infrastructure is not accounted for in the expected damages

Flood risk

- The chance of a dike breach of the Lekdijk is estimated at 1 in 200 years
- Project 'Sterke Lekdijk' of HDSR increases the flood security and makes the chances 1 in 30.000 years
- In the event of a dike breach only the inner city and the centre of Vleuten will stay dry
- In the largest part of the municipality there will be a water level of approximately 0.5m
- In the lower laying areas of Papendorp and Rijnenburg, the water height can reach up to 2m
- Evacuation routes like the A2, A12, A27 and A28 will be partially covered by water
- In case of a looming dike breach the city of Utrecht will be evacuated, the water will reach the city of Utrecht in about 24 hours which limits the evacuation time and this makes flooding risky
- If there is more than 20cm of water on the surface, utilities such as electricity, gas, heat and water will fail and roads will be inaccessible
- It can take up to a year for the area to be dry, accessible and liveable again
- The estimated damage for the region Utrecht Zuidwest in case of a dike breach at Amerongen is €13,8 billion and 105-950 casualties

Goals

Water nuisance

- Rainfall of up to 80 mm/hour does not cause damage to buildings and inaccessible roads
- The soil will be used as a sponge, where possible water will be infiltrated and stored in the soil to be available during dry periods.
- On main roads emergency vehicles should be able to drive 50km/hour, on other routes at a walking pace
- Roads should be able to be used normally again 3-4 hours after the rainfall event
- No combined sewer overflow

Drought

- Provide a minimum of 40% of greenery in the horizontal plane

Heat stress

- Combat the heat island effect and limit the temperature difference between the urban and rural area to max 5 degrees
- Have at least 30% of shade in every street and 40% on routes with slow moving traffic
- Have a cool and green public space of at least 200m^2 available for every inhabitant within 200m walking distance (200m is chosen instead of 300m because a survey showed that inhabitants found 200m an acceptable walking distance and it caters to a larger group of people as elderly and small children can reach 200m within 5 minutes)
- At least 40% of greenery in the horizontal plane
- Aim to have the experienced temperature not higher than 40 degrees, unless the temperature in the rural area also exceeds 40 degrees

The how

Water nuisance

- Rainwater will be stored where it reaches the surface and will be used in a useful way

- A minimum of 90% of the rainwater will be stored/infiltrated where it reaches the surface
- Employ a desired sequence of dealing with rainwater
    1. Hold on roofs and rain barrels and use it in a useful way
    2. Infiltrate it above ground
    3. Infiltrate it below ground
    4. Process it in surface waters
    5. Drain it to a sewage treatment plant
- Additionally, in the long term the goal is to reduce the amount that is drained to the sewage treatment plant to zero
- The goal is to hold at least 90% of the annual rainwater according to the first three steps
    1. This is because the additional investments are relatively high for amenities that will rarely be used. In that case the benefits do not outweigh the costs
- For the most widespread soil structure and infiltration capacity this means that a storage facility with a capacity of 15 mm (15l per m^2) is needed to be attached to the paved surface
- There are certain areas where a higher percentage of storage is required
    1. The aim in these areas is to store 45 to 70 mm
    2. This counts for areas where the paving increases with more than 500m^2
    3. In the transformation of highly urban areas with little public space for water storage, the requirement is higher for the plots
        - In those areas, following the most prevalent soil structure, an infiltration facility (or alternative water storage) with a capacity of 45l per m^2 of adjacent paving
        - The choice to go for a higher situated storage to hold the yearly rainfall has been made in collaboration with HDSR and the province
- Groen, tenzij… principle

Drought
- Use greenery that is fit for the future climate
- Add more greenery to prevent the drying out of the soil
- Infiltrate the rainwater locally

Heat stress
- Employ nature based solutions, like planting trees to create more shade
- Green area on the surface, roofs are seen as elevated surface
- Create a cooling effect by planting more trees to stimulate evaporation, the combination of shade and evaporation creates the largest cooling effect
- If no plants are possible create shade through pergolas, buildings, façade gardens, etc.
- Limit the use of air-conditioning because that merely shifts the problem from the inside of buildings to the outside of buildings
- To reach the goals 60.000 trees need to be planted in the urban area and at least 420 hectares need to be converted from paved area to green area
- This task is in line with the “Schaalsprong groen” which has the ambition of supplying 440 extra hectares of green with the growing of the city
- Create recreation water of good quality
- Create green corridors that lead out of the city, that also provide cool air

Flood risk
- Project sterke Lekdijk, HDSR

- Employ spatial planning in a way that protects vital and vulnerable functions

Collaboration partners and projects

- Linkage of climate adaptation to other projects like sewer replacement, new construction projects, restructuring, mobility projects, energy transition and transition to a circular economy
    1. This way the street only needs to be restructured once and this prevents the nuisance to inhabitants
    2. The aim is to use all opportunities to incorporate climate adaptation in spatial developments
    3. the expectation is that by 2050 45-50% of the public space can be made climate adaptive through the linkage with sewer replacement
    4. through demolition and new construction an additional 15-20% of the public space can be adapted, the remaining 30-40% of the city should still be assigned to a project
- Relatie Visie Water en Riolering
    1. Huge overlap between the two programmes, the programmes are also constructed simultaneously
- Relatie Ruimtelijke Strategie Utrecht (RSU)
    1. The spatial vision for the city for the development of the physical environment of 2040
- Schaalsprong Groen
    1. Green streets: existing and new
    2. Green-blue routes
    3. New park areas within the city
    4. Green wedges that connect the urban and the rural
    5. Green around the city
- Relatie nota beheer openbare ruimte
- Inhabitants
    1. 60% of the space in Utrecht is privately owned by inhabitants or businesses
    2. They should be involved in the climate adaptation strategy
    3. Provide information in an accessible and approachable manner
    4. Make citizens aware of possibilities and subsidies
- Partners in the city and region
    1. Province Utrecht
    2. HDSR
    3. Netwerk Water & Klimaat
    4. GNK and KANS (municipal network climate adaptation and network for middle large cities)
    5. National roofplan

Finances

- Costs for de Groene Schaalsprong are estimated at €1.6 billion until 2040
- HDSR and province Utrecht are important collaboration partners
- Netwerk Water & Klimaat gets €7.5 million from the Deltaprogramme of the national government for the time period 2021-2027
- National government finances 33% of the operational costs of climate adaptation
- Expected €2 million available to increase the sponge function of the city
- Annually €390.000 made available from Gezond Leefklimaat & €500.000 from water and rioleringsprogramma

Document H: Klimaatvisie Oudewater

Current problem

Water nuisance

- Sewage system is designed for rainfall up to 20 mm/hour
- There have been 4 showers with an intensity of > 60 mm/hour that lasted for up to 30 minutes
- In the centres Oudewater and Hekendorp there have been 4 showers with an amount of 30-45 mm/hour
- There are two distinctive effects of water nuisance
    1. Hindrance: temporary water on the street, with hindrance to traffic, but no material damage
    2. Nuisance: water in buildings, material damage and hindrance to traffic on main roads (as a result of flooded tunnels, for example)

Drought

- During longer periods of drought the groundwater table lowers which causes the following effects:
    1. Desiccation of greenery
    2. Speeding up of subsidence in peat areas
    3. Decrease of crop yields
    4. More frequent and longer periods that wooden pile foundations are above the water table with wood rot as a consequence
    5. Degradation of flora and fauna because of a lack of refreshing of surface water which causes the water quality to degrade

Heat stress

- City centre and business parks are hotspots for urban heat islands
- The most prevalent causes of the urban heat island effect are:
    1. The large amount of dark coloured materials in a city, (high rates of paved surface, like asphalt, stone, roof leather, etc.) that absorb and emit heat more than greenery
    2. Dense built up surface, this causes the wind to be obstructed. Wind has an important role in the cooling of an area and the moving of particulate matter which impacts the air quality
    3. Lack of space for large trees which provide shade and evaporate water which cools the air

Flood risk

- In case of a dike breach of the Lekdijk, the entire municipality will be covered in water
- In the village Oudewater the depth varies from 1-2m
- The depth in the surrounding polders varies from 2-5m

Goals

- Have been determined based on:
    1. The connection to other policy fields (water quality is connected to the green blue omgevingsplan, goals of GWP have been supplemented with new insights on heavy rainfall events and the cost benefit analysis)
    2. Neighbourhood focussed approach: for every neighbourhood the spatial uses (above and below ground) are taken into account, as is the fact whether or not the

neighbourhood will be restructured before 2050. This will make the goal realistic and attainable.
3. The amount of influence of the municipality, some neighbourhoods have more public space than others. In case of more privately owned space, the responsibility lies more with citizens and businesses
4. Dialogue partners, province Utrecht, HDSR, and building cooperation De Woningraat
5. Costs and benefits

- General premises for neighbourhood labels are
  1. The neighbourhood labels are a quick scan per neighbourhood, for which the most recent data is used. It is an estimation and not 100% certainty
  2. In order to meet the standards of a label, several indicators will be accounted for. An example is that 40% of the neighbourhood will need to meet a certain standard, this differs per indicator
  3. If the current situation scores better than the aim, the situation cannot worsen

Water nuisance

- No water nuisance during rainfall events of 70 mm/hour
- In new constructions no water nuisance during rainfall events of 90 mm/hour
- In existing build environment
  1. No damage to buildings during a rainfall of 70 mm/hour (label B)
  2. No hindrance to traffic during rainfall of 70 mm/hour (label B)
  3. In existing situations label A is not cost effective, so label B is chosen
- In new constructions
  1. No damage to buildings during rainfall of 90 mm/hour (label A)
  2. No hindrance to traffic during rainfall of 90 mm/hour (label A)
  3. A shower of 90 mm/hour is held in the local area, rainwater may be drained to surrounding areas, but does not cause problems there

Drought

- Infiltration drains have been installed to prevent damage to wooden foundations underneath roads and buildings
- There is no damage to buildings and groundwater
- Water that is needed to irrigate municipal green is locally sourced
- Subsidence does not cause problems in urban areas
- Newly planted trees will have a lifespan of at least 60 years because the groundwater table and soil composition have been taken into account
- In existing build environment
  1. Public space is lightly susceptible to subsidence through loading (label B)
  2. Public space is lightly vulnerable to low groundwater tables (label B)
  3. Water quality label B
- New constructions
  1. Land subsidence label A, despite longer and more frequent periods of drought, subsidence cannot be a problem on the long term
  2. Groundwater table label A, by using concrete pile foundations there is no risk of wood rot
  3. Water quality label B, water is free of bottlenecks like blue algae, duckweed and trash. Dependent on the potential of a water way, a realistic label (B or A) has been determined based on expert judgement

Heat stress

- Heat stress is minimal as a result of heat resistant spatial planning in the built environment and public space
- In the municipality, greenery is available within walking distance
- Existing build environment
    1. Heat during the day:
        - Residential neighbourhoods: label C (40% of the street is 'normal')
        - Recreational areas (areas with slow moving traffic, parks, playgrounds): label B (40% of the street is 'cooler')
        - Business parks: label D (40% of the street is 'warmer')
        - In many cases label B is only attainable with help of citizens to make changes in their gardens and on their plots
    2. Heat during the night
        - Label C, 14-21 nights with a temperature higher than 20 degrees
        - Paved areas slowly emit heat during the night, this makes a higher label not realistic
    3. Distance to a cool area
        - Label C, the distance to a 'cool' area is 366m (5-6 minutes walking distance)
- New construction
    1. Heat during the day
        - Label B, 40% of the street is 'cooler'
        - Business parks label C, 40% of the street is 'normal'
    2. Heat during the night
        - Label B, 7-14 nights where the minimum temperature exceeds 20 degrees
    3. Distance to a cool area
        - Label B, the distance to a 'cool' area is max. 300m (4-5 minutes walking distance)

Flood risk

- The national government and HDSR have strengthened the Lekdijk and other regional flood barriers
- In case of a flood, the consequences are minimised and the recovery time in Oudewater is minimal as a result of the optimal employment of 'meerlaagse veiligheid'
- Label C, chance of dying as a result of flooding is 1:1.000.000 per year

The how

Water nuisance

- Work with intermediate goals to reach label B: 2030: 80%; 2040: 90%; 2050: 100%
- In existing build environment and new constructions
    1. Install green lowered where necessary to create a temporary storage
    2. Where possible, install 'open paving' (for example on parking lots)

Drought

- Intermediate goals: 2030: 100% label C
- In existing build environment
    1. New trees alongside water ways are species with little leaf shedding
- In new constructions

1. In relation to water quality, every waterway has enough sunlight and wind. This means that 60% of the waterway is exposed to sunlight at noon
2. Trees alongside waterways are species with little leaf shedding
3. On private property, rainwater infiltrates where it reaches the surface. What cannot be infiltrated will be drained above ground to public space

Heat stress

- Intermediate goals to label C: 2030: 90%; 2040: 95%; 2050: 100%
- Existing build environment
    1. Newly planted trees will provide as much shade as possible by having a large tree crown and have a lifespan of at least 60 years, focus on tree quality instead of tree quantity
    2. In the creation of new shade by trees, the situation of 20 years in the future will be looked at, when the trees have a full grown crown
    3. Trees will be surrounded by green instead of paving to increase the lifespan of the tree by letting more water infiltrate
    4. Trees are located on the south, southwest or west side of the street to allow for solar panels to capture enough sunlight
    5. In residential neighbourhoods and business parks, in restructuring projects 10% of paving will be replaced by greenery
    6. In case of limited public space, the aim is to create façade gardens of 1 to 2 street tiles
- In new construction
    1. Newly planted trees will provide as much shade as possible by having a large tree crown and have a lifespan of at least 60 years, focus on tree quality instead of tree quantity
    2. In the creation of new shade by trees, the situation of 20 years in the future will be looked at, when the trees have a full grown crown
    3. Trees will be surrounded by green instead of paving to increase the lifespan of the tree by letting more water infiltrate
    4. At least 40% of public space has shade at the time of the highest sun position between 12:00 and 18:00, the focus of the shade is aimed at areas with slow moving traffic
    5. To prevent hot nights, it is important that little heat is stored in materials, to prevent this at least 50% of the south/southwest facing side is designed in a heat repellent way
    6. In case of limited public space, the aim is to create façade gardens of 1 to 2 street tiles

Flood risk

- Intermediate goals to label C: 2030: 100%
- In locations with a water height of up to 50 cm in case of dike breach, it can be considered to build elevated (in a neighbourhood) or use the building as a flood defence

Construction type

- The differences between new construction and restructuring have been explained in the ‘how’ section

Finances

- Existing build area
    1. Climate adaptation measures is included in restructuring projects

2. Neighbourhoods that are not scheduled for restructuring before 2050 will be addressed with an 'uitvoeringsplan klimaatbestendige openbare ruimte (KBOR)' (implementation plan climate robust public space)
3. The financial means are already part of the budget and will be paid for from the sewage tax and the budget that is made available for trees

- In new constructions
    1. Financed from grondexploitatie (ground exploitation)
    2. By making climate adaptation part of construction projects, additional costs will be minimal
    3. If new construction projects are scheduled for subsidence susceptible soils, costs will be paid for by the investors

Monitoring

- Water nuisance
    1. Water nuisance map, updated every 3-5 years
- Drought
    1. Soil subsidence map, updated when new data is available
    2. Focus area map, updated based on KCAF
    3. Particulate matter map, developments are monitored nationally
    4. Ecoscans (water quality), updated every 3 years
- Heat stress
    1. Experienced temperature map, updated every 3-5 years
    2. Hot nights, developments are monitored nationally
- Flood risk
    1. Local individual risk, updated every 10 years (national map)

Document I: Omgevingsvisie/GRP Stichtse Vecht

No LAS (climate adaptation is an integrated part of the GRP). GRP is created by TAUW. Building covenant Klimaatadaptief bouwen is included in GRP

Current situation

Water nuisance

- During heavy rainfall events there will be water on the roads (problem linked to subsidence)
- There will be damage to buildings during heavy rainfall events
-

Drought

- Peaty soils, so susceptible to subsidence
    1. Through loading of the surface
    2. Through peat oxidation
- Largest problems along the Loosdrechtse plassen and in the west side of the municipality (Kockengen)

Heat stress

- Problem in Maarssenbroek and Maarssen
- To a lesser extent a problem in Breukelen

Goals

Water nuisance

- No nuisance in case of 70 mm/hour rainfall
- In case of vulnerable functions, no nuisance in case of 90 mm/hour
- The different stages of water nuisance (acceptable to not acceptable) are determined based on guidelines from NW&K
    1. Hindrance, severe hindrance, nuisance
    2. The size of the problem of water on the street: limited (a few buildings and/or <10 people involved), reasonable (a whole street and/or 10-100 people are involved), large (several streets and/or >100 people are involved)

Drought

- Water quality should be at the level 'zichtbaar'
- With regards to subsidence, the technical lifespan of public space needs to be at least 60 years
- The effects of subsidence remain manageable and affordable

Heat stress

- At least 40% shade at the highest sun orientation (June 21st) for recreation locations and location with slow moving traffic
- At least 30% shade at the neighbourhood level
- Cool, shadow rich locations need to be at walking distance (300m) and publicly accessible. These areas need to be >200m^2
- 40% of all horizontal and vertical surfaces need to be designed heat reflective or cooling
- The air-conditioning of buildings does not lead to warming of the (residential) space in its direct surroundings
- Vital and vulnerable functions and greenery in public space needs to be heat resistant

The how

Water nuisance

- In new constructions need to hold 50mm/hour on their plot
- Preferred sequence of dealing with rainwater:
    1. Hold: prevent the drainage of rainwater, for example through not paving the surface in public space
    2. Store: offer capacity to temporarily hold and store rainwater on the land surface
    3. Drain to surface waters: if holding or storage is not possible, water will be drained to surface waters with a delay
    4. Drain to sewage: if drainage to surface waters is not possible or desirable, it will be drained to the sewage
- Include detachment from the sewage system in every restructuring project
- Act according to the principle, 'Detaching, unless…'
- Give priority to known bottlenecks
- Provide subsidies for inhabitants to take climate adaptive measures on their own plots
- In new construction projects, every plot needs to be able to infiltrate 50 mm/hour (range between 40-70 mm/hour)
- The plots only drain with a delay during the first 24 hours
- The plots are fully available again after a maximum of 60 hours
- Implement a threshold height of 30cm above street level for new buildings

Finances

- Annual budget of €240.000, included in GRP
- Additional €70.000 annually as subsidies for inhabitants

Document J: Actieplan Klimaatbestendig 2050 2.0 (Woerden)

Current situation

Water nuisance

- In the years 2013-2016 rainfall events of more than 50 mm have occurred six times
- Rainfall event of 20-50 mm occur more often, on average 6-8 times a year
- Distinction between hindrance and nuisance
    1. Hindrance means temporary water on the street and limitations to traffic in residential streets, sewage overflows, but no material damage
    2. Nuisance means water in buildings and dwellings, wastewater on the street, material damage and business damage, flooded tunnels, and limitations to traffic on main access roads
- Currently, heavy rainfall events lead to nuisance
- A long term effect of more often occurring water nuisance is the wetting of the soil which causes tree species, which are not resistant to wetness, can die off

Drought

- Longer periods of drought can lead to water scarcity
- Because of the lower groundwater table trees and shrubs can die
- Wooden pile foundations can become dry
- Woerden is mostly located on peaty soils which are susceptible to subsidence, lowered groundwater tables speed up subsidence
- Because of lowered water tables, the water in ditches does not get refreshed which negatively impacts the water quality, this causes flora and fauna to die
- Furthermore, water scarcity as a result of drought can lead to decreased crop yields
- In the future the negative impacts of drought are expected to increase

Heat stress

- In the inner city, the experienced temperature on hot summer days is about 5-6 degrees higher than in the rural area because of the heat island effect
- This uhi effect is mainly caused by the use of dark construction materials like stone and roof tiles, those absorb heat during the day and then emit it during the night
- Additionally, the dense distribution of buildings obstructs the wind from providing a cooling breeze
- The amount of heat waves is expected to increase and the overall temperature will increase as well
- Labour productivity decreases if the temperature exceeds 25 degrees
- Due to the heat island effect, the city becomes less pleasant to live and recreate in
- Paved areas generally score label D on heat during the night

Flood risk

- Due to climate change (sea level rise, increase of snowmelt in the Alps, subsidence, increase in peak rainfall events), the chances of the Lek flooding increase
- The Deltaprogramme mitigates that risk
- In case of flooding, Woerden will be completely flooded
- The effects of a flood are not yet clear, but Woerden is by no means ready for a flood
- Current score in Woerden is label E

Goals

- In 2050, the municipality Woerden is resistant to heavy rainfall events, long periods of drought, heat and flooding.

Water nuisance

- Existing urban areas
    1. No damage to buildings in case of a 60 mm/hour rainfall (label B)
    2. No hindrance to traffic because there is less than 10cm water on the road in case of a rainfall event of 70 mm/hour (label B)
    3. In both situations label A is not cost effective
- New constructions
    1. No damage to buildings in case of a rain event of 90 mm/hour (label A)
    2. No hindrance to traffic because there is less than 10cm of water on the road in case of a rain event of 90 mm/hour (label A)
    3. Rainwater can be drained to surrounding areas, but is not allowed to cause problems in those areas

Drought

- Existing urban areas
    1. Subsidence in public areas is mildly susceptible because of loading (label B)
    2. Public areas are 'a little' vulnerable to low ground water tables (label B)
        - The municipality will make sure that dwellings with a wooden pile foundation can reach at least label B, through the installation of infiltration drains
    3. The water quality is 'lively' (label B)
        - Water is free of bottlenecks like algae, duckweed and trash, dependent on the potential of a waterway an estimation of what goal is attainable (label A or B) is made based on expert judgement
- New construction
    1. Public areas are not susceptible to subsidence (label A)
    2. Foundations of buildings are not at risk of wood rot as a result of low groundwater levels through the use of concrete foundations (label A)
    3. The water quality is 'lively' (label B)
        - Water is free of bottlenecks like algae, duckweed and trash, dependent on the potential of a waterway an estimation of what goal is attainable (label A or B) is made based on expert judgement

Heat stress

- Existing urban areas
    1. Heat during the day
        - Residential neighbourhoods: label C (40% of the street is 'normal')
        - Recreational areas (areas with slow moving traffic, parks, playgrounds): label B (40% of the street is 'cooler')
        - Business parks: label D (40% of the street is 'warmer')
    2. Heat during the night
        - Label C, 14-21 nights with a minimum temperature of over 20 degrees
        - To reach label C, a part of paved area needs to be replaced by greenery
- New construction
    1. Heat during the day
        - Label B, 40% of the street is 'cooler'

        - Business parks: label C, 40% of the street is ‘normal’
    2. Heat during the night
        - Label B, 7-14 nights have a minimum temperature of 20 degrees

Flood risk

- Label C, chance of dying as a result of flooding is 1:1.000.000 per year
- This will happen as soon as project sterke Lekdijk is finished
- In new constructions the consideration has to be made if it is profitable to build flood robustly (label A), for every project additional measures to mitigate the effects of a flood will be considered

The how

- Distinction between design requirements and design principles
    1. Requirements: essential design elements to attain the set goals, these requirements count for restructuring projects and new construction
    2. Principles: strongly recommended measures that can be taken to reach the goal, a distinction has been made between existing structures and new construction
- Implementation approach klimaatbestendige openbare ruimte (KbOR)
    1. In collaboration with HDSR and administrators of the municipality, bottlenecks on the topic of water nuisance, quality and drought have been assessed. This implementation approach shows necessary adjustments to the current public space to reach the goals
- General design requirements’
    1. During restructuring projects or other adjustments, the current label will not decrease
    2. In case of restructuring, there will be a cost benefit analysis to reach a higher label

Design requirements:
Water nuisance

- Heavy rainfall events are held locally and does not cause problems to surrounding areas
- The first 45mm/hour that falls on paved surfaces will be held in ditches, the remaining water is stored above ground
- Results of the research ‘hemelwaterafvoer van de toekomst’ will be implemented in reconstructions

Drought

- 50% of the yearly precipitation (450mm in 2050) will be infiltrated where it reaches the surface
- In case of new construction, a loading free construction like floating building or foundation laying will be used, unless it can be proven that this is not financially or technically feasible
    1. In case loading free construction is not possible, a loading reduced construction will be used. Certain requirements have to be met in this case
- In new constructions it is not desirable from sustainability, flexibility and management stand points to use lightweight heightening techniques
- In case of restructuring projects, loading free will be weighed against loading reduced options, because the possibilities to build loading free are little compared to new construction. In this case, certain requirements need to be met as well
- Because of the use of concrete foundations, there are no attention areas (at risk areas) for low groundwater levels anymore

- In areas that are ‘very vulnerable’ or ‘vulnerable’ for low groundwater tables, infiltration drains will be placed in the public space during restructuring projects, if effective

Heat stress

- In order to prevent unnecessary paving, the principle ‘groen, tenzij….’ Will be used
- Trees with a remaining lifespan of a minimum of 15 years will be kept during restructuring projects
- The cooling of buildings (through air-conditioning) may not lead to heating up of (residential) space in the direct surrounding

Flood risk

- Essential business parts and vital functions are not located on the ground floor or basement
- Locations with a flood depth of up to 20cm do not experience damage to buildings and the main roads will remain accessible
- For locations with a flood depth of up to 50cm, an assessment will be made for the prevention of damage to buildings
- For locations with a flood depth of up to 200cm, vital functions and objects will be protected

Design principles:

Water nuisance

- For existing and new areas
    1. Install green lowered where necessary to create a temporary storage
    2. Where possible, install ‘open paving’ (for example on parking lots)

Drought

- Existing areas
    1. New trees alongside water ways are species with little leaf shedding
- In new constructions
    1. In relation to water quality, every waterway has enough sunlight and wind. This means that 60% of the waterway is exposed to sunlight at noon
    2. Trees alongside waterways are species with little leaf shedding
    3. On private property, rainwater infiltrates where it reaches the surface. What cannot be infiltrated will be drained above ground to public space

Heat stress

- Existing build environment
    1. Newly planted trees will provide as much shade as possible by having a large tree crown and have a lifespan of at least 60 years, focus on tree quality instead of tree quantity
    2. In the creation of new shade by trees, the situation of 20 years in the future will be looked at, when the trees have a full grown crown
    3. Trees will be surrounded by green instead of paving to increase the lifespan of the tree by letting more water infiltrate
    4. Trees are located on the south, southwest or west side of the street to allow for solar panels to capture enough sunlight
    5. In residential neighbourhoods and business parks, in restructuring projects 10% of paving will be replaced by greenery
    6. In case of limited public space, the aim is to create façade gardens of 1 to 2 street tiles
- In new construction

1. Newly planted trees will provide as much shade as possible by having a large tree crown and have a lifespan of at least 60 years, focus on tree quality instead of tree quantity
2. In the creation of new shade by trees, the situation of 20 years in the future will be looked at, when the trees have a full grown crown
3. Trees will be surrounded by green instead of paving to increase the lifespan of the tree by letting more water infiltrate
4. At least 40% of public space has shade at the time of the highest sun position between 12:00 and 18:00, the focus of the shade is aimed at areas with slow moving traffic
5. To prevent hot nights, it is important that little heat is stored in materials, to prevent this at least 50% of the south/southwest facing side is designed in a heat repellent way
6. In case of limited public space, the aim is to create façade gardens of 1 to 2 street tiles

Flood risk

- In locations with a water height of up to 50 cm in case of dike breach, it can be considered to build elevated (in a neighbourhood) or use the building as a flood defence

Intermediate goals

- Water nuisance: 2030: 80% label B; 2040: 90% label B; 2050: 100% label B – to do: 48%
- Drought: 2030: 100% label C – to do: 9%
- Heat stress: 2030: 90% label C; 2040: 95% label C; 2050: 100% label C – to do: 20%
- Flood risk: 2030: 100% label C – to do: 91%

Construction type

- The differences between new construction and restructuring have been explained in the 'how' section

Finances

- Total costs (excluding subsidence): €23 million
- Average annual costs: €775.000
- Budgeted: €14,7 million
- Not budgeted: €8,4 million
    1. Sewage taxes: €5,1 million
    2. Co-financing HDSR: €2,8 million
    3. External financing (yet to be found): €500.000

- To inform citizens and businesses and stimulate them to them to take measures themselves, an annual amount of €150.000 is made available.
    1. €100.000 of this amount is available for subsidising detachment of rainwater from the sewer system and the construction of green roofs
    2. €50.000 is spend on communication with citizens

Monitoring

- Water nuisance
    1. Water nuisance map, updated every 3-5 years
- Drought
    1. Soil subsidence map, updated when new satellite date is available

2. Attention areas map, updated based on KCAF
3. Particulate matter map, developments are monitored on the national level
4. Ecoscans (water quality), updated every 3 years

- Heat stress
    1. Experienced temperature map, updated every 3-5 years
    2. Hot nights, developments are monitored on the national level
- Flood risk
    1. Local individual risk, updated every 10 years (national map)

Document K: Regenwaterstructuurplan, GRP and collegeprogramma Bunnik

The municipality does not have a climate adaptation strategy document yet, relevant information is taken from other reviewed documents (regenwaterstructuurplan TAUW) (the collegeprogramma 2022-2026 does mention that the Programma Water en Riolering will be elaborated and will include an action plan for climate adaptation that includes heat stress, drought and water nuisance. Additionally, implementation programme Klimaatneutraal Bunnik 2040 will be drafted with accompanying route map and concrete and measurable intermediate goals

Current situation
Water nuisance

- Areas that have experienced water nuisance in the past have been identified in Bunnik and Odijk
- Potential bottlenecks have also been identified and mapped on the street level in Bunnik, Odijk and Werkhoven
- Detachment of rainwater from the sewage system is difficult in some places because the distance to surface waters is more than 100m
- Sewage system is designed for a t=2 rainfall event, 20 mm/hour
- Water on the street does not always lead to nuisance, a differentiation is made between:
    1. Hindrance: temporary water on the street (less than 2 hours), no material damage, no limitations to traffic
    2. Severe hindrance: (large) amounts of water on the street (more than 2 hours), floating pothole covers, (severe) limitations to traffic
    3. Nuisance: water inside buildings, material damage and severe limitations to traffic on access roads

Goals

- By 2050 urban areas within the municipality Bunnik should still be attractive to live in

Water nuisance

- Rainwater that falls in urban areas may not cause severe hindrance or nuisance inside urban areas
- No hindrance during a rainfall event of t=2 + 10% (22 mm/hour)
- No nuisance for a rainfall event of t=10

The how
Water nuisance

- Detaching of rainwater from sewer system where possible
- For the processing of rainwater HDSR acts according to the following preferred sequence:
    1. Infiltration in the soil
    2. Visible drainage to surface water
    3. Drainage through rainwater sewage to surface water
        - So, where possible, rainwater is infiltrated
- Infiltration vision:
    1. Infiltration possibilities are dependent on local conditions such as the groundwater level and soil type
    2. Urban centres of Bunnik largely have a groundwater level of 1,6m below the surface, this makes the groundwater level suitable for infiltration
    3. In Werkhoven, there are locally high groundwater levels as a result of impermeable layers, which makes it not suitable for infiltration

4. Residential centres are located on the upper depositions of the Kromme Rijn, which causes the soil to largely consist of clay. These soils are hardly permeable which causes the natural infiltration speed to be low.
    - Because the impermeable clay layer often is not very thick, soil improvement (replacement of impermeable layer by permeable sand) can increase the infiltration capacity
5. As a result of paving in public and private areas, infiltration is hindered. To combat this, unnecessary paving is replaced by green in public areas
6. By lowering green strips in relation to the paved surface, rainwater can infiltrate in those locations
7. Wadis are also locations where water can first be stored and then slowly infiltrated
8. Citizens are asked to infiltrate as much water on their own property as possible
9. Where paving is necessary, infiltration can be facilitated as well by the implementation of infiltration paving or infiltration sewers.

- Storage vision:
    1. Water that cannot infiltrate immediately needs to be stored, by doing this devolution on the regional surface water system is prevented
    2. Rainwater can be stored in yet to be developed water ways
    3. Space is scarce, so a combination of functions is desirable, so green amenities, playgrounds and parking lots can be used as a temporary storage location
    4. By adding relief or wadis, water can be held, this can be created in combination with natural playgrounds
    5. Subsurface water storage in sewage or crates is also possible, however, these measures are costly in both construction and maintenance. They are also not visible, so they do not raise awareness amongst citizens. For these reasons, above ground storage has the preference
    6. In case of extreme rainfall it is acceptable for water to be on the streets temporarily and possibly in gardens as well.
    7. The most important thing is that there is no water inside buildings and the roads remain accessible to emergency services
- Drainage
    1. A robust water system needs, apart from infiltration and storage measures, a subsurface drainage structure to drain excess rainwater to surface waters
    2. For the discharge to surface waters and agreement with HDSR is needed, the municipality needs to provide concrete plans to HDSR that will then be reviewed on the efforts of holding as much water as possible before discharging it on surface waters. Furthermore, HDSR tests whether the discharge capacity of surface water is sufficient or needs to be made sufficient
    3. In Bunnik and Werkhoven consecutive private plots are located between public space and surface waters, here drainage pipes need to go through private property, this requires agreements with the plot owners

Restructuring of public space

- In all renovation projects of the sewage system, a separated sewage system will be installed
- In restructuring projects of public space, water storage will be included (if possible)
    1. Above ground storage and infiltration are preferred
    2. Chances to create less paving and the construction of wadis need to be considered

- Municipality has no set amount of water storage that need to be realised during restructuring projects, the desirable and attainable amount are determined for each separate project
- During restructuring of public space, above ground drainage of precipitation needs to be accounted for. The height of streets will be consciously chosen and the surface will be designed in such a way that the risk of nuisance is minimal

New constructions

- Newly constructed neighbourhoods will be build water robustly. This means:
    1. In new constructions, above ground drainage of precipitation is accounted for. The height of streets will be consciously chosen and the surface will be designed in such a way that the risk of nuisance is minimal
    2. The threshold of buildings needs to be at least 15 cm higher than the highest elevated point of the street. This enables storage of water on the street without causing major damage
    3. In all new spatial developments, water storage will be realised. Through the waterparagraaf water storage is required, according to the standards of HDSR (will be tested through de Keur)
    4. Every development can store and infiltrate a rainfall event of at least 40 mm/hour before water will be discharged on the municipal sewer system

Finances

- All from GRP
- For the period 2025-2027 an annual amount of €100.000 is budgeted

Document L: Integrale Visie Openbare Ruimte (IVOR) 2021-2031 IJsselstein

Climate adaptation strategy is still in development. Documents are currently for internal use only and will be released by the board only when the municipal government has reviewed them. For this reason, the IVOR and Handboek Openbare Ruimte are used to review the climate adaptation plans

Current situation

Water nuisance

- Increase in precipitation can cause problems in urban areas
- Urban areas experience problems during extreme rainfall events

Drought

- Drought is not yet a big problem
- One of the effect of drought the municipality experiences is a decrease in water quality

Heat stress

- In urban areas, heat stress is a problem due to the urban heat island effect
- Heat stress can cause health problems to vulnerable inhabitants
- The stress test has shown that several areas within the municipality experience heat stress

Flood risk

- Due to an increase in river discharges of the Lek, the dike safety can be under pressure in the future

Goals

- Make public space resilient for the future, aim for a robust spatial design
- Prevent nuisance as a result of climate change; water nuisance, heat stress and drought
- Create awareness among citizens by creating visible climate adaptation measures and actively communicate about it; example: visible above ground drainage of rainwater to temporary water storage facilities such as wadis
- Lessen financial damage as a result of climate change by implementing climate adaptive design
- Climate adaptive design leads to less health problems and casualties during extreme weather (heat stress)

Water nuisance

- There is enough space in green squares or on roads, to temporarily store water during peak rainfall events in a safe and controllable manner
- Actively look for locations that are suitable for (temporary) water storage
- If no space is available in the public domain, look for other solutions like storage on streets with a hollow profile or stimulating and facilitating measures for inhabitants like green roofs or creating more green in gardens

Heat stress

- The area is ‘cool’
- Green and water help create a cooling effect
- Trees are of great importance, the right trees in the right place and the total leaf crown are more important than the amount of trees
- Create more and robust green in order to provide cooling
- Improve the green structures around the town centre and make them connected to each other to create green corridors

The how

- Design principle:
    1. In case of restructuring, climate adaptation is taken into account by reserving the necessary and appropriate space
    2. Stimulating separated sewer systems for waste water and rainwater

Water nuisance

- Use water permeable paving where possible
- Implement the preferred sequence of processing rainwater: infiltration, storage, drainage
- Use bowl shaped verges, in which water can be stored temporarily during/after peak rainfall events (in case there is no space available in green squares)
- Use bowl shaped streets, in which water can be stored temporarily during/after peak rainfall events (in case the soil infiltration/water storage allows)
- Car parks on open paving (in case the soil infiltration/water storage allows)
- Replace unnecessary paving by greenery
- Use the canals in the town centre as water storage location
- Create places in residential areas to (temporarily) store rainwater
- Replace unnecessary paving on business parks by greenery or water
- Explore whether temporary water storage on business parks is a possibility

Drought

- Choose appropriate plants and trees that can handle the changing climate
- Implement nature friendly embankments to increase the water quality
- Take the flow of water into account in water ways

Heat stress

- Choose trees based on their quality, rather 1 mature tree than 10 young trees, because mature trees provide more shade
- Create more green, as plants and trees provide a cooling effect
- Prevent stationary water because that can be a breeding place for tropical diseases
- Use the canals in the town centre in a way that combats heat stress
- Use water in residential areas as a cooling mechanism

Flood risk

- HDSR has the project ‘Sterke Lekdijk’ which increases the water safety

New construction

- In construction projects, the ecological and climate adaptive qualities of the greenery are of great importance

Finances

- For now the it is included in the Wet Ruimtelijke Ordening, but this will be moved to the Omgevingswet

Document M: GRP, Groenbeleidsplan, MJOP Oevers Lopik

Lopik does not have a climate adaptation strategy but climate adaptation is integrally included in the GRP (TAUW), Groenbeleidsplan and MJOP Oevers. Additionally, the municipality is already busy with detaching from the sewer system, replacing paving with green, implementing open paving, and constructing nature friendly embankments (personal correspondence). A local adaptation strategy is in development.

Current situation

- In the timeframe 2018-2022 1,33 hectares of paved surface has been detached from the combined sewer system through a rainwater sewer

Water nuisance

- Several locations within the municipality have experienced water nuisance during heavy rainfall events
- Water on the streets can usually be traced back to improper gullies or relatively high water levels in the surface waters
- The urban centres in the municipality have a relatively low urban character and are oftentimes located in close proximity to surface waters, this makes the experienced water nuisance minimal
- Infiltration is not feasible due to high groundwater levels and the not suitable soil layering (clay and loam)
- There is a high surface water availability in the municipality, which decreases the necessity for infiltration
- V-shaped verges are used to drain rainwater above ground to surface waters
- Water drains directly from the street to the verge on increasingly more locations
- Lopik uses three stages to differentiate between the effects of water on the street
    1. Hindrance: Temporary water on the street (<1 hour) of mild amounts, during which transport is still possible (roads remain accessible)
    2. Nuisance: Severe hindrance (such as diluted wastewater on the streets or access limitations) the water remains outside of buildings and takes less than 2 hours to disappear
    3. Damage: inacceptable nuisance as a result of water on the street in case one of the following phenomena occurs:
        - Material damage
        - Long period of nuisance (>2 hours)
        - Nuisance on access roads or near vulnerable locations like care homes

Goals

Water nuisance

- Public space is designed in such a way that nuisance is minimal during a rainfall event of 70 mm/hour
- A t=100 (70 mm/hour) rainfall event does not cause damage to buildings
- A widespread green-blue network in urban areas makes sure that water is held and stored in the soil and water systems optimally during extreme rainfall events
- Vital objects and infrastructure are designed water robustly
- The water system is designed robust and resilient, so as to be able to handle peaks during wet and dry periods
- There is no negative impact on the water quality as a result of combined sewage overflows

- Inhabitants and businesses are aware of the effects of climate change and hold as much water as possible on their property
- Limit the area of paved surface

Heat stress

- Limit the area of paved surface
- Aim for climate specific greenery

The how

Water nuisance

- Detach rainwater from the combined sewer system, this decreases the chances of (waste)water on the streets during heavy rainfall
- Make use of above ground or subsurface drainage to surface waters
- Design public space in such a way that water can be stored in road profiles, green strips, wadis, playgrounds and surface waters
- During restructuring, use permeable paving on parking lots
- Aim for as little paving and as much green as possible during restructuring projects, according to the green policy plan
- Stimulate inhabitants and businesses to detach rainwater from the sewer system
- Use water permeable paving for verges and parking spaces
- Combine greenery with water bodies
- Drain paved surface to verges as much as possible

Heat stress

- Plant trees that are future proof
- Replace unnecessary paving with green
- Plant large trees in parks and wide green strips
- Keep climate change in mind in the design of greenery

Document N: Omgevingsvisie Montfoort

Montfoort uses the RAS as a guideline for their climate adaptation vision. The vision on climate adaptation is not a separate policy, but it is integrated in the Omgevingsvisie

Goals

Water nuisance

- Have a healthy soil that can hold water and limit desiccation and subsidence
- Improve the soil- and groundwater quality of groundwater and surface water
- Create space for water buffers or water surface to handle extreme rainfall

Drought

- Have a healthy soil that can hold water and limit desiccation and subsidence
- In case of subsidence, the soil needs to be handles responsibly
- Hold excess water in rural areas to prevent drought

Flood risk

- Water safety should be taken into consideration in new constructions
- Prevent floods and

The how

Water nuisance

- Where possible, replace paving by greenery
- Create more space to buffer and hold more water
- Conserve and strengthen the urban water system and (regional) water works
- Create new constructions climate adaptive and make them resistant to extreme weather caused by climate change

Drought

- Create new constructions climate adaptive and subsidence proof

Heat stress

- Where possible, replace paving by greenery

Flood risk

- Optimise the ‘meerlaagse veiligheid’ principle (prevention, sustainable design of space, preparation for an eventual flooding)

Regionale adaptatie strategie Utrecht Zuidwest

Current problems

Water nuisance

- The amount of days with rainfall events of over 20 mm/hour has doubled from 3 to 6 per years since 1906
- The amount of precipitation has doubled since 1906
- Local variables, such as the function, percentage paved surface, slope and soil characteristics determine the extent of experienced water nuisance
- The Utrechtse Heuvelrug can experience damage to buildings as a result of rainwater flowing down the slopes
- The Veenweide area can experience nuisance because the lack of draining possibilities if the bosom waters are full. Additionally the area can experience nuisance as a result of subsidence
- In urban areas water can have difficulties in infiltrating into the soil due to the large percentage paved surface, this can result in damage to buildings, gardens and streets
- The chance of a combined sewer overflow increases due to heavier peak rainfall events

Drought

- Sandy soils of the Utrechtse Heuvelrug are extremely vulnerable to drought, which increases chances of damage to agriculture, nature and forest fires
- The Veenweide area can experience subsidence as a result of drought due to lower groundwater levels
    1. In urban areas this can lead to foundation damage to buildings and infrastructure
- Urban greenery cannot sufficiently be supplied with water and water dependent nature disappears because of drought
- In the Rivierengebied longer periods of drought can lead to low water levels in rivers which negatively impacts nautical activities
- Drought has a negative impact on water quality
- Also limits the water quantity and water supply to agriculture

Heat stress

- The average temperature and the amount of hot days and nights has increased and will increase in the future
- Extremely high temperatures can lead to failure of electricity, phonelines, infrastructure and bridges and increase the chances of forest fires
- High temperatures can also lead to decreased labour productivity, health problems and increased chances of death for vulnerable citizens
- In urban areas the effects of heat stress are the largest because the temperatures in urban areas are higher than the temperatures in rural areas
- Cities absorb more heat during the day and cool down less during the nights than rural areas
- This leads to more heat stress in urban areas and more restless nights
- In warm periods there is more desire for swimming water, but the bacterial water quality decreases as a result of heat

Flood risk

- Climate change causes the peak discharge to increase (especially during the wintertime)
- Sea level rise can lead to higher water levels in the rivers in the future, which leads to increased flood risk if no additional measures are taken.

Goals

Water nuisance

- "Dry feet" for water nuisance the following definition is used
    1. We can speak of an inacceptable nuisance when material damage, long nuisance (>2 hours) or nuisance on main roads (including railways), in shopping streets and city centres, and in vulnerable places like hospitals or care homes is the case
- The goals have been formulated according to the above definition and the current knowledge and insights
- The experience is that the goals will be made more concrete following the risk dialogues, with room for local customisation
- Until then the norm that 70 mm/hour will not lead to nuisance will be used
- Goals, in 2050:
    1. Public space is designed in such a way that water nuisance during a rainfall event of 70 mm/hour is limited
    2. A widespread blue-green network in urban areas will ensure water is held and processed optimally in soil and water system in case of extreme rainfall events
    3. Vital objects and infrastructure are designed water robustly
    4. The water system is designed in a robust and resilient manner, in order to intercept peaks during wet and dry periods
    5. Water quality is not negatively impacted by combined sewer overflows
    6. Inhabitants and businesses are aware of the effects of climate change and will hold water on their private property as much as possible

Drought

- Drought is a longer period with very little precipitation; when it is sunny, windy and hot, a lot of water can evaporate which causes water shortage to increase very fast
- If the water demand is higher than the natural water supply, water scarcity ensues
- For extreme drought the definition of the KNMI is used which uses the 5% driest years line as a line to define extreme drought when the line is exceeded, drought is defined as extreme drought
- In 2050
    1. Water will be held locally, through infiltration into the soil and will be used in a useful manner, for example to water greenery
    2. Longer periods of drought will not lead to desiccation or damage to the build environment, including urban green
    3. Rural areas are resistant to longer periods of drought
    4. The spatial planning is adjusted to the natural groundwater levels and the freshwater availability during droughts, so as to create a balance between groundwater extraction and resupply. The natural groundwater levels mean the water level without any technical measures like pumps or water inlets
    5. The effect of drought on increased subsidence is limited as much as possible
    6. In case of extreme drought, there is freshwater of proper quality available for the most urgent functions (the national sequencing will be used)
    7. Inhabitants and businesses are aware of the urgency of drought and take measure to mitigate its effects

Heat stress

- There is no clear definition of being heat resistant because it is a relatively new problem to the Netherlands
- Research indicates that experienced temperature is more important to consider than actual temperature
- In urban areas the experienced temperature rises faster than in rural areas, this causes urban areas to experience heat stress sooner
- In 2050
    1. The difference in experienced temperature between urban and rural areas is less than 5 degrees
    2. The residential areas remain liveable during periods of extreme heat
    3. Vital and vulnerable functions are resistant to the effects of extreme heat
    4. The quality of the surface waters during extreme heat is sufficient for the function it supplies
    5. Citizens and businesses have designed their properties as heat resistant as possible
    6. The urban environment is designed in such a way that heat stress during the night is limited as much as possible

Flood risk

- The principle of 'meerlaagse veiligheid' (multi layered safety) is enforced
- This principle consists of three layers
    1. Prevention (prevent a flood as much as possible)
    2. Realisation of a sustainable spatial planning
    3. Preparation of possible flooding (disaster management)
- Regional working group Effect limitation and provincial working group Floodings determine when an area is flood robust
- In 2050
    1. The effects of a flooding are limited
    2. Evacuation possibilities have been optimised
    3. The resilience concerning rebuilding is increased
    4. The incident control plans with regard to flooding are up to date and the crisis management organisation is educated, trained and practiced

The how

Water nuisance "city as a sponge"

- Hold water in the capillaries of the water system
- Create more green on private properties, roofs and gardens
- Detaching of the paved surface from the combined sewer
- Restructuring of public space like playgrounds, parks and parking lots (accounts for 70% of the surface of urban area)
- By creating more green, the water nuisance will be decreased and a buffer will be created for periods with little to no precipitation
- The first concrete steps:
    1. Develop guidelines for the realisation of "city as a sponge"
    2. Develop guidelines for climate adaptive construction in the provincial bouwconvenant
    3. Leave enough space for climate adaptation in spatial visions and programmes
    4. Stimulate the de-paving and creation of more green of private properties
    5. Create more green in public space

6. Develop locations where water can infiltrate and be stored such as wadis and gravel boxes in the subsurface

Heat stress

- Create ample of cool and shaded places
- Provide sufficient swimming water
- The first concrete steps
    1. Map the current amount of cool places inside the region and determine the desirable distance to and surface area of those places
    2. Identify missing links in the current green-blue networks of the urban environment and develop plans to fill those in
    3. Map the swimming locations in the region and review whether the amount is sufficient
    4. Map which water ways/- parties are vulnerable to heat
    5. Aim for local heat plans per municipality
    6. Develop and share knowledge regarding a heat and drought resistant living environment

Limitation of effects of climate change on vital and vulnerable functions

- A vital or vulnerable function is a function that causes major disruption to society and creates unsafe situations in case of failure.
- Due to an increase in extreme weather events, failure of these functions is becoming more likely
- Functioning of society is intertwined with the functioning of electricity, ICT, infrastructure, health care, food provision, and water management
- Many different parties are involved, so proper collaboration is key
- In case of failure, the focus lies on quick recovery. In the intention statement multi-layered safety Utrecht (2018), partners withing the entire province agreed on creating an approach to limit the effects of floodings
- The firs concrete steps
    1. In 2021 the ambition regarding effect limitation of floodings is determined; when is an area flood robust?
    2. In 2021 the vulnerabilities of vital and vulnerable functions regarding heat, drought and water nuisance have been mapped
    3. In 2022 the effects of a flood in the region have been mapped
    4. Citizens and businesses are aware of the necessity of taking measures to limit the effects of flooding by 2023 and actually take measures by 2030 at latest
    5. New developments are flood robust by at latest 2030 and vital and vulnerable functions are climate proof and water robust by at latest 2030
    6. In 2030 policy for existing build environment has been developed, prioritised according to the Vital&Vulnerable list.

Strengthening natural (water)system

- An increased chance of water nuisance is expected as a result of more frequent and more intense rainfall events
- This can lead to mudflows or sewage overflows which both negatively impact the water quality

- At the same time longer periods of extreme drought are expected to occur, which can lead to a shortage of freshwater for the different functions that need freshwater
- The combination of less precipitation and higher evaporation means that there is less water available from strategic groundwater reserves in the area, this is further affected by groundwater extraction (for drinking water purposes for example)
- The aim is to have a natural, robust and resilient (ground)water system that can catch peaks in wet and dry periods
- Keep working on a water system that is balanced by working on keeping dry feet and sufficient water supply (of good quality), in a way that suits climate extremes
- When there is a surplus of water in urban areas in the future it will be held in visible buffer areas
- The aim is to hold the water in the capillaries of the water system, this prevents drainage and increases infiltration
- First concrete steps
    1. Identify locations in the regional water system where more space for buffering is desirable
    2. Research the chances and bottlenecks with regards to water availability
    3. Research what a climate proof soil- and water system looks like
    4. Research the ecological quality of urban water through ecoscans and find out how the water quality can be improved
    5. Think along with running projects on how to shape water extraction in such a way that the extraction keeps the natural water system in shape

New constructions and restructuring projects climate adaptive

- The living environment is sensitive to the results of climate change
- These effects can be limited by providing enough water, less stones and more green
- Climate adaptive construction and restructuring applies to new constructions, restructuring, renovation and maintenance projects, furthermore the renovation of private property is included
- Climate adaptive (re)construction means that all four climate themes are accounted for in the design
- Where possible, combine with other tasks such as the energy transition and biodiversity
- Region development will not lead to more climate tasks, but rather to a positive impulse to our living environment
- The chance of damage as a result of extreme weather and floods will decrease, during heat the living environment remains healthy and the region becomes more attractive
- First concrete steps
    1. Region Utrecht Zuidwest adds to a province wide building covenant which includes programme requirements for climate adaptive building, these requirements will be secured in surrounding/spatial visions and plans
    2. Knowledge regarding the smart add-ons of functions, in which housing tasks are combined with climate adaptation, health and biodiversity is collected and shared
    3. Performance agreements will be made with housing and building corporations
    4. Innovative concepts regarding climate adaptive construction are stimulated and rewarded

What has already been done

- Water nuisance “city as a sponge”

    1. Many municipalities have subsidy possibilities in place for the detachment of rainwater and the construction of green roofs
    2. In public space they increasingly provide a exemplary role, like green roofs on bus stops in Utrecht
    3. The region has received an contribution from the national government to take climate adaptive measures in five different types of neighbourhoods and find out what works
- Heat stress
    1. A number of municipalities within the region have created a local heat plan to protect vulnerable citizen groups against heat
    2. Several municipalities have developed design guidelines to make streets and neighbourhoods heat resistant
- Limitation of effects of climate change on vital and vulnerable functions
    1. The Lekdijk is currently under construction and will be made climate proof, with as a goal to prevent floods, increase biodiversity on and along the dike, and the strengthening of the experience of landscape and water
- Strengthening natural (water)system
    1. Under the name 'Blauwe agenda' (blue agenda), agreements have been made to tackle problems caused by water shortages and water nuisance in and around national park the Utrechtse Heuvelrug
    2. In the Gooyerwetering, area own water will be held along the flank of the Utrechtse heuvelrug for a longer period so as to be able to use it during periods of drought
    3. Municipality Houten sees attractive surface water in urban areas as something of great importance. For this reason, the municipality and water authority remove exotic plants and replace timbering by nature friendly shores
- New constructions and restructuring projects climate adaptive
    1. Several municipalities experiment with climate adaptive measures, like Bunnik in the Engboogerd neighbourhood and Zeist in the Kerckebosch neighbourhood
    2. The yet to be developed highly urban area 'City West' in Nieuwegein will be designed in a completely climate adaptive manner. In order to do this, the municipality has developed norms for the catching of peak precipitation, heat stress, nature inclusive construction, biodiversity and the construction of a green blue network, that will be offered to area developers. Additionally it will be researched how rainwater and domestic wastewater can be reused completely, for example for greenery during periods of drought.

D. Interview guide

Kernvragen

- Wat zijn de klimaatadaptatie doelen die jullie willen halen en waarom zijn deze specifieke doelen tot stand gekomen (klimaatadaptatie labels)?
    - Welke doelen zijn al gerealiseerd?
- Welk beleid met betrekking tot klimaatadaptatie is er al aanwezig in de gemeente?
- Heeft de gemeente al een LAS en bijbehorende uitvoeringsagenda?
    - Zo ja, hoe is die tot stand gekomen?
    - Zo nee, heeft dat een duidelijke reden en hoever is de gemeente in het opstellen van de LAS?
- Ligt er meer nadruk op bepaalde thema's (wateroverlast, droogte, hitte stress, overstromingsrisico) dan op andere thema's?
- Hoe zorgen jullie als gemeente ervoor dat jullie klimaatadaptatie plannen worden uitgevoerd?
    - Hebben jullie een duidelijke uitvoeringsagenda en planning?
    - Hoe wordt er onderscheid gemaakt tussen openbare ruimte en privé grond?
- Wat is jullie beschikbare budget en capaciteit (hoeveel fte staat er voor klimaatadaptatie)?
- Waar voorzien jullie dat de grootste obstakels in de haalbaarheid van de uitvoering zitten?
    - Hebben die obstakels een duidelijke oorzaak? (budget, capaciteit, kennis)
        - En welke van die oorzaken levert de meeste moeilijkheden op?
- Hoe zien jullie de rol van het HDSR in het klimaatadaptatie proces?
- Hoe zien jullie de rol van de provincie Utrecht in het klimaatadaptatie proces?
- Wat zijn de dingen waar het HDSR de gemeente mee kan helpen?

English translation

- What are the climate adaptation goals you want to reach and how did those specific goals come about?
    - Which goals have already been realised?
- What policy with regards to climate adaptation is already present in the municipality?
- Does the municipality already have a LAS and accompanying execution agenda?
    - If yes, how was it created?
    - If no, is there a clear reason why not and how far is the municipality in the creation of a LAS?
- Is there more emphasis on specific DPRA themes (water nuisance, drought, heat stress, flood risk) than on the other themes?

- How do you, as a municipality, ensure that your climate adaptation plans are carried out?
    - Do you have a clear execution agenda and planning?
    - How do you make a distinction between public space and private property?
- What is your available budget and capacity (number of FTE for climate adaptation)?
- What, in your opinion, seems like the biggest obstacle in the carrying out of climate adaptation plans?
    - Do these obstacles have a clear cause? (budget, capacity, knowledge)
        - And which of these causes cause the most difficulties?
- How do you view the role of HDSR in the climate adaptation process?
- How do you view the role of the province Utrecht in the climate adaptation process?
- What are the things that HDSR can help the municipality with?

E. Interview summaries

Interview A: Zeist

There is a widened GRP aimed at combatting water nuisance, which is planned out up to 2026 and climate adaptation is an integral part of the municipal sewage plan
Detaching from the sewer system is difficult because meekoppel opportunities are limited as the sewage system has a long lifespan so it does not need to be replaced often
There are a few focus neighbourhoods that experience water nuisance in case of heavy rainfall, those neighbourhoods are addressed first
The focus lies mainly on addressing the water nuisance problems and to a lesser extent on combating heat stress and drought. Heat stress is not a big problem in the municipality because there is plenty of greenery and shade. There are goals that are set for heat stress, mainly aimed at the percentage of shade in close proximity to buildings, but those goals are fairly easily met because of the amount of trees. Measures have more effect if you can take a street from label D to B than if you take a street form label B to A, so, with efficiency in mind, the it is smarter to tackle the lower labelled streets before the higher labelled streets. This is also done because heavy rainfall events are expected to occur more often and more extreme by 2030. By 2040 all streets have to be at least labelled B.

Zeist is a middle sized municipality and there are approximately 1,5 FTE available for climate adaptation. The interviewee is specifically hired for climate adaptation about 0.5 years ago, before that there was only a sewage manager and an executor to handle climate adaptation.

Zeist has a relatively favourable location because of the sandy soils and the presence of a lot of greenery. This makes it easier to detach rainwater from the sewer system without having it cause nuisance elsewhere. Decisions have to be made, however, on what level of hindrance is acceptable because it is not desirable to spend an endless amount of money on only slight improvements to nuisance. The municipality needs to accept that climate change is happening and that it brings about certain unpleasant side effects. Not everything can be altered to prevent the effects.

Climate adaptation is also an integral part of other programmes of the municipality like green management and water management. Those programmes can be stimulated to incorporate climate adaptation more in their plans.

The execution of the climate adaptation plans is secured by the responsibility of the programme to justify their decisions, projects and finances to the municipal board. The goals that are included in the GRP need to be justified to the board and every 2 years an update has to be provided on how the process is going. It is also a possibility that the goals are not met, but that then needs to be explained to the board as to why the goals are not met.

There is an implementation schedule that includes the amount of roofs that are to be detached annually and which neighbourhoods need to be tackled.

The municipality is looking at a collaboration with housing corporations to include climate adaptation on private property. The municipality is also trying to involve homeowners by communication projects to inform them on what matures they can take on their own plots to implement climate adaptation measures. In the not too distant future a dashboard will be created to inform homeowners on green roofs and the combination of green roofs and solar panels. That includes free calculations on what effect those measures will have for the homeowners.
There are no subsidies, because that would take too much work and the benefits are not expected to outweigh the costs. However, if a housing corporation or a school or other large building proposes a plan to, for example detach from the sewer system, the municipality will look at how they can help financially. This can be seen as a kind of alternative to a subsidy.

The largest obstacle to climate adaptation is the availability of space. The amount of space is limited and everyone wants something else with the same square metre. Another obstacle is the large amount of private property in the municipality. More than half of the urban area in the municipality is private property and it is very difficult to implement climate adaptation there.

The role of the province is limited because they do not really cater to the needs of municipalities. They carry out their own projects, that are useful, but most municipalities do not have the time to really do anything with the outcomes of those projects or attend the webinars in which the projects are explained.

The role of the HDSR is positive, the contact happens mainly through Tom Overgaauw. HDSR is a provider of knowledge and also provides subsidies for, for example detaching from the sewer system and the construction of green roofs. The unofficial division of tasks is that the municipality manages urban water and HDSR manages rural water.

HDSR can help more by creating a more optimal collaboration on the subject of climate adaptation and maybe provide more expertise on heat stress. Furthermore, they can maybe model the effects of certain measures on the water system by using the expertise of hydrologists.

Interview B: Nieuwegein

The first climate adaptation plans have been made before the national stress tests, in 2015. There are two timelines in the adaptation vision, one for 2025 and one for 2050. The goals in the vision are not SMART and it has been a deliberate decision to omit the mention of any numbers.
The numbers that are adhered to stem from the covenant klimaatadaptief bouwen, for both new constructions and restructuring projects.

The execution programme is updated every four years and in every updated version, the results of the most recent stress test are included.

In the document, every subject of the DPRA receives an equal amount of attention, but in reality (i.e. financially) the attention goes mainly to water nuisance because those effects are the most visible. Furthermore, there are positive spill over effects, as measures that improve the water nuisance often also have a positive effect on drought and heat stress, like more green, increased infiltration, positive for drought as well and also green has a cooling effect which decreases the heat stress.

The increase of green area is also included in the better neighbourhoods policy, it is however difficult to create more green because of the limited space that is available.

Another issue is that there are no clear indicators as to what makes an urban area climate adaptive. The values of the covenant klimaatadaptief bouwen are adhered to for now, but apart from that there are no clear values that need to be reached. The values from the covenant are possible to reach in new constructions, but inside the already existing urban area there are doubts whether or not it is possible to reach those values. The reason for this is that space is limited and different sections want different things for the same area and it is difficult to get the spatial planners on board.
Furthermore, the groundwater level in Nieuwegein is relatively high, which is a problem for the infiltration capacity. On top of that the subsurface is already really full, which further hinders the possibilities to create (temporary) subsurface storage of water.

The bulk of the neighbourhoods in Nieuwegein has been built after 1970, apart from two historic centres Jutphaas and Oud Vreeswijk. Most of the neighbourhoods will be renewed/reconstructed in the coming 4 years and it is easy to include water storage opportunities in those projects. In some neighbourhoods new innovations/experiments to creatively increase the water storage capacity will be included.

In new constructions high rise buildings help climate adaptation measures because there is less space required to house more people and high rise buildings often also have parking garages which severely decreases the need for parking spots on the street. Moreover, those parking garages can be topped with a green roof.

In new construction projects, the requirements of the building covenant are included in the design (50 mm water storage on each plot and no water nuisance for rainfall of 90 mm/hour). In restructuring projects this is difficult. Citizens are stimulated to replace paving by green in their gardens with subsidies, but it is not possible to really demand such things from citizens.

There are 2 FTE available for climate adaptation and a budget of €150.000 annually for climate adaptation and €600.000 for projects.

There has been a delay in the carrying out of projects due to Covid, a lot of proposed projects got postponed. The plan was to do 2-3 better neighbourhoods projects per year, now that is 1 project per 2 years due to a shortage of construction personnel.

The limiting factor in climate adaptation policy is not money but human capacity. But after 2026 that might change as the subsidies from the national government change as municipalities get funding based on a combination of area and inhabitants and Nieuwegein has many inhabitants but little area, so the funding will probably decrease.

HDSR already helps by providing knowledge and being a conversation partner in many climate adaptation projects. There is currently a project with HDSR about what the effects of a Limburg weather event are for the municipality Nieuwegein. The results from this analysis are that even streets with label A will experience water nuisance in the Limburg situation because the water does not only come in the form of rainfall, but also from surface waters in the region. HDSR will give input on how the situation can be dealt with. Arnoud (HDSR watertoetser) will help Nieuwegein with this because surface waters (semi responsibility of HDSR) are the bottleneck in this situation.

Province Utrecht was a collaboration partner in the beginning, but now not so much anymore. Climate adaptation has not been on their agenda for a long period of time, but recently that has changed. Because climate adaptation has not been a priority of the province, Nieuwegein has gone their own way at some point because the province was not acting fast enough. There is collaboration between the municipality and the province, but it is not as close as it has been.

Interview C: IJsselstein

The LAS is in development and will hopefully be approved by the board after the summer recess of the municipal board. The LAS will also be accompanied by a supplementary uitvoeringsagenda.. For now the climate adaptation plans are part of the IVOR, integrated vision of public space. The LAS that is now in creation is based on stress tests and risk dialogues with experts and citizens. The municipality has collaborated with Arcadis to translate the results from the regional stress tests to the municipal level.

and for now some measures are also included in the GRP.

Currently there is no policy on climate adaptation, but the board does want measures to be taken, so now measures are taken without a clear framework. However, the measures and locations at which they are taken are related to the results of the stress test. The situation is quite unusual but for now there are no better options. The results need to be fed back to the board to justify the budgeting.

Flood risk is the least mentioned theme in the climate adaptation process, because that falls under the responsibility of the safety region, Rijkswaterstaat and water authority. Water nuisance is the largest focus area because clear measures can be taken to limit the effects of extreme rainfall. The focus lies mainly on the themes and areas where the municipality can influence the effects of climate change the most.

A large problem in the municipality is the high groundwater level which hinders the infiltration capacity. The variation in groundwater level within the municipality is high. Some neighbourhoods experience a difference in groundwater level of 2m. The monumental buildings in the historical centre have a wooden pole foundation, so the desired groundwater level in the centre is higher than in the surrounding neighbourhoods, even though that might cause nuisance to houses with basements further down the street.

The municipality does experience subsidence, but the subsidence has not led to damage so far. The buildings that are at risk of damage are mapped by Arcadis based on local knowledge, the risk towards the rural area is higher than in the centre.

The LAS is aimed at 2050 and does not include intermediate goals, however, after every stress test the uitvoeringsprogramma will be updated to include the results of the most recent stress test. The municipality will not be using climate labels on the street level.

Citizens are stimulated to take measures on their private property by informing them on what the possibilities are and national campaigns like the NK tegelwippen. It will also be explored if financial stimulation can be implemented.

There is currently 0.8 FTE available for climate adaptation and an annual budget of €100.000 for measures and €20.000 for research. The 0.8 FTE is on paper, but in reality it is closer to 1 FTE, which is still too little.

The limiting factor is both budget and capacity. But the finances are seen as the largest obstacle in the implementation of climate adaptation measures. The message from the board is to keep the goals ambitious but realistic. In the new GRP more budget needs to be made available for climate adaptation measures. It is not clear yet how much money is needed exactly, but the expectation is that this will become clear once the implementation agenda (execution agenda) is established.

Some of the obstacles in carrying out climate adaptation measures are mostly financial, but there are also some capacity problems and some limitations in expertise. The basic tasks of management and maintenance are fine, but in the research area some extra expertise is very welcome.

HDSR is already helping through the Netwerk Water & Klimaat which also helps in the collaboration with other municipalities as the GRP is created together with the municipalities Montfoort and Nieuwegein. There also has been contact with Houten about the LAS and uitvoeringsprogramma, but it is difficult to collaborate closely on that because every municipality has a different timeline in the planning process.

The province is not really present in the climate adaptation process. They do provide subsidies and they also have expertise in several subjects, but those subjects are currently not relevant for the municipality. The collaboration happens mainly between the water authority and the municipality. Furthermore, the process of applying for provincial subsidies takes a lot of time and that time is not available, so it has happened that the decision has been made to explicitly not apply for a certain subsidy because the amount of paperwork would be too much.

HDSR can help IJsselstein by giving expertise knowledge on urban water management and especially on the sewer network and the technical aspects of that. They can also help with the creation of the SSW (systeemoverzicht stedelijk water; system overview of urban water) and knowledge sharing on what measures have what effects.

Interview D: Bunnik

There is no LAS yet, but there is a regenwaterstructuurplan that is created by TAUW. That plan is not a bit too general for Bunnik but the plan is mainly there because Bunnik is required to have such a plan. The plan itself is impeccable and every word is correct but it is not very visionary and the people who have created the plan did not consider the financial situation of Bunnik. The amount of money required to carry out those plans is not at all available at all. This plan is nice and all, but it could also be located in Driebergen or Zeist.

There is no dedicated employee for climate adaptation and this causes the creation of an adaptation plan to be very fragmented. The plans are all separated, but colleagues update each other and try to ensure that there are no contradictions in different plans.

The interviewee is busy creating an adaptation plan for water nuisance, but a different employee is creating a plan for heat stress and the two are not working closely together. There is also no clear programme defined for climate adaptation measures. The interviewee indicated that, at this point, there is no direct urgency or threat for flooding in the municipality.

Currently, a new GRP is in the works and that GRP supplements the Omgevingswet. In that GRP several measures regarding climate adaptation will be named and those measures will mainly target the drainage and buffering of water. The required budget to finance the climate adaptation measures will also be included in the GRP and once that is approved by the municipal board, the implementation of the measures can start.

There is no clear number of FTE available for climate adaptation because it is fragmented over a few different functions, additionally there is also no clear budget available for climate adaptation.

The limiting factors in climate adaptation policy and implementation are both budget and capacity. There is little money available for climate adaptation, but even if the money was available, there would be no capacity to create and carry out plans and measures. There is currently not enough capacity to map and evalueate the meekoppel opportunities because everyone is already busy enough with carrying out their basic tasks. If more money and personnel was available, there could be a more effective climate adaptation plan and strategy instead of the fragmented plans that are in place now. The municipality has so little capacity that they do not have the time to apply for subsidies because the required paperwork takes up too much time and the application deadline cannot be met.

HDSR is helping by collaborating on certain projects. However, HDSR has its own targets that are sometimes in conflict with the optimisation of municipal plans. There are also a lot of rules that need to be adhered to and if a discussion about those rules occurs a sort of wall arises between municipality and water authority. This does not mean that the collaboration between municipality and water authority is bad by any means, but there is some sort of power imbalance between the two.

What could help is for HDSR to be more involved in projects from the beginning and help in the design process of municipalities. By being involved the water authority can provide help in the process instead of just giving feedback on projects that do not meet the requirements of the Keur. This would save the municipality a lot of time and effort and by that also money. The interviewee indicates that there could be an opportunity for the water authority and municipality to optimise their collaboration to get the best results. The cooperation could be more efficient.

HDSR could help in the construction of a LAS like it did for De Bilt because they have the expertise. There are also some employees of HDSR that do a really good job in helping the municipality. What could also help is the availability of one contact person within HDSR that municipalities can reach to ask questions and advice. Or just have a quick conversation about ideas and receive some feedback.

The province plays a very little active role in the climate adaptation process (they provide subsidies, but are not actively involved in policy). The province does provide guides on green blue playgrounds and such. Those guides are useful, but it does not always suit the timeline of the municipality and as a result they often remain unused. This is not because of disinterest but a result of the time shortage of the municipal employees. The green blue playground initiative is a very good one, which really helps solve some of the problems the municipality is experiencing but the municipality needs to be able to process all that information.

The message Bunnik wants to give is that they are anxious to implement climate effective measuresm and to keep supporting Bunnik.

Interview E: Houten

The LAS is created stemming from the RAS and with collaboration of Arcadis. The plan is still in the implementation phase, but some goals have already been realised like the creation of a local heat plan. The rest of the plans will happen according to the execution agenda. The priority lies with bottlenecks

that have experienced water nuisance in the past. Further implementation will happen at the same time of restructuring projects to work efficiently and keep the costs low.

The bottlenecks will be solved mainly by detachment from the sewer system to prevent overflows, but replacing paving by greenery in public and private space is also an important aspect. Inhabitants are stimulated to notify the municipality if they think paving in certain areas is unnecessary and they are also stimulated to remove paving from their own gardens with the free collection of stones.

Currently the new GRP is in development and in that plan an additional financial stimulus is included for people who detach their roof from the sewers.

In restructuring projects it is the ambition to have 10% less paved surface than in the previous situation. Additionally, the parking spaces will be paved by water permeable materials, like grass tiles. Those measures will be evaluated in new stress tests and based on those results a new execution agenda will be created and the plans will be updated. The main goal remains the same, a climate adaptive and robust Houten in the urban area.

2040 is chosen as an end point because the planning started about 10 years ago and around that time the province also used 2040 as their horizon. When the province updated that to 2050 Houten stayed with 2040 because they had already made their plans and 2040 still seemed like a realistic end year.

In 2019 the municipal board decided on certain safety levels they wanted to have regarding extreme rainfall and what investments they were prepared to make. This was then used as input in the adaptation plans with regards to water nuisance. They are currently up to date with the execution of the plans and the goals they want to reach during the first five years.

The focus in the past few years has mainly been to combat water nuisance, but now the most severe bottlenecks for that theme have been resolved, the focus is widening to also include heat stress. There is an overlap in measures that combat water nuisance, drought and heat stress, so in that regard, there already have been some projects that also combat drought and heat stress. This also helps to justify the costs of the measures, because if you only take measures to prevent water form reaching the treatment plants the benefits will never outweigh the costs. The goal is to use the city as a sponge because that not only helps with water nuisance, but also with drought and heat stress, and biodiversity.

To ensure climate adaptation policy will be carried out the execution agenda is used. Once that is approved by the board the projects happen and a good justification has to be given if something does not happen. Additionally adaptation requirements are included in every construction plan. This mainly concerns water storage on the plots. As of now, that requirement is 15mm, but this will increase to 40mm. This is also conform the covenant climate adaptive construction Utrecht. It is important to include those things in municipal policy, otherwise building corporations and inhabitants are not by law required to include and adhere to those things.

There is no clear amount of FTE available for climate adaptation because it is not completely clear what tasks fall under climate adaptation. The estimation is about 0.8, in the past this number has been higher, but now the LAS and accompanying execution agenda are constructed the amount of time required for adaptation has decreased. The amount of FTE available for climate adaptation is enough for the current situation, but the need might increase when the execution agenda needs to be updated after the new stress tests. The currently available budget is also sufficient, although more money would enable more measures to be carried out sooner. Climate adaptation is also integrally taken up in other functions in the municipality like new construction projects.

The most difficult aspect of implementing climate adaptation policy is to include private property in the adaptation process and especially business parks. The municipality tries to stimulate citizens to adopt measures and to involve them in measures that are taken in public space, but this is not always easy because some actions (like grassy playgrounds that act as a temporary water storage) are not very popular. At some point citizen involvement should change to citizen informing because otherwise nothing will be realised. A good vision and explanation is more important along with approval of the board, because then you can actually act. Citizens are, however, also stimulated with the provision of subsidies for removing tiles from their gardens but the expectation is that only 10-15% of the inhabitants will actually do something with those subsidies.

The covenant klimaatadaptief bouwen is a useful instrument to ensure climate adaptation in new constructions, but it also causes some problems because the housing demand is really high and specific. A certain percentage should be social housing, which cannot be too expensive. Furthermore project developers might not want to start projects if all the demands from the covenant need to be met because it will be too expensive to start such a project and the profits will be too small. Additionally, houses should remain affordable and if all those requirements are met it will not be affordable anymore.

HDSR is doing a good job in the provision of subsidies through the impulse arrangement. Furthermore, they play a large role in Netwerk Water & Klimaat which they do very well. Through the network they share expertise knowledge on water management.

HDSR could however do more in urban environments. Right now municipalities are tasked with sewage, green provisions, waterways and it would make sense that the water authority takes more responsibility in those categories. In Houten all the main waterways (that are the responsibility of HDSR) are located outside of the urban area which mans that HDSR does not manage the water inside the urban area of Houten. This is also the Achilles heel of the municipality because they can not easily drain excess rainwater to head waters. Inhabitants of Houten pay the same amount of taxes to the water authority as for example the inhabitants of Maarssenbroek, but they get much less in return because the water authority does no water management within urban Houten. It would make sense to make the water authority responsible for all the water, also in urban areas, this would also solve the grey area of water no one is sure who bears the responsibility for (municipality or water authority), but this is more a decision that needs to be made on the national level than on the level of the municipality or water authority.

Houten would like to see the water authority to take more responsibility in the urban water system and also take up improvement measures in their tasks. It is good that they think with the municipality and give advice, but it would be better that they not only think with but also work with the municipality.

Furthermore, the involvement of the water authority would also help citizens who have questions about water because now they do not know where they need to go with their questions.

HDSR can also act more proactively in the process of new construction projects by providing water storage suggestions. They could also be more flexible in enabling water storage elsewhere if the exact requirements cannot be met on the plot level, like ‘we see that in this way the storage is not possible, but if you try this…’

Interview F: De Bilt

In the creation of the LAS the RAS has been used as an umbrella document and the specific goals that have been mentioned in the LAS are taken from the RAS. The climate adaptation vision has been

translated to a timeline and planning which has resulted in the current execution agenda. Measures like detaching from the sewers, planting more trees to provide more shade and increasing the sponge function of the soil have been planned out and every 5 years the effect of the measures will be evaluated in the new stress tests. The stress test will then tell if the measures that have been implemented have had the desired effect. Those measures also need to be justified to the municipal board because they require a lot of money to be carried out. The stress tests serve as a sort of checking mechanism to see if the policy has been effective and what aspects need to be changed and updated.

The biggest focus lies on water nuisance because the measures and instruments that can be taken and used to combat water nuisance are easily verifiable on their effectiveness. It is easier to estimate the effect of a wadi, or an extra unpaved surface of several square metres on a rainfall event of 90mm/hour than to estimate the effect of the planting of a tree on the experienced temperature. It is currently not possible to calculate exactly how many trees are necessary to decrease the experienced temperature by 2 degrees. The same goes for drought, the effect of the creation of a wadi on the soil moisture percentage is impossible to measure. For drought and heat the control mechanisms are currently not present or not developed well enough.

The adaptation policy will be enforced because every action (or non-action) needs to be justified to the municipal board. Every policy is backed by a execution agenda that serves as both an implementation guideline and a control mechanism for the board. The board wants to know how their money is spent and that needs to be justified.

On private property climate adaptation is stimulated through citizen participation. In De Bilt citizens are very involved in climate adaptation and even demand from the municipality that they take measures. If a street is restructured and inhabitants are asked to invest €1.000 for adaptation measures like detaching rain pipes from the sewer system, 80% is prepared to do that.

Money is not a problem in De Bilt, the problem is vulnerability on the personnel area. If one person in the climate adaptation unit quits their job, a lot of knowledge and expertise is lost. There are also very little people coming from universities that have studied something like water management that want to work for a municipality.

HDSR can help municipalities by offering their expertise knowledge. Now it was the municipality that contacted HDSR to help them with the construction of their LAS, but those roles could also be reversed and the water authority could offer municipalities assistance in the construction of such documents. Some municipalities are big enough to have their own hydrologists, but De Bilt is not one of those municipalities, in general municipalities with less than 60.000 inhabitants have no employees with expert knowledge. Every small municipality has hired a consultancy agency or someone from a water authority to help them with those projects, but the water authority could also supply such expertise knowledge. This could also be a task for the province.

On the topic of climate adaptation projects there are three kinds of impulse arrangements municipalities can apply for, national, provincial and the water authority. Those three arrangements can be added on top of each other but every arrangement requires a different application and has a different application process. Municipalities with little to no capacity simply do not have the time to apply for all those subsidies and even though they desperately need the money, they do not apply for the subsidies because they lack the time. The justification of the subsidy application is also different in all three cases, which makes it even more time consuming. If every application process was the same and it could just be copied and pasted, municipalities that really need the money might be more likely to also actually apply for it and obtain the subsidies.

Interview G: Stichtse Vecht

Stichtse Vecht is a midsized municipality with approximately 60.000 inhabitants. The municipality does not have a LAS and is also not working on a LAS. Climate adaptation policy is integrally taken up in other documents such as the building covenant and GRP. The funding for climate adaptation measures also comes from the GRP. The building covenant is taken up in the GRP and has been approved in 2022. There is no execution agenda for climate adaptation measures but there is a planning in the GRP that includes measures to combat water nuisance, this is coupled to sewage maintenance and replacement. The budget from the GRP needs to be used on water related measures, so it cannot be used to plant trees. The money can however be used on research to combat heat stress and one of the ways the budget has been used in the past is to translate the national shade map to the local level of the municipality.

The focus within the Deltatprogramme lies mainly on water nuisance because that falls under the GRP. Drought is also included because that falls in the same category. Stichtse Vecht does experience subsidence but so far there has been no rotting of wooden pole foundations.

In private space adaptation measures are stimulated through facilitation of measures through subsidies for green roofs and the detachments of rain pipes during sewage construction and replacement. If necessary the municipality could resort to the 'hemelwaterverordening' to demand certain measures from homeowners, but this has not been implemented.

There is currently 0.6 FTE available for climate adaptation and an annual budget of €240.000 for climate adaptation (not specified which measures, so it can be used where needed) and an additional €70.000 for subsidies for inhabitants. The budget has been lowered from €300.000/year because not all the money could be used. This also shows that money is not the problem, but rather capacity. There are not enough employees to create and carry out climate adaptation policy.

HDSR helps through the Netwerk Water & Klimaat and the klimaatklaar portal, which is mainly aimed at private actors. Apart from that HDSR acts mainly in the rural area and the municipality acts in the urban areas. Furthermore, HDSR provides subsidies to private actors and the impulse arrangement which is a good initiative.

The province is not a big partner in climate adaptation but it does carry out some good projects.

HDSR can help more by sharing more knowledge and also carry out some projects in urban areas. Furthermore, they can help with the inclusion of heat stress in the climate adaptation policies.

Interview H: Montfoort

Montfoort is a small municipality with little capacity and expertise knowledge. Montfoort is happy with the RAS that is constructed by Netwerk Water & Klimaat. The goals that are mentioned in the RAS are now being translated to an execution agenda.

The reason that Montfoort does not have a LAS yet is a lack of capacity and budget. The unavailability of money means that the municipality cannot hire someone or some consultancy company to write a LAS. As of now, climate adaptation is included in the Omgevingsvisie and the policy of the province Utrecht is used to force spatial planners to include climate adaptation in their plans. Additionally, when restructuring projects are done, climate adaptation measures are taken in those areas (meekoppelen).

There is no knowledge of specific numbers regarding the tasks related to climate adaptation but there is a global vision on the climate adaptation tasks. Form the GRP there is a BRP/WRP? (cannot find it online) where the specific bottlenecks and capacity tasks are addressed, where the focus lies on water nuisance and mainly rainwater (not wastewater). Based on the BRP there is an execution agenda and with the BRP the impulse subsidies are applied for by the national government.

The climate adaptation focus lies mainly on water nuisance because that causes the largest problem in the municipality. Due to the high groundwater level it is near impossible to infiltrate water into the soil and in case of long periods of rain it is also not possible to pump water to the polder due to the elevation difference between the polder and the sewer. In some instances water even flows from the polder into the sewers.

The stress test is not particularly specific for Montfoort, so the stress test has been omitted by creating the WRP. This is fully focussed on decreasing water nuisance and has been done by making observations during real rainfall events and then looking at where nuisance occurs. Based on those findings, an execution agenda has been constructed where areas with the largest problems are prioritised. With that execution agenda subsidies have been applied for, the impulse arrangement. So while Montfoort has no LAS, there is an execution agenda. The construction of a LAS also does not have the priority, if presented with the choice between having someone to write a LAS and a project leader, the preference would go to the latter. A trainee has started recently and this trainee will possibly work on a LAS.

Drought and heat stress are included to a lesser extent because it turns out that those problems are not really prevalent in Montfoort. In collaboration with the province a local heat plan has been constructed, but the urban heat island effect does not really occur in Montfoort, the difference in experienced temperatures between the urban and the rural does not reach 5 degrees. Drought does not really cause problems and when in conversation with the water authority they also do not see problems regarding drought. There is some subsidence, but that is mainly in the rural areas so that does not cause any problems to the built environment.

To ensure climate adaptation policy is carried out it is looked at how it can be integrally implemented in restructuring projects. Detachment form the sewers happens where possible in those projects. It is looked at how water nuisance can be prevented through for example draining rainwater to surface waters and infiltrating it or partially infiltrating it and partially draining it to nearby surface waters. This is all done to prevent pressure on the existing sewer system.

The largest obstacle in the implementation and carrying out of climate adaptation measures and the creation of climate adaptation policy is the lack of capacity. There is a sewage employee, a sewage manager, and a project leader for 2 days a week. Currently there is 3 FTE for policy, execution, and management. There is €100.000 a year available for climate adaptation projects, this money is also labelled as climate adaptation.

HDSR is seen as a provider of expertise knowledge and also as a collaborator in projects regarding climate adaptation. There is a good collaboration between Montfoort and HDSR, they know how to find one another.

The province is pushing climate adaptation. One problem is that the province has a lot of ambitions and requirements, but it does not seem to realise that small municipalities do not have the budget to carry out all those ambitions. A specific example of the unrealistic ambitions is that a few years back Montfoort had a proposal for 400 new houses that met all the requirements of the province, water authority and other involved governing bodies. The province approved of the project and later said,

‘you know what, this proposal looks really good, why don’t you increase this project from 400 houses to 500 houses’ without even realising the extra problems this brings about and how much bigger the task is if you increase from 400 to 500 houses.

The building covenant is good and works, but the requirement level that is currently bronze with a little plus should stay the same and not increase, because this would make it near impossible for project developers and the municipality to meet the requirement.

There is a model of Quin where a clear visual representation is given of how the different ambitions relate to each other. This can maybe be used by the province to make clear where their priorities lie and communicate this to municipalities. This can then be used by spatial planners as a guideline because if they need to include too many ambitions, one might be negatively impacted by the other. If one ambition needs to be included more, another ambition automatically gets included less. This would also help municipalities to know how they should divide their budget.

Interview I: Utrechtse Heuvelrug

The LAS (approved in February 2022) is made up of a combination of the requirements of the RAS, building covenant and the Blauwe Agenda. There is no clear execution agenda yet, but it is under construction and there is an overlap with the GRP. For new construction projects all climate adaptive measures are written down and the public space department knows what to do with it and how to include it in construction projects. Further, climate adaptation is integrally taken up in the GRP and some of its finances are too. The goal for climate adaptation policy is to include it in every department of the municipality so in due time the separate climate adaptation programme becomes unnecessary.

The emphasis lies on water nuisance and drought because heat stress is a negligible problem in the municipality as the municipality is very green and has only small urban centres. The Blauwe Agenda has set some goals for the Utrechtse Heuvelrug and also some policy for the holding and infiltration of rainwater on the Heuvelrug. This measure combats both water nuisance and drought and it will make the water system more robust.

The enforcement of climate adaptation policy is secured in integrally including it in new construction and restructuring projects. For every project it is considered how climate adaptation can be included, for example when a sewer needs to be replaced it will be looked at how that can be optimised, like including detaching measures and possibly redesigning the street to include more green (and decrease the width of the street). Furthermore it will be taken into consideration how lowered green spaces can be created as temporary water storage and increase the biodiversity. Additionally, climate adaptation measures are ensured by employing the ‘groen, tenzij…’ principle.

In order to ensure citizens also contribute to adaptation measures there is a ‘hemelwaterverordening’ rainwater ordinance, that requires homeowners to hold and infiltrate a certain amount of water on their own plots. The end goal is to be climate adaptive in 2050 and the rainwater ordinance helps to reach that goal by forcing citizens to detach from the sewer for example. In 2050 all existing urban areas need to be detached and all new constructions are already detached from the beginning. There are some focus neighbourhoods that need to be detached sooner and the municipal board can decide to have certain neighbourhoods to be detached from the sewers within 2 years. There is a new alderman (wethouder) that is responsible for the subsidies for citizens, but they see little benefit in the provision of subsidies to citizens and wants to unburden the citizens. The aim is to facilitate and stimulate citizens to take measures and also look into projects like ‘waterhandjes’ that is made up of students that go to houses to detach them from the sewer. Furthermore, it is explored if it is possible

to outsource subsidy policy and measures to platform duurzaam Nederland, so the municipality only has to pay them and they do all the paperwork.

Currently the municipality has 1 FTE for climate adaptation and that is fully for policy. Furthermore, the carrying out of climate adaptation policy is spread over all functions of the municipality, the greenery manager is a climate adaptive greenery manager and the project developer is a climate adaptive project developer. This will continue until the function of climate adaptation employee is unnecessary.

There is also a link with the neighbourhood approach of the sustainability programme. In this programme teams go to houses to inform citizens about the energy transition and how to make their home more sustainable. It is the idea to include climate adaptation in this programme to inform citizens. It does not really make a difference to people if people only talk about sustainability or if they also include climate adaptation in the conversation. This would also make it easier for them because this way they only have to be approached by the municipality once.

The largest obstacles regarding the implementation of adaptation measures lies in the budget because the goals of the municipality are very ambitious. Another obstacle is the participation of citizens. There are some problems when a street is restructured and the street is redesigned with green parking spaces, inhabitants will complain that the street might get muddy and their shoes will get dirty and such. In order to keep citizens happy, it is very important to include them in the process and citizen participation might lead to delays in the implementation.

The role of HDSR is currently to brainstorm and advise on policy and projects. However, the water authority looks differently at some aspects than the municipality. The water authority, for example, is more focussed on larger water systems than having citizens solve water problems on their own plot.

The province is more focussed on heat stress, creating more green spaces, and increasing the biodiversity. It appears that the task division between water authority and province is that the water authority focusses on water nuisance and drought and the province on heat stress and biodiversity.

HDSR could help by engaging in conversation with the landowners of the uphill areas of the Heuvelrug, staatsbosbeheer, natuurmonumenten and Utrechts Landschap and stimulate them to hold more water uphill to prevent damage and nuisance in the urban areas downhill (also benefits the water authority). Furthermore, HDSR could help by providing a ‘detachment coach’ (one person for all municipalities) that helps citizens to detach from the sewer, because most citizens want to but simply do not know how to.

HDSR could also follow the example of Vallei en Veluwe, that organises a catch up event a few times a year where projects are shared between municipalities and they can tell each other what they are currently doing in the area of climate adaptation and innovative projects can be highlighted.

One last remark is that there is too much responsibility placed on municipalities and maybe HDSR could take over some projects to relieve some of the burden of the municipalities.

Interview J: Lopik

The municipality does not have a clear climate adaptation strategy or document and climate adaptation policy does not have the priority in the municipality because Lopik only experiences minor nuisances. There is a GRP and a Groenbeleidsplan which is seen as climate adaptation the Lopik way. Lopik is a very green and rural municipality with only a few small urban centres, so in general, the municipality experiences very little heat stress. Drought is also not prevalent because of the high groundwater levels

in the area. There are plans to make an addendum to the GRP to include more strict requirements for the storage of rainwater. The numbers and requirements that are mentioned in the GRP are taken from the RAS. There is no one working on a LAS and it is also not on the schedule to construct one because it does not seem to have any additional value. There already is too much empty policy and the municipality does not have the capacity to create a LAS.

There is no execution agenda either because of the limited budget. Lopik only has 14.000 inhabitants to generate an income from taxes, but it has an area that is 2/3 of the municipality Utrecht so the available budget is very little for a relatively large area. Therefore, it is near impossible to make separate budgets available for climate adaptation. The internal policy is to only take adaptation measures together with already scheduled projects. The execution agenda for climate adaptation is the same as the meerjarenonderhoudsplan, so climate adaptation measures will be taken, but only in combination with other large restructuring projects.

The focus lies mainly on combating water nuisance through detaching from the sewers and changing the design and drainage of the street profiles. As already mentioned, Lopik does not have severe problems regarding heat stress and drought, but some measures will be taken regarding the water quality through the construction of nature friendly embankments. Furthermore on the topic of heat stress, extra trees will be planted and paving will be replaced by green. Citizen participation is not a thing, because the municipality is already too busy with public space to also take on projects on private space.

There is no budget and no capacity available for climate adaptation, the municipal board does not make money available that is specifically meant for climate adaptation. These factors are also seen as the largest obstacles in the implementation of climate adaptive measures. A higher budget for the execution of projects would result in the carrying out of mor projects with the same capacity and an increase in capacity would mean projects can be done at a higher pace and in the nearer future. This is, however, not a priority because Lopik experiences very little problems. If more money and capacity were available to the municipality, it would probably be used in a different way and for different themes than climate adaptation. Although if a cheque would be given to the municipality, then there would be a few nice projects, like a nature friendly playground with water buffers, be made possible. The themes of money and capacity also overlap to a certain extent, because more money could also be used to employ more people. As of now, there is not enough personnel to carry out day to day maintenance let alone to assist in the spatial developments. If more capacity was available it would go to those positions first, then to the housing developments and only then to climate adaptation. This is also dependent on the political preference of the municipality because especially in smaller municipalities, small issues that inhabitants experience in their day to day life are more important than climate adaptation tasks.

HDSR should be leading in the process and take more responsibilities. Currently, their role is more on the back end of developments, like checking and managing projects, instead of being a visionary organisation. HDSR should take a role that is more on the forefront of projects and there should be an internal look at the goals they have set. The compensation requirements are a bit short sighted and a more local view could be applied to allow the smaller and more rural municipalities a bit more wiggle room. Furthermore, HDSR should weigh their interests better and realistically handle the water compensation requirements. Because of the strict rules of the water authority the municipality now sometimes carries out projects without consulting the water authority and without asking permission. Another suggestion is that the subsidy application can be made easier, right now the impulse arrangement results in extra work and this should not be the case.

Together with the province, HDSR can map the regional problems and then collaborate with the municipalities to find a solution. HDSR should take responsibility and have a leading role in projects and also talk to unhappy inhabitants.

Interview K: Woerden & Oudewater (same person)

The LAS of both Woerden and Oudewater is made using Staat van je Straat of SWECO. They were among the first municipalities to use this labelling system in 2018. Since 2018 some changes in the labelling classifications have been made, most notably in the water nuisance category where first 60 and 80 mm/h (existing locations vs. new construction) were used for label A, now 70 and 90 mm/h rainfall is used. The goals are constructed based on those labels and on how realistic it is to obtain certain labels. One example of this is that the desired label for heat stress in existing urban areas is label B, because there would be a lot of extra measures needed to reach label B and that would cause too much disturbance to public space and it would cost too much money.

Climate adaptation is also included in the building covenant klimaatadaptief bouwen Utrecht and the Landelijke Maatlat (national measuring device).

The LAS has a clear execution agenda and works with intermediate goals. The first 'deadline' is set in 2030 and it differs per theme how far along the municipalities are with the realisation of the goals. For the theme water nuisance all 'low hanging fruit' measures have already been taken and now only the larger and harder measures have to be carried out. This is a difficult process in older neighbourhoods because a severe restructuring of the sewage system is necessary, this is scheduled for 2035. The execution agenda is generally set up to 2050, but adjustments can be made based on new stress tests. For the theme water nuisance a recalculation will be carried out for both wastewater and rainwater.

There is a distinction in urgency of different neighbourhoods, the inner city of Woerden is urgent, but the less urgent neighbourhood will be restructured later. The focus in the less urgent neighbourhoods is the avoidance of capital destruction. This means that climate adaptation measures will only be done in combination with other restructuring projects. There is a clear budget for the proposed measures for the coming 5 years, which ensures that those projects will actually be carried out. The measures for water nuisance and drought are financed through the GRP, from the green department there is money available for trees and subsidence measures are financed from the budget for sewage and roads.

Private actors are stimulated to take measures on their own plots through the availability of subsidies for detaching from the sewer system and the construction of green roofs. Businesses located on business parks also qualify for those subsidies, but they rarely use them because they do not see the urgency of climate adaptation. In Woerden the subsidies amount to €175.000 for green roofs and €125.000 for detaching from the sewer. Additionally, in Woerden the detachment tasks are mapped, so the municipality has a clear overview of what has and wat has not been done yet. In Oudewater the subsidies amount to €15.000 annually.

And for Woerden and Oudewater combined there is 1.5-2 FTE available for climate adaptation.

The largest obstacle in climate adaptation is the availability of space, both above and below ground. The subsurface is full with pipes and cables which makes it difficult to plant trees in some places without having their roots cause damage to the subsurface infrastructure.

The role of HDSR is mostly seen on the theme of water quality and financing measures through the impulse arrangement. In 2017 measures were set for water quality and a robust water system but there

was no money made available for the municipalities to carry out those measures. A suggestion is to structurally make money available for municipalities to carry out plans once plans are made.

For new construction projects, Rijnland has taken up in the Keur that there cannot be water nuisance in the case of a 90mm/h rainfall event. HDSR does not have this taken up in the Keur, but should include it, this makes it easier for climate adaptation employees to convince the municipal board and project developers of the necessity of the inclusion of adaptation measures. Additionally, the new landelijke maatlat should be locally included in policy documents and it should be looked into what aspects of the maatlat can be included in the Keur. Another suggestion is to increase the subsidies for green-blue playgrounds, because now the subsidy amounts for a too little percentage of the total construction costs. Lastly, HDSR is responsible for the supply of freshwater during dry summers. They always say that this will not be a problem, but a numerical justification is lacking, so that should be made and provided to the municipality.

Another remark is that the building covenant, the letter water en bodem sturend, and the landelijke maatlat contain contradictions. There should be simultaneously more housing projects and more green, but the amount of space is severely limited, so the suggestion of how to do that is lacking. A provincial vision on spatial planning should be constructed that includes both the housing tasks and climate adaptation tasks.

Interview L: Wijk bij Duurstede

The goal is to be climate adaptive by 2050, but there is some unclarity about what it means to be climate adaptive. This has made it hard to create a LAS, but the construction of a LAS and complementary execution agenda is in the works and set for somewhere after the summer of 2023. For now, water nuisance is taken up in the WRP (water and sewage programme), but apart from that there is no policy on climate adaptation and there are also no clear goals for heat stress and drought yet. Policy that is used in municipal projects now is the building covenant, which is very practical, but the translation to the local level still needs to be made. The main reason for this is that the requirements of the covenant are quite strict and hard to obtain because detachment from the sewer system is not possible in all locations because of the high groundwater levels and the clay soil. Additionally, the requirements of the different available policy documents (national and provincial) differ from each other, so it is hard to decide what standards to adhere to.

In order to convince the municipal board of the necessity and the benefits of climate adaptation measures a clear cut cost benefit analysis should be carried out for different adaptation measures, like gras tiles for parking spaces. This should also include the extra maintenance costs that those measures bring about. This cost benefit analysis could convince the municipal board and project developers to invest money in those measures.

In the WRP the focus is fully on water nuisance, but in the LAS that is in development, heat stress is also a big theme. The municipality is currently collaborating with Netwerk Water & Klimaat to construct a local heat plan and map all vital and vulnerable functions to determine what locations and routes need more shade. Because heat stress is not yet included in official municipal policy, there is no budget available for combatting heat stress and taking measures that are focussed solely on that theme. The effects of drought in Wijk bij Duurstede are negligible, the only experienced effect is a decrease of water quality, mainly in the Kromme Rijn.

The execution of adaptation measures currently happens in combination with other construction/restructuring projects (meekoppelen).

Currently there is 0.5 FTE available (in the near future this will be increased to 0.7 FTE) for climate adaptation policy and there is 0.2 FTE available for the carrying out of small tasks regarding citizen participation. There is €30.000 available for citizen participation in the form of subsidies and information supply etc. and there is €200.000 available for projects, mainly focussed on water nuisance.

The obstacles in the climate adaptation process lie in the unclarity of climate adaptation requirements that need to be met. Once this is clear and set on paper on the national level, these numbers can be used in the LAS and targeted policy can be constructed. The focus should also be on the goals and not on the measures, because there is a huge variety on the local level in for example groundwater levels, soil type, infiltration capacity, etc. which makes it hard for some locations to hold and infiltrate 90mm of water on each plot. This should be for the municipalities to figure out and as long as the end goals are reached, the exact measures should not matter that much. Furthermore, subsidies should be more easily available, because not only do measures cause money, the maintenance it requires also costs money and more employees.

HDSR and municipalities are seen as two different entities, but in general the goals should be the same and focussed on creating a pleasant living environment for its citizens. There should be a more close collaboration between the municipalities and the Watertoetsers of HDSR, because now it looks like the goals of the municipality and HDSR are different from each other which should not be the case. The area specific goals should be made clear and adjusted to each other's interests.

Water authorities seem to be focussed more on the level of the water system and the municipality has a more local focus which can lead to friction between the two parties. This goes even more for the province.

Interview M: Utrecht

In the creation of the LAS, it has been of great importance to make the goals concrete and measurable. There are 5 main goals: no nuisance for a t=100 rainfall event (80 mm/h), hold and infiltrate 90% of the precipitation to combat drought, 40% of the area to be green to combat heat stress.

There is no separate programme for the execution of climate adaptation measures, but the principle of meekoppelen will be used. This is however slightly problematic, as not all neighbourhoods will be restructured before the set deadline of 2050. Additionally, the lifespan of the sewer system in some neighbourhoods is longer than 2050, so measures will be taken later in those neighbourhoods.

The main focus of the municipality lies on combating heat stress and drought, as those 2 themes are seen as the biggest threat to the urban environment in Utrecht. Furthermore, Utrecht seems to have a good grip on water nuisance, so the focus has shifted to the other topics of the DPRA.

The core team that is involved in climate adaptation makes up about 4 FTE and the budget is …. The difficult part is the financing of the measures that are not water related such as the creation of urban green. The measures regarding everything water related are financed from the GRP, but measures to combat heat stress legally have to be financed by another source. It is estimated that a total amount of 1,5/2 billion euros is needed to make Utrecht climate adaptive, but if meekoppelen is used everywhere only half of that money is required. About half of the required budget can be financed from the GRP, the other half has to come from other sources.

One of the main obstacles is the lifespan of the sewage and other infrastructure, which is often set to beyond 2050, which makes meekoppelen very hard. There is no money for loose measures, so in that case, restructuring will have to wait until after 2050. Additionally, there is a lack of capacity, not only on the policy and planning side, but also on the executive side, currently the sewage replacement is

going too slow which makes it even harder to meet the goals set for 2050. There are also spatial problems, because in order to meet the goals set for heat stress, about 1/3 of the currently paved surface needs to be transformed to green space and this is very difficult if not impossible. This also makes the goals regarding heat stress the most tricky to meet. Current subsidy arrangements are not for the creation of green, so for heat stress there are no subsidies available. Another problem is citizen participation, it is currently not possible for the municipality to force citizens to depave their gardens and even in public space, if a tree would take the place of a parking spot and 50% of the street is in favour and one inhabitant protests, that tree will not be placed. This makes it difficult to carry out climate adaptation measures in some cases.

HDSR is seen as the regional water manager. The water authority and municipality collaborate on regional themes such as drought, floods and water quality. Utrecht sees it as a missed opportunity to not include water quality in the DPRA.

The province is mainly seen as a provider of subsidies for heat stress measures and provides no policy related help. It has provided a level playing field for urban development though through the building covenant.

HDSR can help by ensuring that the Kromme Rijn supplies enough water to Utrecht, as the Kromme Rijn currently is the main source of water for the municipality (about 2x as much water from the Kromme Rijn as from precipitation). Policy wise it is good to collaborate, although there are some differences in opinion between Utrecht and HDSR mainly on the topic of water buffering (HDSR wants buffers to be available again after at most 60 hours and Utrecht wants to give the water the chance to infiltrate to prevent drought problems). Utrecht wants the focus to lie on holding and infiltrating and HDSR is currently more focused on draining.

Interview N: Dries Schuwer HDSR (on the Keur/waterschapsverordening)

Currently HDSR works with a Keur while it is still working on the wateschapsverordening that needs to be ready before 2024 as it will go into force on January 1st 2024. The Keur includes compensation rules which means that for every restructuring project in urban areas, 10% of the paved surface needs to be transformed from paved to unpaved in close vicinity. HDSR is working on creating stricter rules with respect to water storage, for new construction that will be 70mm and for restructuring 45mm. Through the waterschapsverordening it is possible to enforce strict values for water storage, infiltration and buffering but the requirements need to be carefully set because if they are too strict it might be impossible for municipalities to meet them. It is not possible to set future goals through the waterschapsverordening, if the requirement is 70mm, that needs to be met everywhere as soon as the verordening goes into force, so it is not an option to set more ambitious goals with a longer horizon (e.g. 90mm by 2040). Furthermore, municipalities can also set storage and infiltration requirements through their Omgevingsplan so it needs to be carefully deliberated what to demand from municipalities and what to let them decide themselves.

The strategy that HDSR employs is to tempt municipalities to take climate adaptive measures, for example through the regional bouwconvenant, but also through subsidies. There is, however, also a baseline of requirements that municipalities have to meet, so there is a good balance between tempting and enforcement.

To help municipalities with policy and requirements, the Handboek water in ruimtelijke plannen is created with feedback from the municipalities. That guide contains information on the requirements for the different themes of the DPRA and the Landelijke maatlat.

Another water authority, Rijnland, has recently implemented a new waterschapsverordening that includes climate adaptation requirements and that is closely watched to see which aspects work and which do not so as to be able to use it as input for the waterschapsverordening of HDSR.

There is a relation between the provincial ordinance, municipal ordinance and the water authority ordinance, as they are all related to the letter water en bodem sturend of the national government. HDSR collaborates with the province on the creation of requirements and the larger sized (in area) problems to create policy and solutions.

Interview O: Goos Boelhouwer HDSR (on the impulse arrangement)

Officially the impulse arrangement is not a subsidy, because the requirements for a subsidy are a lot stricter than for the impulse arrangement. The first version of the impulse arrangement came about 8/9 years ago and firstly only included six municipalities. A few years later it was included in Winnet (the predecessor of Netwerk Water & Klimaat), which put climate adaptation on the agenda in the region. Before the impulse arrangement, the strategy of HDSR was to share knowledge and stimulate municipalities to take climate adaptive measures and the impulse arrangement is a supplementary strategy. The arrangement has a multiplier effect, as the amount of money invested by HDSR accounts for a maximum of 50% of the total project costs and municipalities have to invest the other percentage themselves.

The premise of the arrangement is that it has to be very easy to apply for it. At first, there was a project for only water quality with an available budget of €300.000, later on climate adaptation was added to the project and the budget was increased to €450.000. A few years ago, the programme climate adaptation was created by HDSR and the budget was increased by €250.000.

The amount of applications by municipalities structurally exceeds the amount set available by HDSR. This year the budget is €1.850.000 and the total amount asked by the municipalities is €2.700.000. In the coming years, the arrangement will be broadened to also include healthy water and the wastewater chain because those themes also relate to climate adaptation.

The experience is that the six municipalities that have been included in the programme from the beginning (also the larger municipalities in the management area): Utrecht, Nieuwegein, Houten, Stichtse Vecht, Utrechtse Heuvelrug and Woerden best know how to find the impulse arrangement and apply for it the most often. In order to get the smaller municipalities included, 2 years ago the arrangement was broadened to also include the preparation costs of the proposed projects and actively stimulate smaller municipalities to make use of the arrangement. This is done by both making them aware of its existence and by actively giving examples of bottlenecks in their municipality and what measures they could use with help of the impulse arrangement to combat those bottlenecks. Area managers will approach the municipalities on this topic.

For now, the arrangement annually provides money to a certain amount of projects until the budget is gone, but the plan of HDSR is to in the near future start working with meerjarenplannen which allows for larger measures, more impact and a larger certainty for municipalities that the money will be provided over a certain period of time.

Because the impulse arrangement has to be used for climate adaptation, all climate adaptive measures can be funded. This means that not just water related topics get funding, but also heat stress. Most municipalities, however, are mostly not aware of this partially due to miscommunication within the municipality and a fragmentation among municipal employees that all work on a different aspect of climate adaptation.

The budget of €1.8 million seems to be the maximum for the coming years, this could change if the board decides to either increase or decrease the budget, but there will be no extra contributions from the climate adaptation programme.