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What Strategy is needed to secure the freshwater supply for future generations in Friesland?

Research on the position of the issue of salinization and the governance strategy used in Friesland on a planning spectrum.

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Abstract

This research is focused on the issue of salinization in Friesland. From a planning perspective a framework of planning focused actions and a planning spectrum are used to analyze the issue of saliziation. This Framework of planning focused actions discusses the degree of complexity of the issue of salinization, the scale of salinization and the governance strategy that could fit this position. From complexity theory, generic approaches are used for linear and simple issues and specific, specific approaches, are used for complex issues. Strategies can be found from a technical rational approach (generic) to a communicative rational approach (specific). Salinization is a complex issue it can therefore be related to a communicative rational approach. From a paradigm shift in water management, the concepts of adaptiveness and resilience are related to complex issues and the characteristics of both concepts are used as a tool to analyze the degree of complexity of the governance strategy of salinization in Friesland. This analysis is based on three qualitative research methods: Document analysis, in-depth interviews and observation and participation. It can be concluded that the governance strategy is focused on learning and gathering information. The awareness of the problem and the available knowledge on the problem are not yet well developed. With the measures taken to develop this awareness and knowledge, this governance strategy on salinization in Friesland fits the positioning of the issue of salinization in the planning spectrum that was used in this research.

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1. Freshwater supply in the Northern Netherlands

1.1. Salinization

Not only the Netherlands but many low laying regions in the world will face problems with their freshwater supply in the future (MIE & MEA-b, 2015). Nearly one third of the surface of Netherlands is located below sea level and the land surface is still subsiding up to one meter per century (Oude Essink et al. 2010). Major factors that influence the freshwater supply are climate change and political conflicts (Cubash et al. 2013). The interrelationship between water, climate and political conflict is complex and depends on regional, national or local contexts (Ligtvoet et al. 2017). Climate change cannot be denied. Multiple lines of evidence across the planet have shown that this is largely a result of human activities. This evidence of climate change derives from observations of the atmosphere, land, oceans and cryosphere. Concentrations of important greenhouse gases have increased over the last centuries. The composition of the atmosphere is changing and as result the climate system is changing (Cubash et al. 2013). The sea level is rising and more extreme weather events will occur. This study will not elaborate in detail on the climate change issue. However, this study will elaborate on one specific problem that is related to climate change and sea level rise – Salinization. Due to droughts the groundwater will be less hydrated by precipitation. Less freshwater is available due to longer periods of drought. Also a rising sea level will cause a higher level of salt water in the underground. Especially in coastal regions salt intrusion due to sea level rise is an issue (Rhein et al. 2013). However, climate change is not the only reason to have salinization. Land subsidence and chloride contamination are two other main drivers for salinization (Stuurman et al. 2006). Drivers for the competition on freshwater are the increase of population and refugees, which will lead to more stress on freshwater (Ligtvoet et al. 2017). Due to these factors there is a risk on the future security of fresh water. Ligtvoet et al. (2017) are concluding that the complexity of the climate-water-conflict interaction requires policy development processes. The policy developments should integrate economic, mitigation, adaptation, social and security risks.

The Netherlands have set up a program to deal with the impact and potential consequences of the degradation of freshwater; the so-called Delta program. The two objectives of the Delta program are about water safety and about keeping the Netherlands livable. To keep the Netherlands livable they must secure a sufficient supply of freshwater for the generations ahead (MIE & MEA-b, 2015). The Delta program divided the Netherlands into seven different regions, because each region has their own specific characteristics. Two of these regions are in the north of the Netherlands, the Ijsselmeer region and the Wadden region. The central government introduces the supply levels in the Delta. The parties (central government, provinces, water boards, municipal councils and users) should elaborate these levels of supply in the upcoming years (MEI & MEA-b, 2015). The central government will have a steering function in the discussion on how to gain a more adaptive strategy for the freshwater supply.

The quality and the quantity of our freshwater are of importance. The Netherlands is using freshwater intensively for domestic, agricultural and industrial purposes. With the Delta program, the Netherlands can serve as a laboratory for other low laying delta areas throughout the world (Oude Essink et al. 2010).

With these objectives from the Delta program and the riks of climate change, it becomes clear that salinization will be a major chalange. The goal to develop supply levels is to gain knowledge on freshwater issues per water system. It is important to understand the problem of salinization and the scale of the problem to develop a strategy that fits the region. This study will elaborate on these issues from a planning perspective to gain knowledge on this water problem. In this study a planning perspective means that the issue of salinization will be investigated by the degree of complexity and the scale. The degree of complexity in this sence means that a generic issue that is linear, could be assumed as simple. A specific issue that is non-liear could be assumed as complex. A framework of planning focused actions will be used to investigate the degree of complexity of the problem and the scale of the problem. This framework is developed by De Roo (1999). From this framework a planning spectrum for planning actions is developed by (Zuidema, 2011) and this planning spectrum can say something about the strategy that is chosen. The planning spectrum has two extremes, the technical rational approach and the communicative rational approach. The degree of complexity and the scale of the issue are important. With simple/linear issues on a central level, a technical rational approach could fit an issue. With complex/non-linear issues on a local level, a communicative rational approach could fit an issue. This will be elaborated more in chapter two.

This study will use this planning perspective to analyse the issue of salinization and the approach that is used for this issue. Cummings et al. (2006) mentioned that mismatches between the issue and the approach that is used for this issue can contribute to a decrease in social-ecological resilience. Social-ecological resilience is included here as the mismanagement of natural resources and a decrease in human well-being.

Salinization has different causes and consequences with high levels of uncertainty and therefore can be seen as a non-linear issue. Therefore it is interesting to do a research about the issue and scale of salinization, to investigate the governance strategy on the issue of salinization. This high level of uncertainty can be related to the paradigm shift in water management en is elaborated, among others, by Pahl-wostl (2007). She says: *"Water management is facing major challenges due to increasing uncertainties caused by climate and global change and by fast changing socio-economic boundary conditions. More attention has to be devoted to understanding and managing the transition from current management regimes to more adaptive regimes that take into account environmental, technological, economic, institutional and cultural characteristics of river basins. This implies a paradigm shift in water management from a prediction and control to a management as learning approach."*

The relation with the planning sprectrum and the shift in water management can be made and the degree of complexity and the high level of uncertainty can be related to each other. A high degree of complexity asks accoriding to Pahl-wostl (2007), for an adaptive approach. According to Nelsson et al. (2007) a resilient framework is usefull if an issue has a high degree of complexity. Charachteristics of apdaptiveness and resilience will be used in this study as a tool to analyse the governance strategy. If the charachteristics are highly present in the strategy, it can be assumed that the issue asks for an approach that is related to an adaptive and resilient approach. The study will analyze therefor the match of the issue of salinization and the strategy that is used for salinization. According to Cummings et al.

(2006) it will be usefull for the social-ecological resilience and a match can lead to an increase in human well-being.

To investigate the issue of salinization and the approach that is used for this issue, a qualitative case study on Friesland will be done. Friesland is a coastal region and salinization is already a problem in several places. Figure 1 shows the levels of chloridic groundwater in the Netherlands. The red color means that salt water is at the ground level. It shows that salinization is already a problem in Friesland and due to climate change, land subsidence and sea level rise it will increase. Also, different crops cannot grow anymore at a certain salt level and this level will rise with the change of the climate, the sea level rise and the land subsidence. Agriculture in Friesland is an important part of the economy and therefore current impacts and the potential consequences of salinization should be taken seriously. However, agriculture is not the only sector that uses freshwater. The population and different economic sectors have to use freshwater.

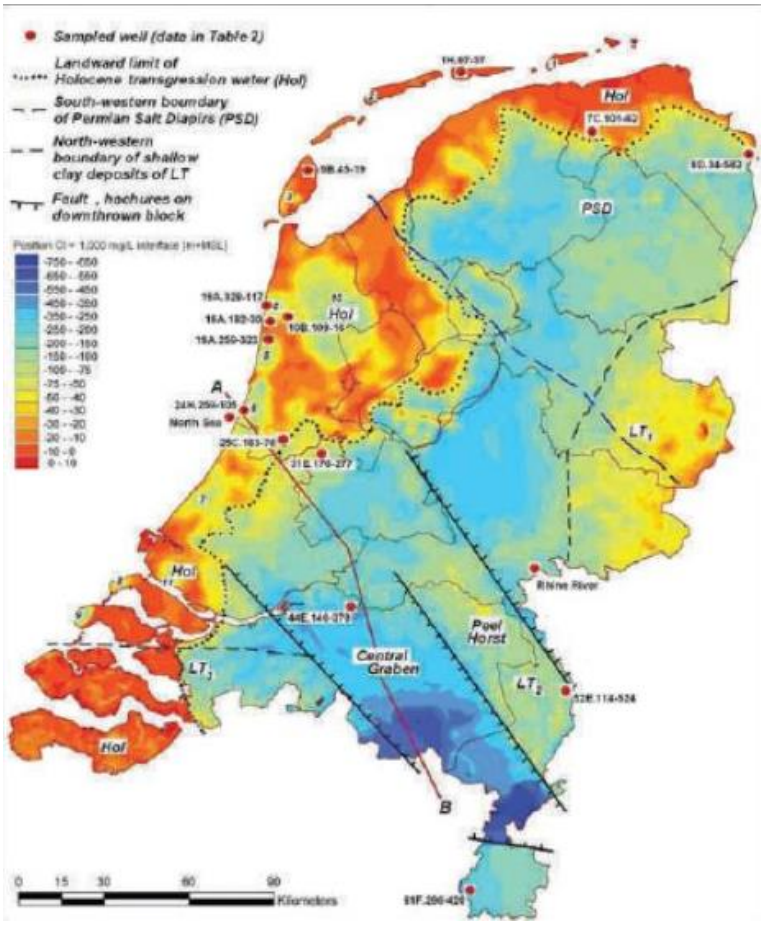

Figure 1 Depth of salt water (Kennis voor Klimaat, 2014)

1.2. Problem definition

Who is responsible for dealing with salinization and how can we define the problem of salinization? How can we make sure there is enough freshwater for the future generation? Are farmers in the region responsible for their crops? Should the government deal with the problem or does the responsibility lay somewhere in between? There are a lot of questions that are related to the problem of salinization. The awareness of the problem and the

information on salinization is not yet well developed (Jeuken et al. 2015). Nevertheless, the central government already sets objectives that should guarantee a freshwater supply for our next generations. The central government introduces in the Delta program the supply levels and the parties (central government, provinces, water boards, municipal councils and users), which should elaborate these levels of supply in the upcoming years. This should be accomplished by 2021 (MIE &MEA-b, 2015).

An important problem is the existing and most used measure in the Netherlands against salinization. "*Salinization of surface water is commonly mitigated by flushing of ditches and canals with extraneous freshwater, diverted from the rivers Rhine and Meuse, during the agricultural growing season. Both the projected decrease of freshwater availability from these rivers and increase of surface water salinization threaten the sustainability of current water management practice, and prompted water managers to seek alternative strategies*" (Delsman, 2015). The flushing of ditches and canals with freshwater is not a sustainable solution in perspective of the decrease of freshwater and the threat of salinization. A more adaptive strategy to deal with the problem of salinization is necessary. To achieve more adaptive measures the central government has set up the Delta program. However, the current measures are not adaptive at all (Delsman, 2015). Therefore it is important to explore what kind of strategies could be possible to make the freshwater supply more adaptive regarding salinization.

This research will elaborate on the degree of complexity of the issue of salinization, the scale and the strategies that are used on different institutional levels. In planning debates, these factors are often used. The degree of complexity of an issue and the scale can say something about the nature of the strategy. Therefore this research wants to position the issue of salinization into a planning spectrum. This is done with environmental problems that have been addressed by, among others, De Roo (1999) and Zuidema (2011). This research wants to investigate if the positioning of a water problem can be placed also in the same planning spectrum. This research will position the issue of salinization in a planning spectrum and with a case study on Friesland it wants to analyze this debate in practice for the governance strategy for this issue.

1.3. Research objective

This study aims to analyze the current governance strategy in Friesland on the issue of salinization. It aims to analyze the positioning of the issue of salinization in the planning spectrum and the cohesion of the governance strategy on salinization with this positioning. From a planning perspective the scale, the goals and how these goals will be achieved are important for the analysis. This can be developed in a governance strategy and therefore these will be analyzed and are formulated into the sub questions. The following main question arises within this objective:

Main question:

- How can the issue of salinization be positioned on a planning spectrum and does the governance strategy on the issue of salinization in Friesland fit this position?

Sub questions:

1. What is salinization and what are the causes and consequences of salinization?
2. On what scale occurs this problem?

3. What are the goals of the governance strategy on salinization?
4. What kind of measures are being taken against salinization and on what institutional scales? (How to achieve the goals?)
5. Who are involved? Who are the stakeholders that have to deal with salinization?

1.4. Reading guide

Chapter 1 includes the relevance and the problem definition of the research. The research objective is formulated and will be the basis for this research. Chapter 2 includes the theoretical framework and it describes the issue of salinization in a planning debate. What causes and consequences does salinization have. Sub question 1 and 2 will be answered. The theoretical framework will be the basis for the analysis of the governance strategy on salinization in Friesland from a planning perspective. The concepts of adaptiveness and resilience, which are developed from the theoretical framework, will be used as a tool to analyze the governance strategy. Chapter 3 includes the methodology. It will explain the process towards an answer on the research questions. Chapter 4 includes the results of the case study of Friesland. Several policies on freshwater and salinization will be elaborated and analyzed. This chapter will give answers on sub questions 3, 4 and 5. Chapter 5 includes the conclusion and will give an answer on the main research question. It will connect the theoretical framework with the data analysis. With this connection, the positioning of the issue of salinization and the governance strategy on salinization will be discussed from a planning perspective.

2. Salinization from a planning perspective

This chapter will develop a basis for the analysis of a governance strategy on salinization in Friesland. This chapter will first give a definition on what salinization is. It is relevant to understand the problem and therefore this chapter will elaborate on what salinization means and on what scale this occurs. It will elaborate on what the causes and consequences of salinization are. It is important to know what causes and consequences this problem has on the freshwater supply to investigate the degree of complexity of the issue of salinization. The scale of the problem will be discussed. It is important to understand on what scale this problems arise. With the causes and consequences and the scale of the problem, the issue of salinization can be positioned in a planning spectrum.

A framework of planning focused actions will be used to investigate the degree of complexity of the problem and the scale of the problem. This framework is developed by De Roo (1999). From this framework a planning spectrum for planning actions is developed by (Zuidema, 2011) and this planning spectrum can say something about the strategy that is chosen. The shift in governance from environmental problems will be connected to the shift in water management. With this connection, adaptiveness and resilience can be related to the positioning of the issue of salinization in the planning spectrum and can be used as a tool to analyze the governance strategy of Friesland. Literature on complexity, governance and paradigm shift in water management will be used to develop this theoretical framework.

2.1. Salinization in the Netherlands

This section will discuss the salinization of groundwater in the Netherlands. It will give an overview of the origin of saline water. This section will categorize the causes and consequences of salinization. The causes will be categorized into natural and anthropogenic causes and the consequences into ecological and social-economic.

The last decades increased *stresses on fresh water* became under the attention. On a national level the Dutch government presented the delta program where protection against flooding and the quality of our freshwater supply were the key objectives. Quality of freshwater supply and therefore fresh groundwater is important (MIE & MEA, 2014). The Netherlands is one of the biggest deltas in the world and coastal regions such as the Netherlands will have major problems with salinization of the groundwater in the near future (Pauw et al. 2015). Coastal areas, like the Netherlands, are densely populated because of the strategic position. Fertile soil, availability of food and water and the economic advantages are widely known. Despite the advantages coastal regions have, these regions also suffer from water management problems related to the occurrence of saline groundwater (Post et al. 2003). The origin of saline groundwater is complicated (Post, 2004). The geological history of the Netherlands is complicated and during periods in time the groundwater in the Netherlands was either saline or fresh in the underground. This study will not elaborate in detail the geological history and origin of saline water but will give a basic overview of causes from the geological history. Studies about the origin of saline water are also not unambiguous because the origin of the saline groundwater is still not fully understood (Post, 2004). However, it is clear that the geological history determined where saline groundwater is located and fresh groundwater is located (Post, 2004).

A *definition of salinization* can be seen as the siltation of freshwater. Fresh groundwater is one of the most vital natural resources for humanity and therefore the impact of saline water

on fresh groundwater is a major one (Pauw et al. 2012). A more specific definition of salinization is given by Stuurman et al. (2006), they define salinization as chloride contamination and salt water intrusion. Chloride contamination includes that the contamination norm of chloride is exceeded. This is possible by natural causes and by anthropogenic causes. Salt water intrusion includes the intrusion of salt water that derives from the sea or from formation water (paleo water). This is also possible by natural causes and by anthropogenic causes (Stuurman et al. 2006). The division between natural causes and anthropogenic causes can also be formulated as primary salinization and secondary salinization (Herbert et al. 2015). The natural or primary causes can be seen as autonomous causes. The anthropogenic or secondary causes are impressionable and will be important for this study to investigate the governance strategy. To make this clear the next sections will elaborate the natural causes and the anthropogenic causes of salinization.

2.1.1. Natural cause of salinization

The distribution of saline water derives from sources such as sea water intrusion, flooding evaporation or dissolutions of salt deposits or anthropogenic changes (Post et al. 2003). As mentioned in the definition of Stuurman et al. (2006) the natural cause of salinization can be divided into geological history and natural chloride contamination.

The *geological history* determined where saline groundwater is found. In the Holocene, when the sea water covered the Netherlands, saline water was able to infiltrate the sand layer. Clay layers which occurs in the underground or where deposited at the time, caused several freshwater layers to be stored in the underground. Eventually the sea withdrew and height in the landscape arose. These elevations in the landscape caused the diversity of the landscape and thus also the diversity in saline and fresh water. This caused the natural origin of saline waters in the Netherlands (Post, 2004). The salinization of freshwater due to the geological history of the Netherlands can be categorized. The first one includes marine transgressions with vertical salinization due to density formation. This means that land was flooded by sea water and that this sea water was able to drain vertically in the groundwater. The second category includes salt water intrusion from sea or sea estuaries which bordered to low lying areas. Sedimentation is the third category and includes the deposition of marine sands and clays, also named as paleo waters. The fourth category is called hyper filtration. It means that clay layers operate as semi permeable membranes which lead to a selective stream of dissolved substances (Stuurman et al. 2006).

Natural chloride contamination is also possible, as mentioned by the definition of Stuurman et al. (2006) and includes four causes. Sea spray is the first one; this means that salty winds from the sea are blown over the coastal regions which can cause higher salt degrees in the groundwater. The second cause of chloride contamination can be evaporation. Surface water can evaporate which leads to a higher chloride grade. This process does not currently occur in the Netherlands. The third cause is the salinization of the groundwater caused by massive salts. Salt in the ground can liquefy in freshwater which influences the chloride grade. The last chloride contamination can be caused by merging of different natural sources (Stuurman et al. 2006).

This outlines the natural causes of salinization. The next section will outline the anthropogenic causes of salinization.

2.1.2. Anthropogenic cause of salinization

Three anthropogenic causes of saline water can be distinguished in the Netherlands; climate change, subsidence of the land and contamination by agriculture, local contamination and sand extraction from the sea (Stuurman et al 2006; Post, 2004).

The entire world is facing temperature and precipitation changes in the recent decades and this is predicted to change even more in the future. This is a result of *anthropogenically driven climate change* (Cubasch et al. 2013; Jeppesen et al. 2015). More extreme weather events will occur which will magnify the seasonal and multiannual amplitude of water level fluctuations (Jeppesen et al. 2015). This creates more stress on the freshwater supply. Due to more flooding and more droughts, salinization of the groundwater will occur. Climate change will put more pressure on the fresh groundwater volumes for drinking water supply, agricultural purposes, industry and ecosystems (Oude Essink et al. 2010).

The Netherlands can be called a *man-made country*. The Netherlands are famous for their engineering and land-reclamation. The main reason to reclaim land from the sea, lakes and wetlands was to gain agricultural benefits. Land reclamation started around the twelfth century and was a start of the construction of many polders in the Netherlands (Mulder et al. 1994). A polder is an area which is protected from water and which has a controlled water level. The present climate in the Netherlands will not lead to salinization of the (sub) soil and the root zone in most of the polders (Oude Essink, 2001). However, due to the predicted sea level rise the salinization process will intensify, also in all low-lying areas in the coastal regions of the Netherlands (Oude Essink, 2001). Since the man-made areas are low-lying, sea level rise will have more impact on the freshwater.

The draining of peat areas resulted in land subsidence due to the compaction and decomposition of peat. Areas of peat disappeared by erosion during floods and by using the peat for fuel. The lakes that were created by the subsidence of land were reclaimed and became polders. Due to compaction, decomposition, erosion and sea level rise the elevation of the polders is currently below sea level (Post et al. 2003). Nowadays, land subsidence is mainly caused by mining raw materials as gas and salt (Pauw et al. 2012). For example, salt extraction in Friesland caused a land subsidence of 0.35 meter over 30 years. Due to this subsidence, it was necessary to lower the absolute surface water level in order to compensate the relative rise of the groundwater table. This led to seepage fluxes increase and upconing of brackish to saline groundwater (Pauw et al. 2012).

Another anthropogenic cause of saline water derives from contamination. Agriculture, greenhouses, sand extraction from the sea and local pollution are the main sources of contamination. Agriculture activities have major impact on the contamination of fresh groundwater. Due to natural and chemical fertilizers the groundwater is contaminated with, among other things, chloride. Also natriumchloride is directly used for dairy cattle for example. Another anthropogenic cause is by greenhouse agriculture. Due to artificial irrigation and evaporation, the shallow groundwater can evaporate and the groundwater will become more saline. The third cause of chloride contamination caused by humans derives from sand that is extracted from the sea and is used for dikes and dunes to heighten them. The flushing of the sea sand is not efficient and effective enough which lead to local increased chlorides in the ground water. Local pollution can be seen as the fourth cause of salinization.

For example road salt is used against slippery roads and causes local salinization (Stuurman et al. 2006). Table 1 gives an overview of causes.

Table 1. Natural and Anthropogenic causes of salinization.

Natural causes of salinization	Anthropogenic causes of salinization
Geological history	Climate change
Natural chloride contamination	Land subsidence
	Contamination

According to Oude Essink et al. (2010) the natural cause of salinization shows that there is a loss of fresh water. The anthropogenic causes of salinization show that it will accelerate salinization. So land subsidence, contamination of fresh water and climate change are the causes that will have the most impact on freshwater. As mentioned before, the natural causes can therefore be seen as autonomous where the anthropogenic causes can be seen as influenceable. Climate change will accelerate other causes of salinization. Reclaimed land is more vulnerable for flooding which leads to salinization. Also areas that deal with land subsidence are more vulnerable for salinization which leads to a relative high ground water table. The increasing frequency of extreme weather events due to climate change can also have major impacts on the contamination of freshwater. More droughts will cause more pressure on the freshwater supply and agricultural land will be less hydrated with freshwater which leads to an increase of chloride by fertilizers (Oude Essink et al. 2010).

From the supply side the coastal regions such as the Netherlands will face more problems due to the increased concentration of human settlements, agricultural development and economic activities. There will be a shortage of fresh groundwater for domestic, agricultural and industrial purposes due to a higher demand (Oude Essink, 2001). Oude Essink also says that the potential consequences are high. *Salt water intrusion in the subsoil may not only be a threat for the public and industrial water supply but also for agriculture and horticulture. Although technical methods for desalinization of saline or brackish water are available and applied, it is (still) an expensive method (Oude Essink, 2001 - p430).* So salinization will gain the pressure on freshwater supply and the exploitation of fresh groundwater resources will increase due to population and economic growth. There will be more pressure on freshwater due to intensified agricultural development and the loss of surface water resources due to contamination (Oude Essink et al. 2010).

This section gave an overview of the causes of salinization. The next section will outline the consequences of salinization.

2.1.3. Consequences of salinization

This section categorizes the consequences into ecology and social-economic consequences. The consequences also differ between humid and arid regions. The consequences have more impact in arid regions than in humid regions, because there is less natural freshwater available. The Netherlands are a humid region (LeBlanc & Rao, 1973). Therefore this study will focus on salinization in humid regions and not in arid regions. To give an overview of increased salinization in the Netherlands, figure 2 shows the salinization due to land subsidence and the predicted salinization due to sea level rise. The occurrence of salinization

due to sea level rise can be seen in different regions than the occurrence of salinization due to land subsidence

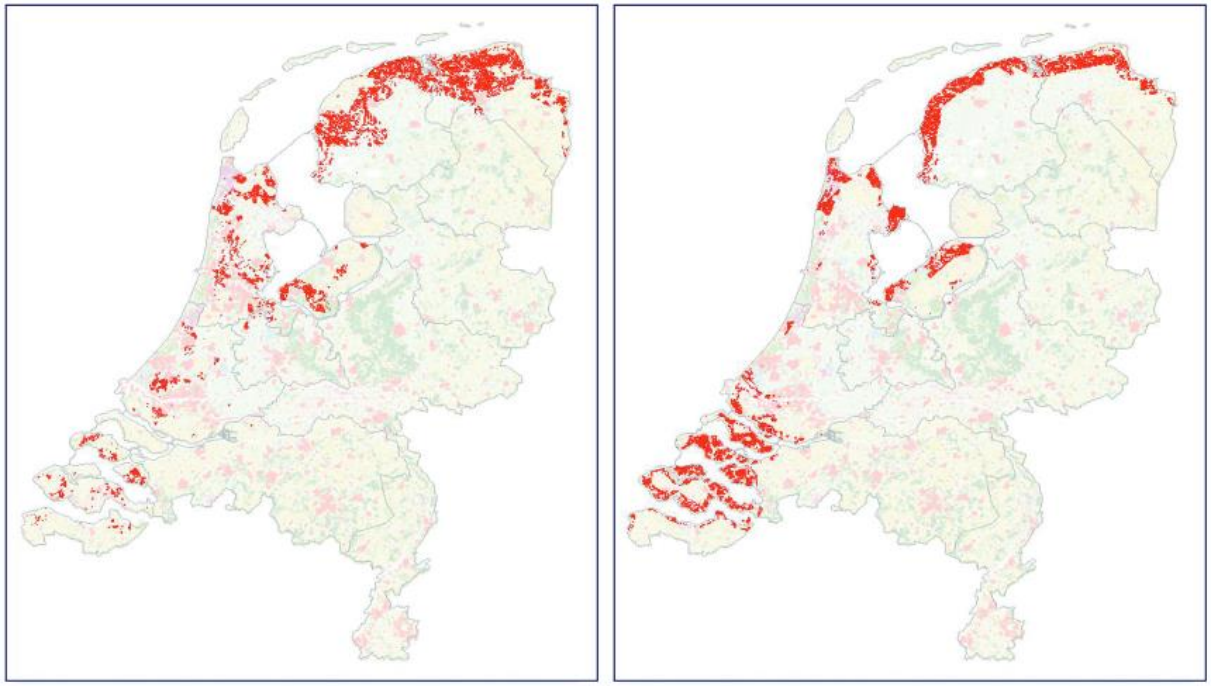

Figure 2. Areas with an increase of salinization due to land subsidence (Left) and the predicted salinization due to sea level rise (right) (Voorde & Velstra 2009).

The *social-economic consequences* are mainly about the threats for agriculture. Salt water can intrude in low-lying areas due to land subsidence and land reclamation. Sea level rise due to climate change will accelerate this process. This will lead to more crop damage in the future (Pauw et al. 2012). The chloride content in the water is important for crops; however, the chloride tolerance of crops differs. These differences in chloride tolerance will become more important in the future in the light of the expected sea level rise. Intolerant crops will not survive any longer and there will be a need for tolerant crops to produce enough food. However, according to Voorde & Velstra (2009) there is a shift to high capital intensive crops which means that these crops are less tolerant against saline water. Besides the agricultural aspect, salinization has economic consequences for industries, water companies and electricity companies. These kinds of companies have demands for the freshwater and due to salinization there will be more pressure on the amount of freshwater (De Boer & Radersma, 2011).

Salinization can have *positive and negative consequences for ecology*. A distinction can be made between between different types of nature. A distiquish can be made between flora and fauna that needs freshwater and flora and fauna that needs brackish or salt water. Besides that, a distinction can be made between the sensitivity of the nature types. In a research of Paulissen et al. (2007) it becomes clear that most of the nature types in low-lying Netherlands need freshwater but that there is a considerable difference between these types in their sensitivity for salt water (Paulissen et al. 2007). It depends on the circumstances, the nature type and the sensitivity of the nature type if salinization has positive or negative consequences on ecology.

The causes and consequences of salinization are related to a lot of uncertainty and unpredictability. The multiple causes of salinization can be seen as a non-linear issue and the causes are not certain. Climate change and its causes and consequenses are for example not certain. There is enough evidence that it will change but the degree of change is uncertain. As Termeer et al. (2011) say, *"There is increasing recognition of the need for society to adapt to the impacts of climate change, defined as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities"*. And every region can have other settings which have their own causes and consequences of salinity, which makes it a non-linear situation. This means that linear solutions might not fit the problem in every region. The complexity of the causes and consequences of salinization are elaborated. Besides the causes and consequences, the scale is important for the positioning of the issue of salinization into a planning spectrum. To analyze the governance strategies this research will go on with the investigation of the scale of salinization.

The next sections will discuss the scale of the anthropogenic causes. It is important to understand on what scale each cause affects the freshwater supply as it is important to know more about the scale of the problem in order to analyze the governance strategy. The scale of the issue and the complexity of the causes and consequences will be the framework for the planning spectrum.

2.2. Scale of salinization

Even with non-linear issues like salinization, there is a need for good governance for the future. Governing water problems like salinization, spatial planning can have a major role in possible outcomes. Spatial planning identifies possible sustainable developments and addressing the causes and the consequences of environmental problems (Wilson & Piper, 2010). The positioning of environmental problems in a framework of planning focused actions is well elaborated by among other De Roo (1999) and Zuidema (2011). The connection with environmental problems and water problems will be elaborated in section 2.4. This section will investigate the scale of climate change, land subsidence and contamination which are all impressionable causes of salinization and therefore important for the investigation of the scale of salinization.

2.2.1. Scale of climate change

As mentioned before, more extreme weather events and sea level rise can have major impact on our freshwater supply. So this section will discuss on what scale possible measures against salinization could be implemented.

Evidence of climate change has been observed around the world. Physical systems and biological processes around the globe are changing and have fundamental importance for the stability of life on this planet. The United Nations (UN) Framework Convention on Climate Change, international institutions and national governments are trying to deal with these changes. They are working towards introducing measures and policies aimed at limiting the changes (Wilson & Piper, 2010). This argues that the scale of climate change is global and should be managed on a global scale. Furthermore, issues of distributive and environmental justice have become more significant. There is a big difference between developed countries and underdeveloped countries and their view on climate change issues. This leads to problems on a global level to manage climate change. Global equity and the rights of those in other countries are not strongly visible in national or local planning decision-making (Wilson

& Piper, 2010). So climate change is a global issue but it is hard to make solutions on a global level with variety of countries and their situations. Therefore multi-level governance can be suggested as an approach for climate change. Wilson and Piper (2010, p94-95) interpreted multi-level governance as follow: "*As the power of the state in many industrialized countries of the West has diminished, with neoliberalizing and deregulatory tendencies, governments have needed to engage with wider networks of interests at international and national level. The wider governance therefore comprises the institutions of state and the surrounding networks of interests and stakeholders from business and civil society: policy formulation and implementation require negotiation vertically and horizontally across these multiple levels (global, national and local). Within the sphere of climate change politics, as well as economic politics, it has been argued that understanding the outcomes of subnational efforts to address climate change requires a recognition of the ways in which the boundaries of these levels are blurred 'by meshing the global and local in the presence of the nation-state'.*

With this statement of Wilson and Piper (2010) it becomes clear that the problem is on a global level, however a new way of thinking is required to solve this problem. There is a need for recognition of subnational efforts to address climate change. Examples of multi-level governance can be seen in different ways. For instance, national or regional levels of governance deal with the regulatory and fiscal contexts of climate change and the specific actions will be done on a local level. Differences can also be made between mitigation and adaptation. According to Wilson & Piper (2010), dealing with mitigation is done on a higher scale and adaptation on a lower scale. On a global level, policy frameworks can be used to reduce the causes of climate change through mitigation. On a local level, adaptation measures can be implemented to deal with the effects of climate change.

2.2.2. Scale of land subsidence and contamination

This section will discuss *the scale of environmental problems* in general. Land subsidence and contamination can be seen as environmental problems that affect a water related problem. Due to land subsidence, it is often necessary to lower the absolute surface water level in order to compensate the relative rise of the groundwater table (Tang & Tang, 2006). This led to seepage fluxes increase and upconing of brackish to saline groundwater. Land subsidence can cause salinization on a local scale. Contamination derives from agriculture, greenhouses, sand extraction from the sea and local pollution. Therefore this section will argue on what scale environmental problems like land subsidence and contamination can be managed. Who causes the subsidence and pollutes the water and on what scale can this be managed to deal with it and thereby with the salinization of the groundwater?

Salinization due to land subsidence is a local problem but is not caused by the locals itself. Land reclamation and mining of raw elements is done by the central government. Profits are on national level, but on a local level, inhabitants have to deal with the environmental problems that are caused by these activities. Who is responsible for these activities and on what scale can this be solved? The struggle with environmental problems also includes the contending actors within the region, what scale is used, which actor is taken into account and which actor does not participate. The political scale is not the same as the environmental scale (Sze et al. 2009). So to manage environmental problems, it is argued that the environmental scale should gain in interest instead of the political scale (Sze et al. 2009). There is a mismatch between the scales at which the problems of environmental inequality are manifested and experienced and the scale at which they are produced. Framing the scale

is important to make it a meaningful and actionable linkage with the problem (Sze et al. 2009). Cummings et al. (2006) mentioned mismatch in scale as a problem between the scale of management of natural resources and the scale of the ecological processes being managed. They argue that mismatches between the scales of ecological processes and the institutions that are responsible for managing them can contribute to a decrease in social-ecological resilience. Social-ecological resilience is included here as the mismanagement of natural resources and a decrease in human well-being (Cummings et al. 2006). This can be caused in either the scale of environmental variation, the scale of the social organization responsible for management, or both. These mismatches are hard to be resolved. There is a need to develop tools to accurately diagnose scale mismatches, there is a need to understand the dynamics that maintain maladaptive institutional arrangements and there is a need to determine what kind of remedial action are most likely to be effective (Cumming et al. 2006).

To link the scale with the causes and consequences, there is a need for well-grounded matches between environmental problems and the institutional arrangement that has to deal with the problem. Also the level on which the problem occurs is of importance. It becomes clear that the governance strategy used for an environmental problem needs a match between the scale and the institutional level. The planning spectrum can be used to analyze this match and will be elaborated in section 2.4. The anthropogenic causes of salinization are divided on different scales where climate change occurs on a global scale and contamination and land subsidence occur on local and region scale. The problem of salinization occurs on a different scale than the causes of salinization occur. It becomes clear that the problem of salinization is non-linear. Different scales are involved and the issue of salinization is non-linear and complex. To clarify the problem of salinization, a theoretical background on how to manage a problem that is non-linear, complex and have different scales will be used to analyze the governance strategy that will fit this problem.

The next section will elaborate on the planning spectrum. It can help to analyze the issue of salinization from a planning perspective. The planning spectrum analyzes the problem issues on an institutional scale and the degree of complexity. It divides issues from generic to specific context-depended issues (De Roo, 1999). As mentioned before, causes of salinization derive from different scales and water related and environmental problems are not solved with simple solutions. Many different stakeholders are dealing with freshwater, which makes it a non-linear problem. Van de Brugge et al. (2005) also mention that water problems are complex and so-called persistent problems. "*Persistent problems are new types of societal problems that are characterized by significant complexity, structural uncertainty, high stakes for a diversity of stakeholders involved, and governance problems"*(Van de Brugge et al. 2005. p.2).

2.3. A planning spectrum as tool for a governance strategy

This section will be the theoretical basis of the governance analysis on salinization. The degree of complexity of the issue and scale will be used as criteria's. Basically it includes whether issues are simple and have simple solutions (generic) or the issue is not simple and need therefore to less or greater extent a strategy that is more specific. The main discussion will be on the differences of simple and complex issues and on what institutional scale these should be tackled. The degree of complexity will be elaborated; this includes the assumption that wicked, complex problems cannot be solved with simple measures. On the other hand the institutional scale of the problem will be a criterion. A framework of planning focused actions is used to connect the degree of complexity and the scale.

2.3.1. The degree of complexity

The degree of complexity is important in planning theory and it can be used as a criterion for the direction of a planning strategy. De Roo (1999) makes use of a distinction between three components of decision making (Table 2). What is the goal of a policy? How can it be achieved? And who will be involved? A) goal-oriented, B) decision-oriented an C) institutional-oriented. It can be useful to investigate these components because each of them can have major influence on the strategy to solve an environmental issue (De Roo, 1999). These components are important to distinguish the strategy that will be chosen. Defining a goal of an issue leads to the questions 'how to achieve this goal' and 'who will solve the issue'. These components all say something about the way they are connected to decision making processes. The goal-oriented component looks to the physical and societal facts, to the object. The decision-oriented component says something about the choices that can be made, the subject. The third component has a more social interpretation. This emphasizes the organizational, the communicative or institutional processes called the intersubjective component. These components can be related to each other (De Roo, 1999).

From an object oriented side the number of elements and features which the issue or object consist of, are more or less clear. Their dimensions, their relations and consistency, the degree in which these elements and features in themselves and between themselves are subject to change and coherently to the conditions surrounding the object of study. Complexity from a subjective, relative and normative understanding includes the appreciation of the actors that are involved in the issue (De Roo, 1999). The degree of complexity of an object or a subject is different from each other. From the object-oriented side it is more or less countable and the goal that should be reached is central. From the subject-oriented side the choices and the decision are central. From the intersubjective view the question is 'who will be involved?'. It is about the interaction between actors and communication is more important.

Table 2. Components of decision making (De Roo, 1999)

	a. What is the goal?	b. How can it be achieved?	c. Who will be involved?
1	**Object**	Subject	Intersubjective
2	**Goal-oriented**	Decision-oriented	Institutional-oriented
3	**Facts**	Choices	Social
4	**Content**	Process	Context

With complexity as a criterion, planning strategies can differ from each other. Linear, simple issues versus complex, non-linear and interdependent issues will lead to different approaches. *A technical-rational approach* can be used if the goal is singular, based on facts and the subject is clear. The actors that are involved are clear. Issues that are linear could be managed with a technical-rational approach. The three components are simple to answer in this approach. The goal is singular, the steps to achieve this goal are clear and the actors that will be involved are also clear. The central government can manage the issue to produce the solution in a linear way. On the other hand, there is a *communicative-rational approach* that tackles issues from the intersubjective side. The goal is not singular but there could be multiple goals. If this is the issue it can be hard to define the steps to achieve a solution for

the issue. The context of the issue becomes more of importance and the relations between actors are important. The composition of this issue is non-linear, dynamic and interdependent to other issues. There is a need for an integrated, communicative approach in a horizontal governance setting (De Roo, 1999). Certain issues can be managed with a technical rational approach, whereas uncertain issues require a more communicative rational approach. These are the extremes of the planning spectrum. There are a lot of planning problems that not will fit these extreme sides but will appear somewhere in between. Therefore it is context-dependent which approach you are going to use.

With this in mind it can be said that the degree of complexity of the issue can say something about the approach that will be used to solve an issue. The next section will discuss the connection of the scale with the approach that can be used for an issue. This is related to environmental issues, the relation between environmental issues and water issues will be discussed later.

2.3.2. Institutional scale; from government to governance

The connection of the scale and the degree of complexity can be made with the division of generic and specific issues. On a national scale more generic issues are solved and specific issues are solved on a local scale. So this distinction between technical rational versus communicative rational can be linked with the institutional scale. Solving problems was mainly a responsibility of the central government. The central government was able to deal with the public good and had the instruments and control to deal with these processes. However, in recent decades both social relations and the technical infrastructure of society have changed significantly (Albrechts, 2006; Zuidema, 2011). The role of the state is changing and the field of governance becoming increasingly popular. Governments are experimenting with new forms of horizontal governance, interactive decision making, stakeholder involvement and other forms of citizen involvement (Klijn, 2008). Also Lemos & Argawal (2006) discussed the role of the state.

The governance triangle of Lemos & Argawal (2006) shows the positions of different types of governance, with market, state and civil society in the corners (figure 3). The market represents governance through competition, the state represents governance through coordination and civil society represents governance through argumentation. And between these corners, different connections can be identified. Hybrid forms of governance filled the gaps between state, market and community. Comanagement is a hybrid mixture between community and state, public-private partnerships between market and state and private-social partnerships between community and state.

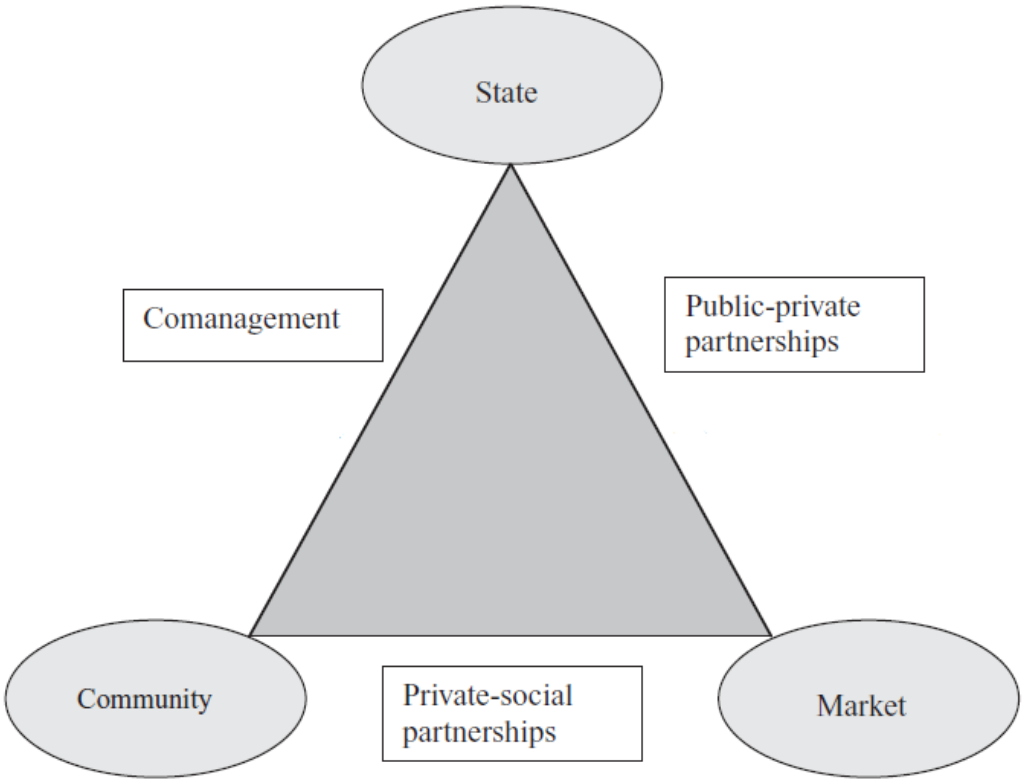

Figure 3. Mechanisms and strategies of environmental governance (Lemos & Argawal, 2006)

This reallocation of governance from the state to other actors can be explained by a phenomenon of the last decades that is called the 'hollowing out of the state' (Stoke, 1998).

This includes that the control of the central state is reallocated upwards, sideways and downwards. Supranational bodies such as the European Union are taking over responsibilities, the market, non-government and civil organizations are taking over responsibilities from the central state and lower governments are getting more responsibilities (Zuidema, 2011; Lemos & Argawal, 2006; Stoker, 1998). This shift from monocentric, hierarchical and well-institutionalized forms of government towards less formalized and more polycentric forms of governance in which state authority interacts with wider group of mutually interdependent stakeholders, can be seen as an example of multi-level governance (Wilson & Termeer, 2011). An example of a polycentric form of governance is the network approach of Koppenjan & Klijn (2004).

Koppenjan and Klijn (2004) advocate that the traditional technical-rational approach for problem solving no longer suffices. They say: "*Uncertainty is a characteristic of modern society which is not simply caused by a shortage of knowledge or information, but also by the strategic and institutional features of the network settings in which these wicked problems are articulated and processed".* They give an accumulation of developments that relate to the wickedness of many societal problems. Increasing intertwinement, deterritorialization and globalization, turbulent environments, value pluralism, horizontal relations and development of knowledge and technologies: new uncertainties and risks are all part of the increasing wickedness of problems.

It is important to understand that this does not provide clear-cut recipes for dealing with societal issues and for organizing societal decision making. The network approach can give insights and prescriptions for dealing with the substantive, strategic and institutional factors that play a role in societal problem solving; the result is not a blueprint of uncertainty management of wicked problems (Koppenjan & Klijn, 2004).

It becomes clear that problem solving has no good or false strategy. The shift from government to governance shows that the focus should not be at the object, but on the process of the strategy. Despite these governance shifts, the central state has also advantages. Effectiveness, routine and economies of scale are examples of advantages of the central state. These advantages are important with issues that are linear and have fixed goals. Central control will then be useful with simple linear issues. When policymakers ask for more integrated goals, the central government is limited. Integral strategies aim to develop a strategy where more actors are involved, more interpretations are possible and causes are more complex. There is a need for a better view on the local context and a more communicative rational strategy (De Roo, 1999; Zuidema, 2011). Figure 4 shows the connection between the degree of complexity of the issue (Vertical) the institutional scale (Horizontal) and the governance approach (Diagonal). The vertical and the horizontal line can be seen as the framework of planning focused action and by using these, the diagonal can say something about the approach that could fit an issue. This diagonal implies the planning sprectrum that is used for this research.

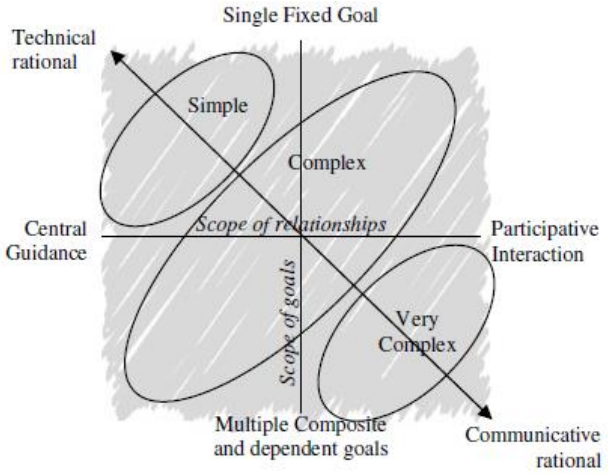

Figure 4. Framework for planning oriented action (Zuidema, 2011).

The risk of strategies on a local level is about the loss of effectiveness and efficiency. Decentral governments can have less expertise, less willingness and do not always have the ability to accomplish their integrated goals (Zuidema, 2011). There is a need for central policy frameworks to achieve decentral integrated strategies. These policy framework can stimulate and support local strategies and this steering function is crucial for decentral strategies to be successful (Zuidema, 2011).

2.4. Planning spectrum for Salinization

The framework for planning oriented action (Zuidema, 2011) shows the planning spectrum from technical rational to communicative rational in figure 4. It can also be used for the issue of salinization. This section will place the issue of salinization on the planning spectrum on the basis of the different causes and consequences and their scale.

2.4.1. Causes and consequences and their scales

As mentioned before in sections 2.1.1 and 2.1.2, there are different causes of salinization and different consequences. The causes are categorized into natural causes and anthropogenic causes. The nature of these causes can be linked to the scale, where climate change can be positioned on a global scale, land subsidence on a local or regional scale and contamination on a local or regional scale which is elaborated in section 2.2.

As mentioned before in section 2.1.4, there will be consequences for agricultural lands, industries, water companies, electric companies and the ecology due to salinization. Social-economic consequences of salinization mainly have negative effects on agriculture and can argue for a regional or local scale. Consequences on ecology are very area specific and therefore can be seen on a local scale; the consequences on ecology might be either positive or negative.

The many causes and consequences of salinization make it a non-linear and complex issue. Therefore it can be assumed more on the right in the bottom corner. It is not placed totally in that corner because it is still linked with global issues like climate change and as mentioned before, climate change will have an accelerating effect on the other causes of salinization. The issue of salinization can be placed on a regional scale with many causes and consequences and it can be primarily linked to communicative rational approach.

To analyze the governance strategy the componets that De Roo (1999) mentioned will be used. And these components are also shown in figure 5.

a. What is/are the goal(s) of the policy documents;
b. How will this be achieved;
c. Who is involved?

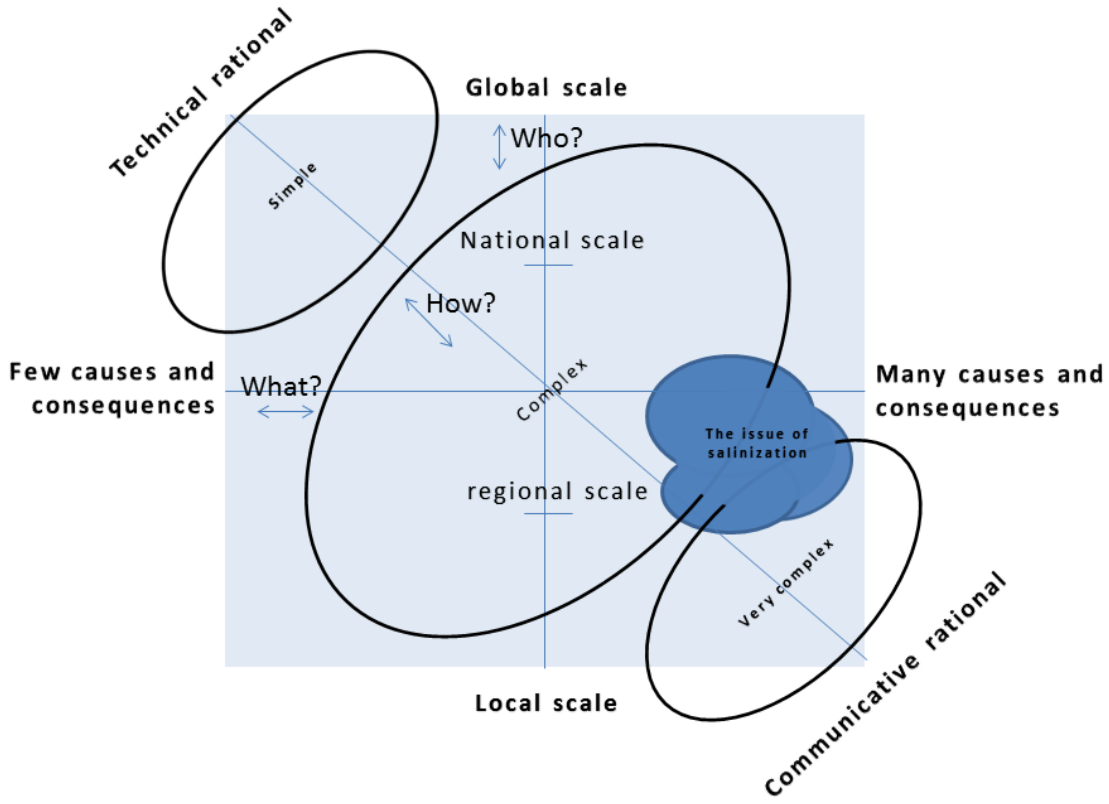

Figure 5. Salinization on the planning spectrum

The questions that are mentioned in table 2 are visualized in figure 5. On the horizontal line the 'what' question is positioned and includes the degree of complexity of the issue. This includes whether there are few causes and consequences or many. The 'who' question is positioned on the vertical line and includes on which scale the problem occurs. The 'how' question is positioned on the diagonal line and includes the strategy that could suit the problem. The governance strategy should be more specific then generic according to the position of the issue of salinization in this framework and the degree of complexity of the issue. This degree of complexity can be related to adaptiveness and resilience and will be discussed in the next section.

The issue of salinization based on causes, consequences and the scale is positioned on the right side of the spectrum (figure 5). There are a couple of concepts that can be linked with this position of the issue of salinization in the planning spectrum. There will be no single strategy that perfectly suits the issue of salinization because there are many causes and consequences and because the positioning of the issue is also blurred, this means that it is not fixed in one position. Concepts related to complex and uncertain issues can help in making a

well-grounded strategy. First, the shift in water management will be elaborated and will be connected to the shift in governance. Second, two concepts from water management that are related to issues with a high degree of complexity will be elaborated. The next section will elaborate these concepts.

2.4.2. Linking concepts from water management to salinization

In water management the degree of complexity of problems and the shift from government to governance is elaborated by, among others, Pahl-wostl (2007) (Figure 6). She says: *"Water management is facing major challenges due to increasing uncertainties caused by climate and global change and by fast changing socio-economic boundary conditions. More attention has to be devoted to understanding and managing the transition from current management regimes to more adaptive regimes that take into account environmental, technological, economic, institutional and cultural characteristics of river basins. This implies a paradigm shift in water management from a prediction and control to a management as learning approach."*

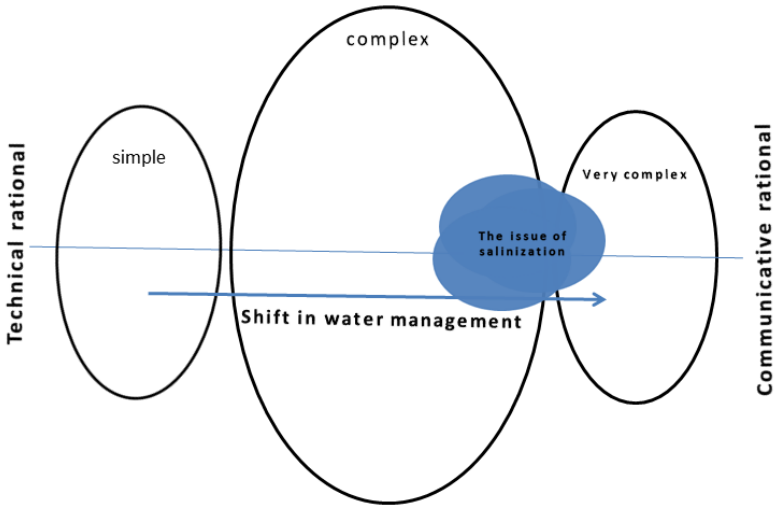

Figure 6. Shift in water management placed in the planning spectrum.

There are a couple of concepts in water management that can be linked to this *shift in water management* and a that are related to issue with a high degree of complexity. *Adaptation and resilience* are two concepts that are often described in water management literature and these concepts are linked with the high degree of complexity, uncertainties and unpredictability that can be found in the right side of the planning spectrum.

The concept of adaptation is well elaborated in water management literature. Most literature discusses the transition in water management and how to deal with the uncertainties of the future. As mentioned in the quote of Pahl-wostl (2007) there is a paradigm shift in water

management. This is the shift from prediction and control to learning by doing. Taking into account complexity of water systems at different scales and an increase in uncertainty is leading to management that is focused on more adaptive and flexible management, so it is operational under fast changing socio-economic boundary conditions and climate change (Pahl-wostl, 2007; Van der Brugge et al. 2005; Gupta et al. 2010).

The concept of resilience basically includes the capacity of a system to manage specific risks. There are three main notions of resilience, the first is 'engineering resilience', the second is 'ecological resilience' and the third is 'evolutionary' resilience. Engineering resilience includes the ability of a system to return to stability or equilibrium after a disturbance. This says something about the maintaining of the efficiency of the function of a system. Ecological resilience includes the ability to absorb shocks and still persist and says something about the maintaining of the existence of function. Evolutionary resilience includes not a desirable return to stability or absorb shocks but advocates a new form and function that can deal better with shocks or stresses (White & O' hare, 2014). The first two concepts of resilience focuses more on short-term damage reduction where evolutionary resilience focuses more on the long-term adaptive capacity building (Davoudi et al. 2012)

Both concepts have similar components. Both are dealing with decision-making processes and the set of actions undertaken to maintain the capacity to deal with current or future change (Nelson et al. 2007). Adaptation has a focus on actors and on reducing vulnerabilities to specific risks. Resilience is based on complex systems with the focus on adaptive capacity and maintaining the ability to deal with future uncertain change (Nelson et al. 2007). Nelson et al. (2007) identify areas in which a resilience framework contributes to a better understanding of adaptation. The core understanding of a resilience framework is that change is a fundamental aspect of any system. This includes that the level of adaptiveness also changes as the context changes. A resilience framework can provide the preparation for surprises and system renewal. Where an adaptive strategy is trying to eliminate vulnerability, the challenges are to identify acceptable levels of vulnerability and to maintain the ability to respond when vulnerable areas are disturbed (Nelson et al. 2007). This means that the concept of resilience can extend the concept of adaptation. Table 3 gives an accumulation of the different characteristics that are mentioned in this section.

Table 3. Characteristics of adaptiveness and resilience

Adaptiveness	Resilience
Flexible	Bounce back; Absorb shocks
Learning by doing	Preparation for surprises
Reduce vulnerabilities	Ability to deal with uncertain change
Capacity to deal with future change	Capacity to deal with future change

This research will focus on the governance strategy on salinization that already exists and will use the framework of planning focused actions and the concepts of adaptiveness and resilience to investigate if the governance strategy suits the problem. The characteristics will

be used as a tool to value the issue of salinization in Friesland. This study assumes that if the characteritics are highly present it can correspond better to more complex issues and if the characteristics are less present, it correspond better with simple issues. If the characteristics are highly present in the governance strategy in Friesland it can be assumed that it will linked more with a communicative rational approach of the planning spectrum and if the characteristics are less present it can be linked more with a technical rational approach. The next section will elaborate the conceptual model that visualizes the used concepts in one model.

2.5. Conceptual model

This section illustrates (Figure 7) the linking concepts of this research and is based on the elaboration of the issue of salinization from a planning perspective. The causes of salinization are categorized into natural and anthropogenic causes. Climate change, land subsidence and contamination are the main anthropogenic causes. The consequences are categorized into socio-economic and ecological consequences. These causes and consequences illustrated the complexity and the uncertainty of the issue of salinization. It becomes clear that in planning the scale of the issue is important. In a planning spectrum the scale and the degree of complexity are used as a criterion.

With the causes and consequences and the scale of the issue as background, the issue of salinization is placed in a planning spectrum. The spectrum shows the technical rational approach versus the communicative rational approach as two extremes in the spectrum. Salinization is placed more on the communicative rational side, where issues are complex and have many causes and consequences. Concepts related to complex and uncertain issues can help in evaluating the governance strategy and the position of the issue of salinization. In water management the concepts of adaptiveness and reslience can be positioned on the right side of the spectrum and that are primarily linked with complex issues. The characteristics of these two concepts will be used to value the governance strategy of Friesland on the issue of salinization. If the valuation of the characteristics is high, the concepts are present in the governance strategy and that will connect the used governance strategy to more complex issues. If the valuation of the characteristics is low, the concepts are not present in the governance strategy. This will mean that the governance strategy is connected to more simple issues. Regarding the planning spectrum, a communicative rational approach is needed with very complex issues.

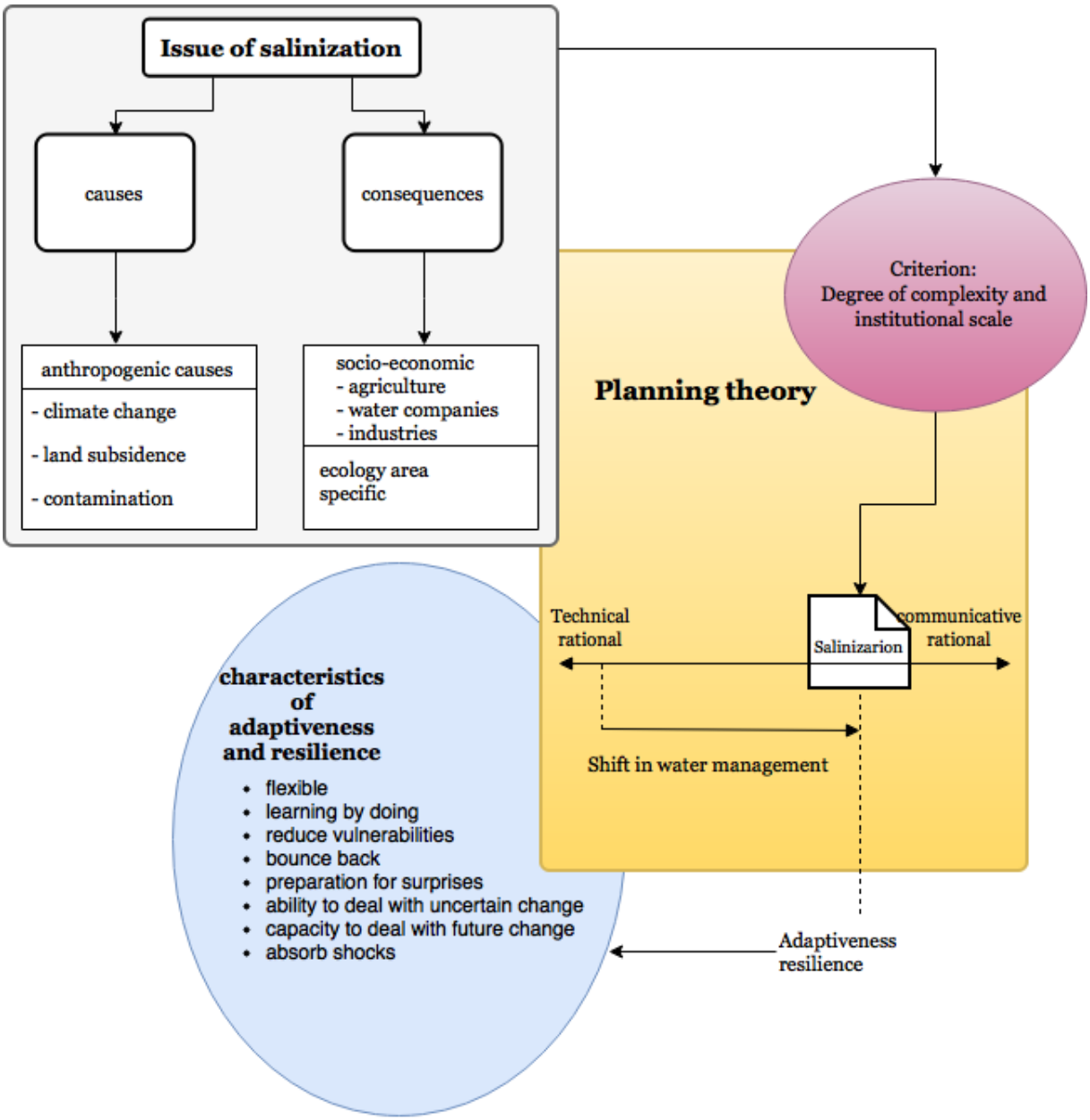

Figure 7. Conceptual model.

3. Methodology

The first chapter gave an introduction of this study and the research objective. The second chapter elaborated on the issue of salinization and the theoretical background of this research and is based on a literature study. This chapter will explain the process towards an answer on the research question. It will discuss why there was chosen for a case study research, it will discuss the research methods that are used, it will illustrate the collection of data and the data analysis of these methods.

The objective of this research is to analyze the current governance strategy on salinization and if it is coherent with the issue of salinization in Friesland. It aims to analyze the problem of salinization from a planning perspective and this research analysis the position of the issue and the strategy used on salinization on a planning spectrum. A qualitative case study will be used in order to provide insides for this objective. Qualitative case studies provide tools for researchers to study complex issues within their contexts (Baxter & Jack, 2008). Another reason to choose for a case study is the function of a case study. It can have an intrinsic value for the research, it can help to disprove a theory, it can help to bring new variables to light or it can help to support a theory or collective use for the basis to form a new theory (O'Leary, 2010).

3.1. Case study

Chapter two made clear that the issue of salinization is a complex issue with many causes and consequences and mainly occurs on regional scale. Therefore this research will investigate the issue of salinization on a regional scale with a case study. According to Yin (2003) a case study can be used if: (a) the focus of the study is to answer "why" and "how" questions; (b) the researcher cannot manipulate those that are involved in the study; (c) the researcher wants to cover contextual conditions because he believes they are relevant to the issue under study. In this study, reason (c) is the main reason to choose for a case study.

The province of Friesland is used as a case in this matter. Section 2.1.4. shows that the province of Friesland has problems with salinization due to climate change, sea level rise and to land subsidence. This research wants to investigate the connection of the governance strategy of the province of Friesland and the water board of Friesland with the concepts that are elaborated in chapter two. The water board of Friesland has the main objective to maintain the quality and the quantity of freshwater. Province of Friesland is in charge of the policy strategy on freshwater (Province Friesland, 2016). These two institutions are used for this reason.

The analysis of a governance strategy with the issue of salinization could also be done in other coastal regions; however the researcher has affection with the province of Friesland and has also connecitions with the water board of Friesland. Besides that, the issue of salinization is already a subject of discussion in this province, the connection and the affection with the province is important for the decision of this case.

3.2. Research methods

This research makes use of different methods to collect data. Clifford et al. (2010) explain the use of various methods as follow: *"in the process of research design it is important not to view each of these methods as an either/or choice. Rather, it is possible (and often desirable) to mix methods. This process of drawing on different sources or perspectives is*

known as triangulation. Researchers can use multiple methods or different sources of information to try to maximize an understanding of a research question."

Primary research for this study includes desk research, in-depth interviews and observation and participation. A desk research is done to analyze policy documents from different institutions. This is done on a national, regional and local level so the positioning of the strategy in the planning spectrum can be evaluated. Interviews with experts will be done to inventorize the policy documents and to get more insights into the policy documents. Also in-depth interviews are done with important interest groups to investigate the performance of the policies. A cross reference will be done with observation and participation. Cross reference is important for the overview of the analysis of the data. The combination of the different methods is the basis of the valuation of the concepts adaptiveness and resilience. By valuating the concepts the position of the strategy on salinization can be developed. These methods are framed in a deliberate research strategy and are shown in figure 9.

3.2.1. Document analysis

Governance strategies used for the issue of salinization are found in different policy documents on different institutional scales. Policy documents about freshwater supply and a good quality and quantity of fresh water are used. On a national level, the Delta program and the national water plan are describing these issues. On a regional scale, provinces have regional water plans and water boards have water management plans (waterbeheersplannen). These documents will be investigated in order to answer the sub-questions:

- What are the goals of the governance strategy on salinization?
- What kind of measures are already being taken against salinization and on what scales?
- Who are involved? So who are the stakeholders that have to deal with salinization?

In particular the water plan of the province of Friesland and the water management plan of the water board of Friesland are used to investigate these questions for the case of Friesland.

Documentation is relevant in every case study (Yin, 2003). Studying documents is in essence similar to observing or interviewing and the researcher should organize the analysis to gather the information that is needed from the documents (Stake, 1995). Policy documents are shown in table 4 and are gathered by making use of a snowballing effect.

According to O'Leary (2010) a clear determination of gathering information for policy documents is needed. The documents should be filtered by information that also is usable for this research. The theoretical framework makes clear that three questions are important to investigate the degree of complexity of an issue. The first step is to analyze the following questions:

d. What is/are the goal(s) of the policy documents;
e. How will this be achieved;
f. Who is involved?

These questions are also related to the sub-questions of the research objective. The second step is to analyze the concepts that are related to the issue of salinization from a planning perspective and to analyze the different characteristics of these concepts. Adaptiveness and resilience are these concepts that are mentioned in the theoretical framework and will be

used as a tool to position the strategy on salinization of Friesland in a planning spectrum. The following characteristics should be found and valuated in the policy documents:

- flexible
- learning by doing
- reduce vulnerabilities
- bounce back
- preparation for surprises
- ability to deal with uncertain change
- capacity to deal with future change
- absorb shocks

3.2.2. In-depth interview

Four in-depth interviews are done. Two interviews are done with one person from the province of Friesland and one person from the water board of Friesland to identify all the important policy documents that are important to analyse. This is done with semi-structured interviews. Semi structured interviews have some degree of predetermined order but still ensures flexibility in the way issues are addressed by the informant (Clifford et al. 2010). Next to the inventory of policy documents the three main questions about the goals of a policy; who is involved and how to achieve are asked in these interviews. The in-depth interviews are used as a tool to position the governance strategy.

Second, two interest groups are interviewed to investigate the performance of the governance strategy of the issue of salinization so the characteristics of adaptiveness and resilience are in line with the policy documents. A representative of LTO Noord is interviewed. This is the interest group of the agriculture sector in the north of the Netherlands. Besides that, a representative of a nature conversation group, It Fryske Gea, is interviewed. Also a local government is asked for its opinion on the governance strategy of the province and water board to investigate the scale. Table 4 shows the interviewees. Appendix A and B include the interview guide and the transcripts of the interviews. The interview guide is made for all the interviewees, but because it is semi-structured, this was only a guideline and in the transcripts several questions are formulated specific for the interviewee.

3.2.3. Observation and participation

Observation and participation includes a college day in Leeuwarden on the subject of groundwater. This day was organised by the province of Friesland and different experts on groundwater were there to talk about groundwater. It took place on the thirteenth of May 2017 and different presentations were held by experts, and it was possibile to ask experts about salinization. This led to a cross-reference of the case study and gave an overview of the issue of salinization in Friesland and its governance strategy. The three methods together; in-depth interviews, document analysis and observation and participation are in line with the aforementioned quote of Clifford et al. (2010) about the use of various methods.

3.3. Data collection

This section will give an overview of the data (table 4) that was collected for the analysis of this research.

Table 4 overview data collection

Organization	document	Interviewees		Goal of data
National level- Rijkswaterstaat	- Water law - national water plan 2014 and 2015) - Delta program (2014 and 2015)			Document: goals, how to achieve.
Province of Friesland	- waterhuishoudingsplan - Document of answer notes of the waterhuishoudingsplan - Kaderlichtlijn water	Wilbert Elderhorst, 19 april 2017	Interview	**Document:** Goals, how to achieve, stakeholders, valuation concepts **Interview:** Inventory of policy and maintenance
Water board of Friesland	- waterbeheerplan - innovatieplan - agenda toekomstbestendig waterbeheer	Jos Schouwenaars, 20 april 2017	interview	**Document:** Goals, how to achieve, stakeholders, valuation concepts **Interview:** Opinion on policy and maintenance
Argiculture and horticulture organisation Norhtern Netherlands(LTO Noord)	- Boeren Meter Water - Deltaplan Agrarische Waterbeheer	Bouwe Bakker, 3 mei, 2017	interview	**Document:** Agricultural opinion on salinization, valuation concepts **Interview:** Opinion on policy and maintenance
Combination of organizations[1]	- Spaarwater	Bouwe Bakker, 3 mei, 2017		**Document:** Valuation concepts **Interview:** Opinion on policy and maintenance
Municipality	- Streekagenda	Wilma Stienstra gemeente Franekeradeel, 4 mei 2017	mailcontact	**Interview:** Opinion on policy and maintenance
Fryske gea, nature conservation	- Zilte vitaliteit	Chris Bakker, 11 mei 2017	Phone call	**Document:** valuation concepts, ecology side of salinization **Interview:** Opinion on policy and maintenance
Researcher, TNO and Artesia water	- TNO rapport on effects of climate change and sea level rise in Noord-Friesland - Artesia water, model calculation on salinization in Friesland			Overview of case

[1] This project is done by Acacia water institute and is financed by the waddenfonds, Provincie Groningen, Provincie Friesland, Provincie Noord-Holland, Hoogheemraadschap Hollands Noorderkwartier, Waterschap Friesland, Waterschap Noorderzijlvest, Waterschap Hunze en Aa's, LTO noord fondsen, STOWA, achmea Agro en Rabobank.

3.4. Data analysis strategy

The data analysis strategy is based on the conceptual model.

The first step of the data analysis strategy is to analyze the case study; it will illustrate the area under investigation. This is done by analyzing two reports. The province of Friesland hired Aresia B.V. for an "oriented model calculation" of salinization in Friesland. TNO did a groundwater model calculation on the effects of climate change and sea level rise for the Northern part of Friesland. Both documents are used to describe the case of salinization in Friesland. Besides these two reports, policy documents and the in-depth interviews with Eldershorst and Schouwenaars, are used to illustrate the case of salinization in Friesland.

The second step is to analyze the policies of every level. Policies on salinization are included in different policy documents on different governmental levels in the water plans. It is important to investigate the policies on salinization on a national level first before investigating the policy on provincial level, and in this case of the province of Friesland. This because the water law says in article 4.1. that there should be a performance (doorwerking) of national water policy to regional water policy to water maintenance policy of the water boards. Figure 9 shows this process of data analyzes. The documents of the province, the water board and both interest groups are validated by the in-depth interviews and the in-depth interviews give some extra insights on the policies. It shows only the main documents that are connected to the stakeholders.

The researcher investigates the issue of salinization by the questions: a) what are the goals?, b) how to achieve?, c) who are involved? In the first round of interviews, the researcher identified the degree of complexity and the scale of the problem so the issue of salinization could be placed and connected to the framework of planning focused actions.

The third step is to connect this placement of the issue of salinization in the planning spectrum with the characteristics of the concepts of adaptiveness and resilience. Examples of the aforementioned characteristics will be elaborated in the results. The researcher valued the degree of the characteristics in the documents, with the opinion of experts and the cross-reference of the college afternoon. Based on these three methods, the valuation of the concepts can be developed. The valuation can be ranged from highly present to present, more or less present, less present or not present. Table 5 shows an example of two issues with one simple issue in red and one very complex issue green. Highly present characteristics can be connected to issues that are very complex and can be assumed with a communicative rational approach. Not present characteristics can be connected with issues that are simple and can be assumed with a technical rational approach. This is shown in figure 8.

Table 5. Valuation of characteristics of concepts

		++	+	+/-	-	--
Adaptiveness	Flexible	x				x
	Learning by doing	x				x
	Reduce vulnerabilities	x				x
	Capacity to deal with future change	x				x
Resilience	Ability to deal with uncertain change	x				x
	Bounce back	x				x
	Absorb shocks	x				x
	Preparation for surprises	x				x

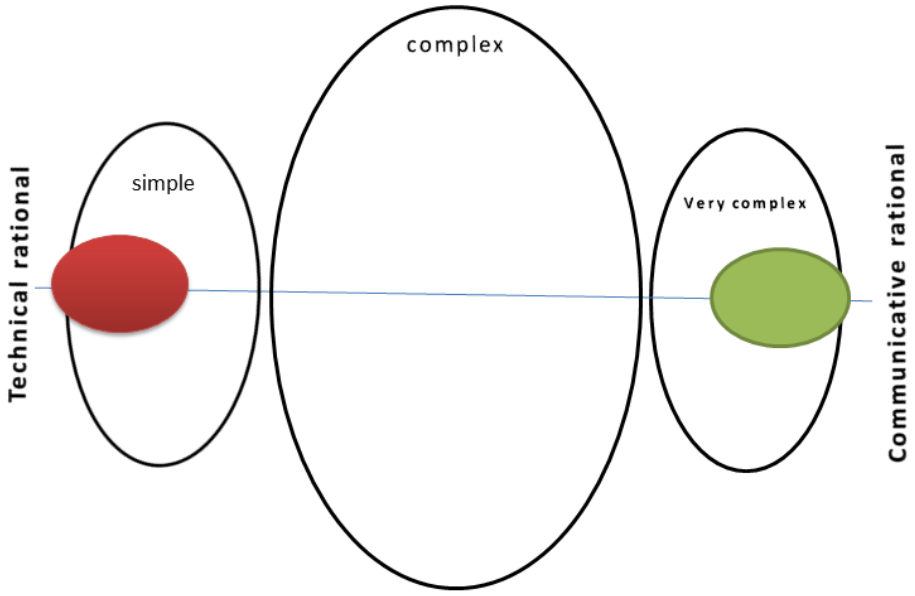

Figure 8. Example of valuation concepts in planning spectrum.

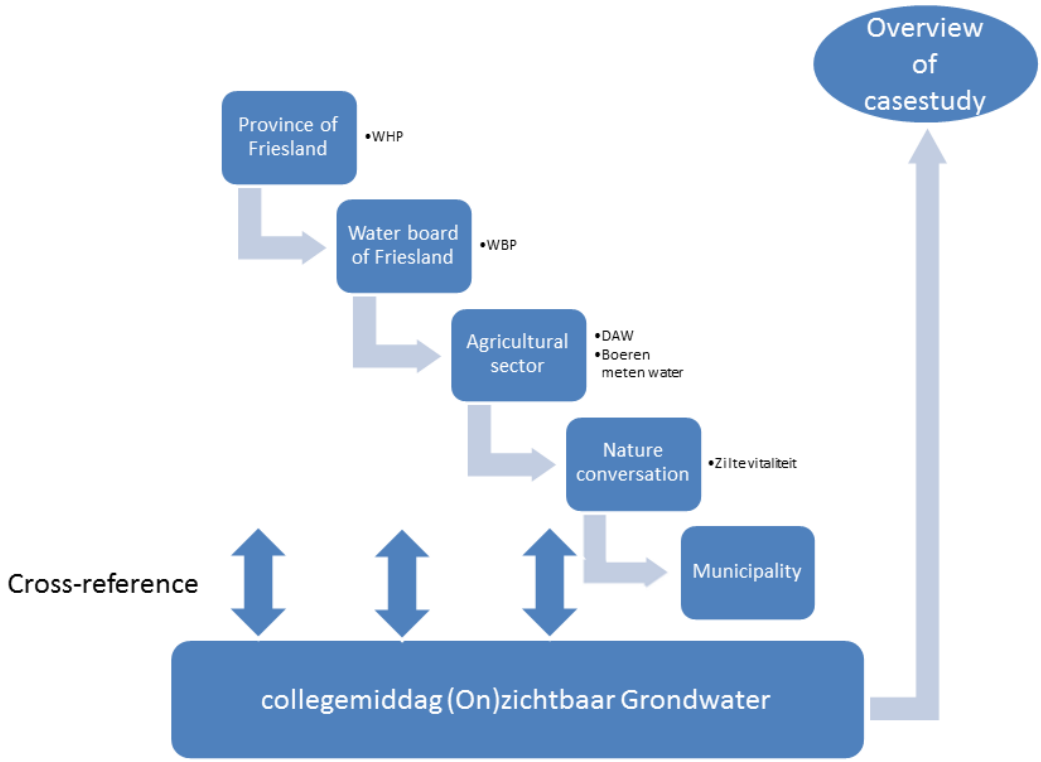

Figure 9. Process of data analysis

4. Governance strategy on salinization

This chapter will discuss the results of this research. It will first analyze the case of Friesland in general; it will illustrate the area under investigation. It will analyze the general settings of the groundwater in Friesland. This is important to understand the areas where salinization of the groundwater is a problem. After, the specific issue of salinization will be analyzed for the case of Friesland. This will be the basis for analyzing the position of the issue of salinization and the governance strategy on salinization.

The second section of this chapter will discuss policies on salinization. Policies on salinization are included in different policy documents on different governmental levels. It is important to investigate the policies on salinization on a national level first before investigating the policy on a provincial level, and in this case of the province of Friesland. This part will include the goals of the policies and provide the first step of the document analysis; *what is/are the goal(s) of the policy document(s)?* It will also include the measures that flow out from each policy. It will therefore also provide the second step of the document analysis; *how will be this achieved?* Also the in-depth interviews will be used to analyze the measures.

The third section of this chapter will discuss the involvement of the interest groups. There are a couple of interest groups that are important by the development of a governance strategy. Their opinions on the policy of the province and the measures of the water boards will be analyzed. Also policy documents with recommendations to improve their situation will be analyzed. This will provide the third step of the document analysis; *who are involved?* Also the in-depth interview will be used to analyze the involvement of interest groups.

The fourth section of this chapter will discuss the analysis of the concepts of adaptiveness and resilience in relation to the governance strategy on salinization in Friesland. The document analysis, the in-depth interviews and the observation and participation methods are basis for the valuation of the characteristics of these concepts. With the analysis on the issue of salinization in Friesland and the valuation of the governance strategy on salinization, the answer on the main question of this research can be developed: How can the issue of salinization be positioned on a planning spectrum and does the governance strategy on the issue of salinization in Friesland fit this position?

4.1. The case: Salinization in Friesland

Salinization in Friesland is under investigation by different institutions. The province of Friesland hired Aresia B.V. for an "oriented model calculation" of the salinization in Friesland. TNO did a ground water model calculation on the effects of climate change and sea level rise for the Northern part of Friesland. Besides these documents, policy documents and the in-depth interviews with Eldershorst and Schouwenaars will be used to illustrate the case of salinization in Friesland.

4.1.1. History

In history, Friesland always had affection with the sea. The shoreline of Friesland changed a lot in the past. Figure 10 shows a paleographic map of Friesland with the shoreline changes over time. These changes have effects on the salinization of the groundwater. Major impacts are connected to these shoreline changes. The last glacial period, the Middle sea, peat extraction and land reclamation are examples of these impacts. In the last glacial period the sea level was rising extremely till 5.500 BC. Tidal and marsh areas were developed in the centuries after the last glacial period. A layer of clay was deposit by the sea in the Holocene. Peat areas where developed more inland, with in some areas a clay layer above. Between 800 and 1500 AC the tidal zone was reclaimed by land, which led to less involvement of the sea in the area (Caljé & Beekman, 2017).

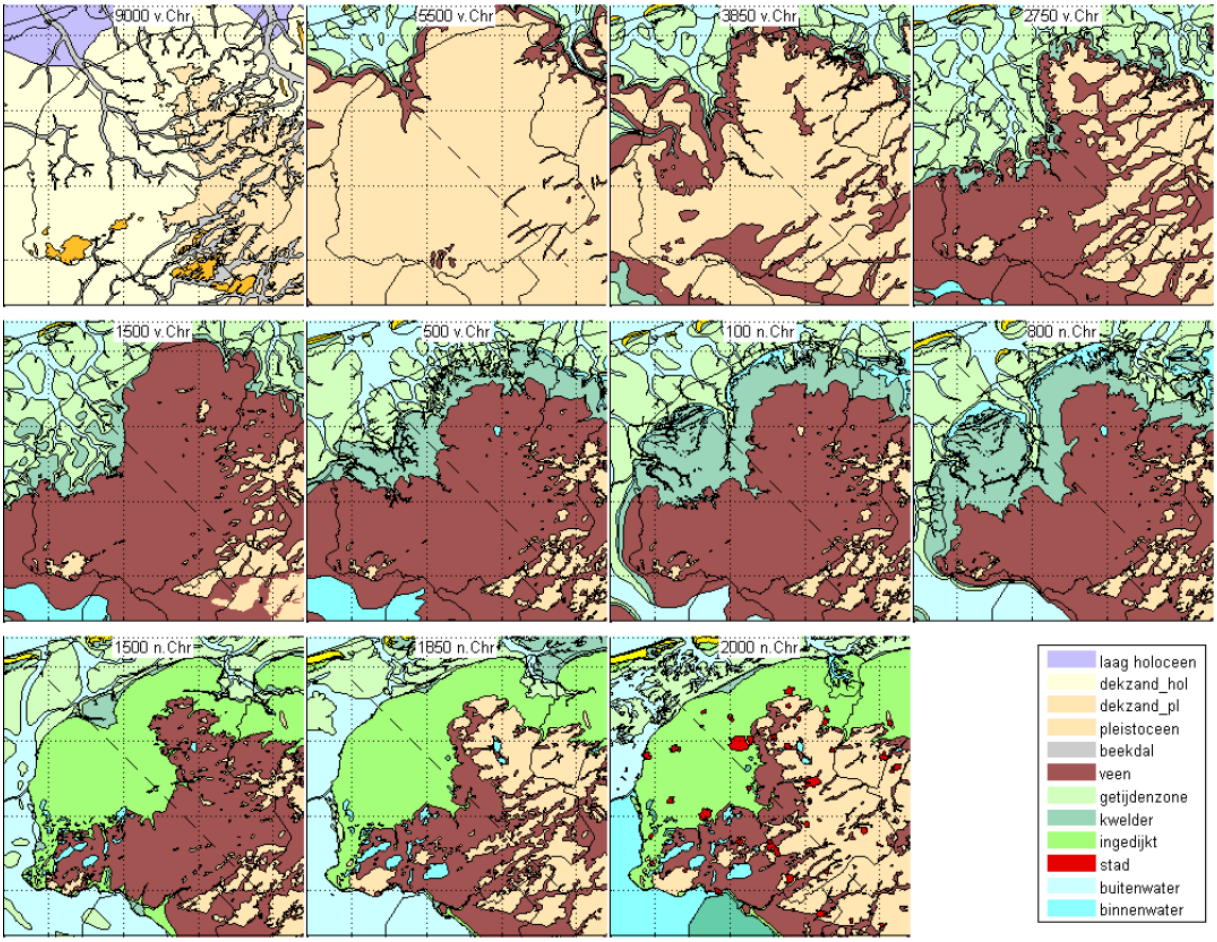

Figure 10. Palaeographic map of Friesland from 9000 BC till 2000 AC (Caljé & Beekman, 2017).

4.1.2. Nowadays

All these changes over time have created Friesland as it is nowadays. Figure 11 shows the situation of the groundwater bodies nowadays. *Zand Rijn-Noord* (yellow) is mainly freshwater and this water body mainly exists in the sand layers. The groundwater comes from precipitation from higher grounds. *Zout Rijn-Noord* (green) is mainly salt water with only a few meters of freshwater. It covers almost the whole Frisian shoreline and is mostly covered by a clay layer. Due to this clay layer a freshwater lens is created by the precipitation. This freshwater lens is important for the agriculture in this area. *Deklaag Rijn-Noord* (purple) includes sand layers with peat layers above it. The groundwater body is mostly brackish and in some areas relative fresh. The area is characterized by the peat distraction. Top layers still have a lot of organic materials and this area is characterized by lakes created due to the peat distraction. *Wadden Rijn-Noord* (orange) is the groundwater body north of the shoreline and includes the islands Vlieland, Terschelling, Ameland and Schiermonnikoog. The groundwater body includes a freshwater bell that is surrounded by salt water. Freshwater extraction is possible under the dunes where small freshwater lenses are positioned. These lenses become thinner under the polders of the islands (Kaderrichtlijn water, 2015).

The case of Friesland is based on the borders of the province of Friesland and the maintenance area of the water board of Friesland. This will be discussed more in the next section (4.2). The Maintenance areas of the water board of Friesland are classified into four functional areas. These areas can be connected with the groundwater bodies that are shown in figure 11.

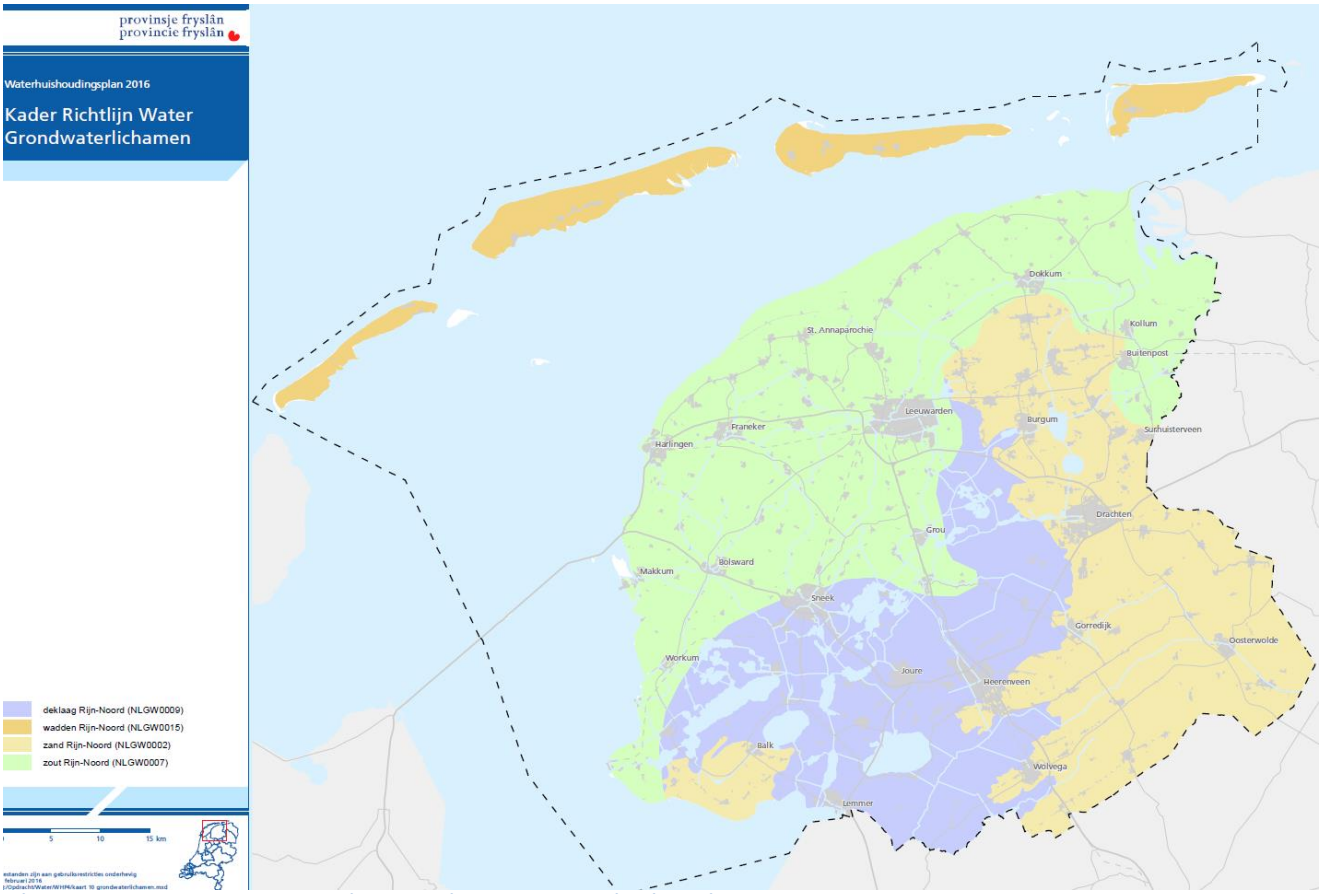

Figure 11. Groundwater bodies of Friesland (Provincie Friesland, 2016)

The depth of fresh-salt interface can be related to these developments from 9000 BC till nowadays. This interface is developed for the Netherlands and figure 12 shows the fresh-salt interface of Friesland. It shows that the tidal and marsh zone that existed before the land reclamation is the line of the shallow parts of salt groundwater in Friesland. These areas can be connected to the *Zout Rijn-Noord* area where salt groundwater is dominating the groundwater and a freshwater lens exists above the clay layers (Caljé & Beekman, 2017; Staveren & Velstra, 2011; Schouwenaars, 2017; (on)zichtbaar grondwater, 2017).

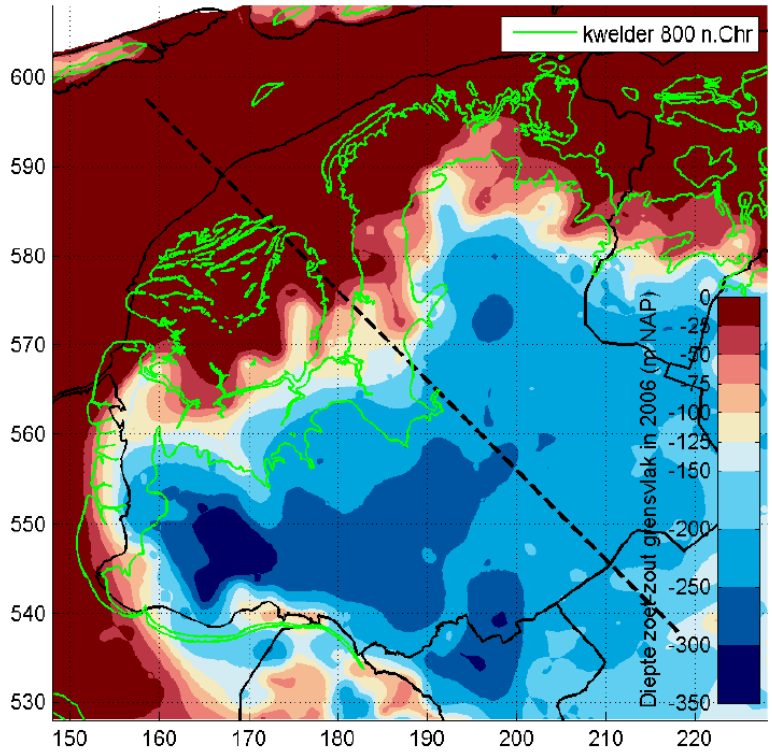

Figure 12. Depth of fresh-salt interface Friesland (m NAP) (Caljé & Beekman, 2017)

The freshwater lenses in the green areas (figure 11) are much thinner than the freshwater lenses in the yellow areas. It can differ from less than two meters till 40 meters in Friesland. Salt water is therefore located relatively swallow. These freshwater lenses are important for agriculture and are important to prevent that salt water reaches the root zone of the crops. The thin freshwater lenses are located in the former marsh and tidal zones (Gunnink et al. 2012). The thicknesses of freshwater lenses differ from each other and also in time. In winter a surplus of precipitation causes a thicker lens and in summer the lens will be thinner. This is caused by less rain but also through more use of the lens for agriculture (Bakker, B. 2017; Elderhorst, 2017). The main issue of salinization in Friesland is the risk that the freshwater lenses will be less filled and that they are overused. This can be caused by climate change, by overuse, land subsidence and by the water level maintenance (Elderhorst, 2017; Schouwenaars, 2017). The next section will describe the main issue of salinization in Friesland.

4.1.3. The issue of salinization in Friesland

Climate change is one of the causes of salinization. It includes sea level rise and the effects of climate change. Due to sea level rise there will be more pressure on the fresh water lenses from salt water in lower layers (Schouwenaars, 2017). Also more extreme weather events, accompanied with climate change, can cause more salinization. The pressure on the freshwater lenses due to extreme drought is a risk for the future (Elderhorst, 2017). Elderhorst (2017) also mentioned that models show us that the average pressure becomes a bit higher, but if there is an extreme dry summer, the freshwater lenses could possibly disappear in some places. This could cause enormous damage in terms of infrastructure, agriculture and nature. Schouwenaars (2017) mentioned that if there will be a shortage of freshwater in the ground, that we need to serve infrastructure first. This includes, roads, houses etc. The highest damage due to salinization is on infrastructure. Second comes nature

interests and as third agriculture interests. This priority list is made by the province in association with the water board (Schouwenaars, 2017).

In the ground water model calculation on the effects of climate change and sea level rise for the Northern part of Friesland of TNO it is researched that in the scenario where sea level rise and a change in ground water infiltration is calculated for 2100 AC, the salt supply will be higher and that that supply of salt will lead to a thinner freshwater lens of one meter up to ten kilometers inland. The ground water infiltration includes the decrease of precipitation and an increase of evaporation of 13% (Gunnink et al. 2012). This scenario is based on the KNMI scenario W+.

Water level maintenance is changing due to the causes of salinization. It was necessary to lower the water level due to the land subsidence in the peat areas (purple in figure 11), to have dry land that is useable for agriculture. In principle, the water level maintenance in Friesland is the opposite of what a natural water level includes. To use the low lying ground, as Friesland mostly is, it is necessary to lower the water level in the winter and increase the water level in the summer. A natural water level includes the opposite, higher levels in the winter and lower levels in the summer (Bakker, C., 2017). With the natural situation, when there would not be artificial water level maintenance, it is possible to have natural salinization in low-lying areas. The water board of Friesland wants to prevent this with artificial water level maintenance, so the land is useable for agriculture and other purposes. The freshwater that flushes through the locks and channels in Friesland comes from the Ijsselmeer (Schouwenaars, 2017). With the land subsidence due to peat inclination it is necessary to lower the water level to have dry lands, also in summer, in these areas. This will lead to a higher risk of salinization (Caljé & Beekman, 2017).

This indicates that due to overuse (that includes the extraction of groundwater by companies that extract groundwater for drinking water or industrial water and agriculture), sea level rise, climate change and land subsidence, the water board needs to use more freshwater from the Ijsselmeer to maintain their water levels. However, if there is a very dry year in the future, it could be possible that the central government (in charge of the Ijsselmeer) decides that Friesland is limited in the use of freshwater from the Ijsselmeer. If the water level of the Ijsselmeer is too low the central government could decide to limit the use (Schouwenaars, 2017). Gunnink et al. (2012) mentioned that there will be a negative impact on the freshwater lenses due to sea level rise and climate change. Elderhorst (2017) also mentioned that due to the effects of climate change, sea level rise and land subsidence it is plausible that there will be a risk for the freshwater lenses.

To sum up the issue of salinization for the case of Friesland the historical background, the land use, the water use and the future predictions will have effects on the increase of risk on salinization. The historical background includes the location next to the sea and the tidal and marsh areas that brought salt water. After the land reclamation most ground water is saline with a freshwater lens above it. Because Friesland in a low-lying area with a lot of polders and still has an intensive land use, artificial water level maintenance is necessary. Future predictions of climate change and sea level rise will affect the artificial water level maintenance and also the land subsidence has effects on the artificial water level maintenance. These effects lead to a decrease of the freshwater lenses in Friesland near the shore line and an increase of risks on salinization.

4.2. Policy on salinization

This section includes the analysis of the policies on salinization. Policies on salinization are included in different policy documents on different governmental levels in the water plans. It is important to investigate the policies on salinization on a national level first before investigating the policy on provincial level, and in this case of the province of Friesland. This is because the water law (article 4.1) says there should be a performance (doorwerking) of national water policy to regional water policy to water maintenance policy of the water boards. Therefore this section will discuss the national water plan and the Delta program that include the water policies on a national level. It will discuss the water policy of the province of Friesland and the water maintenance policy of the water board of Friesland. Table 6 shows the different stakeholders with their policies, goals, achievements, role and conditions and is based on the upcoming analysis.

Table 6 results of policy analysis on Salinization

stakeholder	Policy	Goals	How to achieve	Role	condition
-National government/Rijkswater-staat	-Water law -National water plan -Delta program	- Prevent flooding - **Enough water** - Clean water	**(enough water)** -Supply levels -Knowledge development (pilots) -Water awareness	Strategic development	-Combine water challenges -Climate-proof and robust
Province of Friesland	Waterhuis houdingsplan	- Prevent flooding - **Enough water** - Clean water	**(enough water)** -development supply levels -framework water level management -Spaarwater project -Grondwater meetnet	-Strategic development -Facilitate, direct, regulate and release	-Sustainable and innovative -Integral maintenance of water system and water chain -Effective and cost-efficient -Climate-proof and robust
Water board of Friesland	Water beheerplan	- Prevent flooding - **Enough water** - Clean water	**(enough water)** -Development supply levels -Merge water level areas -Anticipating water level management -Flushing canals and ditches -Spaarwater project -Blue and green services -Grondwater meetnet	Implementation / operation	-Effective and cost-efficient -Payable -Robust and sustainable water system and water chain
LTO	Deltaplan agrarisch waterbeheer	-Solution for water quality -Sustainable fresh water supply -Increase production	- Innovation, pilots and green deals - Boeren Meten Water	Interest group	-Innovative technics -Integration of goals, solutions should go hand in hand with production increase
Fryske Gea	Zilte vitaliteit	-Natural circumstances	Strategies and measures hand in hand with nature conversation goals	Interest group	Dialogue with stakeholders to search for opportunities

There is a pattern that could be recognized in table 6. From national government to the interest groups, the collum of "how to achieve" is more generic on the higher level and more specific on lower level. This pattern can also be seen in the planning spectrum. A generic approach in the planning spectrum is linked to simple issues that could have a technical rational approach. A specific approach in the planning spectrum is linked to very complex issues that could have a communicative rational approach. The performance (doorwerking) of the water law can result in a top-down approach; however the role of the national government is only on strategic development. The province also has a role in strategic

development and is also releasing responsibilities to other stakeholders what leads to a more bottom-up approach. It can be said that the governance strategy on salinization has aspects from both approaches. The table also shows that it is not only the 'government' that governs, but also other parties are involved in the 'governance' strategy.

4.2.1. Policy of national government

The policy of the national government for salinization can be based on the water law, the national water plan and the Delta program. This section will discuss these policies in regard to salinization.

Water law

The water law is responsible for the maintenance of water systems, which include, water dams, surface water and groundwater bodies. The law is initiated to prevent flooding, too much water, water scarcity, protection and improvement of the quality of water systems and the societal relevance of the water systems. The water law is an integrated law of eight former water maintenance laws. The goal of this integration is to simplify rules and licenses (MVW, 2008). Article 2.1. include the goals and norms of the water law and is as follow:

> ***"Artikel 2.1***
> ***1.*** *De toepassing van deze wet is gericht op:*
> *a. voorkoming en waar nodig beperking van overstromingen, wateroverlast en waterschaarste, in samenhang met*
> *b. bescherming en verbetering van de chemische en ecologische kwaliteit van watersystemen en*
> *c. vervulling van maatschappelijke functies door watersystemen.*
>
> ***2.*** *De toepassing van deze wet is mede gericht op andere doelstellingen dan genoemd in het eerste lid, voor zover dat elders in deze wet is bepaald (WVM, 2009)"*

It is about the prevention of floodings, water scarcity and in conjunction with the protection and improvement of the chemical and ecological quality of water systems. Third, the societal relevance of the water systems is a priority. General norms and guideline are mentioned in the water law. Salinization is not mentioned in the water law specific. It can be covered by the subjects of water scarcity and it could also be covered by the chemical improvement of water systems. The performance of the water law becomes clear in article 4. Article 4 includes the water plans on national level, regional level and the maintenance level. The national- and regional water plans include the legal goals and norms, the desired developments and working and protection of the water systems. It also includes the explanation of measures and services. The minister is responsible for the national water plan. The regional plans should cover the national plans and should be in line with the regional plans of the adjacent region. Each province is responsible of a regional water plan and should include the water policy of the province. The water boards are responsible for the maintenance plan and should be in line with the goals of the national and regional water plan. It provides a program with measures and services, which are a completion of the measures from the national and regional water plan (MVW, 2009). The national water plan will be analyzed more in detail in regard to salinization and for this case; the regional water plan of Friesland will be analyzed in regard to salinization.

Specific for the water security and the freshwater supply (water scarcity), the Delta program is developed. This includes the national interest and measures on water security and freshwater supply (MVW, 2009). The last part of this section will analyze the Delta program in regard to salinization.

National water plan

The national water plan covers the strategic goals for water management of the central government. Rijkswaterstaat is responsible for the maintenance of the national waters and is responsible to cover the strategic goals from the national water plan. The national water plan has three main objectives: flood risk management, freshwater and water quality. Salinization belongs to the objective of freshwater and therefore only this objective will be analyzed for this case. The central government is responsible for these objectives in the national waters; however the challenges differ for each area. Therefore the national water plan divides different areas: The Rhine-Meuse delta, Rhine Estuary-drechtsteden, Southwest delta, Rivers and Ijsselmeer region (MIE & MEA, 2015-a). For the case of Friesland, the Ijsselmeer region is the most relevant and therefore this section will discuss this area.

The goal on national freshwater is formulated as follow:

"The aim is to secure supplies in areas that receive water from the main water system. This calls for a critical view of the water demand and the options for retaining and storing water in the region as much as possible. In areas without such supply, the Cabinet wants to change from an approach focused on discharge to one that is also focused on proper conservation and better utilization of freshwater. One aspect of this approach is combating salinisation in susceptible areas to the fullest extent possible. Despite all efforts, salinisation will, however, increase in certain places. At an international level, the Cabinet is committed to reaching agreements to protect the Rhine and Meuse as supply routes for freshwater supplies in the Netherlands, designed to ensure sufficient water of the required quality. The aim is always to combine the various water challenges aspects within the river basin areas. (MIE & MEA, 2015-a, p21)"

With these goals the national government advocates a more effective and economical use of available water. They will provide information on the risk of water shortages and put forward action strategies to anticipate future climate change (MIE & MEA-a, 2015). A couple of pilots are launched to develop knowledge for climate adaptation. For the region of the Ijsselmeer the pilot 'Spaarwater' is launched. This pilot will be analyzed in box 1.

To achieve these goals, the national water plan wants to create, together with all government authorities that are involved, the availability and the quality of freshwater in the form of supply levels. These supply levels should indicate the availability of freshwater and the probability of water shortages in a certain area, under normal and dry conditions (MIE & MEA-a, 2015).

Another measure is called 'smart water management'. This includes a better collaboration between all water managers. By up-to-date, shared information what will improve the balance between supply and demand in times of shortages (MIE & MEA-a, 2015). The program for achieving these goals is the Delta program. Table 7 shows the milestones per year to achieve the goals.

Table 7 Milestones freshwater National water plan (MIE & MEA, 2015)

Process	2016	2017	2018	2019	2020	2021
Elaboration of supply levels			First group ready and evaluation			Laid down for all areas
Implementation of Delta Plan on Freshwater (measures and pilot projects)			Evaluation of Delta Plan on Freshwater Phase 1			Delta Plan on Freshwater Phase 2
Knowledge development and strategy				Problem analysis	Review of adaptive strategy	

Delta program

The Delta program is in line with the objectives of the national water plan and describes the program and agenda of the measures and tools. Figure 13 shows the adaptation path for preferential strategy for freshwater in the Ijsselmeer region.

The colored dots in the adaptation path say something about the strategic level. The blue dots are related to the national water systems where Rijkswaterstaat is responsible to accomplish the short, medium and long term. The green dots are related to the regional water systems where the province and the water board are responsible to accomplish the terms. The orange dots are related to the consumers. Effective and efficient water consumption is necessary in the future and in the long term accepting water shortages is in line with the expectations (MIE & MEA-b, 2015). An important task here is the water awareness. In a nationwide campaign, what is called 'ons water', the water awareness of the Dutchmen subjected. This is an initiative of the ministry of infrastructure and the environment, Rijkswaterstaat, Unie van waterschappen, VNG, IPO, Vewin, water boards, provinces, municipalities and water companies (Ons Water, 2017).

So the strategic development on salinization should be carried out by the provinces, in this case the province of Friesland is taking into account these developments and created a policy strategy for their region. In the next section this policy is analyzed.

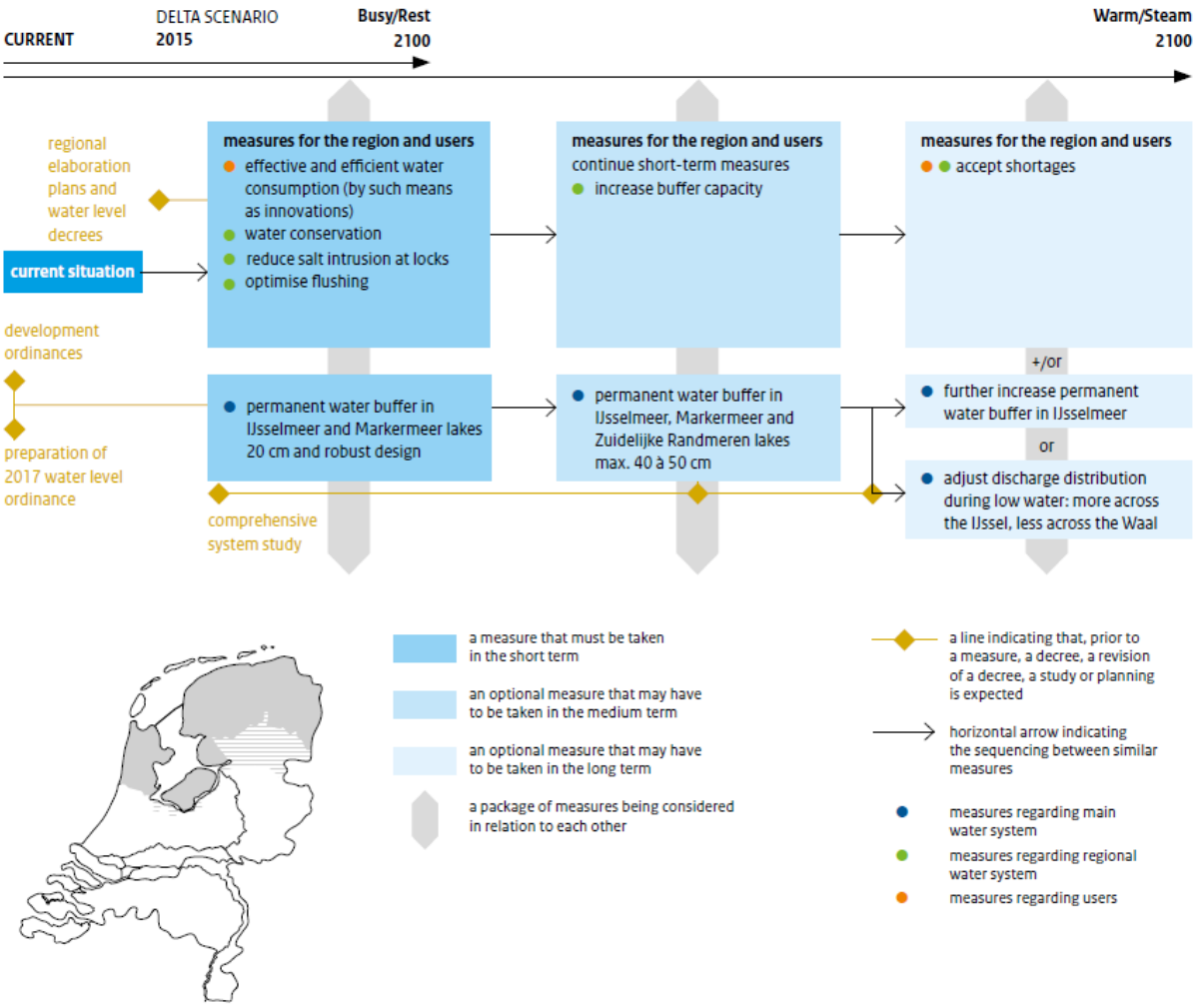

Figure 13. Adaptation path freshwater Ijsselmeer (MIE & MEA-b, 2015)

4.2.2. Policy by province of Friesland

The policy on water management of the province of Friesland is established in the so-called 'waterhuishoudingsplan vier' (WHP). The role of the province will be analyzed, the goals and how these goals will be accomplished. Basis for this analysis is the WHP of the province and the in-depth interview with Eldershorst of the province of Friesland. Eldershorst is a policymaker at the province of Friesland and for a long time engaged with salinization in the province (Eldershorst, 2017).

The goals of the province are described in the regional water plan of the province that deals with all water related topics in the province. It is an integrated plan for water related topics for one region. The WHP is an important tool for the collaboration and tuning between water managers. As mentioned before, the WHP is self-binding and compulsory, however according the water law, it should be in line with the national water plan. The province has a couple of core tasks, including the sustainable spatial development that water management is part of (Provinicie Friesland, 2016). It is also possible that from the other core tasks (which includes: regional economy, mobility, culture and nature conservation) regional water management could be included. The province is the regional director and connects the province with the different interests and develops an integral consideration of these interests. Water issues can be facilitating these goals (Provincie Friesland, 2016).

The goals are similar as in the national water plan. The first priority of the WHP is to protect Friesland against flooding and to provide security for living, working and recreation. Second priority is the quality and the quantity of water. Enough water, not too much and not too little, for now and in the future. And clean water, the quality of the ground and surface water should be good.

The role of the province is to achieve these goals targeted on the collaboration with other partners. The WHP does not describe the measures in detail, the province's role in achieving the goals of the WHP is to: facilitate, direct, regulate and release. Within this role the province has set some conditions for the measures. These conditions are as follows: *Sustainable and innovative, Integral maintenance of the water system and water chain, effective and cost-efficient and climate-proof and robust* (Provincie Friesland, 2016). The province is making the strategy and the water board is responsible for the implementation of the strategy (Elderhorst, 2017).

As mentioned before, salinization can be placed within the goal of enough water, not too much and not too little. The province describes three main strategic choices to achieve this goal:

- Development of the water supply levels. It is important to understand where too much water is and where too little water is. This is also important for the water level management. This is in collaboration with the water board of Friesland, because they are in charge of the water level management. The development od water supply levels comes from the national water plan and every region needs to accomplish their water supply levels in 2021 (MIE & MEA-a, 2015).
- Framework for water level management. Per sub area, the province sets some conditions to the water level management. For areas in the north of Friesland, where salinization is an issue, the province wants to turn on a sustainable development of the area. Salinization due to climate change, sea level rise, land subsidence and lowering the water levels are risks for these areas. The water level management should target to save fresh surface water and to sustain the freshwater lenses as much as possible to limit the salinization.
- Dehydration control of nature conversation areas is the third strategic goal.

The knowledge on the issue of salinization is not yet well developed. Therefore these strategies are chosen. With pilots and research on the region, the province wants to develop more knowledge for their water level management and freshwater supply (Elderhorst, 2017). The aforementioned pilot of Spaarwater will be analyzed in box 1. This pilot is in collaboration with different water managers and gives possible technical solution for our freshwater supply, especially for agriculture. In regard to the water awareness of the citizens of Friesland, the province and the water board set up a website where everyone can see eight measurements of groundwater. It is called grondwatermeetnet ((on)zichtbaar water, 2017). Also the province and the water board are involved in the project 'ons water'.
The next section will analyze the operational stakeholder, the water board of Friesland.

4.2.3. Operation by the water board of Friesland

The national water plan and the regional water plan described the strategic goals and the 'waterbeheerplan' of the water board of Friesland gives substance to these strategic goals. According to Schouwenaars (2017) the water board is also making their own strategic choices, especially in the light of maintenance. The policy made by the province is the directive for the water board. However, the water board also discusses with the province about it and has also input for the strategies that are chosen (Schouwenaars, 2017).

Due to a couple of factors as climate change, sea level rise, extreme weather events, the water board has to invest more in their water maintenance. The investments in the dams and pumping stations will increase due to these factors. Also dikes and other coastal defenses need more investments due to these factors. Next to these factors, the current infrastructure needs a lot of investments because they are outdated and have high maintenance costs. With this in mind, the water board wants to keep the water board taxes for the citenzins of Friesland affordable and the water board strives for cost efficient and effective water maintenance. The arrangement of the water system should be more simple, sober and effective to keep it affordable (Waterschap Friesland, 2014). The following mission is formulated with this in mind:

"Wetterskip Fryslân staat voor schoon en voldoende water en voor veiligheid achter de dijken. Onze kennis en kunde staan borg voor een betrouwbare integrale uitvoering van onze taken tegen maatschappelijk aanvaardbare kosten. Wij zoeken bij ons werk voortdurend de samenwerking met publieke en private partners om maximale maatschappelijke meerwaarde te kunnen creëren en om tot gedragen oplossingen te kunnen komen. Bij al ons werk staan innovatie en duurzaamheid hoog in het vaandel." (Waterschap Friesland, 2016)

With this mission the goal is to create a robust and sustainable water system and water chain on the long term. With water security, enough water and clean water as sub goals (Waterschap Friesland, 2016).

A measure to reduce cost is to *merge water level areas*. One specific area needs different dams and pumps to influence the water level. To make the water level management less expensive, the water board chose to merge water level areas. Less dams and pumps are needed and less maintenance on these buildings is needed (Waterschap, Friesland, 2016; (on)zichtbaar water, 2017).

The water board has different measure scenarios for the goal of enough freshwater. The water board has scenarios for normal, wet and dry situations. The normal situation includes normal weather circumstances and no different circumstances for the water supply in the region. The water board is in this scenario able to deliver enough water in their areas for the different functions like agriculture, nature and urban areas. With operational water level management the water board is able to influence the water level daily with dams and pumps. With a wet scenario the water board has to deal with a lot of water in a very short period. Measures are: anticipating water level management, different projects on water storage and in collaboration with municipalities an adaptation plan for water storage in urban areas. With periods of drought, the water board wants to prevent salinization by buffering enough water and by making arrangement about the distribution of freshwater. The main measure to prevent salinization is *flushing of canals and ditches* and with the *water level management*,

the water board has the ability to raise the water level and lower the water level. Flushing is not a very sustainable way to prevent salinization; therefore the water board also participates in the *project Spaarwater*. And because there is no sufficient information yet about every specific area, the supply levels of the national water plan are developed in the upcoming years (Waterschap Friesland, 2016; Schouwenaars, 2017).

An interesting measure that the water board is using is the so-called *blue and green services*. The water board is collaborating with their users to realize water goals. Within blue and green services the user helps the water boards and in return they get a financial contribution. It can be seen as the maintenance of nature friendly banks or in the form of water storage (Waterschap Friesland, 2016). With nature friendly banks the farmer creates or gives away a part of his land to enlarge the banks. Water storage as a blue service will be beneficial if there is a lot of rainfall in a short period of time. The farmer allows the use of his land for water storage and the water board does not have to pump it away at once. Blue and green services can lead to a better development of nature and saving of costs on pumping away the water (Schouwenaars, 2017).

Concluding, the water board strives to gather more information on salinization considering the area, reduction of costs and preparation for future climate change. More knowledge will be gathered through pilots, the reduction of costs is mainly caused by the merging the water level areas. For the future, the water board developing alternatives. They want to make a map on where flushing is still the best option, where the expansion of the Spaarwater project is possible and where the water level can be raised or lowered to ensure the provision water, not too much and not too little. This should lead to a situation where Friesland does not have to rely only on the water of the Ijsselmeer (Schouwenaars, 2017).

Box 1. Project Spaarwater

It is important to secure the fresh water supply in the Wadden region for the agriculture sector. The Wadden region is a good area for agriculture and it is famous for its agricultural lands in Europe. It is famous for its flower bulbs and for its above average sized farms. As mentioned before, the area is characterized by its shallow fresh-salt transition in the ground water. Agricultural funcitons use the fresh water lenses, which are located above the salt groundwater. Due to climate change, land subsidence and sea level rise, the fresh water lenses could disappear in these agricultural areas and brackish water is upconing to the root zone. This will lead to crop damages (Tolk & Velstra, 2016).

Due to this greater salt pressure from the ground extra flushing of canals and dishes will be needed to secure the water quality for the purpose of irrigation and cattle drench. The water demand from the Ijsselmeer will increase and this area is depending more on it. The Spaarwater project wants to do something to stimulate the independency of fresh water from the Ijsselmeer by becoming more climate robust and independent. To become more independent, self-sufficient in fresh water supply is needed. On the one hand, the government will intervene with water level variation of the Ijsselmeer to secure more fresh water. For the region it is important to become self-sufficient where possible (Tolk & Velstra, 2016).

Spaarwater develops measures to fight against salinization and to secure enough fresh water. Four main measures are formulated to achieve this:

- Own fresh water supply: catch fresh water from the drains,
- Own fresh water supply: underground fresh water storage,
- Efficient use water and fertilizers; drop irrigation and fertigation
- Strengthen the fresh water lenses and prevent salinization; drainage system approach

Four different plots in the Wadden region are used, with different crops on clay or sand, to investigate the measures. The first results were promising. With the drainage system approach the water level could be adjusted and the fresh water lens was increased in the sand plot. It was also possible to catch water from the drains and store them in the ground to use it again for irrigation. Also, efficient use of water and fertilizers was realized with drop irrigation. There was decided that the project was valuable and that the project will be scaled up to investigate the regional benefits (Tolk & Velstra, 2016).

This project is done by Acacia water institute and is financed by the waddenfonds, Provincie Groningen, Provincie Friesland, Provincie Noord-Holland, Hoogheemraadschap Hollands Noorderkwartier, Waterschap Friesland, Waterschap Noorderzijlvest, Waterschap Hunze en Aa's, LTO noord fondsen, STOWA, Achmea Agro en Rabobank. It became also part of the Delta program as climate pilot within the Delta program fresh water (Tolk & Velstra, 2016).

4.3. Involvement of interest groups

In the previous section three important stakeholders (national government, province and water board) have already been analyzed and their role within the issue of salinization has been discussed. There are other stakeholders that are not part of a government but have to deal with the issue of salinization: the agricultural sector and the nature conservation sector. The interests of both sectors will be discussed in this section. In the last part of this section other stakeholders with less or different interests will be discussed.

4.3.1. Agriculture

The interest of the agriculture sector is served by agriculture and horticulture organization Nederlands (LTO Nederland). For the north of the Netherlands LTO Noord is serving the interests of the farmers. This section will be based on the documents; Deltaplan agriculture water management (DAW), Boeren Meten Water (BMW) and the in-depth interview with Bouwe Bakker from LTO Noord.

The DAW describes the goals and measures that should lead to a contribution on the water issues in combination with the strengthening of the agriculture and horticulture. Together with the ministry of I&E, LTO Nederland has developed the Deltaplan for the upcoming years to strengthen the agriculture and horticulture against problems like climate change, land subsidence and sea level rise. Three main goals arise from this vision (LTO Nederland, 2013):

- Solution for the water quality issues solved by 2021 for 80% and by 2027 for 100%.
- Sustainable freshwater supply and saving water on a company level. Water conservation on regional level and smart distribution on national level.
- Spatial instruments and innovative technics should lead to a production increase of two percent per year.

To achieve these goals, LTO is collaborating with the national government to develop innovative solutions, accompany pilots and make green deals. On a regional level they want to connect these developments. LTO is collaborating with water boards to accompany the European water directive with the DAW, so agrarians are concerned with the water derective. On a local level, LTO wants to increase the awareness of farmers of the risks of climate change, among which salinization is an important issue (LTO Nederland, 2013).

Bouwe Bakker (2017) describes the importance of *the awareness of farmers*. He mentions that farmers often have short term visions. The issue of salinization asks for a long term vision; there is a mismatch. Another problem that arises with salinization is the visibility of the problem. Salinization often has the same characteristics as drought for crops. This will increase the problems on a plot, because the farmer will irrigate his plot from the ditches, but these ditches have also saline water in periods of drought (Bakker, B. 2017).

Bouwe Bakker (2017) advocates that the awareness will have high impact on agriculture. Information per plot is needed to inform the farmer about the situation. If the farmer is aware of the impacts of salinization and the farmer also has the information of his plot, then an appropriate measure can be developed. One of the jobs of LTO is to make farmers aware of these issues. Besides that, a new instrument is developed for the *information provision* per plot. LTO Noord wants to improve the information provision with the project 'Boeren Meten Water' (BMW). This includes the idea that farmers will measure their own plot and that this information comes together on a platform. The goal of BMW is to develop a broad network of measures and to optimize the water management (LTO Noord, 2017).

As Bouwe Bakker (2017) mentioned, it is important first to have good information provision and then measures can be taken. This tool can help the water board with their water level management. This instrument is not a fixed tool and is connected to your mobile device. A farmer is able to replace the tool and measure different points across his plots. The thickness of the freshwater lenses can differ a lot, so a tool that is not fixed and is flexible is a big advantage (Bakker, B. 2017). Another innovation that should be mentioned is the *gen manipulation of crops*. It is still a problem with jurisprudence to manipulate crops, so this innovation is not yet well developed. However, according to Bouwe Bakker (2017) it should be possible to develop crops that are resistant to salt.

The aforementioned developments in the agricultural sector are still in an initial phase. The measures of the water board are not that positive for the agricultural sector. The goal of the water board is to create a more robust water system. This will be accomplished by merging water level areas and by anticipating water level maintenance more. According to Bouwe Bakker (2017) salinization asks for differentiation of the water level areas, because the problem can arise at very specific areas. Merging water level areas will lead to a decrease in costs, but will increase to risks of salinization. It is important to develop the information provision with the BMW to get a better understanding of the problem of salinization and to provide customized measures (Bakker, B. 2017). If the information is available, the choice between flushing, Spaarwater projects or anticipating water level management can be made and can be area specific (Bakker, B. 2017; Schouwenaars, 2017).

4.3.2. Nature conversation

Next to agriculture, the interest of nature conversation in Friesland is analyzed. Nature conversation is served by It Fryske Gea. It Fryske Gea is primarily focused on nature conversation in selected areas with nature purposes. The document analysis of Zilte Vitaliteit of It Fryske Gea and the in-depth interview with Chris Bakker from it Fryske Gea are the basis for this section.

Salinization is not a big problem in the light of nature (Bakker, C. 2017). It is more about the transition of fresh water to salt water in water systems. It is important for nature to have a smooth transition from fresh water to salt water. This is a problem for nature conversation in Friesland. Due to dikes, polder and harbors, the transition from salt to fresh water is too direct and has negative effects on nature (Bakker, C. 2017). Flushing ditches and canals are positive for the agricultural sector because they can irrigate their plots with freshwater, but it is negative for the transition of fresh water to salt water in these canals and dithes. The transition will be disrupted every time the ditches and canals are flushed.

The water level management of the water board with the opposite water levels to preserve enough water is also negative for nature. Natural water levels, with low water levels in summer and high water levels in winter, are better for nature according to Bakker, C. (2017). Also merging water level areas can have negative effects on nature. It can bring risks for nature conservation if nature areas are merged together with agricultural areas. Nature conservation areas need high water levels and agricultural areas need to be dry to cultivate.

Positive measures are Spaarwater projects. If we could become self-sufficient and freshwater is stored in the ground, the flushing of canals and ditches could be reduced. This will be positive for the transition between fresh and salt water (Bakker, C. 2017).

It Fryske Gea wants to collaborate and go into dialogue with other stakeholders to investigate opportunities in regard to the issue of salinization that could be positive for nature, but also positive for other interests (It Fryske Gea, 2015). Chris Bakker (2017) mentioned that collaboration is important for nature conservation, but regarding to salinization and the scale of salinization, the province should take more responsibilities. Chris Bakker (2017) also believes that the province is hesitating too much and that the agricultural sector initially denied the problem too long. As salinization could be a problem for the whole coastal area, the province should take the lead.

The project of zilte vitaliteit is about the opportunities that salt water brings with it. It offers opportunities for the coastal defenses, livability, water management, fishery, agriculture and art and culture. According to It Fryske Gea, nature and salinization do not have to compete but can work together. Examples range from hard engineering in coastal defenses to soft engineering with climate buffers. Another example is the opportunity of water storages, because this can go hand in hand with nature. For the aquacultural sector, the smooth transition of fresh to salt water should also be positive. For the agricultural sector 'zilte teelt' could be a solution and accepting salt water in regard to this opportunity will be positive for nature (It Fryske Gea, 2015). It Fryske Gea (2015) wants to open the dialogue with other stakeholders with this project; opportunities are not yet solutions. However, LTO Noord believes that zilte teelt is not able to be economically viable for the agricultural sector is Friesland (Bakker, B. 2017).

4.3.3. Other stakeholders

A couple of other stakeholders can be related the issue of salinization: municipalities, water companies, industry and citizens can have problems with salinization.

Within the so-called 'streekagenda' municipalities, province and water board are working together. The streekagenda brings people, tools and opportunities together to develop projects that have a contribution to the livability of the region. Within this agenda water related topics are also integrated (Waterschap Friesland, 2016; Provincie Friesland, 2016). However, salinization is not a big issue yet in this agenda. According to Wilma Stienstra (2017) from the municipality of Franeker, where salinization is an issue, policies on salinization and freshwater supply are not made yet. She has mentioned that in particular the water board is responsible for policies on water quality and quantity.

Another stakeholder is the water company that has drinking water pumps in Friesland. Vitens is the water company in Friesland and their source is the groundwater. The quality of the ground water is stable, has a constant temperature and a good bacterial circumstance. Vitens is a semi- public company and is responsible for their own policy and problems related to salinization. Two pumps in Friesland are at risk in regard to salinization. These pumping stations are located on the salt – fresh border in the north of Friesland. The capacity of the pumping stations is limited to a maximum. If they extract too much ground water, the pumping stations will extract salt water. Vitens uses innovative technics in attempt to separate the extraction of salt and fresh water with the so-called Freshkeeper ((on)zichtbaar water, 2017) . Besides that, industries extract groundwater and this extraction is increasing (Provincie Friesland, 2016-b). The location of the extraction of groundwater is of importance. Vitens' location of extraction is not tactical in the light of salinization.

Citizens are big consumers of freshwater. In the different water plans it became clear that the water awareness is important. In a nationwide campaign, what is called 'ons water', the water awareness of the Dutchmen is subjected. This is an initiative of the ministry of infrastructure and the environment, Rijkswaterstaat, Unie of waterschappen, VNG, IPO, Vewin, water boards, provinces, municipalities and water companies (Ons Water, 2017).

With the aforementioned policies and stakeholders in mind, the next section will discuss the relation of the governance strategy to adaptiveness and resilience. With the valuation of the concepts the governance strategy can be placed on a planning spectrum for the issue of salinization. After evaluating the governance strategy this chapter will end with a reflection and the main findings.

4.4. The relation of the governance strategy to adaptiveness and resilience

The previous sections analyzed the policies and issues related to salinization in Friesland. This section will be the analysis of these policies and will be the basis for the connection of the issue of salinization and the governance strategy on salinization. Table 8 shows the different characteristics of adaptiveness and resilience in Friesland. Based on the previous data analysis, this table is filled in. The table is filled in based on the document analysis, the in-depth interviews and the observation and participation of the open college of (on)zichtbaar water on 13 mei 2017. Each characteristic will be analyzed from the policies and there presents will be elaborated. With the analysis of the characteristics the degree of complexity of the issue of salinization can be analyzed. If the characteristics are highly present (++) it can be related to very complex issues and if the characteristics are not present (--) it can be related to simple issues. This valuation can be linked to the planning spectrum and therefore the governance strategy can be related to the degree of complexity of the issue.

Table 8 Valuation on the characteristics of adaptiveness and resilience.

		++	+	+/-	-	--
Adaptiveness	Flexible			x		
	Learning by doing	x				
	Reduce vulnerabilities			x		
	Capacity to deal with future change		x			
Resilience	Ability to deal with uncertain change			x		
	Bounce back		x			
	Absorb shocks		x			
	Preparation for surprises		x			

4.4.1. Adaptiveness

The characteristics flexible, learning by doing, reduce vulnerabilities and capacity to deal with future change, are part of the concept of adaptiveness.

The goal is to become more *flexible* in water maintenance. However, the water board of Friesland uses mainly flushing to prevent salinization at the moment. The system is based on

flushing canals and ditches. Also, merging water level areas to make a more robust system is not in favor of the flexibility. On the other hand, a couple of measurements could help to become more flexible. Anticipation of the water level maintenance and the green and blue services will help to become more flexible. Also the project Spaarwater can help to become more flexible. If there are more options to prevent salinization the system can become more flexible. The best option for every area can be elaborated and some areas will still use flushing as method, some areas can have anticipation of water levels and other areas could invest in Spaarwater project. The performance (doorwerking) of the water law is making the policies on lower level less flexible.

On a national level it becomes clear that the goals are to obtain more information on specific regions. The water supply levels have to be analyzed by all the water managers. Smart water management is an important objective on a national level and the pilots to learn and to innovate are important. This strategy is based on *learning by doing*. The pilot of Spaarwater is a good approach to learn more about several innovative ways to deal with salinization. And these innovations could lead to become self-suffient in the future. Spaarwater is a pilot, and it is still very expensive for agrarians to invest in these technical innovations (Schouwenaars, 2017). The LTO is striving to learn more about salinization. The project of Boeren Meten Water is a promising project that can lead to a much better overview of the issue of salinization. At this moment, however, we do not know enough about salinization yet (Bakker, B. 2017).

By using different measures the region will be *less vulnerable*. At the moment, Friesland relies on the freshwater from the Ijsselmeer. On a national level it is decided to raise the water level in the Ijsselmeer, but Friesland should also have alternative options if the Ijsselmeer cannot provide enough freshwater in periods of extreme drought. Therefore, the aforementioned alternatives will reduce the vulnerability of the region. Hereby information and knowledge of the region is also important again. The intentions of the policy strategy are clear; becoming less vulnerable for salinization and having enough freshwater. Despite this, however, Schouwenaars (2017) mentioned that Spaarwater project are not achievable if farmers have to invest solely. Farmers will not choose for Spaarwater projects if once every ten years their crops will be damaged by salinization (Schouwenaars, 2017). Also the green and blue services are not affordable options according to Bouwe Bakker (2017). He said it will become too expensive for the water board to implement this tool. Therefore, a combination of affordable options and expensive options is needed. Also, the acceptance of salinization in the future should be considered. The option and investigation of zilte teelt is interesting. Nature conservation organizations have the opinion that this is an opportunity to deal with salt water and have a positive impact on nature (Bakker, C. 2017). LTO says that it is a niche market and not economically achievable for agriculture yet (Bakker, B. 2017).

The future is uncertain and the developments of the threats of salinization are not clear yet. With climate change, land subsidence and sea level rise in mind it can be stated that changes will occur and that something has to be done. *The capacity to deal with future change* is at this moment in the phase of information collection. What is included in the problem? How accurate can salinization be predicted and where? The policy strategists and other organizations are aware of the problem and want to increase the capacity in order to deal with future changes and use pilots and technological developments to gather more information ((on)zichtbaar water, 2017; Elderhorst, 2017).

4.4.2. Resilience

The ability to deal with uncertain change, bounce back, absorb shocks and preparation for surprises, are characteristics that are part of the concept resilience.

The ability to deal with future change can be seen in the choices to raise the water levels of the Ijsselmeer. Also, the water board of Friesland has the measures to heighten water level areas. If there is more fresh water in the system, it will be able to push back the salt water from below. Heightening the water levels can also have a positive impact on nature conservation. More wet circumstances are positive for the biodiversity. It also has negative effects for nature, if the salt-fresh transition is pushed back (Bakker, C. 2017). For the agricultural sector it is important to have fresh water, which means that higher water levels could be positive. But there are some stresses in the system; Bouwe Bakker (2017) mentioned that the balance between enough fresh water and dry plots can cause problems. Due to the merging of water level areas more stressful situations could occur. In other words, the ability to deal with future changes can be tackled by raising the water levels, but it is accompanied with other problems.

A good example of the characteristics of *bounce back and absorb shocks* are the green and blue services. A farmer that stores water on his plot to secure dry plots around that plot is a nice solution and can be favored over the option of pumping away water in a short time. One farmer can help the whole area and get a financial compensation. This is not necessarily connected to salinization but more to the entire water system. The water system needs to be able to bounce back and absorb more extreme weather events. This example of a blue service will be practical in the case of much precipation over a short period of time. Extreme droughts can be absorbed by the ability to store fresh water in the ground and use it in the period of extreme droughts. The project Spaarwater is therefore a good initiative to become resilient in the future.

Development of a system that has all the information of groundwater per plot and the freshwater supply levels are good examples of how the policy strategies strive to be *prepared for surprises* in the future. According to the Delta program the water supply levels have to be investigated by all water managers before 2021. This will be a good starting position to prepare for surprises. The project of 'boeren meten water', to gather information per plot by farmers itself, is positive in the light of preparation for surprises. The development of becoming self-sufficient is positive and will lead in the future to a better system where we do not have to flush any longer (Elderhorst, 2017).

4.5. Reflection and findings on the analysis of the governance strategy

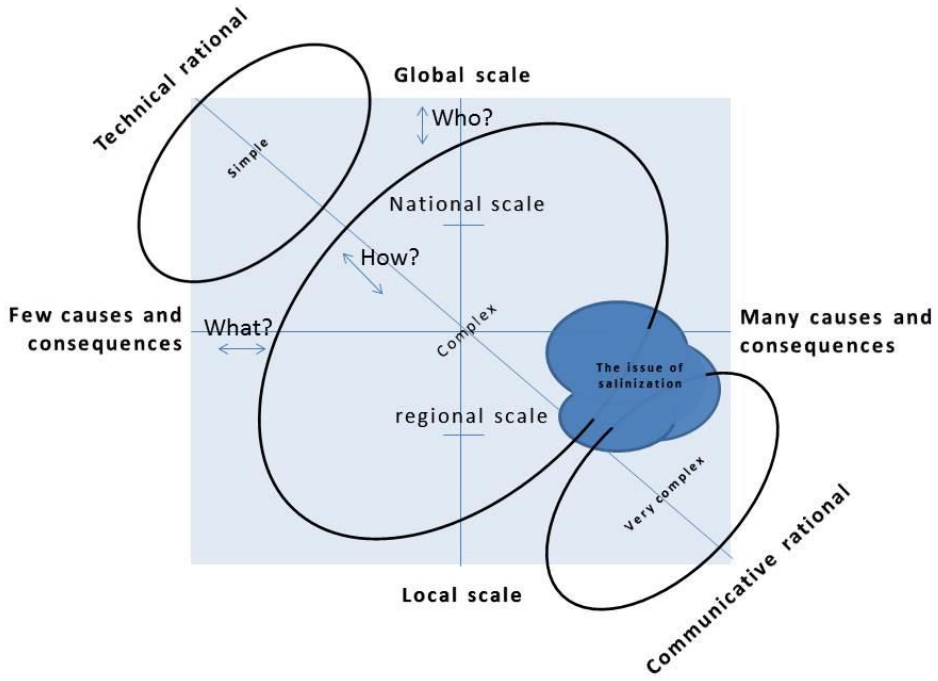

Figure 14. Planning spectrum for salinization.

In regard to the framework of planning focused actions the 'who' line (vertical) and the 'what' line (Horizontal) and the planning spectrum the 'how' line (diagonal), the placement of the issue of salinization in Friesland can be reflected based on the analysis of the governance strategy on salinization in Friesland and the placement of the issue of salinization from the theoretical framework (Figure 14).

The horizontal line relates to the degree of complexity of the issue of salinization. The historical background and the future developments are important for the issue of salinization. Due to the historical background, Friesland always had to deal with salt water. The future is uncertain regarding to the development of the climate, the land subsidence and the sea level rise are factors that are slightly predictable but will stay unsecure. The consequences are also specific. For different stakeholders, the impact of the consequences is different. All together, this makes the issue of salinization a complex problem and close to a very complex problem.

The vertical line relates to the scale of salinization. On a national level the national water plan and the Delta program are carrying out the strategic development on all water related problems. Salinization is part of the strategic development, however, it is still generic and it does not explicitly give answers on the goals of the strategy. The scale of salinization is located on a regional scale. The province and the water board operate on a regional level and where the province is still more on a strategic level, the water board is implementing the strategies and measures. The water board is also responsible for the operations of the measures. The scale of salinization can therefore be placed on a regional scale.

The 'diagonal' line related to the approach that is used for the issue of salinization. This is based on the relation of the policies with the concepts of adaptiveness and resilience to the

issue. From the valuation of the characteristics it becomes clear that one characteristic is highly present, four characteristics are present and three characteristics are more or less present. This means that the issue of salinization can be related to complex issues. Therefore it could not be placed totally on the communicative rational side, but the most characteristics are present what relate to complex issues, which means it is more on the communicative rational side than the technical rational side (Figure 15). This is based on the analysis of the concepts. An important finding is the characteristic of learning by doing. On all scales this characteristic is important and visible in policies. The characteristic of flexibility scores less in the analysis. The system is based on flushing of ditches and canals. If there will be a shortage of water in the future, the water system will be less flexible. Also, the water law makes the policies less flexible. Merging water level areas to lower the costs of the water system is also not positive for the flexibility of the system and lowers the capacity to deal with uncertain change.

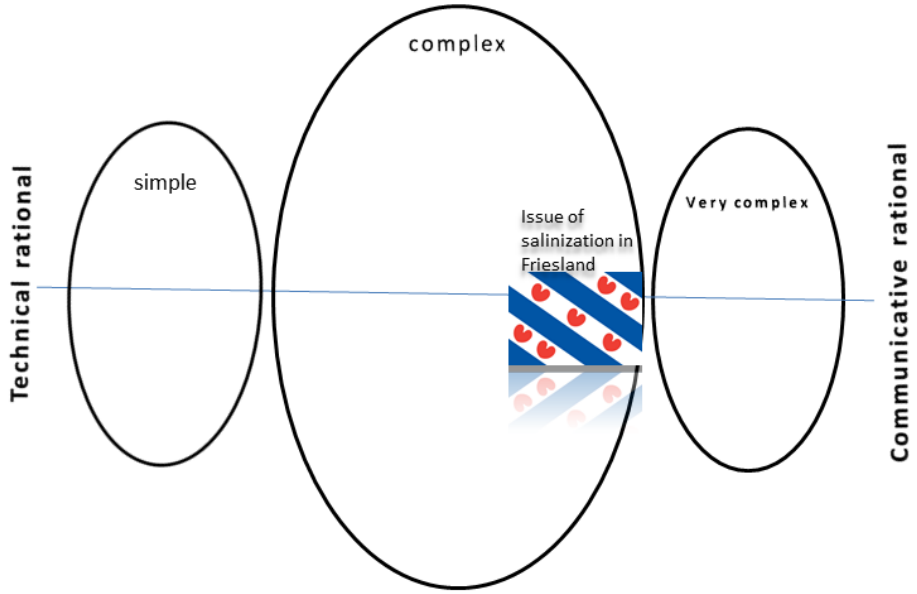

Figure 15: Issue of salinization in Friesland on a planning spectrum.

The next chapter will provide the answer on the main research question and will connect the analysis of the governance strategy with the theoretical background. In the discussion the different aspects of the theoretical background; complexity, governance and the shift in water management will be linked to the results of the analysis.

5. Conclusion and discussion

This chapter will provide the answer to the main research question: How can the issue of salinization be positioned on a planning spectrum and does the governance strategy on the issue of salinization in Friesland fit this position? In the discussion, the connection between the theoretical framework and the data analysis will be made. With this connection, the position of the issue of salinization and the governance strategy on salinization will be discussed from a planning perspective.

The main question consists of two parts; the issue of salinization and the governance strategy used for the issue of salinization. The next sections will discuss the relation of the results with the theory to develop an answer on the main research question.

5.1. Discussion on the issue of salinization

In chapter two *the issue of salinization* is discussed. The different causes and consequences are discussed and the scale of the problem is discussed. The causes have been divided into two categories; natural and anthropogenic causes. The anthropogenic causes are influential and therefore are the ones that are taken into consideration for this research. Climate change, land subsidence and chloride contamination are the main anthropogenic causes. The scale of these causes is discussed as well. Climate change is a problem on a global level. However, it is hard to find solutions on a global scale. It is said that on a global level policy frameworks can be used to reduce the causes of climate change through mitigation. On a local level, adaptation measures can be implemented to deal with the effects of climate change (Wilson & Sniper, 2010). For land subsidence and chloride contamination literature on environmental problems has been used. It is said that the link of scale with the causes and consequences need well-grounded matches between environmental problems and the institutional arrangement that has to deal with the problem (Konisky et al., 2008).

The issue of salinization has been viewed from a planning perspective in a framework of planning focused actions, where the degree of complexity of an issue and the scale of an issue are used as a criterion. The 'how' line can be seen as the planning spectrum and a distinction is made between a technical rational approach on the one hand, and on the other hand a communicative rational approach. In this planning spectrum, salinization is placed based on its degree of complexity and scale; this is shown in figure 16.

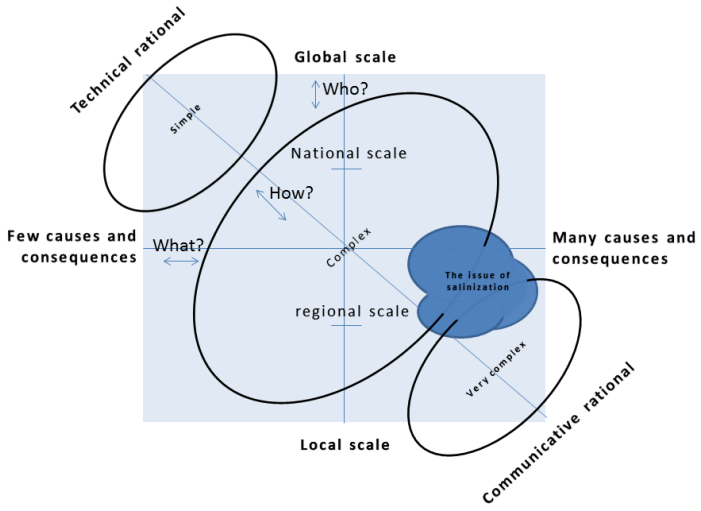

Figure 16. Planning spectrum for salinization.

A connection between the case of Friesland and the issue of salinization can be made. The causes and consequences are matched with the causes and consequences from chapter two. One of the factors that are important in the case of Friesland is the natural cause that is based on the geological history. The tidal and marsh areas that formed before land-reclamation was done are important for the geological settings. The setting in Friesland with the salt groundwater and the freshwater lenses are based on these natural causes. In the anthropogenic causes the connection is also clear. Climate change, sea level rise and land subsidence are the most important causes of salinization in Friesland. These anthropogenic causes lead to a decrease of the freshwater lenses near the shoreline of Friesland which can cause salinization. The cause of chloride contamination could not be connected in the case of Friesland. The consequences can be seen for the agricultural sector, for the water sector and also for citizens; they should be aware of the issue of salinization and save water in period of extreme droughts.

The placement of the issue of salinization in the planning spectrum can also be matched to the analysis of the case of Friesland. It became clear that the problem of salinization is not simple, it is rather complex. Different causes and consequences made this issue a complex problem. Due to the sea level rise and the land subsidence, salinization is mostly a problem near the coast. This means that the scale of the problem can be seen on a regional scale. It is mentioned in different documents and said by multiple interviewees that the whole shoreline will have problems with salinization in the future. The issue of salinization can also be seen on a local scale. It is said that the thickness of the freshwater lenses can differ per plot and per area. However, the thickness of the freshwater lenses is generally less thick near the shore than inland. So the issue of salinization has a regional and local scale. The placement of the issue of salinization in the planning spectrum from the theory can therefore be matched with the case of Friesland.

5.2. Discussion on the governance strategy on salinization

After elaborating the connection of the issue of salinization with the theory and the case, *the governance strategy* that is analyzed for the case of Friesland will be elaborated on and connected with the theoretical framework on the shift in governance. Also the shift in water management, which was the basis of the development of the concepts of adaptiveness and resilience, will be discussed. The connection of the concepts and the policies on salinization with the case of Friesland will provide the answer on the main research question.

The role of the state is changing and the field of governance is becoming increasingly popular. Governments are experimenting with new forms of horizontal governance, interactive decision making, stakeholder involvement and other forms of citizen involvement (Klijn, 2008). From the placement of the issue of salinization it becomes clear that this problem asks for a communicative rational approach and that the shift in governance should be made. Aspects that are connected to this placement are the hollowing out of the state and the governance triangle of Lemos and Agrawal (2006). It means that there should be less involvement of the national government and more responsibilities for a region itself. The triangle advocates a shift in responsibilities from the state towards the market and the community. This shift from government to governance can also be seen in the shift in water management. Pahl-wostl (2007). She says: *"Water management is facing major challenges due to increasing uncertainties caused by climate and global change and by fast changing*

socio-economic boundary conditions. More attention has to be devoted to understanding and managing the transition from current management regimes to more adaptive regimes that take into account environmental, technological, economic, institutional and cultural characteristics of river basins. This implies a paradigm shift in water management from a prediction and control to a management as learning approach." However, according to Zuidema (2011), the risk of strategies is on a local level mainly about the loss of effectiveness and efficiency. Decentral governments can have less expertise, less willingness and do not always have the ability to accomplish their integrated goals. There is a need for central policy frameworks to achieve decentral integrated strategies. These policy framework can stimulate and support local strategies and this steering function is crucial for decentral strategies to be successful (Zuidema, 2011).

This last statement of Zuidema (2011) can be linked to the issue of salinization and also for the water management in the Netherlands in general. The goals in the national policies on water security, water quality and water quantity are clearly formulated and the water law is obligating these goals by the performance (doorwerking) in regional water plans and water management plans. The framework is set by the central government and the regional and local governments needs to implement these goals. This also accounts for salinization. Salinization is part of the goal to provide enough water for the future and is elaborated on a national level, a regional level and in the water management plan of the water boards. The national government is setting the objectives, however, Friesland has to set also their own objectives. The region-specific characteristics are asking for different objectives and solutions than in other regions. Therefore it is a framework and the province decides their own strategy on salinization within this framework.

The role of the province is to facilitate, direct, regulate and release. The two interests groups LTO and It Fryske Gea can be seen as the market and the community stakeholders in regard to the triangle of Lemos & Argawal (2006). By facilitating and releasing responsibilities from the government (province), the market and the community have to do something with the issue of salinization. For that reason LTO also has goals to achieve a better situation for their agrarians. Awareness and information on the issue is important and the tool of 'Boeren Meten Water' is very promising in the light of these goals. It Fryske Gea wants to be involved and wants to start the dialogue with different stakeholders. The province and the water board are important, but starting a dialogue with LTO is also important. Discussing the conflict of nature and agriculture is important to find solutions that fit both interests.

A critical point on the policy strategies is that it is still object-oriented. Certain goals are formulated and afterwards it is elaborated how to achieve these goals. In both the waterhuishoudingsplan and the waterbeheerplan the focus is on the object. This is in conflict with framework of planning focused actions and the placement of the issue of salinization in the planning spectrum.

5.3. Conclusion on the position of the governance strategy

Taken into account the discussion on the issue of salinization, the discussion on the governance strategy on salinization and the analysis of the concepts of adaptiveness and resilience, an answer on the main research question can be given. How can the issue of salinization be positioned on a planning spectrum and does the governance strategy on the issue of salinization in Friesland fit this position?

The issue of salinization is well elaborated and it can be positioned on a planning spectrum by elaborating the degree of complexity and the scale of the problem. The issue of salinization is defined on a regional scale as a complex issue and can be found on the communicative rational side of the planning spectrum. The second part of the question can be elaborated on based on table 9. It shows the characteristics of the concepts of adaptiveness and resilience. It is said that these concepts can be linked with complex issues and therefore can be linked to a more communicative rational approach. If all characteristics are highly present, the governance strategy on the issue of salinization in Friesland can related to very complex issues. Figure 17 shows the placement on the spectrum. It is positioned on the right side, but not totally. Table 9 shows the valuation of the characteristics of the concepts of adaptiveness and resilience. According to the theoretical framework and the conceptual model the valuation of these concepts of adaptiveness and resilience can say something about the degree of complexity and therefore on the position of the governance strategy on the issue of salinization. Three of the eight characteristics have a +/- valuation and this means that they are present but not in all situations. Five of the eight characteristics are mostly present. This means that characteristics are more present than less present. This research therefore can conclude that the issue of salinization is a complex issue. It cannot be place totally on the communicative rational side of the spectrum. Nevertheless, the placement of the governance strategy on salinization is positioned on the side of the communicative rational approach. Taken into account the aforementioned connection between the placement of the issue of salinization in the planning spectrum and the issue of salinization in Friesland, the position of the issue meets the position of the governance strategy that is used in Friesland.

Table 9. valuation of characteristics.

		++	+	+/-	-	--
Adaptiveness	Flexible			x		
	Learning by doing	x				
	Reduce vulnerabilities			x		
	Capacity to deal with future change		x			
Resilience	Ability to deal with uncertain change			x		
	Bounce back		x			
	Absorb shocks		x			
	Preparation for surprises		x			

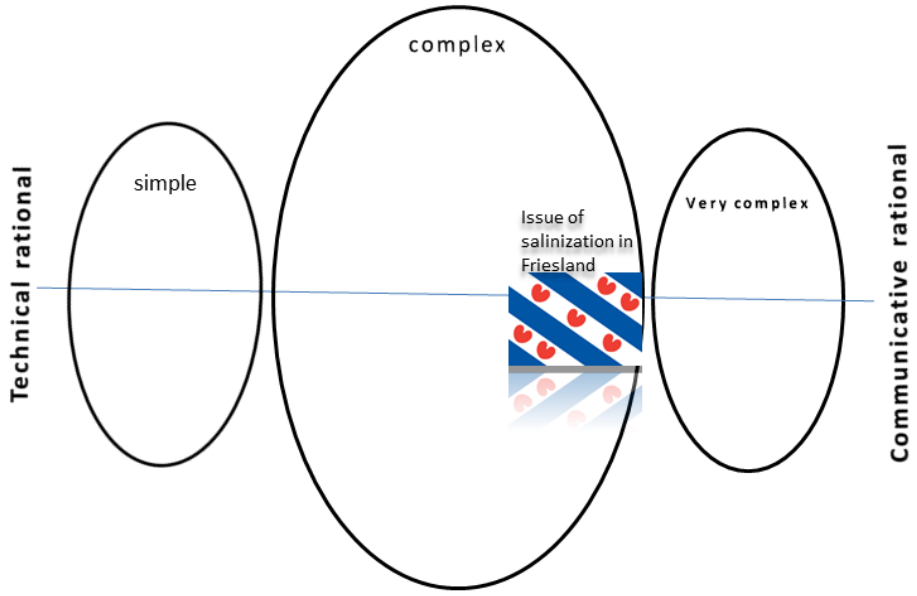

Figure 17. Issue of salinization in Friesland in a planning spectrum.

6. Reflection and recommendations for further research

This chapter will provide the link to current discussions in planning theory and practice and will provide a reflection on the methodology. It also provides recommendations for further research.

6.1. Relevance of the research

This thesis has delivered two things: first, a new insight for planning theory. Salinization is not covered in-depth in the planning debate. The perspective of a low-laying country in one of the biggest deltas in the world often would indicate the risk perspective of flooding and disaster management. Development of adaptive and resilient cities and deltas are often debated in regard to flooding. Therefore it is useful for planning theory and planning practice to have another perspective on our water management; that of a risk for the freshwater supply. Complexity and scale as criteria are well debated in environmental planning. With the outcome of this research, it could be argued that the approaches from environmental planning can also be used in water planning.

Second, the issue of salinization is still in the phase of learning and gathering information. By doing pilots like Spaarwater and developing the water supply levels in the near future, it becomes clear that the issue of salinization is in a learning process and therefore this thesis can be of value. Mismatches in environmental problems are often about the complexity of the problem and the scale of the problem. This thesis shows that the position of the governance strategy on salinization is placed on the side of the communicative rational approach. The phase of learning and gathering information by learning by doing fits this position well. Also the future developments of different options in measures and becoming self-sufficient are promising developments that also fit this position in the planning spectrum.

6.2. Methodological reflection

This research made use of three different qualitative research methods: document analysis, in-depth interviews and participation and observation. The documents are used to investigate the policies on salinization, the in-depth interviews are used to validate and complete the analysis of the documents. Participation and observation are used to get an overview of data for the case of Friesland. The amount of methods is good for a qualitative research and that made the results complete. More in-depth interviews could have been carried out to provide a larger set of data. For example with someone who represents national level of governance, from the ministry of infrastructure and the environment or from Rijkswaterstaat. To get a better overview of the problem and the policies of Friesland, an interview with someone external that had the knowledge about the issue and the policies could also have had a positive effect on the research.

6.3. Recommendations for further research

The national water plan, regional water plan and water management plan of the nation, province and water board are drafted for the period of 2016-2021. Evaluating these policies could be a possibility to do research on the effectiveness of the policies. Another recommendation for further research is the comparison of the case of Friesland with other similar cases. Comparing the governance strategy of other provinces or other countries could give more insights into the positioning of the issue of salinization in a planning spectrum. Analysing more cases can give insights in possible mismatches of the issue and the approach that is used. According to Cumming et al. (2006) this can increase the social-ecological resilience and thereby an increase in human well-being.

Literature

Albrechts, L. (2006). Bridge the gap: From spatial planning to strategic projects. *European Planning Studies*, *14*(10), 1487-1500.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report*, *13*(4), 544-559.

Clifford, N., Cope, M., Gillespie, T., & French, S. (Eds.). (2010). *Key methods in geography*. Sage.

Cumming, G., Cumming, D. H., & Redman, C. (2006). Scale mismatches in social-ecological systems: causes, consequences, and solutions. *Ecology and society*, *11*(1).

Cubasch, U., D. Wuebbles, D. Chen, M.C. Facchini, D. Frame, N. Mahowald, and J.-G. Winther, 2013: Introduction. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., ... & Davoudi, S. (2012). Resilience: a bridging concept or a dead end?"Reframing" resilience: challenges for planning theory and practice interacting traps: resilience assessment of a pasture management system in Northern Afghanistan urban resilience: what does it mean in planning practice? Resilience as a useful concept for climate change adaptation? The politics of resilience for planning: a cautionary note: edited by Simin Davoudi and Libby Porter. *Planning Theory & Practice*, *13*(2), 299-333.

De Boer, H. C., & Radersma, S. (2011). *Verzilting in Nederland: oorzaken en perspectieven* (No. 531). Wageningen UR Livestock Research.

De Roo, G. (1999). *Planning per se, planning per saldo: over conflicten, complexiteit en besluitvorming in de milieuplanning*. Den Haag: Sdu Uitgevers.

Delsman, J. R. (2015). Saline Groundwater - Surface Water Interaction in Coastal Lowlands. Amsterdam, Netherlands: IOS Press.

Deltacommissaris (2016). Deltaprogramma 2016 – Werk aan de delta - En nu begint het pas echt. Retrieved from: https://www.deltacommissaris.nl/documenten/publicaties/2015/09/15/deltaprogramma-2016-pdf

Doorn, N. (2016). Allocating responsibility for environmental risks: A comparative analysis of examples from water governance. *Integrated environmental assessment and management*.

Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., ... & 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 & Policy*, *13*(6), 459-471.

Herbert, E. R., Boon, P., Burgin, A. J., Neubauer, S. C., Franklin, R. B., Ardón, M., ... & Gell, P. (2015). A global perspective on wetland salinization: ecological consequences of a growing threat to freshwater wetlands. *Ecosphere*, *6*(10), 1-43.

Jänicke, M., & Jörgens, H. (2009). New approaches to environmental governance. *The Ecological Modernisation Reader. London: Routledge*.

Jeppesen, E., Brucet, S., Naselli-Flores, L., Papastergiadou, E., Stefanidis, K., Noges, T., ... & Bucak, T. (2015). Ecological impacts of global warming and water abstraction on lakes and reservoirs due to changes in water level and related changes in salinity. *Hydrobiologia*, *750*(1), 201-227.

Klijn, E. H. (2008). Governance and governance networks in Europe: An assessment of ten years of research on the theme. *Public management review*, *10*(4), 505-525.

Konisky, D. M., Milyo, J., & Richardson, L. E. (2008). Environmental policy attitudes: Issues, geographical scale, and political trust. *Social Science Quarterly*, *89*(5), 1066-1085.

Koppenjan, J. F. M., & Klijn, E. H. (2004). *Managing uncertainties in networks: a network approach to problem solving and decision making*. Psychology Press.

Lemos, M. C., & Agrawal, A. (2006). Environmental governance. *Annu. Rev. Environ. Resour.*, *31*, 297-325.

Ligtvoet, W., Knoop, J., de Bruin, S., van Vuuren, D., Visser, H., Meijer, K., Dahm, J., & van Schaik, L. (2017). Water, climate and conflict: security risks on the increase? Planetary Security.

Mostert, E. (2015). Who should do what in environmental management? Twelve principles for allocating responsibilities. *Environmental Science & Policy*, *45*, 123-131.

Mulder E.F.J., Van Bruchem A.J., Claessen F.A.M., Hannink G., Hulsbergen J.G., Satijn H.M.C. (1994) Environmental impact assessment on land reclamation projects in The Netherlands: a case history, Engineering Geology, Elsevier, Issue 37 pag 15-23

Nelson, D. R., Adger, W. N., & Brown, K. (2007). Adaptation to environmental change: contributions of a resilience framework. *Annu. Rev. Environ. Resour.*, *32*, 395-419.

O'Leary, Z. (2010). The essential guide to Doing Your Research Project, Sage, London, UK.

Oude Essink, G. H. (2001). Salt water intrusion in a three-dimensional groundwater system in the Netherlands: a numerical study. *Transport in porous media*, *43*(1), 137-158.

Oude Essink, G. H. P., Van Baaren, E. S., & De Louw, P. G. (2010). Effects of climate change on coastal groundwater systems: A modeling study in the Netherlands. *Water Resources Research*, *46*(10).

Pahl-Wostl, C. (2007). Transitions towards adaptive management of water facing climate and global change. *Water resources management*, *21*(1), 49-62.

Paulissen, M. P. C. P., Schouwenberg, E. P. A. G., Velstra, J., & Wamelink, G. W. W. (2007). Hoe gevoelig is de Nederlandse natuur voor verzilting. *H2O: tijdschrift voor watervoorziening en afvalwaterbehandeling*, *2007*(18), 40-44.

Pauw, P., De Louw, P. G., & Essink, G. O. (2012). Groundwater salinisation in the Wadden Sea area of the Netherlands: quantifying the effects of climate change, sea-level rise and anthropogenic interferences. *Netherlands Journal of Geosciences*, *91*(03), 373-383.

Post, V. E. A. (2004). Groundwater salinization processes in the coastal area of the Netherlands due to transgressions during the Holocene. *Vrije Universiteit, Amsterdam, The Netherlands*.

Post, V. E. A., Van der Plicht, H., & Meijer, H. A. J. (2003). The origin of brackish and saline groundwater in the coastal area of the Netherlands. *Netherlands Journal of Geosciences*, *82*(02), 133-147.

Rhein, M., S.R. Rintoul, S. Aoki, E. Campos, D. Chambers, R.A. Feely, S. Gulev, G.C. Johnson, S.A. Josey, A. Kostianoy, C. Mauritzen, D. Roemmich, L.D. Talley and F. Wang, 2013: Observations: Ocean. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Stake, R. E. (1995). *The art of case study research*. Sage.

Stoker, G. (1998). Governance as theory: five propositions. *International social science journal*, *50*(155), 17-28.

Sze, J., London, J., Shilling, F., Gambirazzio, G., Filan, T., & Cadenasso, M. (2009). Defining and Contesting Environmental Justice: Socio-natures and the Politics of Scale in the Delta. *Antipode*, *41*(4), 807-843.

Tang, C. P., & Tang, S. Y. (2006). Democratization and capacity building for environmental governance: managing land subsidence in Taiwan. *Environment and planning A*, *38*(6), 1131-1147.

Termeer, C., Dewulf, A., van Rijswick, H., van Buuren, A., Huitema, D., Meijerink, S., ... & Wiering, M. (2011). The regional governance of climate adaptation: a framework for developing legitimate, effective, and resilient governance arrangements. *Climate law*, *2*(2), 159-179.

United Nations (2015). Nations Sustainable Development Knowledge Platform. Transforming our world: The 2030 Agenda for Sustainable Development. Retrieved from https://sustainabledevelopment.un.org/post2015/transformingourworld

Van der Brugge, R., Rotmans, J., & Loorbach, D. (2005). The transition in Dutch water management. *Regional Environmental Change*, *5*(4), 164-176.

Voorde, M. T., & Velstra, J. (2009). Leven met zout water: overzicht huidige kennis omtrent interne verzilting. *Gezamenlijk uitgave van Acacia Water, Leven met Water en STOWA*.

White, I., & O'Hare, P. (2014). From rhetoric to reality: which resilience, why resilience, and whose resilience in spatial planning?. *Environment and Planning C: Government and Policy*, *32*(5), 934-950.

Wilson, E., & Piper, J. (2010). *Spatial planning and climate change*. Routledge.

Wilson, E., & Termeer, C. (2011). Governance of climate change adaptation: Introduction to the Special Issue. *Climate L.*, *2*, 149.

Yin, R. K. (2003). Case study research: Design and methods (3rd ed.). Thousand Oaks, CA: Sage.

Zuidema, C. (2011). *Stimulating local environmental policy: Making sense of decentralization in environmental governance* (Doctoral dissertation, University of Groningen).

Documents

Caljé, R., & Beekman, W. (2017) Oriënterende modelberekening verzilting Fryslân. Artesia Water; research Unlimited. Schoonhoven 2017

European Union (2014). The EU water framework directive. Retrieved from: http://bookshop.europa.eu/en/the-eu-water-framework-directive-pbKH0414216/

European Union (2016). Water. What's new. Retriecved from: http://ec.europa.eu/environment/water/index_en.htm

Gunnink, J., Sanchez, M.F., Louw, P., Baaren, E. (2012) Effecten van klimaatverandering en zeespiegelstijging op het kustnabije grondwatersysteem van Noord-Fryslân. Resultaten van een dichtheidsafhankelijke grondwatermodellering. TNO-rapport. Utrecht.

It Fryske gea (2015). Zilte Vitaliteit; Naar een vitale Friese Waddenkust.

Kaderrichtlijn water (2015). Status, toestand, waterkwaliteitsdoelen en maatregelen KRW-waterlichamen Friese binnenwateren. KRW-factsheets. Retrieved from: https://www.fryslan.frl/document.php?m=7&fileid=643&f=3fd28e07aa496d082c63c7fc7aba36a2&attachment=0

LTO Nederland (2013). Deltaplan Agrarisch waterbeheer.

LTO Noord (2017). Boeren Meter Water; participatieve monitorinf en waterbeheer door samenwerking van boeren en waterschappen.

Ministry of Infrastructure and Environment and Ministry of Economic affairs (MIE and MEA) (2014). "Delta Programme 2015. The decisions to keep the Netherlands safe and liveable".

Ministry of Infrastructure and Environment and Ministry of Economic affairs(MIE and MEA-a) (2015), "National Water Plan 2016 -2021".

Ministry of Infrastructure and Environment and Ministry of Economic affairs(MIE and MEA-b) (2015), Deltaprogramma. Werk aan de delta. En nu begint het pas echt.

Ministerie van verkeer en waterstaat (MVW) (2008). Waterwet in het kort.

Ministerie van verkeer en waterstaat (MVW) (2009). Waterwet.

Ons Water (2017). Ons water in Nederland. Retrieved from: https://www.onswater.nl/

Provincie Friesland (2016). Vierde Waterhuishoudingsplan: in feilige provinsje mei genôch en skjin wetter, foar no en foar letter.

Provincie Friesland (2016-b). Antwoordnota vierde Waterhuishoudingsplan Fryslân.

Staveren, G. V., & Velstra, J. (2012). Klimaatverandering, toenemende verzilting en landbouw in Noord-Nederland. Kennis programma Klimaat voor Ruimte. Acacia Water.

Stuurman, R., Essink, G. O., Broers, H. P., & van der Grift, B. (2006). Monitoring zoutwaterintrusie naar aanleiding van de Kaderrichtlijn Water "verzilting door zoutwaterintrusie en chloridevervuiling". *TNO Bouw en Ondergrond Rapportnummer*, 84.

Tolk, L., en Velstra, J. (2016). Spaarwater; pilots rendabel en duurzaam agrarisch watergebruik in een verziltende omgeving van de waddenregio. Hoofdrapport, Acacia Institute.

Waterschap Friesland (2014). Agenda voor het waterbeheer van de toekomst.

Waterschap Friesland (2016). Waterbeheerplan 2016-2021. En wat doen we morgen met water?