

Drought-risk perception

In the municipality of Enschede



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Colophon

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Summary

The effects of increasing droughts are seen all over the world, also in countries that have little or no experience with long-term droughts. One of these countries is the Netherlands, in which two of the five most recent summers are in the top five driest summers ever measured. Enschede, a city located on the high sandy soils in the east of the country, has bigger problems than the rest of the country during dry periods, because they only depend on the precipitation that falls. Drought is a natural hazard that causes immense damages across a lot of sectors, and therefore, drought adaptation policies are needed. One of the main factors that drives adaptation capacity is drought-risk perception. Perception influences an area's vulnerability to drought and their adaptation policies. Therefore, this master thesis investigates *the influence of drought-risk perception on drought adaptation policies and vulnerability in the municipality of Enschede*. Thereby, this study contributes to literature on drought-risk perception, and fills the research gaps of urban droughts, of areas with almost no experience with long-term droughts and of drought in the Netherlands. To answer the main research question, literature study, review of existing policy documents and semi-structured interviews are used.

The research shows that Enschede's vulnerability to drought is quite high, as drought is expected to increase in the future, and Enschede's adaptive capacity is not quite high yet. Because the recent dry summers were not expected at all by the respondents and their organizations, drought is only recently and very little considered in the municipal policy. Not everyone recognizes or prioritizes drought-risk yet, also because still very little is known about what the effects of drought have been in Enschede, how much the damage has cost, in which areas the greatest risks lie, what measures really contribute to combat drought and whether they have negative side effects. Hence, no direction has yet been set on how to deal with drought, what effects of drought are accepted where, and what minimum needs to be done to counteract the effects of drought. Although some measures are being taken to adapt to drought, it still often falls short of other spatial tasks. It can be concluded that because of the lack of experience with drought, the recognition and priority of drought in Enschede is fragmented, leading to incongruent adaptation policies and therefore higher levels of vulnerability. Therefore, it is recommended to conduct more research on the effects of previous droughts and the risks of future droughts in Enschede. Moreover, it is recommended to create more awareness about drought risks, to expand and broaden existing drought policies, and to implement more drought adaptation measures.

Keywords: Drought, drought-risk perception, drought vulnerability, drought adaptation policies.

Preface

This master theses is the final part of the master's programme Spatial Planning at the Radboud University, and is about the influence of drought-risk perception on drought-adaptation policies and vulnerability in the municipality of Enschede. Because I am mainly interested in climate adaptation, regreening and water management, I followed the specialization 'Cities, Water & Climate Change' within the master program. I was able to conduct the research and write the thesis during an internship at the municipality of Enschede. This has enabled me to interact with many professionals in the field of water management. In addition to carrying out my research, this also allowed me to learn more about the working field and orientate myself on what I would like to do after my studies. In total, the research and the internship lasted from February to July 2024.

I would like to thank my supervisor, Tara Saharan, for her trust, guidance, detailed feedback and opportunity to brainstorm on everything. Additionally, I would like to thank my internship supervisors at the municipality of Enschede, Koen Wagelaar and Laura van Tongeren-Rooswinkel. They gave me the confidence, the freedom and the possibilities to conduct my research in my own way. Moreover, they introduced me to what working for a municipality is like.

Lotte Meijer

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1. Introduction to the research

Climate change is one of the biggest global challenges of these times: due to human activity, the amount of greenhouse gases in the atmosphere is rising, leading to an increase in the earth's temperature. Its effects, such as hurricanes, floods, forest fires and droughts, are seen all over the world and have major consequences for people, nature and the environment (Leal Filho, 2015). Although urban areas only cover 3% of the earth's surface, more than half of the world's population currently lives in cities (Zhang et al., 2019). Urban environments tend to amplify the effects of climate change. Urban petrification causes temperatures to rise much higher in the city than outside, and it prevents precipitation from infiltrating in the soil, leading to floods and droughts. It appears to be that 59% of cities with at least 500,000 inhabitants are at high risk of exposure to at least one natural disaster (Dąbrowska et al., 2023). As many cities are densely populated, these effects of climate change lead to major human disaster worldwide (Leal Filho, 2015).

The vulnerability of an area to the consequences of climate change, depends on the combination of a system's sensitivity to climate risks and its adaptive capacity to deal with the resulting harmful conditions (Wandel et al., 2016). One of the main factors that drives adaptivity decisions, is risk perception (Wens et al., 2019). It appears that people are more likely to adapt to climate change when higher risks of climate change threaten one's physical health, finance, production, social relationships and psychology (Ricart et al., 2021). Risk perception is therefore crucial for possible adaptation measures (Ricart et al., 2023). However, the perception on climate risk can vary amongst different stakeholders: what is perceived as an abnormal or damaging varies between cultures and eras and changes with evolving understanding and practices (Kallis, 2008).

1.1 Research problem statement

Drought is one of the effects of climate change that is known as a natural hazard that affects the largest number of people (Dilling et al., 2019) and causes immense economic and ecological damages (Elkouk et al., 2022). The effects of increasing severity and duration of dry periods are seen all over the world and influence sectors such as agriculture, water resources, tourism, ecosystems and human wellbeing. Urban drought directly impacts the ecosystem of a city, from industrial productivity to agricultural yields, social stability and the health of residents (Zhang et al., 2019). As more people in the world live in cities, it is becoming increasingly important to ensure the sustainability of urban water supplies and to adapt to increasing urban drought-risk (Dilling et al., 2019).

Drought-risk does also occur in areas with little or no experience of long-term drought, like the Netherlands (Finley, 2019). In this country, two of the five most recent summers are in the top five driest summers ever measured (Straaten, 2023). Enschede is a city located on the high sandy soils in the east of the country, where the problems during dry periods are bigger than in other parts of the country. Enschede has no access to water via lakes or rivers during a dry period, which means the city only depends on the precipitation that falls. Moreover, from the second half of the 20th century, the area around Enschede was designed to drain rainwater as quickly as possible to avoid flooding. However, it now appears that water is drained too quickly, especially in winter and spring, causing water shortages in summer and during the growing season. These water shortages, have major consequences for farmers, industry, shipping, natural areas and drinking water supplies (Klimaatadaptatie, 2022).

Enschede is located on a lateral moraine, which means the city has height differences of up to 40 metres. This makes Enschede vulnerable to drought in the higher parts and to water nuisance in the lower parts (Royal HaskoningDHV et al., 2022). These local differences lead to a diversity in how drought is experienced among inhabitants, policymakers, nature and water authorities and others. As a result of this diversity, it isn't clear how drought-risk is perceived (Informatiepunt Leefomgeving, 2022). As

drought-risk perception determines adaptive decisions and thus influences the city's vulnerability to droughts, this thesis investigates drought-risk perceptions in the municipality of Enschede.

1.2 Research aim and research questions

Existing research shows the importance of risk perception on possible risk reducing behaviour and climate change adaptation (Ricart et al., 2023). This master thesis aims to gain insight in drought-risk perception and its influence on drought adaptation policy and vulnerability in urban areas where drought is a rather unexplored phenomena. To reach this goal, the main research question of this thesis is as follows:

How does the perception of drought-risk influence drought adaptation policy and vulnerability in the municipality of Enschede?

The questions that will help to answer the main research question are:

1. What are existing drought adaptation policies in the municipality of Enschede?
2. What is the existing drought vulnerability within the municipality of Enschede?
3. How is drought-risk perceived in the municipality of Enschede?

1.3 Societal and scientific relevance

1.3.1 Societal relevance

The effects of increasing duration and severity of dry periods are seen all around the globe (Zhang et al., 2019). A combination of longer and more frequent heatwaves, increasing city populations and increased insecurity in water precipitation and water demand is expected to rise the risk of periodic water shortages in many regions worldwide (Naumann et al., 2015). This risk does also occur in areas with little or no experience of long-term drought, like northern Europe (Finley, 2019). Research found out that periods of droughts will increase in the future in both south-European and north-European cities (Guerreiro et al., 2018). This is also seen in the Netherlands nowadays; two of the five most recent summers are in the top five driest summers ever measured (Straaten, 2023).

Due to climate change, the chance of longer periods of extreme droughts in the Netherlands is likely to increase in the future (Ministerie van infrastructuur en waterstaat KNMI, 2022). This has major consequences on humans, animals and the environment. In the Netherlands, drought resulted in subsidence of houses, damage to infrastructure and cultural heritage, shipping, agriculture, a major loss in biodiversity and damage to people's health (J.P. Witte et al., 2020). The drought of 2018 negatively impacted all these sectors, resulting in an estimated damage of 450 to 2080 million Euros, from which the highest water deficits in the Netherlands were measured in the southern and eastern regions, in which Enschede is located. (Philip et al., 2020). The summer of 2022 even exceeded this record drought of 2018 (Bressers et al., 2014).

Drought-risk depends on a combination of hazard, exposure and vulnerability, where the latter involves the ability to cope with drought impacts, also known as adaptive capacity. To increase a society's adaptive capacity, drought adaptation policies are needed (Finley, 2019). Since adaptive capacity, both private and public, depends for a big part on how drought-risk is perceived, it is required to learn more about this concept. This thesis investigates drought-risk perception in the city of Enschede, where they don't have a lot of experience with long-term droughts. Understanding the perception of drought-risk can help identify drivers or barriers for drought adaptation policies (Teutschbein et al., 2023). Therefore, the municipality of Enschede can benefit from the insights into drought-risk perception and use it to adjust their drought adaptation policies and reduce vulnerability. Greater understanding of drought-risk perception can help policy officers to formulate better drought adaptation policies, which

will automatically be beneficial for residents when it leads to decreasing effects of drought in the future. Moreover, organisations such as foundation Landscape Overijssel, waterboard Vechtstromen or drinking water company Vitens will benefit because they cooperate frequently with the municipality of Enschede in establishing drought adaptation policies for the area.

1.3.2 Scientific relevance

When looking at perceptions of drought in the literature, there are three main debates. First, much research has been done on drought-risk perception and risk reducing behaviour. However, it is notable that existing research has mainly focused on farmers' vulnerability to droughts, their perceptions of drought-risk and corresponding adaptation measures. These existing studies broadly acknowledge that farmers' perceptions are crucial in adaptation behaviour (Ogundeji et al., 2022). For example, if higher risks of climate change, such as drought, threaten one's physical health, finance, production, social relationships and psychology, farmers are more likely to adapt to climate change (Ricart et al., 2021).

Second, when reviewing the literature, it can be seen that a lot of research on drought-risk perception has taken place in rural areas. For example, research on drought-risk perception has been done on communities in the outback of southern Australia (Pearce et al., 2010) or in remote areas in New Zealand (Nguyen et al., 2023). Similarly, research on drought-risk perception of farmers has been conducted in rural areas in the south-west of the Netherlands (van Duinen et al., 2015).

Third, the literature reveals that drought-risk perception has been studied a lot in countries where drought has been present for much longer and more severe than in the Netherlands. This is the case, for example, for countries located near the equator. Here, extreme heat and drought has been present in summer periods already for decades. Due to climate change, dry spells are getting longer and more severe, with all its consequences. The perception in these increasing dry periods has been done on, for example, farmers in the outskirts of South-Africa (Bahta et al., 2016) or on local people in the outback of Ethiopia (Melka et al., 2015).

When looking at water management and adaptation policies, a lot of research in the Netherlands has been done on flood risks and water nuisance (Keessen et al., 2013). This is to be expected because a big part of the Netherlands is located below sea level and another big part is vulnerable to river floods. This is why drought can be seen as a rather new and underrated issue in the Netherlands, which is evidenced by the fact that most of the climate adaptation budget is earmarked for flood protection (Wiering, 2019). One research about urban droughts in the Netherlands is about vulnerability to groundwater drought, to test the resilience of this city to droughts. However, this research has nothing to do with perception of stakeholders (Machairas et al., 2023).

It can be concluded that a lot of research on drought-risk perception has been done on farmers, in remote areas or in countries where extreme droughts have been present for decades. This thesis aims to gain insight into perception of drought-risk in urban areas in a country with little experience of drought. By doing so, it helps filling the research gap about drought-risk perception in cities, which is a rather unexplored concept compared to the countryside (Machairas et al., 2023). In addition, this thesis aims to fill the research gap on drought-risk perception in areas with almost no experience with long-term droughts. Finally, this thesis helps to fill the research gap on droughts in the Netherlands, which is an underexplored phenomena in relation to water nuisance and heat stress.

1.4 Reading guide

This thesis will start in chapter two with a critical review of the existing literature on drought, drought-risk perception and drought vulnerability, resulting in a conceptual framework that will be used for the research. Chapter three describes the methods for data collection and data analysis, as well as research context. The results of the data collection and analysis will be presented in chapter four. This is followed by chapter five in which the research questions will be answered and discussed. Moreover, the research is reflected on, limitations will be addressed and policy recommendations and suggestions for further research are explained.

2. Literature review and theoretical framework

This chapter consists of several sections. First, an overview of existing literature on drought is presented. This is followed by an explanation of the concept of drought-risk perception and how the vulnerability of an area to drought can be understood. These sections are brought together in a conceptual framework that will serve as the foundation for this master thesis.

2.1 Drought

Droughts are among the most costly natural disasters worldwide (Elkouk et al., 2022) and ranks first among all natural disasters in terms of the number of people affected (Dilling et al., 2019). In contrast to other natural hazards like earthquakes, hurricanes or floods, droughts develop slowly and become increasingly severe over time (Teutschbein et al., 2023). Extreme droughts impact human livelihoods and cause immense economic and ecological damages, which affect agriculture, water resources, tourism, ecosystems and human well-being (Elkouk et al., 2022).

Drought occurs when there is a temporary water shortage (Zhang et al., 2019). However, it seems difficult to come to one universal definition of drought, due to differences in hydrometeorological variables, socioeconomic factors and the variation in the amount of water needed in different areas all over the world. What most definitions have in common is that there are periods of time where the supply of moisture fails to meet its demand (Ault, 2020). One commonly used definition is the one of the World Meteorological Organization, and describes drought as: *'a sustained, extended deficiency in precipitation'* (World Meteorological Organization, 1986). Van Loon et al. (2012) define drought as *'a sustained and regionally extensive period of below-average natural water availability'* (Van Loon et al., 2012). The definition used in this thesis comes from the UN Convention to Combat Drought and Desertification, and reads as:

'the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems' (UN Secretariat General, 1994).

This definition is used because it does not only include water shortages but also the effects these water shortages can have. As the effects of drought can cause problems, it is important to include this in the definition. Drought should not be confused with desiccation. Desiccation entails a structural drop in groundwater levels caused by human activity. Desiccation leads to structural damage to nature and that effect is intensified by drought. Drought itself need not yet lead to structural damage (Ramanjulu et al., 2002).

2.1.1 Different types of drought

Drought can be categorized into four different types: meteorological, hydrological, agricultural and socio-economic drought. Meteorological drought is defined as a lack of precipitation over a region for a period of time, and often endures for several weeks. Hydrological drought occurs when a dry period affects groundwater levels and can last several seasons. Agricultural drought refers to a period with declining soil moisture and consequent crop failure and often lasts for months (Mishra et al., 2010). These three types of droughts are physical phenomena. The socioeconomic type of drought concerns drought in terms of supply and demand (Dąbrowska et al., 2023). It occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply (Mishra et al., 2010).

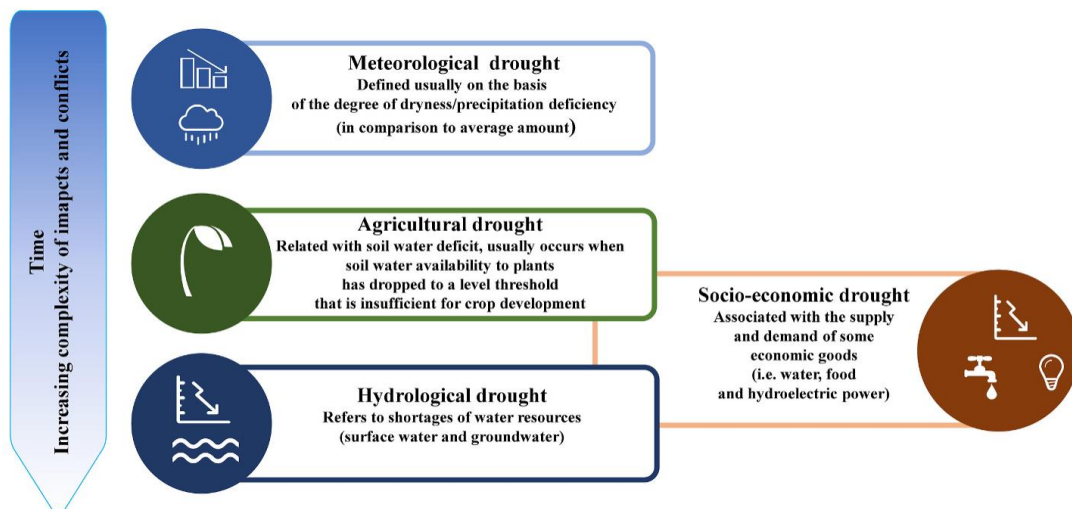


Figure 1: four different types of drought (Dąbrowska et al., 2023)

According to Zhang et al. (2019), urban drought is a subtype of socio-economic drought, because it presents a temporary water shortage in an urban area either due to a sharp decrease in water supply or a sudden increase in water demand. This imbalance between water supply and demand, along with water mismanagement, causes urban drought (Zhang et al., 2019). While urban drought thus primarily has a human cause, rural drought is associated with agricultural drought and therefore has primarily a physical origin. However, both types of drought start with a meteorological drought and both can be exacerbated by human activities: when the water system is designed to drain water as quickly as possible, it affects both urban and rural droughts (Dąbrowska et al., 2023).

2.1.2 Drought mitigation and adaptation

Roughly, there are two ways of dealing with increasing droughts. First, in the past, the way to deal with drought was mainly reactive, related to crisis management. There was no preparation for a dry period, and once a dry spell occurred, people would do everything they could to reduce the consequences. Second, in recent decades, there has been a shift towards more anticipation of potential droughts, a more risk-based approach. This approach means that a dry period is taken into account in advance, and measures to mitigate or adapt to the effects of drought are taken. Mitigation is more focused on preventing a dry spell, for example by preventing further global warming by reducing the amount of greenhouse gas emissions. Adaptation is about adapting to a dry spell rather than preventing it. Adaptation is aimed at reducing drought vulnerability and increasing a system's resilience (Wang et al., 2019). Since this master thesis is about drought adaptation policies and vulnerability, it focuses more on adaptation measures and less on mitigation measures. Drought adaptation measures are mostly focused on retaining water instead of draining it. The table below provides an overview of possible measures to adapt to the consequences of drought:

Table 1: possible measures for drought adaptation (author) adapted from (Wang et al., 2019) and (Logar et al., 2013)

Drought adaptation measures	
<ul style="list-style-type: none"> Water conservation in industry, agriculture, gardening and households 	<ul style="list-style-type: none"> Replace paving with greenery to allow water to infiltrate in the soil
<ul style="list-style-type: none"> Disconnect rainwater from the sewer and let it infiltrate into the soil 	<ul style="list-style-type: none"> Create green roofs, gardens or facades to retain water longer
<ul style="list-style-type: none"> Create water reserves and buffer precipitation 	<ul style="list-style-type: none"> Make waterways shallower or meandering so that water is drained less quickly

2.2 Drought-risk perception

According to Wachinger et al. (2010), perception of risks involves the process of collecting, selecting and interpreting signals about uncertain impacts of events, activities or technologies. These signals can refer to direct observation or information from others. The term ‘risk’ can be defined in the natural sciences as the probability distribution of adverse effects (Wachinger et al., 2010). When looking at drought-risk, it can be described as: ‘*the consequence of drought frequency, population exposure and human development as a proxy of vulnerability*’ (Elkouk et al., 2022). Drought-risk is constituted by drought hazard, drought exposure and drought vulnerability (Elkouk et al., 2022).

Drought-risk= drought hazard X drought exposure X drought vulnerability (Wens et al., 2019).

The term natural hazard refers to any process, phenomenon or human activity that may cause health impacts, property damage, social and economic disruption or environmental degradation. Droughts are, as mentioned before, hazards resulting from a lack of water compared to the long-term average over an extended period (Zhang et al., 2019). Exposure describes resources and activities in drought-prone areas and can be expressed as the number of people potentially affected by water shortages, the production area susceptible to crop stress or the ecosystems that could be harmed. Vulnerability can be regarded as the combination of a system’s sensitivity to drought-risks and its ability to deal with the resulting harmful conditions (Wens et al., 2019).

Drought-risk perception is one of the main factors driving adaptation decisions (Wens et al., 2019). Also, shared perception of the problem seems to be one of five underlying mechanisms that help to steer and accelerate transitions in Dutch drought governance (Brockhoff et al., 2022). The perception of drought-risk can vary amongst different stakeholders: what is perceived as an abnormal or damaging shortage of water varies between cultures and eras and changes with evolving understanding and practices (Kallis, 2008). In addition, figure 2 shows four context levels that can influence the judgments of individuals about the seriousness and acceptability of risks:

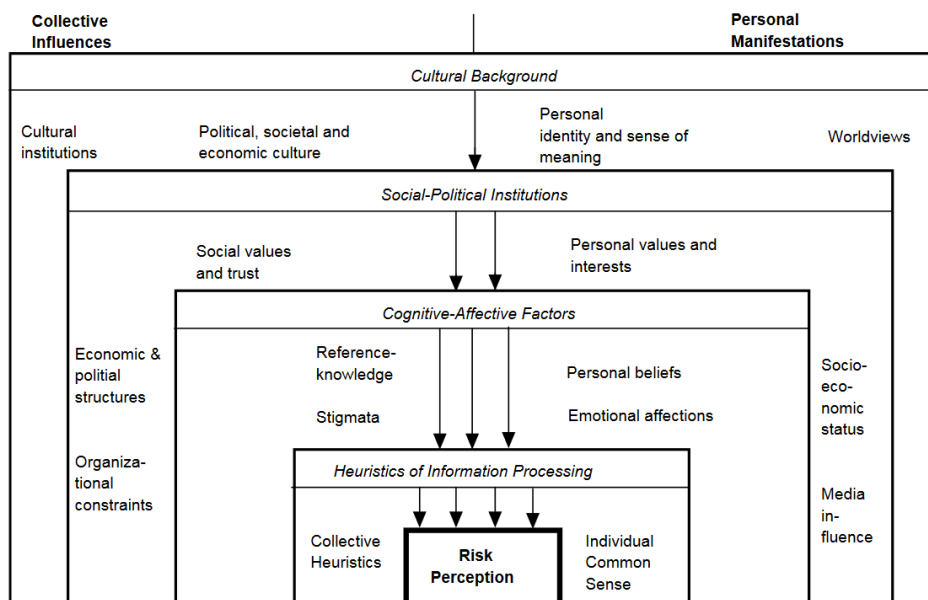


Figure 2: four context levels of risk perception (Wachinger et al., 2010)

According to Wachinger et al. (2010), perceptions may differ depending on the type and context of the risk, the personality of the individual and the social context. In other words, there are many factors that can influence drought-risk perception. Therefore, the perception of drought-risks among different actors often diverges from what actual “hard” data shows (Teutschbein et al., 2023). When looking at

figure 2, it can be imagined that drought-risk perception can vary greatly from person to person and that a shared perception of drought-risk is not easy to arrive at.

2.3 Drought vulnerability

As mentioned before, vulnerability is about the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (Wandel et al., 2016). Vulnerability, and more specific drought vulnerability, combines two dimensions: the exposure to droughts and its impacts on social systems, and the social conditions that determine the sensitivity as well as the system’s adaptivity capacity. This is shown in figure 3, where exposure is a characteristic of a climate system, which refers to droughts and their characteristics, such as intensity, duration and coverage, that determine the magnitude of their impact on social systems. Sensitivity and adaptive capacity, on the contrary, are characteristics of a social system and are defined by the access to and control over a variety of resources. Sensitivity is determined by the lack of resources, or limited resources. Adaptation is defined by the existence of resources that could be mobilized to reduce sensitivity. Adaptation and sensitivity are therefore each other’s opposites. Vulnerability is thus a characteristic of a social system that occurs when, in this case, a period of drought affects human systems.

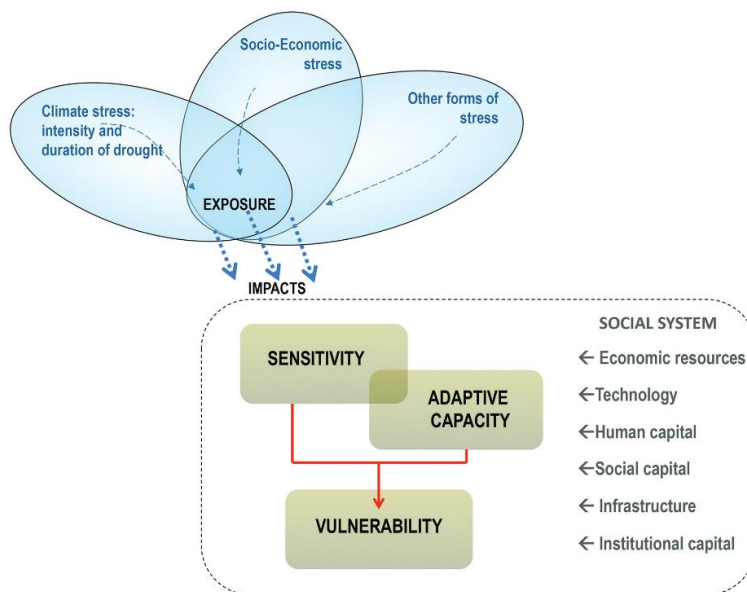


Figure 3: the two dimensions of vulnerability (Wandel et al., 2016)

According to Wandel et al, (2016), when all areas have the same exposure to drought, it does not mean they are all equally vulnerable. Differences in vulnerability are related to a variety of social, economic and political conditions and capacities, which are presented on the right side of the figure above. These ‘determinants of adaptive capacity’ either facilitate or constrain an area’s ability to cope with harsh climate conditions such as droughts. A social system that is characterized by a limited number of these determinants is more vulnerable to drought (Wandel et al., 2016). The determinants of adaptive capacity are shown in table 2.

Table 2: determinants of adaptive capacity (author) adapted from (Wandel et al., 2016)

Determinant of adaptive capacity	Description
Economic resources	Financial resources such as government subsidies for research or municipal money for drought adaptation measures
Technology	Technical solutions/measurements for drought management

Human capital	Knowledge, skills and expertise to adapt to droughts
Social capital	Informal local institutions based on friendship or affiliation that could reduce stress of natural and economic hazards or increase the capacity to organize adaptation actions
Infrastructure	The current water system and wider spatial planning in drought adaption should find a place
Institutional capital	Larger institutional context (politics/power) from which resources, programs and polices are provided to local communities

The framework with two dimensions of vulnerability is used in this master thesis because it contains aspects that can help examine drought vulnerability in Enschede. However, the framework only deals with vulnerability and does not include perceptions at all. As a result, the framework lacks a human factor, and since perception largely determines whether adaptive measures are implemented, this component is essential to include. This framework could therefore be part of the final conceptual framework, but is not enough to answer the research question. Another limitation that needs to be taken into account is that the framework does not distinguish different geographical areas. This is striking because it does matter for drought vulnerability whether it is about a low-lying area with enough water supply, or as in the case of Enschede, an upper area without water supply from rivers or lakes. Therefore, geographical characteristics should be added to the framework.

2.3.1 Vulnerability framework

To analyze the perception of drought in the municipality of Enschede, the vulnerability framework presented in the study of Taylor et al. (2016) could be used. The vulnerability framework shows the interaction between three sections. The first section is about the perception on drought, which is shaped by the four elements experience, memory, definition and behavior. The second section is the vulnerability to drought, which is about the exposure to droughts, a system's sensitivity to droughts or the adaptive capacity, as described in paragraph 2.3 (Wandel et al., 2016). The third element contains the actions to address drought implemented by individuals, the collective or the government (Taylor et al., 1988).

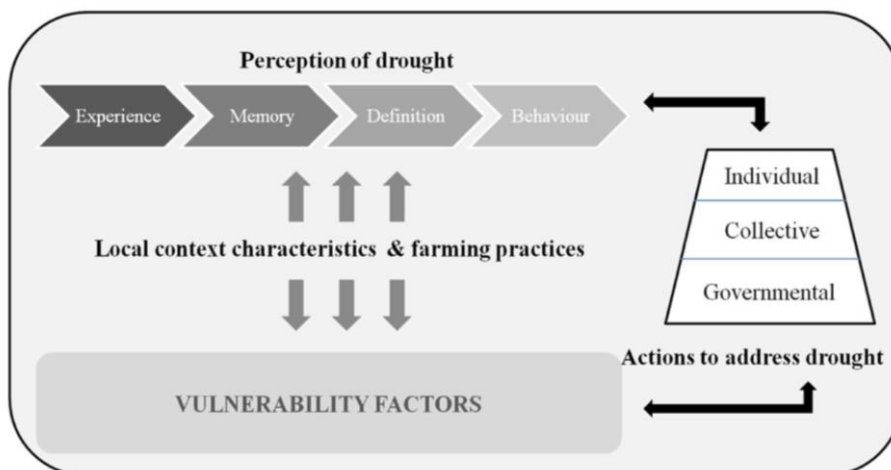


Figure 4: vulnerability framework (Taylor et al., 1988)

The first of the four elements that shape perception is experience, which refers to the episodes of drought that hit a region. It seems to be that the capacity to cope with drought is based on the experience with past droughts. Understanding the processes involved in successful drought adaptation in the past can provide insight in how to adapt to future conditions (Wandel et al., 2016). Memory refers to the drought events that were part of the stakeholders direct experiences and could be recalled. This means that sometimes, drought might not be recalled by stakeholders, because it did not

affect them. Drought definition is a set of criteria used by stakeholders for classifying a time period as a drought. It is about the way a dry episode is characterized. The last one, behaviour, refers to the type of measures implemented to address water shortages (Taylor et al., 1988).

The relations between the elements that shape perception are shown in figure 5. The experience with droughts influences drought memory and drought definition. Memory and definition interact in a way that how one defines drought is influenced by the droughts one remembers. New in this figure are the expectations one holds about future droughts, which depend on how drought is defined and on which past experiences are remembered. The expectation of future droughts include how often future droughts occur, how severe they are expected to be and the expectations about the impacts, such as whether the effects of future droughts could be overcome. All these elements combined influence one's behaviour in preparation and adaptation towards future droughts (Taylor et al., 1988).

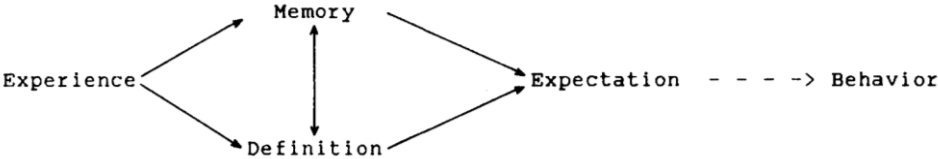


Figure 5: elements of drought perception (Taylor et al., 1988)

The vulnerability framework from Taylor et al. (1988) can serve as a foundation for this master thesis because it helps understand drought perceptions at the individual level. Because perception is a rather subjective concept, it is difficult to investigate. The framework helps with this by dividing the concept into different elements. To these elements, topics can be linked that make it manageable and clear what needs to be investigated to understand perceptions. However, the framework mainly focuses on individual perceptions of drought, but among the stakeholders important in determining drought policy, institutional, political and organizational factors may also play a role. This should be taken into account when examining drought perception among respondents. Since the framework is from 1988, it can be questioned whether it is still relevant of this time. However, the framework has also recently proven to be a good basis for many studies. It has been widely cited and applied in various disciplines (Datta et al., 2022), suggesting that it can still offer valuable insights into drought perceptions.

Other frameworks were considered, such as the psychometric paradigm to understand and measure risk perception of hazards (Clahsen et al., 2019) or the theory of coping used in several studies on perception (Quandt, 2021) and adaptation decisions (Melka et al., 2015). However, the psychometric paradigm was better suited for quantitative research and the theory of coping was more suitable for investigating individual adaptation behavior, while this study focused on governmental adaptation behavior. The vulnerability framework is therefore better suited for this research.

2.4 Conceptual framework

The Vulnerability framework by Taylor et al. (1988) will be used for this research on drought perception and its influence on drought policy and vulnerability. This framework is combined with the framework about two dimensions of vulnerability by Wandel et al. (2016). This is done because the framework about two dimensions of vulnerability gives a more detailed method of operation on how vulnerability can be investigated. When combining these two frameworks, there is a clear approach to examining both the concepts. However, some changes in the framework by Taylor et al. (1988) need to be made to make it suitable for this research. First, this master thesis is not about farming practices but about the urban context, so this part will be replaced. Second, this master thesis looks at the influence of drought-risk perception on drought adaptation policy, which means that it only focuses on 'governmental', and not on 'individual' or 'collective'. This leads to the following conceptual framework:

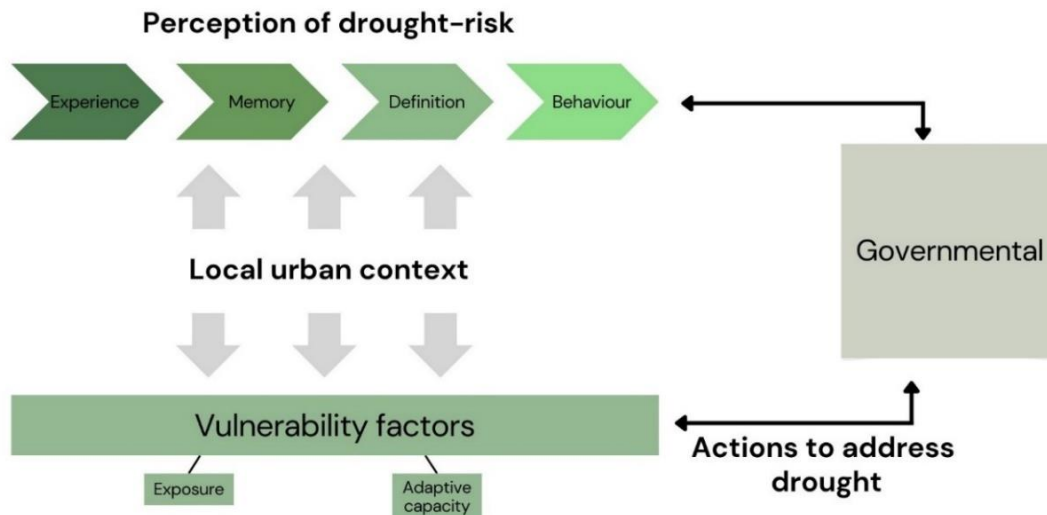


Figure 6: conceptual framework (author)

2.5.1 Operationalisation

The conceptual framework is operationalised in the following table. The concept of perception is divided into the four elements experience, memory, definition and behaviour. Each element is further operationalised in several themes that serve as indicators for the element, based on the research of Taylor et al. (1988). This makes the concept of perception more tangible and makes it more manageable to draft questions for the respondents. The concept of expectation is included in the element exposure, because the scientifically drought expectation is also included there. Enschede's vulnerability is divided into exposure and sensitivity and adaptive capacity. Because sensitivity and adaptive capacity are each other's opposites, this is included as one component. The exposure is based on the scientific exposure to future droughts. The adaptive capacity or sensitivity is further operationalised in indicators, based on the determinants of adaptive capacity (Wandel et al., 2016). As mentioned before, the factor "geographical characteristics" is added to this framework.

Table 3: operationalization of the conceptual framework (author)

Concept	Element	Indicator
Drought-risk perception	Experience	<ul style="list-style-type: none"> Expectation of past dry periods Effects of past dry periods Changes because of past dry periods
	Memory	Periods remembered as dry or not
	Definition	<ul style="list-style-type: none"> Concept of drought Drought recognition Acceptability of drought and its effects
	Behaviour	<ul style="list-style-type: none"> Drought policy Perception on drought policy Drought adaptation measures Collaborations Priority of drought Future vision
Drought-vulnerability	Exposure	<ul style="list-style-type: none"> Scientific expectation of future droughts Future drought expectation
	Adaptive capacity	<ul style="list-style-type: none"> Geographical aspects Economic resources Technology Human capital Social capital Infrastructure Institutional capital

3. Methodology

This chapter describes the methods that will be used in this research to eventually answer the research question. First, the research philosophy and strategy will be elaborated. Next, the methods for data collection and data analysis will be explained. This is followed by a description of the research context. Lastly, the validity, reliability and research ethics are discussed.

3.1 Research design philosophy and strategy

The main underlying research philosophy of this thesis is interpretivism. In the interpretive approach, researchers assume that there is not one empirical world, but everyone has their own personal view of reality. In the interpretive approach, a particular event can be perceived and experienced differently by different people, dependent on their background, different circumstances and at different times (Guba et al., 1994). According to van Thiel (2014), researchers that take on an interpretive approach start by studying people's perceptions: how events are experienced and what kind of meaning is given to those events. In this research, interpretivism refers to investigating the perception of drought-risk in the municipality of Enschede. Someone's experience with drought in Enschede is a subjective reality and an interpretation of the researcher.

This thesis will use a qualitative research approach. The research question of this master's thesis is exploratory, which means that the research question is open-ended and presuppose there is yet no knowledge on the subject of study (Van Thiel, 2014). The chosen research strategy is case study research. This strategy is a pragmatic and flexible research approach, which helps to provide comprehensive in-depth understanding of an issue (Harrison et al., 2017). According to van Thiel (2014), case study approach allows the researcher to gather and analyse data on complex and non-numeric variables such as perceptions, and later arrive at an interpretation of these. This research strategy therefore fits this master's thesis best. In case study research, one or several cases are examined in their real-life context (Van Thiel, 2014). A case study approach has a predominantly interpretative approach, which is also the research philosophy in this master's thesis. With the use of the case study strategy in the interpretive approach, the risk of double hermeneutics should be taken into account: the researcher can reinterpret the perceptions of the respondents, which leads to a layering of interpretations and may lower the reliability or validity. Moreover, the researcher's personal beliefs and preferences may influence the study, which could lead to researcher bias. Lastly, it can be difficult to generalise the research findings from one case study to other settings (Guba et al., 1994). The case for this master's thesis is the city of Enschede, which will be further explained in section 3.4. The research will be combined with an internship at the municipality of Enschede.

3.2 Data collection

A typical case study has a holistic approach, which means that a large body of mainly detailed, in-depth qualitative data is gathered from multiple sources of information (Van Thiel, 2014). In this case study research, a qualitative research method is chosen, in which primary and secondary data are combined. The primary data is collected through semi-structured interviews, the secondary data is gathered through review of policy documents.

3.2.1 Primary data

Semi-structured interviews were used to collect the primary data. In this section it is described how the respondents were selected, approached, how the interviews were held and how data saturation was achieved.

Sampling

Purposive

Together with the supervisor from the municipality of Enschede, six organisations were selected to participate in this research. The choice for these organisations was based on if the organisation could influence drought policy in the municipality of Enschede, for example because an organization owns large areas of land, collaborates to set policy or provides advice to the municipality. The organizations are given in the table below, together with a small description.

Table 4: six organizations selected together with the internship supervisor (author)

Organization	Description
Water board Vechtstromen	Owner and mainly responsible for groundwater and surface water in rural areas around Enschede, which connect to the municipality's waterbodies
Province of Overijssel	Responsible for policies and objectives for the regional water system and supervises water boards. Policies work through to municipal levels
Foundation Landscape Overijssel	Hold ownership of many nature reserves and landscapes in and around Enschede and try to influence the municipality's policy
Drinking water company Vitens	Responsible for sufficient and clean drinking water in the area of Enschede
Sustainable and rural development foundation STAWEL	Represent those living and working in Enschede's countryside, advise the municipality of Enschede on issues in rural areas
Municipality of Enschede	Responsible for groundwater, wastewater and rainwater within the urban area. Write and implement drought policy for the city of Enschede

Within these organisations the choice was made to interview people who have the most affinity with the subject of drought and who are active in the area of the municipality of Enschede. The internship supervisor of the municipality of Enschede was asked for contacts within the selected organisations. These turned out to be mostly people working on climate adaptation or in the water domain. This resulted in two interviews with policy advisors and one communication advisor within the municipality of Enschede and interviews with the water board, STAWEL, Vitens, the province of Overijssel and foundation Landscape Overijssel. Through expert consultation, or purposive sampling, a total of eight interviews respondents could be approached.

Snowballing

The additional interviews were arranged via snowballing: contacts from other relevant organisations came from previous interviews. For example, during the interview with STAWEL, the contact details of a respondent of foundation Overijssel private land ownership were collected. Moreover, the internship made it possible to arrange interviews with civil servants and designers within different fields of the municipality of Enschede. For instance, interviews were held with a neighbourhood manager and with landscape-, water-, and urban designers to investigate how policies work through in designs and in practice. This resulted in a total of 14 respondents from seven different organisations:

Table 5: explanation of respondent's functions (author)

Organisation	Function respondent	Explanation
Water board Vechtstromen	Project leader	Responsible for redesigning water projects such as streams, such as HOP, which is about retaining water longer in the country estates of Enschede. He works a lot with the municipality of Enschede

Sustainable rural development foundation (STAWEL)	Rural developer and advisor	STAWEL's rural developer is familiar with the rural area of Enschede for 25 years. Serves as the bridge between the people in the rural area and the municipality, knows how policies work through to the plot level and can advise the municipality on this. The advisor recently joined STAWEL, lives in the outskirts of Enschede and knows exactly what impact the municipality's policy has on the plot level.
Drinking water company Vitens	Environmental manager	Responsible for the protection of existing groundwater extractions in Twente and for possible future extractions. Works together with local authorities such as the municipality of Enschede to ensure sufficient drinking water.
Province of Overijssel	Policy officer rural area and water	Responsible for the implementation of water policy, especially in the field of drought and fresh water extraction. Responsible for the ZON program and the HOP project, which both work through in Enschede municipality's policy.
Foundation Landscape Overijssel	Policy advisor spatial development	Tries to provide input and influence the policies of the municipality of Enschede on landscape and nature that are not in ownership of foundation Landscape Overijssel themselves. Works a lot with the municipality of Enschede to create more space for nature and water and to make the landscape more climate-robust.
Foundation Overijssel private land ownership	Director and water portfolio manager	Responsible for representing the interests of country estate owners in terms of water, from which there are a lot around Enschede.
Municipality of Enschede	Policy advisor climate adaptation	Responsible for making policy in the field of water and climate adaptation, ensures that policy is correctly implemented in projects. Thus also concerned with drought policy and its implementation.
Municipality of Enschede	Policy advisor rural area	Is busy with area processes in the outskirts of Enschede. Works together with citizens and farmers on all kinds of issues from which also drought.
Municipality of Enschede	Urban designer	Approached to see how the municipality's policies work through in urban projects, and to what extent drought is taken into account in designs.
Municipality of Enschede	Landscape designer	Approached to see how the municipality's policies work through in greening projects and how it is taken into account in practice
Municipality of Enschede	Water designer	Defends the interests of water in spatial plans. Responsible for rainwater, groundwater and wastewater in one part of Enschede. Contributed to policies on climate adaptation that include drought.
Municipality of Enschede	Water designer	Defends the interests of water in spatial plans. Responsible for rainwater, groundwater and wastewater in one part of Enschede. Tries to make sure there is no nuisance due to excess or shortage of water.
Municipality of Enschede	Neighbourhood manager	Provides input for plans and designs for a particular neighbourhood. Complaints and problems in the neighbourhood come to him, so he sees exactly how policy works through at the neighbourhood level.
Municipality of Enschede	Communication advisor climate adaptation	Is the connection between the municipality and the citizens in the area of climate adaptation. Handles communication around participation and encourages citizens to take climate-adaptive measures. She knows what is going on among residents and how they perceive the drought-risk.

Establishing access

Once the respondents were selected, they could be approached. From the first eight respondents, the contact details were given by the supervisor of the municipality of Enschede. This contact information included email addresses only. Since the contact details were already collected before the internship started, the first eight respondents were emailed from the researcher's personal email address. These respondents were emailed with an explanation of the research, a participation information sheet, and were asked if they were open to an interview. Six of the eight respondents responded positively and

the first interviews could be scheduled. No response was received from the remaining two respondents. It was then decided to send them a reminder from the municipal email address which was obtained at the start of the internship. They did respond to that and those interviews could also be scheduled.

Four of the remaining six respondents were approached in the corridors during the internship. They either offered to schedule an interview themselves or were asked by the researcher. The respondent from Foundation Overijssel private land ownership and the neighbourhood manager from the municipality of Enschede were also approached via email, and they also responded positively straight away. As mentioned, all respondents received a participation information sheet in advance via email where they could read up on the study. Prior to the interviews, each respondent signed a consent form in which they agreed to participate in the study. The participation information sheet and consent form are shown in Appendix A and B.

Interviews

Interviews are often applied in case studies and are a flexible way of collecting data. An interview can be unstructured, semi-structured or fully structured. In an unstructured interview, the initial question is the only fixed item, which marks the topic but provides no leads to where the interview should be heading. A fully structured interview is actually an oral version of the questionnaire and leaves no room for following-up questions (Van Thiel, 2014). In this research, it is desired to learn about different components of vulnerability and drought-risk perception, such as experience and behaviour. Therefore, semi-structured interviews were held in which a list of questions is prepared before the interview takes place. This leaves room for following-up questions, gives the possibility to clarify unclear answers and makes sure that all desired topics are covered (Van Thiel, 2014). The interview questions are based on the variables derived from the conceptual framework. This divides the body of the interviews in several themes with corresponding questions, shown in table 6. The themes are the same for all respondents, to see if there is any difference in how respondents perceive the same topics. Depending on the organisation and the respondent’s function, the questions within the theme may change slightly. The interview guides are given in appendix C.

Table 6: themes for questions based on the variables of the conceptual framework (author)

Topic	Theme	Topics
Perception on drought-risk	Experience with drought	<ul style="list-style-type: none"> • Expectation of past dry periods • Effects of past dry periods • Changes because of past dry periods
	Memory of drought	<ul style="list-style-type: none"> • Periods mentioned as drought
	Definition of drought	<ul style="list-style-type: none"> • Drought recognition • Attention to drought • Acceptability of drought and its effects
	Behaviour	<ul style="list-style-type: none"> • Drought policy • Perception on drought policy • Drought adaptation measures • Priority of drought • Collaboration with other organisations • Future vision
Enschede’s vulnerability to drought	Exposure	<ul style="list-style-type: none"> • Future drought expectation
	Adaptive capacity	<ul style="list-style-type: none"> • Physical aspects of Enschede • The biggest drought-risks • Opportunities/ barriers to make Enschede drought resilient

Beforehand, respondents were asked whether they preferred to do the interview online, at their office or at the Enschede municipality’s office. This lead to eight interviews in person, from which four were held at the Enschede municipality’s office, and four at other offices. In advance, the respondents were

asked to keep an hour free for the interview. Accordingly, the longest interview lasted one hour and six minutes, while the shortest interview lasted 38 minutes. Before the interview started, respondents were asked if the interview could be recorded, to which all the respondents agreed. The recording was done using the recording app on a mobile phone. To each interview, the interview transcript was brought on paper to use as a guide during the interview. Besides the recording, notes were also taken by the researcher.

Data saturation

Data saturation occurs in research when sufficient data is collected to draw necessary conclusions. It means the interviews no longer provide any new information. In this study, this was the case after about 12 to 13 interviews. By that time, no new information on vulnerability of Enschede was forthcoming, as well as on the four elements of perception. The last interviews was certainly enjoyable to conduct, but was more a confirmation of the information that had already been gathered. Because the researcher had collected notes during the interviews, it was also clear what important points had already been collected, without the interviews being transcribed already.

3.2.2 Secondary data

In this research, literature study has first been conducted to investigate what is already known about drought, drought-risk perceptions and vulnerability. The results of the literature study are shown in chapter 2. Subsequently, review of policy documents has taken place. First, material relevant for the subject of the study was selected. These documents were found during the literature study or were obtained through the supervisor of the municipality of Enschede. Actually all documents were publicly available, but not always easy to find. Moreover, it was difficult to know which documents are all there. The supervisor was again able to help with this. The policy documents that were reviewed are mainly national, provincial, regional or local policy visions or implementation plans about water and climate adaptation in the urban and rural area of Enschede. An overview of the documents are given in the table below:

Table 7: policy documents and reports reviewed (author)

Level	Document
National	Delta plan spatial adaptation (Ministerie van Infrastructuur en Waterstaat, 2023)
National	Delta plan freshwater phase 2 (Ministerie van Infrastructuur en Waterstaat, 2023a)
National	Final report policy table drought (Ministerie van Infrastructuur en Waterstaat et al., 2019)
Subnational	Freshwater supply east Netherlands phase 1 and 2 (ZON) (Zoetwatervoorziening Oost-Nederland, 2021)
Provincial	Provincial rural program (Provincie Overijssel, 2023)
Regional	Water vision water board Vechtstromen (Vechtstromen, 2022)
Regional	Theme plan climate water board Vechtstromen (Waterschap Vechtstromen, 2024)
Regional	Water balance Overijssel, Twente (van Houwelingen et al., 2022)
Local	Vision rural area Enschede (Gemeente Enschede, 2021)
Local	Water and climate adaptation plan Enschede (Gemeente Enschede et al., 2021)
Local	Water vision Enschede (Gemeente Enschede, 2012)
Local	Nature and landscape plan Enschede (Gemeente Enschede, 2023)

3.3 Data analysis

The collected data consists of large policy documents and transcribed interviews with lots of texts. How these are analysed is explained in this section.

3.3.1 Review of policy documents

The policy documents selected are analysed mainly to find out more about what is already known and done in Enschede about drought adaptation and to what extent drought is already taken into account in Enschede's municipal policy. The review of policy documents is therefore mainly used to answer the first question about existing drought adaptation policies and the second question about existing vulnerability in the municipality of Enschede. The policy documents were coded by hand. This means the pdf's of the documents were highlighted and notes were appended to the text. This way, relevant pieces for this study were highlighted and could be easily retrieved later. When looking at vulnerability, the themes exposure and adaptive capacity were kept in mind. This made it possible to analyse based the documents on these two components, with the determinants described in section 2.4 taken into account for adaptive capacity.

3.3.2 Thematic analysis

The semi-structured interviews were analysed through thematic analysis. First, the recordings of the interviews have been automatically transcribed with the programme Descript and have been checked afterwards. The interview transcripts have been analysed using the programme Atlas.ti. In this programme, the transcripts were systematically analysed by coding the text. With coding, qualitative data is interpreted by the researcher and different pieces of information are subsequently assigned with codes or labels (Van Thiel, 2014). The data has initially been coded according to an deductive approach, which means that the variables of the conceptual framework are used. The codes are divided into the same themes and topics as the interviews. This was complemented with inductive coding, paying special attention to similarities and differences and adding new codes if necessary. New codes are mainly new topics that are also attributed to the different themes. When the data has been coded, the different codes and categories have been compared to search for patterns and interactions. The code scheme is shown in appendix D.

The review of policy documents was used as a foundation for the interviews. by first analysing what information already exists, it was possible to avoid asking for the obvious during the interviews. This allowed for in-depth questions during the interviews instead of superficial ones. Moreover, for the sub-questions both analyses were combined: for example, what policy documents revealed about vulnerability was checked with the respondents.

3.4 Research context

3.4.1 Drought occurrence in the Netherlands

The Netherlands is a country in which a wide area is flood prone. Until recently, droughts have been much less common, and therefore also receiving less attention (Bressers et al., 2014). However, the dry summers of 2018, 2019, 2020 and 2022 have made the effects of drought more visible. In 2018, each month in the period May to October was drier than normal, together with warmth that was above average in these months. This combination lead to high values of the drought indicator 'precipitation shortfall', which is commonly used in the Netherlands. The precipitation shortfall was larger in the south and the east of the Netherlands than in the rest of the country, because of lower precipitation values, higher temperatures and more sunshine (Philip et al., 2020).

Before 2018, 1976 was the most extremely dry year ever measured. In this year, the drought was so extreme that it had major consequences for the agricultural sector and nature. The year 2018 did not

exceed this record year, but ended up in the top 5 driest years ever measured. The years 2019 and 2020 were also very dry in the Netherlands, with a precipitation deficit of 214mm and 251mm compared to an average of 100mm. The extreme drought of 2018 was exceeded by the year 2022, with the peak precipitation deficit at 318mm (Straaten, 2023). This year was marked by both a dry spring and summer, with lot of sunshine in both seasons. This resulted in a lot of water evaporation (Ministerie van infrastructuur en waterstaat KNMI, 2022a).

Neerslagtekort 2022

Lopend neerslagtekort (verschil neerslag en verdamping)

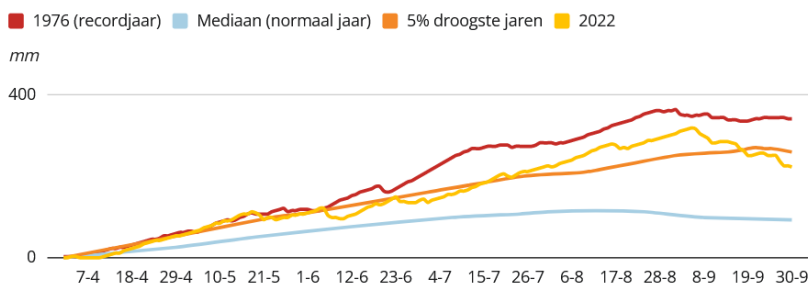


Figure 7: precipitation deficit in the Netherlands in 2022 where the red line is the record year of 1976, the blue line is an average year, the orange line is the 5% driest years ever measured, the yellow line is 2022 (Straaten, 2023)

In the past, years with a high maximum precipitation deficit of 250 millimetres or more were normally at least 10 years apart. But 2022 is, along with 2018 and 2020, the third year in five years with a precipitation deficit above this value. The maximum precipitation deficit has increased in the Netherlands over the past 30 years by 11% every 10 years (Ministerie van infrastructuur en waterstaat KNMI, 2022b).

3.4.2 The city of Enschede

The case that is chosen for this research is the municipality of Enschede. Enschede is located in the region Twente in the eastern part of the Netherlands, and falls under the Province of Overijssel. In this part of the Netherlands, the high sandy soils are above sea level, which makes it difficult to access water via lakes or rivers during a dry period. This makes the problems during dry periods bigger than in other parts of the country. Moreover, the water system in this area was originally designed to drain water as quickly as possible, which can cause water shortages in periods with less rainfall (Klimaatadaptatie, 2022).

The municipality of Enschede does not only contain the city of Enschede, but also four surrounding villages. The municipality has a total of 160.000 inhabitants, making it the largest city in the province of Overijssel. Its size means there is plenty to do: there is an attractive city centre, a great cultural variety, an appealing countryside and the city has one of the three technical universities in the Netherlands creating a rich student life (Gemeente Enschede, 2022).



Figure 8: Enschede is located in the east of the Netherlands (Gemeente Enschede, 2021)



Figure 9: the division of rural area (green) and urban area (white) in Enschede (Gemeente Enschede, 2021)

Only one-third of the municipality of Enschede is urban, over two-thirds is rural. The relationship and interaction between city and countryside is therefore very characteristic for Enschede: from anywhere in the city you can be in the countryside within fifteen minutes by bike. Enschede's green surroundings are mainly due to its textile past: in the early 20th century, it was one of the most important textile cities in the Netherlands. At that time, all kind of country estates were created for textile barons who wanted to escape the filth and bustle of the city. These country estates are now 150 to 200 years old and characterize the countryside of Enschede. Most parks, garden cities, villas and country properties in the city also originate from Enschede's textile industry past. The textile industry has since been lost, but thus leaves its marks in the city (Gemeente Enschede, 2022).

3.5 Validity and reliability

Validity

The small number of units of study in case studies can endanger the reliability and validity of case study research. The internal validity of the research is about the extent to which the observed results represent the truth in the case being studied (Van Thiel, 2014). In other words: has the researcher really measured the effect they intended to measure? To ensure the internal validity of the research, triangulation will be used. This is a way of collecting information by using different sources or methods. The researcher gathers as much information as possible to ensure the conducted data are valid (Van Thiel, 2014). In this research, literature study, review of policy documents and semi-structured interviews are used to gather information. Moreover, the draft version of the thesis is presented to the respondents, so that they can check their share. This helps increasing the internal validity.

The external validity of the research is about the generalisability of the results. In single case studies, it is not easy to generalize research outcomes to other situations, because the results found only apply to the specific context that has been studied. This makes the external validity of case studies limited (Van Thiel, 2014). However, when cities are found with more or less similar characteristics of the municipality of Enschede, and these characteristics are taken into account, the results could be used for other cases.

Reliability

Reliability is about the reproducibility or replicability of the study. The content of the study should therefore not be dependent on the researcher carrying out the research. If the research would be conducted in the same way again, it should lead to the same results. A risk with qualitative research is that it often involves a lot of interpretation on the part of the researcher (Van Thiel, 2014). To make sure the reliability of the research is ensured, a database will be used which can be reviewed afterwards and in which the steps taken in the study and the data sources used are documented. The interviews will be recorded and stored safely, and the interviews will be transcribed literally, which ensures all the data could be checked afterwards.

3.6 Research ethics

In qualitative research it is important for the researcher to reflect on their own positionality and how that may have influenced the research process and outcomes. I am a Dutch, white woman which could have given me some privileges. I must acknowledge that the process of finding an internship, recruiting respondents and conducting interviews went very well for me. I believe being Dutch has given me an advantage in all these aspects: finding an internship might be harder if I could only speak English. Moreover, if the interviews were held in English, it could have been possible that some of the respondents would not participate or that less useful information was gathered because of the language barrier. An other aspect from which I believe it has benefited me is the fact that I am still a

student and do not yet “belong” to an organization. During the interviews, I noticed that some respondents not only gave me their professional or desired opinions, but also their personal opinions that might conflict with other organizations or even their own. This has provided very useful information. I believe the fact that I am young, at the beginning of my career, and therefore still fairly neutral on all sides, has reinforced that.

As respondents share their perceptions on drought-risk, they face some risks. First, conflicts can for example arise if respondents mention things that contradict the policies of the organisation where they work. Second, respondents may be sharing information that should not have been shared from their organization’s point of view. Third, respondents may take statements about other organisations that may be received negatively and can cause friction. These things can compromise the position of the respondents and should therefore be avoided. This could be done through sending information sheets and consent forms to the respondents. By doing so, the respondents know what kind of research they are participating in and they can give their formal permission to participate in the study. The information sheet and consent form are attached in appendix A and B. Moreover, personal information about the respondents are kept confidential and only their functions are given in the transcripts and the thesis. Lastly, the interview records and transcripts are stored safely in the Radboud University repository, and are not shared publicly without respondents’ consent. These precautions allow the anonymity of the respondents to be maintained.

4. Results

This chapter discusses the results of the review of policy documents and the 14 interviews. The chapter follows the sequential order of the sub-questions. First, the existing drought adaptation policies in the municipality of Enschede are discussed. Next, Enschede's vulnerability to drought is addressed. The chapter ends with an elaboration on the perception of drought-risk.

4.1 Drought adaptation policies

In this section, existing drought adaptation policies are described. First, it explains how water management is regulated in the Netherlands and Enschede. Second, the policies that touch on drought in Enschede are explained.

4.1.1 Water management in the Netherlands

In the Netherlands, water management is not arranged by one party, but is an interaction of all levels of government. There is shared responsibility, where tasks are performed in co-management. This means that there are also multiple parties involved in water management in Enschede, which all have an impact on drought policies in the area (Rijkswaterstaat, 2024).

Rijkswaterstaat

Rijkswaterstaat is the caretaker of the major rivers, lakes, the North sea and the Wadden sea in the Netherlands. They continuously monitor water levels and issue water level forecasts. With dykes, dams and other flood defenses, they protect the Netherlands against flooding. When river levels are high, excess water can be discharged into the sea by sluices. In stormy weather and high water levels along the coast, storm surge barriers can be closed (Rijkswaterstaat, 2024). Rijkswaterstaat is thus mainly concerned with large-scale water bodies in the Netherlands. As there are no large rivers or lakes around Enschede, they do not have a lot of influence on drought policy in Enschede.

Province of Overijssel

The province of Overijssel is responsible for the translation of national policy to a regional policy framework and for strategic goals at regional levels. Moreover, they can make their own policies and set objectives for the regional water system, for instance related to flood mitigation. The water boards further elaborate these policies and implement measures to achieve the policy goals set by the province. The province of Overijssel checks whether the objectives are met, and thus supervises the water boards. The province also deals with sufficient clean wells for drinking water supply, the water quality for swimming water, bridges, sluices, roads and nature (Rijksoverheid, 2023).

Water board Vechtstromen

A water board is a governmental organisation, just like a municipality or a province. A water board takes care of water management in a particular area. They ensure that there is enough water, that there is clean water and that people are protected from too much water. To do so, they use tax money from residents and entrepreneurs (Rijksoverheid, 2024). In Enschede, water board Vechtstromen is active. They are mainly responsible for wastewater purification, groundwater in rural areas and for surface water such as ditches and ponds. Their responsibility goes as far as the urban area of Enschede. Within the urban area, the municipality is in charge when it concerns groundwater, see the figure below (Vechtstromen, 2023).

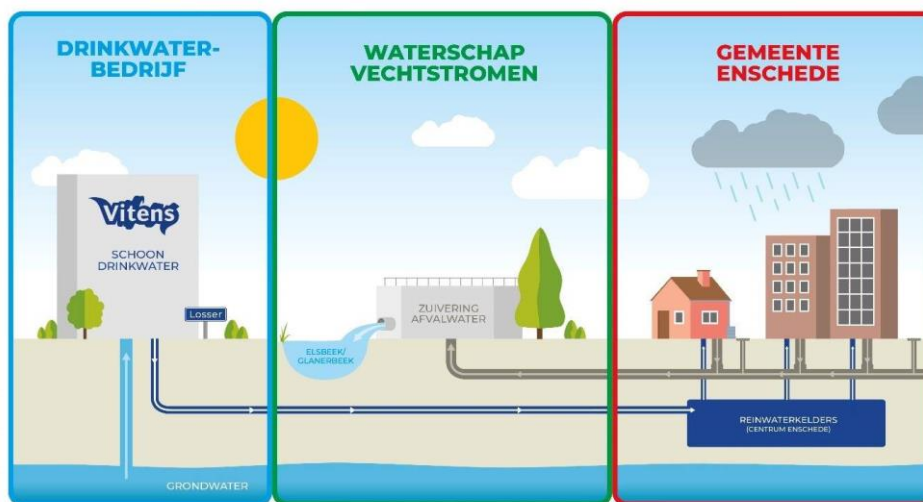


Figure 10: the distribution of water management in the municipality of Enschede: Vitens extracts, purifies and supplies drinking water. The water board purifies waste water and manages ground water outside the built-up areas. The municipality regulates rainwater, wastewater and groundwater within the built-up area (Rijkswaterstaat, 2024).

Municipality of Enschede

Every municipality in the Netherlands has three tasks when it comes to water management and which they have a duty of care for. This concerns a waste water care duty, a rainwater care duty and a groundwater care duty. Municipalities are obliged to ensure that matters around these three tasks are sufficiently regulated. This means that the municipality of Enschede is responsible for collecting and disposing wastewater and rainwater that falls on public ground. Concerning groundwater, the municipality has a duty of care within the urban area. Groundwater in another owner's land, is the responsibility of that owner (Rijkswaterstaat, 2024).

Drinking water company Vitens

Vitens is the biggest drinking water company in the Netherlands and is active in the area of Enschede. Together with the province of Overijssel, they are responsible for sufficient drinking water, now and in the future. The province ensures that there are enough places where water can be pumped up to make drinking water. Vitens turns this water into clean drinking water and delivers it to residents (Rijkswaterstaat, 2024).

4.1.2 Drought policy in the Netherlands

The Netherlands has years of experience with excess water, but a water shortage is less common. During the eighties drought was for the first time recognised at policy level as one of the major environmental policy themes. However, this recognition did not lead to effective measures that addressed the drought problem. Since 55% of the country can be labelled as a flood prone area, almost all attention went to the risk of water nuisance and floods, and not so much to the risks of droughts and water scarcity. It was only that attention for drought issues increased, after the waterboards in the east and south of the Netherlands organised a conference in 2012 where they presented a Delta plan for high sandy soils (Bressers et al., 2014). At the national level, there is roughly a direction provided on how to deal with drought, which is structured in two Delta plans. At the regional level, these Delta plans are worked out a bit more and several parties collaborate in taking measurements to adapt to drought. At the municipal level, drought is only recently included in policy, and still features little in it. The most practical policies that already involve regular implementation are therefore regional in scope, such as the ZON and HOP project, which stem from the national Delta plans. The existing drought

policies in the Netherlands are explained in the table below, distinguishing national, regional and local policies.

Table 8: drought policies in the Netherlands (author)

Level	Policy	Explanation
National policy	National Delta programme	Outlines how the government protects the Netherlands against flooding, how sufficient fresh water is ensured and how they provide for a climate-proof and water-robust spatial planning of the Netherlands in 2050. Consists of three Delta-plans, which involve concrete measurements for policy implementation and planning of these measures (Ministerie van Infrastructuur en Waterstaat, 2023b).
National policy	Delta plan spatial adaptation	Consists of projects and measurements that steer the Netherlands to being water-robust and climate-proof in 2050. It involves seven ambitions which describe how municipalities, provinces and the state are going to accelerate and intensive the spatial adaptation. This Delta plan is commonly applied in the urban area (Ministerie van Infrastructuur en Waterstaat, 2023).
National policy	Delta plan fresh water	Consists of measures, research and financial contributions related to the availability of fresh water. In phase 1 (2015-2021) multiple measurements have been successfully realised. In phase 2 (2022-2027), more than half of the investments are focused on the high sandy soils, concerning the improvement of water retention. The focus in the high sandy soils is on (Ministerie van Infrastructuur en Waterstaat, 2023a): <ul style="list-style-type: none"> • A robust water system: from draining to more retaining water system • Efficient water use: decreasing demand for water • Spatial adaptation: algin land use to ensure adequate water retention
Sub-national policy	Zoetwater-voorziening Oost-Nederland (ZON)	Part of the Delta plan fresh water, in which 107 parties in the east of the country are collaborating in taking freshwater measures to mitigate the effects of climate change, including drought (Zoetwatervoorziening Oost-Nederland, 2021).
Regional policy	Haarvaten op Peil (HOP)	Part of the ZON program in which water board Vechtstromen collaborates with the province of Overijssel and others. Aims at better water retention in the higher parts of the water system (capillaries) where no water supply is possible from rivers or lakes. Better water retention where streams emerge will help to reduce drought in the higher parts and flooding in the lower parts of the water system. Many areas around Enschede have been selected since a number of streams spring there (Waterschap Vechtstromen, 2023).
Regional policy	Twents Waternet	Professional network in which 14 municipalities in Twente collaborate with waterboard Vechtstromen, the province of Overijssel and Vitens. Main focus is smarter use of water. Research is conducted such as “Twente op waterbasis” about a water balance in the region Twente (Twents Waternet, 2022).
Local policy	Water and climate adaptation plan	Describes how the municipality of Enschede deals with water and sewerage and what is being done to prepare for the consequences of climate change, mainly in the urban area. Enschede works with risk-based management: major risks are prevented or limited and minor risks are accepted. For water nuisance, the risks are already clear, but not yet for drought. Drought is only taken into account to a small extent in this policy document (Gemeente Enschede et al., 2021).
Local policy	Vision rural area	Deals with Enschede’s rural area, where the municipality has the tasks of making policy, management, supervision and consultation. They don’t have a lot of property there and thus just a little ability to steer directly. This vision contains only a short section on combatting drought through retaining water better and making existing nature and crops more resilient to drought (Gemeente Enschede, 2021).

4.2 Enschede's vulnerability to drought

When looking at Enschede's vulnerability to drought, a division can be made between the climate system and the social system. The climate system includes exposure to droughts, the social system includes the sensitivity and adaptive capacity to droughts (Wandel et al., 2016). The results of the review of policy documents and the interviews concerning both the systems are given in this section.

4.2.1 Exposure to droughts

Exposure to drought refers to the characteristics of drought such as intensity, duration and coverage, that determine the severity of their impact on a social system (Wandel et al., 2016). This part looks at what is scientifically expected for future droughts in Enschede and what is expected according to the respondents.

Scientific expectation of future droughts

The Royal Netherlands Meteorological Institute (Koninklijk Nederlands Meteorologisch Instituut (KNMI)) is the Dutch center for knowledge and data according weather, climate and seismology. The KNMI develops climate scenario's for potential future climates in the Netherlands, translated from the global climate projections derived from the Intergovernmental Panel on Climate Change (IPCC). The KNMI climate scenarios of 2023 entail four scenarios that outline potential future climates in the Netherlands for the years 2050, 2100 and 2150. The four scenarios are based on the amount of greenhouse gas emissions and the extent of precipitation change in the Netherlands. Two of the four scenarios are based on high emissions of greenhouse gases, resulting in a temperature rise of 4,9 degrees Celsius in 2100. The other two scenarios are based on decreasing emissions in the coming years, resulting in a temperature rise of 1,7 degrees Celsius in 2100. All the scenarios are possible and there is no likelihood statement given (KNMI, 2023).

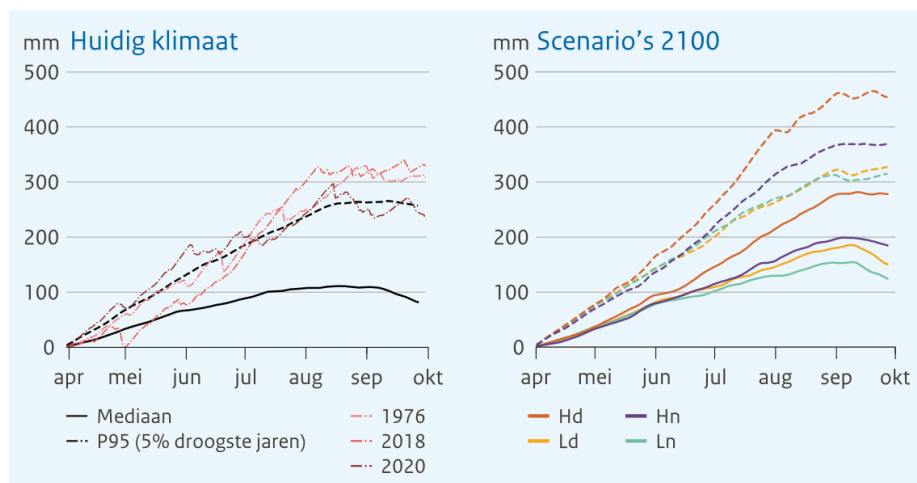


Figure 11: the precipitation shortfall in the four KNMI'23 scenarios. On the left the precipitation shortfall nowadays, with the black line as average and the black dotted line the 5% driest years. On the right precipitation shortfall in the four scenarios in 2100 (KNMI, 2023)

The figure above shows that all four scenarios for the Netherlands around 2100 indicate an increase in precipitation deficit. In two scenarios, limited summer drought increase is expected, while in the other two scenarios a moderately to very strong drought increase seems more likely. Moreover, the KNMI estimates that an extremely dry year as experienced in 2018, will probably occur twice as often in 2050 than it does nowadays. In the most critical scenario, an average summer in 2100 is as dry as an extreme dry summer nowadays, like the summer of 2018 (KNMI, 2023).

Recent summers in the Netherlands showed that dry periods were more severe inland than on the coast. This trend is expected to continue in the future. While summer precipitation could increase in the coastal area, that is not likely to happen inland (KNMI, 2020). Philip et al. (2020) confirm that there is no trend observed in summer drought near the coast, but there is in the inland region. This is due to the fact that the inland region is mainly dependent on local precipitation and the amount of solar radiation will probably increase more inland than in the coastal area. Together with a trend in temperature rise this will lead to more evaporation, resulting in increasing droughts (Philip et al., 2020).

Respondents' future drought expectation

Respondents were asked whether they expect dry periods to become more frequent in Enschede in the future, and if so, how severe they expect it to be. Their expectations can be broadly structured into three scenarios. First, it is acknowledged that increasingly extreme weather conditions will have to be taken into account in the future (interview 1,3,4,7,9,10,12,13,14). The extremes mentioned are long periods of drought and more extreme forms of rainfall. It is expected that climate change will cause more dry summers and wet winters in the future (interview 5,7,8,12,13,14), and that it will be much more unpredictable when rain falls and how much (interview 4,5,9,11). Also, summer droughts are expected to be more intense, due to higher temperatures and more evaporation, based on the KNMI scenarios (interview 1,4,9).

Second, some respondents are more nuanced about the extent to which summer droughts can become more severe. They mention there is still a lot of uncertainty about whether it will be very dry in summer and very wet in winter, or slightly drier in summer and slightly wetter in winter (interview 8,10,11,13). Also, it is mentioned that the extremes may arise much faster or slower than currently expected (interview 9,10).

Third, one respondent believes that the severity of drought occurred with the series of dry years in 2018, 2019, 2020 and 2022 was a unique phenomenon and will not happen again in the future anytime soon. This respondent expects maybe one standalone severe dry summer again, but not several in a row. He believes these series are temporary undulations and not necessarily an upward trend. He does expect to experience more extremes and that it will gradually become drier, but not as extremely as that series (interview 14).

4.2.2 Adaptive capacity

Sensitivity to drought and adaptive capacity are basically each other's opposites. If an area is very sensitive to drought, the resources to adapt to drought are limited and thus the adaptive capacity is low. On the contrary, if there are a lot of resources to deal with droughts, the sensitivity to droughts is low and the adaptive capacity high (Wandel et al., 2016). As mentioned in chapter two, there are different determinants that influence Enschede's adaptive capacity. The determinants of adaptive capacity are discussed in this section.

Physical capital

Lateral moraine

Enschede is located on a lateral moraine: a hill formed thousands of years ago by ice pushing up the land. Because of this moraine, the city has height differences up to 40 metres. The lowest part is at 24 metres above sea level, the highest at 65 metres. On this lateral moraine, several springs used to arise, which together formed streams that constituted a river (Gemeente Enschede et al., 2021). Enschede is therefore a source city and lies at the beginning of the water system. Springs are characterised by their continuous and gradually release of water. However, the city of Enschede is built over the springs with a paved surface area of over 1400 hectares. Because of all this paving, the spring action is disturbed. When a lot of rain falls, the water is suddenly drained away, the spring no longer fills completely and runs dry more quickly. The amount of paved surface therefore prevents water from infiltrating into the soil (Gemeente Enschede, 2012).

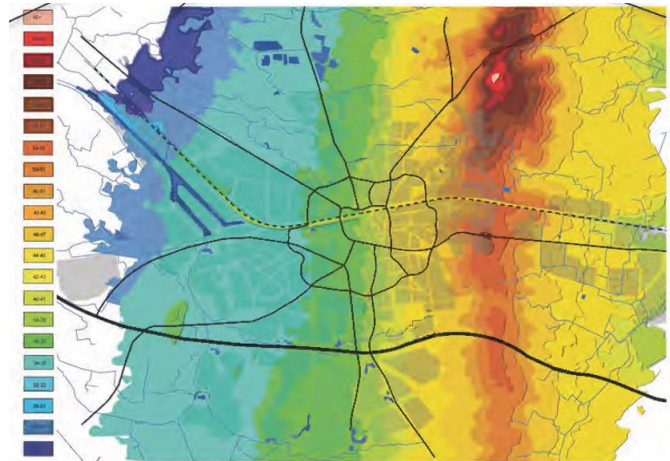


Figure 12: Height differences in Enschede (Gemeente Enschede, 2012)

Soil

Simultaneously with the formation of the lateral moraine, the penultimate ice age left a boulder clay subsoil in the area of Enschede. Because this boulder clay layer prevents water from passing through, Enschede has always had a high groundwater level. During the last ice age, a cover sand layer blew over the boulder clay and the lateral moraine. Precipitation falling on the high part of the lateral moraine penetrates the sandy soil and replenishes the groundwater level. As it encounters the boulder clay layer, it cannot penetrate further into the soil, flows towards the lower part of the town and seeps up there, resulting in water nuisance. In the higher parts, the difficulty with infiltration causes lower groundwater levels more quickly, and drought is seen earlier (Gemeente Enschede, 2022).

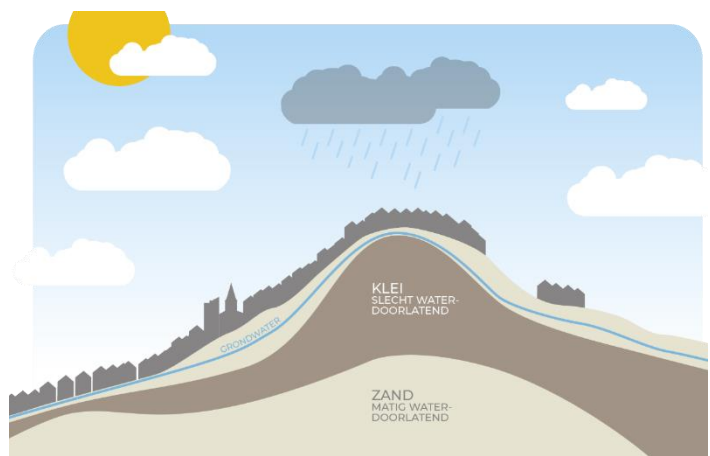


Figure 13: Enschede is located on a lateral moraine and is characterised by boulder clay (dark colour) and sandy soil (light colour) (Gemeente Enschede et al., 2021)

Water supply from rivers and lakes

The vulnerability to drought does not only depend on local weather conditions, but also on the supply of fresh water via major rivers (Kennisportaal Klimaatadaptatie, 2024). Enschede has no natural water supply from external sources and is therefore completely dependent on precipitation. Enschede receives enough rain throughout the year, it is just not evenly distributed. In general, Enschede has a precipitation surplus in winter and a shortfall in summer. This shortage in precipitation causes faster low groundwater levels in the higher parts of the city. It also takes longer to replenish the groundwater level, as this can only happen through rain. If it does not rain for a long time, Enschede notices the consequences faster than many other places in the Netherlands (Enschede, 2023).

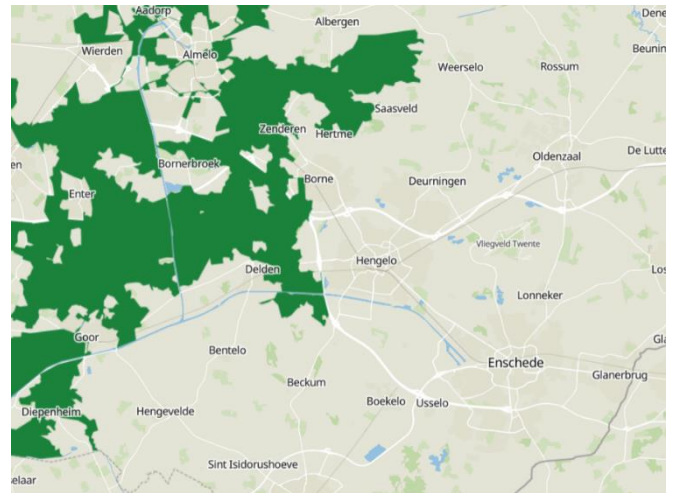


Figure 14: Enschede has no natural water supply from rivers and lakes (green= water supply) (Waternet, 2019)

Infrastructure

Infrastructure is about the current water system and wider spatial planning in which drought adaption should get a place (Wandel et al., 2016). According to respondents, the current water system in the Netherlands as well as in Enschede is designed to drain water as quickly as possible, mostly via the sewer system (interview 1,3,4,5,7,9,10,13). Moreover, originally wet places have been drained to build there and water is supplied in dry areas where, for instance, water-demanding crops are grown. So the water system is completely adapted to our needs, in other words, groundwater level follows function. It is acknowledged that throughout the year, enough rain falls in Enschede, but the current way of draining water and the way the land is spatially designed, causes drought (interview 1,3,4,9,13). The current infrastructure therefore makes Enschede more vulnerable to drought.

Human capital

Human capital is about knowledge, skills and expertise to adapt to droughts (Wandel et al., 2016). Since Enschede does not have a lot of experience with droughts, there is not a lot expertise on this topic yet. Moreover, there is currently too little knowledge about drought in Enschede (interview 1,4,5,7,8,9,10,11,13). It is not yet known what the effects of the recent dry years have been, how much it has cost, how big the drought problem really is and which areas have the biggest drought-risks. Neither is it known what the effects will be of measures that can be taken against drought, such as making streams shallower or making more space for water storage. These measurements could cause more flooding in wet periods on one hand, but on the other hand, it isn't clear whether it actually contributes to drought mitigation. More research is needed for that and monitoring should take place in the coming years on the already implemented measures. Lastly, according to respondents, it really needs to be determined what is acceptable in terms of drought, which is not clear yet (interview 4,5,7,8, 9,10,11,13). Looking at skills, respondents do think the skills to come up with creative solutions relating to drought are present in Enschede, as will be illustrated more in the next section about technology (interview 1,7, 9,10). It can be concluded that there is not much knowledge and expertise on drought yet in Enschede, which makes the city more vulnerable to droughts.

Technology

Technology is about the technical means and skills present in the area to combat drought (Wandel et al., 2016). Respondents indicated that technical interventions to prevent drought are mainly aimed at retaining water longer, such as creation of wadi's, shown in figure 15. What measures can be taken is different in urban and rural areas, and are illustrated in the table below. Some of these measurements are already taken, some are planned to be taken or ideas mentioned by the respondents.



Figure 15: : wadi in Enschede to let rainwater slowly infiltrate into the soil (Gemeente Enschede et al., 2021)

Table 9: drought measures in urban and rural areas in Enschede (author)

Possible measures in urban areas	Possible measures in rural areas
Disconnect rainwater from the sewer and let it infiltrate in the soil	Making streams shallower, wider and meander to keep water in the area longer
Replace asphalt by green and blue structures	Throw sandbags into culverts to retain water longer
Make water storage facilities underground such as infiltration crates	Improve the humus level in the ground to make the soil retain water longer
Making streams and canals meander so that water is drained less quickly	Plant different types of vegetation with roots at different depths to make it more drought-resistant
Conserve water to reduce water shortages, for example to build water-saving residential areas	Create large water buffers and retention areas
Encourage citizens to replace tiles with greenery, to build green roofs and facades and purchase rain barrels	Use level-controlled drainage whereby more water is drained in winter by opening weirs and retained in summer by closing weirs

Economic capital

This determinant of adaptive capacity concerns the financial instruments available for drought adaptation (Wandel et al., 2016). The interviews show that there are three main debates when it comes to economic resources. First, there are some financial resources existing at the moment. For example, the national government provided money for projects on climate adaptation, via the Delta plan on Spatial Adaptation. Also, there is €50,000 a year available for making shallower ditches that are located along foundation Landscape Overijssel sites. This reduces water run-off in dry times. In Enschede itself, there is an incentive regulation allowing citizens to take climate-adaptive measures such as replacing tiles with greenery. However, this is not much used yet (interview 6,13). For farmers, there are subsidies for storing water or managing nature. However, these are often only for six years, for which farmers cannot take a long-term view (interview 2,11,13).

Second, it is mentioned that the money available is a good start but certainly not enough to make big steps in drought adaptation (interview 2,4,5,7,8,10,11,12,13). In fact, most money goes to what is most profitable, such as housing and agriculture. Greenery and water storage generate little to no money (interview 1,4,7,8,10,12,13). Therefore, it will cost a lot of money to really create more space to adapt to drought, and that it would require more money from the central government or the province of Overijssel (interview 7,10,11,12). Farmers and country estates really need more economic support to make sure they can financially survive if they have to do more on drought adaptation (interview 2,5,11,13). However, it is also indicated that technical adjustments within the water system to prevent drought, as is currently done with weirs and dams, will also become increasingly expensive. The question is then what is more sustainable and cost-effective in the long term (interview 5,10).

Third, there are some options mentioned to make more money available for drought adaptation, such as capitalizing drought damage. If it is known how much drought damage costs, it could be compared to the costs of mitigating and adapting to drought. Then, more money might be made available for it (interview 12). Also, budgets should not solely be reserved for green or water, but be included in other themes, such as health, recreation or biodiversity. This way, it is more likely to be realized (interview 7,12). Finally, it is important that the budgets for green and water should remain guarded in the future, so that it is not the first thing to be cut if the municipality runs into financial difficulties (interview 14). It can be concluded that although there are some financial resources to deal with drought, much more money is needed to really make a change.

Social capital

Social capital is about informal local institutions that could reduce the stress of drought hazards or that increase capacity to organize drought adaptation actions, such as flexibility, the capacity to learn from experience or the capacity to innovate (Wandel et al., 2016). Whether this is present in Enschede or not does not emerge very much from the interviews. However, it is mentioned that there are organisations such as foundation Landscape Overijssel, STAWEL and OPG in which people voluntary stand up for common interests. Within these organisations there is room for experiments, learning from changing climate conditions and pioneering (interview 1,2,4,11,13). STAWEL, for instance, provides knowledge exchange and experiments for farmers to adapt to changing conditions, and they bridge the gap between the municipality and people in the countryside (interview 2,13). OPG does the same but for estate managers (interview 2,11). So, there are some institutions based on common goals and interests that try to deal with changing climate conditions such as droughts.

Institutional capital

The last determinant of adaptive capacity is about the larger institutional context in which the municipality of Enschede operates (Wandel et al., 2016). It is mentioned that at all administrative levels, there is no courage to make fundamental choices that benefit drought adaptation. This results in no major steps on drought adaptation yet. If those choices would be made, it could mean that flooding will consciously be accepted in certain areas, and thus it will no longer be possible to build or farm there in the way we are used to. An example of this is the manure law, which entails that farmers can only spread their manure from February onwards because it causes too much water pollution in winter. When farmers enter their fields in February, the groundwater level must be low enough to prevent the big machines from getting stuck in wet lands. That means that at the end of the winter, a lot of water is drained, which could actually be retained better to cope with drought (interview 1,2,5,13). However, fundamental choices to adjust this law are postponed (interview 1,3,4,5, 7,8,10,13). The water system is caught in this institutional context, making Enschede more vulnerable to drought.

In relation to this, the political formation is very influential for the choices made in practice. Politics is mainly short-term oriented, making it more difficult to make long-term plans. Moreover, respondents say they need a government that is steady on course, so that policy does not change all the time. For instance, farmers who want to make climate adaptations are often told that provincial or municipal policy is not yet ready to support them in their plans (interview 2). Besides that, a right-wing national cabinet seems to be coming up in the Netherlands, from which the respondents are not expecting much money and space for climate adaptation (interview 4,5,8,9,12,13,14). At the municipal level, politics also determine what is prioritized. So the municipal council ultimately decides where most money goes. That too can change every four years. However, civil servants do not change together with them every four years, so there is a fairly steady and directional line at municipal level (interview 13,14).

4.3 Drought-risk perception

In this section, the respondents' drought-risk perception will be discussed. According to Taylor et al. (1988), drought-risk perception entails the elements experience, memory, definition and behaviour. This section is divided into three sections which present the results of the 14 interviews regarding these four elements. First, it looks at how recent dry periods have been experienced in Enschede. Then it looks at how much attention there is for drought. Finally current drought policy and implementation is discussed.

4.3.1 Recent dry periods in Enschede

This part is about the recent dry periods that Enschede has experienced. This topic relates to the elements experience and memory. Experience is about the episodes of drought that hit a region, memory is about the periods that could be recalled and are part of a respondent's direct experience (Wandel et al., 2016). This section is divided into two parts, namely how the recent dry periods were experienced and what effects were seen.

Dry periods as wake-up call

The interviews reveal two things regarding the expectation of recent dry spells. First, it emerges that most respondents and their organisations did expect that the Netherlands and Enschede would face slightly longer and more severe dry periods in the future. It was expected overall that drought would have to be taken into account more in the future, but that it would not become a major problem in the short term (interview 1,4,3,6,7,9,10,13). For example, in the field of drinking water in the area of Enschede, the drinking water demand was increasing and possible drier summers were considered, but a drinking water shortage because of drought was not in line with expectations (interview 1,3,13).

Second, therefore, the dry summer of 2018 and the subsequent years of 2019, 2020 and 2022 came as a big surprise according to the respondents (interview 1,3,7,9,10,13,14). Previously, 1976 was seen as the most extreme year up to then in terms of drought. So, 2018 was really a wake-up call that such an extreme dry year could occur nowadays. Hence, the dry summer of the year 2018 is remembered most by the respondents, illustrated by the quote on the right (interview 1,3,4,6,7,9, 10,14). As several dry summers followed, the realization grew that what happened in 2018 was not just an incident, but there seemed to be a trend that extreme drought is becoming more common (interview 1,6,7,9,10,13). Consequently, the other thing that was mostly remembered according to respondents is the consecutive of dry years. One dry year could be an isolated incident, but the succession of dry years can cause many problems (interviews 1,2,4,7,9,10,13).

*“as extreme as that time, yes that was really... well, panic is too big of a word, or maybe it isn't”
(environmental manager Vitens)*

The effects of dry periods

As mentioned before, the 2018 drought in the Netherlands negatively impacted a lot of sectors, such as agriculture, shipping, drinking water, recreation and constructions. The interviews revealed that different effects are noticed from past dry spells. Before the dry period of 2018, mainly agriculture suffered, but as more frequent and longer periods of drought occur, respondents see more consequences for nature, infrastructure and drinking water availability (interviews 1,2,3,4,8,13,14).

Nature

In general, it is mentioned that one dry year is not that harmful for nature. Although nature is sensitive to drought, it is quite resilient and robust, so it can often recover after one dry year. However, if it happens more often in a row, drought can lead to desiccation, which means that the damage to nature

cannot be reversed. This change is seen in Enschede by respondents over the past years (interviews 1,4,5,8,13). It is mentioned that desiccation is, together with nitrogen, one of the most important causes for the decline quality of nature (interview 1). The nature in Enschede contains mainly inner-city greenery and parks, country estates and nature reserves around Enschede. The country estates, together with the canals, sport parks and garden areas, were all found between 1850 and 1900, meaning that the vegetation is about 150 years old now, making it extra sensitive to drought. In urban areas, lot of vegetation is planted in paving, leaving no room for water to infiltrate in the soil. Paving, buildings and heat lead to more evaporation, making it even drier in urban areas. The effects seen on nature in Enschede are given in the table below:

Table 10: effects of drought seen on nature (author)

Country estates and nature reserves
• Extinction of beech trees
• Extinction of Norway spruce due to bark beetle burrowing beneath the bark
• Dying vegetation in parks, garden areas and canals
• Groundwater levels sink, fens fall dry, threatening species like the comb salamander with extinction
• Visual quality decreases because of yellow lawns and brown sports field
Urban area
• Trees losing leaves
• Vegetation dying because of desiccation
• Water quality problems: blue-green algae in still water
• More money and labor needed from the municipality to allocate water for public vegetation
• Newly planted vegetation died because of lack of time to root deeply enough

Drinking water

The effects of drought on drinking water availability were frequently mentioned. The extreme dry summer of 2018 came as a complete surprise for drinking water company Vitens. The demand for drinking water increased and the fresh water availability decreased: the clean water cellars were emptying (interview 1,3,6,8,13). The following table lists the mentioned impacts on drinking water:

Table 11: effects of drought seen in the field of drinking water (author)

Effects on drinking water
• Vitens exceeds their monthly permit for groundwater extraction for the first time in history
• Vitens reduces one groundwater extraction because of drought damage on the surrounding nature
• Less drinking water extraction sites available without negative effects on the direct environment
• Vitens was unable to connect 20 wholesale customers in Enschede to drinking water
• Vitens rejects applications from companies that applied to expand their current drinking water withdrawal
• Warnings towards citizens about not using drinking water for garden irrigation or inflatable pools
• Vitens gives extraction bans whereby no more water could be pumped from surface water

Agriculture

Around Enschede, there are basically only livestock farms. The crop farming there is purely for the benefit of livestock farming, to grow feed for cows. What applies to nature also applies to agriculture: one dry year is often manageable for farmers, but several years in a row cannot financially sustain (interview 2,9,11). The effects on agriculture are given in table 12.

Table 12: effects of drought seen on agriculture (author)

Effects on agriculture
<ul style="list-style-type: none"> • Crops failed, grass fields turned brown, maize fields dried up and yields declined
<ul style="list-style-type: none"> • Fodder harvests failed, the price of fodder increased, farmers had to buy fodder and ran into financial binds
<ul style="list-style-type: none"> • Farmers drilled own wells to pump up groundwater, which could lead to locally lower groundwater levels and more damage to the surroundings
<ul style="list-style-type: none"> • Herbs, wildflowers and cereals on field margins didn't grow as desired
<ul style="list-style-type: none"> • Leased nature plots did not generate anything but did cost money, creating negative cash flow

Constructions

Other effects were observed in the field of constructions. These effects were less visible and less widespread than the effects on nature, drinking water availability and agriculture, according to the respondents. The effects are given in the table below.

Table 13: effects of drought seen on constructions (author)

Effects on constructions
<ul style="list-style-type: none"> • Subsidence of houses followed by cracks
<ul style="list-style-type: none"> • Damage to infrastructure like roads and bridges
<ul style="list-style-type: none"> • Canal on a country estate dried up leading to crumbling foundation and collapse of the quay walls

Unknown effects

It is acknowledged that many effects of drought are still not obvious. Several policy makers and designers from the municipality of Enschede say they still don't have a clear understanding of which problems because of drought they exactly faced in the last years and how much it has cost (interviews 5,6,7,8,10,13). Respondents indicate that drought is also difficult to grasp (interview 10), that drought damage is hard to see (interview 7) and that the effects of drought are much more insidious than with other natural phenomena (interview 6). Drought could also cause effects that are not known yet, for example for the drinking water quality (interview 10). Lastly, it is not yet known which areas have been hardest hit by drought and where the biggest risks for the future lie (interview 13).

4.3.2 Attention for drought

This section looks at how respondents regard drought. In this part, the element of drought definition comes up most. It first looks at how drought is described, then it looks at how much recognition and attention they believe there is for drought.

Defining drought

Defining drought is about the way a dry period is characterized, which could be a set of criteria or a description. There is no general accepted drought definition, drought can mean different things to different people (Wandel et al., 2016). Most respondents define drought as a period when no rain falls for a long time. However, a period is only considered dry when it also becomes visible and causes damage, for example when crops are failing or vegetation is dying (interview 1,2,3,4,5,7,8,9,10,11,13). Drought is also characterized by lower groundwater levels than normal (interview 4,7,9,10,13). Lastly, it is indicated that drought is unpredictable, much more than flooding, and that the effects of drought are much more intangible (interview 1,5,6,7,13).

“The effects of drought are insidious. It is something that builds up very slowly and the moment you realize it you are already too late”
(communication advisor municipality of Enschede)

The environmental manager of Vitens characterizes two types of drought. The first is less rainfall due to climate change. This drought occurs because the water system is designed to drain this rainwater as quickly as possible. Basically, enough water falls every year in Enschede, but because it is drained so quickly, drought occurs. The second type of drought is caused at the local level because Vitens extracts groundwater from the soil there. That can cause damage on the surrounding area (interview 3).

Recognition of and attention for drought

Respondents acknowledge that understanding and awareness of the drought problem is really needed in order to take measures against drought (interview 1,3,4,5,6,7,8,9,10,12,13). A distinction is made between the organizations interviewed, the municipality of Enschede and society. First, within the organizations interviewed, there already was awareness that dry spells would occur more frequently in the future due to climate change, but the urgency was not yet felt. Therefore, drought was not a very high priority at all organizations before the dry period of 2018. Due to the dry summers thereafter, there has been more attention to it, for example at the province of Overijssel and at drinking water company Vitens (interview 1,3,4). The water board is also paying attention to it, although they are mainly focused on meeting the 2027 Water Framework Directive (KRW) targets (interview 5,9,10,11,13).

Second, recognition of drought-risk has grown in recent years within the municipality of Enschede. Because Enschede depends solely on rainwater that falls, it was the first area to feel the effects of drought (interview 1,3,9,10,11). However, awareness of drought seems to vary greatly from person to person and has not reached everyone. Some employees have also simply forgotten about a dry period after a period of rain and have no idea what risk drought poses (interview 3,4,5,7,8,9,10,13). It is indicated that the awareness of the drought-risk is present among the designers and policy makers, but less so in the management department (interview 5,12,13). Other respondents, on the contrary, indicate that the awareness of the drought problem is there within the whole municipality (interview 6,10,14). It is mentioned that, in recent years, steps have been made within the municipality to make drought a higher priority, but it is still in early stages and there is still limited attention to it. More attention is given, for example, to countering flooding (interview 1,4,7,8,10,13).

Third, on the contrary, there is much less awareness that drought could be a risk in society than within the organizations. When it is dry for a long time, many citizens do notice and are aware that drought could also be due to climate change, but as soon as a dry period is over they have forgotten about it. Moreover, most citizens are not concerned with drought in their daily lives, and it is only an important topic within organizations such as municipalities, provinces or water boards (interview 1,3,4,5,6,7,8, 9,10,11,13). However, it is said that the tide in society is turning a bit. Citizens increasingly realize that water and greenery is important, but they don't take action themselves (interview 1,4,6,8,12,13,14). For instance, the subsidy program that the municipality of Enschede has for regreening a plot or buying rain barrels is not yet widely used, nor is the website with tips on climate adaptation (interview 6,13). Farmers themselves are also not very eager to come up with solutions to adapt against drought (interview 5,10). Respondents also indicated that citizens are not yet willing to give up their privileges to make space for water and greenery. For instance, a parking space in front of the door is still more important than space for water storage (interview 6,8,10,14).

4.3.3 Drought policy implementation

In this section, the implementation of current drought policy is discussed. Since drought behavior is about implementing practical measures to address water shortages, this element of perception is mainly dealt with in this section (Wandel et al., 2016). Besides drought policy implementation, it is looked at the perception on current drought policy and respondent's future vision.

Drought policy in practice

This section looks at how separate organization's policies are implemented in practice. However, it is stressed that cooperation between the parties is necessary because no one can solve drought issue alone (interview 1,3,4,5,6,7,8,9,10,13).

The province of Overijssel and waterboard Vechtstromen

In Twente, the province of Overijssel has been working together with the water board and land management organizations to retain fresh water in the area as part of the ZON program. The first phase took place between 2015 and 2021, where mainly measurements were taken in rural areas around Enschede. These projects took place mainly in natural areas owned by land managers such as foundation Landscape Overijssel. Only land managers are involved there, which means there are fewer interests in the area which makes it easier to implement measures (interview 1,4,5,9). The measurements taken in this phase are given in table 14.

Table 14: measures taken in phase 1 of the ZON program (author)

Measures	explanation
Redesigning streams	<ul style="list-style-type: none">• Making streams more meandering to make sure water drains out of the area less quickly• Widening ditches and making them shallower so that water runs off more slowly but so that a lot of water can also be drained in wet periods
Deepening ditches	<ul style="list-style-type: none">• Make ditches less deep to retain water longer• Replace one deep stream with two shallower ditches

For the second phase of the ZON program, concerning 2022-2027, the water board wants to expand the measurements, mainly through the HOP program. In Enschede, the HOP program is mainly focused on water that springs in the country estates around the city. This property belongs often to land management organizations such as foundation Landscape Overijssel, where the water board is responsible for groundwater. The water board is now working on an implementation program to see which measures can be taken between now and 2027 in the country estates. If agreement is reached on this implementation program, execution can start. The HOP project is a larger scale project than what has been done so far in the ZON project, and it is looking more at creating a buffer around nature areas where water is retained longer as well. That means more stakeholders are involved, which is why it probably will take longer before concrete results can be achieved (1,4,5,9,10,13).

So, what is currently being done within the HOP project is not yet implementing measures, but is more focused on preparing them. In this way, the water board is currently figuring out how to collaborate with stakeholders involved in buffer zone areas, which are mainly land management organizations, country estate owners and farmers. Conversations are held and water markets are organized to inform and stimulate farmers to take water retaining measures. In some areas, these conversations have gone really well, resulting in clarity about which measures can be implemented. In other areas, the content of measures implemented is not clear yet. However, the aim is to create support first in order to achieve more and more results in small steps. This means the first measures may be sub optimal, for example

streams made shallower instead of filled in. But this is how trust is gained in an area, which makes it possible to implement more optimal measures in the future (interview 9).

In addition to the measures taken or to be taken within the ZON and HOP program, the province itself has taken a number of measures to adapt to increasing droughts, or there are measures yet to be implemented. According to the province of Overijssel's policy officer, national policy regarding the Delta plans freshwater and spatial adaptation, are mainly sector-based. At provincial level, they try to unify this more within the provincial program rural area (PPLG), in which fresh water and drought problems are combined with quality and livability (interview 1). Measures already taken by the province are given in the table below:

Table 15: measures taken by the province of Overijssel (author)

Measures	Explanation
Large-scale rewatering projects	<ul style="list-style-type: none"> • Rewatering of Natura 2000 areas • Rewatering of buffer zone around Natura 2000 areas. Because this zone includes other parties like farmers, it generates resistance and implementation takes long
Structural rewetting	<ul style="list-style-type: none"> • Making rural areas around Natura 2000 areas structurally wetter, returning to how it used to be, which could mean the current way of farming is no longer possible there. Fundamental choices regarding this are not made yet

The water board has also implemented measures or is planning to implement measures beyond the HOP and ZON program to retain water longer in the area. In doing so, the water board seeks a high form of participating. In projects, the neighborhood is always included and an attempt is made to create awareness and support. This takes a lot of time, but with support, small measures can be taken now and bigger measures can be taken in the future (interview 9). The measures are shown table 16.

Table 16: measures taken by the water board to retain water longer (author)

Measures	Explanation
Placing weirs and ballons in culverts	<ul style="list-style-type: none"> • These where ad hoc measures during dry periods to avoid water from draining out of the area
Adjusting mowing management	<ul style="list-style-type: none"> • This possibility of using this measure has been examined, because less mowing will retain water longer
Setting standards for groundwater undercharge	<ul style="list-style-type: none"> • Instead of only having standards for groundwater flooding, the water board is in the process of setting standards for groundwater undercharge as well
Green-blue services	<ul style="list-style-type: none"> • Entails that landowners can get paid if a nature-friendly bank is managed on their land or when water is retained on the property
Modifying weirs	<ul style="list-style-type: none"> • The water board is experimenting with this in the stream system. These weirs are normally set to drain in the winter, but now it is looked if they can be set to summer level in winter, meaning to hold more water

Municipality of Enschede

At municipal level, drought has only recently been included in policy. As drought became more frequent as of 2018, they started thinking at the municipality about how they would want to deal with drought in Enschede. This led to the inclusion of drought in the water and climate adaptation plan, which is mainly focused on the urban area. This plan specifically states that the municipality wants more green and blue structures in the city, in order to combat not only flooding, but also heat stress and drought. So for the first time, policy has been formulated that focuses on drought. However, drought is not very

prominent in this plan yet (interview 4,7,10,12,13). This emerges by the fact that the municipality has been working in a risk-based manner for about 10 years now: it is looked at what effects occur, how bad those effects are and how often they may occur. Then agreements with the city council are made about what is acceptable, after which all areas are tested to this standard. For flooding this risk-based approach is made, but for drought they are still puzzling with that. It is therefore not yet clear in the municipal policy what effects are accepted in terms of drought (interview 13). Still, some things are already being done in practice to combat drought, given in the table below:

Table 17: measures taken by the municipality of Enschede in urban areas to adapt to drought (author)

Measures	Explanation
Soil and water guiding in districts	<ul style="list-style-type: none"> In new residential districts, the natural water balance is respected: areas are no longer drained or raised enormously to make them drier
Green-blue structure plans	<ul style="list-style-type: none"> These plans are in the making and include ambitions for green and water in a particular neighborhood for the coming 40-50 years
Climate labels	<ul style="list-style-type: none"> A higher percentage of green and space for water infiltration area must return in an area after it has been redeveloped, for example because the sewer was replaced
Make room for water	<ul style="list-style-type: none"> Laying out wadis Transforming straight streams into attractive green areas to capture peak rainfall and let it slowly infiltrate in the ground Disconnect water that falls on roofs from the sewer system and let it infiltrate in the ground Replacing asphalt through greenery Planting different types of vegetation to retain water longer Draining water via more natural ways instead of through the sewer system
Change planting maintenance	<ul style="list-style-type: none"> Planting vegetation in autumn instead of spring to give them longer time to root before a dry period occurs Planting other vegetation that can withstand drought better
Encourage citizens	<ul style="list-style-type: none"> Platform GroenBlauw Enschede contains all information for citizens to make their environment climate-adaptive Providing subsidies for individuals or businesses to take climate-adaptive measures on their own property, such as replacing tiles with greenery or installing rain barrels
Flexible groundwater regulation system	<ul style="list-style-type: none"> For the future, the municipality is thinking about a system where within a bandwidth, as much water as possible is retained. Below that even more and above that, more water is drained. Towards the summer, more water will be accepted to deal with drought, towards the winter more water will be drained to avoid flooding

While there are some measurements taken in urban areas, the municipality was previously not an active player in rural areas because they do not have a lot of property there. For example, they had not been participating actively in the ZON and HOP project. However, since they did set ambitions for outside urban areas in the vision rural area, they have been participating much more actively there for about a year now. Although it is recognized that drought will become an important issue rural areas, it is just slightly part of this vision (interview 4,7). In the table below are some measurements explained.

Table 18: measures taken by the municipality of Enschede in rural areas to adapt to drought (author)

Measures	Explanation
Area-oriented approach	<ul style="list-style-type: none"> Includes working together with residents and farmers on all tasks that are involved in the rural area to make a comprehensive plan for an entire area

Adjust ditches to drain water more slowly	<ul style="list-style-type: none"> • Making ditches shallower • Replacing one deep ditch with two shallow ditches • Making ditches more meandering
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Drinking water company Vitens

The dry summers as of 2018 have really been a wake-up call for Vitens. Therefore, a number of things have changed to be more water-efficient and to retain water longer. These measures are given in the table below.

Table 19: measures taken by Vitens since the drought of 2018 (author)

Measures	Explanation
Consideration framework	<ul style="list-style-type: none"> • Created to help Vitens decide whether or not they can supply drinking water to companies or houses. It is looked at whether drinking water quality is really necessary or that less quality will also suffice. They used to connect everyone to drinking water without considering.
Participate in area processes	<ul style="list-style-type: none"> • Vitens used to be only active in their own extraction areas, but now participates in larger area processes around their extraction sites. • They collaborate with the people living and working around the extraction site to work towards a system that retains more water in the whole area • They participate in Twents Waternet
Retain water in own extraction areas	<ul style="list-style-type: none"> • Vitens used to drain the rinse of water from the production process into a ditch, but now infiltrates it back into its own extraction area
Pilot Notter	<ul style="list-style-type: none"> • In this pilot, Vitens is looking whether they can supply water during very wet periods in order to raise the groundwater level in the winter, to be less vulnerable to drought in the summer
Information provision	<ul style="list-style-type: none"> • Vitens informs residents about the differences in water management between municipalities, water boards and Vitens, to raise more awareness for the complexity of drought
Extract water from surface water	<ul style="list-style-type: none"> • Vitens is experimenting with this, to avoid being solely dependent on groundwater
Program on water conservation	<ul style="list-style-type: none"> • For example, if a new residential area is built, Vitens advocates for it to be water efficient
Vision about water balance	<ul style="list-style-type: none"> • Vitens is experimenting with a vision that seeks to put the amount of water that runs out of an area back in

Foundation landscape Overijssel

Foundation Landscape Overijssel is taking various measures to combat drought. They were already working on this within their own nature areas before the 2018 drought. There, they do already see recovery from measures they have taken. The dry summer as of 2018 did help to prioritize drought among other parties, which makes it easier for the foundation to implement measures outside their own areas as well. However, foundation landscape Overijssel mainly has the function of nature to serve, while the municipality of Enschede and the water board have multiple functions to serve. In cooperation, foundation landscape Overijssel is therefore often more progressive than the other parties (interview 4). The measures foundation landscape Overijssel implemented are shown in table 20.

Table 20: measures taken by foundation Landscape Overijssel to retain water longer (author)

Measures	Explanation
Visits of field consultants	<ul style="list-style-type: none"> These consultants advise people living in the countryside on how the landscape can be strengthened. For example, pools can be created or wooded banks can be restored to retain water longer
Create buffer zones	<ul style="list-style-type: none"> They seek to create buffer zones between nature and urban area, trying to minimize the effect of buildings on nature. If buffer zones are not possible, measures are taken such as building fences to keep the two separated.
Making own areas more climate-robust	<ul style="list-style-type: none"> Making waterways less deep, wider or completely closed to retain water longer Cutting down trees that died from the drought and replacing them with more natural and drought-resilient forest

STAWEL

STAWEL has established a broad coalition consisting of a number of parties. The municipality of Enschede has made an amount of money available for the broad coalition to help the transition of agriculture. STAWEL is connected to the vision rural area of the municipality of Enschede which contains 3 pillars: connect, broaden and preserve. STAWEL uses the money to organize knowledge sessions and workshops and farmers can apply for a voucher if they have an idea that meets one of the pillars. In this way, change in the agricultural sector is stimulated. Measures that can be implemented at plot level and that are already happening are given in table 21.

Table 21: measures taken on farm level, seen or encouraged by STAWEL (author)

Measures	Explanation
Water retention	<ul style="list-style-type: none"> Putting sandbags into culverts Making smart systems with overflow pipes
Soil and water plans	<ul style="list-style-type: none"> These are made at farm levels to advise farmers on how to improve their soil or how to retain water longer.
Productive herbal mix	<ul style="list-style-type: none"> Sowing this into the grass makes grass more resistant to drought because productive herbal grasses root at different depths
Level-controlled drainage	<ul style="list-style-type: none"> When a lot of rain falls, more water is drained. When no rain falls, less water or no water is drained
Improving humus level	<ul style="list-style-type: none"> By improving the humus level in the soil, the soil is better able to retain water

Perception on current drought policy

Respondents were asked for their opinions on current drought policy in the municipality of Enschede. This could be about the policy that the municipality itself has formulated, but also about the water board's policy or the province's policy that affects drought policy in the municipality of Enschede.

Perception on the municipality of Enschede's drought policy

When looking at the municipality of Enschede's drought policy, three debates emerge. First, it is mentioned that the municipality involves more in rural areas. In inner-city areas, Enschede was doing well on water-related issues regarding their policy and in practice, but was even less so in rural areas. The countryside was not a priority for the municipality and few officials were concerned with it. However, respondents do feel that the municipality has made a big step in recent years: there are better policy documents and slowly there is more capacity to it. Also, the municipality is more involved in the ZON and HOP program. STAWEL's respondents say that the municipality is thinking along and helping in the transition of agriculture, through understanding and some money. Yet, they still do need to catch up internally, so that drought really gets a place within the organization (interview 1,2,4).

Second, respondents within the municipality feel that drought still features little in policy documents. According to them, it is not yet clear what exactly the municipality's strategy is in relation to retaining water and therefore, current policy would still lack an underpinning for addressing drought. This is because not much yet is known about drought: it is not clear what effects drought has caused in Enschede in recent years. Also, it is not clear what effects longer water retention would have on functions such as housing, roads and agriculture. Perhaps it will cause more inconvenience in wet periods than currently expected. Neither is it clear whether water retention measures are actually helping to prevent the effects of drought. It is said that more research should be done and at the same time measures should be taken to experiment with drought adaptation. When more is known about drought, it can also be given a more prominent place in policy (interview 7,8,9,10,12,13).

Third, because no real direction has yet been established in policy, drought is not yet a priority in practice. This is because there are many functions that require space. When water storage or greenery is given more room, it is at the expense of other functions such as agriculture or housing. That does not often happen in practice, because other functions generate more money. At the end, a project development should be profitable, so less space is reserved for green and water than was aspired at the beginning (interview 4,5,8,9,10,12,14). Moreover, the lack of fundamental policy leaves a lot of room for individuals to determine how much is done about drought. Then it seems that not everyone prioritizes drought: for planning economists and urban planners, for example, the urgency to build houses has more priority because of the high demand for housing in the short term and the agreements on the national housing deal (interview 3,5,8,10,12,14). Also, the importance of drought adaptation in relation to social problems such as poverty is questioned (interview 8,10,14). Moreover, management departments often have their own budgets and ideas about how things should be done in practice, ending in policies not being adopted. If drought policies are laid down in the environmental vision, it can get more status and a bottom line would be determined to which everyone will have to stick within the municipality (interview 5,13).

"To be honest, drought is only partly included in our policy. We are still busy with solving water nuisance, that is the primary goal. We are also trying to combat drought by retaining water or letting it infiltrate in the soil. But how much that really contributes to combatting drought? We are not able to measure that yet" (water designer, municipality of Enschede)

Perception on drought policy of water board Vechtstromen

Regarding the water board's policy, particularly the HOP program is mentioned among respondents, which is mainly managed by the water board. When looking at this, there are two debates. First, the HOP program is seen as a good start to prevent drought and to steer towards a system where water and soil are given more priority. The water board is really seen as the driving force behind the redesign of this water system in Twente, because they have the most holistic view of this system (interview 1,3,4, 5,10,11,13). Also, the HOP program could be expanded, according to respondents, as it would now be too little to prevent drought. More attention and funding for HOP would be desirable, for example through cooperating with other cities and exchanging knowledge (interview 4,9,13). The respondents from STAWEL mention that there are more possibilities on country estates and farms to retain water as part of HOP. Water retention can particularly be done on farms that are relatively flat, and not in the areas situated on sloping ground because of the lateral moraine (interview 2).

Second, on the contrary, it is mentioned that the water board does not have much administrative support yet to redesign the water system and that they are mainly still searching to what extent they can solve everything technically within the current system (interview 4,5). Moreover, it is felt that the water board, together with foundation Landscape Overijssel, does not have a clear vision of what they want to achieve with the HOP program. According to respondents, it is not clear what exactly the drought problem entails and thus what effects of drought are to be combatted. Also, it is not clear what the effects will be of measures to be taken for drought adaptation. It would be a shame if water were to be retained longer while that does not help solve the drought problem, but does cause water nuisance in winter (interview 7,9,10,13). However, respondents do feel that it is necessary to start implementing measures in order to learn more about the effect of those measures (interview 9,10,13)

Perception on drought policy of province of Overijssel

The province of Overijssel is mainly called upon by respondents to take the lead more. Currently, the province does not have the courage to make fundamental choices in the redesign of the water system as well as on other issues. The province should have more perseverance and courage to make these choices with sometimes painful consequences (interview 3,4,10,12,13). It is mentioned that the province's drought policy is currently still abstract and fragmented, and that more systematic measures are needed from above. If that happens, less project-based work and more area processes will be carried out in which separate parts of the water system will be connected (interview 3,4,7,10,12,13).

On the contrary, it is mentioned that the province should delegate more risks and freedom. This can for example be performed by setting a limit to what can be done technically within the water system. Now, technical measures are used to discharge water where it is undesirable and pump it up where it is needed. According to a municipal policy officer, there is a stretch in what the current water system can handle and what is technically solvable. When the province puts a limit to technically regulating groundwater levels, it leaves more risks to, for example, farmers to deal with natural consequences (interview 5). Also, more freedom can be given by setting targets instead of generic measures. An example is the generic measure that every stream must have 200 meters of buffer zone on each side, which could be replaced by the target that water in the stream must be cleaner, leaving more room in the way it is achieved.

Future vision

Lastly, respondents were about asked how they envision the future. This mainly appears to be about whether the water system should be redesigned completely or not. A redesign of the water system means that the system should return to when water and soil were naturally guiding. Back then, it was obvious that houses were not built in a stream valley because there was a risk of flooding, and crops that needed water were not cultivated on high ground. About 50 years ago, the water system in the Netherlands was redesigned to drain water as quickly as possible. Land consolidation took place and technical measures such as dams and weirs allowed functions to be realized in places where it naturally could not. Neighborhoods were for example built in wet areas by using drainage. From then on, the principle of level follows function was central, with groundwater levels being adjusted to the desired function of an area (interview 4,5,9,13). It seems to be that there are two currents regarding this principle.

First, respondents in favor of water and soil steering do not expect that this system of level follows function will be sustainable for the future. So far, it has been managed to cope with droughts and floodings with adjustments within the current water system, but respondents believe the limits of this system are being reached. It is said that water and soil should once again be steering, with the water system central and other functions subordinate to it, so function follows level. This means making fundamental choices administratively and politically, which will result in certain functions no longer being able to stay where they are now. For example, houses cannot be built in certain areas because it is low-lying and can be flooded. A fundamental change in the water system thus has major consequences for the way people live and work nowadays and will take decades to work out (interview 1,3,4,5,8,9,11,12,13).

Second, respondents more nuanced about water and soil steering do not expect that such fundamental change in the water system will be possible. It is said the country is already so built up that it is impossible to reverse it. One scale leap back would be feasible, but that's all. It is not believed that retaining and storing as much water as possible will be efficient. Moreover, they don't believe going back to this principle will solve the problems caused by drought and flooding nowadays and it would take many years to accomplish (interview 7,10,14). Therefore, the effects of drought should partly just be accepted in Enschede, also since the geographical features in some parts of the municipality ensure that drought is more likely to occur (interview 2,6,7,10,14).

5 Discussion and conclusion

This master thesis aimed to investigate the perception of drought-risk in the municipality of Enschede, to find out its influence on drought adaptation policy and drought vulnerability. This chapter will first answer the three sub questions, which lead to an answer to the main research question. This is followed by a reflection on the theory and methodology used in this research. The chapter finishes with recommendations for follow-up research and policy recommendations for the municipality of Enschede.

5.1 Conclusion

The three sub questions will be answered consecutively, after which an answer to the main question will be formulated.

The first sub question reads: *“what are existing drought adaptation policies in the municipality of Enschede?”* Water management in the Netherlands is an interaction of different levels of government. In Enschede, there is shared responsibility between the national government, the province of Overijssel, water board Vechtstromen, drinking water company Vitens and the municipality of Enschede itself. All have different tasks when it comes to water management and all of them therefore also have influence with their policies on what is happening in terms of drought adaptation in the municipality of Enschede. National policies, such as the Delta plans fresh water and spatial adaptation, provide a rough direction on how drought should be dealt with. On regional levels, this has been developed in practical policies of which projects like ZON and HOP are an outcome, in which practical measures are already being taken. On municipal level, drought is only recently and to a small extent included in policy documents, and at an abstract level. Existing drought adaptation policies in the municipality of Enschede therefore consists of policies at different levels, with the regional level currently being most implemented in the area of Enschede.

The second sub question reads: *what is the existing drought vulnerability within the municipality of Enschede?* Drought vulnerability is determined by the level of exposure to drought and the level of adaptive capacity, or sensitivity. First, the review of policy documents and interviews reveal that Enschede’s exposure to drought is likely to increase in the future. The scientific expectation in all four KNMI climate scenarios is that summer drought will increase in the inland parts of the Netherlands, and thus in the area of Enschede. The extent to which drought will increase is still uncertain, but that it will become drier seems clear. This is also recognized by the respondents, who expect Enschede to increasingly face longer and more severe periods of drought in the future. Second, although the exposure will increase, the collected data shows that Enschede’s adaptive capacity is currently not very high. This is due to multiple determinants of adaptive capacity. The geographical location of Enschede, on a lateral moraine and with no water supply other than precipitation, combined with a sand layer over a boulder clay layer in the soil, makes Enschede naturally sensitive to drought. The combination with infrastructure aimed at draining water as quickly as possible via the sewer system, ensures that rain that falls disappears quickly out of the area. Although there are many technical measures known in Enschede to retain water longer in urban and rural areas, it is not implemented very widely yet. This is due to limited economic resources to combat drought and the lack of expertise and knowledge on the effects of drought and adaptation measures. Also, there are institutional contexts that influence early water runoff from the region. Finally, national, provincial and local politics determine how much attention and money should go to drought adaptation, and this is subject to change. With a new cabinet coming, it is expected that not much will be done on drought adaptation. From these determinants of adaptive capacity can be concluded that although there are skills and technical measures to adapt to drought, there are too many aspects that do not always make drought adaptation happen. Enschede’s

increasing exposure to drought and a relatively low adaptive capacity makes Enschede currently vulnerable to drought.

The third sub question is: *how is drought-risk perceived in the municipality of Enschede?* Drought-risk perception consists of the elements experience, memory, definition and behaviour. Looking at experience and memory, the dry summer of 2018 and consecutive years were not expected at all by the respondents and have stayed in their minds the most. All kinds of effects were seen on agriculture, nature, drinking water and constructions. This experience causes respondents to define drought as a long period without rainfall or with lower groundwater levels than normal, causing damages in different sectors. It appears that the recognition of and attention to drought has increased with the experience of these dry spells, yet it is also mentioned that it is quickly forgotten again at the time of a wet spell. This is also reflected in the element behaviour: how much drought is recognized and prioritized in relation to other spatial issues can really vary from person to person. Enschede has more experience with flooding, which is therefore in practice still a priority compared to drought. Moreover, relative to other spatial issues such as housing or agriculture, space for water storage and greenery is less profitable, making it not the first priority. Also, still very little is known about what exactly the effects of drought have been in Enschede, how much the damage has cost, in which areas the greatest risks lie, what measures really contribute to combat drought and whether those measures have any negative side effects. Some measures are being taken to retain water longer, but not nearly enough to combat drought. Drought-risk perception varies thus a lot in Enschede, leading to priority differences and not many measures being implemented yet.

The main research question reads: *How does the perception of drought-risk influence drought adaptation policy and drought vulnerability in the municipality of Enschede?* Because the recognition and awareness of drought-risk only increased after 2018 and the subsequent dry years, drought has recently been included in Enschede's municipal policy for the first time. It is said that drought is a fairly new issue in Enschede and therefore has not yet a prominent place yet in policy. This is also due to the fact that there is still a lot uncertainty about the risks and effects of drought and about the measures to mitigate drought. The lack of knowledge ensures that no course has yet been set in the municipality's policy on how they intend to deal with drought. This leaves a lot of room for individual interpretation of drought approaches, which varies because not everyone sees drought as a priority. As a result, where functions come together and where interests clash, drought adaptation measures most of the time lose out. This is also due to little decisiveness regional and provincial level to make fundamental choices about the water system. It is believed that water and soil should be steering and that function follows water level should be leading to be able to adapt to increasing droughts. However, that will cause major changes in the way the land is currently used. The courage needed to steer in this direction is not there yet at all administrative levels, which ensures that drought is only addressed to a small extent. It can be concluded that because of the lack of experience with drought, the recognition and priority of drought in Enschede is fragmented, leading to incongruent adaptation policies and therefore higher levels of vulnerability.

5.2 Reflections and recommendations

This section reflects on the theories used, followed by a reflection on the methods used, which comes with limitations. This section ends with recommendations for follow-up research and policy recommendations.

5.2.1 Reflection on theory

The theory section in chapter two is divided in literature on drought, drought-risk perception and drought vulnerability. For this research, the vulnerability framework by Taylor et al. (1988) is used in combination with the framework about the two dimensions of vulnerability by Wandel et al. (2016). The framework on the two dimensions of vulnerability proved to be a good basis for figuring out how vulnerable Enschede currently is to drought. However, it became clear during the review of policy documents and interviews that an important component was missing: namely, the geographical characteristics of Enschede. These were added afterwards as one of the determinants of adaptive capacity. The vulnerability framework served as a good foundation for exploring perceptions. This framework was certainly necessary because perception is a rather subjective concept. The framework allowed the element of perception to be divided into four separate parts, which gave more guidance in creating questions for the interviews. However, it was difficult to determine which topics should fall under which element. A clearer theoretical underpinning of the four elements would have been helpful, but this was not found in the literature. In practice, therefore, the four elements are not as separate as the framework makes it appear. In the draft version of this thesis, the results were more strictly attributed to these four elements, creating a lot of overlap in this chapter. By taking parts of the elements together in the final version, the results chapter became more comprehensible.

5.2.2 Reflection on methodology

In this research, various methods have been used: literature research, review of policy documents and semi-structured interviews, from which the semi-structured interviews made up the majority of the data collection. This section reflects on four components. First, it can be questioned whether expert consultation was the best method to select respondents. A total of fourteen interviews were conducted within seven organizations. Eight respondents were selected through expert consultation with the internship supervisor, six respondents were approached via snowballing. Expert consultation involves the risk that other relevant organizations or stakeholders are missed out on the research and not all perspectives are included.

Second, approaching and recruiting the respondents went very smoothly. This is because respondents were approached even before the internship has started, so planning ahead was possible and there was still room in respondent's schedules. Also, the email address obtained from the municipality was used when approaching respondents, as well as the supervisor's name. This created trust and recognition and respondents reacted quickly and positively to the invitation for interviews.

Third, only one respondent was interviewed from all external organizations, that is other than the municipality of Enschede. Because this study is about the rather subjective concept of perceptions, how people perceive drought-risk may differ from person to person within one organization. Therefore, the perception of one respondent can actually not be seen as representative for the entire organization. To really get a good idea of how the organizations think about drought-risk in Enschede, several people from each organization should have been interviewed. Within the municipality of Enschede, in contrast, as many as eight different people were interviewed. Therefore, more information was gathered on the perspective of the municipality itself, although the perceptions within the municipality also varied.

Fourth, the method for data analysis, namely using Atlas.ti, was used to interpret the collected data systematically. However, this data was only analysed by the researcher herself, which leaves room for

interpretation. This could lead to certain statements given more value than others, or be mentioned more often than others. An attempt was made to indicate by which respondent and by how many respondents certain statements were made, which provides more clarity on the value of the statements. Finally, the data that fit the conceptual framework and thus answered the research questions, were prioritized. As a result, some relevant information that did not connect directly to the research may not have made it into the thesis, even though an intention was made to include as much collected data as possible in the thesis.

5.2.3 Recommendations

Now that the main question has been answered and the research has been reflected upon, recommendations can be made. First, recommendations are given for follow-up research. Second, recommendations for the municipality of Enschede are made.

Recommendations for follow-up research

Investigate the risks of drought

To get a clearer idea of what drought-risks actually exist in Enschede, it is good to investigate it. Which areas will fall dry first? Which areas will suffer the most damage in a dry spell and which areas the least? If this is known, it allows for more targeted action to counter the effects of drought in these areas. Investigating risks has already been done for flooding in Enschede, and could be done the same way for drought. According to respondents within the municipality, investigating drought-risk in Enschede is scheduled to execute, and it is definitely recommended to do so.

Investigate the impacts of previous droughts and corresponding costs

To know where the biggest drought-risk lie, it is also good to look at what previous dry spells have brought. Respondents indicated that it is not yet clear exactly what effects there have been from previous dry spells and how much the damage has cost. When the effects become clear and the costs are quantified, the municipality of Enschede will have a better idea of what can be prevented by drought adaptive measures. Countering the effects of drought then gets more value, and it will hopefully automatically lead to more awareness and recognition of drought-risks.

Investigate drought-risk perception in the different districts

Because Enschede is built on a lateral moraine, leading to height differences of up to 40 metres, drought-risk perception may differ from one part of the city to another. In one district, more water nuisance may be experienced while in another, drought is more common. To see if there are actually differences in drought-risk perception between the districts and what consequences that has for the implementation of drought adaptation policies, this perception could be investigated.

Mapping actors involved in drought governance in Enschede

Since this thesis used expert consultation to select the organizations and respondents for the interviews, relevant organizations or respondents could be missed out. Therefore, it is recommended to map the actors that are involved in or could influence drought adaptation policies in Enschede. This could for example be done through stakeholder analysis. Within this analysis, stakeholders, the relationship between stakeholders and their needs will be identified systematically, so it is less likely that stakeholders will be overlooked.

Policy recommendations

Create more awareness about drought risks

First, it is important to create greater recognition and awareness of the risks posed by drought. When more people recognize the problems of drought, it is more likely that drought will be given more priority and that more measures will be taken to adapt. This can be achieved by first following the recommendations for follow-up research so that more is known about drought. Then, through campaigns, information sessions, events or resident's evenings, more attention can be drawn to it.

Expand policy on drought

It is recommended that the municipality of Enschede further expands its policy on drought. To ensure that drought adaptation measures are really implemented, drought should be given more status and priority in policy. For example, a minimum threshold could be set of what needs to be done the least to prevent drought. As one respondent mentioned, a bandwidth could be determined at neighbourhood or area level in which water should be retained as much as possible. Below this bandwidth, more water should be retained, above this bandwidth, more water should be drained. A flexible system could also be considered, using mostly technical measures to retain more water in spring and summer to prevent drought, and more water discharged in autumn and winter to prevent flooding. When these things are set out in policy, how much is done about drought can no longer vary from one individual to another. A course is then set for everyone to follow, and drought adaptation measures are more likely to be implemented.

Make drought adaption more profitable

This research showed that creating space for green and water still often loses out to more profitable functions such as housing and agriculture. If it is clear what costs are saved in preventing the effects of drought, and if more money is made available for drought-adaptive measures, it is more likely that it will get more value in spatial developments and that more drought adaptation measures will be implemented.

Implement more drought adaptive measures

When the recommendations above will be followed, it is important that more measures to adapt to drought are actually taken in practice to adapt to drought. In urban areas, existing water flows could be given more space to drain water more slowly, paving could be replaced by greenery to infiltrate water into the soil and residents could be further encouraged to retain water on the plot level. In rural areas, more space can be created to buffer and retain precipitation that falls. Measures can be taken to shallow or fill ditches or allow them to meander to drain water less quickly. Green-blue services can be used to make it attractive for farmers, for instance, to retain water on their land, as this provides an income model.

References

- Ault, T. R. (2020). On the essentials of drought in a changing climate. *Science*, 368(6488), 256-260.
- Bahta, Y., Jordaan, A., & Muyambo, F. (2016). Communal farmers' perception of drought in South Africa: Policy implication for drought risk reduction. *International Journal of Disaster Risk Reduction*, 20, 39-50.
- Bressers, J. T., Boer, C., Browne, A., Lordkipanidze, M., Larrue, C., Özerol, G., & Stein, U. (2014). Observations on the governance context of drought policy and pilot measures for the Twente region of Vechtstromen. Extended final report DROP project.
- Brockhoff, R. C., Biesbroek, R., & Van der Bolt, B. (2022). Drought governance in transition: a case study of the Meuse River Basin in the Netherlands. *Water Resources Management*, 36(8), 2623-2638.
- Clahsen, S. C., Van Kamp, I., Hakkert, B. C., Vermeire, T. G., Piersma, A. H., & Lebet, E. (2019). Why do countries regulate environmental health risks differently? A theoretical perspective. *Risk analysis*, 39(2), 439-461.
- Dąbrowska, J., Orellana, A. E. M., Kilian, W., Moryl, A., Cielecka, N., Michałowska, K., . . . Włóka, A. (2023). Between flood and drought: How cities are facing water surplus and scarcity. *Journal of Environmental Management*, 345, 118557.
- Datta, P., & Behera, B. (2022). Climate change and Indian agriculture: A systematic review of farmers' perception, adaptation, and transformation. *Environmental Challenges*, 8, 100543.
- Dilling, L., Daly, M. E., Kenney, D. A., Klein, R., Miller, K., Ray, A. J., . . . Wilhelmi, O. (2019). Drought in urban water systems: Learning lessons for climate adaptive capacity. *Climate Risk Management*, 23, 32-42.
- Elkouk, A., Pokhrel, Y., Satoh, Y., & Bouchaou, L. (2022). Implications of changes in climate and human development on 21st-century global drought risk. *Journal of Environmental Management*, 317, 115378.
- Enschede, G. (2023). Enschede zoekt naar de juiste waterbalans. Retrieved from <https://deopenbareruimte.nu/enschede-zoekt-naar-de-juiste-waterbalans/>
- Finley, S. (2019). *Vulnerability and Adaptation to Urban Water Scarcity Outside of Meteorological Drought Events: Updated Perspectives for a Warming World*. Paper presented at the AGU Fall Meeting Abstracts.
- Gemeente Enschede. (2012). "Water verbindt". Retrieved from https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://documenten.enschede.nl/budgetting/media/741904f4-597c-4fc5-be73-5647bcf87a70/Watervisie%25202012-2025%2520DEFINITIEF%252012%2520vastgesteld%252027%2520mei%25202013.pdf&ved=2ahUKewj938b4y-eFAxW7IP0HHeqmBNIQFnoECBAQAQ&usg=AOvVaw0XWYNb0N_e1EiL4fodbTi-
- Gemeente Enschede. (2021). *Visie landelijk gebied Enschede*. Retrieved from <https://www.enschede.nl/landelijk-gebied>
- Gemeente Enschede. (2022). *Ruimtelijk verhaal van Enschede*. Retrieved from <https://enschede.bestuurlijkeinformatie.nl/Agenda/Document/0fa2d620-71c5-42ba-baf6-0ebb1e10b262?documentId=bd36390a-8738-4c67-a26b-b375b193f12d&agendatItemId=30957dd3-4815-412b-8f8b-92f5c1eeba86>
- Gemeente Enschede. (2023). *Natuur- & Landschapsplan*. Retrieved from <https://www.enschede.nl/file/natuur-en-landschapsplan-enschede>
- Gemeente Enschede, & Royal HaskoningDHV. (2021). *Water- en Klimaatadaptatieplan Gemeente Enschede 2022-2026*. Retrieved from <https://groenblauwenschede.ireporting.nl/hoofdrapport-wek/downloads>
- Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research*, 2(163-194), 105.

- Guerreiro, S. B., Dawson, R. J., Kilsby, C., Lewis, E., & Ford, A. (2018). Future heat-waves, droughts and floods in 571 European cities. *Environmental Research Letters*, 13(3), 034009.
- Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). *Case study research: Foundations and methodological orientations*. Paper presented at the Forum qualitative Sozialforschung/Forum: qualitative social research.
- indebuurt Enschede. (2022). Abraham Ledeborpark begin augustus. In: Informatiepunt Leefomgeving. (2022). Het hoofd boven water bij zware regenval. Retrieved from <https://iplo.nl/nieuws/perspectief/hoofd-boven-water-houden-zware-regenval/>
- J.P. Witte, P. d. L., R. van Ek, R. Bartholomeus,, G. van den Eertwegh, H. K. G., M. van Rijswick,, & G. Beugelink, R. R., W. van der Kooij. (2020). *Aanpak droogte vraagt transitie waterbeheer*. Retrieved from <https://edepot.wur.nl/538739>
- Kallis, G. (2008). Droughts. *Annual Review of Environment and Resources*, 33, 85-118.
- Keessen, A. M., Hamer, J. M., Van Rijswick, H. F., & Wiering, M. (2013). The concept of resilience from a normative perspective: examples from Dutch adaptation strategies. *Ecology and Society*, 18(2).
- Kennisportaal Klimaatadaptatie. (2024, 2024). Droogte Retrieved from <https://klimaatadaptatienederland.nl/stresstest/bijsluiter/droogte>
- Klimaatadaptatie, K. (2022). 'Twente op waterbasis' geeft richting voor aanpak van droogte. Retrieved from <https://klimaatadaptatienederland.nl/actueel/actueel/nieuws/2022/twente-waterbasis-geeft-richting-aanpak-droogte/>
- KNMI, M. v. i. e. w. (2020). Vaker droogte in het binnenland. Retrieved from <https://www.knmi.nl/over-het-knmi/nieuws/vaker-droogte-in-het-binnenland>
- KNMI, M. v. i. e. w. (2022a). Droogte. Retrieved from <https://www.knmi.nl/kennis-en-datacentrum/uitleg/droogte>
- KNMI, M. v. i. e. w. (2022). Meerjarige droogtes in Nederland waterland? . Retrieved from <https://www.knmi.nl/over-het-knmi/nieuws/meerjarige-droogtes-in-nederland-waterland>
- KNMI, M. v. i. e. w. (2022b). Niet eerder deze eeuw zo droog als dit jaar. Retrieved from <https://www.knmi.nl/over-het-knmi/nieuws/droge-zomerhalfjaar-van-2022/>
- KNMI, M. v. i. e. w. (2023). *KNMI'23 Klimaatscenario's voor Nederland* Retrieved from https://cdn.knmi.nl/system/ckeditor/attachment_files/data/000/000/357/original/KNMI23_klimaatscenario's_gebruikersrapport_23-03.pdf
- Leal Filho, W. (2015). *Handbook of climate change adaptation*.
- Logar, I., & van den Bergh, J. C. (2013). Methods to assess costs of drought damages and policies for drought mitigation and adaptation: review and recommendations. *Water Resources Management*, 27, 1707-1720.
- Machairas, I., & van de Ven, F. H. (2023). An urban drought categorization framework and the vulnerability of a lowland city to groundwater urban droughts. *Natural Hazards*, 116(2), 1403-1431.
- Melka, Y., Kassa, H., Ketema, M., Abebaw, D., & Schmiedel, U. (2015). The effect of drought risk perception on local people coping decisions in the Central Rift Valley of Ethiopia. *Journal of Development and Agricultural Economics*, 7(9), 292-302.
- Ministerie van Infrastructuur en Waterstaat. (2023a). Deltaplan Zoetwater. Retrieved from <https://www.deltaprogramma.nl/themas/zoetwater/deltaplan>
- Ministerie van Infrastructuur en Waterstaat. (2023b). Wat is het nationaal Deltaprogramma? . Retrieved from <https://www.deltaprogramma.nl/deltaprogramma/wat-is-het-deltaprogramma>
- Ministerie van Infrastructuur en Waterstaat, Ministerie van Landbouw Natuur en Voedselkwaliteit, Unie van Waterschappen, Interprovinciaal Overleg, Bestuurlijk Platform Zoetwater, Rijkswaterstaat, & INFRAM B.V. (2019). *Eindrapportage Beleidstafel Droogte* Retrieved from <https://www.rijksoverheid.nl/documenten/rapporten/2019/12/18/eindrapportage-beleidstafel-droogte>

- Ministerie van Infrastructuur en Waterstaat. (2023). Deltaplan Ruimtelijke adaptatie. Retrieved from <https://www.deltaprogramma.nl/themas/ruimtelijke-adaptatie/deltaplan>
- Mishra, A. K., & Singh, V. P. (2010). A review of drought concepts. *Journal of hydrology*, 391(1-2), 202-216.
- Naumann, G., Spinoni, J., Vogt, J. V., & Barbosa, P. (2015). Assessment of drought damages and their uncertainties in Europe. *Environmental Research Letters*, 10(12), 124013.
- Nguyen, T. M., Stahlmann-Brown, P., & Noy, I. (2023). Past experience of drought, drought risk perception, and climate mitigation and adaptation decisions by farmers in New Zealand. *Environmental Hazards*, 22(3), 264-284.
- Ogundejji, A. A., & Okolie, C. C. (2022). Perception and adaptation strategies of smallholder farmers to drought risk: a scientometric analysis. *Agriculture*, 12(8), 1129.
- Pearce, M., Willis, E., Wadham, B., & Binks, B. (2010). Attitudes to drought in outback communities in South Australia. *Geographical Research*, 48(4), 359-369.
- Philip, S. Y., Kew, S. F., Van Der Wiel, K., Wanders, N., & Van Oldenborgh, G. J. (2020). Regional differentiation in climate change induced drought trends in the Netherlands. *Environmental Research Letters*, 15(9), 094081.
- Provincie Overijssel. (2023). *Ontwerp PPLG Overijssel* Retrieved from <https://www.overijssel.nl/onderwerpen/omgeving/provinciaal-programma-landelijk-gebied-pplg>
- Quandt, A. (2021). Coping with drought: narratives from smallholder farmers in semi-arid Kenya. *International Journal of Disaster Risk Reduction*, 57, 102168.
- Ramanjulu, S., & Bartels, D. (2002). Drought-and desiccation-induced modulation of gene expression in plants. *Plant, cell & environment*, 25(2), 141-151.
- Ricart, S., & Castelletti, A. (2021). *Exploring socio-natural factors of farmers' adaptation: A review on risk awareness and perception towards climate change*. Paper presented at the Book of Abstracts 9th SISC Annual Conference 2021.
- Ricart, S., Gandolfi, C., & Castelletti, A. (2023). Climate change awareness, perceived impacts, and adaptation from farmers' experience and behavior: a triple-loop review. *Regional environmental change*, 23(3), 82.
- Rijksoverheid. (2023). Provincie voert landelijk en eigen beleid uit. Retrieved from <https://www.rijksoverheid.nl/onderwerpen/provincies/taken-provincie>
- Rijksoverheid. (2024). Waterschappen. Retrieved from <https://www.rijksoverheid.nl/onderwerpen/waterschappen/taken-waterschap>
- Rijkswaterstaat, M. v. I. e. W. (2024). Organisatie waterbeheer. Retrieved from <https://www.infomil.nl/onderwerpen/lucht-water/handboek-water/wetgeving/waterwet/organisatie/>
- Royal HaskoningDHV, & Enschede, G. (2022). *Water- en Klimaatadaptatieplan Gemeente Enschede 2022-2026*. Enschede Retrieved from https://groenblauwenschede.ireporting.nl/FbContent.ashx/pub_1001/downloads/v210622195815/Water-%20en_klimaatadaptatieplan%20Gemeente%20Enschede%202022-2026.pdf
- Straaten, B. v. (2023). Dit waren de droogste jaren in Nederland. Retrieved from <https://www.weeronline.nl/nieuws/dit-waren-de-droogste-jaren-in-nederland>
- Taylor, J. G., Stewart, T. R., & Downton, M. (1988). Perceptions of drought in the Ogallala Aquifer region. *Environment and Behavior*, 20(2), 150-175.
- Teutschbein, C., Albrecht, F., Blicharska, M., Tootoonchi, F., Stenfors, E., & Grabs, T. (2023). Drought hazards and stakeholder perception: Unraveling the interlinkages between drought severity, perceived impacts, preparedness, and management. *Ambio*, 52(7), 1262-1281.
- Twents Waternet. (2022). 'Twente op waterbasis' geeft richting voor aanpak droogte. Retrieved from <https://www.twentswaternet.nl/actueel-informatie/nieuws/nieuwsberichten/twente-waterbasis-geeft-richting-aanpak/>

- UN Secretariat General. (1994). United Nations convention to combat drought and desertification in countries experiencing serious droughts and/or desertification, particularly in Africa. *Particularly in Africa*.
- van Duinen, R., Filatova, T., Geurts, P., & van der Veen, A. (2015). Coping with drought risk: empirical analysis of farmers' drought adaptation in the south-west Netherlands. *Regional environmental change*, 15(6), 1081-1093.
- van Houwelingen, J., & Benninga, H. F. (2022). *Waterbalans Overijssel, deelopdracht: Twents Waternet* Retrieved from https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://klimaataadptatienederland.nl/publish/pages/204680/twents-waternet-eindrappport.pdf&ved=2ahUKEwiUioTTz5mHAXWd_rslHY0KCOMQFnoECA8QAQ&usg=AOvVaw0st-9cE_WiGNQpvl3mCpPH
- Van Loon, A., Van Huijgevoort, M., & Van Lanen, H. (2012). Evaluation of drought propagation in an ensemble mean of large-scale hydrological models. *Hydrology and Earth System Sciences*, 16(11), 4057-4078.
- Van Thiel, S. (2014). *Research methods in public administration and public management* (S. P. Osborne, O. Hughes, & W. Kickert Eds.). New York Uitgeverij Coutinho BV.
- Vechtstromen, W. (2022). *Watervisie 2050*. Retrieved from <https://www.vechtstromen.nl/bestuur/watervisie-2050/>
- Vechtstromen, W. (2023). Over ons. Retrieved from <https://www.vechtstromen.nl/over-ons/>
- Wachinger, G., Renn, O., Bianchizza, C., Coates, T., De Marchi, B., Domènech, L., . . . Pellizzoni, L. (2010). Risk perception and natural hazards. *CapHaz-Net WP3 Report*.
- Wandel, J., Diaz, H., Warren, J., Hadarits, M., Hurlbert, M., & Pittman, J. (2016). Drought and vulnerability: A conceptual approach. *Vulnerability and Adaptation to Drought: The Canadian Prairies and South America*, 15-36.
- Wang, H., & Asefa, T. (2019). Drought monitoring, mitigation, and adaptation. In *Extreme hydrology and climate variability* (pp. 457-474): Elsevier.
- Waternet, T. (2019). Droogte. Retrieved from <https://tw.n.klimaatmonitor.net/?urldata=%7B%22theme%22%3A%22%22%2C%22view%22%3A%22public%22%2C%22themeInfoOpen%22%3Afalse%2C%22catalogModalOpen%22%3Afalse%2C%22fullscreen%22%3Afalse%2C%22locationModalOpen%22%3Afalse%2C%22urlDataMap%22%3A%7B%22mapViewport%22%3A%7B%22latitude%22%3A52.6892%2C%22longitude%22%3A5.9%2C%22zoom%22%3A8%7D%2C%22boundingBox%22%3A%220%2C0%2C0%2C0%22%2C%22backgroundLayer%22%3Anull%2C%22popupCoordinates%22%3A%5B%5D%2C%22show3dBuildingLayer%22%3Atrue%7D%2C%22activeLayers%22%3A%5B%5D%2C%22location%22%3Anull%7D>
- Waterschap Vechtstromen. (2023). Haarvaten op Peil. Retrieved from <https://www.vechtstromen.nl/projecten/actuele-projecten/haarvaten-peil/>
- Waterschap Vechtstromen. (2024). *Themaplan klimaat* Retrieved from <https://www.vechtstromen.nl/bestuur/themaplan-klimaat/>
- Wens, M., Johnson, J. M., Zagaria, C., & Veldkamp, T. I. E. (2019). Integrating human behavior dynamics into drought risk assessment—A sociohydrologic, agent-based approach. *Wiley Interdisciplinary Reviews: Water*, 6(4), e1345.
- Wiering, M. (2019). Understanding Dutch Flood-Risk Management: Principles and Pitfalls. *Facing Hydrometeorological Extreme Events: A Governance Issue*, 115-124.
- World Meteorological Organization. (1986). Report on drought and countries affected by drought during 1974–1985. *WMO, Geneva*, 118.
- Zhang, X., Chen, N., Sheng, H., Ip, C., Yang, L., Chen, Y., . . . Rajabifard, A. (2019). Urban drought challenge to 2030 sustainable development goals. *Science of the Total Environment*, 693, 133536.
- Zoetwatervoorziening Oost-Nederland. (2021). Zoetwatervoorziening Oost-Nederland. Retrieved from <https://zoetwatervoorzieningoostnederland.nl/>

Appendixes

A. Participation information sheet

Title of Study:	Perception on drought-risk; and its influence in drought adaptation policies in the municipality of Enschede
University:	Radboud University
Department:	Nijmegen School of Management. Master in Spatial Planning, specialisation Cities, Water and Climate change
Master's student:	L. Meijer

1. Introduction

You have been invited to participate in a scientific research project at Radboud University. Before you decide whether you want to participate in this study, you will receive an explanation of what the study entails. Please read this information carefully.

2. What is the study about?

This study is about the perception on drought-risk within the municipality in Enschede. It is examined whether the perception of different stakeholders influences drought adaptation policy in this city.

3. What is expected of you?

In this study, you will be interviewed by Lotte Meijer. If you consent, an audio recording of this interviews will be made to ensure the accuracy of the study. The recording will be used as research data. An interview will take approximately one hour. In the interview we will ask you questions about your perception on drought-risk within the municipality of Enschede. An example questions is:

- What do you remember from dry periods in the summers of 2018/2022?

4. Voluntary participation

You decide whether to participate in this study. Your participation is voluntary. You may say no at any time. You do not have to answer questions you would rather not answer, and you can stop your participation and withdraw your consent at any time during the study. You do not have to indicate why you are stopping. You can also have your research data and personal data deleted up to two weeks after participation, by sending an email to l.s.meijer@outlook.com.

5. What will happen to my data?

Recordings are deleted as soon as the interview transcript is finished. The interview notes are anonymized, meaning that it is nearly impossible to trace data back to you. We do this by removing all information leading to you as an individual from the research data (such as your name, contact information, or any other mentioned individuals). The main researcher will only work with the anonymous data, which will also be used for scientific articles and presentations. The anonymous data will not be used for other studies unless you give your explicit consent.

6. Consent statement

If you want to participate in this study, we will ask you to sign a consent form. Your written consent indicates that you have understood the information and agree to participate in the study.

7. Do you have any questions about the study?

If you would like to know more about the study or storage of the research data, please contact the main researcher:

Contact details:

Name: Lotte Meijer
Title: Master student spatial planning
E-mail address: l.s.meijer@outlook.com

B. Consent Form

Consent

I have been informed about the purpose of the study. I was able to ask questions about the study. I am participating in the study voluntarily. I understand that I may stop at any time during the study if I wish. I understand what the data will be used for. I agree to participate in the study as described in the information document.

In addition, I consent to (please check the appropriate box):

Yes **No**

Making audio recordings

Storing the audio recordings until the transcript is ready

Name of participant:

Date:

Signature:

Name of researcher:

Date:

Signature:

Thank you for reading this information sheet and for considering taking part in this study.

C. Interview guides

Standard format interview guide

Part 1: general information	
1	Can you describe your function as...
2	To what extent do you deal with drought in your function?
Part 2: Perception on drought(risk) Experience with drought in the past and the consequences of it	
3	Some of the last summers in the Netherlands were very dry (2018,2019,2020,2022). How has your organization experienced these dry spells?
4	Were you prepared for these dry period? If yes, how so? And if not, how come that you were not prepared?
5	Did you experience consequences or effects of these dry periods? If yes, which one? And were you prepared for these effects?
6	Did you notice differences between the province/working area/municipality considering the severity and effects of the dry periods? If yes, which one?
7	How do you look back on these dry periods? What went (not so) well? Did you learn from it?
Definition of drought (risk)	
8	What is your perception on drought-risk? Did you find the recent dry spells acceptable or not? Do you expect drought to occur more often in the future?
9	Do you think that the consequences of these dry periods should be prevented in the future? Or not? If no, why not?
10	What do you think is acceptable? To what extent may drought occur in Enschede/Overijssel? Which consequences of drought are acceptable? And is there a difference made between regions?
11	How does the perception on drought-risk relate to other challenges that require space? Do you think addressing one more important than others? If so, why and how is this manifested? If not, why not?
12	What do you think of current drought policy in the municipality of Enschede/province of Overijssel/water board Vechtstromen? Are you content about it or does it need to change (can it be more ambitious/strict/get more money)? Is drought taken into account enough in current policy?
13	Do you think there is enough attention for drought in the Netherlands/Overijssel/Enschede? And do you think drought-risk is recognized in the Netherlands/Overijssel/Enschede?
Behavior (drought policy and drought adaptation measures)	
14	What is the role of you/your organization in relation to drought adaptation and mitigation?
15	Have there been changes in your organization's policy because of the recent dry summers? If yes, what changes? If no, why not?
16	In what way can your organization/function influence drought policy in the municipality of Enschede?
17	How do you collaborate with other parties in drought management?
18	How do you see the future (how is drought policy going to look like? Do you prepare for extreme dry periods?
Part 3: Enschede's vulnerability towards drought	
19	How vulnerable do you think Enschede is when looking at the geographical aspects?
20	Do you think Enschede will be hit more often and more sever by dry periods in the future? Do you think Enschede is prepared for that? If yes, how? If no, why not?
21	Do you notice instruments in Enschede that can stimulate to tackle drought (financial, knowledge etc.)?
22	Do you also see aspects that can hinder combatting drought in Enschede? If yes, which one?

Additional questions per interview

Interview	1
Organization	Province of Overijssel
Function respondent	Policy officer rural area and water
Additional questions	<ul style="list-style-type: none"> • Can you tell me more about the HOP project and the explorations of raising the groundwater level in the stream valleys in south east Twente (What is going (not so) well in these projects)? Do you experience resistance or support for these projects? • I read in the PPLG especially about raising groundwater levels in the stream valleys and the HOP project. Do you think these things are enough to combat drought in the country estates around Enschede?

Interview	2
Organization	Sustainable rural development foundation Enschede (STAWEL)
Function respondent 1	Rural developer
Function respondent 2	Advisor
Additional questions	<ul style="list-style-type: none"> • What things does STAWEL encounter when trying to mitigate the effects of drought?

Interview	3
Organization	Drinking water company Vitens
Function respondent	Environmental manager
Additional questions	<ul style="list-style-type: none"> • What is the limit for pumping up groundwater in drought-prone areas? When does it endanger the availability for groundwater? • Did Vitens already had to close/move/reduce groundwater extraction in drought-prone areas?

Interview	4
Organization	Foundation Landscape Overijssel
Function respondent	Policy advisor spatial development
Additional questions	<ul style="list-style-type: none"> • Do you think the HOP project will be enough to combat the effects of drought in Enschede? Do you expect may positive or negative effects of the HOP project? • Did you receive resistance or support with already implemented measures combatting drought to achieve nature recovery? Which things are going well? What did you learn?

Interview	5
Organization	Municipality of Enschede
Function respondent	Policy advisor rural area
Additional questions	<ul style="list-style-type: none"> • There are different projects in Enschede (HOP, Broekheurne, raising groundwater in stream valleys). Which things are going well? Do you encounter barriers? • Do you already see results from already implemented measures? • I do read especially about HOP and stream valleys in the municipality's vision rural area. Do you think it is enough to combat drought?

Interview	6
Organization	Municipality of Enschede
Function respondent	Communication advisor climate adaptation

Additional questions	<ul style="list-style-type: none"> • What did you experience among citizens during the dry spells? Do you think the dry periods caused more awareness about drought-risk? • To what extent are citizens involved in combatting drought? How important do you think it is to involve citizens? And how is that going so far? • Do you stimulate citizens to take measurements themselves to combat drought? If yes, how? And does dis work? • What do you experience among citizens when their environment is changed/upgraded?
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Interview	7
Organization	Municipality of Enschede
Function respondent	Water designer
Additional questions	<ul style="list-style-type: none"> • Do you think the ambitions in the water and climate adaptation plan/ the vision rural area are also pursued for in practice? Do you see differences between urban and rural areas? • There are different projects in Enschede (HOP, Broekheurne, raising groundwater in stream valleys). Which things are going well? Do you encounter barriers? • Do you notice water and green being subordinated to other functions that require space? Or the opposite? • You work with risk based management in Enschede: do you have clear already where the biggest risk lie in the field of drought? Which consequences are accepted there? How do you make sure the biggest risks are prevented? And are you convinced that it will work?

Interview	8
Organization	Municipality of Enschede
Function respondent	Green designer
Additional questions	<ul style="list-style-type: none"> • Do you think the ambitions in the water and climate adaptation plan/ the vision rural area are also pursued for in practice? Do you see differences between urban and rural areas? • Do you notice water and green being subordinated to other functions that require space? Or the opposite? • You work with risk based management in Enschede: do you have clear already where the biggest risk lie in the field of drought? Which consequences are accepted there? How do you make sure the biggest risks are prevented? And are you convinced that it will work?

Interview	9
Organization	Waterboard Vechtstromen
Function respondent	Project leader
Additional questions	<ul style="list-style-type: none"> • Do you think the ambitions in provincial/municipal policy are also pursued for in practice? • Do you notice water and green being subordinated to other functions that require space? Or the opposite? • The water vision is about establishing a new water balance for the water system and adapting within functions. What is required to achieve this? What role should the municipality/province take in this? What obstacles do you foresee?

	<ul style="list-style-type: none"> How do you intend to ensure a better balance between 'keeping dry feet' and minimizing flooding?
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Interview	10
Organization	Municipality of Enschede
Function respondent	Water designer
Additional questions	<ul style="list-style-type: none"> Do you think the ambitions in the water and climate adaptation plan/ the vision rural area are also pursued for in practice? Do you see differences between urban and rural areas? There are different projects in Enschede (HOP, Broekheurne, raising groundwater in stream valleys). Which things are going well? Do you encounter barriers? Do you notice water and green being subordinated to other functions that require space? Or the opposite? You work with risk based management in Enschede: do you have clear already where the biggest risk lie in the field of drought? Which consequences are accepted there? How do you make sure the biggest risks are prevented? And are you convinced that it will work?

Interview	11
Organization	Foundation Overijssel private land ownership (OPG)
Function respondent	Director and water portfolio manager
	<ul style="list-style-type: none"> There are different projects in Enschede (HOP, Broekheurne, raising groundwater in stream valleys). To what extent are you involved in this? Which things are going well? Do you think this is enough to combat drought?

Interview	12
Organization	Municipality of Enschede
Function respondent	Urban designer
Additional questions	<ul style="list-style-type: none"> Do you think the ambitions in the water and climate adaptation plan/ the vision rural area are also pursued for in practice? Do you see differences between urban and rural areas? There are different projects in Enschede (HOP, Broekheurne, raising groundwater in stream valleys). Which things are going well? Do you encounter barriers? Do you notice water and green being subordinated to other functions that require space? Or the opposite?

Interview	13
Organization	Municipality of Enschede
Function respondent	Policy advisor climate adaptation
Additional questions	<ul style="list-style-type: none"> Do you think the ambitions in the water and climate adaptation plan/ the vision rural area are also pursued for in practice? Do you see differences between urban and rural areas? There are different projects in Enschede (HOP, Broekheurne, raising groundwater in stream valleys). Which things are going well? Do you encounter barriers?

	<ul style="list-style-type: none"> • Do you notice water and green being subordinated to other functions that require space? Or the opposite? • You work with risk based management in Enschede: do you have clear already where the biggest risk lie in the field of drought? Which consequences are accepted there? How do you make sure the biggest risks are prevented? And are you convinced that it will work?
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Interview	14
Organization	Municipality of Enschede
Function respondent	Neighborhood manager
Additional questions	<ul style="list-style-type: none"> • How are the ambitions in the water and climate adaptation plan/ the vision rural area pursued for in practice? • Do you notice water and green being subordinated to other functions that require space? Or the opposite?

D. Coding scheme

Deductive coding: black. Inductive coding: blue

Drought experience	<ul style="list-style-type: none"> • Wake-up call or not • Effects of past dry periods <ul style="list-style-type: none"> ○ Nature ○ Drinking water ○ Agriculture ○ Other effects 	<ul style="list-style-type: none"> • Lessons learned from past dry periods • Changes because of past dry periods • Preparation for past dry periods
Drought memory	<ul style="list-style-type: none"> • Periods of drought that hit Enschede 	<ul style="list-style-type: none"> •
Drought definition	<ul style="list-style-type: none"> • Acceptability of drought • Acceptability of the effects of drought • Definition of drought • Priority in relation to other topics 	<ul style="list-style-type: none"> • Perception on current drought policy • Attention to drought • Recognition of drought
Drought behaviour	<ul style="list-style-type: none"> • Collaboration/conflicts with other organisations <ul style="list-style-type: none"> ○ Water authority Vechtstromen ○ Municipality of Enschede ○ Province of Overijssel ○ Stawel ○ OPG ○ Vitens drinking water company ○ Foundation Landscape Overijssel ○ Farmers ○ Citizens ○ National government ○ Twents Waternet • Future plans <ul style="list-style-type: none"> ○ System change 	<ul style="list-style-type: none"> • Current drought policy <ul style="list-style-type: none"> ○ Zoetwatervoorziening Oost Nederland ○ Policy implementation in practice ○ Haartvaten op Peil ○ Balance drought and water nuisance • Actions during past dry periods
Vulnerability of Enschede	<ul style="list-style-type: none"> • Exposure • Expectation of drought in the future • Sensitivity • Geographical aspects <ul style="list-style-type: none"> • Lateral moraine • Sandy soil • Boulder clay • Water supply • Textile history 	<ul style="list-style-type: none"> • Economic resources • Technology • Human capital • Social capital • Infrastructure • Current water system • Institutional capital • Politics