Urban Climate Adaptation in Water Management Policy: Implementation of Measures at Regional Water Authority Zuiderzeeland

Master's Thesis - master Water Science & Management

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Date	29 September 2020
Words	10637

Abstract

The climate is changing, and the impact of these changes is affecting countries and communities globally. In 2018 the Delta Plan on Spatial Adaptation was created with the aim of establishing a climate-proof and water-robust country. This thesis aims to analyze what the role of regional water authorities is in the process of climate adaptation, and what factors and measures account for an effective climate adaptation policy to help ensure a water robust and climate proof urban environment.

This thesis combines results from a literature study on climate adaptation measures and their successful implementation with a case study of the current situation at regional water authority (RWA) Zuiderzeeland. The current climate adaptation measures at the RWA are explored, as well as the adaptation measures that can be found in scientific literature. The literature study shows that urban climate adaptation measures can be divided into multiple categories, such as blue, green and gray, or physical and non-physical. The case study reveals that, while the concept of climate adaptation is present in many of the policy documents at Zuiderzeeland, detailed objectives are lacking. It is still in its infancy.

The current measures are discussed in terms of their effectiveness, as well as factors that might contribute to or hamper the effectiveness of climate adaptation measures. According to employees of Zuiderzeeland, the current situation is not very acute in Flevoland, and so the current set of measures seems to be effective. For getting ahead, however, the tools are lacking. Integration of the issue, formulation of clear goals, public and internal awareness about climate adaptation, and cooperation with private actors can all be improved. Resources such as staff, funds, and knowledge generally seem to be sufficient.

For an urban area, introducing visible multifunctional green and blue measures combined with more robust gray measures provides an effective set of physical climate adaptation measures. For non-physical measures improving guidelines for regulation, increasing awareness and education, and gathering knowledge and setting guidelines about vulnerabilities and acceptance of risks are some suggestions.

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1. Introduction

1.1 Climate adaptation

The climate is changing, and the impact of these changes is affecting countries and communities globally. The Netherlands as a country is especially vulnerable to climate change such as flooding, as close to one third of the country lies below the mean sea level (Oude Essink, van Baaren & de Louw, 2010), including many of the largest urban centers. Another threat that accompanies climate change is the more frequent occurrence of extreme weather events, where there may be excess precipitation or a shortage of (fresh) water over a longer period (Stocker et al., 2013). Without sufficient drainage, the excess water can become a nuisance and cause local pluvial or fluvial flooding. Drought in turn may lead to a decrease in water quality, increased salinization, hinder for navigation using waterways, amongst many other consequences (Prinsen et al., 2015).

After the North Sea flood of 1953, it was determined that the country needed better protection against floods (Rijksoverheid, 2019). At the beginning of this century, new insights regarding climate and societal changes led to expansion on these ideas (Rijksoverheid, 2019). To ensure the Netherlands remains protected from floods, freshwater shortages, and the effects of extreme weather events, the Delta Commission was set up. Each year this commission creates a Delta Programme, where plans regarding the safety of water in the Netherlands are developed, proposing a safe and attractive living environment, and effective management of fresh water supply, flood risk management and spatial planning (Prinsen et al., 2015).

In 2018 a special plan was created as part of the Delta Programme, the Delta Plan on Spatial Adaptation (Kennisportaal Ruimtelijke Adaptatie, 2020-b). It is a joint plan drafted by municipalities, regional water authorities (RWAs), provinces and the central government with the aim of establishing a climate-proof and water-robust country. There are seven ambitions included that structure the plan, which can be seen in figure 1.

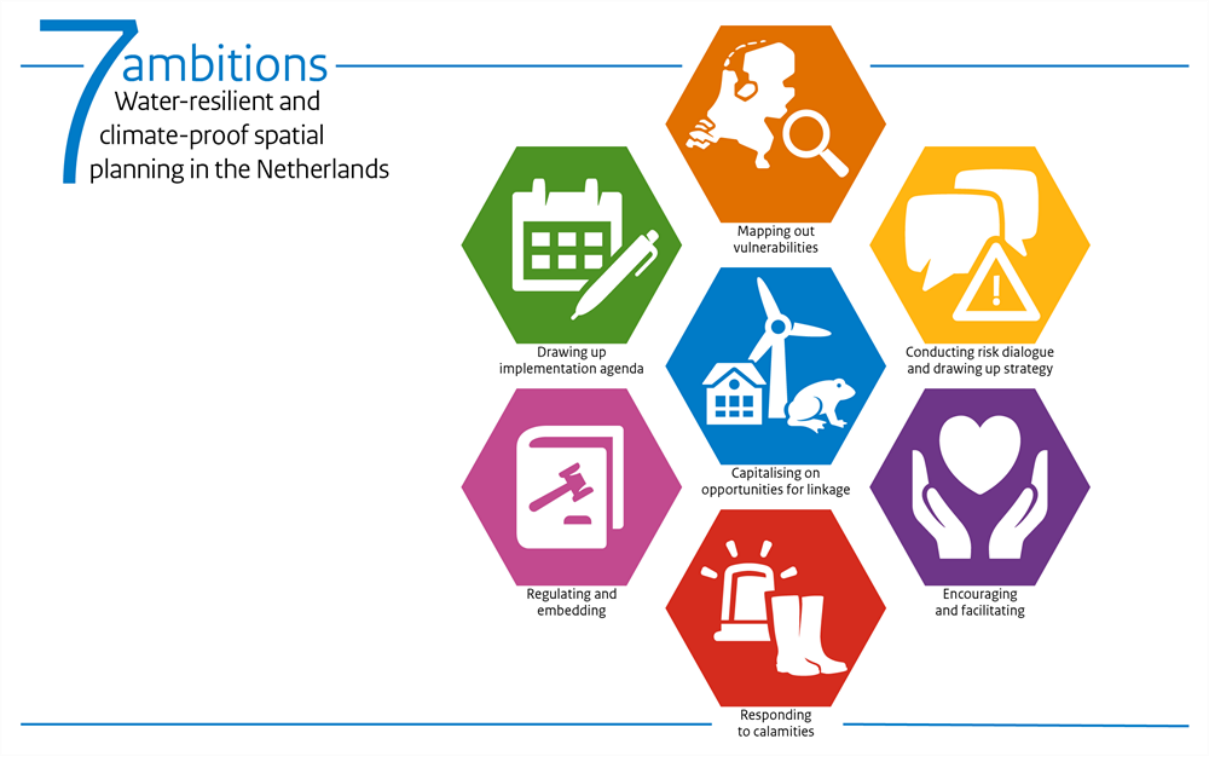

Figure 1: Seven ambitions in the Delta Plan on Spatial Adaptation (Kennisportaal Ruimtelijke Adaptatie, 2020-b)

1. *Mapping out vulnerabilities*

The Delta Plan distinguishes four different climate themes: waterlogging, drought, heat, and urban flooding (Kennisportaal Ruimtelijke Adaptatie, 2020-d). To understand what the vulnerabilities are in our cities and rural areas for these four climate themes, stress tests were conducted by the responsible governments, finished in 2019 at the latest as required by the Deltaplan (Kennisportaal Ruimtelijke Adaptatie, 2020-a). These stress tests consist of collection information on the effects that certain stresses, in this case the effects of climate change, may have on an area and its vital functions. By doing this, locations and situations of bottlenecks can be discovered.

2. *Conducting risk dialogue and drawing up strategy*

After the stress tests have been conducted, a risk dialogue is conducted between municipalities, regional water authorities, provinces and the central government, together with other relevant stakeholders in the affected area (Kennisportaal Ruimtelijke Adaptatie, 2020-b). Through this dialogue the involved stakeholders become aware of the vulnerabilities, and possible measures to minimize these vulnerabilities are discussed.

3. *Drawing up implementation agenda*

The next step towards realizing measures is to make agreements regarding the execution of the measures to be taken (Kennisportaal Ruimtelijke Adaptatie, 2020-b).

4. *Capitalizing on opportunities for linkage*

Especially in urban areas, it is important to use planned renovations and construction with other goals such as green energy to implement the actions for the Delta Plan on Spatial Adaptation (Kennisportaal Ruimtelijke Adaptatie, 2020-b). Since in these crowded urban centers large-scale construction is not always efficient, for all spatial development there should be an aim for creating a climate adaptive environment.

5. *Encouraging and facilitating*

Sharing of knowledge and experience in the process of creating a climate-proof living environment is important (Kennisportaal Ruimtelijke Adaptatie, 2020-b). By making everyone aware of spatial adaptation, the process of implementing it is becomes easier.

6. *Regulating and embedding*

To ensure that the Netherlands reaches the goal of being climate-proof in 2050, there is a need for regulation with regards to spatial adaptation and planning of our living environment (Kennisportaal Ruimtelijke Adaptatie, 2020-b). This can be done by the central government through laws, plans, and standards.

7. *Responding to calamities*

Despite taking measures to minimize vulnerabilities, there is always a chance that an extreme event occurs (Kennisportaal Ruimtelijke Adaptatie, 2020-b). It is essential that we are prepared in such a scenario to protect vital infrastructure

1.2 The role of regional water authorities

In the process of spatial adaptation, regional water authorities are involved for the area under their management. A water authority is responsible for providing safety from flooding, and sufficient and clean water (Waterschap Zuiderzeeland, 2020-b). These tasks are interlinked with

the goals of the Delta Plan on Spatial Adaptation, so that the regional water authority can fulfill its core tasks even when the climate and society are changing.

Scientific literature on the topic of regional water authorities in relation to climate adaptation is scarce. Kamperman & Biesbroek (2017) discuss that while climate adaptation has become more prevalent in plans of RWAs, it is all very much in the starting phase of determining that measures should be taken, and where vulnerabilities lie. Additionally, progress differs amongst the multiple RWAs in the Netherlands, leading Kamperman & Biesbroek (2017) to conclude that 'soft' policy instruments might not be enough to ensure a climate adaptive future.

The responsibility of preparing for and dealing with climate change risks often lies largely with municipalities or provincial politicians (Runhaar et al., 2012). Plans that are related to spatial development and more particularly with alteration to the water system, are designed in cooperation with regional water authorities. The issue herein, according to Runhaar et al., (2012) lies in the fact that recognizing the need for climate adaptation measures is limited amongst planners, and so is the attention given to this adaptation. Climate adaptation is often either legally required, or a secondary argument for implementing measures in addition to spatial quality. Barriers to recognizing the problem of climate adaptation and implementing measures are found to be lack of knowledge and sense of urgency, institutional fragmentation, inflexibility of existing urban areas, and a lack of resources (Runhaar et al., 2012). The institutional fragmentation and lack of agreement amongst actors is a reoccurring aspect in literature on climate adaptation. Van Buuren et al. (2015) conclude that in order to make flexible arrangements that are suitable for dealing with climate risks, involving local actors might be a solution. In a case example of this, stakeholders were involved in workshops to exchange knowledge about the area and ideas for possible adaptation measures (Brouns et al., 2014).

The role of RWAs remains unclear, and while involvement of and cooperation between stakeholders seems to be a key element of climate adaptation, many uncertainties remain. There needs to be a shift away from simply mapping out vulnerability and policy recommendations, to concrete implementation of climate adaptation measures.

1.3 Knowledge gap

While there is a lot of literature on climate adaptation measures and their effectiveness, there is limited research on the role of regional water authorities in mainstreaming climate adaptation. It is clear the RWA has an obligation to ensure security, sufficient, and good quality water, and

it might play a role during multiple stages of the climate adaptation process. For the sake of timely implementation and motivating stakeholders to take action, it needs to be clear in what ways regional water authorities can implement climate adaptation measures in their policy. There is no clear academic literature on specific climate adaptation measures to be taken by RWAs in the Netherlands, and how these can be implemented in an effective policy. This thesis aims to contribute to this academic debate by providing a comprehensive overview of factors that account for an effective climate adaptation policy of regional water authorities by assessing the current state of climate adaptation, specific climate adaptation measures, and ways to implement these measures into their policy.

Zuiderzeeland and its management area in particular are interesting to examine, as the area consists of polders and is largely artificially constructed land. This means that an effective climate adaptation strategy is all the more important, as the area is very vulnerable should something go wrong.

1.4 Problem description

As stated previously, the state of climate adaptation policy at regional water authorities is limited. Existing research is often done only after measures have been implemented, or analyzes the current state of climate adaptation policy while making general suggestions for the future. There is however a lack concrete knowledge of implementing climate adaptation into an effective policy. Comprehensive analyses of regional water authorities and their implementation of climate adaptation measures are needed to help advance the debate on climate adaptation policy.

With a changing climate it is especially important further into the future to protect the people and assets located in urban areas. It is therefore essential that urban climate adaptation is sufficiently included in the policy and practice of regional water authority Zuiderzeeland.

Zuiderzeeland has several instruments that help them reach the goal of creating a climate-proof and water-robust living environment. One important instrument is the ‘Watertoets’, which can be directly translated to ‘water test’. With this tool initiators can determine in what ways their plans for spatial development have to take into account the existing water system (Waterschap Zuiderzeeland, 2020-a). For example, when an initiator wants to create a new neighborhood or business park, there will be a certain area of newly impermeable surface, where water can no longer infiltrate into the ground. This has effects on the water system and in some cases, needs to be compensated (College van Dijkgraaf &

Heemraden, 2013). This compensation is currently advised to be in the form of newly created surface water according to the Waterkader from 2013 (College van Dijkgraaf & Heemraden, 2013). This strategy, however, is not as easily implemented in already existing urban areas, where there is limited room for open water. In this case, other solutions are required to ensure that water can infiltrate or drain quickly.

1.5 Research aim and questions

The aim of this research is to explore the possibilities regional water authorities have to develop and implement effective climate adaptation policies, so that they continue to function well and protect urban environments from negative climate change effects. The case of Zuiderzeeland is studied in this paper to determine the current state of climate adaptation policy at a regional water authority in the Netherlands, and an advice will be given to Zuiderzeeland for integration of climate adaptation in their policy. To this end, the following research question and sub-questions will be answered in the paper:

"What measures and factors account for an effective climate adaptation policy of regional water authorities to help ensure a water robust and climate proof urban environment in 2050?"

1. What measures can be found in literature on climate adaptation?
2. To what extent are climate adaptation measures currently taken by Zuiderzeeland?
3. To what extent are the current measures effective?
4. What factors account for the current measures and the level of effectiveness?
5. What extra measures could be chosen?
6. In what way can these extra measures be incorporated in the policy of Zuiderzeeland?

1.6 Research framework

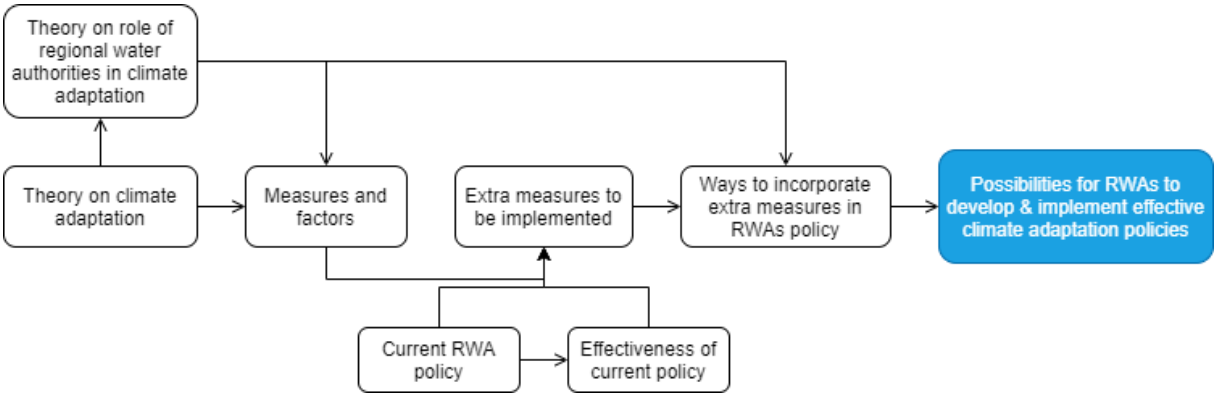

Figure 2:Research framework of the project that illustrates the steps to be taken to attain the goal

2. Theoretical background

2.1 Retain-store-drain

In the year 2000 the Commission Water Management 21st Century published a report in which an advice was outlined for the government and regional water authorities regarding water management for the upcoming century (Commissie Waterbeheer 21e eeuw, 2000). The main idea behind the report is that the focus needed to shift from mainly technical, to a more broad and adaptive strategy to deal with water (Ritzema & Loon-Steensma, 2018). Before, the approach was to increase the drainage capacity only, and with this report the approach shifted to draining or removing only when retaining or storing the water is not sufficient (Ritzema & Stuyt, 2015; van Overloop, 2006). Water does not need to be controlled at all times, but it should be given space in our nature and urban development (Commissie Waterbeheer 21e eeuw, 2000).

In this report a so-called 'three-step strategy' was suggested (see figure 3), for it to become mandatory for governments later on (Commissie Waterbeheer 21e eeuw, 2000). The three steps should be followed when choosing measures to prevent damages from excess water or drought.

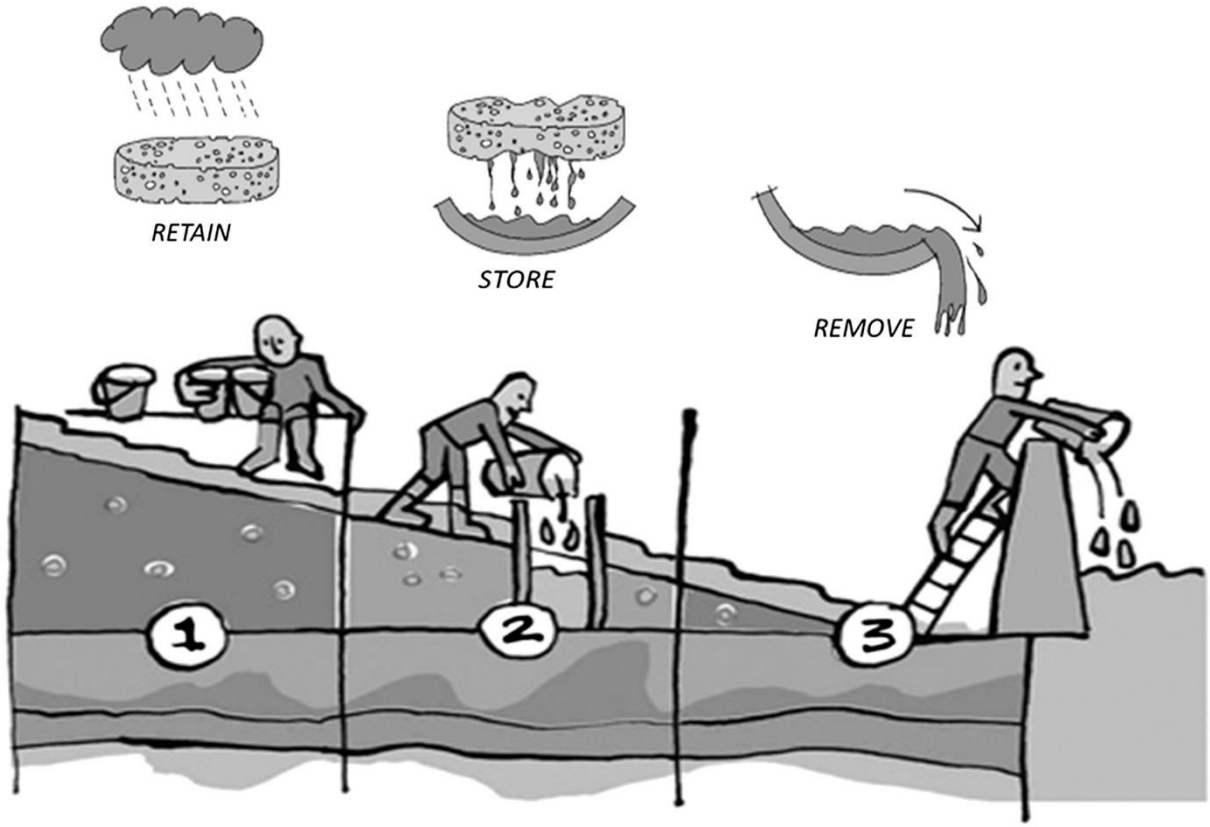

Figure 3: The new water management approach: retain, store, and only then remove (Ritzema & Stuyt, 2015).

1. *Retain* – The first step is to retain as much water as possible upstream in the soil and surface water
2. *Store* – If required, for example during long and intense precipitation events, store water in the main waterways or by inundating designated areas alongside the waterways
3. *Drain/remove* – If retaining or storing the water is no longer possible, the water should be drained in a controlled manner

The steps are focused on keeping the water at or close to the source (van Bakel et al., 2002). This prevents an accumulation of runoff further downstream, where it may cause problems. The aims of this strategy are to both reduce peak discharges during intense precipitation, and to store water for periods with a lack of precipitation causing water stress (Ritzema & Stuyt, 2015).

Controlled drainage may help with controlling the groundwater level, controlling the outflow of a water system, lowering peak discharges, and better use of water (Ritzema & Stuyt, 2015). In rural environments there is the additional benefit of reducing leaching and thus better use of applied nutrients.

2.2 Challenges in an urban environment

The challenges in urban environments can be divided amongst the four climate themes from the Delta Plan on Spatial Adaptation: waterlogging, drought, heat, and urban flooding (Deltacommissaris, 2018-a). On an urban or neighborhood scale, measures against flooding will be less important compared to the other problems. This is because protection against flooding is organized on a larger scale, outside specific areas in cities. The other three themes do pose problems for urban environments

Water generally has three destinations after it falls down as precipitation: it can infiltrate into the ground, evaporate or be transpired by trees into the air, or runoff over the land surface, which can also be seen in figure 2. In built-up urban areas a large share of the land surface is covered by buildings, roads and parking spaces (Mohajerani et al., 2017). These structures are often mostly impermeable to water, meaning that if precipitation falls on these surfaces, it cannot directly drain into the soil below (Sterling et al., 2013; Xu et al., 2020). A significantly larger share of the water will become runoff, as is pictured on the right side of figure 4 (United States Environmental Protection Agency, 2003). This can lead to water storage on the streets during peak moments and even urban flooding (Xu et al., 2020).

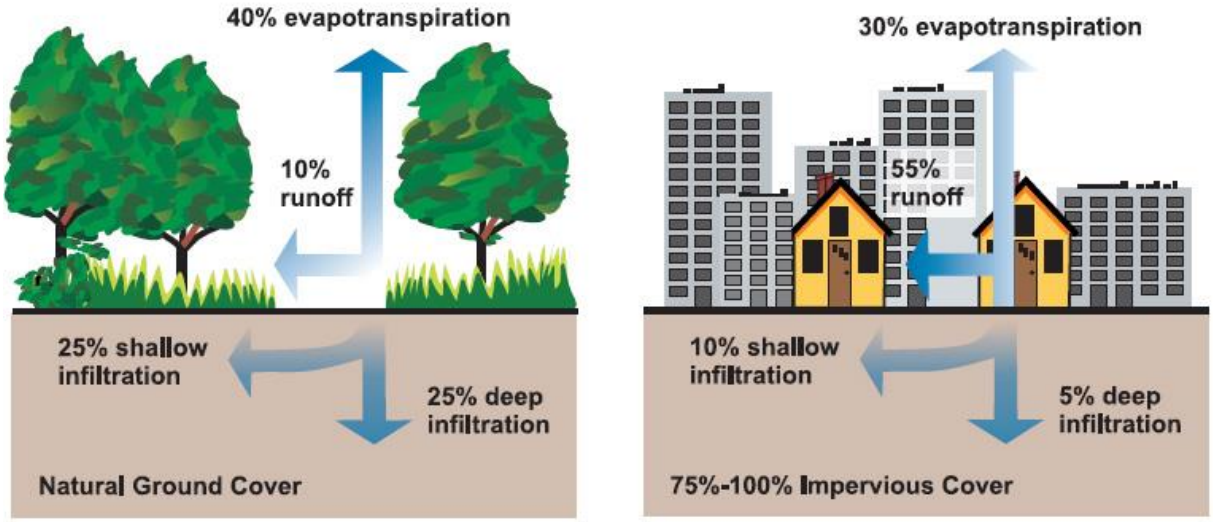

Figure 4: Effect of impermeable land cover on surface runoff (United States Environmental Protection Agency, 2003)

Another problem in urban environments that can be aggravated by climate change is the Urban Heat Island effect (UHI). The cause of this problem also partly lies in the increase of man-made materials, together with an increased production of heat from human sources such as cars (Mohajerani et al., 2017). The largest share of urban surfaces that are exposed to radiation from

the sun are roofs and roads or pavements. These surfaces generally have a low albedo, that is to say they absorb most of the solar irradiation (Mohajerani et al., 2017). The part they do reflect, is often redirected to another urban surface, due to high structures. When the dark materials absorb the radiation, their temperature rises. The surface materials in turn radiate this absorbed energy, heating up the air in the urban area. The heating of urban areas is a threat to the habitability. With climate change causing global warming, this effect is increased.

Finally, drought is not so much an urban-specific problem, but the effects for these areas can be severe, especially with increasingly frequent periods of drought (Ray & Shaw, 2019). In cities there is a high demand for essential freshwater, such as for drinking water and economic activities.

Due to changing precipitation patterns, both instances of intense precipitation, and drought and heat are expected to occur more frequently. Ideally, spatial adaptations for these four climate themes solve multiple issues at once, since the literal and figurative room for new developments in densely developed urban centers is limited.

2.3 Urban climate adaptation measures

On the topic of effectiveness of climate adaptation measures much research has been published in recent years. Voskamp & van de Ven (2015) scored adaptation measures on whether they are effective for storage, reducing runoff, infiltration and cooling. They acknowledge that adaptation measures may differ for each specific location.

Urban water management measures related to climate adaptation can help to reduce the amount of water on streets during precipitation events, provide a source of freshwater for periods of drought, or help cool the environment through evapotranspiration.

An example of measures that contribute to all these goals, is ‘green infrastructure’ (GI) (Liu & Jensen, 2018). These are green spaces in an urban environment such as gardens, trees, and parks, which have proven to be effective in reducing temperature in cities (Klemm, Lenzholder & Brink, 2017). GI requires space to create it; in urban areas this implies that previously paved surfaces need to be removed in order to make room for these green elements. In cases where the possibility to replace existing infrastructure is not present, vertical movement of measures can be realized. A green roof, where a substrate is placed on top of a roof, can help with both limiting runoff and cooling (Jim, 2015). Infiltration crates that are placed underground create an underground water storage, from which water can slowly percolate into

the deeper soil (Claessens et al., 2014). This last measure is mostly effective against waterlogging and drought, and not as much for cooling due to its location underground.

For waterlogging, there are two effects that a measure can have. Often the goal is reducing the peak runoff flow as a result of precipitation (Liu & Jensen, 2018). Another impact that a measure can have, is reducing the total time that water is present on streets. This means that while initially there may be more water present, it will be removed faster. These effects are not exclusive, and measures can contribute to both.

2.4 Implementation of climate adaptation

There are several strategies for effectively implementing climate adaptation into policy. The focus in this research will be on 'mainstreaming', in recent literature considered to be an alternative way of policymaking (Boezeman & de Vries, 2019; Brouwer et al., 2013; Runhaar et al., 2018; Uittenbroek, 2016; Uittenbroek et al., 2013; Veraart et al., 2014). The term 'policymaking' is perhaps somewhat misplaced, as the concept of mainstreaming refers to integrating climate adaptation into already existing policy and practice (Runhaar et al., 2018). This goal fits with the ideas in the Delta Plan on Spatial Adaptation, in that climate adaptation should not be considered separate from everything else, but instead be taken into account during all development planning, so that development activities are not as vulnerable to future climate changes (Brouwer et al., 2013). Mainstreaming applies not only to governmental organizations, but also to private stakeholders (Boezeman & de Vries, 2019).
Klein et al. define mainstreaming as follows:

> "Mainstreaming involves the integration of policies and measures to address climate change into ongoing sectoral and development planning and decisionmaking, so as to ensure the long-term sustainability of investments as well as at reduce the sensitivity of development activities to both today's and tomorrow's climate" (2005).

The concept of mainstreaming will also be applied when discussing options for implementing climate adaptation at regional water authority Zuiderzeeland. To this end, first the current policy needs to be analyzed and understood, after which (further) integration of climate adaptation measures is possible.

3. Methodology

3.1 General approach

The approach for each sub-question differs. The first sub-question consists of a literature review about measures that can be found in climate adaptation academic literature. The second sub-question, which focuses on the current climate adaptation measures taken by Zuiderzeeland, will be analyzed through a review of policy documents, plans, and instruments from both the regional water authority Zuiderzeeland as well as the broader national framework of policy in which the policies of the regional water authority are situated. The third and fourth sub-question will be answered through combining the review of policy from the previous question, as well as interviews with employees of Zuiderzeeland and reports on climate adaptation in Flevoland, such as the results of climate stress tests that were conducted. The fifth and sixth questions are discussed based on the results of the other sub-questions on climate adaptation measures and current policy, in combination with scientific literature on mainstreaming and other governance strategies. Possible options to integrate measures into existing policy and practice are explored. Here the focus is not just on implementation, but also how the implemented measures can be secured in the registry. This last part is important to ensure that maintenance of measures is properly observed and that it can be regulated. Integrating the answers to the sub-questions leads to an overview of the factors that account for an effective climate adaptation policy for regional water authorities.

3.2 Analytical framework

3.2.1 Climate adaptation measures

In this research, climate adaptation measures in scientific literature and policy are considered actions to be taken by either the regional water authority itself or another actor (as instructed by the regional water authority), with the goal of limiting the negative effects of climate change, more specifically drought, heat, waterlogging and flooding. Climate adaptation measures may not explicitly be described with terms such as climate. This research limits climate adaptation measures to those that have minimizing drought, heat, waterlogging or flooding as (one of) the primary goal(s). Measures that unintentionally contribute to minimizing these effects, are not the focus of this research.

3.2.2 Effectiveness vs. efficiency of measures

Effectiveness is considered to be the extent to which a climate adaptation measure affects the four climate adaptation themes drought, heat, waterlogging and flooding. This is measured quantitatively and qualitatively, depending on the measure. The quantitative effect can be either absolute, e.g. the water storage capacity in mm/m^2, or relative, such as the percentage reduction in air temperature. Perceived effectiveness of measures by people is more qualitative in nature, and more related to whether the presence of a measure in policy actually contributed to the climate themes.

Effectiveness does not take into account the cost of measures in terms of time and/or money. In this research, effectiveness is the main indicator for climate adaptation measures. Efficiency is however still discussed, as this is especially relevant for a regional water authority when looking at which measures to implement in policy. The efficiency is more broad and does include factors such as time and money.

3.2.3 Difference between measures and factors

For the purpose of this research, a distinction has been made between the climate adaptation measures and the factors that determine their effectiveness. Sometimes, these factors and measures seem to be very similar. The distinction made is that the factors are the current state, and that measures are specifically actions that are taken to alter the state. An example would be the difference between public awareness, which is a factors, and *increasing* public awareness, which is a measure.

3.3 Data collection and analysis

3.3.1 Scientific literature

For the first phase of the research a literature study is conducted. Papers and reports on climate adaptation, measures, the role of regional water authorities, and policy implementation are to be collected to complete a theoretical framework which can be used to compare current climate adaptation at Zuiderzeeland to possible measures, determine what factors are relevant for effective climate adaptation measures, and how to implement extra measures.

This literature is acquired through databases such as Google Scholar and Scopus. Keywords that are used to search for relevant literature are the following:

Climate adaptation; Climate change; Climate policy; Flevoland; Green infrastructure; Green measures; Governance; Implementation; Integration; Mainstreaming; Measures; Netherlands; Regional water authority; Urban areas; Urban planning; Water board; Water management.

With the above search terms, a start set of literature is created, based on the ideas of snowballing as determined by Woblin (2014). This start set includes papers from multiple disciplines, such as water management, sustainable development, (urban) planning, and governance. Additionally, a diverse start set is created by including papers from a variety of publishing years and publishers or journals. As the topic is quite broad literature searches tend to generate many results, and thus the amount of references to a specific paper is also taken into account when selecting the start set. If the start set is complete, backward snowballing is used by using the reference lists of the start set literature to gather other relevant publications.

3.3.2 Policy documents and plans

At Zuiderzeeland most policy documents are available through their website. In addition, some policies are still being developed alongside this paper, such as a climate agenda, partially a response to the Delta Plan on Spatial Adaptation. The online availability is also the case for national policies and plans that are required. Examples of relevant policy documents are the Waterkader (College van Dijkgraaf & Heemraden, 2013) and the Waterbeheerplan (Waterschap Zuiderzeeland, 2015).

Some instruments exist that help Zuiderzeeland in executing their policy. The most relevant tool for this research is the ‘Watertoets’ or ‘water test’. With this tool, spatial plans can be tested to see if measures should be taken regarding the existing water system. This tool is also analyzed as part of the policy review.

3.3.3 Semi-structured interviews

To help answer the question of effectiveness of current climate adaptation measures at Zuiderzeeland, semi-structured interviews are conducted amongst employees of the RWA. The focus will be on the division “Ontwikkeling, Advies en Regie” (Development, Advice, and Direction). Additionally, colleagues from Hydrology and Water Management are interviewed. These interviews will focus on the knowledge and perceived effectiveness of measures present in the current policy of Zuiderzeeland, which have been explored and collected in previous steps of the research. Additionally, several other factors as introduced by Runhaar et al. (2018)

on successful mainstreaming are questioned, such as the cooperation, available resources, and general awareness at the regional water authority.

From these interviews the effectiveness of measures and the factors that determine this effectiveness are explored. The results of the different factors are processed in NVivo and are used to determine what could be improved upon to successfully implement new measures in an effective policy.

Factor categories

The factors that determine the effectiveness of measures and their implementation are divided into six categories. These categories as well as the factors are rated based on the interviews conducted with employees of regional water authority Zuiderzeeland.

1. Cognitive
    - Level of awareness at Zuiderzeeland
    - Sense of urgency at Zuiderzeeland
    - Uncertainty as a problem
2. Resources:
    - Available staff to work on the issue of climate adaptation
    - Sufficient financial resources to work on the issue of climate adaptation and implement measures
    - Available knowledge & expertise at Zuiderzeeland
3. Characteristics of the issue:
    - Climate adaptation as a separate issue or integrated in other processes
    - Clear and detailed goals regarding climate adaptation for Zuiderzeeland
4. Organizational
    - Cooperation between colleagues and departments at Zuiderzeeland
    - Cooperation with municipalities and other governmental agencies
    - Cooperation with private actors
    - Clear responsibilities of Zuiderzeeland within cooperation strategies
    - Incentives to take climate adaptation actions
5. Political
    - Level of public awareness in the management area

- Level of public support in the management area
- Alignment of law and regulation framework with adaptation goals

6. Timing
    - Presence of current events that help or hamper climate adaptation
    - Action taken based on current events

Rating of factors

One of three possible ratings is given to each of the factors:

- -- Not present or very limited
- - Present but can be improved
- + Present and little to no improvement required

Multiple scores can be given to the same category when there are large differences depending on the person or department.

4. Results

4.1 Overview climate adaptation measures in scientific literature

In academic literature a wide variety of studies on climate adaptation measures can be found. However, studies use different approaches when classifying measures into separate categories. Other studies merely focus on one specific problem to be solved such as … or …. In this chapter scientific literature on climate adaptation is reviewed in an attempt to obtain an overview of climate adaptation measures and to define them consistently and categorize them in clear classes and categories.

4.1.1 Physical and non-physical measures

When considering measures for adapting to climate change, physical measures likely come to mind. This is what the focus often has been on when considering climate adaptation measures (Dilling et al., 2019). These physical measures may also be called structural measures (Birkmann et al., 2010), although the same term is used differently to refer to the systemic nature of implemented measures (Dannevig et al., 2012). A third term used to refer to physical adaptation measures in literature is infrastructure (Derkzen et al., 2019; Jones & Somper, 2014; Klemm et al., 2017; Zhou et al., 2019). As the name suggests, physical or structural climate adaptation measures in this case consist of structures that are built, or removed, in our living environment, to help reduce the effects of climate change impact. This type of measure can for example be a flood barrier such as a dyke, a drainage system for (excess) rain water, or urban green space (Birkmann et al., 2010). They generally require some alteration of the physical infrastructure, and are in contrast to non-structural measures.

The non-structural measures have a social component and consist of changes in regulations and planning (Birkmann et al., 2010). Examples of non-structural measures are increasing public awareness, changing behavior, warning systems in case of a threat, and rules regarding the use of water (Birkmann et al., 2010). An advantage of non-structural adaptation measures is that they generally engage the local citizens more actively (Chan et al., 2020).

Generally, a combination of both structural and non-structural measures is advised (Birkmann et al., 2010; Chan et al., 2020, Kundzewicz, 2002). This is especially important due to the fact that structural measures, although designed to protect even in case of extreme events, may fail, in which case the population needs to be aware and prepared to deal with the consequences (Kundzewicz, 2002).

4.1.2 Blue, green and gray measures

The concept of green infrastructure which has been discussed previously is also part of a distinction between climate adaptation measures. Green infrastructure is considered as structural measures according to the classification by Birkmann et al. (2010). The other types of physical measures are gray and blue. Gray measures consist of concrete structures, like above and underground drain pipes and dams, whilst blue and green measures utilize natural functions of water and vegetation for adaptation benefits (Müller et al., 2014; Voskamp & Van de Ven, 2015). In literature sometimes other terminology is used that can fit within the blue/green categorization, such as 'urban water bodies' (Sun & Chen, 2012), 'urban forests' (Ordóñez Barona & Duinker, 2014), 'urban green spaces' (Govindarajulu, 2014), and 'ecosystem-based adaptation' (Geneletti & Zardo, 2016).

Blue and green measures generally have an advantage over gray measures because they are more adaptive (Voskamp & Van de Ven, 2015). Gray infrastructure is often fixed and difficult to alter. In this regard blue and green measures are more suitable to a situation where the exact outcome is still unknown or ever changing, which to a certain extent is the case with climate change and its effects. The magnitude of changes in temperature and precipitation, especially on the longer term and regional or local, is difficult to estimate with precision due to lack of data, unknown climate system feedbacks, and the possibility of human interference resulting in different scenarios (Stocker et al., 2013). Booker (2001) elaborates on the link between scientific uncertainty about climate change, and difficulty in creating effective adaptation policies. Uncertainty will always be present to some extent, especially in climate change since the problem is relevant on multiple temporal and spatial scales (Booker, 2001). Adaptive measures are therefore helpful as climate adaptation measures, since many of the consequences of climate change are described as a bandwidth with an uncertainty. Buurman & Babovic (2016) underline the need for adaptive plans to respond to the deep uncertainty that is inherent to climate change and adaptation. Adaptive plans ensure flexibility and the ability to respond and change when the situation changes (Buurman & Babovic, 2016). Another advantage of green and blue measures is that they often have co-benefits (Alves et al., 2019), elaborated on in the next paragraph as multifunctionality. According to Alves et al. (2019), these co-benefits make blue and green measures more efficient compared to gray measures, that often serve one sole purpose.

Alves et al. (2019) propose using a combination of both grey, green and blue measures for an optimal adaptation strategy. These measures tend to complement each other, as gray

measures are very effective for reducing flood risk, with the green and blue options providing the co-benefits (Alves et al., 2019).

4.1.3 Climate themes and multifunctionality

Adaptation measures can also be classified according to the problem that they help solve. The four climate themes from the Delta Plan on Spatial Adaptation are an example of this, where climate adaptation is divided into drought, heat, waterlogging and urban flooding (Kennisportaal Ruimtelijke Adaptatie, 2020-b). Measures can contribute to one or more of these climate themes. As an example, the Urban Heat Island effect, where the air temperature in built up urban areas is higher than the surrounding areas, is related to the fractions of surface that are taken up by buildings, other impervious surfaces, and green space (van Hove et al., 2015). Decreasing the impervious surface area and increasing green space can help improve both the urban heat problem, as well as provide a solution for waterlogging due to precipitation (Salerno et al., 2018; van Hove et al., 2015). Measures that improve multiple climate adaptation themes have the advantage that overall less space is required, which is especially relevant for urban areas where the space available for measures is limited (Alves et al., 2020). Multifunctionality of measures and infrastructure is thus preferable in urban areas. Blue and green measures often contribute to multiple climate themes, and may help with water drainage, storage, and cooling (Connop et al., 2016; Meerow & Newell, 2017; Scott et al., 2016). Other goals apart from the climate themes can also be attained through climate adaptation measures. The measures can also create better social circumstances, such as improving health, well-being and recreation (Cabral et al., 2017). Green areas can function as recreation spaces as well as water retention areas during peak precipitation events. Sides of roads and buildings can be transformed into green patches, combating heat or increasing drainage capacity, with the added benefit of possible biodiversity improvement (Connop et al., 2016).

Multifunctionality is also criticized in scientific literature. Both Madureira & Andresen (2014) and Meerow & Newell (2017) conclude that while multifunctionality is often listed as one of the main advantages of green infrastructure, benefiting the social, cultural and environmental conditions, tradeoffs have to be considered as the goals are not always in line with one and the same adaptation measure. Choices between functions have to be made in the decision making process, and it is in this process that innovative planning can help achieve multifunctionality (Madureira & Andresen).

4.1.4 Cooperation and engagement

An important aspect of climate change adaptation lies within the non-physical measures. These mostly concern the governance and social sphere. Implementing new climate adaptation measures is inherently linked to the socio-economic circumstances in the urban area where they are introduced, and so knowledge of the distribution of socio-economic properties in the city is relevant when taking measures (van der Hoeven & Wandl, 2018). Certain groups of the population will be more vulnerable in case a hazard occurs, depending on for example their socio-economic status or age (Kubal et al., 2009). By analyzing where a hazard may impact vulnerable people, the risk can be calculated and based on that, specific spatial measures can be taken (Kubal et al., 2009).

Different cities and villages face different challenges when it comes to climate adaptation. Wardekker et al. (2020) argue that good policymaking includes a transparent decision making process, and making explicit choices. Subsequently, reflecting on choices that have been made and their consequences also improves the policymaking process (Wardekker et al., 2020).

The non-physical measures are important when considering the role of the regional water authorities in implementing climate adaptation measures, since it is far from a sole effort. The Dutch Water Act (Waterwet, 2009) states that together with regional water authorities, municipalities and provinces, along with the central government, all have responsibilities when it comes to water management. The central government provides a national policy framework, after which the provinces have the task of incorporating these national policies into their own strategies for regional measures. Regional water authorities manage (Rijksoverheid, n.d.) the quality of regional water, as well as the regional flood defenses. Finally, the municipalities are responsible for urban groundwater, and the drainage of waste and rain water through the sewers. Depending on the scale, cooperation between two or more of these governmental organizations is required to implement measures. For local urban climate adaptation measures, this will mostly concern the regional water authority and the municipality. Apart from the national, regional and local governments, non-government actors are often also highly involved in climate adaptation. As mentioned before, the population's degree of awareness surrounding climate change and its accompanying problems and solutions determines climate adaptation at the individual or household level. If people are aware of the risks and know what actions they

can take to adapt, they might be inclined to do so separately from larger-scale adaptation projects spearheaded by governments.

4.2 Current adaptation measures at regional water authority Zuiderzeeland

The main responsibilities of Zuiderzeeland and other regional water authorities is to provide sufficient water and of high quality, as well as protect inhabitants from flooding. With climate change, the conditions related to water may become more extreme, so that there is too much or too little water. For all these circumstances the water authority must ensure that the water system is resilient enough to deal with these fluctuations. The water board operates within the national guidelines, and it creates its own water management plans for making sure the abovementioned goals are achieved in a good manner. Most of the plans related to spatial development such as the Waterbeheerplan ('Water management plan') are renewed once every five to ten years, and some like the Waterkader ('Water framework') are constantly being reviewed (Waterschap Zuiderzeeland, 2019). Recently, the initiative has become to more explicitly tackle the challenge of climate change in the upcoming plans. This chapter discussed the state of climate adaptation in the current plans and future plans.

4.2.1 Cooperation, engagement and awareness

In many documents from Zuiderzeeland, cooperation with other relevant partners inside and outside the operating region is emphasized, since water management is a joint effort (Waterschap Zuiderzeeland, 2013; Waterschap Zuiderzeeland, 2015; Waterschap Zuiderzeeland, 2019). An example of a coalition where Zuiderzeeland cooperates with the central, regional and local governments as well as other regional water authorities is the Delta Program IJsselmeergebied (Waterschap Zuiderzeeland, 2015). The regional water authority functions as an authority for its own management region, and provides other actors with knowledge on its water system, water safety and climate adaptation (Waterschap Zuiderzeeland, 2015). Especially important when it comes to climate adaptation, is the involvement of Zuiderzeeland by other actors when new plans are drafted for spatial development. In case of Zuiderzeeland these other actors are most notably the municipalities in the management area, as most contact with private actors that are involved goes through them. As the new spatial development is situated within the water management area, the regional

water authority can provide essential knowledge on the functioning of the water system and safety (Waterschap Zuiderzeeland, 2015).

Zuiderzeeland is regionally involved the partnership initiative 'Klimaatadaptatie Flevoland' (KAF), together with the six municipalities of the province of Flevoland, the municipal health service GGD, and the regional department of Rijkswaterstaat Midden Nederland. This partnership specifically focuses on climate adaptation in the region. One example where the water authority has worked together in the past years are the climate stress tests (Waterschap Zuiderzeeland, 2019). In cooperation with the local municipalities in Flevoland, stress tests have been conducted to determine the degree to which a city and its directly surrounding area are vulnerable to the four climate change themes as determined in the Delta Plan on Spatial Adaptation. Now that this process has been completed, Zuiderzeeland wants to increase awareness of climate adaptation and make sure that it is taken into account during spatial planning processes in the region (Waterschap Zuiderzeeland, 2019). To this end, events such as masterclasses are organized for policymakers. In their policy documents Zuiderzeeland describes they want to increase awareness especially among urban citizens,

4.2.2 Climate agenda & future developments

In 2020, Zuiderzeeland is working on what is referred to as 'the climate agenda'. This climate agenda deals with climate change in a very broad understanding, and includes both climate mitigation as well as climate adaptation, and both a more theoretical and practical part. The exact content has not been determined yet, but the agenda is supposed to include ambitions, strategies and measures to ensure that the province of Flevoland is climate proof and water robust in the year 2050 (Ecorys, 2020). The climate agenda will also include the regional plans for incorporating national guidelines such as the Delta Plan on Spatial Adaptation.

The current Waterbeheerplan is effectual until 2021. Next year, a new version for the five years after 2021 is created. The Waterkader is constantly evaluated and added to. In updated versions of these documents, climate adaptation will play a significant part.

4.2.3 Waterkader, Waterbeheerplan & Watertoets

Considering the existing policies more in detail, the most important documents for spatial planning and urban climate adaptation are the Waterkader and the Waterbeheerplan, the former of which provides guidelines for the procedure known as the 'Watertoets' (water test). It is

important that the interest of the water system is guaranteed during spatial planning and urban development, to ensure it continues to function properly and safely (Waterschap Zuiderzeeland, 2013). The Waterkader provides guidance for the process of spatial planning, during and after the planning and execution.

Indicators during the Watertoets procedure for new developments are largely related to altering the existing water system, as well as the creation of new waterways. To ensure a climate proof water system, there should be sufficient drainage capacity, as well as a buffer against periods of drought (Waterschap Zuiderzeeland, 2013). An increased impermeable surface or groundwater drainage both require evaluations whether compensations need to be made. If the impermeable surface increase passes a certain threshold, the water drainage capacity needs to be increased in the area. In urban area, this threshold lies at 750 square meters of impermeable surface (Waterschap Zuiderzeeland, 2013). The current method of compensation is an area of open water that needs to be created, calculated for each individual project. The advantages of open water are that it is easily monitored and maintained. Other measures however could perhaps provide additional benefits for multiple climate themes, as well as be more space efficient in dense urban areas.

The hydrologists at Zuiderzeeland take the KNMI'14 climate scenarios into account during all their work. Although the work they do is mostly not explicitly related to climate adaptation, many of the 'measures' and changes they implement are therefore climate proof to a large extent.

All in all there seems to be a consistent effort in all recent plans to try and incorporate climate adaptation and climate change in plans and policies, but specific measures and efforts have not yet been elaborated on. This will be likely improved with the climate agenda that is currently in development, as well as by being involved in new spatial development planning projects by regional partners. Moreover, in current plans the main focus is on often on waterlogging and flooding, with an increasing focus on periods of drought, while heat is not as much considered.

4.3 Effectiveness of current measures

4.3.1 Interviews with employees of Zuiderzeeland

As stated before, the effectiveness of a measure describes how well it performs in terms of its goal, quantitatively or qualitatively. The general sentiment amongst employees of Zuiderzeeland who have worked on and are working on implementing measures, is that they would not implement the measures if they thought them to be ineffective. They do however find it difficult to quantify or describe how effective these measures are. This sentiment seems mostly related to the structural measures. There have been attempts at non-structural measures in the past years, such as raising awareness by engaging the public with a contest, but the results were disappointing with a low turnout.

The interviewees from Zuiderzeeland also found it difficult to elaborate on the effectiveness since, according to most of them, climate adaptation efforts have not been around long enough and are still considered to be in the beginning stages. Additionally, climate change and therefore adaptation does not seem to be as large of an issue in the management area of Zuiderzeeland compared to other regional water authorities, according to some employees. To that extent, the current measures are effective for the regional situation.

Finally, one of the employees mentioned that, while 100% effectiveness would be preferable, with the almost tangibly changing climate, it might be necessary to debate whether investing exponentially more money into measures is worth the small increase in robustness, and whether we should perhaps allow a slightly larger risk in return for cost reduction.

4.3.2 Stress test results in the region

If we look at the reports of stress tests from the different municipalities in the region, the results show that in urban environments the risk of waterlogging is present, as well as increased heat stress (Aveco de Bondt, 2019; Deltacommissaris, 2018-b; Huisman, 2019; Kennisportaal Ruimtelijke Adaptatie, 2020-d; Tolk & van de Wardt, 2019). In one of these reports is mentioned that the current situation is adequate when it comes to drought, as there is a sufficient amount of freshwater available in the region (Huisman, 2019). It is difficult to determine whether in the future this will be as effective as it is currently, because it is uncertain if and to which extent the precipitation will decrease in the long term (Huisman, 2019). Zuiderzeeland has standards for managing the water levels, which seems to be effective thus far (Huisman, 2019). As far as the waterlogging is concerned, the current situation does not seem to be very effective, but here the question of how much water should be ‘allowed’ in extreme situations

can be considered before implementing additional climate adaptation measures. Overall, the common theme seems to be that, while taking measures can be effective, the most effective way to implement them is during new development and maintenance of urban areas (Aveco de Bondt, 2019; Deltacommissaris, 2018-b; Kennisportaal Ruimtelijke Adaptatie, 2020-d).

The effectiveness of non-structural measures is also limited. There is a lack of communication and cooperation with mostly the public and involved businesses such as gardeners, and to a lesser extent the municipalities (Tolk & van de Wardt, 2019). The nature of building requirements regarding climate adaptation is not yet contractual in most cases, which would help regulation (Tolk & van de Wardt, 2019).

4.4 Factors that determine effectiveness of measures

It has become clear that Zuiderzeeland has already implemented some measures for climate adaptation, albeit indirectly at times. Although the perceived effectiveness of these measures according to the employees was difficult to gauge, they were also questioned about other factors that might contribute to or hamper the effectiveness of measures and their implementation. These factors and categories are based on the research by Runhaar et al. (2018) about drivers and barriers for mainstreaming climate adaptation.

Category/factor	Rating
Cognitive	**-**
Level of awareness	-
Sense of urgency	-
Dealing with uncertainty	+
Resources	**+**
Staff	+ / -
Financial resources	+
Knowledge & expertise	+ / -
Characteristics of the issue	**--**
Integration of issue	--
Clear & detailed goals	--
Organizational	**-**
Cooperation: internal	-

Cooperation: governments	-- / +
Cooperation: private actors	--
Clear responsibilities	-
Incentives	+ / -
Political	**-**
Public awareness	-
Public support	-
Law & regulation alignment	+
Timing	**-**
Events present	+
Event-based actions	--

4.4.1 Cognitive factors

In general, the staff at Zuiderzeeland is aware of the need for climate adaptation, but most feel it can be improved. Because there is no need yet for rapid climate adaptation in the management area, some people do have a sense of urgency, but many others do not. The ones that do mostly cite the potential financial benefits and limiting future damage as advantages for implementing climate adaptation measures sooner rather than later. Uncertainty has not proven to be much of a problem. The KNMI'14 climate scenarios are used to determine the impact of climate change in Flevoland, and the management is adapted based on this data. It is not so much uncertainty that is an issue, but mostly dealing with the bandwidth of the set of climate scenarios, and determining which adaptation measures are worth the investment.

4.4.2 Resources

Zuiderzeeland overall has sufficient resources available. Financial resources do not seem to be an issue at all. The government has an impulse fund available the next few years to co-finance climate adaptation efforts. A request for funding can be made, and money can be distributed towards climate adaptation efforts if this is included in a program at one of the departments. New, short term adaptation efforts might not directly have funds available, it does require advance planning. Staff is available to work on the issue of climate adaptation. The one department where some said more people could be helpful, is for the Watertoets. However, as some stated, (temporary) staff shortages can be solved by hiring external people. Should the

problem be structural, then additional permanent staff could be discussed. Knowledge and expertise are available, but not every single person possesses this knowledge. It is often a matter of personal interest if a person is not directly working on climate adaptation whether they are informed on the subject. As one employee stated, the knowledge is available, albeit sometimes outside of Zuiderzeeland, and it is just a matter of collecting the right information and adapting it to our own management area.

4.4.3 Characteristics of the issue

The characteristics of climate adaptation at Zuiderzeeland is where much can be improved. This is also largely because it is still in the beginning stages. As has become clear earlier, specific goals and clear objectives regarding climate adaptation are not present. Some employees are unsure whether this is a necessity, as by striving for the goal of a robust management area, and ensuring safety and sufficient and clean water, climate adaptation goals are already met to a large extent. The integration of the issue is very limited. It is mostly still seen as a separate issue, with a separate team working on it. However, as stated before, the climate scenarios are taken into account during hydrological management. Because of the limited integration, other departments such as the Watertoets are lacking in theoretical and practical resources they can use, such as alternatives to open water storage.

4.4.4 Organizational factors

Cooperation on climate adaptation at the government level is mostly present in the form of the partnership Klimaatadaptatie Flevoland (KAF). The province is barely involved in climate adaptation cooperation, although this is slowly changing. The strongest cooperation Zuiderzeeland has is with the several municipalities in the management region. This is partly because the communication with citizens and private actors often goes through the municipalities instead of directly, and since the municipalities are also responsible for the spatial development in the urban areas. Cooperation with private actors is virtually non-existent in urban areas. Some small-scale initiatives have been introduced in the past years, but overall the engagement has been limited. One issue is that private actors ask for a subsidy for individual climate adaptation measures around their homes, but the regional water authority and municipalities in the management area do not provide this. This is also often the point that cooperation efforts stop.

The KAF partnership is not yet very formalized, and it still needs to be determined what each partners' precise responsibilities are within the partnership. Zuiderzeeland does have its own responsibilities as a regional water authority, to ensure the safety, quantity and quality of water in Flevoland.

Incentives to work on climate adaptation are present, such as the Deltaplan on Spatial Adaptation and the impulse fund from the government. The nature of many plans is not binding however, and regulation of the implementation and execution of plans is lacking, with subsequently no consequences for the actor.

4.4.5 Political factors

While the level of awareness among employees of Zuiderzeeland is good, the awareness of the public can be improved. Many people know of climate change, but do not consider it to be something that will have an impact on their own direct living environment, and thus do not consider climate adaptation to be a necessity. The support for climate adaptation is present, as people do understand that measures can also help improve environmental quality. The main problem with the support is that many people think that climate adaptation should be free and cost nothing.

The current efforts of Zuiderzeeland align with the national framework of regulations and laws. Many actually think, as mentioned in the paragraph above, that the national framework incentivizes taking measures.

4.4.6 Timing

Regarding the timing, most people mentioned the need for a (small-scale) disaster for people to realize that action needs to be taken, and for more money to be invested. They of course do not wish this to happen, but it would help with urgency and actions to be taken. This would work best if it occurs close to home. While some mentioned a flood or severe waterlogging, others noted that the very hot and dry summers we have had in the past years may also be an example of such events. One employee stated that while this is an idea that seems to be prevalent, actual results are lacking. We have had severe waterlogging and drought problems in the past years, and yet there are no large efforts as a result of that. Another suggested that Zuiderzeeland perhaps does not respond quickly and explicitly enough to these events to engage the public.

4.5 Potential additional measures

Currently climate scenarios are taken into account by hydrologists, and the actions taken fit within the requirements of Zuiderzeeland to provide safety & sufficient water of good enough quality. Additional measures are divided into a physical and non-physical category.

4.5.1 Physical measures

As far as explicit climate adaptation measures go, the compensation of newly built impervious area as regulated by the Watertoets is the most significant. This compensation is currently done through creation of new open water surface. From scientific literature, as well as employees that work on the Watertoets process, the concern arises that the surface space in urban areas is limited, and thus alternatives to this open water compensation are required.

From the literature has become clear that a combination of gray, blue, and green measures provides the optimal adaptation strategy, as you get the security from the gray measures, with the multifunctionality and additional benefits of the green and blue infrastructure. Adhering to the retain-store-drain strategy also means implementing measures that contribute to each of these three steps.

If there is no space for open water compensation on the surface, then a 'vertical' solution can be considered. This can be done by replacing otherwise impervious surfaces, such as installing a blue or green roof combined with a drain for delayed discharge. Temporarily retaining water on the roof causes evapotranspiration leading to a cooling effect in addition to reducing peak flows and waterlogging. Finally, they also do not function well when the groundwater level is too high (Amsterdam Rainproof, 2020).

Another vertical solution is the use of infiltration crates. These do not take up space above the surface. They generally have a large water storing capacity (Amsterdam Rainproof, 2020), and can store a significant amount of precipitation. After storing the water, it can infiltrate slowly into the ground. There are many disadvantages to this option. In some urban areas the space underground is also limited, so this would not be an option in that case. Additionally, the installation and access after installation is difficult in existing urban areas, which is particularly problematic since the crates do require regular maintenance to clean them of debris. The invisibility of the crates aboveground make monitoring and maintenance also more difficult.

Another possibility is accepting waterlogging in designated areas. If there is room for green spaces, making these suitable for temporary water storage aboveground helps in reducing

the effect of intense precipitation events (Amsterdam Rainproof, 2020). These buffers have the additional benefit that the problem becomes visible as water fills them, contributing to awareness. The green spaces function as a recreational space during both wet and dry periods. If green or blue measures are not an option, adjusting pavements and roads to direct water away from more valuable infrastructure such as buildings. This can be achieved by making roads slightly hollow and creating higher pavements. Allowing water to 'flood' designated public spaces requires a change in behavior from the people in the surrounding environment, which can be achieved through non-physical measures.

4.5.2 Non-physical measures

First of all, new tools for impervious area compensation in the Watertoets can help improve climate adaptation over time. Rules regarding the use and alteration of the water system can be made more strict, so that with a smaller impervious area compensation is required. New guidelines for implementing green and blue measures on and surrounding buildings also contribute to this issue. A disadvantage of this change is that it requires more projects to be evaluated, and thus more people to work on these evaluations.

Mapping out the distribution of socio-economic characteristics helps the policymaking process to determine where vulnerable groups are located, that might benefit more from green adaptation measures that improve well-being and health. Improving awareness among both employees and residents, for example by creating a transparent and explicit decision making process. To focus the work on adaptation, the responsibilities of Zuiderzeeland and its partners should be decided on, and, if it proves helpful, detailed goals regarding climate adaptation drawn up. Education on coping with a hazard in case it does occur is an additional measure, but again, it should be decided whose responsibility this is.

An issue with cooperation with municipalities is that there is little to no contact with those working on spatial planning not actively involved with climate adaptation. It is important the cooperation and awareness among all involved actors is at level, so that the planning processes can hopefully be more inclusive from an early point. This increases the chance of successful implementation of effective adaptation measures during both new developments and spatial reorganization or maintenance.

4.6 Mainstreaming of additional measures

Klein et al. (2005) defined mainstreaming as integrating policies and measures into existing development planning, to increase the sustainability and longevity of the measures that are implemented. Implementing the policies into existing developments also ensures that spatial developments are not as vulnerable to future climate changes (Brouwer et al., 2013).

To a certain extent mainstreaming – implementing climate adaptation into existing policy (Runhaar et al, 2018) – is already the case at Zuiderzeeland. While it is still being worked on as a separate issue, the goal is to implement climate adaptation into the renewal and revision of the most important policy documents: the Waterbeheeerplan and the Waterkader. This in turn means that in practice, the climate adaptation measures are also implemented in processes such as the Watertoets, since this uses the Waterkader as a guideline.

Zuiderzeeland can help with mainstreaming climate adaptation, especially concerning water challenges, at cooperation partners such as the municipalities. This way, climate adaptation can be mainstreamed into not just water management policy, but also into other processes such as urban spatial planning and public health (Uittenbroek et al., 2013), focusing more on integration in existing developments outside of the direct scope of the regional water authority. To this end, the organizational factors are essential. Cooperation with these partners should be strong, and before specific plans are made, it should be clear what each parties' role in the climate adaptation process is.

To ensure successful mainstreaming of measures, the factors as proposed by Runhaar et al. (2018) should be improved where needed. For Zuiderzeeland, this especially means working on getting clear what its responsibilities and goals are surrounding climate adaptation, increasing awareness and integration, and with that also internal cooperation. Since integration is more or less similar to mainstreaming, proper integration at multiple departments can help make mainstreaming more effective. By not just relying on personal interest, but including climate adaptation in multiple programs, staff are able to dedicate time to the issue.

5. Discussion

The results show quite clear some factors that can be improved to effectively implement climate adaptation measures. It does not become clear from this research whether these factors are lacking because climate adaptation is still in the beginning stages, or if climate adaptation has not advanced a lot due to the lacking factors.

The number of people interviewed was limited to employees of Zuiderzeeland, and did not include all departments. To broaden the understanding of climate adaptation in Flevoland and the role of the regional water authority (RWA) as perceived by other actors, partners in the region could be involved in future research.

The factors Runhaar et al. (2018) use, are difficult to quantify and are thus evaluated qualitatively. A quantitative approach to effectiveness is useful when considering an area with a small spatial scale. Since the case study concerns the entire area of Flevoland, with multiple different urban areas that each require different solutions, a quantitative approach would not have been useful for the aim of this research. Specific quantified effectiveness of measures in the spatial context in which they are placed is a matter of customized adaptation strategies for each specific location.

This thesis provides an overview of both measures and factors that account for an effective climate adaptation policy. The factors are not discussed in terms of their importance compared to each other. This will likely differ inter- and intra-organizational, and thus would provide little added value when considering the broader scientific debate.

6. Conclusion

The goal of this thesis was to analyze what measures and factors account for an effective climate adaptation policy of regional water authorities, to help ensure a water robust and climate proof urban environment.

Climate adaptation measures are manifold, but not every urban environment is the same. Social, political, and economic considerations should be taken into account to decide on an effective solution. This emphasizes the need for strong cooperation partnerships and clear communication in the decision making process about objectives and responsibilities.

In an urban area combining gray, green and blue measures is most effective to create a climate robust and multifunctional environment. The blue and green measures do not just

contribute to the responsibilities of the regional water authority for safety, and sufficient and clean water, but also help reduce the problem of urban heat. Climate change impacts can be made ‘visible’ but controlled, increasing education and awareness about the topic among the public.

The distinction between factors that account for an effective implementation of climate adaptation measures and the climate adaptation measures themselves is often vague. By implementing non-physical measures, the factors are improved, making the successful implementation of other measures easier. Integrating the issue in other processes instead of approaching it separately helps with cooperation between those involved. Overall, having a clear vision of the issue, the goals and responsibilities, and having the correct practical tools helps to achieve the goal of an effective climate adaptation policy.

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Acknowledgements

First and foremost, I would like to express my sincerest gratitude to my thesis supervisor, prof. dr. Martin Wassen, for your professional guidance and help during this project.

I also want to thank the people at regional water authority Zuiderzeeland, for giving me the opportunity to be involved in your climate adaptation process, participating in interviews, and providing me with invaluable insight into the practice of policymaking and water management. In particular I want to thank Willemijn Rossen, my internship supervisor at Zuiderzeeland, for both your professional and personal guidance during the research process, and involving me as much as possible despite the limitations for presence at the office.