Climate adaptation in the built environment

A holistic approach to barriers in the climate adaptation process

Master thesis Industrial Ecology

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ARCADIS

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Dorine van der Linde
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Summary

This thesis investigates the challenges and opportunities associated with implementing climate adaptation policies in municipalities, focusing on understanding the barriers, contextual elements, and stakeholder dynamics that shape the process. The study utilizes a multifaceted approach, analyzing policy documents, conducting stakeholder assessments, and exploring contextual factors through interviews. The findings reveal a complex landscape characterized by numerous policies and diverse stakeholders.

Despite having numerous documents at all levels of government, The Netherlands struggles with the slow implementation of climate adaptation strategies. As a result of the "Maatlat groene klimaatadaptieve gebouwde omgeving" and the National Adaptation Strategy (NAS) falling short of expectations, the national government must take more proactive measures and engage in long-term planning. The nation is still in the understanding and planning stages with little implementation. Effective climate adaptation depends on including multiple stakeholders throughout the process as well as on government involvement.

The identified barriers to effective climate adaptation implementation include insufficient signal detection, limited interest and focus, knowledge gaps, and feasibility thresholds. Challenges also arise in developing and agreeing on viable options that align with established goals, inadequate resources, and legal and procedural obstacles inherent in non-binding climate adaptation policies. However, the study highlights enablers tied to some barriers, such as the motivating effects of climate change, dedicated policy employees driving interest, and cost competitiveness of certain measures compared to non-adaptive alternatives.

Building on these insights, the thesis provides a practical road map, addressing the central question: *"How can climate adaptation policies be implemented in the Netherlands?"* This road map serves as a valuable guide for municipalities, offering a systematic approach that considers stakeholders, contextual factors, and potential barriers. Particularly beneficial for collaborative efforts, the road map fosters a shared language for knowledge exchange and coordinated policy creation across different government levels. With this tool, municipalities are empowered to efficiently accelerate the implementation of climate adaptation measures in an organized and collaborative manner.

Contents

1 Introduction

1.1. Introduction

Climate change is having a significant impact on the urban environment. This is seen in the urban heat island intensification (UHII) that cities suffer from, as well as strong and turbulent winds in some areas and stagnant air in others if proper planning is not implemented. Climate change and population growth also cause changes in the hydrological cycle. More frequent rainstorms have significantly increased runoff from urban areas, as the proportion of green areas has significantly decreased (Jarosińska & Gołda, 2020). All these effects can have an impact on the safety, health, and well-being of (urban) residents (Lenzholzer et al., 2020). The citizens' awareness of the climate is heavily influenced by how the urban environment is designed. By designing the environment in a climate-adaptive manner, local temperatures can drop, water can be stored or more natural run-off options can be created, and the effects of drought can be managed. Climate adaption is necessary as it is thought that mitigation efforts will not be enough to limit the impacts of climate change (Goosen et al., 2014).

Climate adaptation can be implemented in several ways, in the Netherlands it is often closely linked with spatial planning due to the high population density (Goosen et al., 2014). Furthermore, there is potential in incorporating building design to support climate adaptation (van Hooff, Blocken, Hensen, & Timmermans, 2014). When tackling climate change by implementing climate adaptation measures in the urban environment, residential homes and neighbourhoods can play a significant role. When climate adaptation measures are implemented and used throughout the neighbourhood, this can have a positive effect on the adaptation of the whole neighbourhood (Müller, Kuttler, & Barlag, 2014). As biodiversity declines, including nature-inclusive solutions for climate adaptation, should be considered wherever possible.

1.1.1. Climate adaptation in the Netherlands

The debate over climate adaptation is ongoing in the Netherlands. The Netherlands is experiencing a housing crisis, as there is a shortage of available homes (Van Deursen, 2023). There are many plans to build more homes in the Netherlands. This creates a great opportunity to implement climate adaptive measures for new homes and neighbourhoods to make them future-proof. The national government wants the newly constructed homes to be resilient to changing weather conditions in the future (Arcadis & Tauw, 2023). Not only in the Netherlands governments and organisations are busy with climate adaptation. International and national organizations have seen this potential, and have several reports published about climate adaptation measures for homes and neighbourhoods. The EU, municipalities and provinces in the Netherlands already have reports published containing several implementation measures for new construction. The national government of the Netherlands released a report in March 2023 "Maatlat groene klimaatadaptieve gebouwde omgeving", about how to incorporate

climate-adaptive strategies for new construction. The reports published by governmental organisations all focus on the increased heat, drought, heavy precipitation, risk of flooding, and subsidence as these are five themes that are most subject to climate change. All reports include the importance of biodiversity and nature-inclusive solutions (Arcadis & Tauw, 2023; Provincie Zuid-Holland, 2019; Metropoolregio Amsterdam, 2021).

These five dimensions, heat, drought, heavy precipitation, risk of flooding and subsidence can open doors for other dimensions to be implemented as well. The majority of implementations do not just benefit one particular kind of dimension. There are several ways you can limit the effect of climate change, however, the European Union and the government have pronounced that they have a preference for nature-inclusive adaptation measures (Arcadis & Tauw, 2023; EEA, 2021). These measures include a focus on biodiversity, thus for example include greenery in the garden and grass or porous pavements, instead of only using a water tank.

1.1.2. Barriers and challenges in climate adaptation policy

Municipalities have a significant role in enabling climate adaptation in the built environment. They help to implement adaptive strategies and develop actor networks (Bulkeley, 2010; Uittenbroek, 2015). The way municipalities approach climate adaptation in their policies varies by municipality. However, due to overburdened political agendas and limited resources, not all cities can or are willing to take a focused strategy. Several researchers have commented on challenges to adaptation in practice (Moser & Ekstrom, 2010; Rijke et al., 2012; Ford & King, 2015; Mclean & Becker, 2019). According to Biesbroek, Klostermann, Termeer, and Kabat (2013), the majority of the barriers arise during policy implementation. During this step, policy must be converted into practice. The framework of Moser and Ekstrom (2010) introduces the climate adaptation process, which consists of three phases. The understanding phase, the planning phase and the managing phase. The understanding phase focuses on understanding the problem, the planning phase on assessing which measures meet the designated criteria and the managing phase focuses on implementation and monitoring of the measures implemented.

Since governmental organisations recognize that mitigation alone is insufficient, climate adaptation is becoming more crucial. Municipalities and provinces released their own policies, which contain their own targets and minimums. Since March 2023, the Dutch government released a policy report about the built environment as well. This results in not having one clear target and policy throughout the Netherlands, as all the policy reports live alongside each other. This can confuse the municipalities, a single government agency needs to take the coordinating lead to oversee adaptation processes (Ford & King, 2015). However, due to the many options available and the difficult environment of decision-making, there is no coordinated lead. With the "Maatlat groene klimaatadaptieve gebouwde omgeving" by the national government, they are going in the right direction. National governments play a crucial role in establishing coherence, coordination, long-term planning, and the integration of adaptation into policies at all levels of government (Ford & King, 2015).

Climate adaptation can be promoted or discouraged by (political) organizations (Ford & King, 2015). Research demonstrates that when a single government organization takes the lead, adaption strategies and planning are most successful (Ford & King, 2015; Biesbroek et al., 2010). The creation of coherence, coordination, long-term planning, and the integration of adaptation into climate-sensitive policies across government sizes are all viewed as key roles for governments, particularly national governments (Ford & King, 2015).

However, Eriksen, Nightingale, and Eakin (2015) cite the need for sufficient focus on the importance of local government for climate adaptation. They argue that local governments should receive more attention because the effects of climate change are felt locally. Eriksen et al. (2015) say that the involvement of local government in adaptation is made apparent by the interest in planning and policies for it, its ultimate involvement in terms of the actual implementation of policies and measures depends on other actors in the governance network.

Ford and King (2015) show the importance of involving stakeholders in the creation and implementation of climate adaptation plans, both on normative grounds in good governance, and practical grounds for efficient policy implementation. The stakeholders help with implementation and creation due to their knowledge of local conditions and the decision-making processes (Hedger, Connell, & Bramwell, 2006; Bauer, Feichtinger, & Steurer, 2012). There are different ways stakeholders can participate in the adaptation process. They can have a more informing role, being a consultative participator and contributing expertise, or they can be in a more decisional role where the stakeholder has a say in the decision-making process (Bauer et al., 2012). The precise type of involvement needed for adaptation will rely on the context of the decision-making process, but participation must go beyond gestures and involve effective communication to get the public and decision-makers to assess the dangers posed by climate change and to identify and develop adaptations (Moser & Ekstrom, 2010).

This research will look at how to proceed through the steps of implementing climate adaptation policies in the urban environment. It especially looks at different phases and stages, what barriers are faced during the process, how you can go from having policy to implementing policy, and how stakeholders are involved in the process. The framework of Moser and Ekstrom (2010) is used for this research. The framework focuses on understanding, planning and managing climate adaptation.

1.2. Research questions

This research aims to comprehend how climate adaptation policies can be put into practice and what has been causing difficulties. The research is intended to identify the barriers and assess how municipalities can go from policy to implementation. There are numerous policies in place, various topics that must be addressed, and different stakeholders involved. Creating a difficult environment. The framework of Moser and Ekstrom (2010) focuses on barriers that arise during the climate adaptation process. This framework and the belonging phases will be used throughout this research to understand the environment better and to offer more guidance in these stages. The research provides a road map that helps with taking the step to implementing climate adaptive policy. This can help municipalities to go from the planning or understanding stage to the managing stage and start implementing their policies, by showing where change should occur in order for barriers to be avoided.

Considering the aim of the study the research question is formulated as follows:

"How can climate adaptation policies be implemented in the Netherlands?"

To accomplish the goal of this study, four sub-questions have been formulated.

1. *What types of policies for climate adaptation are available in the Netherlands?*
2. *Who are the stakeholders and how are they involved in the climate adaptation process?*

3. *What factors should be taken into account when implementing climate adaptation measures?*
4. *What are the barriers and enablers during the climate adaptation process?*

1.3. Scientific relevance

For this research, the framework of Moser and Ekstrom (2010) about diagnosing barriers to climate adaptation has been applied. In the Netherlands, more understanding of the climate adaptation process is required, as there is currently too much talk and too little action. There are several policies in place, numerous transitions to address, and numerous stakeholders involved. Too much policy can cause uncertainty in choosing the right action, stakeholders all have different opinions, creating a difficult environment. This research can help shed more light on the barriers and what steps you need to consider when wanting to implement climate adaptation measures. The research and road map can help to understand the difficult environment of climate adaptation.

The framework of (Moser & Ekstrom, 2010) allows for the identification and analysis of governance-related barriers. They define barriers as leadership issues that result from misunderstandings in responsibilities and duties at various levels of governance. Barriers mentioned in policy attempts also reflect these difficulties. Many studies have explored barriers to the implementation of climate adaptation, Biesbroek et al. (2013) put barriers in context and Ford and King (2015) examined adaptation readiness. Both types of research focus more on a single aspect of climate adaptation and the implementation of it. However, this research aims to present a clear overview throughout the whole process of where the barriers are in the Netherlands and how you can implement climate adaptation measures, with the inclusion of phases and actors. All of the difficulties and barriers that could arise during this process were addressed by Moser and Ekstrom (2010) in a comprehensive policy framework for identifying and analyzing barriers. This research differs from previous research as this research offers a holistic approach to the climate adaptation process in the Netherlands. With the engagement of stakeholders and the application of Moser and Ekstrom (2010) three phases of the climate adaptation process, there is an in-depth analysis of the barriers and what is required to establish guidelines to overcome these barriers.

1.4. Relevance to Industrial Ecology

In the future, changes in the Earth's systems due to climate change will likely happen more often and be harder to predict. This raises important questions about how our societies, buildings, resources, and cities will be impacted, and how we can get ready for it. Showing the importance of knowing how to adapt to the changing climate and becoming future-proof. Climate adaptation is often complicated and involves different areas of study. Climate adaptation is a multidisciplinary field in which industrial ecology can help, having a multidisciplinary approach as well. Industrial Ecology is a scientific discipline that promotes a holistic approach to human problems by integrating technical, environmental, and social factors. Industrial ecology also underlines the need for adequate governance, governance strategies and policies. These are needed to facilitate the implementation of climate adaptation.

2
Theoretical framework

The theoretical framework will introduce what climate adaptation is and why it is necessary (2.1). It will discuss the framework that was used to examine the barriers to climate adaptation processes (2.2). It will also give insight into the policies that are in place to address climate adaptation (2.3). Following that, background information on various measures and what needs to be considered when implementing is provided (2.4), then the gap in literature will be addressed (2.5).

2.1. Climate adaptation

Climate adaptation can be seen as complementary to climate mitigation (de Bruin et al., 2009). Mitigation focuses on preventing change, whereas climate adaptation focuses on coping with, preparing for and responding to the impacts of climate change (Stein et al., 2013). According to the Intergovernmental Panel on Climate Change (IPCC) there are two definitions of climate adaptation: “initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects” (IPCC, 2007a) and “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007b). Both definitions of the IPCC show a focus on human behaviour and human response to climate change (active or passive). Adaptation can be seen as managing change, where there is a focus on adaptation as a continuous process (Stein et al., 2013).

A clear understanding of the problem is required for effective adaptation. This necessitates the translation of climate impact information to the local level in order to connect with other—often non-climate related—priorities. The majority of studies concur that despite all mitigation efforts, climate change will still occur (Rooijers et al., 2004; RIVM, 2004). Therefore, addressing climate change in the Netherlands will require more than just mitigation measures. Demonstrating the value of national guidance in creating a national building sector adaptation strategy. It is critical that information on potential climate change impacts address the specific needs and perceptions of municipal, district, and provincial spatial planners (Goosen et al., 2014). The urban environment and citizen-level actions have been identified as critical (Klein, Juhola, & Landauer, 2017). Because of the high population density and extensive economic activities in the Netherlands, adaptation to climate change is directly linked to spatial planning, and adaption strategies frequently involve a spatial component (Goosen et al., 2014). The predicted effects of climate change will create several challenges for buildings. There will be an increased risk of flooding, increased demand for cooling and thermal discomfort in buildings during high temperatures, increased subsidence risk, water shortages and long-term droughts (Roberts, 2008). Thus, changes to building design and neighbourhood planning must be taken into account.

2.2. Process of planned adaptation and barriers

The framework of Moser and Ekstrom (2010) will be used to study the climate adaption process in the Netherlands and where the barriers are. Moser and Ekstrom (2010) identify all stages of the climate adaption process as well as associated barriers. They also integrated the structural elements of the climate adaptation process, making this a comprehensive framework that encompasses the entire process. Knowing the whole process and its barriers could make it less complicated to move forward with the implementation of climate adaptation policies.

The framework consists of three elements, and all three will be addressed throughout this research. The three elements are:

1. Process of adaptation
2. Structural elements of adaptation
3. Identifying barriers through the adaptation process

First, the adaption process will be described. The method of climate adaptation demonstrates the basis for identifying and arranging the obstacles that appear. Moser and Ekstrom (2010) have created phases that are typical of a decision-making process during this component. These steps include problem understanding, planning for climate adaptation measures, and managing the implementation of the options that have been chosen (Moser & Ekstrom, 2010). Each phase consists of several stages, with a total of 9 stages.

1. Understanding
    a. Problem detection and awareness raising (resulting in an initial problem framing)
    b. Information gathering and use to deepen problem understanding
    c. Problem (re)definition (resulting in a framing that does or does not warrant further attention to the issue)
2. Planning
    a. Development of adaptation options
    b. Assessment of options
    c. Selection of options
3. Management
    a. Implementation of the selected options
    b. Monitoring the environment and outcome of the selected options
    c. Evaluation

Second, the structural elements of adaptation will be explained. During this stage, the focus will lie on why a certain barrier arises during the climate adaptation process. Moser and Ekstrom (2010) built a different framework meant for the analysis of the social-ecological system. In this framework, three interconnected pieces are considered. The relationship between these pieces is also shown in Figure 2.1.

1. Actors
2. Larger context in which they act
3. Object upon which they act

Third, identifying barriers throughout the adaptation process will be explained. Moser and Ekstrom (2010) have found in literature research the most common barriers that are encountered in all phases, so in the understanding phase, the planning phase and the managing phase. The barriers to the understanding, planning and managing phase can be found in tables 2.1, 2.2, & 2.3.

A couple of the barriers and opportunities intersect through the process and may return at another stage. Furthermore, the policy process is iterative rather than linear. This suggests that previous barriers and possibilities may reoccur as the policy process proceeds (Moser & Ekstrom, 2010; Uittenbroek, Janssen-Jansen, & Runhaar, 2012).

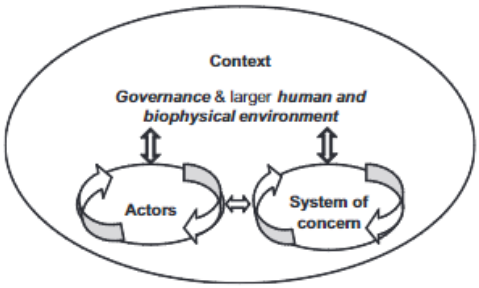

Figure 2.1: The structural elements of the diagnostic framework (Moser & Ekstrom, 2010)

Table 2.1: Common barriers in the stages of the Understanding phase (Moser & Ekstrom, 2010)

Phase and process stages: Understanding	**Barriers**
Detect problem	Existence of a signal
	Detection (and perception) of a signal
	Threshold of concern (initial framing as problem)
	Threshold of response need and feasibility (initial framing of response)
Gather/use of information	Interest and focus (and consensus, if needed)
	Availability
	Salience/relevance
	Credibility and trust
	Legitimacy
	Receptivity to information
	Willingness and ability to use
(Re)define problem	Threshold of concern (reframing of the problem)
	Threshold of response need
	Threshold of response feasibility
	Level of agreement of consensus, if needed

Table 2.2: Common barriers in the stages of the Planning phase (Moser & Ekstrom, 2010)

Phase and process stages: Planning	Barriers
Develop options	Leadership (authority and skill) in leading process
	Ability to identify and agree on goals
	Ability to identify and agree on a range of criteria
	Ability to develop and agree on a range of options that meet identified goals and criteria
	Control over process
	Control over options
Assess options	Availability of data/information to assess options
	Accessibility/usability of data
	Availability of methods to assess and compare options
	Perceived credibility, salience, and legitimacy of information and methods for option assessment
	Agreement on assessment approach, if needed
	Level of agreement on goals, criteria and options
Select option(s)	Agreement on selecting option(s), if needed
	Sphere of responsibility/influence/control over option
	Threshold of concern over potential negative consequences
	Threshold of concern over potential negative consequences
	Clarity of authority and responsibility over selected option

Table 2.3: Common barriers in the stages of the Managing phase (Moser & Ekstrom, 2010)

Phase and process stages: Managing	Barriers
Implement options	Threshold of intent
	Authorization
	Sufficient resources
	Accountability
	Clarity/specificity of option
	Legality and procedural feasibility
	Momentum to overcome institutional stickiness, path dependency, and behavioural obstacles
Monitoring outcomes & environment	Existence of a monitoring plan
	Agreement and clarity on monitoring targets and goals
	Availability and acceptability of established methods and variables
	Availability of technology
	Availability and sustainability of economic resources
	Availability and sustainability of human capital
	Ability to store, organize, analyse, and retrieve data
Evaluate effectiveness of option	Threshold of need and feasibility of evaluation
	Availability of needed expertise, data, and evaluation methodology
	Willingness to learn
	Willingness to revisit previous decisions
	Legal limitations on reopening prior decisions
	Social or political feasibility of revisiting previous decisions

2.2.1. Governance factors for implementing climate adaptation measures

The Netherlands' Rijksinstituut voor Volksgezondheid en Milieu (RIVM) developed an article outlining the success factors for implementing climate adaptation measures in governance and how actors can play a role. These parts properly fit into two stages of the structural elements of the diagnostic framework (Moser & Ekstrom, 2010). Namely, governance and larger human environment, and actors. The system of concern can be viewed as the necessary measure (e.g., measures for heat); thus the paper of RIVM does not include the framework's factors of the biophysical environment.

According to the RIVM (2013) these are the success factors:

1. Triggers for climate adaptation
2. Initiatives of local governments
3. Cooperation between local governments, citizens and sometimes private parties

4. Connecting different fields of policy (such as health and climate adaptation)
5. The use of communication for public participation and regulation
6. Making use of European or national subsidies for climate adaptation
7. Making information available at a local level

2.3. Governmental guidelines on climate adaptation measures

Governmental organizations recognize the value of the role that building design plays in society and are working to create policies that are climate-proof. However, attention to climate-proof design is not self-evident in spatial planning and building development. This is due to the pressure on the construction sector and the difficulty of having many parties involved with different interests (*Klimaatbestendige gebiedsontwikkeling*, n.d.). To ensure that the sector will become resilient to the effects of climate change, new homes in the Netherlands will need to adhere to new national regulations. Because many cities are already dealing with climate-related issues, municipalities are developing climate adaptation strategies, often ahead of national plans. Natural adaptations such as vegetated drainage ditches and stormwater retention ponds are increasingly being recognized as viable alternatives to technical flood protection solutions. To combat the urban heat island effect, municipalities have begun to incorporate green space into streetscape design in order to create more comfortable urban environments (Derkzen, van Teeffelen, & Verburg, 2017).

When it comes to climate adaptation, research and governance frameworks are still developing. Within the European Union, there is a European Adaptation Strategy. The EU asked the member states to prepare themselves with the help of this strategy. Over the past years, strategies for coping with climate change have already been created for designated vulnerable areas, but under the guidance of local programs that are primarily motivated by local interests and have not been guided or supported by a larger framework. Since March 2023 a policy framework has been published by the government. National support is seen as a requirement for the widespread application of adaptation measures (Roders & Straub, 2015).

2.3.1. EU influences on Dutch policy

The European Parliament published the so-called EU taxonomy in 2021. The EU taxonomy is a classification of economically sustainable environmental activities. The taxonomy might be helpful in increasing sustainable investment in the EU and benefit the European Green Deal. The EU taxonomy clarifies for businesses, investors, and policymakers which economic activities are environmentally sustainable. This should provide security and shield investors from greenwashing. It should also assist businesses in becoming more sustainable (EU, 2021). The EU taxonomy includes climate adaptation for buildings as well. Many property owners in the Netherlands reacted to the taxonomy and wanted to implement the climate-adaptive measures that were developed. The table of climate adaptation measures as in the EU taxonomy can be found in Appendix A.

2.3.2. Dutch governmental policy

Nationaal Deltaplan Ruimtelijke Adaptatie (NDRA), or National Delta Plan spacial adaptation, is a program made by the Dutch government that entails the strategy to protect the built environment of the Netherlands against climate change (Kennisportaal Klimaatadaptatie, n.d.). The goal of the NDRA is to ensure that the Netherlands is water-robust and climate-proof by 2050 (Ministerie van Infrastructuur en Waterstaat, 2023a). They have determined 7 ambitions, these describe how municipalities, water boards, provinces and the national government want

to accelerate and intensify the process of spatial adaptation. The governments work together in 45 working regions. The 7 ambitions are:

1. To have the vulnerabilities due to climate change known
2. To have risk dialogues and create a strategy
3. To have an agenda for implementation
4. To create opportunities for synergy with other transitions
5. To stimulate and facilitate
6. To regulate and secure
7. To act during emergencies

The first two ambitions ensure that the vulnerabilities to extreme weather and climate change are well-known. All seven ambitions together ensure that risks are known and minimalized where possible. This serves as the foundation for spatial adaptation. Stress tests are conducted to identify vulnerabilities specific to each region. The risk dialogue and strategy act as a bridge between the stress tests and actual implementation. They provide stakeholders with the opportunity to determine which risks they deem acceptable or unacceptable, make informed choices, and establish ambitions that can be articulated in a climate adaptation strategy. Implementation agendas consist of agreements specifying what actions will be taken, when, and by whom. These agreements are made at the regional level, both locally and on a larger scale (Ministerie van Infrastructuur en Waterstaat, 2023a).

An increasing number of organisations and governmental institutes are considering the integration of climate adaptation measures with other transitions in the physical living environment. Such integration offers numerous opportunities, particularly in urban areas, as it can accelerate the implementation of climate adaptation measures, allow for multiple interventions to be carried out simultaneously, and provide financial benefits. In 2019 and 2020, the Minister of Infrastructure and Water Management allocated financial resources to encourage and facilitate climate adaptation. Local governments promote and facilitate climate adaptation in various ways within their own organizations, as well as among residents, housing associations, and companies (Ministerie van Infrastructuur en Waterstaat, 2023a).

The NDRA supports governments and market parties in their efforts to effectively safeguard and regulate their targets. Building covenants that encompass climate adaptation have been established in multiple regions. However, many municipalities and organizations perceive the non-binding nature of these agreements as an obstacle and advocate for a more mandatory framework for climate adaptation at the national level. There is always a risk of damage and disruption caused by heavy precipitation, drought, heat waves, or flooding. The government, citizens, and companies in a region work together to determine who can and should take action if things go wrong (Ministerie van Infrastructuur en Waterstaat, 2023a).

The government published a report in March 2023 that included targets for climate-adaptive construction, "Maatlat groene klimaatadaptieve gebouwde omgeving". The creation of this report was important because of the ongoing climate change, the decline in biodiversity, the plan to build one million new homes within the next ten years, and the ongoing discussions about urbanization. Many provinces, property owners and other parties were asking for these types of measures. Some provinces created their own already or property owners focused on the EU taxonomy for climate adaptation measures. The government did have the Deltaplan Ruimtelijke Adaptatie, but there were no clear guidelines and targets. The "Maatlat groene

klimaatadaptieve gebouwde omgeving" contributes to the Delta plan. The purpose of the targets is to realise green, climate-adaptive housing in every project. The national target does not only focus on climate adaptation and biodiversity, it also shows synergies with other transitions, such as the energy transition and circular economy (Arcadis & Tauw, 2023).

The national target for the "Maatlat groene klimaatadaptieve gebouwde omgeving" consists of 6 themes, namely:

1. Heat
2. Drought
3. Heavy precipitation
4. Risk of flooding
5. Subsidence
6. Biodiversity and nature inclusiveness

These themes have great coherence and interaction.

2.3.3. Policies in local governance areas

Within the framework of the Deltaplan Ruimtelijke Adaptatie, an agreement has been reached among municipalities, water boards, provinces, and the central government, stipulating that the Netherlands must attain climate resilience and water sustainability no later than 2050. The primary role of the provinces in this endeavour lies in the stimulation and facilitation of municipalities, water boards, and local organizations (Klimaatadaptatie, n.d.).

Numerous municipalities, provinces, and other organizations have developed their own policies, which, while consistent with the National Delta plan's aims, exhibit variances that can generate uncertainty during the implementation of actual measures. Each province has developed its own vision for climate adaptation, reflecting the various problems that each region faces. When compared to other provinces in the Netherlands, the increasing occurrences of excessive rainfall, drought, heatwaves, subsidence, and sea-level rise present specific concerns in South Holland. Drought, for example, creates enormous issues for nature and agriculture in the Veluwe region, whereas in South Holland, it mostly generates substantial risks associated with foundation damage (Provincie Zuid-Holland, 2021; Provincie Gelderland, 2023).

There are also reports more focused on the built environment and new construction, such as the Convenant Klimaatadaptief Bouwen Zuid-Holland, and the Klimaatadaptief bouwen from the Metropolitan Region Amsterdam (MRA). These are a lot like the Green Adaptive Built Environment from the national government but were published earlier. This paper has similarities to the national government's "Maatlat groene klimaatadaptieve gebouwde omgeving" but provides more specific aims.

The above mentioned policies and initiatives show a clear willingness of multiple municipalities and stakeholders to move towards climate adaptation, significant results are not as evident. This raises the question which barriers influence the climate adaptation process. Though the connection between policies and its encountered barriers will be further analysed in this thesis, it is important to understand some background information of measures that can be taken to help climate adaptation and what needs to be considered when making decisions about this.

2.4. Background information of measures for climate adaptation

A lot of research has been done on effective climate adaptive measures. The challenge in selecting measurements is that there are many to pick from, that they serve diverse purposes, and that there are numerous external factors that influence the best measures to use. Some measures have different goals and can reinforce/counteract each other. In the next section, these are explained in more depth. In Appendix A examples of measures per problem can be found for more clarification.

2.4.1. Possible climate adaptive measures

One of the challenges of implementing climate adaptation strategies is the seemingly limitless number of options. There are several solutions to each problem, and it is often difficult to decide which is the best. Some divisions will be formed for this research to make it easier to discuss. First, if possible, a distinction will be established between collective and individual measures, i.e., measures that can be applied on a neighbourhood level vs measures that can be imposed on residences and surrounding ground. The second division, if possible, will be created based on measures based on repellent versus absorption qualities. All the measures are organized by problem.

Wadis, greener sidewalks, and using the space of the street for water storage or drainage are measures for neighbourhood level, whereas green roofs, disconnection of rain pipes, or an entry higher than ground level are measures for property level. For heavy precipitation and flooding, the distinction between repellent and absorption measures is based on what can absorb or drain water into the earth and what measures can repel water. More vegetation, porous pavement, gravel in gardens, and disconnecting the drainpipe with infiltration possibilities are all examples of absorbent techniques. Water-repellent solutions include raising the entry, having fewer inflow points in dwellings, utilizing water-resistant materials, and establishing a maximum garden level.

In terms of heat, more greenery can be a neighbourhood-level solution, but it also has to go on and around houses. One of the most crucial things to do while dealing with heat is creating shadows. This can be accomplished through more natural means, such as trees and other plants that create shadows, or using a (architectural) overhang in front of windows. Other alternatives include green roofs, which provide extra insulation, and white roofs, which reflect light and hence reduce heat. Natural ventilation is also vital, thus streets should be designed to allow for this, and buildings should have enough window openings to allow for natural ventilation.

In the case of drought, it is critical to have infiltration capabilities for the soil to be healthy and sufficiently moist to absorb water. Thus, additional green, (open) waters. Greywater recycling is needed to ensure that more water is available even during droughts. However, there are fewer natural methods, such as concrete piles for houses to avoid the effects of subsidence. Subsidence is caused by sinking land. This can happen for a variety of causes, including low water levels or drought.

All policy papers favour a solution that includes nature. This means that natural solutions, such as the utilization of trees, natural infiltration, green roofs for insulation, and open waters, are preferred. Biodiversity can be changed positively by adopting more green and natural solutions. Something extremely important nowadays, given the current state of biodiversity.

2.4.2. Co-benefits and trade-offs

Some of the measures listed in the tables can serve multiple purposes. Green roofs, for example, not only have a positive effect on water retention and thus fall under the theme of heavy precipitation, but they also affect decreasing temperatures. As the plants evaporate water, the air cools, influencing heat stress. However, there are also interactions between measures and themes that can result in negative effects for one of the themes. More vegetation and trees, for example, can have a negative impact on subsidence because the trees absorb groundwater, which can influence subsidence (Hinze, 2011).

It is crucial to consider measures that can improve biodiversity when choosing which ones to put into action. Finding out which measures can lead to opportunities for one another is important during this decision-making process. More than one theme can benefit from several interventions. Additionally, climate-proof housing offers the chance to include the energy transition and examine how it can be incorporated into the design.

Several factors must be considered when choosing the appropriate course of action when designing a climate-proof house and neighbourhood. Costs must be considered when selecting the most suitable option. When it comes to implementing policy for climate-proof housing and neighbourhoods, it can be simple to choose the least expensive option, even though this option does not fully utilize its potential by missing out on opportunities to include measures that are beneficial for biodiversity or the energy transition.

2.4.3. Influence location in the Netherlands on climate adaptation measures

Despite the fact that the Netherlands is a small country, climate change poses different risks throughout the country (Hegger, Mees, Driessen, & Runhaar, 2017). As can be seen in figures 2.2 and 2.3, the east side of the Netherlands has a lower risk of flooding because of the area's higher altitude and lack of major rivers passing through. Figure 2.2 demonstrates the differences in NAP (below Normaal Amsterdams Peil (NAP)) throughout the country. This demonstrates that not all areas in the Netherlands need to include the risk of flooding in their climate adaptation strategies. There is also a difference between urban and rural measures due to less available space in urban areas. The biggest urban area in the Netherlands is located on the west side in the middle of the Netherlands. Around the two dark blue spots at the left of figure 2.2 that represent the -7 to -4 meters beneath NAP. This area is at high risk of flooding as well, as can be seen in figure 2.3.

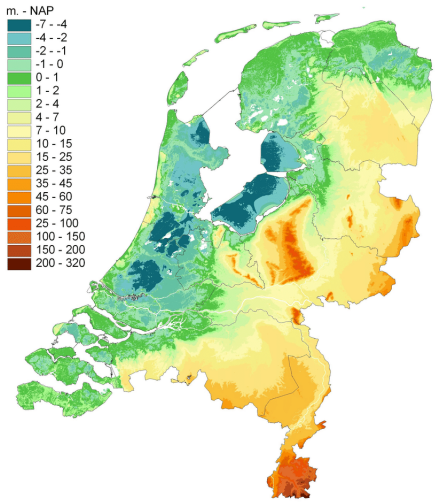

Figure 2.2: Contour map of the Netherlands NAP (Blom-Zandstra et al., 2009)

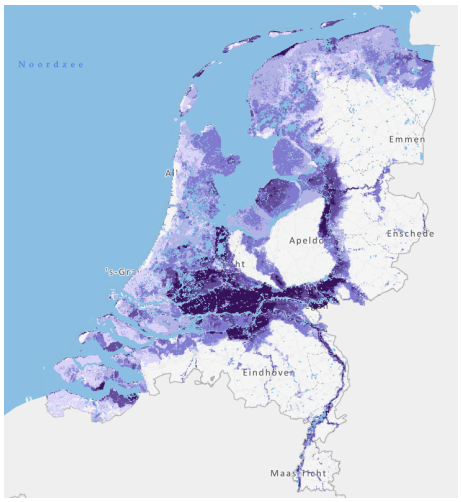

Figure 2.3: Flood risk in the Netherlands in 2050 (Deltares, 2023)

Another influence that differs per location in the Netherlands is the groundwater level. The level of groundwater varies across the Netherlands. Problems can result from excessively high or low groundwater levels, which can affect the possible climate adaptation measures. High groundwater levels have negative effects such as damage to homes and issues with the living environment are a result of wet crawl spaces and rising dampness along walls. Less well-known, but no less significant given the high costs of damage, are the negative effects of low groundwater levels. Examples include the demise of green spaces, the rot of wooden structures, and irregular subsidence that causes the infrastructure beneath roads and in underground parking lots to crack (Hoogvliet, van Vliet, Schasfoort, van de Ven, & Buma, 2020).

According to the KNMI (2015) scenarios, winter precipitation and extreme precipitation are predicted to increase, while summer extreme rainfall is predicted to intensify. Low groundwater levels are anticipated to happen more frequently because the summertime precipitation deficit is expected to increase. The average groundwater levels in both summer and winter may be lower than they are now at some locations if this decrease can no longer be adequately offset

during the winter (Stuurman, Bachelaar, & van Oostrom, 2007).

Wadis and storage crates are facilities that encourage infiltration and influence the groundwater system. Other types of measures, such as permeable pavements, can be provided with a foundation layer that can have a storage, delaying, and purifying effect without the rainwater eventually infiltrating into the groundwater. Groundwater level management is also required for measures that encourage more greenery. There must be enough water to sustain all of the greenery. Groundwater levels may not fall any further near vulnerable structures as a result of the extra vegetation's water demand. It is therefore critical to pay close attention to the effects of this greening on groundwater levels and water availability in the city (Hoogvliet et al., 2020).

2.5. Gap in literature

To implement the created policies by the municipalities, different types of measures can be used. As described in this chapter, several challenges emerge when considering the implementation of climate adaptation measures. The presence of a multitude of policy documents contributes to a difficult and unclear operational landscape. Additionally, technical complexities, organizational hindrances, financial limitations, and the variety of alternatives that are available. The necessary measures and ideal solutions are also shaped by the geographical context. The implementation of climate adaptation strategies is made even more difficult by these issues that come up when putting adaptation measures into practice. It demonstrates that there are various kinds of barriers, including institutional ones and ones that arise when deciding which actions to take in order to follow established policies.

Despite the fact that these barriers have been identified, it is unclear where they exactly fit in the process of climate adaptation. Municipalities find it difficult to implement their policy initiatives in an efficient manner because of this ambiguity. Therefore, the goal of this study is to use the Moser and Ekstrom (2010) framework to assess the barriers faced by those involved in the climate adaptation process. Semi-structured interviews will be used to interview several stakeholders and identify the barriers they encounter. To identify the barriers in the climate adaptation process, the framework of Moser and Ekstrom (2010) will be used. Following the identification of these barriers, a systematic plan will be developed to outline the steps required for effectively completing the climate adaptation process. The Gemeente Ede will be used as a municipality that will validate the suggested structure.

3
Approach and methodology

In this chapter, the chosen research methods will be explained. First, the study objective and approach will be justified. Second, the methods of data collection and analysis will be explained and finally, the validity and reliability will be addressed shortly.

3.1. Study objectives and approach

More awareness of the climate adaptation process is needed in the Netherlands, as there is currently too much discussion and not enough action. Several policies are in place, there are numerous transitions to manage, and there are numerous stakeholders involved. Too much policy can lead to uncertainty in determining the best course of action, as stakeholders' perspectives disagree, producing a tough environment. If climate adaptation measures need to be put into practice, this research can clarify the barriers and steps that you need to follow. The research and road map can assist in understanding and dealing with the challenging context of climate adaptation. The goal of this research is to offer a clear overview throughout the entire process of where the barriers are in the policy process in the Netherlands and how climate adaptation measures can be implemented, with the inclusion of phases and actors.

To achieve the research goal, a framework of Moser and Ekstrom (2010) has been applied and tested using expert interviews. This framework assists in identifying barriers in the climate adaptation processes and offers insight into the many phases of the climate adaptation process. The framework consists of two parts, the first part consists of the structural elements, consisting of the context, being the governance and larger human and biophysical environment, the actors and the system of concern. The context has been researched with the interviews and see if these factors influence the climate adaptation process. The actors have been analysed in the stakeholder analysis. The research of Moser and Ekstrom (2010) does not dive into the connection of the actors and context to the barriers. This research aims to make this connection.

The second part of the framework consists of three phases: planning, managing, and understanding. Each phase has its own stage and belonging barriers. As a result, Moser and Ekstrom (2010) outlined a number of barriers, providing a clear structure for identifying them in interviews. However, as barriers vary greatly depending on the situation, it does not guarantee that all of them will be discovered in the research, as was the case. The framework also helps by identifying the point at which the barrier appears, but it makes no recommendations for where to make changes in order to prevent the barrier. Thus, while the framework assisted the research in identifying barriers and comprehending the climate adaption process, it was not useful in assigning where change should occur in order for the barrier to be avoided. Therefore, the roadmap was created to give insight and guidelines for avoiding barriers.

Arcadis and Tauw (2023) have identified eight different stakeholders participating in the

use of the "Maatlat groene klimaatadaptieve gebouwde omgeving". These stakeholders will be studied as well in this research. At least one person/expert from each of these stakeholders has been interviewed. Because of the multidisciplinary nature of the climate adaptation procedures, the interviews were conducted with experts from the fields of the predefined stakeholder list. Understanding the role of stakeholders is essential for understanding the climate adaptation process. Thus a stakeholder analysis has also been done.

The research has a deductive and exploratory approach. It is deductive as it has a theoretical preliminary study. It was not possible to identify all expected factors and barriers in advance, hence an exploratory component was included in the research. During the research, we search beyond the framework of Moser and Ekstrom (2010). The framework is used as support. It is chosen to use the framework as support, as this leaves the discovery of new barriers open.

Qualitative research was chosen because there are numerous stakeholders involved in the creation process and there is a variety of knowledge regarding climate adaptation measures. Qualitative research is often used to understand situations that are being studied, where the focus is on better understanding a situation or phenomenon (Casebeer & Verhoef, 1997). The fact that qualitative research is more open-ended than quantitative research poses one of its challenges, due to more subjectivity (Castleberry & Nolen, 2018). But it also offers the possibility to explore and go more in-depth. Because the interests of stakeholders in climate adaptation vary, qualitative research provides an opportunity to better study and understand the situation.

3.2. Methods

Throughout this research, different methods have been used. The following section describes the used methods. In table 3.1 an overview of the methods is given.

Table 3.1: Methods per sub-research question

	Literature review/ Document analysis	Stakeholder analysis	Expert interviews
1. What types of policy for climate adaptation are available in the Netherlands?	X		
2. Who are the stakeholders and how are they involved in the climate adaptation process?	X	X	
3. What factors should be taken into account when implementing climate adaptation measures?			X
4. What are the barriers and enablers during the climate adaptation process?			X

3.2.1. Literature review

A literature review was conducted in order to provide insight into the framework employed by Moser and Ekstrom (2010). Due to the many policies available for climate adaptation, a look at the various policies was also included in the literature study. Because the policies in existence are complex, an overview was required to acquire a better understanding.

3.2.2. Stakeholder analysis

Stakeholder analysis is widely utilized by policymakers, regulators, public and nongovernmental organizations, businesses, and the media (Reed et al., 2009). According to Reed et al. (2009), stakeholder analysis is a process that identifies people, groups, and organizations who are affected by or can affect those parts of the phenomenon (this may include nonhuman and non-living entities and future generations) and prioritizes these people and groups for

participating in the decision-making process. Two questions that need to be answered before a stakeholder analysis are: Who is a stakeholder?" and "Why is their role needed?" (Hassan & Curry, 2021). In line with the article of Reed et al. (2009) the following steps have been followed and the questions of Hassan and Curry (2021) have been asked to conduct the stakeholder analysis:

1. Identifying the stakeholders
2. Prioritizing stakeholders by creating a power/interest grid
3. Understanding the stakeholders

Due to the large number of organizations involved in the climate adaptation process, it is critical to gain insight into these stakeholders how they interact and react to one another and how they are involved in policy. Arcadis and Tauw (2023) classified the stakeholders for this research as the national government, provinces, municipalities, property developers, housing associations, financiers and real estate investors, regional water authorities, and consultancy and design businesses. Tenants have also been included in the stakeholder list because they are affected by climate change, and thus have an interest in climate-adapted neighbourhoods.

The stakeholders have also been assigned to one of the phases of the framework of Moser and Ekstrom (2010). Thus, the understanding, planning or managing phase is to see in which phase they are most active. Knowing this, this can help to identify and overcome the found barriers, as you know which parties are involved. Stakeholders have a big role in the creation and implementation of climate adaptation plans (Ford & King, 2015). They help with implementation due to their knowledge of local conditions or their experience in the decision-making process (Hedger et al., 2006; Bauer et al., 2012). Due to their influence on the implementation and creation of climate adaptation policies, stakeholder analysis and knowing when they are active in the climate adaptation process is of value to know for this research.

3.2.3. Expert interviews

Expert interviews are thought to be a great way to gather information. The expert may be more inclined to participate in the interview if the interviewer and interviewee have similar scientific backgrounds. The need for further justification can largely be eliminated because there is likely a consensus regarding the research's social relevance (Bogner, Littig, & Menz, 2009). When conducting expert interviews, it is important to know what an expert constitutes. According to Bogner et al. (2009), in scientific research, a person is referred to as an expert because the researcher assumes that she or he has knowledge that is exclusive to that person in the topic that is being studied, even though the expert may not necessarily possess it alone. The interviewed experts have been selected based on their job description or area of expertise. To give an example, when interviewing someone from a municipality, it had to be somebody responsible for climate adaptation in that area. For this research, the experts have been found with the help of Arcadis where the status of the expert in his or her field is known. An overview of the characteristics of the experts can be found in Appendix A. Open-ended interview questions were chosen as the best research approach for this study because they allow participants to recall more information than closed-ended interview questions. Because the barriers are not fixed and not easily characterized, adopting more open-ended questions allowed for more in-depth questioning while allowing the respondents to talk.

Arcadis and Tauw (2023) identified 8 stakeholder groups that are involved in the process of climate-adaptive building. The 8 stakeholder groups are:

1. The national government
2. Provinces
3. Municipalities
4. Property developers
5. Housing associations
6. Financiers and real estate investors
7. Regional water authorities
8. Consultancy and design firms

The chosen experts all belong to one of these stakeholder parties, except for the national government. Retail organizations for climate adaptation measures have been added to create more insight into the market. For all the other parties, a minimum of one expert has been interviewed. In total 12 interviews were held, after these interviews saturation occurred, meaning that there was repetition in the information that was told. According to Guest, Bunce, and Johnson (2006) this is a sign that enough interviews have been done.

Interview procedure

The interviews were conducted via Microsoft Teams or happened in real life. The interviews were between 30 minutes and an hour. The preference was for at least 45 minutes, but due to other activities of the experts, this was not always possible. The interviews were conducted with a semi-structured interview structure. The semi-structured interview protocol consisted of 9 questions almost all with sub-questions. According to Jacob and Furgerson (2015) 6 to 10 well-structured interview questions will be sufficient for an interview of an hour. The interviews were mostly held in Dutch as that is the native tongue of most of the experts, one interview was held in English. The main questions that were asked during the interviews were about climate adaptation and what it meant in their area of expertise, their awareness of the new report of the Dutch government for new construction, the importance of nature-inclusive solutions, the involvement of the end user in the decision-making process, the differences of homes and neighbourhoods and the effect on solutions, and the influence of the worsening effects of climate change in the future.

The full interview protocol can be found in Appendix B. During the interviews, there were also additional questions asked that came up during the conversations. The interviews were recorded and transcribed afterwards. A verbatim transcription of the interviews was done. According to this method, all spoken words—including those with grammatical errors—are accurately reproduced. However, extra details like stutters and repetitions are removed. To ensure that all data is handled correctly, the Human Research Ethics Committee (HREC) of the TU Delft approved the data management plan of this research.

3.2.4. Data analysis

For the analysis of the interviews, a deductive approach has been used. A deductive technique, according to Azungah (2018), employs a previously selected framework that comprises themes for the coding process. Prior known codes were searched for in the transcript due to the deductive character of this research and the usage of a theoretical preliminary investigation.

For the question *"What factors should be taken into account when implementing climate adaptation measures?"* the structural elements of the diagnostic framework of Moser and Ekstrom (2010) have been used to generate more insight into the larger context in which they act. Thus it looked at different factors from the governance perspective and the biophysical environment

perspective that influence the implementation of climate adaptation measures. The factors for the government perspective have been predefined by the RIVM (2013) and the factors for the biophysical environment perspective have been found in the interviews.

The framework of Moser and Ekstrom (2010) has already framed barriers per phase in the climate adaptation process for this research. As a result, these barriers served as a starting point for themes and as a start list. This framework will mainly be used to answer the following question: *"What are the barriers and enablers during the climate adaptation process?"*. As new barriers were discovered, an exploratory method was also used.

A coding tree is created using a deductive approach. This tree is made up of the observed codes/themes in the chosen framework, as a second phase the codes were divided into categories, if possible, to create more clarity and focused answers. Appendix D contains the code tree for the question *"What factors should be taken into account when implementing climate adaptation measures?"*. Appendix E contains the code tree for the question *"What are the barriers and enablers during the climate adaptation process?"*.

3.2.5. Road map and validation

A road map is created to show the steps that need to be taken before being able to implement climate adaptation measures successfully. This road map uses the phases as defined by Moser and Ekstrom (2010), the understanding, planning and managing phases. The road combined the results of the factors that influence implementation, the barriers and the importance of including nature inclusivity to enhance biodiversity. The road map is a guideline that uses examples from the interviews and shows how barriers can be prevented if all the steps in the road map are taken or considered. The road map is validated with the Gemeente Ede, a municipality located in the province of Gelderland. After validating with Gemeente Ede, a new road map is created with their feedback. The road map depicts how climate adaptation implementation should take place in an ideal world and includes a critical reflection.

the road map is followed with a matrix, based on research from Moser and Ekstrom (2010). This matrix helps with assessing how much influence a stakeholder has on solving the barrier. Examples from the interviews are used to give context to the matrix and how it can help in solving barriers.

3.3. Validity and reliability

The validity and reliability of the study must be taken into consideration in order to guarantee the research's quality.

3.3.1. Validity

Long and Johnson (2000) define validity as the degree to which the overall conclusions are accurately supported by the evidence. Three types of validity will be examined in this study: construct, internal, and external validity. Construct validity refers to whether the approach measures the constructs required for the outcome (Van Burg, 2011). The literature review was used in this study to generate constructs. This is an attempt to ensure the construct's validity.

Internal validity

Internal validity of a study refers to how objectively the study's design, execution, and analysis respond to the research topic. The qualitative character of this study helps its internal validity because questions were asked and answers were repeated during the interviews to ensure that

the results were appropriately understood. The framework was found after the interviews were done, thus this reduces internal validity as the interview questions were not based on the chosen framework. Due to time limits, the transcripts were not reviewed with the participants. This reduces internal validity. Quotes from the transcript were used to confirm that all statements were made truthfully.

External validity

An externally valid study is one whose findings can be projected to a broader group or a more general scenario (Van Burg, 2011). The study is externally valid because it requested instances of the process and decision-making for daily climate adaptation implementation. This produces results that are consistent with reality (Van Burg, 2011).

3.3.2. Reliability

Long and Johnson (2000) define reliability as the likelihood that the same themes and codes would emerge if a similar study were repeated. To ensure credibility, the method section includes a full explanation of the study approach. The consistency of the research's purpose, design, and technique has been maintained throughout. Reliability can be raised further by providing accurate and complete transcripts based on the notes and audio recordings generated during the interviews (Thorogood & Green, 2018). However because qualitative research is subjective and only uses one method and one interviewer, the study's findings are open to interpretation, which calls into question the study's reliability. The methodology of interviews is used to improve reliability by recording, transcribing, and coding the interviews. For clarity, the interview protocol (Appendix B) and code trees (Appendix D and E) can be found in the appendices. As a result, the research may be repeated and traced.

4
Policy description

The Netherlands has many policies in place for climate adaptation processes. This chapter will discuss the various policy documents in more detail than described in Chapter 2. The following chapter will dive into the similarities and differences of the policies in place and show how and if they are related to each other. The process of climate adaptation in the Netherlands will also be explained. This chapter will show the results of the following research question: *"What types of policy for climate adaptation are available in the Netherlands?"*.

4.1. Policies

As can be seen in the previous sections, there is attention towards climate adaptation on all levels of governmental organizations, from the EU to the national government and local governments as well. As for the Netherlands, the policies are made at the national government level, provincial level, municipality level or in partnerships. The different types of policies examined per governmental organisations can be seen in figure 4.1.

4.2. National policies

As can be seen in figure 4.1 contains the National Adaptation Strategy, the Deltaplan Ruimtelijke Adaptatie (DPRA) and more focused, the "Maatlat groene klimaatadaptieve gebouwde omgeving", a policy document about climate adaptive building are the main policy documents on the national level for climate adaptation. The national adaptation strategy was the first to be published in the Netherlands. The NAS is the Dutch answer to the European Commission's request that all Member States develop a climate adaptation strategy by the end of 2017. The NAS presents an overview of the most significant climate threats (Ministerie van Infrastructuur en Milieu, 2016). Recent years have revealed that the climate is changing faster than predicted and that weather extremes will become more frequent and intense. Thus, an evaluation of the NAS and its implementation was done (Ministerie van Infrastructuur en Waterstaat, 2022). This evaluation revealed that the sense of urgency has increased, but that the NAS implementation has to be faster. Three suggestions have been proposed to accomplish this:

1. Concrete goals must be set and there must be more insight into the progress and effectiveness of the policy.
2. More management and coordination are needed and more implementation power for decentralized authorities.
3. More attention must be paid to the consequences of climate change for people, culture and nature.

The National Delta plan was launched because, by 2050, the Netherlands must be climate-proof and water-resilient. This requires flood risk management, freshwater supplies, and spatial planning. The NAS consists of these three dimensions, flood risk management, freshwater

supplies, and spatial planning (Ministerie van Infrastructuur en Milieu, 2016). The Delta plan is part of the Deltawet, which has been in place since 2012. The statutory agreements on the Delta plan are set out in the 'Delta Act on Flood Risk Management and Freshwater Supply' (Ministerie van Infrastructuur en Waterstaat, 2023c). Spatial planning is not included and is therefore expected to not be legally bounded. The spatial planning dimension is called the Deltaplan Ruimtelijke Adaptatie (DPRA). The DPRA was the first strategy that raised public awareness of climate adaptation. The stress tests included in the DPRA were actually adopted by local governments, prompting them to develop their own strategies (Ministerie van Infrastructuur en Waterstaat, 2023b).

The "Maatlat groene klimaatadaptieve gebouwde omgeving" is mostly concerned with new building and neighborhoods. The "Maatlat groene klimaatadaptieve gebouwde omgeving" differs from past strategies in that it includes actual targets and a narrower focus on neighbourhoods and new construction. The goal is to achieve green, climate-adaptive housing in every project. The national aim is not only concerned with climate adaptation and biodiversity but also with other transitions, such as the energy transition and the circular economy. The report was published in March 2023 (Arcadis & Tauw, 2023).

These policies are developed separately from each other, and even though they serve the same purpose, they have not been developed with the primary intention of complementing each other. The biggest difference between the policies is that the DPRA and NAS are strategies and contain visions instead of real targets, while the "Maatlat groene klimaatadaptieve gebouwde omgeving" does have targets. None of the policies is legally bound, this is only possible once the environmental law (omgevingswet) is changed. It has been chosen to look at these documents, as the "Maatlat groene klimaatadaptieve gebouwde omgeving" is the first released document from the government.

4.3. Provincial policies

In terms of provincial policies, all twelve provinces have established climate adaptation plans. These initiatives are in response to the DPRA. The provinces' strategy documents cover their own distinct view of climate adaptation. Each province has produced its own vision for climate adaptation, reflecting the particular problems that each region is dealing with. When compared to other provinces in the Netherlands, South Holland faces particular issues due to increased incidences of severe rainfall, drought, heatwaves, subsidence, and sea-level rise. Drought, for example, causes tremendous problems for nature and agriculture in the Veluwe region, whereas it mostly causes significant hazards linked with foundation deterioration in South Holland (Provincie Zuid-Holland, 2023; Provincie Gelderland, 2023). The province is the party capable of connecting urban and rural communities in a regionally coordinated manner. To achieve this wide strategy, provinces must collaborate closely with the national government, municipalities, water boards, and civil society organizations. The provinces primarily stimulate and support this process. This is seen in the way they have implemented their climate adaptation measures. The documents contain visions and strategies, and they assist municipalities in developing their own policies. Provincial policies include more broad policies, but they also have the Bouwconvenant Zuid Holland for example. This is a policy document for climate adaptative new construction in the province of South Holland (Provincie Zuid-Holland, 2020). This document is similar to the "Maatlat groene klimaatadaptieve gebouwde omgeving" of the national government and also contains more actual targets. And it has been said that the "Maatlat groene gebouwde omgeving used the Bouwconvenant for inspiration.

4.4. Policies of municipalities

Municipalities, for their part, have developed their own policies. These policies are more concerned with climate adaptation implementation. Municipalities have pledged to create a 'climate-proof and water-resistant' Netherlands by 2050 through the DPRA. This means that communities assist their inhabitants and companies in adapting to changing climates and dealing with challenges in public spaces. This makes the inhabitants' living environment more appealing as well as healthier. Municipalities have encouraged residents' initiatives and private parties in recent years (Klimaatadaptatie Nederland, n.d.). They will continue there, but in addition to engaging and appealing, they will also place a greater emphasis on climate adaptation. In this manner, they can get residents and businesses moving. Municipalities achieve this based on the multidimensional nature of climate adaptation: for each component, municipalities work on citizens' quality of life at the appropriate scale level. We are taking steps to adapt our villages, towns, and outlying areas to the changing environment. This necessitates integrated thought and action.

4.5. Governmental partnerships and policies

Working regions have been established as part of the DPRA. The Netherlands has 45 working regions. The seven goals of the Delta Plan for Spatial Adaptation are implemented by the authorities engaged in a working region in cooperation. For instance, they conduct a joint stress test to better understand the vulnerabilities to climate change, establish ambitions and policy with the relevant parties, create a schedule for implementation, and take the necessary actions. Additionally, it is anticipated that this will ensure that the decentralized authorities' spatial policy will better incorporate climate adaptation. Decentralized authorities frequently work on implementing the seven goals for their own municipality, water board, or province in addition to this collaborative approach in a working region (Ministerie van Infrastructuur en Waterstaat, 2023a). However, there are other collaborations that do not belong to the working regions of the DPRA, but they do create policy. The Amsterdam Metropolitan Area is a collaboration of the North Holland and Flevoland provinces, 30 municipalities, and the Amsterdam Transport Region. They have developed a guide for climate-adaptive new construction (Metropoolregio Amsterdam, 2021). The concept underlying this paper is related to the Zuid Holland Bouwconvenant and the national government's "Maatlat groene klimaatadaptieve gebouwde omgeving".

4.6. Analysis of the climate adaptation process in the Netherlands

The phases of the climate adaption process of the framework of Moser and Ekstrom (2010) are closely linked to the development and final implementation of policy. Thus, it is essential to analyse it in the Dutch context. The framework's phases include understanding, planning, and management (Moser & Ekstrom, 2010). The problem identification, awareness raising, information gathering, and problem defining phases form the understanding phase. This can be considered the initial stage in policy development. Here the need for climate adaptation is identified and information on why and how to address the problem is gathered. The following step is the planning phase, which consists of developing adaptation alternatives, assessing the choices, and selecting the options. This is the next stage in policy development, in which alternative climate adaptation strategies are evaluated to determine which choice is best suited. The final phase is the management phase. This step consists of implementing the chosen choice, monitoring the outcome, and evaluating the results. This is the final phase in policy development when the implemented solution is implemented and its function is evaluated.

In figure 4.1 different types of policies that have been published are shown. The figure

shows that all levels of government have published policy articles with regard to climate adaptation. It also shows that the NAS has already been published in 2016. The bouwconvenant of Zuid-Holland and the MRA Klimaatadaptief bouwen were published years earlier than the "Maatlat groene klimaatadaptieve gebouwde omgeving" of the national government. The Netherlands is currently mostly in the understanding and planning phase. Where a lot of policy has been created, as can be seen in figure 4.1. There is a lot of debate happening around the use and need for climate adaptation measures, but not a lot happened yet. Local governments play a significant role in climate adaptation since adaption varies depending on the effects of climate change that are felt locally Eriksen et al. (2015). However, national governments, are seen as playing important roles in the formation of coherence, coordination, long-term planning, and the incorporation of climate adaptation into policies (Ford & King, 2015). Figure 4.1 shows that the NAS was published first, but according to the 2022 evaluation, the implementation was not completed quickly enough. The national government was similarly late in developing a policy paper for new construction and the requirement for climate-adaptive housing. demonstrating the national government's shortcomings in coordination and long-term planning.

In an attempt to make the above-mentioned policies more concrete, implemented examples were investigated. These best practices, however, were difficult to identify; there were some examples of porous parking lots and spaces, but no major changes were discovered. Stichting CAS (2021) (Climate Adaptation Services) argues that in recent years, the municipalities analyzed have taken numerous steps: risks are better identified, trust in the necessity of climate adaptation is high, and many municipalities have developed a strategy and are implementing measures. Municipalities want to tackle climate adaptation integrally, but the effect is often limited. Municipalities, for example, frequently do not integrate all climate themes in stress tests, ambitions, and implementation. Heavy precipitation is frequently approached in the most evident manner. Heat stress is receiving more attention, although it frequently lacks a problem owner and a budget. Drought and flooding are given the least attention. These findings are consistent with the general perception that most policies are still in the understanding and planning stages.

4.7. Conclusion

In conclusion, various policy documents are in use in the Netherlands at all levels of government. However, given that the "Maatlat groene klimaatadaptieve gebouwde omgeving" was created later than expected and the NAS was shown to not have the desired effect, the national government should have shown more initiative in the implementation of the policy documents and should have had greater long-term planning. The Netherlands is still in the understanding and planning phase with all the policy documents available and little implementation taking place at this time.

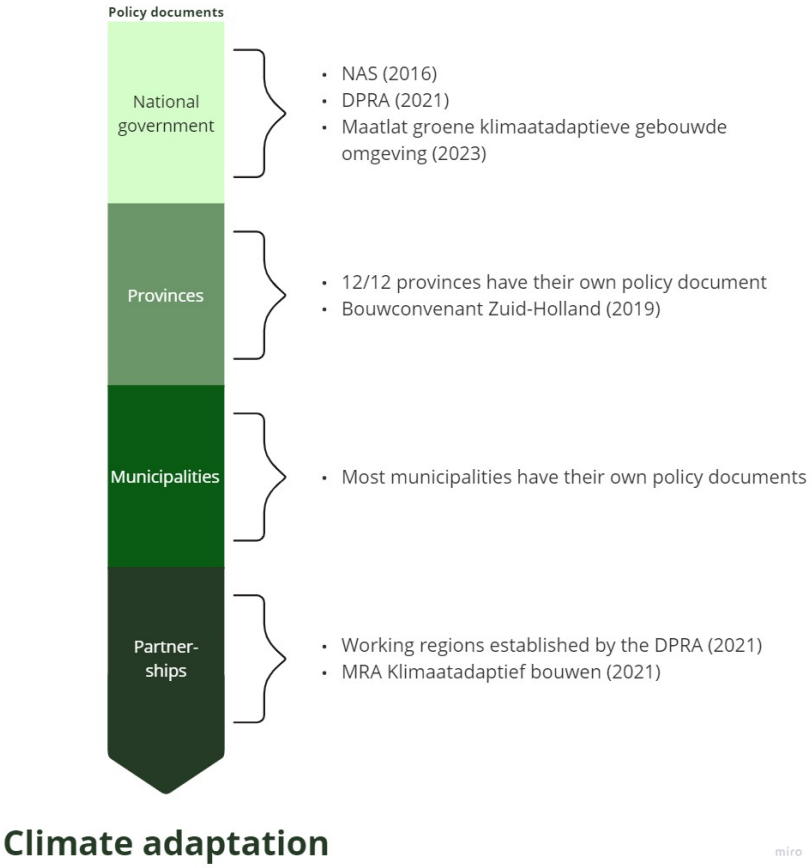

Figure 4.1: Policy types for climate adaptation

5
Stakeholder analysis

To gain a better understanding of the climate adaptation process in the Netherlands it is important to know the stakeholders and to understand how they relate to one another and interact with each other. The stakeholders are the actors in the framework of Moser and Ekstrom (2010). First, the stakeholders, their interests and their roles will be explained. Then a power interest grid will be made and analysed, followed by the stakeholder mapping that shows how the stakeholders are related to each other. This chapter will give the results to the question: *"Who are the stakeholders and how are they connected to each other?"*.

5.1. Stakeholders interest and role

The following are the stakeholders in the climate adaptation process in the Netherlands, along with their interests and roles:

1. **The national government**

   National spatial planning is directed by the national government. They are ultimately accountable for a pleasant and healthy living environment and must protect citizens. The national government can develop policy documents that other governmental entities must follow. They can also provide less compulsory rules, such as guidelines.

2. **Provinces**

   The provinces manage the site through urbanization goals, provide provincial-level guidelines for the home construction process, and invest in important housing constructions on occasion through active land policy. They are responsible for monitoring and maintaining provincial roadways, as well as protecting and improving the environment and groundwater. They can either build their own visions or follow orders/rules issued by the national government. The welfare and safety of their population are also vital to the provinces.

3. **Municipalities**

   Municipalities are responsible for planning and maintaining their surface water system, sewerage, and water purification plants. Municipalities can utilize spatial plans to limit housing and land use inside their own borders. They are free to make proposals of their own but must adhere to national government regulations and/or listen to the visions of their respective provinces. It is also in the interest of municipalities to provide a pleasant and healthy living environment for its inhabitants.

4. **Property developers**

   Property developers are the driving and risk-taking forces behind the city and building construction. Developers make an investment and either develop on their own land or win a development position in a municipal tender. Their main interest is to be able to create these buildings and generate profit from them.

5. **Housing associations**

   Housing associations oversee the development and the building of social rental housing in collaboration with municipalities. They also manage a substantial real estate portfolio that comprises existing social rental homes and related outdoor facilities. Their primary goal is to build, rent, and sell houses.

6. **Financiers and real estate investors**

   They manage real estate assets, plan developments, and set standards for (climate)risks based on their interests. It is in their best interests, as a result of the new EU taxonomy, to invest in "green" buildings for their portfolio. Climate adaptation measures are also included. Their next goal is to make a profit.

7. **Regional water authorities**

   In an environmental plan or when giving licenses for construction projects, regional water authorities defend water and climate interests from the standpoint of the waterboard. They are also in charge of significant waterways and pumping stations, as well as wastewater treatment. They work with other government organizations, and it is in their best interests to safeguard citizens as well as water and climate interests.

8. **Consultancy and design firms**

   Consultancy and design firms create spaces and buildings for both public and private clients, create policies and strategies for public clients, and provide assistance. The objective of consulting and design firms is to generate profit and employment for the party that generates a task for the firm.

9. **Tenants**

   They buy or live in the houses built. Their primary concern is to live in a secure and pleasant environment.

5.2. Power interest grid

The stakeholders' interests and power have been defined in figure 5.1. According to Bryson (2004), stakeholders with a high interest and power need to interact closely with one another and have the ability to influence activities. They must be informed, consulted, and collaborate with one another. Stakeholders with high power but low interest must be engaged on a regular basis and kept satisfied. They must be kept informed and consulted. Low-power and low-interest stakeholders must be watched and informed. Stakeholders with low power but high interest must participate when necessary and be informed and consulted.

A critical note must be made, the tenants are stated as having high interest and low power, as the measures are designed to allow them to live in a pleasant environment as climate change worsens, but as seen in the earlier section "barriers," tenants lack knowledge and understanding of the importance of climate adaptation. As a result, they may not consider themselves to be high-interest stakeholders. Their impact on project management plans is minimal, but they do have the authority to design their gardens in a climate-adaptive manner by adding green. Governmental institutions are viewed as high-power and high-interest organizations because they bear the ultimate duty of addressing these issues and protecting populations from climate change. Property developers, housing organizations, financiers, and real estate investors are viewed as having a lot of power but little interest. They have the ability to create and finance ideas, but for most organisations, their primary goal is to make profit. There are exceptions, such as social housing organisations. Climate adaptation can be costly, and implementing climate adaptation measures can be difficult. Due to the European taxonomy, they have a

bigger interest in investing in green buildings. Consultancy and design firms are seen as low power and low interest. They advise on their expertise but have no further interest in the plan.

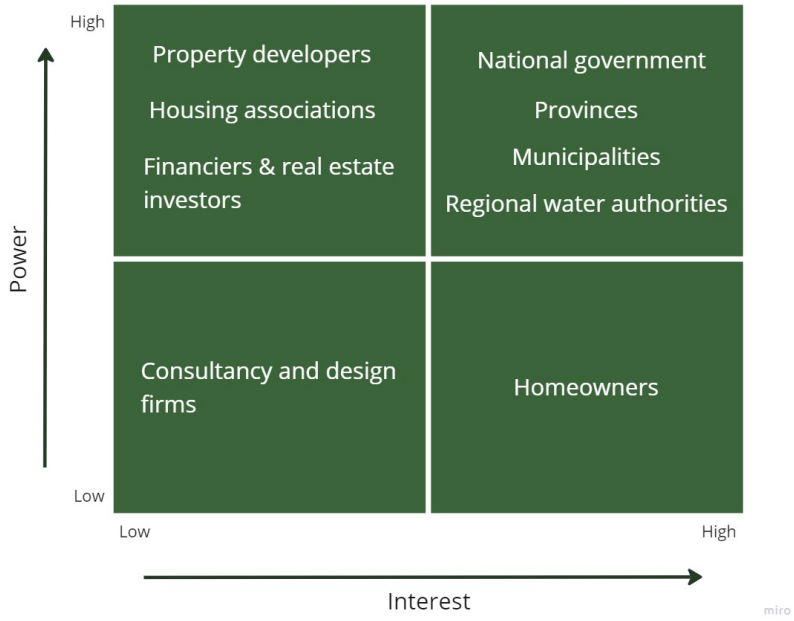

Figure 5.1: Power interest grid stakeholders

5.3. Stakeholders and the climate adaptation process

Not all stakeholders are simultaneously engaged in the same stage, as outlined by the framework of Moser and Ekstrom (2010). Ideally, every stakeholder would partake in the understanding phase, wherein the identification and definition of the problem occur. In the environment of governmental organizations, the national government, alongside provincial bodies, predominantly operates within the planning phase. This entails the formulation of visions and objectives, prompting municipalities and regional water authorities to execute these directives. Consequently, municipalities and regional water authorities take the lead during the managing phase. It's worth noting that they also contribute to the planning phase by shaping their own policies. Property developers play a significant role in the planning phase. Crafting the blueprint for a new neighbourhood, for instance, necessitates a profound understanding of appropriate climate adaptation measures. Financiers and real estate investors are mostly present in the managing phase. They're obligated to evaluate plans to extend financial support, but the plans have already been made by other stakeholders. During the managing phase, their involvement revolves around ensuring the financial feasibility of implementation. Housing associations exhibit extensive involvement throughout all stages. They supervise the progression and construction of socially rented housing in collaboration with municipalities. Moreover, they manage a substantial real estate portfolio, encompassing pre-existing socially rented residences and associated outdoor facilities. Consultancy and design firms primarily operate during the planning phase, offering advisory services. Tenants assume the managing phase role, as they're responsible for executing and overseeing the implementation of climate adaptation measures that have been adopted.

Figure 5.2: Stakeholders and the climate adaptation process

5.4. Conclusion

Governments play an essential part in the climate adaptation process since they are involved in planning and developing policies; however, other actors are also required in order for policies and measures to be put into action (Eriksen et al., 2015). Stakeholders can participate in the adaptation process in a variety of ways. They can have an informative function, such as being a consultative participant and giving expertise, or they can have a say in the decision-making process (Bauer et al., 2012). Even if the stakeholders are from the same group, the positions do not have to be the same, and how the roles are filled differs depending on the organization. As a result, the specific type of participation required for adaptation will be determined by the context of the decision-making process. Thus, in order to successfully implement climate adaptation strategies, it is important to understand who the stakeholders are and how they are related to one another. As a result, they can help at the appropriate stage of the climate adaptation process. Stakeholders can be active in multiple phases of the climate adaptation process, ideally, every stakeholder would partake in the understanding phase. However, problem definition and identification should happen throughout the whole process. Efforts must go beyond gestures and effective communication should be incorporated to convince the involved actors of the importance of climate adaptation (Moser & Ekstrom, 2010).

6
Factors for implementation

This chapter will identify the factors that must be considered while implementing climate adaptation measures. It will concentrate on the framework of Moser and Ekstrom (2010), where aspects influencing climate adaptation implementation from the governmental perspective and the biophysical environment are discussed. This chapter will present the answers to the following questions: *"What factors should be taken into account when implementing climate adaptation measures?"*. The factors that belong to the governance will be explained followed by the factors from the biophysical environment. The answers are based on the interviews done with the stakeholders. The governance factors have been identified by the RIVM (2013) but the biophysical factors have been identified solely on the content of the interviews. The code trees can be found in Appendix D.

6.1. Governance

The RIVM (2013) identified the factors that belong to the governance section, as can be found in section 2.2.1. All of the factors stated were mentioned in the interviews. Some were mentioned more frequently than others. Table 6.1 displays the factors and number of codes found. The codes that were mentioned more than once will be detailed further down.

6.1.1. Triggers for climate adaptation

Triggers for implementing climate adaptation measures have been found 3 times in the interviews. They can be divided into two subcategories, namely the need to create a climate-proof environment and the need to use more green, which can be beneficial for climate adaptation as well.

6.1.2. Initiatives of local governments

Initiatives of local governments have been found 5 times in the interviews. There were no distinct categories found, but it was found that there is a difference in the initiatives taken by local government. This is mostly due to differences in time and space for climate adaptation. One interviewee said:

"It is now mainly on a voluntary basis, and some municipalities are better at it because you see that they have it in their zoning plans and you get that it does apply to the area because the municipality has properly secured it."

6.1.3. Cooperation between local governments, citizens and sometimes private parties

Cooperation between local governments, citizens, and occasionally private parties was discovered eight times throughout the interviews. It can be split into multiple categories, including the use of private gardens and communication between different parties. When it comes to the

utilisation of private gardens, many governments wish to work with homeowners to see if they might establish more green gardens. In terms of communication between different parties, the interviews revealed that people go directly to the government to report a problem. They frequently are unaware that climate adaptation measures may solve the problem, yet there is an increase in cooperation between citizens and towns. This is demonstrated by the following quote:

"But with every development that happens, the municipality tries to include citizen participation, so that's right, we do work as municipal property, but a small part goes through the residents ... For them, of course, it is hidden, climate adaptive change. Then we have already made that translation and then we can change that for them. We have quite a few projects that have been carried out in this way. So it's kind of like, the policy is there to have citizen participation and a lot can roll out of that."

6.1.4. Connecting different fields of policy

Connecting diverse policy domains is a factor mentioned seven times in the interviews. During the interviews, primarily two policy domains related to climate adaptation were mentioned: energy transition and health. Green roofs can help with the energy transition and more green means cleaner air. Another connection mentioned was the combination of sewage modifications and other underground infrastructure development. If the streets are opened, climate adaptation can be done when they are closed again. By incorporating more green or permeable pavement.

6.1.5. Making use of European or national subsidies for climate adaptation

According to the interviewees, subsidies are widely used. It appears three times in the interviews. However, interviewers acknowledged that it can be difficult to determine which subsidy is best suited for what. As noted by one of the interviewees:

"Yes, it is a thing, although, at the end of the day, the costs are provided for, so there is a subsidy for it, there are many possibilities and if someone really wants it, then it is all possible. Putting it into operation is not quite smooth yet, you have to be able to find the right people, be able to address the right subsidy."

Table 6.1: Number of codes found factors governance

Factors	Number of times code found
Triggers for climate adaptation	3
Initiatives of local governments	5
Cooperation between local governments, citizens and sometimes private parties	8
Connecting different fields of policy (such as health and climate adaptation)	7
The use of communication for public participation and regulation	1
Making use of European or national subsidies for climate adaptation	3
Making information available at a local level	1

6.2. Biophysical environment

The interviewees have mentioned the following factors that are part of the biophysical environment. All of the factors stated have been found throughout the interviews. Some were discovered more commonly than others. Table 6.2 shows the factors and the number of codes discovered.

6.2.1. Enough space

One of the factors found for the biophysical environment that influences the implementation of climate adaptation measures is the space available. In the interviews, it was found that there

are problems with finding enough space under the ground as well as above the ground. In the Netherlands, the underground infrastructure is close to each other, creating little space left for trees and other greenery. However, due to the density of buildings and other places in the Netherlands, is it also difficult to find enough space above ground to implement climate adaptation measures. One of the interviewees said the following about wadis:

"There are very clear measures that require a great deal of space, such as wadis that cannot be accommodated in a densely built-up city centre or working-class neighbourhood."

6.2.2. Groundwater level

The groundwater level of the Netherlands is another factor found in the interviews. It was mainly found that there were difficulties with high groundwater levels. Due to the high groundwater level, there is little to no infiltration possible in some places. One of the interviewees noted the difficulties of high groundwater levels:

"We also try to disconnect water from greenery, for example by having slightly sloping roads, but in The Hague, we have the problem that certain parts of the city have very high water levels. So you can't actually infiltrate because there is simply no buffer capacity in the ground because the groundwater level is so high. So on the one hand you have heat stress because everything is so petrified, but on the other hand, it is actually that if a little bit of rain falls, you immediately have a big problem."

6.2.3. Difference in soil type and possibilities

Another aspect discovered for the biophysical environment is the difference in soil type and potential. Sand has the ability to absorb more water than clay. According to one interviewee:

"This particular city is partly on a levee of sand and some clay and a distribution point on peat, and you can already see many differences there. You can infiltrate water in the neighbourhood on the levee there much more than in the neighbourhood around it."

Table 6.2: Number of codes found factors biophysical environment

Biophysical environment	Codes found
Enough space	6
Groundwater level	7
Difference in soil type and possibilities	2

6.3. Factors in relation to stakeholders

When considering all of the factors that can influence and are taken into account throughout the climate adaptation process, it is interesting to look into how the stakeholders interviewed are related to the factors found. The governments, which include municipalities, the province, and the water board, not only mentioned the main governance elements, but they were also aware of the biophysical factors. They were also the most up-to-date on the necessity to use subsidies. Furthermore, practically all stakeholders recognize the value of collaboration among local governments, residents, and private parties. This is possible since they all belong to the above. Many people have commented that space is needed for the implementation of climate adaptation measures and that high groundwater levels make this problematic at times. However, this is common knowledge in the Netherlands.

6.4. Conclusion

In short, to show the factors that have been found, they are put together in table 6.3.

Table 6.3: Factors that influence the climate adaptation process

Governance	**Biophysical environment**
Triggers for climate adaptation	Enough space
Initiatives of local governments	Groundwater level
Cooperation between local governments, citizens and sometimes private parties	Difference in soil type and possibilities
Connecting different fields of policy (such as health and climate adaptation)	
Making use of European or national subsidies for climate adaptation	

7

Barriers and enablers for climate adaptation processes

In this chapter, the framework will be tested on the interviews and will be tested on which barriers and possible enablers are applicable in this research. The chapter will review the barriers and enablers per phase of the framework, thus the understanding phase, the planning phase and the managing phase. It will also explain extra barriers and enablers found in the interviews. Sometimes the barrier can be used in a positive way or it can be turned around to one. If this is found in the interviews, the barrier will have an enabler in the found categories belonging to the barrier. The code trees of the found barriers and enablers can be found in Appendix E. Merely codes discovered more than once or twice will be thoroughly examined, as one or two codes discovered do not demonstrate consistency in the barrier and may, for example, merely be a personal barrier. This chapter will show the results of the following research question: *"What are the barriers and enablers during the climate adaptation process?"*.

7.1. Understanding phase

The interviews did not disclose all of the barriers identified by Moser and Ekstrom (2010) that belong to the framework's understanding phase. The barriers that were found and how many open codes belong to the codes can be seen in table 7.1. The four barriers found will be explained below.

7.1.1. Detection (and perception) of a signal

The detection (and perception) of a signal was the main barrier during the interviews. There were 12 open codes found, that belonged to the detection of a signal. It was discovered that the problems associated with climate adaptation were either not noticed or detected incorrectly. There were two categories found, lack of awareness and complexity of the problem. Citizen engagement suffered from a general lack of awareness, demonstrating the difficulty in involving residents in order to get the most out of the ideas developed. Another difficulty was the complexity of the problem. This means that one problem, such as heat, could be found in one location but the temperatures surrounding could be different. Because of the differences in signal strength (in this case, temperature differences) between surrounding places, it can be challenging to construct suitable measures. One respondent said:

"Well heat is, we often look at the perceived temperature and that is very variable, so it differs from meter to meter. If you measure in a certain place, you don't know the temperature for the city yet, not even for the neighbourhood or for that street."

Next to the barriers found, there was also an enabler found due to the existence of a signal. The enabler is not predefined by the framework of Moser and Ekstrom (2010) but was

discovered during the coding process. The enabler is the noticeable effects of climate change. The interviewees all noted the severe effects of climate change and the signal it gave that change is needed and that we need to adapt and look into the future in order to handle the effects.

7.1.2. Interest and focus

The key issues identified for the interest and focus barrier are stakeholder preference and difference in ambition. If the stakeholder prefers, they will devote more time and resources to climate adaptation. However, there is frequently insufficient time and no preference. Here are two more detailed samples of interviewees:

"So it can be a very sustainable project for one person and for another it is just a bit old school. That also depends very much on personal preference, if your internal processes are not properly arranged."

"One municipality can be very tightly organized, but in other municipalities, it depends a bit on the preference of the project leader and the spatial planning project leader who is responsible for the project."

The difference in the ambition of stakeholders can be seen as both an enabler and a barrier. The barrier is a lack of ambition, while the enabler is a great deal of ambition. The enabler was not predefined in the framework of Moser and Ekstrom (2010) but was discovered throughout the interviews. During the interviews, it was discovered that if a party lacks ambition, the plans are not comprehensive and do not match the standards. However, there are instances when a party is particularly ambitious, and the entire plan can be carried out by this party, and a climate-adaptable strategy is created. One interviewee said:

"Otherwise you often see it indeed, then there is 1 good civil servant somewhere who has strong persuasive powers so that it will work or that a developer will get to work very energetically because there are also large builders who see that this is important so to speak."

7.1.3. Availability of information

Availability of information on climate adaptation during the understanding phase is a barrier that is seen a lot, in the interviews there were 8 open codes found that belong to this barrier. These open codes can be sub-categorized as insufficient scientific knowledge, outdated policy and that knowledge is not available at the same place.

One interviewee said that due to a lack of scientific knowledge policies cannot be made legally binding. Even though there is a lot of new policy being created for climate adaptation, the policies for the water authorities on water draws are outdated. Knowledge is also spread through organisations, thus it can be difficult to gather all the knowledge together. Having little knowledge can slow down the process of collective climate adaptation. One interviewee said:

"But most municipalities don't even know yet whether it is feasible to install a heat network, and if you wait too long, half of the people will have a heat pump."

Even though heat pumps are not a bad scenario, it does suggest that municipalities need to act or individuals will take it upon themselves.

7.1.4. Threshold of response feasibility

The threshold of response feasibility is a barrier that is seen four times during the interviews. This can be split into two categories, being afraid to experiment and acting too slowly. In

the interviews, it was mentioned that there is little experimentation in the climate adaptation measures and that this can slow down the process. Or that the stakeholders are acting too slowly to reach the climate adaptation goals of 2050. As one interviewee said:

"But yes, they shouldn't wait too long, because if you want to be climate-resistant in 2050, you have to start planting now to ensure that the trees have large enough crowns to create shade and so on, so I don't think it should be taken too long, otherwise, you won't make it anymore."

Table 7.1: Codes found in interviews of the understanding phase

Understanding phase		
Stage	**Barriers**	**Number of open codes found**
Detect problem	Existence of a signal	1
	Detection (and perception) of a signal	12
	Threshold of concern (initial framing as problem)	1
	Threshold of response need and feasibility (Initial framing of response)	2
Gather/use of information	Interest and focus (and consensus, if needed)	7
	Availability	8
	Accessibility	0
	Salience/relevance	0
	Credibility and trust	1
	Legitimacy	1
	Receptivity to information	0
	Willingness and ability to use	1
(Re)define problem	Threshold of concern (reframing of the problem)	0
	Threshold of response need	0
	Threshold of response feasibility	4
	Level of agreement or consensus, if needed	1

7.2. Understanding phase in relation to stakeholders

Almost all stakeholders stated that they felt the need for climate adaptation as a result of climate change; however, most governmental parties stated that not everyone with whom they work feels the same way. The most often reported barrier to knowledge accessibility was likewise mentioned by governing parties and knowledge institutes. This could be due to the scale of their organizations, and the fact that knowledge is easily distributed around the organization and hence difficult to find. Additionally, governments point out interest and focus the most. Whereas the threshold of response feasibility was generally indicated by the project developer as well as the consultant and design firms.

7.3. Planning phase

The interviews did not reveal all of the barriers mentioned that belong to the planning phase of the framework. Table 7.2 shows the codes that were discovered and how many open codes relate to the codes. The two codes discovered will be discussed more below.

7.3.1. Ability to develop and agree on a range of options that meet identified goals and criteria

During the interviews, the ability to develop and agree on a range of options that meet identified goals and criteria was seen 5 times. The ability to develop and agree on a range of options that meet identified goals and criteria is a barrier that is part of the develop options stage. The answers can be divided into two categories, little knowledge of the long-term effects of measures and the translation of problems into measures can be challenging.

One interviewee said the following about the choice of measures and the long-term effects of them:

"There are many that work well and they are now fine-tuning what materials they use. Nowadays they place plastic crates in the soil, but do you want that? You do not know exactly what the lifespan is and the soil does not have its own material that is placed in the soil, so do you want that or not? Nowadays there are also discussions about this, so it is really something that is developing enormously."

7.3.2. Level of agreement on goals, criteria and options

The level of agreement on goals, criteria and options is a barrier that has been seen 3 times during the interviews. The level of agreement on goals, criteria and options is a barrier that is part of the assess options stage. It can be categorised into two categories, projects that do not meet the criteria and new goals that are not as good as the current situation. These codes are mainly focused on the use of green solutions for climate adaptation. An example of the new option that is not as good as the current situation is the following quote from an interviewee:

"That is the same with a tree somewhere that has been there for 100 years, you cut it down and you plant a new one and you say, we have done what we have to do, but such a tree is also an ecosystem in itself, so yes, it's good that they're working on it and probably they're doing it for legal reasons, but it's never as good as it used to be. And as soon as you have a moment when it comes close again, then you are 20 years further and then the next developments are already imminent."

As for projects that do not meet the criteria, these are discussions that take place during the planning phase and developers have handed in their plan, but the municipality or other stakeholders do not agree with their plan.

Table 7.2: Codes found in interviews of the planning stage

Planning phase		
Stages	**Barriers**	**Number of open codes found**
Develop options	Leadership (authority and skill) in leading process	1
	Ability to identify and agree on goals	0
	Ability to identify and agree on a range of criteria	0
	Ability to develop and agree on a range of options that meet identified goals and criteria	5
	Control over process	0
	Control over options	1
Assess options	Availability of data/information to assess options	0
	Accessibility/usability of data	0
	Availability of methods to assess and compare options	0
	Perceived credibility, salience, and legitimacy of information and methods for option assessment	0
	Agreement on assessment approach, if needed	1
	Level of agreement on goals, criteria and options	3
Select options(s)	Agreement on selecting option(s), if needed	1
	Sphere of responsibility/influence/control over option	0
	Threshold of concern over potential negative consequences	0
	Threshold of perceived option feasibility	0
	Clarity of authority and responsibility over selected option	0

7.4. Planning phase in relation to the stakeholders

The barriers discovered during the planning phase were not acknowledged by every stakeholder interviewed. They were mentioned most frequently by interviewees from municipalities and the project developer. Both barriers relate to the options, goals, and criteria that must be met according to the policy created. Municipalities and project developers are both involved in these decisions, with the project developer frequently creating designs and the municipality determining if the project developer's design fulfils the requirements.

7.5. Managing phase

The interviews weren't able to identify all of the barriers listed within the framework's managing phase. Table 7.3 displays the identified codes as well as how many open codes are related to

the codes. The two codes found will be addressed in greater detail below. There was also one enabler found.

7.5.1. Sufficient resources

Sufficient resources is a code that was seen 16 times during the interviews. It is part of the implement options stage. Two categories were found, one barrier and one enabler. The barrier was that some measures were too expensive and the enabler was the availability of measures that were the same price or less as 'standard' practice.

Often climate adaptation measures are too expensive, however, there are some measures found that are the same price or even cheaper. The interviews showed that there are options available for less the price or the same price. The following quotes have been heard during the interviews:

"I said to the developer, are you going to reduce the heat island problem with your building or make it worse? And finally, with a little insistence, it turned out that a white roof also turned out to be possible. And that the costs were actually almost nil compared to the dark grey roof. And if you have a roof surface of 20,000 m2, it makes a big difference if it is white."

"But more green on your ground level, that is often cheaper than laying hard surfaces. Some of the measures cost nothing, nothing extra and you just have to be there early in your planning destination."

7.5.2. Legality and procedural feasibility

Legality and procedural feasibility is a barrier that was found 13 times in the interviews. There are two categories found that belong to this barrier and these are that climate adaptation measures are not legally binding in the Netherlands and that there are different policies in place in different regions. Legality and procedural feasibility are part of the implement options stage.

Because climate adaptation measures are not legally binding, it is clear from the interviews that external factors are required to recognize the importance of taking these measures. The following two quotes from the interviews support this:

"So we also need the government to force us to do things differently, because we are already happy if we can take on projects, you see. And then we need external incentives to do something more. That it comes from yourself would also be nice, but not always, not always."

"And as long as greening still remains a bit in the background and is non-binding, you can see that if things go a little less economically, parties are still inclined to think, I'll postpone that for a while."

Table 7.3: Codes found in interviews of the managing stage

Managing phase		
Stages	**Barriers**	**Number of open codes found**
Implement option(s)	Threshold of intent	0
	Authorization	0
	Sufficient resources (fiscal, technical, etc.)	16
	Accountability	0
	Clarity/specificity of option	0
	Legality and procedural feasibility	13
	Sufficient momentum to overcome institutional stickiness, path dependency, and behavioural obstacles	0
Monitor outcomes & environment	Existence of a monitoring plan	1
	Agreement, if needed, and clarity on monitoring targets and goals	0
	Availability and acceptability of established methods and variables	0
	Availability of technology	0
	Availability and sustainability of economic resources	0
	Availability and sustainability of human capital	0
	Ability to store, organize, analyse, and retrieve data	0
Evaluate effectiveness of option	Threshold of need and feasibility of evaluation	0
	Availability of needed expertise, data, and evaluation methodology	0
	Willingness to learn	0
	Willingness to revisit previous decisions	0
	Legal limitations on reopening prior decisions	0
	Social or political feasibility of revisiting previous decisions	0

7.6. Managing phase in relation to the stakeholders

During the interviews, all stakeholders cited both barriers, namely an insufficient amount of resources as well as an absence of legality and procedural feasibility. This could be due to the fact that practically all interviews lead to these themes and were either asked or brought up.

7.7. Discovered barrier

The framework did not address all of the barriers identified during the interviews. One barrier was discovered: conflicting interests. Table 7.4 shows the detected code as well as the number of open codes associated with the code. The code discovered will be discussed more below.

7.7.1. Conflicting interests

Conflicting interests are another barrier discovered. This occurred nine times during the interviews. There is only one category associated with it, and that is that there are too many interests. This is mostly a barrier that appears during the planning process when several stakeholders negotiate new spatial plans. The following quote illustrates the different interests of the stakeholders:

"Yes, there are very often lively discussions here between ecologists, sewers and soil experts, because everyone claims their own space in the ground, where there is actually no space. And everyone has different interests."

Table 7.4: Discovered codes outside the framework

Discovered barriers	**Number of open codes found**
Conflicting interests	9

7.8. Conclusion

In short, to show the barriers that have been found per phase, the barriers are put together in table 7.5.

Table 7.5: Barriers found per phase of the climate adaptation process

Understanding phase	Planning phase	Managing phase	Discovered barrier
Detection (and perception) of a signal	Ability to develop and agree on a range of options that meet identified goals and criteria	Sufficient resources	Conflicting interests
Interest and focus		Legality and procedural feasibility	
Availability of information	Level of agreement on goals, criteria and options		
Threshold of response feasibility			

8
Road map

In this chapter we describe the focal points in each phase of the climate adaptation process based on the analysis of the policy documents (Chapter 4), the actors involved (Chapter 5), the implementation factors (Chapter 6) and the barriers and enablers (Chapter 7). After determining the barriers, the following stage is to find ways to overcome these barriers. Because barriers are context-dependent, there is not one strategy to overcome them. This chapter addresses the focal points, it is important to know where and why barriers arise. We use the framework of Moser and Ekstrom (2010) to address these focal points. The chapter is based on research of Moser and Ekstrom (2010) and the results of this research. First, a summary of the current situation will be presented, followed by a road map that shows what steps need to be taken before being able to implement climate adaptation policies successfully. In this road map the results of the factors that influence implementation, the barriers and the stakeholder analysis are combined. This road map is validated with the Gemeente Ede. A new road map is created with the feedback of Gemeente Ede. After this, the matrix of Moser and Ekstrom (2010) will be introduced, to show how much influence you have on overcoming the barrier that may arise when taking the steps of the road map.

The road map will serve as a useful guide for the climate adaptation process. The road map is especially beneficial for collaborating municipalities since it provides a common language that allows knowledge exchange and the development of well-coordinated policies across multiple levels of government.

8.1. Current situation

As presented throughout this thesis, there is much that may be done to improve the current state of the climate adaptation process in the Netherlands. There is a lot of policy ambiguity, according to the literature research, stakeholder analysis, and interviews. According to Ford and King (2015), a single government organization needs to take the lead; but, as demonstrated in Chapter 4, the NAS was not implemented quickly enough, and the "Maatlat groene klimaatadaptieve gebouwde omgeving" was introduced after local governments had already built their own. Due to the ambiguity of policy, the findings of the interviews revealed that it is difficult to reach an agreement on goals and criteria for measures. The Netherlands is still in the understanding and planning phase with all the policy documents available and little implementation taking place at this time.

Furthermore, this research demonstrates that policy implementation varies by location, as climate adaptation methods are very context-sensitive. The Netherlands features a variety of soil types, high groundwater levels, and scarce space areas. According to the interviews and the literature research, this is a barrier that slows down the implementation process. Furthermore, the study demonstrates the stakeholders involved and the significance of this in

the development and execution of climate adaptation programs (Ford & King, 2015). Some barriers occur among stakeholders; some believe that climate adaptation is not essential enough or that they do not know enough about it. In addition, many ideas and visions have been developed, but there has been little implementation.

This study evaluates the current situation in further depth and addresses the most common barriers identified by stakeholders. The road map will address barriers from the understanding phase, such as a lack of detection (and perception) of a signal, a lack of interest and focus, a lack of information availability, and a lack of a response feasibility threshold. The barriers that will be addressed during the planning phase are a lack of ability to establish and agree on a range of options that achieve stated goals and criteria, as well as a lack of agreement on goals, criteria, and options. The barriers that will be addressed during the management phase include a lack of sufficient resources as well as a lack of legality and procedural feasibility. The road map will address the barriers with steps and questions that highlight the importance of focusing on these subjects. Thus, the road map will not function to bring solutions, but it will be a guideline during the process, to make sure everything is thought about.

8.2. Road map

The road map in figure 8.1 shows the steps that need to be considered when successfully implementing climate adaptation measures or policy. The road map shows all the phases of the framework of Moser and Ekstrom (2010) alongside steps to take based on the barriers that were found during this research. All phases will be covered separately, starting with the understanding phase.

8.2.1. Understanding phase

The understanding phase can be seen as a continuous process throughout the whole climate adaptation process. During the planning and managing phase, it is still essential to pay attention to the understanding of the problem and know why it is needed to act on climate change. Therefore, the first question you need to ask is, "Is there enough understanding of the need for climate adaptation?". There needs to be understanding with all the stakeholders involved.

The next step, asking the question: "Do people believe there are possibilities for implementing (new and innovative) climate adaptation measures?". This question covers the barrier of threshold of feasibility response, where the interviewees noted that they believe some organisations are not willing to take innovative measures and therefore do not believe that implementing the policy for climate adaptation is feasible. The interviews showed that especially consultancy and design firms and project developers experienced this barrier, as they often create plans and designs this is an important step that needs to be agreed on before implementation will happen. They can put extra focus on the need for innovative ideas and try to convince the municipality or other parties to agree to the plan.

The third step is to ensure that the individuals working on the project(s) are driven and have adequate time assigned for project(s)-related activities. The interviews revealed that some people are given jobs related to climate adaptation programmes even when they have little interest in the subject. As a result, there has been less emphasis on the importance of climate adaptation.

The availability of knowledge and knowing where or who holds the information is the fourth step of the understanding phase. Knowledge on climate adaptation may be spread

throughout the organisation because it is a quite broad topic. The process of obtaining enough knowledge can be accelerated by knowing who knows what or by establishing a knowledge centre.

During the understanding phase, it is also important to be aware of how the biophysical environment works. Thus to understand how measures differ when there is a different soil type or when the water level is too high. You must be aware of this information, and you must then appropriately present it. This is important for all four steps. The interviews revealed that while everyone was aware of the scarcity of open space in the Netherlands and most people were also aware of its high groundwater level, relatively few people addressed the various soil types and how they would affect potential solutions. The municipality was informed of every aspect of the biophysical environment. As they get to an agreement on the plans, they can use the factors while evaluating the ones that were made. But they can also communicate this early on to the other stakeholders so that it can be taken into account at the beginning of the project.

8.2.2. Planning phase

In terms of the planning phase, there are more steps required than barriers because there were only 2 barriers detected but 7 steps need to be completed. To avoid barriers during implementation, better planning is required, which is why there are extra procedures here. So, in order to overcome the difficulties encountered during the management phase, they must be identified earlier.

Knowing what goals and criteria climate adaptation measures must achieve is step 5, which is the first stage in the planning process. A concise description of this makes it simpler to develop successful policies. This was mentioned as a barrier that especially the project developers and the municipalities experienced. Of the stakeholders, they are the ones that are especially active in the implementation phase. Next to a concise description of the goals and criteria, they must communicate early on in the project.

The following stage is to determine whether these approaches may be used in combination to achieve the goals of enhancing biodiversity. Because nature-inclusive methods are frequently the solution for climate adaptation, it is interesting to observe how these two issues might be combined. The potential for integrating climate adaptation strategies with other goals or policies is the topic of step 7. This is consistent with the governance-related element that was discovered to have an impact on the implementation of climate adaptation.

Step 8 focuses on the many climate adaptation solutions that are possible. Because there are numerous possibilities available, it is important to understand which options best meet the established targets and criteria and to understand the surrounding environment, and the biophysical factors. This was one of the issues raised during the planning stage.

The barrier that led to the following step was pointed out in the interviews during the understanding phase, but the planning phase is where the answer rests. It was claimed that individuals doubted the feasibility of climate adaptation measures because governmental organisations moved too slowly. Organisations can gain more confidence in the viability of their climate adaptation strategies by having a defined deadline.

The barriers discovered in the management phase—namely, a lack of resources—are the basis for steps 10 and 11. Interviews revealed that those resources were mostly limited by a

lack of funding. Having sufficient funds set aside during the planning phase and being aware of the costs of measures and alternatives should not hinder the implementation during the management phase.

8.2.3. Managing phase

The last phase, the managing phase is relatively short compared to the other two phases. The first step of the managing phase is that throughout the whole implementation process, the importance of climate adaptation is known. Also, among residents and those actively involved. When individuals witness what is going on or are inconvenienced by it during the implementation activities, it can be helpful to explain why these changes are being made. That is why it is critical to bring it back to the public.

As there are many conflicting interests during the implementation phase, it is important to make sure that everyone understands the need for climate adaptation. This is also linked to the understanding phase, which is a continuous process through the planning and managing phase. To adapt to climate change, it's important to be actively involved in the decision-making process. This means more than just making gestures – it requires clear communication. People and decision-makers need to understand the dangers of climate change and work together to come up with ways to adapt. The last step is to make sure that all measures implemented are legally embedded.

8.2.4. Reading guide road map

Figure 8.1 depicts a road map that contains all of the steps described previously. The steps described in the text are shown using examples from the interviews. The steps that were developed are primarily based on the barriers identified during the interviews; stakeholders are not involved because this road map focuses on the situation in general.

The road map is especially useful for (cooperating) municipalities because it provides a common language for knowledge exchange and the formulation of well-coordinated policies at many levels of government. It can be used in the initial meetings to determine whether all the resources (time, people, and finances) are available or whether they need to make investments in particular areas in order to make it happen. It can also be utilized throughout the process to understand what steps are coming up and how they can prepare for them.

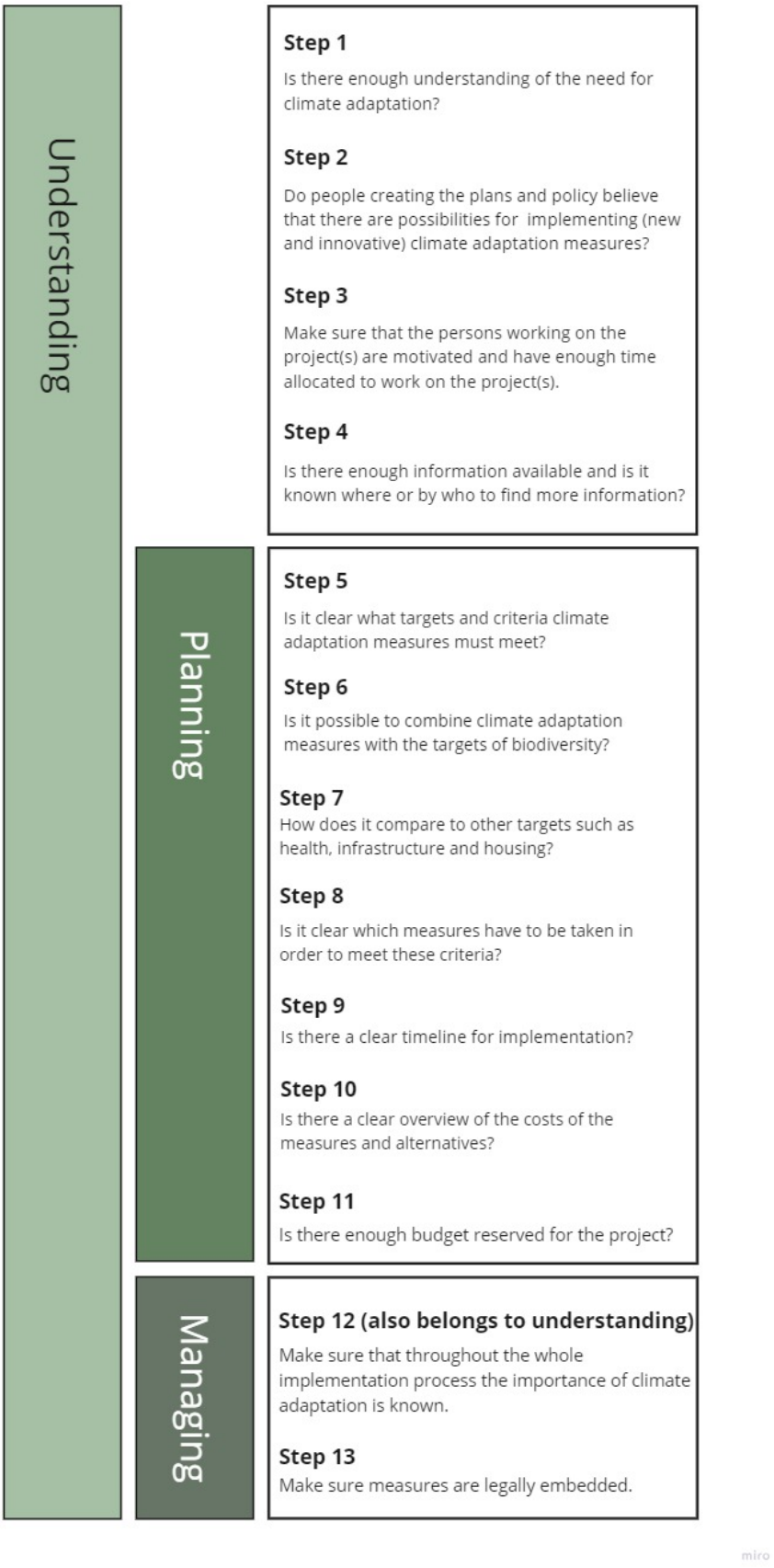

Figure 8.1: Road map to go through the climate adaptation process.

8.3. Validation of road map at Gemeente Ede

The road map as seen in figure 8.1, has been validated by the Gemeente Ede. The road map was presented to an urban professional responsible for biodiversity and climate adaptation in Ede and he has given comments on the steps created. The road map created after the validation can be found in figure 8.2.

8.3.1. Understanding phase

The Gemeente Ede seconded the need for an understanding of all stakeholders involved in the need for climate adaptation. However, they argued that there should be more attention to the ongoing effort throughout the whole process of raising awareness, in accordance with Moser and Ekstrom (2010). They argue that participation must go beyond gestures and include effective communication, to get the public and decision-makers to understand the potential risks posed by climate change and to identify and implement responses. Therefore, a step concerning this has been added (step 2). As for the motivation and time someone needs to have when working on a climate adaptation project, Gemeente Ede argued that knowledge and skills are also important. Therefore, this has been added to the designated step (step 4).

8.3.2. Planning phase

To continue to the planning phase, Gemeente Ede argued that there should be more focus on the combination of climate adaptation with spatial planning. As the Netherlands is very densely built, there is little space for climate adaptation measures to be implemented. This was also revealed in the interviews and previous research (Goosen et al., 2014). Therefore, there needs to be enough attention and it should be thought about early on in the planning process. Thus steps 8 and 9 have been created or adjusted. The Gemeente Ede also noted that they try to combine climate adaptation with biodiversity targets early on in their process. To maximize this effort, step 7 has been added. For the budget, they argued that to limit the costs, they try to combine it with other work or projects that have to be done in the public space. By combining projects the costs can be limited tremendously, therefore step 14 has been added. To make sure that the measures are legally embedded was first a step that was located in the managing phase, however, the Gemeente Ede noted that this is a process that also happens during the planning phase.

8.3.3. Managing phase

This leaves only step 16 in the managing phase, where the continuous attention towards the need for climate adaptation returns. During the climate adaptation implementation process, it should be known to all stakeholders involved in the implementation process that it is important to implement these measures. The implementation process will probably happen faster and climate adaptation will not be set aside.

Overall, the Gemeente Ede stated that the road map could be beneficial to municipalities that are still developing their climate adaptation plans. The road map provides an outline of everything that needs to be considered if wanting to carry out policy effectively. It provides the municipality with an estimate of how much time and effort it will take. This is critical information for a municipality to have. It is beneficial to have such a road map to translate activities into money, resources, and capabilities. Gemeente Ede also noted that such a road map is mostly beneficial when creating a new neighbourhood. It can also be beneficial for other projects in existing neighbourhoods, but some steps might be irrelevant.

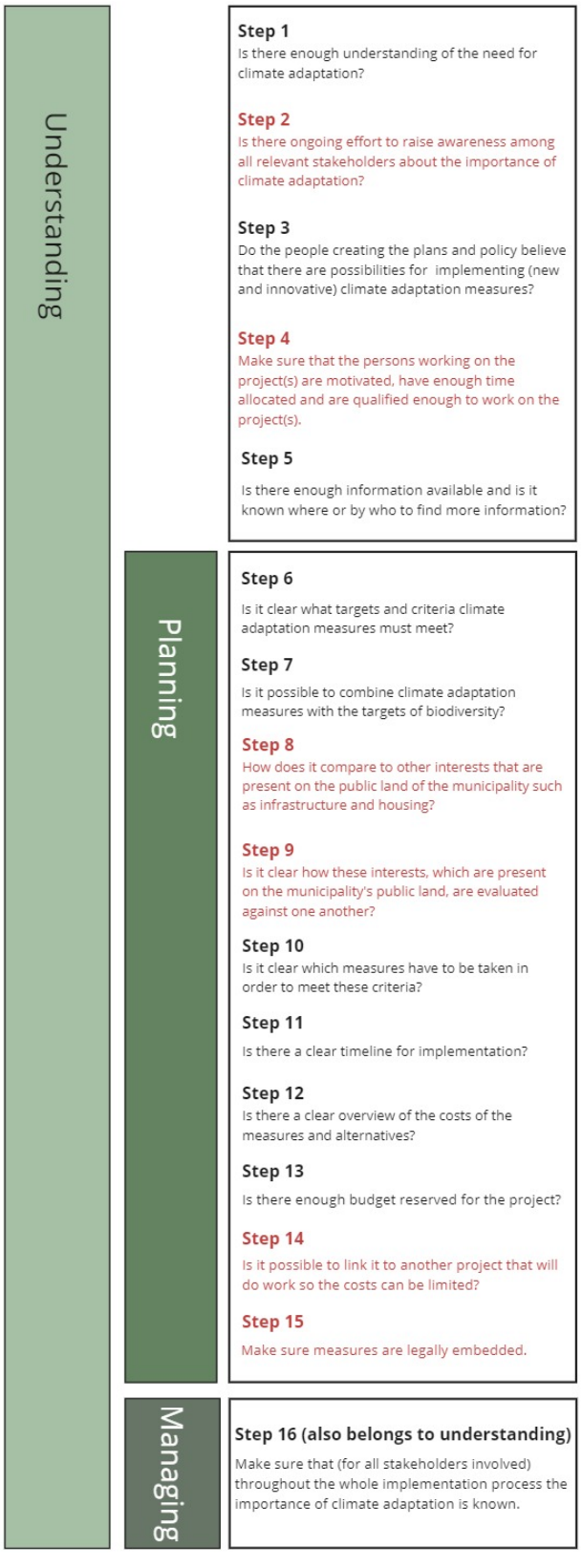

Figure 8.2: Road map after validation Gemeente Ede (changes are shown in red).

8.4. Navigating challenges: understanding barriers and strategies

Following the road map does not guarantee that there will be no challenges along the way, despite the fact that it provides instructions for asking the appropriate questions and taking the proper steps. Moser and Ekstrom (2010) developed a matrix to measure influence and intervention opportunities to overcome barriers.

The matrix is a useful tool for determining the nature of a barrier and the degree of control over it. It helps to overcome barriers by providing such information. Barriers are greatly influenced by context, hence there is no one consistent strategy for overcoming them. The following part describes the four types of barriers as well as suggested ways to overcome them based on the interviews.

8.4.1. Matrix to assess opportunities for influence and intervention to overcome barriers

When a barrier arises when going through the steps of the road map, the matrix of Moser and Ekstrom (2010) can help assess how much influence you have in overcoming the barrier. Moser and Ekstrom (2010) created a matrix where you need to assess your position given the barrier, thus if you are near the barrier or far away, or if you are in direct control to do something or not. Second, you need to know if the barrier is contemporary or structural. A barrier is structural if it is a structural barrier in the system, for example, funding. Funding is contemporary when there is no budget for a green roof in a particular project. It is structural when over the past years, there have not been going enough resources for climate adaptation measures in a municipality, resulting in a structural shortage of resources (Moser & Ekstrom, 2010). The final step is determining the location in the matrix of figure 8.3. Knowing your position in the matrix allows you to determine how much influence you have over the barrier. The following describes the difference in control and action options, followed by examples from the interviews showing how the interviewees managed the barriers.

A Contemporary and nearby, the actor has direct control to solve the barrier.

B Structural and nearby, the actor has control over initiating changes, but cannot make changes directly. Making it more challenging.

C Contemporary and far away, the actor does not have control of the barrier, but the barrier is happening now.

D Structural and far away, the barrier is not easily overcome by addressing its source, or by having significant resources, time and expertise. The barrier is out of control for the actor and it is a structural barrier in the system.

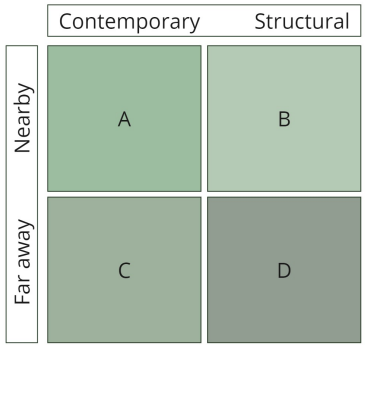

Figure 8.3: Matrix to assess opportunities for influence and intervention to overcome barriers (Moser & Ekstrom, 2010).

Contemporary and nearby

The interviews revealed all forms of barriers; for example, someone from a municipality observed a barrier that all available types of policy were not yet known around their organization and that employees did not know where to access this type of information. The barrier is contemporary since the organization has direct control over it, and it is also exclusively placed within their organization, therefore it may be said to be nearby. To solve the barrier, the municipality established a knowledge centre in which all policies were stored and anyone throughout the organization with knowledge of any form of climate adaptation activity may participate. However, it is now quite easy to find and understand, thus it is genuinely understandable for everyone. So now they know to check the knowledge base if they have a problem with a project.

Contemporary and nearby barriers have few stakeholders involved, one could argue. As they are in direct control of the actor and nearby, the barrier often does not involve many other parties. This type of barrier could happen throughout the whole climate adaptation process.

Structural and nearby

The absence of tenant participation was identified as a structural and nearby barrier in the interviews. One municipality identified this barrier, stating that while the municipality can do a lot in the public space, the gardens at the back of the house, or the front if they have one, must not be paved over. As a result, the municipality developed a variety of projects in which residents are encouraged to participate. The barrier is structural since the municipality has no direct influence over the actions of residents; nonetheless, it is near because it is in their jurisdiction.

In the above scenario, there are just two stakeholders: the municipality and residents. This is a small number, which may be due to the location of the barrier, as the barrier is nearby. This type of barrier could arise anytime during the climate adaptation process.

Contemporary and far away

A barrier identified in the interviews by the housing organization is that everyone uses various criteria, different sorts of policies, or different procedures to test their projects to see if they are indeed climate-adaptive. They argued that this is a barrier that exists throughout the

Netherlands. As a result of the numerous stakeholders involved, it can be viewed as a barrier that is far away. However, it is contemporary since they have control over it by jointly making and using the same scan. They agreed, along with 30 other stakeholders, to develop an open and transparent process for conducting a climate risk scan at the building level. So the physical climate risk is the chance that your building will suffer from physical difficulties due to heat stress or flooding, not the transition risks in the area. There were many scans available for it, but they were all somewhat black box techniques. Then one building received a green rating while the other received a red rating, although it was unclear why. As a solution, they consulted with 30 parties before deciding to offer such scans.

A barrier that is located far away could face more parties involved. Therefore, as shown in this example, good stakeholder communication and a solution that is created together are very important to overcome such barriers. Especially because this type of barrier is contemporary, so there is more influence to make changes for the better.

Structural and far away

A structural and far away barrier is that climate adaptation is not seen as standard practice and it is not a priority for a municipality. As someone from a municipality stated in the interviews:

"I actually think that the benchmark can be much more compelling. Everything that is now called a guideline, I actually think that everything should simply become a standard. Now I already know that I will have discussions, one is a guideline and the other is a standard, so you don't necessarily have to comply with that. If they had said, this is just the standard, you have to meet it, then it would have been easier for me to get things done in such a municipality".

When asked if he thought this would change, he was hesitant as he believed there was too little knowledge in the higher government to make a decision. In this example, there are several barriers in place, such as knowledge, finances, and legal procedures. As there are multiple barriers in place, it is more difficult to have control over the barriers. The barriers are also not easily fixed. Therefore, it can be seen as a structural and far-away barrier.

This type of barrier often has multiple stakeholders involved. Also, it is not easily fixed and good cooperation and communication between parties involved is necessary.

9 Discussion and conclusion

The discussion will first show the interpretation of the results, presented per research question. The interpretation of the results will be put into the context of the framework of Moser and Ekstrom (2010) and how it connects to the difficulties of implementation. Then the limitations, conclusion, implications, and recommendations for further research will be shown.

9.1. Interpretation of results

The interpretation of the results will be put forward per research question. The conditions for the road map's success will also be addressed.

9.1.1. Policy description

In this section, the results of the question: *"What types of policy for climate adaptation are available in the Netherlands?"* will be answered.

Climate adaptation plans have been developed at all levels of government in the Netherlands. The National Adaptation Strategy (NAS) was developed in 2016 before there were other local strategies. There have been many policies written, but few have been implemented. In the Netherlands, the emphasis is currently on understanding and planning for climate adaptation. Although there hasn't been much action taken yet, there is a lot of debate about the necessity for actions to adapt to climate change. The NAS was the first policy, however, it was not implemented as rapidly as needed, according to the 2022 evaluation. The national government also took a long time to develop policies for new buildings and climate-friendly housing, demonstrating that they could perform better in terms of planning and coordination. Meanwhile, provinces and municipalities developed their own policy texts to be followed. This created ambiguity for policymakers and other stakeholders involved in climate adaptation. Local governments are crucial because they deal with the local implications of climate change Eriksen et al. (2015). National governments, on the other hand, are critical for ensuring that everything fits together, preparing for the long term, and including climate adaptation in their big plans (Ford & King, 2015). Because of the national government's lack of long-term planning, an uncertain scenario developed in which many local governmental organizations did not know how to act on climate adaptation.

In summary, there are many policy documents in the Netherlands, but the national government should have acted faster in making these plans happen. Right now, the country is mostly in the understanding and planning phase, even though there are lots of policies in place. Not implementing enough yet. The stakeholder analysis and interview research shed light on the underlying reasons for this conclusion, as discussed in the upcoming paragraphs.

9.1.2. Stakeholder analysis

To answer the question *"Who are the stakeholders and how are they connected to each other?"*, first a critical analysis of the stakeholders will be given. Followed by an explanation of how they relate to each other in the light of the framework of Moser and Ekstrom (2010).

Review of list of stakeholders

The list of stakeholders interviewed in this research consists of the following:

1. Provinces
2. Municipalities
3. Property developers
4. Housing associations
5. Financiers and real estate investors
6. Regional water authorities
7. Consultancy and design firms
8. Tenants
9. Retail organisations

Provinces frequently play an important role in offering a broader regional viewpoint, helping municipal collaboration, and connecting policies with regional characteristics. Difficulties in balancing regional interests may occur, and provinces may encounter difficulties in aligning strategies with various local needs.

Municipalities are at the forefront of climate adaptation, dealing with immediate local implications. They have the ability to adjust methods to specific community requirements and conditions. Their ability to adopt adaptation strategies may be limited due to resource restrictions. There may be differences in commitment and capacity among municipalities.

Property developers can help by adding climate-adaptive designs into new developments, demonstrating that environmentally friendly practices can be commercially viable. The problem is for developers to emphasize long-term sustainability over short-term economic rewards. It's possible that there will be situations where financial success comes before climate resiliency.

Housing associations have a large impact on social housing and can include climate resilience in both new and existing buildings. Limited resources may slow down implementation. Achieving a balance between social and environmental goals may present difficulties.

The financial backing of financiers and real estate investors is critical for large-scale deployment. They may encourage projects by ensuring their financial viability. Profitability concerns may lead to a reluctance to invest in long-term projects. Financial interests must be aligned with sustainable practices.

Regional water agencies help to increase overall resilience. They frequently collaborate with municipalities. The scope may be limited to water-related issues, necessitating a more integrated strategy with other stakeholders.

Consultancy and design firms offer experience in planning and design, assisting in the development of climate-resilient infrastructure. Their participation in the early stages is crucial. Consultancy and design firms act on the assignment received, and their advice may not always

be consistent with long-term sustainability objectives.

Tenants are actively involved in the managing phase, they are crucial for the actual implementation of adaptation measures. They have limited influence in decision-making processes, especially in comparison to property developers and financiers.

Retail businesses may be able to persuade consumers and supply chains to adopt more environmentally friendly and climate-resilient practices, depending on the type of retail they engage in. However, emphasizing short-term earnings above long-term sustainability may be difficult. Effectively engaging retail enterprises can be challenging.

The stakeholders are based in the stakeholders mentioned by Arcadis and Tauw (2023) in the "Maatlat groene klimaatadaptieve gebouwde omgeving". Tenants and retail organisations have been added. This was done as tenants can have a big influence on creating a climate-adaptive environment. Their gardens or how they design their homes, can influence the whole neighbourhood especially if it is done by multiple homes. Retail organisations have been considered as stakeholders as well. They design products that play into a problem that is not or cannot be fixed easily. For this research, it was interesting to know why they design these products, if they see changes in the market and how they experience the current climate adaptation situation in the Netherlands.

Stakeholders in relation to the framework

Within the framework proposed by Moser and Ekstrom (2010), not all stakeholders are uniformly engaged across the various stages of the climate adaptation process. The ideal scenario involves every stakeholder contributing during the understanding phase, where the identification and definition of the problem take place. In the context of governmental organizations, the national government, alongside provincial organisations, primarily operates within the planning phase. This requires developing visions and objectives and directing municipalities and regional water authorities to carry them out. As a result, municipalities and regional water authorities take the lead during the management phase, while also contributing to the planning phase through the development of their own policies. Property developers play an important role in the planning phase, necessitating a thorough understanding of relevant climate adaptation methods when designing new areas. Financiers and real estate investors are primarily present during the management phase, reviewing financial support plans developed by other stakeholders. Their assistance throughout the management phase is focused on assuring the implementation's financial feasibility. A critical note should be made, that when considering the created road map, the financial support is already brought to attention in the planning phase. Showing a difference in the framework of Moser and Ekstrom (2010) and the phases of the created road map.

Housing associations exhibit extensive involvement across all stages. They oversee the progression and construction of (socially) rented housing in collaboration with municipalities, managing a substantial real estate portfolio that includes pre-existing (socially) rented residences and associated outdoor facilities. Consultancy and design firms primarily operate during the planning phase, offering advisory services. Tenants are more in the managing phase, as they are responsible for executing and overseeing the implementation of adopted climate adaptation measures.

Governments are integral to the climate adaptation process due to their involvement in policy planning and development. However, effective implementation of policies and measures necessitates the engagement of various stakeholders, each contributing in unique ways (Eriksen

et al., 2015). Stakeholders can participate informatively, provide expertise, or actively engage in decision-making processes (Bauer et al., 2012). The specific form of participation required depends on the decision-making context. To successfully implement climate adaptation strategies, it's crucial to comprehend the stakeholders' roles and relationships, enabling their contribution at the appropriate stage of the process. While the ideal scenario has all stakeholders participating in the understanding phase, problem definition and identification should occur throughout the whole process.

9.1.3. Factors for implementing climate adaptive measures

The results of the factors that should be taken into account when implementing climate adaptation measures can be divided into two parts. The factors that belong to the governance section and the factors that belong to the biophysical environment. This section shows the results of the question: *"What factors should be taken into account when implementing climate adaptation measures?"*.

Governance

The factors that belong to the governance section have been predefined by the RIVM (2013). All the factors mentioned have been found in the interviews, however some factors more than others. The use of communication for public participation and regulation and making information available at a local level have both only been found once in the interviews. However, that does not mean that they are not factors that play a role during the climate adaptation process. As for the use of communication for public participation and regulation, research of Moser (2014) and Kreemers, van Brecht, Bakker, and Renes (2020) shows that this is an essential factor but has not been done enough yet. Due to the lack of awareness of climate adaptation and therefore participation, they suggest communicating more if you want participation from the public. They recommend increasing the risk perception of climate change, in costs and benefits, to show easy options to participate and to try to increase their feelings of responsibility. When looking at the factor to make information available at a local level, this has been done already. There are easily accessible websites in the Netherlands, such as klimaatadaptatienederland.nl and amsterdamrainproof.nl. Municipalities and provinces also offer information about climate adaptation on their websites.

Biophysical environment

The factors of the biophysical environment were derived from the interviews. The difficulties associated with excessive groundwater levels and the implementation of solutions were more prevalent in the interviews than the challenges associated with low-ground water. This could be attributable to the geographical location of those interviewed. Thus, this does not rule low groundwater out as a factor. The difference in soil type was not discussed in the literature review. The results showed that some soils can infiltrate water better than other soils. In the interviews, it was mentioned that sand can store and infiltrate water better than other soil types, such as peat. This is consistent with the research of Ekwue and Harrilal (2010). The availability of space factor discovered in the interviews makes sense given the Netherlands' dense population and densely developed character. Due to this, climate adaptation is often combined with spatial planning (Goosen et al., 2014).

These findings highlight factors that should be considered when implementing climate adaptation measures, both from a governance and a biophysical environment standpoint. It demonstrates how social and environmental factors have an influence on the creation of an environment in which climate adaptation measures can be easily implemented. However, it should be noted that these are merely a few of the characteristics discovered throughout the

interviews. There may be additional aspects that should be considered but were not discovered in this study. These factors are most important to take into account during the planning phase. In this phase, the plans are being made and the governance and biophysical environment factors influence the creation and understanding of these documents.

9.1.4. Barriers and enablers

The climate adaptation process is divided into three phases: the understanding phase, the planning phase, and the managing phase. The barriers and enablers discovered during the interviews can be classified into one of these phases. The barriers were established using the framework of Moser and Ekstrom (2010). Enablers and extra barriers were discovered during the interviews. Not all barriers listed in the framework of Moser and Ekstrom (2010) were found in the interviews. Numerous barriers were discovered just once or twice and may, for example, only be a personal barrier. Therefore, codes found more than once or twice have been carefully analysed. This section will show the results of the question: *"What are the barriers and enablers during the climate adaptation process?"*.

Understanding phase

The main barriers found in the understanding phase were the detection of a signal, interest and focus, availability and threshold of response feasibility. The barriers discovered in the interviews were primarily related to knowledge. Lack of knowledge is a significant barrier that influences other obstacles such as lack of awareness and thus no understanding of the need for climate adaptation. It also has an effect on people's perceptions of feasibility. They feel hesitant to experiment since they do not have enough information to determine if it would succeed. This causes the parties involved to react slowly. Notable was the discovery of an enabler for the detection of a signal for climate adaptation. The interviewees did perceive the effects of climate change and hence felt the need for something to be done. This can mean that there is awareness of climate change and that something must be done, but that there is insufficient understanding to link climate adaptation to this.

Planning phase

Within the planning phase, there were only a few barriers found. The two main barriers were the ability to develop and agree on a range of options that meet identified goals and criteria, and the level of agreement on goals, criteria and options. The first barrier was linked to little knowledge of the long-term effects of measures and the difficulty of translating problems into measures. This shows that there is a lack of knowledge about the best manner to choose climate adaptation measures. As climate adaptation measures are very context-dependent, this focuses mainly on how the decision-making process currently goes. The barrier agreement on goals, criteria and options shows the difficulties of creating goals and reaching the intended criteria.

Managing phase

During the management phase, the main barriers are financial and legal. Because of the numerous diverse policies in the Netherlands, there is a lot of confusion about what to put into practice and what policy to follow. Because the policies are not legally binding, the interviewees believe people will easily disregard climate adaptation measures. In terms of financial constraints, it is believed that implementing measures is too expensive. Within the managing phase, an enabler has been discovered, namely that some measures cost the same as normal practice. For example, a white roof compared to a black roof. With the recent weather developments in the Netherlands, It should also be emphasised that the initial investment in climate adaption measures may be more, but the harm caused by extreme weather events may outweigh these investment costs.

Discovered barrier

The barrier found outside of the framework was conflicting interests. Conflicting interests are a barrier that connects to many other barriers, but due to its prime presence throughout the interviews, it is its own barrier. The Netherlands is a small country, where spatial planning is important. During this planning process, there are often conflicting interests and climate adaptation does not always get the preference.

Conflicting interests is a barrier that is closely related to figure 2.1 of Moser and Ekstrom (2010). In the figure, the structural elements, the actors, the context and the system of concern are all related to each other. Between these elements, conflicting interests can occur, as conflicting interest is at the centre of actor interaction.

9.1.5. Road map

The road map is a product of all the results of the previous sections. It shows how policy can be implemented, considering the stakeholders, factors and barriers that can arise during the climate adaptation process. The road map is of importance, as it can be beneficial for collaborative municipalities to have such a road map, so they speak the same language. By having this, it is easier to share knowledge and create policies that have been streamlined at various levels of government. The road map can help municipalities to accelerate climate adaptation in an organized manner.

The road map shows that before coming to implementation, the understanding phase is important and that there needs to be attention to it throughout the entire duration of the project. It also shows that when you want to implement and tackle the barriers that arise during implementation, you need to address this already in the planning phase. Research of Brody and Highfield (2005) shows that when there is a deviation from the agreed-upon plans, it tends to occur more often in the same places and under the same conditions. Showing that the use of a predefined road map could be useful. Furthermore, well-planned plans are associated with a higher level of plan implementation. This emphasizes the need for thorough planning, but also the importance understanding of the road map to see where specific barriers could arise so they can be solved quickly.

There are some conditions in which the road map would work best. The road map is focused on helping municipalities in the Netherlands get a better view of what they need to consider when implementing climate adaptation measures. Some municipalities have their own climate adaptation department, and for them, it can serve as a checklist to ensure that every relevant aspect has been covered. For other municipalities, it can serve as a guideline to assess where barriers could arise and see how much time it would cost and how many people they would need to implement the climate adaptation measures. Not all municipalities have the resources, money, people, or knowledge, however, they can work together regionally or create an alliance with different municipalities to combine resources. To allocate more budget the municipalities can see if they can combine the implementation with other subjects, such as changes that need to be made in the sewage system.

The matrix to assess opportunities for influence and interventions to overcome barriers of Moser and Ekstrom (2010) describes four barriers, the first being contemporary and nearby, the second is structural and nearby, the third is contemporary and far away and the fourth is structural and far away. All four barriers were found in the interviews, and the first three solutions were presented in the interview as well. However, the last barrier had no solution that

could be found in the interviews. If all barriers would fall into this category, finding solutions would be difficult. As the barrier is structural and far away, it means that it is repeatedly encountered and that there is no one really responsible for the barrier. Resulting in difficulty in solving this type of barrier. This demonstrates that extra attention is required for this type of barrier in order for the climate adaptation process to function properly.

9.1.6. Limitations

The framework was selected after the interviews were performed, which is the main limitation of this study. As a result, the interview protocol does not correspond to the framework. There was an attempt to find a framework that would fit the interview material, but the findings might be biased as a result. Some barriers that were defined by Moser and Ekstrom (2010) were also missed, which might be attributed to not asking appropriate questions throughout the interviews. As a result, further interviews with the framework in mind could therefore be conducted for future study. To see if the same barriers appear or if new ones develop.

Another potential issue is that this research was conducted for Arcadis, and some of my respondents were Arcadis employees. This might have resulted in a bias in selection. The following research might benefit from a better selection of respondents who are not affiliated with a particular organisation. To determine whether the interviewees are in fact experts in their fields, a test could be applied in further study. Another list including participant location, organization type, and role might be developed to collect respondents. This would ensure that the views of people about climate adaptation are evenly distributed throughout the Netherlands.

Other biases include the respondents' geographical location and the culture of the organisations where they work. The interviewees' geographical location determines what is achievable and what the risks of climate change are. As a result, their perspective on the importance of climate adaptation may be influenced. Because some companies are more progressed in their climate adaptation initiatives, certain interviewees may be more in favour of climate adaptation.

Another limitation could be that the road map is only validated by one municipality. Hereby there is only one viewpoint on the use of the road map and steps that could be different in order to offer more guidance. Just as insights in climate adaptation are constantly evolving, the framework will need to evolve by implementation in different municipalities, growing validity and added value along the way.

A final barrier is that throughout the thesis it has been chosen to not link any stakeholder specifically to certain tasks. However, this allows the research to remain unspecific. It has been chosen to not link any stakeholder to a task, as the climate adaptation process is very context-specific. As there was only one or two interviewees per stakeholder group, there was not enough information to generate tasks for the belonging group. However, for future research, the roles and belonging tasks of stakeholders for implementation should be investigated further.

9.2. Conclusion

The goal of this study was to determine how climate adaptation strategies can be implemented and what obstacles have arisen along the way. The study aims to uncover barriers, as well as the contextual elements that influence climate adaptation and how stakeholders participate in the adaptation process. The answers to these questions provide insights into how municipalities might transition from policy to implementation.

This study examined several policy documents, examined stakeholders and their relationships to the climate adaptation process, revealed contextual factors that play a role when implementing climate adaptation measures through interviews and revealed the barriers encountered during the process. These findings served as the foundation for the road map. It demonstrates how policy can be implemented while taking into account stakeholders, contextual factors, and barriers that may occur during the climate adaptation process. This can assist municipalities in moving from the planning or understanding stage to the management stage and beginning to implement their policies by demonstrating where change should occur in order to prevent barriers.

In summary, the road map outlined in Chapter 8 provides a clear answer to the question: *"How can climate adaptation policies be implemented in the Netherlands?"*. It serves as a practical guide, considering stakeholders, factors, and potential barriers. The road map is especially valuable for collaborative municipalities, offering a shared language that facilitates knowledge exchange and the creation of well-coordinated policies across different government levels. With this road map, municipalities can efficiently accelerate the implementation of climate adaptation measures in an organized manner.

The knowledge I gained during my master's program in Industrial Ecology assisted me in answering this question. Because of the interdisciplinary approach, it was learned early in the program to take a holistic perspective regarding particular issues. Industrial ecology also emphasizes the importance of proper governance, governance strategies, and policies. This was useful for taking a critical look at existing policy and developing the road map.

As we face an uncertain future in the context of climate change, the lessons from this thesis can serve as an orientation to a future-proof built environment. This thesis generates more understanding of the climate adaptation process, what the barriers are in the Netherlands and how the actors and phases relate to the process. Providing the road map allows more certainty for municipalities to choose the right action and it assists them in involving stakeholders throughout the process. This research can be seen as one of the starting points of helping municipalities to implement climate adaptation policy, by providing a clear overview throughout the whole process with the inclusion of phases and actors. We can pave the way for climate adaptation by overcoming the identified barriers and protecting both our environment and our communities for future generations.

9.2.1. Implications

To bring climate adaptation measures into place, this research can clarify the barriers and steps that you need to follow. The research and road map can assist in understanding the challenging context of climate adaptation. This research offers a clear overview throughout the entire process of where the barriers are in the Netherlands and how climate adaptation measures can be implemented. By carefully considering stakeholders, factors, and potential barriers, this road map offers a practical guide for municipalities. The significance of this approach lies in its ability to create a shared language among collaborative municipalities, streamlining knowledge exchange and policy development across various levels of government. This road map serves as a valuable tool, empowering municipalities to accelerate climate adaptation initiatives in an organized and efficient manner.

9.2.2. Recommendations for further research

As a result of this research, future studies can be conducted to advance past the starting point created by this thesis, contribute even more to our understanding of the process of climate adaptation, and overcome the barriers identified in this research.

Additional studies on this issue might look at citizen engagement and see what can be accomplished if people participate in climate adaptation efforts. The study could provide insights into their actions and attitudes, and it could also look into what would inspire individuals to engage. There might also be studies done after implementation has been done to look back and analyze where the barriers were and what would have helped them best during the other phases, such as understanding and the planning phase.

For further research, other stakeholders can be taken into account as well. The national government could be interviewed to see their perception towards the implementation of climate adaptation measures. In this research, there was little attention to the role of tenants. Thus, for further research, this could be taken into account more.

As for the structural and far away barrier, as mentioned in Chapter 8, the research has not found a solution. This could be further investigated in future research.

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A

Measures climate adaptation

These measures have been found in research from Kennisportaal Klimaatadaptatie (n.d.), European Commission (2023), Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (2020), Voskamp and Van De Ven (2015), de Bruin et al. (2009) and van Hooff et al. (2014). They have been put together in the tables A.1, A.2, A.3, and A.4.

Heavy precipitation
Avoid square and rectangular flat surfaces perpendicular to the wind
Entrance higher than ground level
Parking basement or other underground space that can (temporarily) hold water
Minimal other inflow points (cellar window, cavity and/or crawl space ventilation)
Anti-return valves for toilets and sinks/sewage pumps
Placement of fixed equipment and installations higher
Place sockets, switches and connection points high enough
More green (so that water is absorbed by the roots of the plants and trees)
Green facade
Green roof
Blue roof
Metal for roofing
Pitched roof
Inverted roof
Warm roof
(Nature-friendly) wadi (storage and drainage)
Rainwater pond with access to sewerage
4mm thick tempered glass panes
Storage (crates) under the paved surface (with slow passage to sewer)
Ditch or infiltration strip
Maximum garden level
Replace cladding, flooring, and linings with water-resistant materials
Maximum of hardening garden/private terrain
Build a second or multiple stories and use the lower storey as non-living or 'non-productive' space
Ground preparation
Porous pavement
Gravel in garden
Disconnect drainpipe with infiltration possibilities
Sustainable urban drainage systems (SuDS)
Rainwater tanks
Passive landslide control measures
Inspection and cleaning of the roof drain, gutters and downspouts, and snow
Rainscreen or cladding system

Table A.1: Measures for heavy precipitation

Heat
Orientation of main facades away from direct sunlight to minimise solar gains
Reflective glass
Limiting glass surface
Insulation of walls, windows and roofs
Exterior shading for windows
Photovoltaic (PV) installations on roof
Green roofs
Light-coloured roof
Green facades
(Architectural) overhang
Presence of non-active cooling
Possibility to open windows for ventilation / natural ventilation
Design planting and landscape to provide for shading in garden/on building
Aquifer Thermal Energy Storage (ATES)
Temperature zones (preventing flow of heated air)
Thermal mass and phase-change materials
Active cooling and ventilation
Connection to district cooling

Table A.2: Measures for heat

Risk of flooding
Square shape
Preliminary soil study
Entrance higher than ground level
Parking basement or other underground space that can (temporarily) hold water
Minimal other inflow points (cellar window, cavity and/or crawl space ventilation)
Placement of fixed equipment and installations higher
Place sockets, switches and connection points high enough
Replace cladding, flooring, and linings with water-resistant materials
Build a second or multiple stories and use the lower storey as non-living or 'non-productive' space
Permanent flood barrier (automatic barriers, flood walls, retractable barriers)
Temporary flood barriers (flood shields, sand bags, deployable and inflatable barriers)
Buffer zones around the building
Drainage system around the building
Tree planting

Table A.3: Measures for risk of flooding

Subsidence
Greenspace management regimes
Keep trees at a safe distance from the building and keep the amount to a minimum
Deep or semi-deep foundations
Underpinning
Homogenous foundations (avoid partial basements)
Structural strengthening (horizontal and vertical reinforcements)
Movement joints

Table A.4: Measures for subsidence

B

Characteristics of experts interviewed

Table B.1: Characteristics of experts interviews

Expert number	Stakeholder area
Respondent 1	Consultancy and design firms, knowledge institution
Respondent 2	Retail organizations
Respondent 3	Municipality
Respondent 4	Housing association
Respondent 5	Property developer
Respondent 6	Consultancy and design firms
Respondent 7	Knowledge institution
Respondent 8	Retail organizations
Respondent 9	Province
Respondent 10	Consultancy and design firms, ecologist
Respondent 11	Regional water authority
Respondent 12	Municipality

C

Interview protocols

Both interview types had an introductory and finalizing part, where the thesis was explained, consent was asked and some chatting was done.

C.0.1. Interview protocol normal

1. What kind of job do you have?
2. What does climate adaptation mean in your field of expertise?

   - Do you have an example of climate adaptation in your field of expertise?
3. Are you aware of the "green climate-adaptive built environment" for new construction in the Netherlands?

   - Do you notice changes in your area of expertise due to the "green climate-adaptive built environment"?

   - Do you think measures like these are necessary?

   - What kind of measures would you advise?

   - What is considered when deciding on the measures?
4. In recent years we have seen a trend in nature-inclusive construction, for which various measures have been created, such as green roofs and green facades. Do you think this is more important than other types of measures?

   - What kind of measures are best for nature-inclusive construction and promote climate adaptation?

   - Do you believe there are chances of contributing to the energy transition? If yes, how may these be carried out?
5. How does the final decision-maker participate in the process?
6. Is there a lot of difference in types of homes, so between an apartment complex and a terraced house for example, in terms of measures that are possible?

   - Can you elaborate on this?
7. The effects of climate change will probably only get worse, how is this taken into account in the project?

   - Would you mind listing the top three measures that you believe are most future-proof?
8. Do you have any supplementary information or important topics that I should pay attention to for my research?
9. Do you have any further questions?

C.0.2. Interview protocol ecologists

1. What kind of job do you have?
2. What does climate adaptation mean in your field of expertise
3. Are you aware of the "green climate-adaptive built environment" for new construction in the Netherlands?

   - Do you think these measures are necessary?

   - What kind of measures would you advise?

   - What are common trade-offs between climate-adaptive measures and green solutions?

   - What is considered when deciding on the measures?
4. What is the importance of measures with a focus on nature inclusion?

   - What role does nature play in climate adaptation?

   - What kind of measures are best for nature-inclusive construction and promote climate adaptation?

   - Do you believe there are chances of contributing to the energy transition? If yes, how may these be carried out?
5. What should be taken into account when installing green measures?
6. How can someone with little garden space or an apartment implement measures that promote biodiversity?

   - To what extent are residents important in the successful implementation of nature-inclusive measures? How can you make them aware of this?
7. Do you prefer collective solutions?

   - Can you give some examples?
8. The effects of climate change will probably only get worse, how is this taken into account in the project?

   - Would you mind listing the top three measures that you believe are most future-proof?
9. Do you have any supplementary information or important topics that I should pay attention to for my research?
10. Do you have any further questions?

D

Code trees for factors of implementing climate adaptation measures

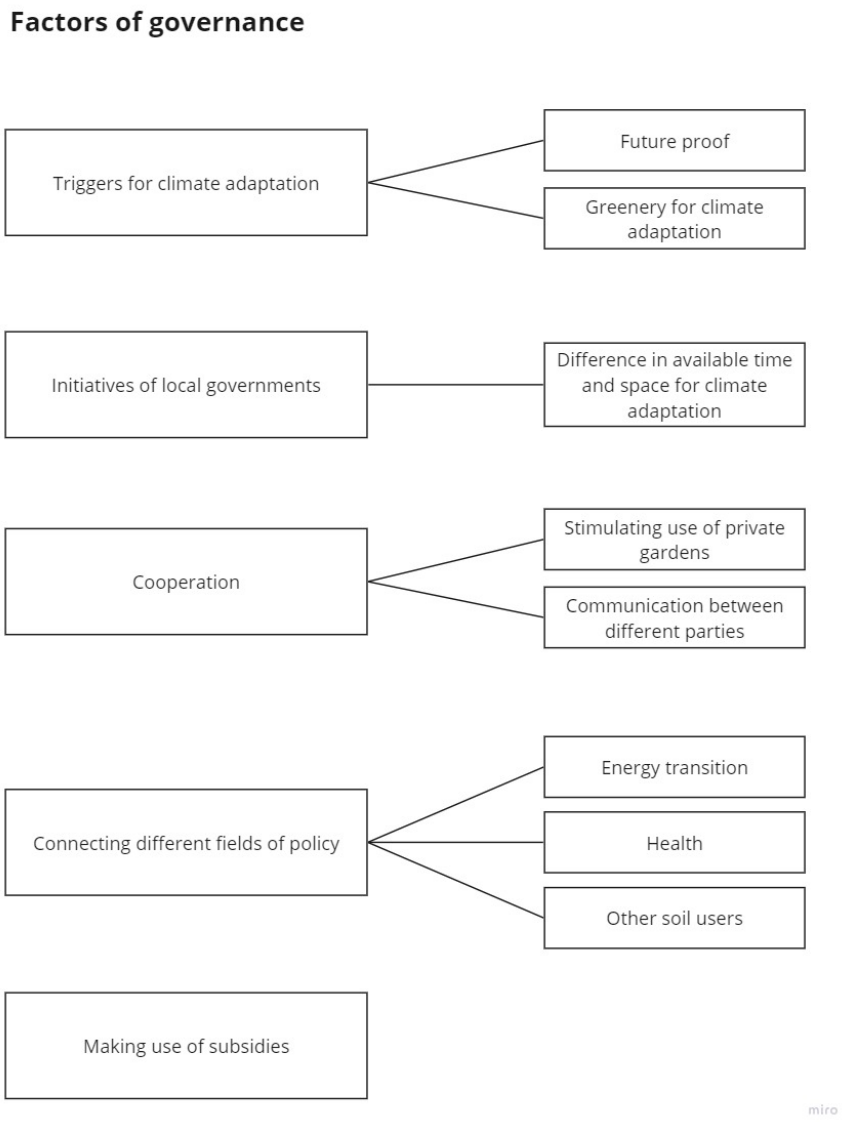

Figure D.1: Code tree of the factors of governance.

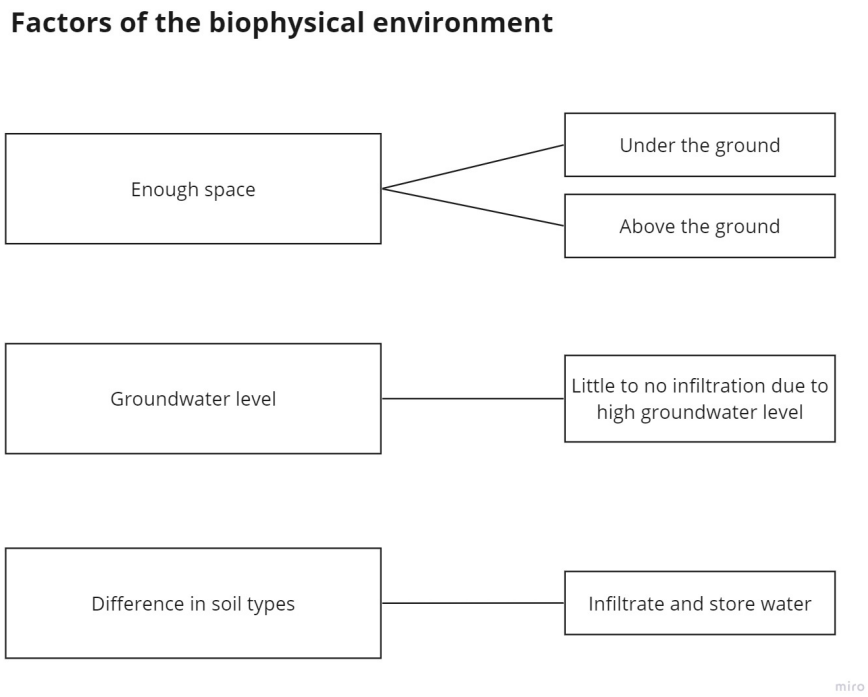

Figure D.2: Code tree of the factors of the biophysical environment.

E

Code trees of found barriers and enablers

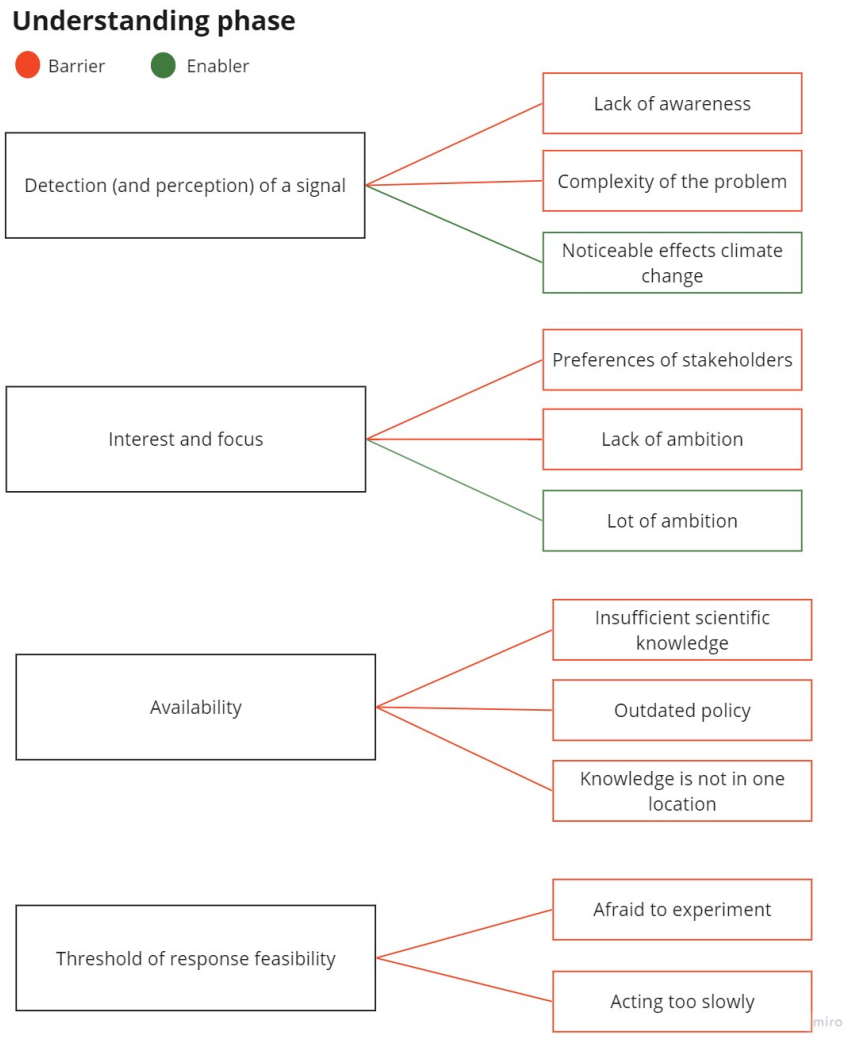

Figure E.1: Code tree of the barriers and enablers in the understanding phase.

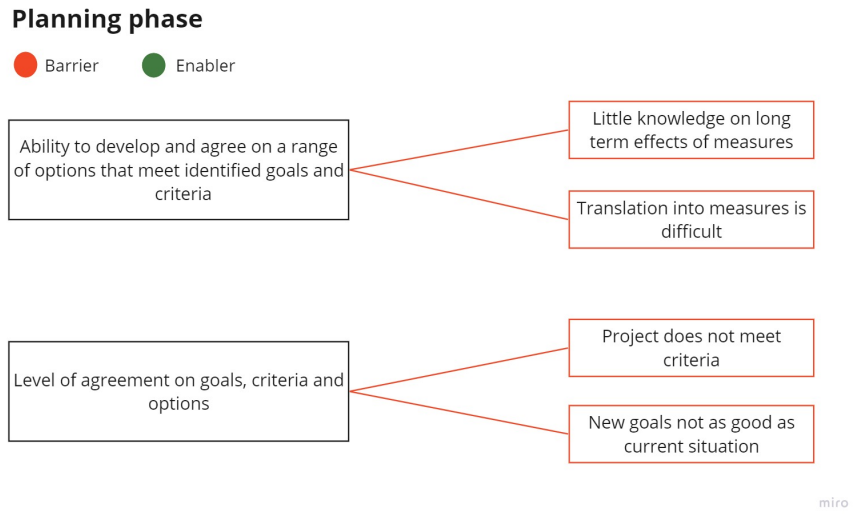

Figure E.2: Code tree of the barriers in the planning phase.

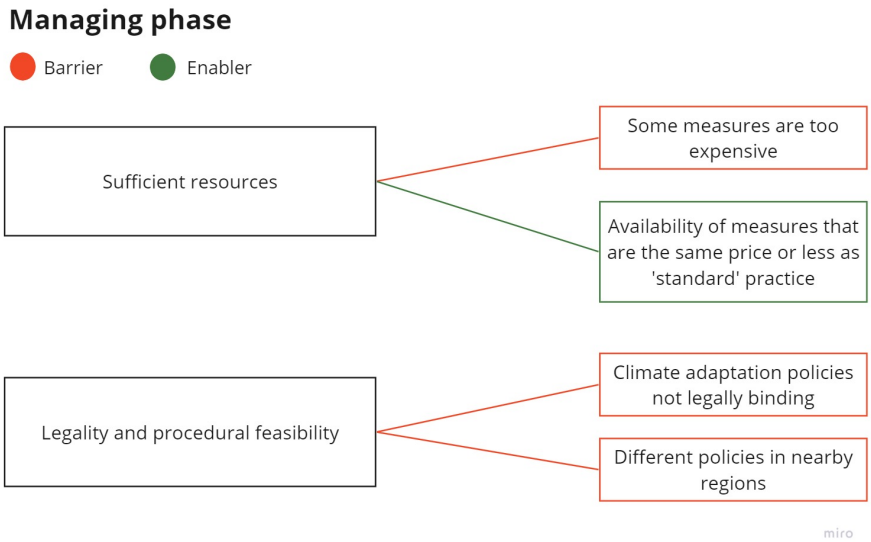

Figure E.3: Code tree of the barriers and enablers in the managing phase.

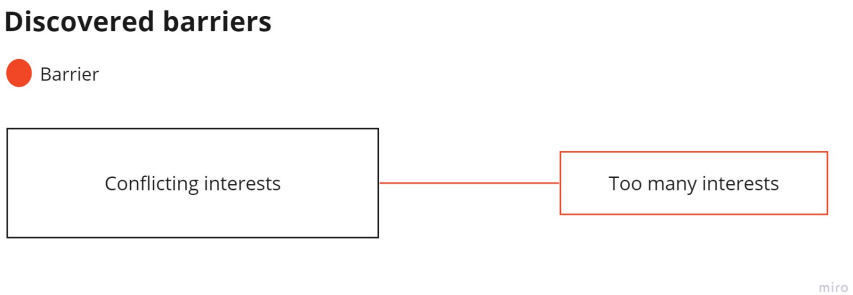

Figure E.4: Code tree of the discovered barriers and enablers.