



Adaptation in Limburg

An evaluation of the adaptive capacity of the institutional arrangement surrounding the drinking water services in the Dutch province Limburg in light of the increasing pressures put on water quality due to climate change

Bachelor thesis Geography, Planning and Environment (GPE)
Nijmegen School of Management
Radboud University
August 2018

Renée Beelen

Adaptation in Limburg

An evaluation of the adaptive capacity of the institutional arrangement surrounding the drinking water services in the Dutch province Limburg in light of the increasing pressures put on water quality due to climate change

Bachelor thesis Geography, Planning and Environment (GPE)
Nijmegen School of Management
Radboud University
August 2018

Student: Renée Beelen
Student number: 4417461
Supervisor: M. Kaufmann
Word count: 20211

Cover image: Adapted image from *Kaart Limburg* [map]. Retrieved on August 25, 2018, from:
<http://limburg-kaart-vakantie.blogspot.com/2013/02/kaart-limburg-maastricht-vakantie.html>

Preface

This thesis completes my one-year pre-master programme Environment and Society studies at the Radboud University Nijmegen after which I will continue with the one-year master programme of the same name. The writing of this thesis was one big learning process and I take the lessons learned with me to my master studies and hope to improve further.

I would firstly like to thank the interviewees for making free some of their time during their working hours to help me with my thesis. Secondly, I would like to thank my family and friends for supporting me though my ups and downs; my fellow students' enthusiasm for their projects motivated me for mine. Finally, I would like to thank my supervisor Maria Kaufmann for the helpful feedback she provided to me during me writing process.

Renée Beelen
Nijmegen, 2018

Summary

The effects of climate change are or will be felt all around the world and action is required. The science around climate change is well-developed, however tackling the issue in a social setting, reaching a consensus, creating policies and then proceed to taking action brings forth many difficulties. Climate change has been described as *wicked* problem and in recently has been elevated to the description of a *super wicked problem*. These are societal problems which, to name but a few of the characteristics, have no straightforward solution, in which many stakeholders are involved, which have no clear ending, of which the time is running out and those who cause the problem also seek to provide the solution (Rittel & Webber, 1973; Levin, Cashore, Bernstein & Auld 2012) Nonetheless, despite the difficulty of the matter it is important to address the issue of climate change and to mitigate and adapt in order to protect and preserve not only the human world but also the ecosystem of the planet.

One of the resources which is affected by climate change is freshwater. Climate change negatively impacts the quality of freshwater. It is essential to human life and no substitutes are available but in a global perspective, we are nearing the limits of human exploitation of freshwater resources. Due to population growth, urbanization and shifts towards more meat based diets more pressure will be put on the world's freshwater resources (Cooley et al., 2014). The resources which are available to us should therefore be treated with care and in order to secure the availability of this precious resource adaptation strategies need to be implemented.

The Netherlands also suffers from the effects that climate change has on the quality of freshwater resources and there have already been situations in which there was a greater demand for freshwater than there was available (Ministerie van Infrastructuur en Milieu, & Ministerie van Economische Zaken, 2015). The issues with water quality are closely linked to water quantity issues; droughts aggravate the already existing water quality problems and an increase in precipitation causes more runoff from agricultural lands into surface waters (RIVM, 2010). Adaptation strategies are needed but the question arises whether the institutions in the Netherlands are capable of devising and implementing adaptive strategies and to what degree. This capability is called adaptive capacity and it is the focus of this research.

For this research the institutional arrangement surrounding the drinking water services in the Dutch province Limburg has been evaluated on its adaptive capacity. It is a case which could be representative of the other institutional arrangements in the Netherlands. This evaluation has been conducted by making use of the adaptive capacity wheel, a theory by Gupta et al. (2010) which provides a methodical way of evaluating the adaptive capacity of institutions. This theory has divided adaptive capacity into six dimensions. Each dimension has been further divided into several criteria in order to structurally evaluate each dimension. Combined, the evaluation of the dimensions provide the degree of adaptive capacity. Due to time restrictions, in this research two of the six dimensions have been evaluated: variety and learning capacity.

The dimension of variety evaluates whether there is room in the institutional arrangement for differences; be it different actors, different sectors or different solutions. Having different options and insights into issues such as climate change and water quality can lead to new and perhaps better strategies to deal with the issues that come up. This dimension consists of the criteria: problem frames and solutions, multi-actor, multi-level and multi –sector, diversity and redundancy (Gupta et. Al., 2010).

The dimension learning capacity evaluates whether the institutional arrangement adapts based on past experiences. Because climate change cannot be accurately predicted, the process of adaptation can be considered a learning process and how the institutional arrangement approaches this is indicative of the adaptive capacity of the institutional arrangement (Termeer et al., 2012). This dimension consist of the criteria: trust, single-loop learning ,double-loop learning, discussing doubts and institutional memory.

The parties which have been identified to be part of the institutional arrangement are: are *Waterschap Limburg*, *Provincie Limburg*, *Waterleiding Maatschappij Limburg (WML)*, The 33 municipalities of Limburg, the *Limburgse Land- en Tuinbouwbond (LLTB)*, the *Natuur- en Mileufederatie Limburg (NMF)*, and *Rijkswaterstaat*. In order to gather data interviews were arranged with people working at the institutions or organizations. Other data was gathered through documents.

The results of the analysis and evaluation show that, based only on the two evaluated criteria, the institutional arrangement has a slight positive degree of adaptive capacity. Each criterion has been evaluated and scored on a scale from -2 to +2. The results of the evaluation are shown in the figure below.

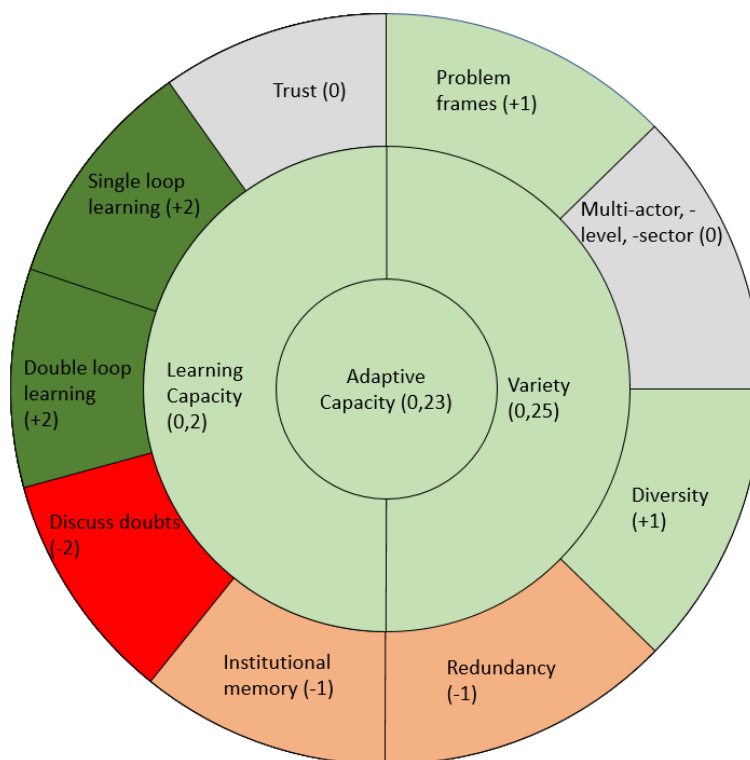


Figure 1: Results of the analysis and evaluation

The strengths of the institutional arrangement can be found in single-loop and double-loop learning as well as in the variety of problems frames and solutions and in diversity. Many instances of learning are instigated by outside influences such as the implementation of laws by the national or European government which influence the institutional arrangement. The institutional arrangement can improve its adaptive capacity in various ways. Discussing doubts is the criteria

with the lowest score and improvement can be made by openly discussing uncertainties and doubts about the managing of the issues around climate change and water quality. Doing this would also improve the score on the criterion trust, as an open discussion and dialogue fosters trust within the arrangement. Further improvement could be made by having a bigger budget. However, this is a complicated issue and the institutional arrangement is already doing well with the resources they have to their disposal.

Table of contents

Preface	III
Summary	IV
1. Introduction.....	1
1.1 Project framework	1
1.1.1 Global climate change	1
1.1.2 Water crisis	2
1.1.3 Climate change in the Netherlands	3
1.1.4 Water quality in the Netherlands	4
1.2 Research goal and research questions	4
1.2.1 Research goal.....	4
1.2.2 Research questions.....	5
1.3 Relevance	5
1.3.1 Societal relevance.....	5
1.3.2 Scientific relevance	6
1.3.3 Research framework.....	6
1.4 Outline thesis	6
2. Theory	8
2.1 Theoretical framework	8
2.2 Operationalization	10
2.2.1 Variety	10
2.2.2 Learning capacity.....	12
2.3 Conceptual model.....	13
3. Methodology	15
3.1 Case.....	15
3.2 Research strategy.....	18
3.3 Research material/data collection.....	20
3.3.1 Interviews	20
3.3.2 Secondary documents	21
4. Analysis and evaluation.....	23
4.1 Variety.....	23
4.1.1 Problem frames and solutions.....	23
4.1.2 Multi-actor, multi-level, multi-sector	25
4.1.3 Diversity	28
4.1.4 Redundancy	29
4.2 Learning capacity	30
4.2.1 Trust.....	30
4.2.2 Single-loop learning.....	32

4.2.3 Double-loop learning.....	33
4.2.4 Discussing doubts	34
4.2.5 Institutional memory.....	35
4.3 Other remarks.....	35
4.4 Evaluation	37
4.4.1 Variety	37
4.4.2 Learning capacity.....	38
4.4.3 Adaptive capacity	40
5. Conclusions and recommendations	41
5.1 Conclusions	41
5.2 Recommendations	42
5.3 Reflection	43
5.4 Further research	44
6. Bibliography	45
Attachment 1: E-mail sent to interviewees.....	50
Attachment 2: Interview Guide.....	51

1. Introduction

This introductory chapter provides a broad context for the research topic. To start with, a section is dedicated to the project framework. Second, there will be a part in which the case selection is briefly explained. The case selection will be further elaborated on in the method chapter. The third section explains the research goal, describes the research questions and includes the research framework. Then, a section on the social and scientific relevance of the research. And lastly, a paragraph explaining the outline of the rest of the thesis.

1.1 Project framework

1.1.1 Global climate change

Throughout history, earth's climate has changed so a changing climate is nothing new. However, when we talk about climate change today, we talk about the global warming and all its consequences caused by human activity. In their 5th assessment report the Intergovernmental Panel on Climate Change (IPCC, 2014) stated that the effects of an increase in atmospheric concentrations of carbon dioxide, methane and nitrous oxide due to anthropogenic greenhouse emissions combined with other drivers originating from human activity are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.

The science around climate change is well-developed. The IPCC is an international scientific body dedicated to providing the world with a clear scientific view of climate change and its possible environmental, political and economic impacts (IPCC, 2014). They have done countless research and presented several scenarios based on different amounts of greenhouse gases emitted, in order to cover several possible futures. Having scenarios helps when assessing impacts, risks, and vulnerabilities. However, no matter which emission scenario, surface temperature will continue to rise; heat waves will occur more often and be of a longer duration; in many regions extreme precipitation events will become more frequent and will be more intense; the ocean will continue to warm and acidify and global average sea level will rise (IPCC, 2014).

The effects of climate change are numerous and cannot be ignored. Action, be it adaptation or mitigation, has to be taken. However, while the science is well-developed, tackling the issue in a social setting, reaching a consensus, creating policies and then proceeding to taking action is another matter altogether. It comes with many complications and difficulties and because of this, the issue of climate change has been labeled as a *wicked problem*. Rittel and Webber introduced this term in an article in 1973 to describe societal problems that have no straightforward solutions or answers because of incomplete knowledge, the number of stakeholders involved, the problem's connection with other issues, the constant change in the understanding of the problem and the fact that there is no clear ending. They contrast wicked problems to technical problems which often do have a straightforward solution (1973). Levin, Cashore, Bernstein, and Auld (2012) went even further and described climate change as a *super wicked problem*. Four characteristics of such problems are: "time is running out; those who cause the problem also seek to provide a solution; the central authority needed to address it is weak or non-existent; and, partly as a result, policy responses discount the future irrationally" (p.123).

Because climate change is not a reversible process and because various impacts such as a rise in sea-level, droughts and extreme precipitation events will take place, it is important for the world to recognize the causes of climate change, to assess the vulnerability and risks of the affected regions, and to mitigate and adapt in order to protect and preserve not only the human world but also the ecosystem of the planet. In 2015, former Secretary-General of the United Nations (UN), Ban Ki-moon, said the following about climate change:

“Mitigating climate change and adapting to its effects are necessary to eradicate extreme poverty, reduce inequality and secure equitable, sustainable economic development. Climate change is intrinsically linked to public health, food and water security, migration, peace and security. It is a moral issue. It is an issue of social justice, human rights and fundamental ethics. We have a profound responsibility to protect the fragile web of life on this Earth, and to this generation and those that will follow” (“Secretary-General’s Remarks at Workshop on the Moral Dimensions of Climate Change and Sustainable Development “Protect the Earth, Dignify Humanity”; [As Delivered],” 2015).

As stated in the quote above, climate change is linked to water security. It is under threat because one of the resources which is affected in various ways by climate change is freshwater. Freshwater is essential to human life and has no substitutes. To guarantee the availability of fresh water in the future, adaptation strategies are needed.

1.1.2 Water crisis

Currently, most researchers agree that on a global scale we are dealing with a water crisis. (Anisfeld, 2010; Newson, 2009; Carpenter, Stanley, & Vander Zanden, 2011). The amount of water on Earth is fixed and in a global perspective, we are nearing the limits of human exploitation of freshwater resources. Increasing pressure will be put on the world’s freshwater resources due to population growth, urbanization and shifts towards more meat based diets (Cooley et al., 2014). Since 2010, the human right to water and sanitation was recognised as a human right by the UN General Assembly (United Nations, 2010) and one of the UN’s sustainable development goals is to ensure access to water and sanitation for everyone (United Nations, 2018). With increasing pressures put on fresh water resources and with the added pressure of climate change this will prove to be a challenge for many regions in the world.

As mentioned before, the availability of freshwater is essential for human life, but freshwater is not evenly distributed over space, nor is it evenly distributed over time. To make this resource available at all times water is being stored or diverted. Some examples are irrigation, drainage, groundwater pumping, levee construction, the building of dams and interbasin transfer. As a result, the freshwater ecosystems are among the most extensively altered ecosystems on Earth (Carpenter et al., 2011). But, not only availability, but also quality is important to consider when assessing drinking water availability. Availability of freshwater resources does not automatically imply clean and safe drinking water. Climate change will influence water quality negatively. A higher water temperature will promote algae growth and increase bacterial and fungi content; decreased river flow will result in salinity intrusion and more concentrated levels of pollutants, and more and heavier rainfall will result in pollutants such as pesticides to be washed from the lands into

waterbodies. Such great damage to water quality may ultimately result in a source being unsuitable for use, as purification will no longer be possible (IPCC, 2007). Other drivers that impact water quality negatively are due to human activity such as agricultural activities, industrial activities, waste management and household waste disposal.

It is not only developing countries that face these issues. An example of a water crisis in a developed country is for example the water shortage in the city of Cape-town. Recently it was one of the first modern cities which is at risk of running out of water. Due to the combination of three years with minimal rainfall and population growth, the city was, and to some degree still is, running a risk of being without any water to provide for its citizens. The citizens are asked to not use more than 50 litres a day to avoid what they call 'Day Zero', which is the day on which the taps are turned off. Already, the original 'Day Zero' of the 22nd of April has been avoided; it has now been moved to 2019 ("Cape Town drought: South African city may avoid 'Day Zero'", 2018; Mahr, 2018). This case shows that water security is a serious issue, not only in the developing world but also in developed regions of the world.

1.1.3 Climate change in the Netherlands

While the four scenarios from the IPCC give a global view on the effects of climate change, the effects will differ per region. In order to specify what exactly will, or might be happening in the Netherlands, the Royal Netherlands Meteorological Institute (KNMI) presented their own four climate scenarios for the future. These scenarios are meant to serve as a guide for developing possible strategies in climate change adaptation specifically for the Netherlands. In general, it is projected that the temperature will continue to rise, more hot summers and more mild winters will become more common, the sea level will continue to rise and more (extreme) precipitation will occur (KNMI, 2015).

As mentioned before, in a global context climate change is a *wicked*, or *super wicked* problem and even on a smaller scale the issue can be defined as such. The Dutch government is investing and has invested in programmes to gain insight into the issue and is creating mitigation and adaptation strategies to help reduce and cope with the effects of climate change. In a report by the Planbureau voor de Leefomgeving (PBL) (2015), it was noted that although the Netherlands is a well-organised country, it is not yet prepared for the coming changes to the climate due to climate change and adaptations need to be made in many areas and on all scale-levels. Without such adjustments the, what has been termed adaptation deficit, will only increase. In 2016, the National Climate Change Adaptation Strategy report was released (Ministry of Infrastructure and the Environment). This report provided a broad perspective on climate change in the Netherlands and introduced new initiatives and expanded on already existing initiatives to make the Netherlands more climate-change proof. A good example of an already existing initiative are the Delta programmes, of which the eighth version has been brought out in 2017. The Netherlands has a history of water management regarding both fluvial and coastal floods. The goal of Delta programmes is to protect the country against floods, to arrange the country in such a way that it is climate proof and to ensure that there will be enough freshwater (Deltaprogramma, 2017). The majority of the programmes focus on water issues related to quantity, but, because of the increased (and longer) periods of drought, water quality comes under pressure as well, and as a result water scarcity might occur. Therefore, Deltaplan Zoetwater (freshwater) has been introduced in 2010 to the Delta programmes and within Deltaplan Zoetwater, Delta-aanpak Waterkwaliteit en Zoetwater

(approach water quality and freshwater) of which the aim is to reduce the runoff of nutrients and pesticides to ground- and surface waters.

1.1.4 Water quality in the Netherlands

The impacts on water quality are less known than the impacts on water quantity but nonetheless deserve further examination (van Vliet & Zwolsman, 2008). In the Netherlands, there is already sometimes less freshwater available than there is demand for it and it is expected that in the future this will occur more often due to the impacts of climate change, salinization and socio-economic developments such as population growth and economic growth (National Waterplan 2016-2021, 2015).

The impacts of climate change on water quality in the Netherlands are numerous and often linked to water quality issues. A direct effect of climate change on water quality is that due to an increase in temperature there will be higher rates in (bio)chemical reactions in the water. An indirect effect is the change in hydrology due to climate change. An increase in precipitation leads to an increase in runoff from agricultural lands into surface waters and in cases of excess rainfall in a short period of time, the sewers can overflow and flow into waterbodies. All of this has a negative effect on water quality. Extreme droughts also have negative effect on water quality. Droughts can lead to lower river discharges and this can affect the concentration of nutrients, contaminants and harmful substances (RIVM, 2010). A higher concentration of these substances makes it more difficult to purify the water for consumers. The RIVM (2010) concluded that the already existing pressures put on freshwater resources are aggravated due to climate change. Examples of these pressures are the release of cooling water discharges by power plants, industrial waste water, agricultural waste and runoff, landfill run off and the waste stream generated by households.

With all these impacts, it is important for the Netherlands to adapt to these pressures. The question arises whether the institutions in the Netherlands are capable of devising and implementing adaptive strategies and to what degree. Whether organizations and institutions are capable of adapting is called adaptive capacity and this is the focus of this thesis.

1.2 Research goal and research questions

1.2.1 Research goal

While changes in freshwater quality also have effects on ecological systems and on recreational activities, I have decided to focus only on water quality related to drinking water. For my research, I have decided to focus on the institutional arrangement that surrounds the drinking water sector in Limburg. Limburg is the southernmost province in the Netherlands and the institutional arrangement consists of all parties involved in the drinking water process, be it producer, protector, or polluter. In chapter three, the institutional arrangement will be further elaborated on.

The main objective of this research is to analyze the adaptive capacity of the institutional arrangement surrounding the drinking water services in the province of Limburg, to provide new insights on the existing capacity and to offer, if necessary, some advice on where and how to improve the adaptive capacity. To assess the adaptive capacity of this institutional arrangement the adaptive capacity wheel is used, which is a framework designed by Gupta et al. (2010) in order to

assess the adaptive capacity of institutions. In chapter two the adaptive capacity wheel will be explained in detail.

1.2.2 Research questions

To achieve this research goal a main research question and several sub-questions are formulated. The main question to be answered by this research is the following:

- *Based on two of the six dimensions of the adaptive capacity wheel, variety and learning capacity, what is the adaptive capacity of the institutional arrangement surrounding the drinking water services in Limburg with regards to the increasing pressures put on fresh water resources due to climate change?*

To answer the main question, several sub-questions have been formulated. The first question to be answered is:

- *Who is part of the institutional arrangement surrounding the drinking water services in Limburg?*

The next sub-questions have been formulate based on the theory by Gupta et al. (2010).

- *By evaluating the criteria: trust, single-loop learning, double-loop learning, discussing doubts and institutional memory, how does the institutional arrangement score on the learning capacity dimension in the adaptive capacity wheel?*
- *By evaluating the criteria: problem frames & solutions, multi- sector, -level, actor, diversity and redundancy, how does the institutional arrangement score on the variety dimension in the adaptive capacity wheel?*

1.3 Relevance

1.3.1 Societal relevance

Awareness on the topic of fresh water quality and adaptive capacity is not as widely spread as it is with flood risk management (van Vliet & Zwolsman, 2008). And while flooding is a more visible threat, a decline in freshwater quality is no less threatening. Having clean drinking water is essential for living our daily lives but having a robust freshwater supply is also of great importance to the Dutch economy. 16 percent of the Dutch economy is dependent on a steady supply of freshwater; together all these sectors account for a turnover of more than € 193 billion per year (Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken, 2015).

This thesis will try to give more insights into the issues surrounding the securing of drinking water and provide insights on the capacity of Dutch drinking water services to adapt to climate change impacts.

1.3.2 Scientific relevance

This thesis will contribute to the research into the adaptive capacity of institutions. By applying the framework designed by Gupta et al. (2010) to a case study, this thesis will test the assessment framework and perhaps provide an example for other institutional arrangements to assess their adaptive capacity. Furthermore, researching the adaptive capacity specifically for water quality in relation to drinking water services in Limburg has not yet been done before and may provide new and useful insights.

1.3.3 Research framework

The research has been done in four main stages. In the first stage (a), I have read literature on the topics outlined in the model below. In the second stage (b), I have done empirical research; this consisted of interviews with relevant actors related to the case. Other data has been collected through document analysis. In the third stage (c), the data has been analysed and connected to the theory. The last stage (d) consisted of drawing conclusions and making some recommendations.

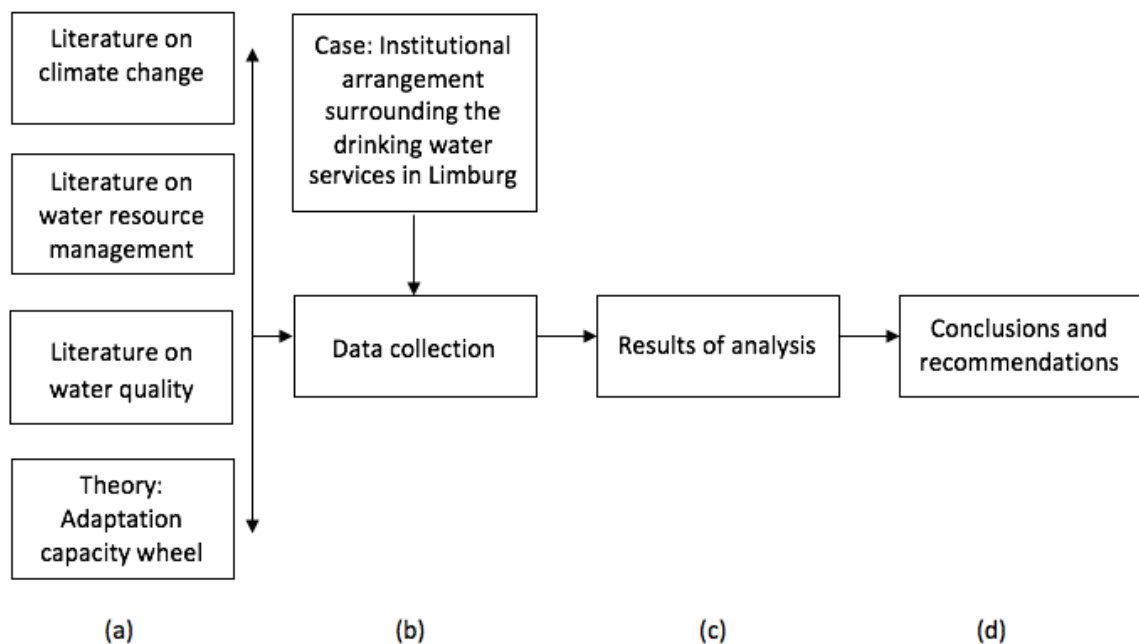


Figure 1: Research framework

1.4 Outline thesis

The structure of this thesis is as follows. The second chapter will outline the theory that is used to answer the research question. The third chapter is the chapter that explains the case and details the research methods that have been used. The fourth chapter is the chapter in which the analysis of the data will be discussed and evaluated, and the last chapter is the chapter in which recommendations are given and conclusions are written down.

2. Theory

This chapter will explain the theoretical framework that will be used to answer the research questions. The first part is about the theory in general. The second part is about the operationalisation of the theory and the last section contains the conceptual model.

2.1 Theoretical framework

As stated in the section on the research questions, I will assess the adaptive capacity of the institutional arrangement surrounding the drinking water services in Limburg with regards to the increasing pressures put on freshwater resources due to climate change. To do this, I will use a framework designed to evaluate adaptive capacity of institutions. Such a framework has been designed by Gupta et al. (2010). It is based on Giddens' structuration theory (1984) and other existing literature from different disciplines that touch upon the topic of assessing institutions.

First, I will clarify the difference between adaptation and adaptive capacity. It is important to note that adaptive capacity is different from adaptation. Adaptation is defined by the IPCC (2014) as "[t]he process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (p.118). Adaptive capacity, on the other hand, as defined by the IPCC (2014) is "[t]he ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (p.118). In their article, Gupta et al. (2010) settled on the definition of adaptive capacity as "...the inherent characteristics of institutions that empower social actors to respond to short and long-term impacts either through planned measures or through allowing and encouraging creative responses from society both ex ante and ex post" (p.461). These definitions essentially mean the same thing. In short, adaptive capacity is the ability of an institution or system to adapt whereas adaptation is simply the process of adapting.

Processes can be monitored and evaluated afterwards on whether they were successful or not. An assessment of an institution's adaptive capacity, on the other hand, gives insights into whether an institution or system has the ability to implement adaptive measures and to what degree. It is important for institutions to have at least some degree of adaptive capacity and to aim to achieve a higher degree of adaptive capacity because, as the IPCC (2014) note in their report,

"[b]uilding adaptive capacity is crucial for effective selection and implementation of adaptation options.... Successful adaptation requires not only identifying adaptation options and assessing their costs and benefits, but also increasing the adaptive capacity of human and natural systems ...This can involve complex governance challenges and new institutions and institutional arrangements" (p.80).

Adaptive capacity is essentially the step that comes before adaptation. While it does not guarantee that adaptation measures will be implemented, having a certain degree of adaptive capacity is necessary for an institution to at least be able to adapt.

Next, I will settle on the definition of the term institution. There exist many definitions for this concept but for this research I settle on the description given by Gupta et al. (2010) because it is their theory that I apply to my case. They defined institutions as “systems of rules, decision-making procedures, and programs that give rise to social practices, assign roles to the participants in these practices, and guide interactions among the occupants of the relevant roles” (IDGEC, 1999, as cited in Gupta et al., 2010 p. 461). The difference of their description from others is that they clearly want to separate institutions from organisations; often, they are mistaken as being the same. The key difference is that organisations do not include underlying ideological values and norms (Berkhout, 2012; Gupta et al. 2010). However, organisations can be embedded in institutions because they can be considered to be formalised patterns of rules and decision making. When assessing the institutional arrangement surrounding drinking water services in Limburg, embedded in the institutional arrangement there will be organisations; for example, the drinking water company: Waterleiding Maatschappij Limburg (WML).

To assess the adaptive capacity of institutions Gupta et al. (2010) defined six dimensions on which to score an institution: variety, learning capacity, room for autonomous change, leadership, resources and governance. Each dimension has several criteria on which to score said dimension; these criteria should be assessed through qualitative methods.

In order to structure the information and to be able to communicate the results from using the assessment framework, Gupta et al. (2010) designed the Adaptive Capacity Wheel (figure 2); they visualised the six dimensions and their accompanying criteria in a figure.



Figure 2: The Adaptive Capacity Wheel (Gupta et al., 2010).

2.2 Operationalization

In this section the operationalization of two of the six dimensions will be explained. Because of limited time and because this research is only done by one person, I will assess two of the six dimensions for the institutional arrangement surrounding the drinking water service in Limburg. I have chosen to assess variety and learning capacity. I have chosen to assess the dimension variety because the institutional arrangement consists of several institutions and organisations and while that in itself points to at least some form of variety, it does not guarantee that this arrangement works as it meant to. I have chosen to assess the dimension learning capacity because improvement is only really made by looking at past actions and mistakes and taking the lessons learned from them into new situations. Learning is crucial to be able to adapt; it is therefore interesting to assess this dimension. The other dimensions are also interesting and a crucial part of assessing an institution's adaptive capacity. However, I have not settled on analysing and evaluating these because in the case of leadership or fair governance for example, it could be a rather sensitive topic to interview employees of an organization about. Room for autonomous change, after reading about it, seemed to be more relevant in an institutional arrangement with more individual involvement; for example, civilian involvement and for analysing the dimension resources a document analysis on its own would suffice as this dimension largely focusses on whether or not monetary, human and technological resources are available (Gupta et al., 2010).

The operationalization of the two selected dimensions is important because it defines the concepts that are being researched. The dimensions variety and learning capacity are not directly measurable in any way but operationalizing these concepts allows for them to be evaluated and assessed.

2.2.1 Variety

Developing an optimal and fixed climate adaptation strategy for the next decades is not possible because not enough is known and, because as mentioned before, the issue of climate change is a *wicked* or even a *super wicked* problem. Multiple stakeholders are involved with multiple perspectives and interests. It is therefore argued that a better strategy to deal with the many uncertainties, ambiguities and interests is to allow for and encourage variety (Termeer, Biesbroek, & Van Den Brink, 2012).

The dimension of variety encompasses the idea that issues such as climate change can only be dealt within a framework of multiple discourses and solutions in which various actors intervene at different levels of governance; in which there is no single appropriate ideological framework, and no unique optimal policy strategy or set of mutually consistent solutions, instead there are many (Gupta et al., 2010). Variety essentially means room for differences; be it different actors, different sectors or different solutions. Having different options and insights into issues such as climate change and water quality can lead to new and perhaps better strategies to deal with the issues that come up. It is therefore an essential part of adaptive capacity.

The dimension of variety has been split up into four criteria which can be evaluated:

- Problem frames and solutions
- Multi-actor, multi-level and multi –sector
- Diversity

- Redundancy

Problem frames and solutions:

This criterion evaluates whether institutions allow for a variety of problem frames and solutions. Climate change does not have one single solution nor does it have one single cause; there are many. It is therefore better to approach this issue with several different problem frames and with several different solutions (Gupta et al., 2008). Furthermore, it cannot be determined beforehand which problem frame or which solution is best to use. Keeping options open is therefore useful. An example of a variety of problem frames can for instance be the different climate scenarios by the KNMI or IPCC that governments work with.

This criterion can be evaluated by researching whether the institutional arrangement works with different problem frames and develops different solutions. Do they work with climate scenarios? Is climate change approached as an isolated issue or are more issues taken into account? What are the solutions and strategies that are being developed?

Multi-actor, multi-level and multi-sector:

The criterion multi-actor, multi-level and multi-sector assesses whether an institution allows for a variety of actors, levels and stakeholders during the process in which a solution or strategy is formulated. Having different actors involved encourages social ingenuity from a large variety of people and helps in continuously generating tailor-made solutions for complex issues in different settings. Multi-level refers to multi-level governance and multi-sector to the involvement of different sectors. (Gupta et al., 2008).

As mentioned before, the institutional arrangement exists out of various organisations and institutions on different levels but what should be evaluated is how much each of these actors are involved in processes, how well the communication between these parties is and whether the interests of each party are taken into account.

Diversity:

Diversity is a criterion which assesses whether institutions promote diversity in order to reach tailor-made policies. This can be done by, instead of describing procedures, measures or directions to describe goals; by avoiding monopoly positions and by leaving the decision making to the lowest relevant level (Gupta et al., 2008). This criterion can be evaluated by, for example, researching whether the institutional arrangement works with goals instead of working with strict procedures, by asking what these goals are and by asking who does the decision-making.

Redundancy:

Redundancy refers to whether institutions adopt 'more of the same', and whereas variety means almost the opposite this still is a relevant criterion to assess because allowing for redundancy on the short-term promotes better long-term solutions (Gupta et al., 2010). For example, having more than one emergency exit or a back-up system for energy. By discouraging cost effectiveness and optimal solutions, room is created for overlapping responsibilities and solutions and thereby redundancy is promoted (Gupta et al., 2008).

For an overview, the criteria and their definitions are presented in table 1 below.

Variety	
Criterion	Definition
Variety of problem frames and solutions	Room for multiple frames of references, opinions and problem definitions
Multi-actor, multi-level and multi-sector	Involvement of different actors, levels and sectors in the governance process
Diversity of solutions	Availability of a wide range of different policy options to tackle a problem
Redundancy (duplication)	Presence of overlapping measures and back-up systems; not cost- effective

Table 1: The criteria and their definitions for the dimension of variety (Gupta et al.,2010).

2.2.2 Learning capacity

Learning capacity is an important aspect to include when assessing an institution's adaptive capacity because learning allows for, but does not automatically guarantee, change. The effects of climate change cannot be completely accurately predicted and the process of adaptation could be considered a learning process (Termeer et al., 2012). Furthermore, climate change is a relatively new phenomenon which requires new strategies to be developed and these new strategies are likely to clash with dominant values, routines and problem perceptions and solutions (Termeer et al., 2012). A process of learning, in which actors critically reflect on their underlying assumptions and are open to discussing doubts is therefore needed.

The dimension of learning capacity has been split up into five criteria:

- Trust
- Single-loop learning
- Double-loop learning
- Discussing doubts
- Institutional memory.

Trust:

The criterion trust tests whether institutions encourage actors to mutually respect and trust each other. Trusting and respecting each other is an important aspect of learning capacity because when actors trust each other, collaborating becomes easier.

It is difficult to measure trust but several actions can indicate that trust exists between actors. For example, the sharing of knowledge, the discussing of doubts and ideas, and whether each party's interests are taken into equally into account.

Single-loop learning:

Single-loop learning refers to the ability of institutions to learn from past experiences and improve their routines (Gupta et al., 2010). It occurs "when errors are corrected without altering the underlying governing values" (Argyris, 2002, p. 206). This is evaluated by asking how improvements are made. Are they made by simply adapting or is the underlying process changed? Are new ways of working introduced?

Double-loop learning:

Double-loop learning occurs when social actors challenge norms and basic assumptions (Gupta et al., 2010). It is different from single-loop learning because double-loop learning “occurs when errors are corrected by changing the governing values and then the actions” (Argyris 2002, p. 206). To illustrate the difference between the two, Argyris (2002) used the example of a thermostat. In single-loop learning a thermostat is programmed to turn on if the temperature in the room is cold, or turn off the heat if the room becomes too hot. Whereas in double-loop learning the thermostat questions why it is programmed to measure temperature, and then adjusts the temperature itself. To assess the criterion double-loop learning it will be evaluated whether dominant frames, different problem definitions and methods are being challenged (Gupta et al., 2008).

Discussion of doubts:

Whether institutions allow for the discussion of doubts and uncertainties can be assessed by checking if, first of all, doubts and uncertainties are even mentioned. Secondly, whether these doubts are categorized and thirdly, whether these doubts and uncertainties are dealt with through research, keeping options open, developing future scenarios, spreading risks etc. (Gupta et al., 2008). In this research this criterion is researched by asking if doubts are made explicit by mentioning and discussing them, and by asking how these doubts are dealt with.

Institutional memory:

The criterion institutional memory can be assessed by evaluating if institutions allow for the creation and maintenance of databases, publications, education materials and archives; and whether there is a willingness to study and use these documents combined with past experiences in current policy (Gupta et al., 2008). This criterion can be evaluated by looking at the databases of the relevant institutions and organisations and see whether they are available for all involved parties to use and by asking whether the stored materials are also used in actual processes.

For an overview the criteria and their definitions are presented in table 2 below.

Learning capacity	
Criterion	Definition
Trust	Presence of institutional patterns that promote mutual respect and trust
Single-loop learning	Ability of institutional patterns to learn from past experiences and improve their routines
Double-loop learning	Evidence of changes in assumptions underlying institutional patterns
Discuss doubts	Institutional openness towards uncertainties
Institutional memory	Institutional provision of monitoring and evaluation processes of policy experiences

Table 2: The criteria and their definitions for the dimension of learning capacity (Gupta et al., 2010).

2.3 Conceptual model

Derived from the theory, a conceptual model can be drawn (figure 3). The adaptive capacity can be assessed through six dimensions. In this model, only two are drawn because, as explained earlier, in this research only two dimensions of the institutional arrangement are analysed. Each dimension consists of several criteria which are analysed separately. When taken together and applied to the selected case, the analysis of these criteria form the assessment of the adaptive capacity of the institutional arrangement.

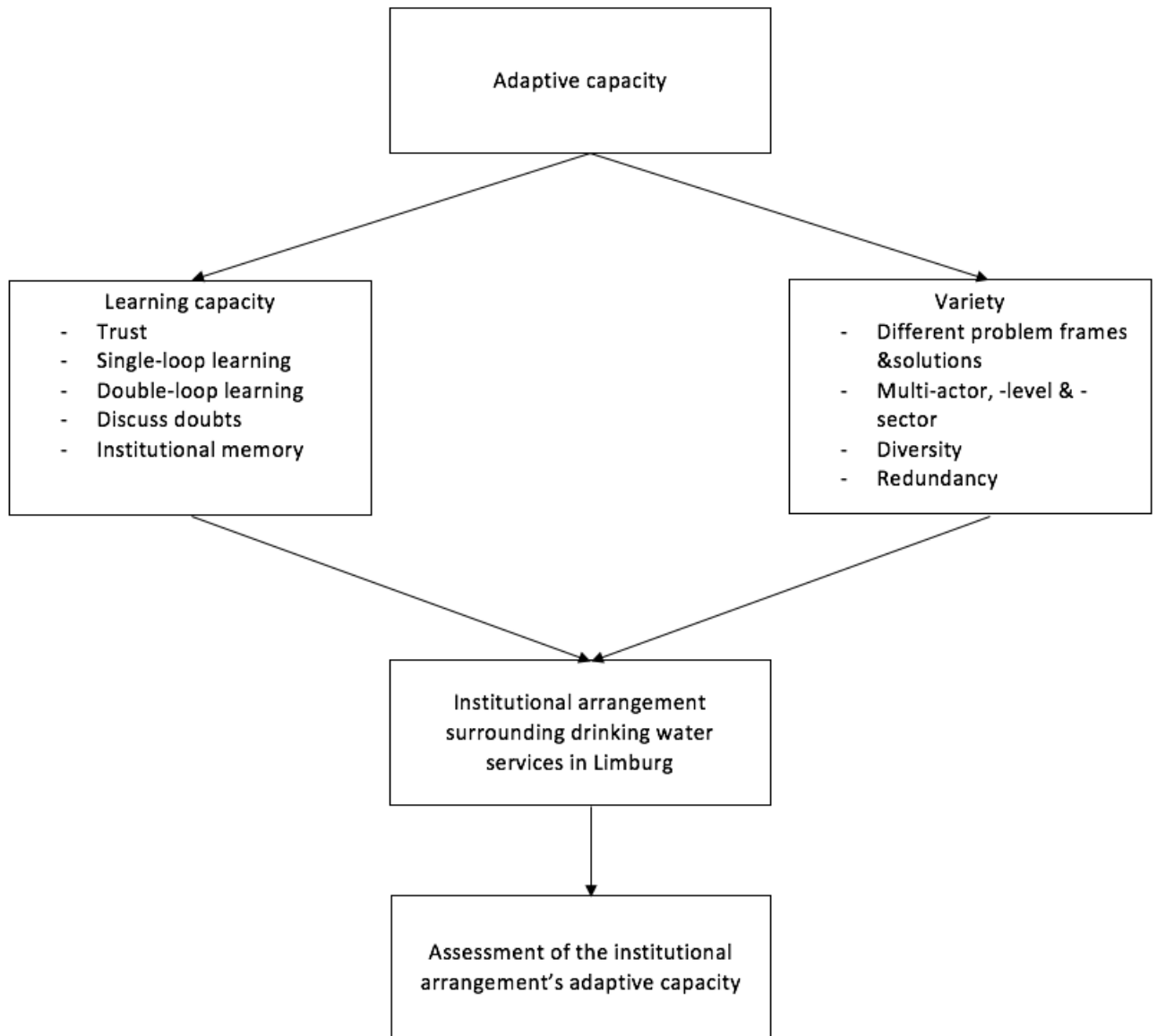


Figure 1: Conceptual model

3. Methodology

In this chapter I will firstly clarify my case selection. Next, there will be a section in which I will explain my research strategy. The last part of this chapter will be dedicated to the research material.

3.1 Case

As already explained in the research questions and goal section of this thesis, the case that is being studied for this thesis is that of the institutional arrangement surrounding drinking water services in the Dutch province of Limburg. Over time this institutional arrangement has seen some changes and it will most likely continue to undergo changes in the future. I am researching the current situation, meaning the current degree of adaptive capacity of this institutional arrangement.

Because I wish to analyze the institutional arrangement to get a better understanding of it within its context, a case study design has been chosen. Yin (2003) defined a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (p.13). It is a single case study design and can be defined as a typical case because researching this specific institutional arrangement could serve as an example for the other institutional arrangements surrounding drinking water services in the Netherlands and the findings could be representative for these arrangements as well (Flyvbjerg, 2006). The other arrangements consist of similar parties; the difference being that they are responsible for a different area which faces different issues regarding water quality and climate change.

Furthermore, I have chosen to study Limburg’s institutional arrangement because this institutional arrangement is nicely delineated by the province’s borders. The parties that have been provisionally identified to be part of this arrangement are *Waterschap Limburg*, *Provincie Limburg*, *Waterleiding Maatschappij Limburg (WML)*, The 33 municipalities of Limburg, the *Limburgse Land- en Tuinbouwbond (LLTB)*, the *Natuur- en Milieufederatie Limburg (NMF)*, and *Rijkswaterstaat*. Throughout this thesis these parties will be referred to by their Dutch names or their abbreviations. All of these parties are delineated by the province’s borders with the exception of *Rijkswaterstaat*. Below, further descriptions of these institutions and organizations and their tasks are given.

Limburg is the most southern of the 12 Dutch provinces and is in the southeastern part of the country (figure 4). It borders Germany on the east and Belgium in the south. In the north it borders the province Brabant and for a very small part it borders the province Gelderland as well. The most notable river that runs through this province from south to north is the Meuse. The province differs from the other Dutch provinces because it is less flat; it is more undulating and unlike one third of the country it is not below sea-level.



Figure 4: Location of the province Limburg (“Limburg (Netherlands)”, 2018.)

Below are the descriptions of the organisations and institutions and their role in the institutional arrangement surrounding drinking water services in Limburg.

Waterleiding Maatschappij Limburg (WML):

Waterleiding Maatschappij Limburg is the drinking water company in Limburg. They are responsible for providing good quality drinking water to over 500.000 households and 14.000 businesses in the province without a profit objective. In Limburg, the water used for drinking water purposes is partly extracted from a surface water resource and partly from groundwater resources. The majority, 75 percent, comes from various groundwater abstraction points and the remaining 25 percent comes from the river Meuse (WML, 2018).

The company is also involved in securing the public water supply by protecting the sources and stimulating sustainable use of water. One example of this is the project Duurzaam Schoon Grondwater (DSG), which literally translates to sustainable clean groundwater. It is an initiative of the WML which has been set up in 2007 to sustainably protect the water sources in order to ensure that in the long term, the drinking water will remain clean, reliable and affordable. The aim is to reduce the risk of nitrates and pesticides leaching into the groundwater. Farmers who have their business in a groundwater protection area participate voluntarily without any accompanying costs. They are assisted in carrying out fertilisation and crop protection in such a way that they produce optimally with the lowest possible non-avoidable leaching. Such collaborations prove to be successful as research shows that farmers who have been working with WML for some time now have a lower nitrogen surplus, without loss of production. (WML, 2018).

The Provincie Limburg:

The *Provincie Limburg* is the provincial governmental authority and, with regards to water related issues, is responsible for translating the national water policy to regional measures, supervising the regional water authority and monitoring compliance with environmental laws for water quality. Provincial authorities also clean up pollution and carry out soil remediation (Rijksoverheid, 2018). The management of the groundwater quality is also a responsibility of the *Provincie*. They allocate and manage environmental protection areas to protect the groundwater abstraction points. In Limburg, there are three types of protection areas: water extraction areas, groundwater protection

areas and the areas Roerdalslenk and Venloschol. The first is the most protected area with the strictest rules as these areas are close to the extraction points, any pollution would reach the extraction point within 60 days. The second is the larger area that surrounds water extraction areas. The water that falls on these areas reaches the extraction point in 25 years or more. In the areas Roerdalslenk and Venloschol the groundwater is protected by hard to penetrate clay layers. These layers prevent pollution and therefore it is not allowed to penetrate these protective layers (Provincie Limburg, 2018).

Waterschap Limburg:

Waterschap Limburg is the regional water authority in the province. Since 1 January 2017 several regional water authorities merged to form *Waterschap Limburg*. They are mostly concerned with water quantity. They maintain and build dikes, install rainwater buffers and fish passages. However, they are also involved in water quality issues. They monitor the quality of the water in streams and other regional waterbodies, and they purify the wastewater from companies and households before they allow the water back into the rivers and streams. In order to maintain good water quality, they set up rules and regulations and enforce them. It is for example forbidden to dump waste(substances) in the water or on dikes, and permits are needed to build near the water or dikes (Waterschap Limburg, 2018)

Municipalities:

Municipalities are responsible for the groundwater in urban areas. The municipalities take care of the drainage of wastewater and the excess rainwater via the sewer systems (Rijksoverheid, 2018) For this case I selected one municipality to include in the research as it would not be possible to interview all 33. The municipality that has been selected is Roerdalen (figure 5). It is located in the same area as the Roerdalslenk and several smaller waters, such as the river Roer, cross through it.

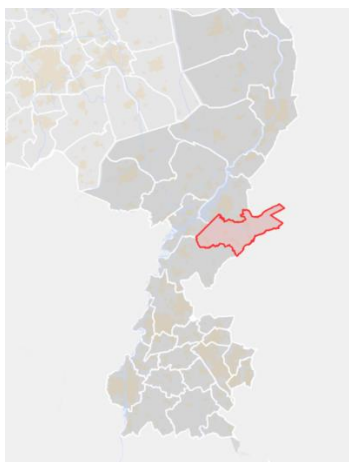


Figure 5: Municipality Roerdalen highlighted in red (“Roerdalen”, 2018)

Limburgse Land- en Tuinbouwbond (LLTB):

The Limburgse Land- en Tuinbouw Bond literally translates to the Limburgian Agricultural and Horticultural association. They represent the interests of all agrarian sectors and are the biggest agricultural and horticultural organisation in Limburg. Farmers have need of good quality water but

their activities also affect water quality. The LLTB works together with other institutions to maintain clean water resources (LLTB, 2018).

Natuur- en Milieufederatie Limburg (NMF):

The NMF is a federation of around a hundred nature and environmental organisations in Limburg. They represent nature, the environment and the landscape on a provincial level and want to realise and help with the transition to a sustainable society. Among other things they assess the provincial policy on sustainability, are actively involved in solving nature and environmental issues, they generate support for taking necessary measures, actively inform about different aspects of sustainability and provide advice and information for all the people in Limburg. They are also involved with issues regarding water quality (Natuur- en Milieufederatie Limburg, 2018).

Rijkswaterstaat:

Part of the Ministry of Infrastructure and Environment, *Rijkswaterstaat* is concerned with the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands. This includes the main road network, the main water network and, with regards to water quality, the water systems. *Rijkswaterstaat* monitors the water quality of the larger waterbodies in the Netherlands. The agency is divided into regional and specialist services. The regional service relevant to the institutional arrangement in Limburg is *Rijkswaterstaat Zuid-Nederland*, which is responsible for an area which includes the province of Limburg and the northern part of the province of Brabant (Rijkswaterstaat, 2018). The main body of water *Rijkswaterstaat Zuid-Nederland* monitors is the river Meuse. Smaller waters are monitored by the regional water authority.

3.2 Research strategy

To answer my research question and achieve my research goal I will be doing qualitative research, which will consist of a study of literature, interviews and document analysis. The literature study has been done in order to create and get insight on the project framework. This has already been worked out in the previous chapters. The interviews and the document analysis will serve to gather data. I have chosen for a qualitative approach.

In their article, Gupta et al. (2010) presented a protocol which should be followed when applying the adaptive capacity wheel. It is a five-step approach which details the actions the researcher must take in order to correctly apply the adaptive capacity wheel. Much of this protocol is reflected in the research framework which was presented in the introduction chapter (figure 1). Nonetheless, the approach will be discussed here because it gives a more detailed overview of the steps taken in this research. The steps are as follows:

1. Preparing for the research
2. Collecting the data
3. Analyzing the data
4. Interpreting the data
5. Presenting the data

Preparing the research:

The first step consists of identifying the research focus and deciding on the case which will be researched. This has already been done in the introduction chapter when defining the research goal and research questions, and when introducing and further explaining the case selection in this chapter. Also part of this step is the operationalizing of the dimensions and their accompanying criteria. It is important for the researcher to understand what these entail and how to translate them to the selected research project. This has been worked out in the previous chapter in which the theory was explained.

Collecting the data:

Gupta et al. (2010) state that data can be collected in various ways. Depending on the case, data gathered by different means can be used; such means are interviews, document analysis and observations. For example, for informal rules such as norms and values, and implementation challenges, interviews are useful to collect the needed information. For formal rules, such as governmental policies, document analysis is perhaps more fitting.

In this research both interviews and document analysis have been done to collect data.

In order to secure the information for each criterion Gupta et al. (2010) suggest creating a list of questions. For the interviews, these questions should be open and have possible follow-up questions when further explanation of an answer is needed. Technical language should be avoided as much as possible in the questions. For document analysis, it is more useful to have a more detailed list of questions. Because, of time limitations I have chosen to only analyze two of the six dimensions. Therefore, more questions can be dedicated during the interviews to these dimensions than there would have been when researching all dimensions. This results in a more detailed understanding of the situation regarding the two selected dimensions.

Lastly, all answers and observations must be documented without any interpretation. I have recorded the interviews with approval of the interviewees with my cell-phone and fully transcribed these recordings in a word-document without any interpretation.

Analyzing the data:

The third step is analyzing the data. Gupta et al. (2010) state that it is necessary to have different researchers independently score the data and discuss their findings to ensure transparency and robust results. However, involving another student in this bachelor thesis was not possible and therefore I was the only person analyzing and scoring the data.

Gupta et al. (2010) designed a scoring system for the dimensions and their criteria ranging from -2 to +2. In the analysis step this scoring takes place. After analyzing the data, I have evaluated and scored each criterion.

As mentioned earlier, for this case two types of data were gathered for this research: interviews and documents. The interviews were analyzed using the programme Atlas.ti by way of coding the relevant parts. The coding was done deductively using the theory as a guideline. The documents were not coded, but keeping the codes in mind, formal rules and policy information was gathered and included in the analysis.

Interpreting the data:

This step consists of translating the findings into a story which communicates the various strengths and weaknesses of the institutional arrangement in the context of adaptive capacity (Gupta et al., 2010). This interpretation of the data can be read in the next chapter and also in the conclusion and

recommendations chapter. To order my findings each criterion has been written about separately using the criteria as headers. The findings of the data from the interviews and the documents have been combined and presented as a whole. In chapter 5, possible ways to improve the institutional arrangement's adaptive capacity are presented.

Presenting the data:

In this thesis, the data has been presented in textual format. Gupta et al. (2010) suggest presenting the data visually using the wheel and colors to indicate the scores given to each criterion and dimension. In the table below the scores and their accompanying color-codes are given.

Effect of institution on adaptive capacity	Score	Aggregated scores for adaptive capacity as a whole
Positive affect	2	1.01 to 2.00
Slightly positive effect	1	0.01 to 1.00
Neutral or no effect	0	0
Slightly negative effect	-1	-0.01 to -1.00
Negative affect	-2	-1.01 to -2.00

Table 3: Scoring and color system (Gupta et al.,2010).

The scoring and color-coding have been done in this thesis but while presenting data visually does give a quick and eye-catching overview of the results, by no means is it representative for the findings.

3.3 Research material/data collection

The data needed to assess the adaptive capacity of the institutional arrangement was gathered through interviews with employees of the various institutions and organizations whose work is related to water and water quality, and by analyzing relevant secondary documents which were suggested by the interviewees.

3.3.1 Interviews

The interviews were semi-structured in order to allow for the interviewee to bring up new insights. The questions were about the two dimensions: variety and learning capacity, and their accompanying criteria. The interviews were held in Dutch as this is the native language of nine out of the ten interviewees as well as my native language. The interviewee whose native language is not Dutch was fluent in the language. The interview guide is included as an attachment at the end of this thesis.

The first interview was held with an employee from the WML, through this interviewee the other interviewees were selected. After each interview, I asked the interviewee whether they had suggestions for people to interview. For this research 7 interviews were conducted. Some interviews were with two people. The inclusion of another person was suggested by the people I

initially contacted because of their expertise regarding water quality. In total, I have spoken to ten people. Below is a table detailing the interview details.

Organisation/institution	Interviewee	Interview information
Waterleiding Maatschappij Limburg (WML)	Marie-Louise Geurts	Date: 4 May 2018 Duration: 53:47 Location: Home location, Roermond
Provincie Limburg	Marja Korevaar & Harry ter Heegde	Date: 30 May 2018 Duration: 54:54 Location: Gouvernement aan de Maas, Maastricht
Waterschap Limburg	Myrjam de Graaf & Maurice Franssen	Date: 30 May 2018 Duration: 1:09:00 Location: Head office, Roermond
Limburgse Land- en Tuinbouwbond (LLTB)	Twan Gielen	Date: 9 June 2018 Duration: 52:42 Location: Facetime
Limburgse Natuur en Milieufederatie (NMF)	Marloes Fransen & Frank Vermeij	Date: 5 June 2018 Duration: 52:42 Location: Het Groenhuis, Roermond
Municipality Roerdalen	Jan Trommelen	Date : 17 May 2018 Duration: 46 :33 Location: Head office, Sint Odiliënberg
Rijkswaterstaat	Aleksandra Jaskula	Date: 19 June 2018 Duration: 41:56 Location: Head office Rijkswaterstaat Zuid-Nederland, Maastricht

Table 4: Interview details

3.3.2 Secondary documents

The secondary documents used in this research were chosen based on suggestions by the interviewees after the interviews were conducted. Because I am researching the current adaptive capacity of the institutional arrangement the documents have to be recent enough to still be relevant. Below is a list with the names of the secondary documents used to gather data for this research.

- Water Act
- Deltaplan Hoge Zandgronden
- Provinciaal Waterplan Limburg 2016-2021
- Bestuurlijke Klimaat Tafel Limburg
- RIVM zorgplicht drinkwater

What follows is a brief description of the documents named above.

Water Act:

This law regulates the management of surface water and groundwater (Waterwet, 2018).

Deltaplan Hoge Zandgronden:

The provinces Limburg and North-Brabant work together with the regional water authorities, municipalities, drinking water companies, agricultural organisations and the state to devise adaptation measures to deal with climate change regarding water related issues. A separate Deltaplan has been set up because the landscape differs in this region and because of this the issues that have to be dealt with differ too (Deltaprogramma, 2017).

Provinciaal Waterplan Limburg 2016-2021:

This report contains the provincial water policy for the coming years (Provincialen Staten van Limburg, 2015).

Bestuurlijke Klimaattafel Limburg:

Literally translated: Administrative Climate table Limburg. This is an initiative from the municipalities, the *Waterschap*, the *Provincie*, the *WML*, the agriculture and horticulture community and a few other actors. This report describes the regional governance model for climate change adaptation (Bestuurlijke Klimaattafel Limburg, 2018).

RIVM zorgplicht drinkwater:

In the water act it is mentioned that several parties have a *zorgplicht*, a duty of care, when it comes to drinking water. However, it is not explicitly stated what it means for the different parties; they can decide on their own how to interpret this duty of care. This document gives some advice on how to meet the requirements of this duty of care (RIVM, 2018).

4. Analysis and evaluation

In this chapter the results of the analysis are presented. As mentioned in the previous chapter, both the results from the analysis of the interviews and the analysis of the secondary documents are presented together in this chapter. The analysis is presented by dimension and further divided by each dimension's criteria. I provide a brief explanation of the criteria at the beginning of each section as a short reminder of this criteria's definition. Some findings fit several criteria and therefore there might be some repetition of topics. Additionally, a section titled 'other' is presented. This has been done to include additional relevant information that the interviewees brought up which, while it featured partly in some criteria, could not be placed directly under the two dimensions. At the end is a section in which the findings are summarized and evaluated. In this section the scores are given to each criterion. The average of all these scores provides the degree of adaptive capacity for the institutional arrangement.

4.1 Variety

The criteria for variety are: problem frames and solutions, multi-actor, -level and -sector, diversity and redundancy. They will be presented in that order.

4.1.1 Problem frames and solutions

This criterion evaluates whether there is room for a variety of problem frames, problem definitions and viewpoints.

Climate change and water quality issues do not have clear problem definitions, not do they have simple and straightforward solutions. The institutional arrangement will have to take into account a variety of possibilities that might occur and a variety of solutions that might serve well in these situations. For climate change in the Netherlands, as already discussed in the introduction, four scenarios have been calculated by the KNMI. These four scenarios are essentially four different problem frames for the problem of climate change. The institutional arrangement works with these scenarios when devising strategies and when planning long-term projects. However, as noted by *Waterschap Limburg* and the *Provincie*, it is not possible from a resource perspective to prepare and strategize for all four scenarios. Calculating the four different scenarios also means four times the consultancy costs and the institutional arrangement does not have an unlimited budget. The solution is to look at two scenarios, instead of all four. They take the worst-case scenario and the scenario in which the least changes are predicted to occur. Doing this saves money but keeps options open. It allows the institutional arrangement to be flexible and open to change. Over the years, by monitoring what occurs and what does not, it has become apparent that the worst-case scenario is the most likely to be an accurate prediction. Therefore, more attention will be paid to that scenario. In 2021, the KNMI will come with a new set of scenarios. The institutional arrangement will take these and use them as guidelines for their strategies using the same approach.

The climate scenarios are not the only differing variables taken into account when framing the problems and planning adaptive strategies for the future. Socio-economic factors, such as a decline or increase in population and the demand for water, are also kept track of. Sometimes, as

noted in the interview with the WML, projections for the future do not turn out as expected. For example, Limburg has been identified as a region in which the population is declining and it was expected that the demand for drinking water would decrease. However, when monitoring the demand for water, this turned out not to be the case.

Within the institutional arrangement, the WML has a slightly different outlook on these different scenarios. They too work with the scenarios provided by the KNMI and look at socio-economic factors, but it was noted in the interview that because WML is responsible for providing good quality drinking water 24 hours a day seven days a week, they must prepare for the worst-case scenario. There is no room for unexpected changes that could threaten their task. The WML devises strategic plans for the future in which they look 40 to 50 years ahead and every six years they revise these plans and incorporate any new projections. With this approach, they are constantly adapting to make room for the changes that could occur.

Another way in which the institutional arrangement is open to a variety of problem frames and solutions is that, recently in the arrangement, there is more room and interest for each party's problems, questions, goals and interests. *Waterschap Limburg* noted that, compared to the past, there has been more of a dialogue between all the parties. Other parties are involved in earlier stages of the process, creating more room for a variety of problem frames and approaches. Previously, there was more of a hierarchy and while *Waterschap Limburg* note that this still exists, it is not as strict as it was in the past. The *Provincie* also noted that they are working toward involving the industry more in solving issues with water quality and quantity. The *Provincie* gives permits to the industry but they are also more interested in the problems the industry encounters and what the industry can do to help solve the issues that the other parties in the institutional arrangement face. This contact had not yet been established to the same degree as it has with the other institutions and organizations because, as noted by the interviewee, it is always a search for the right person to establish this contact with and with the industry this has proven to be more difficult.

The increasing equality within the institutional arrangement is also noted by the interviewee from the agricultural organization LLTB. In the interview, the interviewee noted that the problems that they are facing are not so different than they were in the 60s, 70s or 80s, but the manner of approaching these problems has changed.

“...de toon is anders omdat je als alle partijen meer en meer gelijkwaardig wordt gezien. Je bent allemaal partner, je bent mede-eigenaar van het probleem en de oplossing. En vooral in die oplossingsrichting kunnen wij heel veel betekenen” (LLTB, Facetime, June 9, 2018).

Because of the involvement of other parties and because of the equal position of each party, a wider variety of problem frames and solutions is brought forth. The interviewee also noted that, programmes such as the Delta programmes, have helped to create this equality among the institutions and organisations that are involved.

“Je wordt gezien als een serieuze kandidaat ...Vroeger was het, de provincie verzint iets, ze legt het aan de mensen op, het wordt uitgevoerd en dan heb je het resultaat. Nu kun je zelf meedenken want kijk hier bepaalt niet, maar je doet je eigen inbreng in de hoop de oplossingen te optimaliseren” (LLTB, Facetime, June 9, 2018).

However, it should be noted that the *Waterschap* and also the *Provincie* do still have somewhat of a position of power. They have a whole host of civil servants working for them and when compared to, for example, the provincial environmental organization NMF, this offers them a major advantage. The *Provincie* also noted that, while each party's interests and input are listened to, at the provincial level they are the authority and sometimes have to make the decisions that not everyone would agree with.

4.1.2 Multi-actor, multi-level, multi-sector

This criterion evaluates whether cooperation takes place between different actors, organizations, governments and sectors and to what degree.

As mentioned earlier in this thesis, because the subject of research is an institutional arrangement of which several institutions and organizations are part, already there is a certain degree of cooperation. Different actors, sectors and governmental levels are part of the institutional arrangement and this collaboration is of great importance because water quality issues are closely related to water quantity issues and no single organization or institution will be able to solve these issues on their own. Furthermore, as mentioned by the WML, when devising strategies and solutions for climate change and water related issues, some solutions for water quantity problems might have a negative effect on water quality. It is therefore important that when devising strategies and solutions that both water quantity and water quality are taken into regard. In the institutional arrangement, WML constantly works to get more attention paid to water quality. Because, as mentioned by several interviewees, traditionally a lot more attention is paid to water security in the Netherlands. The interviewee of the WML gave the example that stimulating civilians to have plants and grass in their gardens instead of concrete and stones in order to reduce stress on the sewage system and stimulate replenishing of groundwater levels might also lead to people using more herbicides, which has a negative effect on water quality.

In all interviews, the interviewees stated the most important players regarding water quality in Limburg were the WML, *Waterschap Limburg*, the *Provincie Limburg*, the municipalities, *Rijkswaterstaat* and agriculture. The document analysis showed this too and also showed that these parties collaborated often and were part of programmes such as the Delta programme *Hoge Zandgronden* or the *Bestuurlijke Klimaattafel Limburg* (Waterwet, 2018; RIVM, 2018)

Some interviewees included the industry but they were hesitant to do so as there is no direct contact with this party like there is with the others. There is often only contact with the industry when it regards specific projects or when the industry request permits from the *Provincie* or *Rijkswaterstaat* to, for example, discharge wastewater or use cooling water. Considering that the industry is sometimes the cause of pollution, it is noteworthy that they are not involved in the institutional arrangement to the degree that other parties, such as the agricultural organization is. However, as mentioned in the previous section, the *Provincie* is working towards including them more, which is a step in the right direction.

With regards to the involvement of farmers, it should also be noted that when the LLTB is involved it does not mean that all farmers in Limburg are represented. The LLTB only represents about 50% of all farmers in Limburg. Including the other 50% in the institutional arrangement is therefore more of a challenge. Involving them, however, is crucial because farmers play a very important role in the water quality discussion. They are the major land users. *Waterschap Limburg*

noted that when they have specific projects or information meetings that these farmers do involve themselves to some degree. But, as mentioned by an interviewee of *Waterschap Limburg*, not all farmers are the same, “Je hebt boeren en je hebt ondernemers. Dat is niet hetzelfde” (*Waterschap Limburg*, personal communication, May 30, 2018). The difference is that some farmers have a vision for their business and have to take changes for the future into account; while other farmers are intending to sell their land when they reach retirement age. The latter do not involve themselves in water quality and climate change issues to the same degree the former do. But, nonetheless, their actions do influence their environment.

Another party that could also be part of the institutional arrangement according to some interviewees are the terrain managers such as *Staatsbosbeheer*. Organizations such as these are responsible for the management, development and protection of forest and nature reserves. This also includes the responsibility for the water quality in these assigned areas. (*Landschap in Nederland*, 2018) However, because the focus of this research is on water quality related to drinking water only, these parties have not been included in the institutional arrangement. Other involved actors could be from governmental representation from the Ministry of Infrastructure and Water Management, the Ministry of Economic Affairs and Climate Policy and the Ministry of Agriculture, Nature and Food Quality. However, their contact is largely only with the *Provincie* and not with the other actors in the institutional arrangement. Therefore, they are not included in the institutional arrangement. And lastly, the civilians also play a role to a certain degree because they do influence water quality. Take for example medicine use, the use of herbicides, or the paving of their properties making it impossible for water to drain into the ground. However, they are also not actively part of the institutional arrangement. Their point of contact is largely only with their municipality.

The environmental organization NMF has been included in the institutional arrangement because they are often present in meetings and projects regarding the subject of water quality and because they are capable of exerting some type of influence in the decision making processes. The NMF is important for the institutional arrangement, not only because they represent nature, but also because they are somewhat of an outside party. They are not a governmental organization and they do not have a production or economic objective like the WML and the farmers have. They report and bring attention to certain issues that other parties in the institutional arrangement might prefer to avoid. While the NMF cannot implement measures directly, they are capable of bringing certain topics to attention and creating awareness about certain issues.

When asked about the quality of the collaboration and communication between the various parties in the institutional arrangement, all interviewees stated that in general the communication is good. However, they also noted that whether the communication goes well depends wholly on the party and person they are dealing with. As an example the interviewee of the LLTB brought forth the difference in whether a person has an ecological mindset or not. Communicating with an ecological minded person is more difficult than with one who is not. “Kijk, sommige mensen zien liever een alternatieve landbouw en anderen zien liever een alternatief voor landbouw” (LLTB, Facetime, June 9, 2018). The *Provincie* also noted that the ease or difficulty of the communication also depends on each party’s interest. Sometimes they clash and that makes it more difficult to reach agreements. But as the interviewee for the LLTB said, it is important that the dialogue remains open and, according to all interviewees, in this institutional arrangement that is the case.

However, some interviewees did have some things to note about the collaboration and hierarchy within the institutional arrangement. The NMF remarked that they believe that within

the institutional arrangement, the agriculture does have somewhat of a protected position. And they noticed that in collaborative projects, the municipalities are often the first to drop out. The cause of this, they believe, is that municipalities have too many responsibilities. The interviewee for *Rijkswaterstaat* stated that *Rijkswaterstaat* is only responsible for the River Meuse in Limburg and that *Waterschap Limburg* is responsible for the smaller regional waters. While on paper this is also true, in reality water knows no borders and bordering responsibilities seems to almost disregard this. It is noteworthy that other interviewees included *Rijkswaterstaat* as an important partner but that *Rijkswaterstaat* did not regard these parties as important to the same degree.

The Municipality Roerdalen stated that they have the most contact with *Waterschap Limburg* and with civilians. They do have contacts with farmers but not to the degree the municipality Roerdalen would like to; they would like to have more of a dialogue between them. The *Provincie* is also further removed from them. There is no direct contact with them regarding water quality issues. This is the case for this municipality because there are no groundwater extraction point in the area. Because of the new *omgevingswet* which will soon be implemented, municipalities will get more responsibilities, also regarding water quality. The interviewee of Roerdalen expects that, because of this, there will be more contact between the municipalities and the *Provincie*. The type of contact that the municipality has with *Waterschap Limburg* changed. It used to be that the *Waterschap* had more of a supervisory and controlling role. Now, there is more of a dialogue and both are players of equal importance. The interviewee also noted that they have some contact with the NMF but that often they have a conflict of interests. The interviewee noted that a municipality is used to looking at all the different interests of parties and that an agricultural or environmental organization does not do the same. This makes communicating and coming to an agreement sometimes difficult.

While not part of the institutional arrangement, *Waterschap Limburg* noted that the collaboration with the bordering countries, Germany and Belgium, could be and should be better. As previously stated, water knows not borders and collaboration between countries is necessary to solve certain issues. The interviewees believe that it is the difference in language, in culture and in politics that serve as obstacles to a better communication. *Rijkswaterstaat* also has contacts with the bordering countries, specifically with Belgium. *Rijkswaterstaat* is responsible for the River Meuse and this river runs in the countries France, Belgium and the Netherlands. However, *Rijkswaterstaat* indicated that the collaboration between them and Belgium were fine. Last year, *Rijkswaterstaat*, together with the water authority in Wallonia and Flanders, detected the origin of a harmful substance which was detected in the Meuse. *Rijkswaterstaat* noted that it is not their task to blame someone for the problems but to take note of them problems and together devise solutions. Furthermore, *Rijkswaterstaat* is working towards bettering the communication with the bordering countries by offering language courses to its employees.

4.1.3 Diversity

This criterion evaluates whether there is a wide variety of options to tackle the issues surrounding climate change related to water quality issues.

As mentioned several times before, water quality is closely related to water quantity and it is therefore not an isolated problem with one single solution. Even though there are different Delta programmes for water quality and water quantity, *Waterschap Limburg* noted that in Limburg, they try to combine the issues and look at them as a whole. Furthermore, each area in Limburg faces different problems and therefore, different measures need to be implemented to tackle these various problems. The institutional arrangement is very aware of this and the strategy of the *Provincie* and the LLTB, for example, is largely to implement small-scale customized solutions. There is a whole host of options available and each party within the institutional arrangement is involved in devising solutions, be it in collaborative programmes or on their own.

The *Provincie* plays an important role in deciding on the solutions. Often, they are the deciding factor. They note in the interview that, while they try to involve as many people and parties in the devising of the solutions, sometimes a consensus cannot be reached between the several interest groups and they, as the regional government, will be the deciding party on what is to happen. The *Provincie*, as the regional government, does have a certain power in this regard.

The interviewee from the LLTB noted that the agricultural sector tries to avoid that the *Provincie* becomes involved in the solution process. The interviewee remarked that, as experts in their own field, farmers often know where the problems occur and how to solve them. Furthermore, the interviewee remarked that, often when the *Provincie* does become involved, farmers who have been doing everything correctly are punished by the measures the *Provincie* implements because these are often large scale or regulatory measures. The interviewee does note that the legal frameworks can and should be devised from above so that everyone knows what is allowed and what is not, but for the solutions those in the field are more knowledgeable.

“Voor oplossingen denk ik dat de mensen in het veld meer verstand hebben van zaken dan iemand achter het bureau. ...een boer die al dertig jaar op zijn eigen land zit die weet precies hoe het zit met dat water, waar het vandaan komt en wat er gebeurt in de seizoenen. Achter een bureau zijn de seizoenen lastig te zien” (LLTB, Facetime, June 9, 2018)

The municipality Roerdalen also noted in the interview that they are mostly implementing small-scale measures and that they make use of the civilians' knowledge. The locals often know where the problems occur and the interviewee remarked that the people also appreciate being involved and being asked. Being a smaller municipality helps in this regard but the interviewee mentions that he has worked at the municipality for a longer period and has established good contacts. In the case for Roerdalen, the interviewee noted that, because of budget limitations, that places where the most issues are, are tackled first. For example, these are places with sewer problems combined with road damage and flooding issues.

The NMF also noted that the *Provincie* plays an important role in setting the legal frameworks but they also remark that the monitoring and the enforcement of the standards that are set by them is something that should be done better. One interviewee noted that when they did their own testing of the water quality standards in farming areas that the levels exceeded the

standards that were set by the *Provincie*. The NMF believe that the *Provincie* disregards this because economic growth and the expansion of farming is considered more important than any other issue such as water quality.

Waterschap Limburg stated that they do not have many means to directly tackle the issues and problems because they are dependent on the national and even on the European legislation. They cannot forbid a farmer from using certain crop protection agents when they are allowed to use them according to European or national law. What they can do is inform the farmers of the effects their methods have on the water quality. Together, with the parties involved they hope to generate alternatives or solutions. *Waterschap Limburg* notes that awareness plays an important role; they not only bring awareness to the local farmers but they also report their finding to the European Union.

The WML also works on keeping water quality at a good level. *Duurzaam Schoon Grondwater* is such as project. However, as noted by the NMF, some solutions such as the *Duurzaam Schoon Grondwater* project of the WML are often only on a voluntary basis and those who participate are often already interested in sustainable farming and are therefore already doing a good job. It is the farmers who do not participate who are often the problem.

On a larger scale, the Delta programmes are also largely involved in the devising of measures and solutions. For Limburg and for freshwater this is *Deltapan Zoetwater* and *Deltaplan Hoge Zandgronden*. Through collaboration, more money becomes available and expensive large-scale measures become possible to implement.

4.1.4 Redundancy

This criterion evaluates whether there are overlapping measures and back-up systems in place.

During the analysis it became clear that this criterion was not as important for this institutional arrangement as the others were. As explained in the section above on solutions, there are a wide variety of solutions available. However, because the measures and solutions are largely tailor-made for a specific case or area, applying them multiple times does not solve the issues better or quicker. Each area needs something different.

Nevertheless, a good example of redundancy in the institutional arrangement was brought up in the interview with the WML. The WML has realized a back-up for when there are longer periods in which they cannot take water from their surface water source. They have arranged with the *Provincie* to have a permit for when there is a longer period in which they cannot extract water from their surface water source. When this situation occurs they are allowed to extract water from an extra groundwater resource. The interviewee specified however that this back-up has not been made in light of climate change but that having such a backup was deemed necessary and had therefore made. Back-up measures are largely made for water shortages or for when the quality of the surface water is compromised in such a way that it is not suitable for use.

As mentioned in the previous section, there is a large variety of measures available however, due to monetary restrictions not all of them are implemented. All interviewed parties noted that adaptive measures which are not expensive and of which they know for sure that they will not regret them are worked out. The interviewee of the WML called them 'no-regret measures' and the *Provincie* referred to these measures as 'low-hanging fruit'. *Waterschap Limburg* remarked that whether measures are implemented depends on cost-effectiveness. If it is expensive but makes a

large difference then it is implemented. For measures that are not needed at this moment but which would be beneficial and even necessary in the future, a planning for the long term is made.

Furthermore, it is not only monetary restrictions that limit the measures that can be implemented to lessen the impact of climate change on water quality. The *Provincie* and *Waterschap Limburg* note that it is easier to implement measures for which no land or space is needed. Space is in high demand. In the Netherlands there is a shortage of space as all the land is owned by someone. The question which the institutional arrangement is confronted with is who is going to take the responsibility? An alternative to space-consuming measures are regulatory measures. These are cheaper and easier to implement but, as noted by the *Provincie*, such measures could impact the economy because they often restrict farmers or the industry.

4.2 Learning capacity

The criteria for learning capacity are: trust, single-loop learning, double-loop learning, discussing doubts and institutional memory. These are presented below in that order.

4.2.1 Trust

This criterion tests whether institutional patterns are present that promote and generate trust.

In general, all interviewed parties stated that the relationship and communication with the different institutions and organizations in the institutional arrangement was good. This indicates that there is at least a certain amount of trust between these parties. They noted that the current approach, an integrative approach, helped in establishing this. Integrative, in this case, refers to the increasing degree of involvement of parties in the institutional arrangement and the increase of the equality among these parties. In previous years, this integrative approach was not yet adopted which made for a different communication; one that was more hierarchical. Now, all parties are involved in processes to a certain degree and no longer are decisions solely made at the highest government level in the province. The change to a more integrative approach helps to build more trust between the parties because each party feels that they are taken more seriously.

Waterschap Limburg noted that, since the merging of the two regional water authorities into one regional water authority for the whole province of Limburg, more attention is paid to the position of the stakeholders, such as farmers or businesses. Their positions are included earlier on in processes and projects and *Waterschap Limburg* aims to be more open to their suggestions and ideas. *Waterschap Limburg* and the *Provincie* note that this change is happening on different levels of government. Merely laying down rules in order to solve issues is not the most effective way to solve problems. In previous times, *Waterschap Limburg* laid down the rules for others to follow and operated with the idea that they had all the knowledge and expertise on the subject and were therefore in the best position to make decisions and devise solutions. This has changed and both interviewees from *Waterschap Limburg* noted that this new approach asked for a different culture within the organization. While they are making progress with this they are still searching for a way to approach this new manner of working.

In the interview, the *Provincie* also noted that collaboration and trust is essential because it would not be desirable to have parties that feel excluded or to have parties that feel the need to

file for lawsuits regarding certain measures that are being implemented. The *Provincie* is therefore in favor of an approach that stimulates trust between parties. All parties in the institutional arrangement indicated a desire to keep working on fostering more trust. In the interview with *Rijkswaterstaat*, the interviewee indicated that, while *Rijkswaterstaat* is a technical organization in origin, over the past 20 years a change has been made to focus more on communication with other parties. They have arranged meetings with what they refer to as user categories. These are people, businesses, and farmers who make use of the river Meuse in some way. These meetings served to spread awareness about the situation and to establish better contacts.

Collaboration and communication are essential to trust and these are made possible largely through collaborative programmes such as the various Delta programmes or the *Klimaattafel Limburg*. Such programmes open the dialogue between the varying parties and contribute to keep the dialogue going. These programmes foster information exchange and by setting up meetings the dialogue is actively kept going. Other activities that build trust are the hosting of information meetings and shared research projects. The interviewee for the WML noted that the *gebiedsdossiers*, which were set up on a voluntary basis, have helped to foster trust and communication between the involved parties. In these documents, it is noted which measures are desirable or are necessary and who can implement these measures the best. These measures are incorporated in, for example, the *Provinciaal Waterplan 2016-2021*. The project Duurzaam Schoon Grondwater is an example of the execution of measures which were deemed necessary by the *gebiedsdossiers*. Municipalities, the WML and *Waterschap Limburg* have made these *gebiedsdossiers* under the direction of the *Provincie*. The fact that this was done on a voluntary basis indicates a willingness for good communication and a trust in each parties' collaboration.

Another way to build trust is the sharing of knowledge. This already happens within the collaborative projects when a common goal has to be reached. However, the NMF mentioned that it should be noted that the sharing of knowledge only happens when it strengthens one's own argument. The NMF knows that their reports do not always support the positions of the agricultural or industrial sector and are therefore not always taken into account. Furthermore, they note that sometimes parties use the NMF's supporting arguments to strengthen their own arguments. "Dat is natuurlijk in zijn algemeenheid met milieufederaties. Op het moment dat de overheid je erbij wil hebben. Dan is dat een beetje uit eigen belang van die overheid" (NMF, personal communication, June 5, 2018). It depends on the subject whether other parties want to include the NMF but at the moment they state that they are included, in various degrees, in most processes and projects; meaning they are not excluded in any way.

"Je moet wel altijd een oogje in het zeil houden. Dat geldt niet alleen voor water, meer voor andere onderwerpen dan voor water. Maar als ze met iets bezig zijn waarvan ze weten dat wij het er niet mee eens zijn dan gaan ze ons meestal niet uitnodigen. En dan proberen ze het zo een beetje sneaky" (NMF, personal communication, June 5, 2018).

The trust of the NMF in other parties can be said to be somewhat fragile in this regard.

Another case in which trust seems to be lacking to some degree is between the WML and the municipalities. While at the moment, these relations are good, the introduction of the *omgevingswet* has caused some uncertainties to arise. The *omgevingswet* will come into effect this year and a lot of laws, including the Water Act will be included in it. It will mean that the municipalities will have more responsibilities regarding the granting of permits, while previously

this was the responsibility of the *Provincie*. These uncertainties have arisen because municipalities have many different interests to take into account when making decisions. The new law is based on trust that the municipalities will take into account the water aspect as well when making decisions. This trust has not yet been established. Changes within the institutional arrangement can be said to temporarily shake the foundations on which the trust within said institutional arrangement was built. In the interview with the municipality Roerdalen the interviewee also noted that it was as of yet unclear what changes the *omgevingswet* is going to bring about. However, the interviewee also stated that they are quite happy with the *omgevingswet* because it creates more dialogue between them and other parties.

“Eigenlijk vind ik dat fantastisch want de wet gaat je dus gewoon dwingen om met elkaar in gesprek te gaan en het voordeel van een gesprek vind ik dat iedereen de kans krijgt om te vertellen wat er speelt. En mijn ervaring vanuit de projecten is eigenlijk gewoon als je dat eerlijk en oprecht doet, dan snapt iedereen dat bepaalde dingen wel kunnen en bepaalde dingen niet kunnen” (Municipality Roerdalen, personal communication, May 17, 2018)

Where previously, there was very little contact with the *Provincie* for example, this act can bring these two parties closer together. Changes bring about uncertainties but also allow for new opportunities.

4.2.2 Single-loop learning

Single-loop learning evaluates if measures and routines are adapted based on new insights and experiences from the past.

Great learning experiences in the case of water management, both for quality and quantity related issues, are when a calamity or incident occurs. In most interviews, calamities were mentioned as drivers for action. When a calamity occurs, the situation is often re-evaluated and it helps to speed up projects and processes. Furthermore, a calamity helps to put the issue of water quality on the political agenda. This helps to generate funds which are necessary for the implementation of measures. The interviewee of the LLTB said that he remembers a comment made by his university professor for water management.

“...watermanagement is helemaal geen management. Wij komen pas in actie als er een ramp gebeurd is. Het is onze doelstelling om de rampen voor te zijn en dat lukt ons nooit. Wij kunnen een heleboel dingen doen. Soms gaat het net goed door onze inzet maar we komen pas echt in actie en we krijgen pas echt iets voor elkaar als er iets mis is gegaan” (LLTB, Facetime, June 9, 2018).

Now that he is working in water management himself, he finds this statement to be very true.

An interviewee of the *Provincie* called these moments, these calamities, *knikpunten*. These are moments at which one realizes that the current approach is no longer suitable. These do not have to necessarily be calamities but can also be when, through monitoring, the conclusion can be made that the projections for the future turn out to be incorrect and that the reality is presenting a more extreme future. At these moments, decisions need to be made on how to continue and

adaptations need to be made. The institutional arrangement is aware of these moments. They monitor the situation to the best of their capability and adapt accordingly because the goal is to avoid these *knikpunten* and calamities. It should be noted that these *knikpunten* are mostly applicable to water quantity related issues such as water shortages but as mentioned before, water shortages are linked to water quality issues. For water quality on its own, the interviewee of the *Provincie* noted that standards are set by the EU and the national government and that these standards simply have to be met.

The awareness of these *knikpunten* indicates that the institutional arrangement is very aware of having to change the pace at which measures are implemented or the amount of measures that have to be taken. Changing the pace or implementing more measures is an example of single-loop learning. As mentioned by the interviewee of the municipality Roerdalen, in most cases this is enough. It depends wholly on the situation. Sometimes quick tailor-made solutions are the best option, particularly with issues that demand immediate attention. A change of the underlying approach, which is an example of double-loop learning, is mostly only a long-term option.

4.2.3 Double-loop learning

This criterion examines whether underlying assumptions are changed or challenged based on new insights.

A good case of double-loop learning is the change to the more integrative approach. This has been a gradual change, largely facilitated by the formation of the Delta programmes by the national government. The *Klimaattafel Limburg* is a good example of an integrative approach that has been recently set up. The *Klimaattafel Limburg* is a joint initiative of several parties. Those in the institutional arrangement are all part of it. It is an arrangement in which these parties jointly determine strategies and make agreements to make Limburg climate-proof and capable of dealing with the changes of water quantity and quality.

Waterschap Limburg and the *Provincie* note that they are still searching in some areas to improve on this integrative approach. The change towards this approach is an example of double-loop learning but within the approach itself a lot of learning still has to be done. For example, within collaborative projects someone has to take the lead and according to some interviewees it is as of yet unclear who this should be.

Another example of double-loop learning for the institutional arrangement was when the Water Framework Directive was implemented. This forced the arrangement to shift their views to setting goals rather than preventing disasters. While this was not a change which came from within the institutional arrangement, it did force the arrangement to reflect on their approach and adapt accordingly. According to the interviewees, the Water Framework Directive was an impetus to work harder to improve the water quality. The interviewee from the NMF also noted that the Water Framework Directive helped to stimulate the integrative approach. Not only within Limburg, but also with contacts between countries. The *omgevingswet*, as mentioned in the section on trust, will also bring about changes and force parties in the institutional arrangement to reflect on their underlying assumptions.

The general awareness of the effects of climate change also helped change processes. Whereas calamities and *knikpunten* induce changes in the current approaches to certain issues, the

increased awareness of climate change resulted in an overall change in assumptions regarding the approach of issues related to climate change.

Also crucial in instigating moments of double-loop learning are knowledge institutions and consultancy firms. As noted by the *Waterschap Limburg* and the WML, the generating of new ideas and to continue to evolve is important. Knowledge institutions and consultancy firms are crucial in this aspect. They are able to objectively, from a distance, evaluate the practices, processes and plans of the parties within the institutional arrangement and provide them with new insights. An example of a consultancy firm that several organizations and institutions in the arrangement make use of is KWR.

Furthermore, as brought to attention by an interviewee from the *Waterschap Limburg*, challenging underlying assumptions is often done by young people. He notes that the institutions and organizations in the institutional arrangement could benefit from having more young people work at these institutions. Institutions such as the *Waterschap Limburg* and WML are working towards recruiting such people.

“Wij zitten zo in ons straatje dat wij denken, we weten het best allemaal. Wij weten het goed. Maar af en toe eens een keer eentje die zegt: waarom doe je dat eigenlijk? En dan even nadenken waarom doe ik dat ook al weer; omdat ik dat altijd zo gedaan heb, ja. Ik bedoel, en ik hoop eigenlijk, we gaan nu met een generatiepact aan de slag. Een aantal oudere collega’s gaan nu minder werken en dan krijgen we ruimte om meer jonge mensen binnen te halen. Om in ieder geval die slag te maken. We moeten toch wel meegaan met de maatschappij eigenlijk” (*Waterschap Limburg*, personal communication, May 30, 2018).

The awareness of this, indicates that there is a desire to increase instances of double-loop learning.

4.2.4 Discussing doubts

This criterion evaluates whether there is open discussion about doubts in the institutional arrangement.

Dealing with climate change and its effects is dealing with uncertainties and doubts because, as the interviewee from the municipality stated “...klimaat is een grote onzekerheid” (*Municipality Roerdalen*, personal communication, May 17, 2018).

Most interviewees indicated that working with the uncertainties of climate change is a challenge. The uncertainties are dealt with by working with scenarios. As explained by *Rijkswaterstaat*, they do not work with prognoses but with scenarios in order to leave room for change and uncertainties. As mentioned in the section on variety, every organization and institution works with these scenarios and also includes other aspects such as socio-economic factors. An interviewee from the *Provincie* noted that these uncertainties are cause for some political unrest, especially on a financial level. The preferred situation would be that it is known beforehand what the impact will be and what the measures to adapt to these changes will cost. Making decisions on where to spend resources becomes a difficult task.

As mentioned earlier, changes such as the *omgevingswet*, are also cause for some uncertainties within the institutional arrangement. These are not as openly discussed. Part of the reason for this is that it is very difficult to predict the changes that it will bring.

On the one hand, uncertainties that can be mapped out by technical observations and monitoring, such as the climate scenarios, are well discussed within the institutional arrangement. But, on the other hand, uncertainties and doubts that come with changes in management and are less discussed.

4.2.5 Institutional memory

This criterion evaluates whether knowledge, projects and data are stored and available for other parties to use.

All parties in the institutional arrangement keep track of their research, reports, documents, data and processes and also make these public. However, each organization and institution does this differently. There is not a single database regarding all projects and research on water or water quality which includes all parties' documents. As noted by *Waterschap Limburg* in the interview, storing data in such databases is a way of sharing information in a very passive way and whether it is truly easily accessible to others is rather unclear. "Het staat wel ergens maar die toegankelijkheid kun je vraagtekens bij zetten" (Provincie Limburg, personal communication, May 30, 2018). The interviewee of the WML remarked that it is still somewhat of a challenge how to share information in a practical way. They, and all other interviewees, noted that personal contacts were more useful when one is in need of particular information and that reports that are relevant for their job are always brought to their attention. They emphasized that what is most important is working on one's network and having contacts with the people who are active in your field of work. All interviewees did remark that they made use of the other parties' documents.

Regarding the amount of research being done in the Netherlands, it was noted by the WML, *Provincie* and *Waterschap Limburg* that, in general, a lot of research is being done which relates to their work in some manner. However, there is a limit to what can be read during working hours and therefore a lot of research done by, for example, universities, is not read by them. Also, as noted by the WML, it is a challenge to translate the relevant research into practice. The interviewee for the LLTB remarked that abstract research is not even relevant and the research that they do themselves, through a subsidiary Arvalis, is more practically oriented and therefore, for them, more useful. Abstract research, as noted by the LLTB, happens on another level. For example, LTO, the agricultural organization for the whole country does invest in such research.

When research is being conducted, parties such as *Waterschap Limburg*, the *Provincie* or the WML try to include others in the research. This is done, in part, as was explained earlier to collaborate and work on a more integrative approach but also to get more funding.

The interviewees of the NMF, the LLTB and *Rijkswaterstaat* noted that the accessibility of the data could be organized better. The interviewee of the NMF noted that, whereas current data and information was easy to get a hold of, older information was harder or even impossible to find. The interviewees of the LLTB and the municipality Roerdalen note that one has to get used to working in the field and that, with time, it becomes easier to find what you need.

4.3 Other remarks

In this section, other noteworthy topics which were brought forward during the interviews will be discussed. Some of these topics are also part of a dimension in the adaptive capacity wheel, but because I have not operationalized these dimensions I cannot evaluate them the same way I have evaluated the dimensions of variety and learning capacity.

A topic that was frequently brought up during the interviews was that that of resources, and in particular monetary resources. the *Provincie* noted that there is no pre-set budget for issues such as climate change. One of the reasons for this is, they believe, that climate change is not recognized by everyone to be as important as some think it is. The NMF also notes that money is often the end of the discussion. Monetary resources are gathered by first planning and estimating the costs. Then, it is up to the politicians who decide where to spend the money. I cannot make judgments on whether this is the best approach. Having a pre-set budget will have certain advantages but having to design the project in advance has its advantages as well.

Regarding the reaching of goals, *Waterschap Limburg* remarked that it would, for example, be possible to quintuple the number of people working for the *Waterschap*; a lot more would be possible then. It would also be possible to build expensive water purification plants but, this would cost a lot of money and the question is whether one is willing to spend that much money on it. Preventive measures are a better solution in this case. Furthermore, a tight budget can prove to be an advantage as it stimulates creativeness and collaboration. The *Provincie* notes that the goal is to spend the money as efficiently as possible. This is where the importance of collaboration comes into play. By collaborating with the province Brabant or other parties, the money can be spent more efficiently and this way you avoid doing things double. Another solution for limited resources is spreading the financial burden over a longer period and taking the measures you have to take for water quality and combine them, for example, with the renewal of the sewer systems and the renovating of the roads. That synergy makes it so that the financial burden is more manageable.

Waterschap Limburg noted that it is observable when there are no resources made available on a national level. Little to no progress is being made in such cases. As an example, they brought forth *Deltaplan agrarisch waterbeheer*, a Delta plan set up by the national agricultural organization LTO. The *Waterschap* noted that Limburg in comparison to other provinces does not make as much progress. A possible cause for this is the lack of money.

As mentioned in an earlier section, when a calamity or incident happens, more resources become available to adapt or solve the issues. “...op een gegeven moment wil men gewoon een oplossing bijna tegen elke prijs” (Municipality Roerdalen, personal communication, May 17, 2018). The fact that climate change is rather a trending topic in society aides in the gathering the monetary resources for issues such as water quality. However, as an interviewee of the NMF remarked, it is possible that the topic of climate change diverts the attention from the true underlying issues.

“Ja, maar ik denk dat het niet zozeer met klimaatverandering dit specifiek te maken heeft als meer met het gebruik en ja, gewoon hoe wij hier boeren in Nederland en wat we daarbij toestaan. Ik denk dat dat een hele andere discussie is en dat die vaak ondersneeuwt onder de klimaatdiscussie misschien zelfs” (NMF, personal communication, June 5, 2018)

Other topics get less attention because of the focus on climate related issues. It would perhaps be better if over the years equal amounts of attention is paid to water quality issues instead of peaking

at certain moments in time and in other moments be lost because of the focus on another trending topic.

Furthermore, the economy is currently in good health; this too, provides more monetary resources. However, this is likely to change in the future because as an interviewee of the *Waterschap Limburg* noted,

“...de economie gaat als een tierelier dus er is ook wat meer geld en ruimte, om dat soort dingen, om het voor elkaar te krijgen. Als we straks weer in een crisis zitten over een aantal jaren gaat het weer de andere kant op” (Waterschap Limburg, personal communication, May 30, 2018).

Not only resources are needed to keep projects going and to be able to make progress but adequate leadership is also necessary. Collaboration is good but a lack of leadership could hinder projects in their progress as well. *Waterschap Limburg* gave the example of the *Klimaattafel Limburg*. The interviewee noted that it is rather unclear who will take up the mantle of leadership because water quality is related to many other environmental and spatial matters. This indecisiveness does not contribute positively to the adaptive capacity of the institutional arrangement.

4.4 Evaluation

In this section, the findings of the analysis are shortly summarized and evaluated. According to the theory by Gupta et al. (2010) each criterion will be scored between -2 and +2. The score for each of the two dimensions is made up of the average of the scores of each dimension's criteria. The score of adaptive capacity for the institutional arrangement is made up of the average score of the two dimensions. The results under the heading 'other', will not be included in this.

4.4.1 Variety

The average score for variety is 0,25. This positive result came about because of the positive scores for the criteria problem frames and solutions and diversity. Multi-actor, -level and -sector received a neutral score and redundancy was scored negatively and brought the average down a little.

Problem frames and solutions:

The score I have settled on for this criterion is that of +1. What contributed the most to a positive score for this criterion was the shift to a more integrative approach and therefore more equality for each party within the arrangement. More different problem frames and solutions were brought forth due to this. In general, a lot of different scenarios are taken into account when planning for the future; this includes climate change scenarios but also socio-economic factors. However, due to budget restrictions not every single scenario can be calculated. Out of the four possible climate change scenarios, two are included in the institutional arrangements' plans; the worst case and the best case scenarios.

In the institutional arrangement, the WML does not leave room for unexpected changes. Their responsibility to provide drinking water 24/7 cannot be compromised and therefore they prepare for the worst and arrange adequate back-ups. This is the safest and best approach.

Multi-actor, multi-level, multi-sector:

For this criterion the score is a neutral 0. There is collaboration between different actors, levels and sectors because this is inherently part of the institutional arrangement. The communication has been regarded as good by the interviewees with some comments on things that could be better.

The reason for this criterion not receiving a positive score is because the industry should be more involved than it is now. They are cause for some of the problems and they could offer solutions for other issues. It is a positive development that the institutional arrangement is working towards including them more. What also weighs somewhat negatively on the score is the fact that not all farmers are represented in the institutional arrangement; only 50% are represented. Considering that they, too, are a part of the problem but also provide the solution, it is rather important to have at least the majority included.

Diversity:

This criterion received a +1 as a score. In the case of the institutional arrangement in Limburg, solutions are made on several levels and there is a wide variety of solutions available; from regulatory measures by the *Provincie* to small-scale and tailor-made solutions by farmers themselves. When these smaller-scaled solutions no longer suffice, the ultimate decision on what type of measures are implemented is made by the *Provincie*. The *Provincie*, and ultimately the national government, has to reach the goals set by the European Union.

Redundancy:

Redundancy received a negative score of -1. The main reason for this is because of the monetary restrictions the institutional arrangement has. One of the aspects of this criterion is the presence of overlapping measures and that these measures are not cost-effective. However, due to some restrictions on resources, the institutional arrangement is forced to stick to cost-effective measures. The WML did have clear back-up measures however because they simply cannot afford for something to go wrong.

4.4.2 Learning capacity

The average score for learning capacity is 0,2. The criterion trust received a neutral score and the criteria single-loop learning and double-loop learning received positive scores bringing the average up. However, the criteria discussing doubts and institutional memory received a negative evaluation and counterbalanced the positive results from the other criteria back to a score of 0,2.

Trust:

Trust I gave a neutral score of 0. The change to an integrative approach and programmes such as the Delta programme and the *Bestuurlijke Klimaattafel Limburg* which stimulate information exchange and keep the dialogue going positively influence the evaluation of this criterion. Better communication and information exchange promote trust. The *gebiedsdossiers* are an example of good information exchange. However, this criterion is not scored positively because, as will be

explained in the criterion on discussing doubts, uncertainties such as the implementation of the new *omgevingswet* are not as openly spoken about. It seems that changes within the institutional arrangement cause these uncertainties and this impacts trust negatively for a period of time. Furthermore, the NMF has indicated that they do not always trust the other parties in the arrangement because of their clashing interests.

Single-loop learning:

Single-loop learning received a score of +2. The institutional arrangement continuously monitors the situation on water quality and quantity and tries to avoid *knikpunten* or calamities. However, when they do occur they, to some degree, positively impact the overall approach because the institutional arrangement has to adapt their approach in order to avoid future incidents.

Calamities serve as learning moments for the institutional arrangement and they tend to speed up the implementing of measures, positively impact the gathering of funds and put the issue of water quality on the political agenda.

Double-loop learning:

This criterion received a positive score of +2 as well. A lot of cases of double-loop learning were found in the analysis and although they do not originate from within the institutional arrangement, they do contribute to double-loop learning. An example of an outside influence which had an effect of the institutional arrangement is the change to a more integrative approach, of which the cause was the nationally organized Delta programmes. The *omgevingswet*, also such an outside influence, will cause the arrangement to question underlying assumptions too.

Another outside influence is the EU. The implementation of the Water Framework directive changed the approach from preventing disasters to setting goals. A more subtle outside influence is the general increased awareness of the topic of climate change. This made sure that the issue of water quality was put on the agenda.

Waterschap Limburg also showed in their interview that they are looking for influences that stimulate double-loop learning. They noted the desire to have more young people work at the institution because they often challenge and question underlying assumptions.

Discussing doubts:

A score of -2 is given to this criterion. The main reason for this is that the institutional arrangement does not seem to really openly discuss doubts. It seems that they heavily rely on technical monitoring and working with scenarios. But, as mentioned at the beginning of this thesis, the technical aspect of climate change is very well developed but the managing and the political aspect is more of a challenge. This is reflected in this institutional arrangement.

Institutional memory:

Institutional memory received a score of -1. The main cause for a negative score on this criterion is that there is no single database in which all research, projects and other relevant material on water or water quality is stored. The interviewees from *Rijkswaterstaat*, the NMF and LLTB stated that it should be organized in a better way. The interviewees all stated that they received most of their material through personal contacts. While sharing information through a database is a rather passive way of sharing information, having it all accessible and in one place makes sure that they do not miss anything; human memory is finite whereas digital memory is not.

4.4.3 Adaptive capacity

The aggregated scores for variety and learning capacity lead to the score of 0,23 for the adaptive capacity of the institutional arrangement. This means that the institutional arrangement has a positive degree of adaptive capacity. Meaning that the institution has the ability to implement adaptive measures to a certain degree. Below is the colored adaptive capacity wheel which presents the results in a visual manner (figure 6).

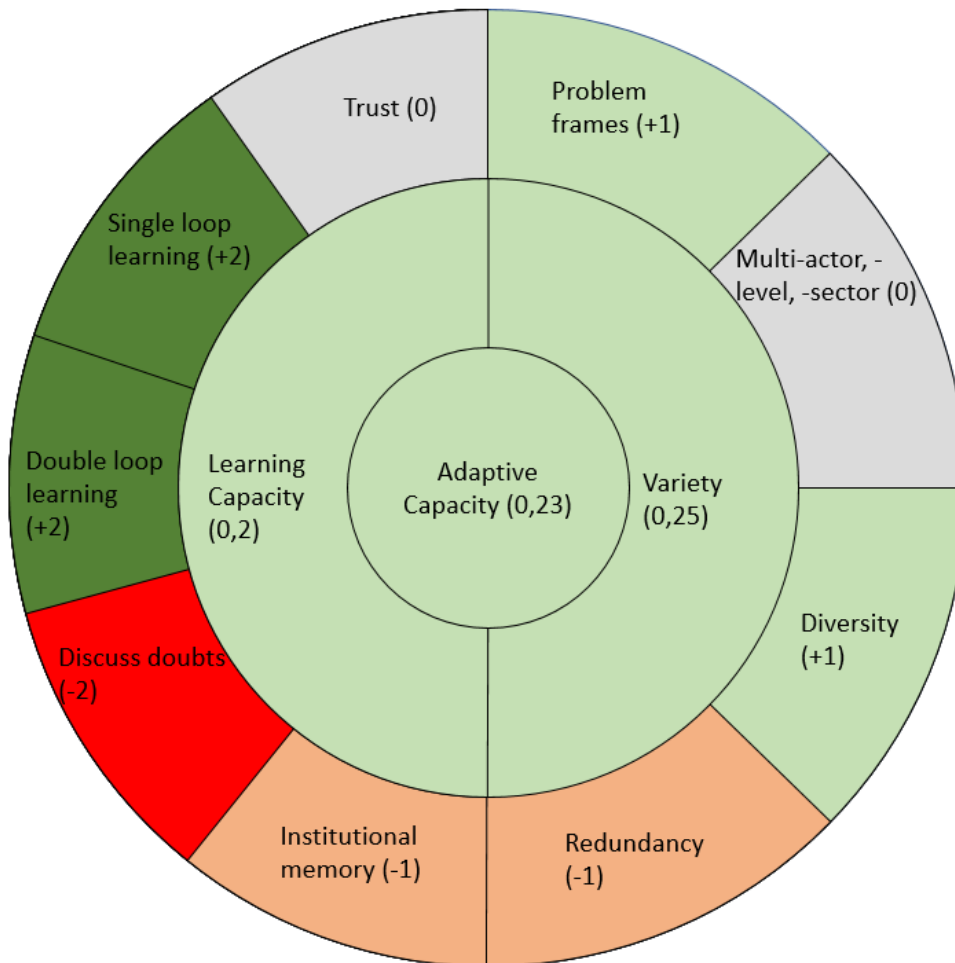


Figure 6: Evaluation of the dimensions and criteria visualised in the adaptive capacity wheel

Nevertheless, there is always room for improvement. The recommendations for this improvement will be presented in the last chapter after the general conclusion.

5. Conclusions and recommendations

In this final chapter, in the first section the main findings and conclusions will be presented. Based on these findings, in the next section recommendations will be given to increase the degree of adaptive capacity of the institutional arrangement. The last two sections will be a reflection on the theory and method and suggestions for further research.

5.1 Conclusions

During the research, the answers to the sub-questions to the main research question were answered first in order to then answer the main research question. The first question to be answered was which institutions and organizations were part of the institutional arrangement surrounding the drinking water services in Limburg. First based on the literature and then confirmed by the interviews, I have concluded that *Waterschap Limburg, Provincie Limburg, Waterleiding Maatschappij Limburg (WML)*, The 33 municipalities of Limburg, the *Limburgse Land- en Tuinbouwbond (LLTB)*, the *Natuur- en Milieufederatie Limburg (NMF)*, and *Rijkswaterstaat* are currently part of the institutional arrangement.

After having established this, the next two sub-questions had to be answered through an analysis and evaluation using the theory by Gupta et al. (2010). This theory provided a structured way to evaluate the adaptive capacity of institutions. The questions to be answered were:

- *By evaluating the criteria: trust, single-loop learning, double-loop learning, discussing doubts and institutional memory, how does the institutional arrangement score on the learning capacity dimension in the adaptive capacity wheel?*
- *By evaluating the criteria: problem frames & solutions, multi- sector, -level, actor, diversity and redundancy, how does the institutional arrangement score on the variety dimension in the adaptive capacity wheel?*

The results were that, based on the evaluation of the several criteria of each dimension, variety scores an 0,25 and learning capacity scored an 0,2 on a scale from -2 to +2.

In the dimension variety this score came about due to a score of +1 for the criteria problem frames and solutions and diversity, a neutral score of 0 for multi-actor, -level –sector, and a negative -1 for redundancy. The higher scores were received because the analysis of the data showed that the arrangement had a wide variety of solutions and measures available to solve the issues around water quality and because the arrangement worked with an integrative approach to, not only frame the problems, but also pose and implement possible solutions to them. The lower scores were due to the industry not being as involved and the inclusion of only 50% of the farmers in the institutional arrangement. Another aspect that had a negative impact on the scores was the lack of resources in some areas which hinders the implementation of measures.

In the dimension learning capacity the score came about because of a high positive score of +2 for the criteria single-loop and double-loop learning, a neutral score for trust and a negative score of -1 for institutional memory and a negative score of -2 for discussing doubts. The high positive scores in these criteria came about because of the many outside influences which encouraged double-loop learning and the manner in which the institutional arrangement handled the occurrence of calamities and incidents. The negative scores were due to the arrangement not

discussing doubts about the management of climate change issues and because of the lack of an all-inclusive database, which would have served the institutional memory of the arrangement well.

By having the results to the sub-questions, the main research question can be answered.

- *Based on two of the six dimensions of the adaptive capacity wheel, variety and learning capacity, what is the adaptive capacity of the institutional arrangement surrounding the drinking water services in Limburg with regards to the increasing pressures put on fresh water resources due to climate change?*

For a complete evaluation all six dimensions should be evaluated but based on only the two evaluated dimensions, the overall degree of adaptive capacity is slightly positive. In terms of the scoring system by the theory by Gupta et al. (2010), the adaptive capacity of the institutional arrangement surrounding the drinking water services in Limburg received a 0,23. A visual presentation of the scores can be seen in figure 6. A positive degree of adaptive capacity means that the institutional arrangement is capable of implementing adaptive measures. However, the score is not considerably high and there is room for improvements. In the next section these will be presented.

5.2 Recommendations

Based on the findings some recommendations can be given for the institutional arrangement to improve its adaptive capacity. As can be seen in the visualised wheel (figure 6) the most improvements can be made in the criteria redundancy, discussing doubts and institutional memory as these were scored negatively. However, in the other areas there is room for improvement too.

To start with multi-actor, multi-level, multi-sector, the institutional arrangement can improve on this criterion by actively involving the industry in the arrangement. They are working towards it, but actual improvement is only gained by the industry being actively involved. Further improvement can be made by having more than 50% of the farmers represented in the arrangement because farmers, like the industry, play an important role.

Next, for various criteria such as problem frames and solutions, diversity and redundancy a lot of improvement can be made by simply having a bigger budget. However, I realize this is a complicated issue and the institutional arrangement makes do with the resources that they do have by collaborating and combining measures and research.

A better institutional memory can be created by the creation, an subsequent good maintenance, of a database or platform which is easily accessible by all in the institutional arrangement and in which all projects, research and programmes related to water and water quality are archived. Merely relying on personal communication to receive information is not enough.

Another major improvement can be made by openly discussing doubts and uncertainties about managing the issues of climate change and water quality. Exchanging data and information on the topic is not enough. Much can be gained by also addressing the communicative and political difficulties. Furthermore, discussing uncertainties and doubts openly also increases trust within the institutional arrangement.

5.3 Reflection

In this section I will shortly reflect on the theory and method used in this research.

The adaptive capacity wheel proved to be a useful framework to analyse adaptive capacity. It provided a structure in which to collect and analyse the data. However, the theory cannot be readily applied to any institution or institutional arrangement. For example, in my research I found that the criterion of redundancy was not at all as relevant as the other criteria were. However, in the evaluation this criterion has as much weight as any other criterion in the dimension; this could influence the results significantly. A solution would be to use the theory as a starting point and tailor the dimensions and criteria in such a way that they fit the subject of research best, or one could change the weight of each criterion and dimension based on its relevance.

Furthermore, the analysis and evaluation is very subjective and context specific. I have conducted the research on my own and I feel that it could have benefitted significantly from another's perspective. The theory suggests that different researchers independently score the data and then discuss their differences in opinion. This would have to be done to increase the transparency as well as ensure robust results (Gupta et al., 2010). After doing the research on my own I agree that it is essential to include at least one other person in the research. Not only is the evaluation very objective, the dimensions and criteria are in some cases very abstract and open to a lot of interpretation. In addition, I believe that the research would benefit from a collaboration between an objective researcher and an expert on the topic. The topic of research proved to be rather complicated. Water quality is not something that can be regarded as a closed-off topic. It is related to many other things, one of which is water quantity but another is socio-economic factors; as such it becomes a very complicated topic to research. As someone who is not an expert on the topic, I provide a somewhat objective view on the issues but I run the risk of overlooking important things. An expert on the topic would help to guide the research in, what I believe, would be a beneficial way.

The context of the research topic also has an influence on the results. A positive score of an institutional arrangement in the Netherlands means something different than a positive score of an institutional arrangement in a third world country. Furthermore, the time at which the institutional arrangement is evaluated is determinative of the results. The institutional arrangement is constantly changing. For example, the makeup of the arrangement could change, depending on the involvement of the industry. Involving the industry in the institutional arrangement might lead to different results.

As already mentioned, the dimensions and criteria are very open to interpretation. Because I have focussed on only two of the six dimensions I have conducted a rather comprehensive research for the institutional arrangement regarding these two specific dimensions and perhaps interpreted the dimensions differently than I would have if I had done the research with all dimensions included. I have conducted interviews of which the average duration was round 55 minutes. I found that I could ask endless questions about each dimension and that it was difficult to draw the line at a certain point. After each interview I adapted the order of the questions and the questions themselves. When conducting an analysis using the whole of the adaptive capacity wheel the depth and time spent analysing each dimension and criteria will be less and this too will influence the results.

Another note I have on the dimensions and criteria is that some aspects of the criteria overlap. For example, diversity in solutions and redundancy were closely related in that they both

discussed solutions. Perhaps this overlapping can be prevented in some cases by interpreting the criteria differently but I believe overlap is unavoidable with certain criteria.

I would also like to remark on the evaluation and colour-coding of the results. It communicates the results clearly and quickly. It shows which aspects influence the adaptive capacity negatively and where the institutional arrangement would have to improve to increase its adaptive capacity. Additionally, when comparing the results of this institutional arrangement to another the colour-coded wheel also instantly highlights the differences between the two. However, presenting the results in this manner is very simplistic. The visual representation of the results does not reflect the analysis. For example, a neutral score could be given because three negative findings outweigh three positive findings. Hence, the wheel should not be presented separately from a written analysis or evaluation.

5.4 Further research

Having presented the conclusions and recommendations of this research and reflected on the process of the writing and researching of this thesis, what remains are some suggestions for further research.

Although the adaptive capacity is scored in this research, the evaluation is not complete without the other four dimensions. To get a complete evaluation of the adaptive capacity of the selected institutional arrangement, research should be done with all the dimensions included. The results of this research should not be reused in another evaluation of this institutional arrangement. However, the research done for this thesis could serve as an example and guideline. The reason that the results should not be reused in a complete evaluation is because, as already mentioned above, the results of this research are specific for this moment in time and over time the results will no longer apply to this institutional arrangement.

In light of doing a complete evaluation, also interesting to research would be whether a different adaptive capacity theory would garner the same results or whether these show considerable differences and why. This would be a comparative study between theories, applied to the same case. Such research could give insight on how influential the use of a similar, but different, theory has on the results.

Another interesting comparative research to do would be between two differing institutional arrangements. This could be two institutional arrangements in Netherlands, to see whether one institutional arrangement is representative for others. Or, a comparison of similar institutional arrangements between two countries. Such research could show in which areas the institutional arrangements could learn from one another to better themselves. However, as I mentioned in the section above, the scoring system is very context specific and when doing a comparative case study between an institutional arrangement in the global north and an institutional arrangement in the global south, the scoring system may not be as reliable for comparative use.

6. Bibliography

- Anisfeld, S. C. (2010). *Water Resources*. Washington: Island Press. Bates, B. C., Kundzewicz, Z. W., Wu, S., Palutikof, J. P., & (eds). (2008). *Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change* (Vol. VI). Retrieved from <http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf>
- Argyris, C. (2002). Double-loop Learning, Teaching, and Research. *Academy of Management Learning and Education*, 1(2), 206-218. <http://doi.org/10.5465/amle.2002.8509400>
- Berkhout, F. (2012). Adaptation to climate change by organizations. *Wiley Interdisciplinary Reviews: Climate Change*, 3(1), 91-106. <http://doi.org/10.1002/wcc.154>
- Bestuurlijke Klimaattafel Limburg (2018). *Bestuurlijke Klimaattafel Limburg: Regionaal governance model voor klimaatadaptatie*.
- Cape Town drought: South African city may avoid “Day Zero.” (2018, March 7). *BBC News*. Retrieved from <http://www.bbc.com/news/world-africa-43321093>
- Carpenter, S. R., Stanley, E. H., & Vander Zanden, M. J. (2011). State of the World’s Freshwater Ecosystems: Physical, Chemical, and Biological Changes. *Annual Review of Environment and Resources*, 36(1), 75–99. <http://doi.org/10.1146/annurev-environ-021810-094524>
- Cooley, H., Ajami, N., Ha, M.-L., Srinivasan, V., Morrison, J., Donnelly, K., & Christian-Smith, J. (2014). Global water governance in the twenty-first century. *The World’s Water*, 8, 1–18. http://doi.org/10.5822/978-1-61091-483-3_1
- Deltaprogramma. (2017). Retrieved from <https://deltaprogramma2018.deltacommissaris.nl/viewer/publication/1/2-deltaprogramma->
- Flyvbjerg (2006). Five misunderstandings about case study research. *Qualitative Inquiry*, 12(2), 219-245. <https://doi.org/10.1177/1077800405284363>
- Giddens, A. (1984). *The Constitution of Society: Outline of a Theory of Practice*. Cambridge: Polity Press.

- Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., Bergsma, E. (2008). Institutions for climate change: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Vrije Universiteit, Institute for Environmental Studies.
- Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., Bergsma, E. (2010). The Adaptive Capacity Wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science and Policy*, 13(6), 459–471. <http://doi.org/10.1016/j.envsci.2010.05.006>
- IPCC (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, pp. 976.
- IPCC (2014). *Summary for Policymakers. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. <http://doi.org/10.1017/CBO9781107415324>
- KNMI (2015). KNMI'14 climate scenarios for the Netherlands: A guide for professionals in climate adaptation, *Koninklijk Nederlands Meteorologisch Instituut, De Bilt, The Netherlands*.
- Landschap in Nederland. (2018). *Terreinbeherende organisaties*. Retrieved July 25, 2018, from <https://landschapinnederland.nl/terreinbeherende-organisaties>
- Levin, K., Cashore, B., Bernstein, S., & Auld, G. (2012). Overcoming the tragedy of super wicked problems: Constraining our future selves to ameliorate global climate change. *Policy Sciences*, 45(2), 123–152. <http://doi.org/10.1007/s11077-012-9151-0>
- Limburg (Netherlands). (2018). *Wikipedia*. Retrieved June 1, 2018 from [https://en.wikipedia.org/wiki/Limburg_\(Netherlands\)](https://en.wikipedia.org/wiki/Limburg_(Netherlands))
- LLTB (2018). Duurzaamheid. *Limburgse Land en Tuinbouwbond*. Retrieved June 2, 2018, from <https://www.lltb.nl/over-lltb/speerpunten/duurzaamheid>

- Mahr, Krista. (2018, May 4). How Cape Town was saved from running out of water. *The Guardian*. Retrieved from <https://www.theguardian.com/world/2018/may/04/back-from-the-brink-how-cape-town-cracked-its-water-crisis>
- Ministerie van Infrastructuur en Milieu, & Ministerie van Economische Zaken (2015). *Nationaal Waterplan 2016-2021*.
- Ministry of Infrastructure and the Environment (2016). *National Climate Adaptation Strategy*.
- Newson, M. D. (2009). *Land, water and development: sustainable and adaptive management of rivers* (3rd ed.). London: Routledge.
- NMF (2018) Wat doen we. *Natuur en Milieufederatie Limburg*. Retrieved June 2, 2018 from <http://www.nmflimburg.nl/wat-doen-we>
- PBL (2015). *Aanpassen aan klimaatverandering – Kwetsbaarheden zien, kansen grijpen*, Den Haag: Planbureau voor de Leefomgeving.
- Provincialen Staten van Limburg (2015). *Provinciaal waterplan Limburg 2016-2021*. Retrieved from <https://www.limburg.nl/onderwerpen/water/provinciaal/>
- Provincie Limburg (2018). Drinkwater en Grondwater. Retrieved June 1, 2018, from <https://www.limburg.nl/onderwerpen/water/drinkwater/>
- Rijksoverheid (2018). Taken van een provincie. *Informatie van de Rijksoverheid*. Retrieved June 2, 2018, from <https://www.rijksoverheid.nl/onderwerpen/provincies/taken-provincie>
- Rijksoverheid (2018). Waterbeheer in Nederland. *Informatie van de Rijksoverheid*. Retrieved June 1, 2018, from <https://www.rijksoverheid.nl/onderwerpen/water/waterbeheer-in-nederland>
- Rijkswaterstaat (2018). *Over ons*. Ministerie van infrastructuur en waterstaat. Retrieved June 1, 2018, from <https://www.rijkswaterstaat.nl/over-ons>
- Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), 155–169. <http://doi.org/10.1007/BF01405730>
- RIVM (2010). *Impact of climate change on water quality in the Netherlands*. National Institute for

Public Health and the Environment

RIVM. (2018) *Zorgplicht Drinkwater*. Retrieved from

https://www.rivm.nl/Documenten_en_publicaties/Algemeen_Actueel/Brochures/Milieu_Leefomgeving/Informatieblad_Zorgplicht_Drinkwater

Roerdalen. (2018). *Wikipedia*. Retrieved June 2, 2018, from

<https://nl.wikipedia.org/wiki/Roerdalen>

Secretary-General's Remarks at Workshop on the Moral Dimensions of Climate Change and

Sustainable Development "Protect the Earth, Dignify Humanity" [As Delivered]. (2015).

Retrieved March 12, 2018, from <https://www.un.org/sg/en/content/sg/statement/2015-04-28/secretary-generals-remarks-workshop-moral-dimensions-climate-change>

Termeer, C., Biesbroek, R., & Van Den Brink, M. (2012). Institutions for adaptation to climate

change: Comparing National Adaptation strategies in Europe. *European Political Science*, 11(1), 41–53. <http://doi.org/10.1057/eps.2011.7>

United Nations (2018). Sustainable development goals. Retrieved March 17, 2018, from

<http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

United Nations, General Assembly, The human right to water and sanitation, A/RES/64/292 (28

July 2010). Retrieved from

<https://www.un.org/es/comun/docs/?symbol=A/RES/64/292&lang=E>

Vliet, M. T. H., & Zwolsman, J. J. G. (2008). Impact of summer droughts on the water quality of the

Meuse river. *Journal of Hydrology*, 353(1–2), 1–17.

<http://doi.org/10.1016/j.jhydrol.2008.01.001>

Waterschap Limburg. (2018). Over ons. Retrieved June 1, 2018, from

<https://www.waterschap limburg.nl/overons/>

Waterwet. (2018). Retrieved from <http://wetten.overheid.nl/BWBR0025458/2018-07-01>

WML. (2018). Alles over water. *WML Limburgs Drinkwater*. Retrieved June 2, 2018, from

<https://www.wml.nl/alles-over-water>

WML. (2018). Duurzaam Schoon Grondwater. *WML Limburgs Drinkwater*. Retrieved June 2, 2018,
from <https://www.wml.nl/projecten/duurzaam-schoon-grondwater>

Yin, R. K. (2003). *Case study research: Design and methods*. Sage Publications: Thousand Oaks.

Attachment 1: E-mail sent to interviewees

Betreft: verzoek voor een interview in het kader van mijn onderzoek

Beste meneer/mevrouw [naam],

Ik ben een pre-master student environment & society aan de Radboud Universiteit Nijmegen. Voor mijn scriptie doe ik onderzoek naar de betrokken partijen (het institutionele arrangement) rond de bescherming van de bronnen voor de drinkwatervoorziening in Limburg met name gericht op waterkwaliteit in het licht van de klimaatverandering. De [vul in] is hier ook bij betrokken en heeft hierin een rol. Mijn onderzoek richt zich op de adaptieve capaciteit van de betrokken partijen.

Voor dit onderzoek wil ik u graag interviewen. Mijn eerste interview heb ik gevoerd met mevrouw Marie-Louise Geurts, adviseur zekerstelling grondstof en winning bij WML (Waterleiding Maatschappij Limburg). Zij raadde mij aan ook u te interviewen voor mijn scriptie onderzoek.

Het interview zal ongeveer driekwartier tot een uur duren. Een telefonisch interview is een optie maar voor mij is het geen probleem om u op uw werkplek te ontmoeten wanneer het u uit komt. Ik vind het zelfs heel interessant om zo eens als student in contact te komen met de werkwereld.

Ik hoop van u te horen.

Alvast bedankt.

Met vriendelijke groet,

Renée Beelen

Attachment 2: Interview Guide

Om te beginnen hartelijk bedankt voor het deelnemen aan dit interview voor mijn bachelor scriptie onderzoek. Ik doe onderzoek naar de adaptieve capaciteit van de instituties en organisaties rondom de drinkwatervoorziening in Limburg in het kader van klimaatverandering. Ik doe dit aan de hand van een theoretisch kader dat is opgezet om de adaptieve capaciteit van instituties te testen. Onderdelen waarop getest wordt zijn leervermogen en variëteit (d.w.z. ruimte voor variatie binnen processen, oplossingen en ruimte voor verschillende actoren etc.). De vragen die in dit interview aanbod komen zullen over deze twee onderwerpen gaan. Mochten er vragen zijn waar u geen antwoord op wilt geven dan hoeft u dit niet te doen en gaan we verder met de volgende vraag.

Het interview zal naar schatting ongeveer driekwartier tot een uur duren. Ik wil u vragen of u het goed vindt als ik dit interview opneem.

Voordat we officieel beginnen, heeft u vragen voor mij of zijn er dingen onduidelijk?

Inleidende vragen

- Kunt u kort uw functie beschrijven?
- Hoe bent u in uw werk betrokken bij waterkwaliteit?
- Bent u daarbij ook betrokken of bezig met klimaatverandering?

Variëteit

- Wie zijn volgens u de belangrijkste actoren/organisaties/ stakeholders betrokken bij waterkwaliteit in Limburg?
- Heeft u meer (of minder) contact met bepaalde instanties/organisaties/actoren? Met wie hebt u het meeste contact?
- Hoe vindt u dat de samenwerking tussen de verschillende instituties rondom waterkwaliteit verloopt?
- Worden de belangen, naar uw mening, van iedereen evenveel in acht genomen?
- Is er volgens u sprake van vertrouwen tussen uw organisatie/institutie en de organisaties/instituties waarmee u samenwerkt?

- In het kader van klimaatverandering en waterkwaliteit. Klimaatverandering heeft invloed op de waterkwaliteit. Wat voor een soort problemen/moeilijkheden die te maken hebben met waterkwaliteit komt u tegen in u werk/functie?
- Hoe worden deze problemen aangepakt?
- Waar (op welk niveau) worden oplossingen gegenereerd? (Worden oplossingen voor problemen van bovenaf opgelegd of is er ruimte voor een divers aantal oplossingen van onderaf?)
- Wordt er gekeken naar verschillende probleem scenario's?
- En worden er ook verschillende oplossingen ontworpen voor een probleem?
- Bij het vinden voor oplossingen wordt er volgens u veel gekeken naar de kosten of is er een ruim budget voor klimaat gerelateerde zaken? Wordt er veel gekeken naar korte termijn of lange termijn?

- Worden oplossingen die op korte termijn goed werken veel toegepast/ ook op andere vergelijkbare zaken toegepast?

Leervermogen

- Wat waren volgens u recent de grootste veranderingen rondom watermanagement met betrekking tot waterkwaliteit?
- Hoe verbeteren jullie het managementproces rondom waterkwaliteit?
- Wordt bij dit verbeterproces gekeken naar de achterliggende werkwijze of wordt er alleen oppervlakkig verbeterd?
- Worden er nieuwe werkwijzen geïntroduceerd?
- Wordt hierbij ook samengewerkt met andere organisaties/instanties of de overheid?

- Hebben jullie ook te maken met onzekerheden?
- Wat voor soort onzekerheden?
- Worden deze bespreekbaar gemaakt? Met wie? / Hoe wordt hiermee omgegaan?

- Leggen jullie ook processen, publicaties etc. ergens vast?
- Hoe wordt er omgegaan met onderzoek en publicaties binnen uw organisatie/instantie?
- Is er sprake van uitwisseling van onderzoek/documenten tussen de organisaties rondom waterkwaliteit in Limburg?
- Worden deze documenten veel gebruikt bij andere processen/besprekingen of bij nader onderzoek?

Rest

- Is er nog iets dat niet ter sprake is gekomen dat u met mij wil bespreken?

Slot

Dit waren de vragen die ik voor u had in verband met mijn onderzoek naar de adaptieve capaciteit.

- Is het mogelijk om u te mailen mocht ik naderhand nog vragen hebben?
- Welke documenten raadt u aan/ denkt u dat ik nog moet opnemen in mijn onderzoek?
- Heeft u nog personen in gedachte waarvan u denkt dat ze cruciaal of relevant zijn om te betrekken bij mijn onderzoek?
- Heeft u nog vragen voor mij?

Tot slot, hartelijk bedankt voor het interview!