No-regret in water management decision-making

Exploring perspectives in Dutch water policymaking

MSc Thesis Engineering & Policy Analysis

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by

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to obtain the degree of Master of Science

at the Delft University of Technology,

to be defended publicly on Wednesday August 9, 2023 at 15:00.

Student number:	4480619	
Project duration:	March 1, 2023 – August 9, 2023	
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Cover:	Luchtfoto kust Zuid-Holland by Siebe Zwart
Style:	TU Delft Report Style, with modifications by Daan Zwaneveld

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Preface

This thesis project started with the question: what measures in water management are no-regret? The answer proved to be more complicated than the question suggests. This research provides multiple answers, and proposes new important questions. This research process has had significant contributions, that should be acknowledged.

Ellen Minkman, Frans Klijn and Kees van Ginkel provided valuable feedback and guidance throughout the research process. They also helped reaching the right participants for the survey, which contributes significantly to the quality of the results. Tom van der Wekken & Erik van Berchum, organised frequent meetings at the Delta Futures Lab, an interdisciplinary research group where valuable insights were exchanged. Ronald Waterman took the time to provide a personal lecture on two centuries of integrated water management, which was immensely helpful in understanding the complexity of this challenge. Shawn Banasick developed the software for the data collection, data analysis and made it available for free. Maarten Kroesen contributed to understanding the theoretical basis of Q-methodology and implementing the software.

Adam Ignasse
Delft, July 2023

Summary

Water poses persistent policy problem in the Netherlands where decisions are made under deep uncertainty, and no-regret measures are frequently mentioned as an appropriate method for dealing with this uncertainty. However, regret is inherently subjective and it is unclear what exactly causes regret and how it can be prevented. It is therefore necessary to identify perspectives on no-regret measures among actors involved in the decision-making process.

First, a theoretical framework is constructed by synthesising the state-of-the-art in academic research on regret. The framework combines insights from psychology, decision theory, decision-making models, policy analysis, and cultural theory. This resulted in a framework that can be used to describe and compare perspectives on no-regret measures in integrated water management. By describing the views on uncertainty, timing, qualitative factors, adaptivity and the decision-making process, perspectives on no-regret measures made under deep uncertainty can be described, identified and compared. Second, the framework is applied to identify perspectives on no-regret measures among individuals using Q-methodology. The debate on no-regret measures has been summarised into 29 statements, that were presented to experts that work on making, implementing, and researching integral water management policies in The Netherlands. A total of 29 participants from public, private and research organisations ranked these statements. From this data, three factors were extracted that group participants based on share views. The three produced a total explained variance of 50%, with 10, 11, and 8 participants in each of the respective factors. Using the theoretical framework, these factors were translated from purely mathematical items to perspectives and narratives.

The perspectives describe how individuals perceive no-regret measures, what role they should play in decision-making, and what factors should be considered when designing a no-regret measure. By analysing the statements that distinguish between factors and the explanations provided by participants, these factors were translated into perspectives. Four consensus statements were found that were ranked similarly by all perspectives. They all agree on that research and scenario exploration are essential to identify no-regret measures. The goal of no-regret measures should not be to prevent needing additional measures afterwards, which is actually beneficial in the context of adaptive policymaking. The goal of no-regret measures is also not to prevent damage to the reputation of the decision-makers. However, based on the varying views found within perspectives these consensus statements can be interpreted differently.

Perspective A, named ”technocratic design”, participants have a strong belief in our technology and our ability to use it. The design process should be scientifically based with a long-term perspective, where the strategy is implemented incrementally. If the (technical) design process is of high quality, the measures does not necessarily have to be adaptive. Increasing safety margins however is necessary to account for uncertain sea level rise. Perspective B, named ”adaptive egalitarian”, values both adaptivity and equality. Both concepts can even be mutually beneficial, as an adaptive strategy requires participation from a wider range of perspectives. A fair distribution of social costs and benefits is regarded as a principle that should apply to any policy, not just no-regret measures. The explanations provided on the statements about adaptivity suggest strong consciousness on the magnitude of future uncertainties, which motivates the call for adaptive measures. Changing social views and values are also seen as an uncertainty that influences the outcome of a decision. A transparent, participatory and egalitarian decision-making process is therefore necessary to yield socially robust policies. Perspective C, named ”minimalist innovation”, views the role of no-regret measures differently than as observed in the other perspectives. No-regret measures are not applicable anywhere, as they can be inefficient in time-urgent situations and have a dampening effect on innovation. They do however have a great potential to be implemented on a short-term basis as small-scale measures with a minimal chance of

regret. When no-regret measures are designed on a smaller scale, decision-makers also have to pay less attention to qualitative factors. In this perspective, qualitative factors are seen as too subjective and uncertain to consider. In other words, they can by definition not be no-regret, as they are too subjective. On the other hand, social support can be maintained by informing stakeholders and motivating design choices focusing on their scientific validity.

The perspectives imply fundamentally different world views exist among actors involved in integrated water management decision-making, similar to those found in earlier studies. These views are especially different for the perceptions of uncertainty, role of adaptivity and how the decision-making process should be designed.This research is an exploration of perspectives, and the findings open doors for further research. The theoretical framework synthesised in this research can be applied to other fields, but is especially valuable in similar research with a smaller scope. Further research is therefore recommended that focuses on specific areas, for example coastal defence. This would allow researchers to identify perspectives on no-regret measures for a specific project.

Contents

1

Introduction

Climate change and sea level rise pose a great challenge in The Netherlands. The complexity of this challenge requires an integrated approach, where adaptivity, robustness and resilience have emerged as central design principles. As a result, designing policies that minimise or prevent regret has gained more attention (de Jonge et al., 2022). No-regret measures have often been mentioned as a key to robust policy design in a deeply uncertain future. However, a clear definition of regret in this context does not exist. The aim of this study is to explore what regret means in Dutch water management, by identifying different perspectives that exist among decision-makers. This chapter will provide the context, importance and relevance of this research. The context will focus on the role of water management in The Netherlands, and how its high complexity requires new policymaking approaches. The focus will then shift to the role of no-regret measures and why perspectives must be identified. This will be followed by the research goals, research questions and scope of this research. The last section of this chapter contains an elaborate reading guide of the complete thesis.

1.1. Context

The Netherlands has a long and intricate relationship with water that has shaped the country in profound ways (Lintsen, 2002). Water has played a vital role in the development, economy, and culture throughout the centuries. The Dutch have been masterful in using water to their advantage. The construction of an extensive network of canals, dikes, and polders has allowed them to conquer vast areas of land from the sea, creating fertile soil for agriculture and new habitable areas. The strategic use of water has furthermore facilitated the growth of a prosperous maritime nation. The Dutch have become skilled shipbuilders, navigators, and traders, dominating global trade routes during the 17th century. Water, in the form of rivers, canals, and ports, connected the nation to the world and fuelled economic prosperity. Water however also causes a permanent threat in The Netherlands. It's geography makes it susceptible to flooding from both rivers and the sea, causing a continuous battle against the destructive forces of water. More than half of the surface area is susceptible to floods from the sea or rivers; 26% [1]of the total area lies beneath sea level. Throughout history, floods have caused immense damage to Dutch communities, resulting in loss of life, destruction of infrastructure, and economic adversity (Disco et al., 2014). The best known of these calamities is the North Sea Flood of 1953, which claimed the lives of over 1,800 people and caused widespread devastation. This catastrophe required the Dutch to take drastic measures to protect their people from future floods. The Dutch therefore took on an ambitious engineering challenge known as the Delta Works. This massive project involved the construction of complex system of dams, dikes, and storm surge barriers to shield the vulnerable areas from the dan-

[1]an IPCC report from 2007 mentioned 55%, but this figure is the percentage of the area susceptible to floods. see: https://www.pbl.nl/correctie-formulering-over-overstromingsrisico

gers of the sea. These efforts have been largely successful, significantly reducing the risk of flooding and protecting the population. However, the fight against floods continues to present challenges. Climate change and rising sea levels pose new threats, requiring constant adaptation and innovation in flood prevention strategies.

1.1.1. The complexity of Dutch water management

One should note that in this context, the dominant narrative is the military metaphor of a fight *against* water. This narrative was very popular in the 19th and part of the 20th century. Coastal engineers, often with a military background, used this framing explicitly, as well as representatives from construction companies (Lintsen, 2002). At that time, the dominant view was established that large infrastructural projects were needed to keep the population safe. This narrative is rooted in an anthropocentric, optimistic world view where science and technology will ultimately save us from any danger caused by nature. It has been named the ”National Hydraulic Technocracy” (Disco et al., 2014) ”Technocratic-Scientific Regime” (Lintsen, 2002). The first Delta plans very explicitly demonstrate they are the fruits of this view. It has resulted in a highly sophisticated, but relatively closed water defence system (Van der Brugge et al., 2005). For several, definitely relevant reasons, this perspective has changed. The transition and its driving forces will be discussed in chapter 2. But first, it is important to take some time to discuss how complex water management in the Netherlands actually is.

The wicked water problem

Water management has early on been characterised as a ‘wicked problem’ (Liebman, 1976), relating to the typology Rittel and Webber (1973) use to describe certain challenges: ill-structured problems in which complex societal interactions, highly uncertain physical processes and management dilemmas are present. Such problems are especially complex to analyse, because the problem formulation cannot be separated from the solution space.

Furthermore, decisions concerning water management are made under deep uncertainty. This type of uncertainty is defined as a condition in which analysts and/or decision-making actors do not know and/or cannot agree on three key factors: what models should be used to describe interactions in system variables, the probability distributions of variables in these models, and how to value the desirability of alternative outcomes (Lempert, 2003). This uncertainty is aggravated by the long-term planning scale of most water management policies that often lies within several decades, even centuries. On top of that, massive sunk costs are a consequence of the sheer size of the water systems. Policies have to be designed on a large geographical scale. Costs, more often than not, amount to billions. These high sunk costs also lead to path dependency (Heinmiller, 2009). The effectiveness of a chosen policy can only become visible after several years, which is often too late to change course. This learning process is furthermore very harsh, as we can learn a policy was ineffective the hard way.

Persistent problems

It can, and will, get more complex: typologies as ’wicked problems’ and ’deep uncertainty’ leave out and important part of Dutch water management complexity: the cultural and societal factors, rooted in the intricate role water has played throughout history. To take this into account, Dirven et al. (2002) used the term ‘persistent problems’ to append another layer of complexity. Persistent problems are new types of societal problems that are characterised by significant complexity, structural uncertainty, high stakes for a diversity of stakeholders involved, and governance problems. They are considered to be of an even higher degree of complexity than wicked problems, because they are deeply rooted in our societal structures and institutions.

The water ’problem’ is persistent because water has multiple forms, functions and values. Consequently, many stakeholders are involved with high stakes and varying, sometimes conflicting interests.

The ‘individual water problem’ does not exist, because the different forms of water (rainwater, groundwater, surface water, sea water) come forward in various issues: water demand and supply, scarcity, sea level rise, and disruptions in the hydrological cycle. Water furthermore has different societal functions: an economic function for transport and agriculture, an ecological function, and a social function in terms of safety and drinking water supply.

Water therefore also represents different values. An economic value can be expressed as the utility value of water through any form of pricing mechanism. The ecological value is expressed as the water regulation services for ecosystems. A social value, indicating the cultural and emotional meaning of water, can also be represented. Therefore, only an integrated approach addressing the multiplicity of water would be compatible. This, however, requires a different style of water management than the traditional[2] one. An approach is required that manages multiple uses at different scales: flood control, drought, potable water supply, irrigation, recreation and ecological preservation. Water managers can therefore no longer focus on optimising one specific utility function, but have to manage multiple functions and multiple stakeholders. Water management is furthermore constrained by regulation, and therefore subject to the influence and complexity of political decision-making. integrated water management thus needs to be pluralistic, involving multiple stakeholders who represent multiple perspectives (world views, values, biases and preferences). For this reason, policies in water management must also be ’socially robust’ (Offermans, 2010). A socially robust strategy is able to cope with changing societal perceptions to maintain the necessary level of social support.

Complexity and uncertainty are not the same thing, but are strongly related. Challenges are complex because of high interests, high risks, multiple stakeholders *and* large uncertainties. The uncertainties are large *because* of the complexity. Both ’external’ and ’internal’ factors make integrated water management complex. External factor such as climate change, sea level rise and heavy rainfall pose constant threats, and are by nature uncontrollable, unpredictable and thus uncertain. Internal factors are ’controllable’, but remain complex and uncertain. Policies are complex because of multiple values and stakeholders, and the social robustness depends on uncertain social factors and human behaviour.

1.1.2. New approaches and no-regret

The Dutch water management regime has transitioned from fighting *against* water, to living *with* water (Van der Brugge et al., 2005). This transition, together with the emergence of novel decision-making approaches, has shifted the focus towards policy (models) that value resilience, robustness and adaptivity. This has also resulted in an increased interest in no-regret measures. In the broadest sense, no-regret measures are measures that yield benefits in all possible future scenarios(Hallegatte et al., 2012). This notion is rooted in the precautionary principle, which has been adopted in several important international documents, like the 1992 Rio Declaration on Environment and Development. The precautionary principle has been proposed as a new guideline in environmental decision-making. It has four central components: taking preventive action in the face of uncertainty; shifting the burden of proof to the proponents of an activity; exploring a wide range of alternatives to possibly harmful actions; increasing public participation in decision-making (Kriebel et al., 2001). The precautionary principle however is also subject to controversy. On one hand, it is seen as a useful principle for averting potentially harmful consequences. On the other hand, it is seen as a pointless and potentially dangerous principle that stands in the way of any innovation (Bourguignon, 2015).

No-regret measures are policy alternatives proposed to cope with (deep) uncertainty, as they yield benefits even if the forecasts reveal wrong (Hallegatte et al., 2012). Many researchers have argued for the identification and implementation of no-regret measures. Middelkoop et al. (2001) for example argue that the appropriate response is to adopt the ‘no-regret and flexibility’ principle, when discussing the impact of climate change on water resource management in the Rhine basin. Heltberg et al. (2009) discuss no-regret adaptation measures, which they define as actions that generate net social benefits under all future scenarios. They argue that the links between risk, adaptation and vulnerability must

[2]The different styles will be discussed in more detail in chapter 2

be understood in order to identify no-regret measures. Closely resembling the precautionary principle, developing a set of low-regret solutions has been recommended to reduce vulnerability (Döll et al., 2015 ;Wilby, 2008).

Regret is also widely used in decision-making models, as an indicator of performance. Famous examples include the Wald (1945) maximin-model and the Savage (1951) minimax-regret approach, which paved the way for the development of Regret Theory by Loomes and Sugden (1982) and Bell (1982). Novel decision-making approaches like Robust Decision-Making (RDM) use regret as an indicator of relative performance when comparing different policy alternatives through simulation (Marchau et al., 2019). Regret in this case is modelled as a loss of utility caused by a decision made under uncertainty (Diecidue & Somasundaram, 2017). Or, put more simply by Lempert (2003), *"any deviation from optimality"*.

Robust Decision-Making however does not fully address the challenges of irreversibility and path dependency in wicked problems (Kwakkel et al., 2016). Several authors thus point to Dynamic Adaptive Policy Pathways (DAPP), a method proposed Haasnoot et al. (2013). In this approach, the goal is ultimately to map all possible policy pathways, in order to identify and formulate no-regret measures. Adaptivity is seen as a key to preventing regret in DAPP. In short, both methods are complementary but use different conceptualisations of regret. RDM uses regret in the same (utilitarian) way as classical decision theorists. In DAPP, regret is seen as intrinsically linked to irreversibility and path-dependency. Mapping policy pathways is therefore needed to identify no-regret measures. These approaches will be discussed in more detail in section 2.2.2.

This short review of the various conceptualisation and applications of regret in decision-making (models) should evoke some fundamental questions. What is regret? Can regret be measured? How can we know what we will be regretting in the future? Is no-regret not just a theoretical ideal? The next section discusses how regret can be defined, and might answer some questions. It will also create more.

1.1.3. Defining regret

Most importantly, if one wants to use regret in any model, qualitative or quantitative, the concept of regret has to be defined clearly. Examples from decision-making approaches like RDM and DAPP show that one can conceptualise regret in different ways. Conceptualising regret as ”a loss of utility” implies a clearly defined utility function. Utilities however are often based on preferences, which are subjective. The same can be said for ”any deviation from optimality”: optimality is almost never objective in challenges with vast societal impacts. To gain a better understanding, it is necessary to also view regret on a fundamental level, from a psychological perspective.

Psychologists commonly define regret as “*an emotional response to the remembrance of a past state, that one wishes had been different*” (Zeelenberg & Pieters, 2007). In the context of water management, this definition creates countless ‘sources’ of regret. In highly complex situations and deep uncertainty, the potential sources of regret near infinity. Moreover, regret fundamentally is an emotional response, and therefore prone to subjectivity. As mentioned before, the complexity of the Dutch water management challenge is partly due to cultural and societal factors. The presence of multiple stakeholders with varying interests, values and preferences imply that all choices contain trade-offs. This opens many doors to discussions on moral, ethical and political implications of water management. These complications all create new sources of regret.

For individuals, regret thus depends on what they value in a decision (i.e. their definition of optimality). The psychological view only describes regret from the perspective of individual decision-making. In the context of integrated water management, decisions are made collectively. It is however very plausible that all individual values can be summarised in a finite set of ’perspectives’. This is not just plausible, but has been an area of study in social sciences for several decades. Examples include the Hofstede (2011) 6D model and Cultural Theory (Douglas, 1970; Thompson et al., 1990). Perspectives,

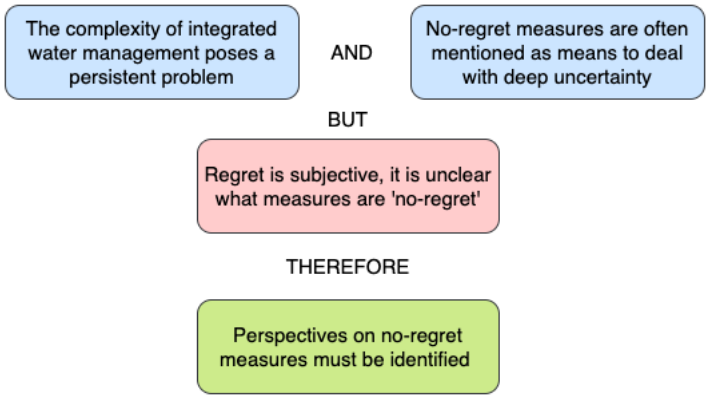

Figure 1.1: Structure of the problem statement

through shared values, beliefs and biases, can be used to explain how regret influences one's decision-making. This knowledge can also be used to explain how individuals view no-regret measures, what their role in policymaking should be and what process is needed to define no-regret solutions.

1.2. Research goals

So far, the discussion on regret has shown that regret is subjective: how we experience regret and how it influences our decision-making is more than ambiguous. Thus, multiple perspectives on no-regret measures should exist. Perspectives are defined as perceptual screens through which people interpret the world (their worldview) and which guides them in acting (the management style) (Van Asselt, 2000). These perspectives have not yet been identified in relation to no-regret measures. In decision-making models two conceptualisations can be distinguished: regret as a loss of utility and regret from irreversibility. In Dutch water management, perspectives such as the technocratic-scientific and the integrated-participatory perspectives were found to be of significant influence on the decision-making process. These distinctions further support the hypothesis that multiple perspectives on (no-)regret exist among actors involved in water management, that can influence the decision-making process and its outcome. This leads to the formulation of the following problem statement: *The complexity of integrated water management in the Netherlands poses a persistent problem where decisions are made under deep uncertainty. No-regret measures are frequently mentioned as an appropriate method for dealing with this uncertainty. However, regret is inherently subjective and it is unclear what exactly causes regret and how it can be prevented. It is therefore necessary to identify perspectives on no-regret measures among actors involved in the decision-making process.*

The goals of this research effort are therefore to:

A identify perspectives on no-regret measures
B define possible implications on decision-making in integrated water management
C present recommendations for actors to account for these perspectives in the decision-making process

Perspectives are a set of coherent positions (arguments, attitudes, emotions) that allow people to give meaning to reality. In this context, perspectives on no-regret measures are a set of coherent positions that describe how individuals view no-regret measures. Identifying also means contextualising and explaining. Perspectives can be identified mathematically, using Q-methodology which will be explained in chapter 3. The mathematically extracted perspectives have to be put into context and explained, creating a 'narrative' that describes these sets of coherent positions. If different perspectives exist, there must also be consensus as well as disagreement on certain topics. By identifying these topics

the implications on the decision-making process will be discussed. The implications in this context are ways in which the (difference in) perspectives can influence the decision-making process. The recommendations for actors to account for perspectives will therefore focus on how the areas of both consensus and disagreement can be used improve the decision-making process.

1.3. Scope

As is clear from the title and introduction so far, this research only studies integrated water management in the Netherlands. There are several reasons for this. First, how water affects a society heavily depends on geographical factors. In this context, the role water plays in the Netherlands is unique. With one quarter of the country below sea level, a coastline of 451 km, the geography of the Netherlands creates a unique situation. Also very important: it is one of the most densely populated countries in the world, with several large cities that developed along rivers and close to the sea. Amsterdam, the largest city with a population nearing one million, lies two metres below sea level. Estimations from 2015 indicate that 3.93 million people live below sea level, and this figure will almost double if the sea level rises one metre (Hut, 2015). Water management policies cannot be discussed without considering these factors. Second, water management is bound to regulations and a certain governance structure in the Netherlands with a Ministry for Infrastructure and Water Management, its executive agency (Rijkswaterstaat), democratically elected water boards, a Delta Committee and several other important organs. The governance structure of Dutch water management will be elaborated on in chapter 2. In short, also in this context the Netherlands is unique, and these factors need to be considered. Third, as mentioned before, water is also part of Dutch culture and history. These relationships and its implications will be discussed in more detail in chapter 2. This however is the most important reason for focusing only in the Netherlands. As the goal is to study subjective perceptions that are partly shaped by cultural factors, the population that is studied must be representative of this culture. It would however be possible to reproduce this research in another country, and compare the two results.

1.3.1. System boundaries

This section describes the boundaries of the system that is studied. A system is defined as a part of reality that is being studied as a result of the existence of a problem (Walker, 2000), in this case: the water management policy problem in The Netherlands. It is important to keep in mind the comment from Dirven et al. (2002), that there is no singular 'water problem'. This makes defining system boundaries more difficult, but nonetheless necessary to study it.

The Dutch water system

The purpose of defining the system is also to understand what we are dealing with. The system boundaries define what factors need to be taken into account when discussing any policy and its implications.

Forms Water essentially takes four main forms in this system: seawater, surface water, rain and groundwater. Rising sea levels threaten all coastal areas in The Netherlands. If sea levels rise, flood probabilities increase in coastal areas. Rising sea levels also cause (salty) seawater to move more inland. This limits the supply of fresh water for agriculture and drinking water. It also induces salinisation of the ground which makes it no longer suitable for agriculture. Excess surface water has several implications. In rivers, this means more water has to be transported towards the sea. Currents increase which can cause more erosion of river beds and makes it more difficult to navigate. It also increases flood risks in areas surrounding the river. This can be aggravated by heavy rainfall, and cause a destructive synergy. Heavy rainfall on its own however can also cause problems in drainage. As a result of urbanisation, the ground has lost much of its ability to properly absorb and diverge rainwater. The same applies to groundwater. Climate change however can also lead to shortages in water. Lower sea

levels are not a realistic threat, but longer periods of drought do have serious implications. Low water levels in rivers and canals make them more difficult to navigate. Longer periods without rainfall increase the demand for fresh water from reserves, in order to sustain agricultural and potable water demand. A low groundwater level also has serious implications. With certain soil types, a low groundwater level cause the ground to dry out and sink. This can cause serious damage to the buildings and infrastructure built on this ground.

Functions Water not only different forms, it also has different functions. Economically, water plays a pivotal role in the country's agricultural sector. Water is used extensively in irrigation, enabling efficient cultivation and ensuring high crop yields. Furthermore, water is a vital component of the transportation infrastructure. The highly sophisticated network of canals, rivers, and harbours facilitates efficient transportation of goods, connecting major cities and providing access to international trade routes. On top of that, water-based transport large investments have been made in water-based transport, as it is environmentally friendly and reduces the reliance on congested road networks. The recreational value of water in the Netherlands cannot be overlooked. The country's numerous lakes, rivers, and coastal areas offer opportunities for boating, swimming, fishing, and other water-based activities. These recreational activities attract tourists and contribute to the local economy, supporting businesses such as marinas, hotels, and restaurants. Water also plays a critical role in maintaining biodiversity and supporting fragile ecosystems. The Netherlands is home to diverse aquatic habitats, including wetlands, marshes, and estuaries. These areas provide crucial breeding grounds for birds, fish, and other aquatic species, contributing to the overall ecological balance and preserving biodiversity.

Stakeholders As a consequence of the various functions of water, multiple stakeholders are involved. Stakeholders are affected by the outcome of the policy process: the implementation of a new policy has significant impact on their lives. These stakeholders can range from individuals living in flood-prone areas, to farmers using fresh water for their crops, to companies who use the water infrastructure for transportation. In the Netherlands, almost any individual can be regarded as a stakeholder. In this research, no general definition of a stakeholder is used. If a clear definition is required, it will be provided for that specific case.

Policy space The policy space is defined as the collection of possible policies that can influence the system. This research focuses on water management policies initiated by the government. Policies can physical such as building dykes, sluices and dredging. The can also be regulatory, by (not) allowing certain uses. They can furthermore be spatial. This refers to policies in spatial planning that determine where the built environment should be located, which can be used strategically in flood risk management. Nevertheless, water management is complicated and the distinction as presented in this list is not as straightforward as it is in reality. The point is to illustrate what forms no-regret measures can take, and that they are policies initiated by public institutions that aim to best represent the interests of its population.

1.4. Research questions

The research goals have been translated into research questions, which are divided into one main research question and four sub-questions. This section contains both, including some elaboration and explanation on the approach towards answering these questions.

1.4.1. Main research question

The research goals described in section 1.2 can be summarised in one main research question. Further elaboration on the main research question is provided in this section. The main research question is:

What different perspectives on no-regret measures exist that can influence the decision-making process of policies for integrated water management?

As mentioned before, perspectives are screens shaped by values and beliefs through which individual perceive the world. In the main research question, it is stressed that perspectives that *can* influence decision-making are researched. This puts the emphasis on *identifying* the perspectives, and less on researching *how* they influence decision-making. While both research goals are relevant, they require completely different methodologies. They will nonetheless both be investigated, but with more emphasis on the identification of perspectives. Another important part of the main research question is the decision-making process, which also requires some elaboration. The word 'process' is broad and its boundaries are not instantly clear. In reality, the process is not linear but iterative and cyclical. At all stages of the policy cycle different stakeholders are involved that view the problem differently. The problem and the solution cannot be viewed independently, but must be viewed through a holistic lens by considering the decision-making process as a continuous cycle.

1.4.2. Sub-questions

The main research question can be split into four sub-questions that also relate to the research goals.

SQ1 What perspectives on regret in decision-making have previously been identified in academic literature and other relevant sources?
SQ2 What perspectives on no-regret measures can be identified in actors involved in strategic decision-making of policies for water management?
SQ3 How can the identified perspectives influence the decision-making process and solution space?
SQ4 How can actors account for these perspectives in future decision-making processes?

Sub-question 1 will be explored in a literature review. Some examples of known perspectives identified in various areas of social science have already been mentioned, and will be elaborated on in the next chapter. The goal of this sub-question is two create a theoretical framework that can be used to identify and interpret perspectives on no-regret measures. The identification and interpretation of perspectives on no-regret measures are the main goal of sub-question 2, and will be researched using Q-methodology. This method is a quantitative approach to studying qualitative (subjective) factors, where data is gathered through the systematic sorting of statements derived from literature. This will be further explained in chapter 3. The theoretical framework constructed in sub-question 1 will be used both to guide and structure the statements, and to interpret its results. Sub-question 3 focuses on the implications of the findings of the first two sub-questions. How can perspectives influence decision-making? By discussing areas of agreement and conflict between the identified perspective, The last step will be to provide recommendations to account for the influence of these perspectives. The goal of the recommendations is to advise on how the perspectives can be managed within the policy cycle. The starting point here is that policies should be both technically (changing physical environment) and socially (changing social environment) robust. Managing the different perspectives can help balancing both goals. This fourth sub-question also involves describing findings that are worth exploring more profoundly.

1.5. Structure

The next chapters of this report contain the theoretical context, methodology, results, discussion, conclusions and implications of this research. The theoretical context is described in chapter 2. The main purpose of this chapter is to build a theoretical framework that can be used to both identify and describe perspectives on no-regret measures.This tool will be used in two ways throughout this research. Q-methodology starts with a description of the concourse, a collection of ideas and statements that describe what is being said about a certain topic. The theoretical framework was used to structure and

draft the statements, resulting in a set of 29 statements that were presented to and ranked by strategically selected participants. Second, the theoretical framework will be used to interpret the factors extracted from the dataset and translate them into perspectives on no-regret measures.

Chapter 3 describes the methodology. It starts with an explanation of Q-methodology and why this method is suitable for these research purposes, followed by a description of how Q-methodology was applied in this research. This includes how the statements and participants were selected, how the sorting is organised and what data analysis techniques are used to identify perspectives.

The results of the Q-methodology research are presented in chapter 4. Three perspectives were identified through an analysis of the responses of 29 participants: technocratic design, adaptive egalitarian and minimalist innovation. This chapter contains the identified perspectives, the interpretation of these perspectives and a statistical analysis on the relevance of the results. In chapter 5 the identified perspectives are discussed along with all other relevant results of the entire research effort. The possible implications of the perspectives on the decision-making process will be discussed, as well as recommendations for actors to manage the different perspectives. The final section of this chapter will be devoted to discussing the limitations of this research. The main limitations are related to the scope of the research, which is large. This complicates describing precise implications and recommendations.

All aforementioned steps in the research process lead to conclusions that are discussed in chapter 6. These conclusions will be summarised by answering the research questions described in section 1.4. Any information that is relevant, but too big for the main text is added to the appendices. The relevant methodological information can be found in A, where all the statements and the details on the surveying method are listed. Appendix B contains the (raw) results from the Q-sorting.

2

Theoretical context

The purpose of this chapter it to establish the theoretical context necessary to identify perspectives on no-regret measures in integrated water management, and synthesise this into a theoretical framework. As has been argued in the previous chapter, a framework to analyse perspectives on no-regret measures should combine:

1. Theoretical insights on regret from a psychological angle
2. The use of regret in decision-making models
3. The role of perspectives in water management decision-making

These parts of are each discussed in one section. The outcomes are synthesised in the final section of this chapter. The purpose of the theoretical context itself has two components. First, it is necessary for methodological purposes when conducting Q-methodological research. This methodology is explained in more detail in 3, but some information is relevant here. The methodology revolves around a set of statements (Q-set) that represent all the different views that exist on one topic (the concourse). The theoretical context is necessary to establish the concourse, and structure the statements.

Second, the theoretical context will be used later to interpret the results. Factor analysis is used to find correlations between the ways participants have ranked the statements, resulting in a set of factors. These factors are purely statistical metrics that group the responses of individual participants based on correlations. The next step is to construct a narrative to translate these mathematical objects into real perspectives. The theoretical context is thus necessary to translate from statistics to perspectives. Context on the history and governance structure of water management in The Netherlands is furthermore necessary to discuss possible implications on the decision-making process.

It is important to note the different between the theoretical *context* and the theoretical *framework*. The theoretical context is defined as the collection existing research and information that is necessary to understand the context of water management in The Netherlands, and therefore also to understand the implications of perspectives. The theoretical framework is a synthesis of research on three topics: the psychology of regret, the role of regret in decision-making (models), and the role of perspectives in decision-making. Together, they will provide a theoretical basis for the identification and description of perspectives on no-regret measures. This distinction has been visually represented in 2.1

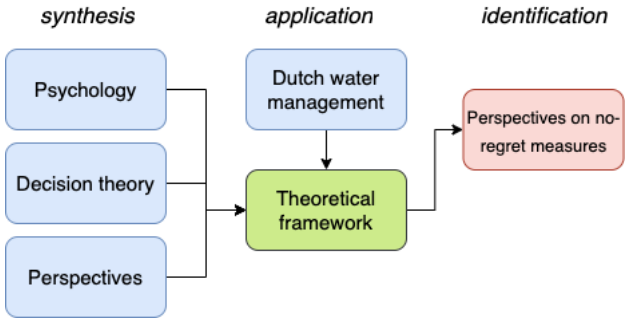

Figure 2.1: The role of the theoretical framework within the research process

2.1. A brief history of regret

This section provides an overview of the relevant knowledge on regret that has been produced so far. The purpose of this section is to create a better understanding of regret.

2.1.1. What is regret?

Regret has been defined as *"a negative emotion predicated on an upward, self-focused, counterfactual inference"* (Roese & Summerville, 2005). Counterfactual thinking is a cognitive process in which individuals imagine alternative outcomes or scenarios that differ from reality. It involves mentally revisiting past events and considering what-if scenarios. This type of thinking allows individuals to reflect on the past, evaluate their own actions and decisions, and explore how different choices could have led to different outcomes. Counterfactual thinking can have both positive and negative effects, influencing emotions, decision-making, and the interpretation of events (Roese, 1997).

In other words, we experience regret when realising or imagining that our current situation would have been better if we had acted differently in the past (Zeelenberg, 1999). Another definition is "an aversive emotional state elicited by a discrepancy in the outcome values of chosen versus unchosen actions" (Zeelenberg & Pieters, 2007). Both definitions imply the same: when decisions are made under uncertainty, regret is experienced if the choice made turns out not to be the best one. Regret can affect people *before* and *after* a decision. Ex-post, it can lead people to try to undo the effects of their regretted choice, after the decision has been made. Second, it can affect people's choices before the decision is made, when they anticipate the regret they may feel later (Medvec et al., 1995).

2.1.2. What causes regret?

Regret has been linked to several cognitive biases. The most important biases, effects and paradoxes are discussed in the following paragraphs. In most cases, they are seen as biases or as 'irrational', because the decisions seem not to be made based om maximising expected utility. According to Expected Utility Theory, an individual's utility (or happiness) depends on the outcomes of their actions. An outcome's utility is calculated by multiplying its value (the benefits or costs) by the probability of its occurrence. For example, if an individual faces a decision between two options, A and B, with potential outcomes of X and Y, they would choose the option that provides the highest expected utility. The expected utility of each option can be calculated by summing the utility of each potential outcome, weighted by its probability (Hansson, 1994). However, early on several behaviours were found that were inconsistent with this theory.

Allais' paradox One example that contradicts the principles of Expected Utility Theory is Allais' paradox (Allais, 1953). This paradox involves a choice between two lotteries with different probabilities and

payoffs. Despite the difference in probabilities and outcomes, individuals tend to exhibit inconsistent preferences when faced with different formulations of the same problem. Allais' paradox highlights the limitations of the expected utility framework in capturing individuals' actual preferences and decision-making behaviour under risk and uncertainty. Tversky and Slovic (1974) have shown that experts in decision theory consistently show Allaisian behaviour, even though (being experts in decision theory), they should know better. Ellsberg's Paradox (Ellsberg, 1961) is also a phenomenon in that challenges Expected Utility Theory. It involves two scenarios with uncertain probabilities, and many people tend to choose the "known" option even when it offers a lower expected utility. The paradox suggests that individuals are averse to ambiguity and prefer options with known probabilities, and has been influential in the development of alternative theories of decision-making.

Prospect theory Kahnneman and Tversky (1979) have incorporated the 'irrationalities' that challenged expected utility theory into a new model. Prospect theory accounts for two important decision-making mechanisms related to regret: the certainty effect, and the isolation effect. According to the certainty effect, people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty. This tendency contributes to risk aversion in choices involving sure gains and to risk seeking in choices involving sure losses. A simple example of the certainty effect can be seen in a lottery scenario. Imagine you are given a choice between two options:

Option A: You receive $50 for certain.
Option B: You have a 50% chance to win $150 and a 50% chance to win nothing.

According to prospect theory, most people would exhibit a preference for Option A, even though Option B has the potential for a higher expected value. This preference for the certain outcome is driven by the psychological aversion to uncertainty and the desire to avoid potential losses. The desire to avoid potential losses, also known as loss aversion, has also been described in an updated version of prospect theory (Tversky & Kahneman, 1992). Loss aversion refers to the tendency to place greater weight on losses than on gains of equal magnitude. In the context of regret, loss aversion can lead individuals to avoid taking risks or making decisions that could result in significant losses, even if the potential gains outweigh the potential losses.

Actions vs. Inactions Regret fundamentally is about making choices under uncertainty. Carmon et al. (2003) found that the mere act of choosing already produces a sense of immediate post-decisional regret that is accompanied by an increased attractiveness of the non-chosen alternative. The grass is always greener on the other side. However, not making a choice is also a choice. While both are essentially choices, there is a substantial difference between choosing to act (action/commission) and choosing not to act (inaction/omission). Perhaps the most famous of the early regret studies was published by Kahneman and Tversky (1982). They asked students to assess the regret that would be felt by two investors, both of whom lose $1,200, one as a result of buying a particular stock, the other as a result of holding on to the same stock. A stunning 92% of the respondents guessed that the active buyer would feel more regret than the passive holder. A bad outcome resulting from action seemed to be more regrettable than the same bad outcome when it was the result of inaction. However, exactly the opposite pattern was found in a series of studies by Medvec et al. (1995) when studying retrospective regrets. People asked to recall real-life regrets tended to recall omissions[1] more frequently than commissions, the opportunities they missed rather than the leaps of faith they had taken. The authors explained this by arguing that regret follows a characteristic temporal pattern: regrettable actions hurt more than omissions in the short run, but when looking back, people experience more regret over paths not taken.

Anticipated regret can make us postpone important decisions, or not make them at all. Omission bias is a cognitive bias where people tend to judge harmful actions as worse than equally harmful

[1] omissions are choices not made, also referred as inactions; they are the opposite of commissions or actions

inactions or omissions. In other words, people tend to view the consequences of not acting as less severe than the consequences of taking action, even if the outcomes are the same (Ritov & Baron, 1992). This is also closely related to status-quo bias. The term status-quo bias has been used to describe people's tendency towards "doing nothing or maintaining one's current or previous decision" (Samuelson & Zeckhauser, 1988). This statement implies two claims: the claim that people prefer to keep the current state of affairs, and the claim that people would prefer not to take action that will change this state. When considering the question of how regret influences decision-making, it is clear that regret can lead to postponing difficult choices or can even lead to complete inaction. Ironically, we have also seen that people experience more intense regret over lost opportunities.

Decision justification Regret can stem from decisions to act and from decisions not to act: the more justifiable the decision, the less regret. The previous discussion on action vs. inaction suggests that it is not only the outcome that plays a role in regret, but that the quality of the decision process is also relevant. Sugden (1985) explains this very well with a simple example: *Imagine leaving a party slightly intoxicated. You decide to drive home and do so safely. The morning after, however, you might regret your decision when reflecting on what might have occurred.* This illustrates that a decision process that is 'bad' in comparison to an alternative decision process can be regretted even if the decision outcomes are positive. Pieters and Zeelenberg (2005) conducted a series of experiments, exploring this notion. More precisely, the authors examined the regret that people experienced when they behave in ways not originally intended. These studies show that intention-behaviour inconsistency, which is often hard to justify, amplifies regret independent of the outcomes of the behaviour. The results of these studies clearly indicated that a bad decision process impacted on regret, independent of the quality of the decision outcomes. The crucial determining factor was indeed whether the decision process was judged to be sensible and therefore justifiable.

Sunk costs Regret can also lead decision-makers to become overly attached to a project, even when it is clear that it is no longer useful or profitable. This is known as the sunk cost fallacy, where decision-makers continue to invest in a project because of the resources they have already put into it, even if it no longer makes sense from a financial or strategic perspective (Arkes & Blumer, 1985). Sunk costs are also related to the disposition effect: a behavioural bias observed in financial decision-making. According to the disposition effect, investors tend to hold onto losing assets too long and sell winning assets too soon (Weber & Camerer, 1998). Some evidence indicates that the sunk cost fallacy might be age-related. In a study with subjects aged between 18 and 91, older adults were found to be less likely than younger adults to commit the sunk-cost fallacy (Strough et al., 2008). To further complicate things, Yoder et al. (2014) have shown that sunk-cost bias is culturally influenced. When presented with a set of decision scenarios, American subjects made more 'sunk cost errors' than Indian subjects.

Uncertainty Regret is by definition fundamentally linked to uncertainty. If the future was completely predictable, there would be no regret. Uncertainty itself however is also uncertain. It has been said for a long time that probabilities are subjective. Frank Ramsey Ramsey, 1926 incorporated the notion of subjective probabilities and subjective utilities into expected utility theory, which led to Bayesian decision theory. Subjective utilities are easy to imagine in water management. As mentioned before in section 1.1.1, water represents different values (safety, economic, ecologic) and thus also different utilities. Subjective probabilities are related to several cognitive biases. The pseudo-certainty effect describes the tendency to make risk-averse behaviour if the expected outcome is positive, but risk-seeking behaviour if the expected outcome is negative (Hardman, 2009). The ambiguity effect describes the tendency to avoid options for which the probability of a favourable outcome is unknown (Baron, 2000). Availability bias is a cognitive bias in which individuals tend to overestimate the likelihood of events based on how easily they can recall or remember examples or instances of those events. It occurs because our judgements and perceptions are heavily influenced by the vividness, salience, or recentness of information (Tversky & Kahneman, 1973). Anchoring bias explains how individuals rely too heavily on the first piece of information presented to them (the "anchor") when making decisions (Tversky & Kahneman, 1974). The subjectivity of probabilities also exists ex-post. This is commonly referred to

as hindsight bias, which is the tendency to overestimate the predictability of past events. In the context of regret, hindsight bias can lead individuals to believe that they should have known better or made a different decision, even when the outcome was not foreseeable at the time Fischhoff, 2003.

The rationality of regret One important question arises when discussing all the cognitive biases associated with regret: is regret rational? The short answer is 'yes', as argued by Bourgeois-Gironde (2010). Regret can be defined as a rational emotion because it helps to optimise decision behaviour. The presence of regret seems correlated with improved decision-making. This notion is also shared by Zeelenberg and Pieters (2007): regret is a cognitively based emotion that motivates one to think about how the negative event could have happened and how one could change it, or how one could prevent its future occurrence. Landman et al. (1995) reported that regret is associated with emotional distress in the short run, but with motivational benefits in the long run. Gilbert et al. (2004) however suggests that people are less susceptible to regret than they imagine, and that decision makers who pay to avoid future regrets may be buying emotional insurance that they do not actually need.

2.1.3. A theory of regret regulation

The most complete synthesis of the psychological research done on regret in the past decades is provided by Pieters and Zeelenberg (2007). In their paper, the authors summarise their theory of regret regulation in a series of propositions. In this context, regret regulation refers to the process of minimising regret, before or after the decision. Regulating regret ex-ante refers to how anticipated regret influences current decision-making. Regulating regret ex-post on the refers to coping mechanisms individuals tend to use to deal with the regret they feel.

- Proposition 1: Regret is an aversive, cognitive emotion that people are motivated to regulate in order to maximise outcomes in the short term and learn maximising them in the long run.
- Proposition 2: Regret is a comparison-based emotion of self-blame, experienced when people realise or imagine that their present situation would have been better had they decided differently in the past.
- Proposition 3: Regret is distinct from related other specific emotions such as anger, disappointment, envy, guilt, sadness and shame, and from general negative affect on the basis of its appraisals, experiential content and behavioural consequences.
- Proposition 4: Individual differences in the tendency to experience regret are reliably related to the tendency to maximise and compare one's outcomes.
- Proposition 5: Regret can be experienced about past ("retrospective regret") and future ("anticipated or prospective regret") decisions.
- Proposition 6: Anticipated regret is experienced when decisions are difficult and important and when the decision maker expects to learn the outcomes of both the chosen and rejected options quickly.
- Proposition 7: Regret can stem from decisions to act and from decisions not to act: The more justifiable the decision, the less regret.
- Proposition 8: Regret can be experienced from the processes ("process regret") and decision outcomes ("outcome regret").
- Proposition 9: The intensity of regret is contingent on the ease of comparing actual with counterfactual decision processes and outcomes, and the importance, salience and reversibility of the discrepancy.
- Proposition 10: Regret aversion is distinct from risk aversion, and they jointly and independently influence behavioural decisions.
- Proposition 11: Regret regulation strategies are goal-, decision-, alternative, or feeling-focused and implemented based on their accessibility and their instrumentality to the current overarching goal.

2.1.4. Synthesis of psychological research

The psychological research on regret has revealed several important factors that influence how intensely regret is experienced by individuals. It is important to note that that these factors influence the experience of regret, but not determine it. The existing research show that these factors exist, but depend on too many external factors for them to be anywhere close to deterministic. It is also important to note that these factors do not operate independently, but together form a context that can explain a decision and why regret is felt over this decision. The factors can be summarised as follows:

- *Timing:* influences regret in two dimensions. Regret can be felt before or after the decision, and in both cases influences decision-making differently. Anticipated regret is furthermore felt more intensely if the decision-maker expects the outcome of the decision to be known soon. This can lead to inaction (omission bias). Meanwhile there is substantial evidence that inaction leads to more intense regret in the long run.
- *Uncertainty:* the root of all regret. Probabilities are subjective and often not agreed upon by decision-makers. The predictability of past events is furthermore often overestimated (hindsight bias).
- *Action / inaction:* anticipated regret can lead to inaction, but lost opportunities lead to more intense regret in the long run. The lost opportunity principle suggests that the potential costs and benefits should be incorporated into cost-benefit analysis.
- *Process / results:* Regret can be experienced from the processes (”process regret”) and decision outcomes (”outcome regret”). A ’bad’ outcome is less regrettable if the decision-making process was ’good’.

This list exemplifies the argument that these factors are independent nor deterministic. The factor of timing for example cannot be viewed independently from uncertainty and action/inaction. The quality of the decision process cannot be viewed independently from the choice to act or not to act.

2.2. Regret in decision-making models

Regret has been and still is being used in different ways in decision-making models. This section briefly explains the various uses of regret throughout the history of Decision Theory and decision-making models. As will become clear, regret has mostly been used as a performance indicator in models, based on a definition of optimality, which perforce is inherently subjective.

2.2.1. Origins: Wald and Savage

The Wald (1945) Maximin model and the Savage (1951) minimax regret approach are decision-making frameworks that address uncertainty and aim to minimise regret. Both models focus on the concept of regret, which represents the feeling of disappointment or dissatisfaction that arises when a decision leads to an outcome worse than the best alternative. The Wald Maximin model, also known as the maximin criterion, adopts a pessimistic approach. It assumes that decision-makers are risk-averse and seek to minimise the maximum potential loss or regret. The model identifies all possible decision alternatives, determines the worst possible outcome for each alternative, and selects the alternative with the best worst-case outcome. This model is applicable in fields such as finance, economics, and game theory, providing a conservative approach to decision-making when there is limited or no information about outcome probabilities. Savage’s minimax regret approach, also known as the regret criterion, focuses on minimising regret directly. It assumes that decision-makers are more concerned with avoiding regret for making sub-optimal choices than with maximising potential gains. The approach involves constructing a regret matrix that quantifies the difference in outcomes between each alternative and each possible state of nature. By calculating the maximum regret for each decision alternative and selecting the alternative with the minimum maximum regret, decision-makers aim to minimise potential regret.

This approach is widely used in decision theory, particularly in situations involving uncertainty, encouraging decision-makers to consider the potential consequences of their choices. Both approaches have scientific relevance in decision-making under uncertainty. They acknowledge the role of regret and provide practical tools for decision analysis. While the Wald Maximin model does not require knowledge of outcome probabilities, Savage's minimax regret approach incorporates probabilities in the construction of a regret matrix. The Wald Maximin model focuses on minimising the maximum potential loss or regret, while Savage's minimax regret approach directly minimises the maximum regret. The Hurwicz (1951) Optimism-Pessimism Rule combines elements from Wald's and Savage's decision theories. The Hurwicz rule integrates these concepts by encouraging individuals to explore both optimistic and pessimistic scenarios. By considering best-case and worst-case outcomes and their associated probabilities, individuals apply a form of minimax thinking to mitigate potential losses and maximise potential gains. This combined approach also acknowledges the importance of subjective probabilities in decision-making, as emphasised by Savage's theory. It prompts individuals to assess the likelihood of various outcomes and make informed judgements about potential risks and rewards.

2.2.2. Contemporary approaches

The use of (mathematical) decision-making models has increased significantly is the past decades, and technological advances have allowed us to build more complex models than Wald and Savage could in the 1950's. Many of those models however are built upon the same foundations: utility maximisation under uncertainty. Regret is therefore used as a performance indicator. The contemporary approaches discussed in this context have emerged from the paradigm of Decision-Making Under Deep Uncertainty (DMDU) (Marchau et al., 2019). The following sections discuss robust and adaptive decision-making approaches that fall under DMDU (Kwakkel et al., 2016). But first, it is necessary to understand the levels of uncertainty and what 'Deep Uncertainty' actually means.

Levels of uncertainty

Walker et al. (2012) provide a detailed overview of five distinct 'levels' of uncertainty. While all five levels are important, a distinction between 'regular' and 'deep' uncertainty suffices in this context.

Regular uncertainty In general, uncertainty can be defined as limited knowledge about future, past, or current events. With respect to policymaking, the extent of uncertainty clearly involves subjectivity, since it is related to the satisfaction with existing knowledge, which is coloured by the underlying values and perspectives of the policymaker and the various actors involved in the policymaking process, and the decision options available to them (Walker et al., 2012). Uncertainty is not simply the absence of knowledge. Funtowicz and Ravetz (1990) describe uncertainty as a situation of inadequate information, which can be of three sorts: inexactness, unreliability, and border with ignorance. However, uncertainty can prevail in situations in which ample information is available (Van Asselt & Rotmans, 2002). Furthermore, new information can either decrease or increase uncertainty. New knowledge on complex processes may reveal the presence of uncertainties that were previously unknown or were understated. In this way, more knowledge illuminates that one's understanding is more limited or that the processes are more complex than previously thought (Sluijs, 1997).

Deep uncertainty Lempert (2003) have defined deep uncertainty as the condition in which analysts do not know or the parties to a decision cannot agree upon:

1. the appropriate models to describe interactions among a system's variables,
2. the probability distributions to represent uncertainty about key parameters in the models, and/or
3. how to value the desirability of alternative outcomes.

Several authors have already established that decisions in water management and flood risk management are made under deep uncertainty (Kwakkel et al., 2016). The discussion on the role of uncertainty on regret (see section 2.1.2) has shown that the individual perception of uncertainties and probabilities can be subjective and biased.

Robust Decision-making

Robust Decision-Making (RDM) suggests an iterative approach to planning in which candidate strategies are tested across a very large number of scenarios and, in light of insights gained from this model-based scenario analysis, candidate strategies can be improved (Kwakkel et al., 2016). The goal is to design a robust strategy that produces positive results across a wide range of scenarios. The RDM method can be summarised in a number of steps. Lempert (2003) explains how RDM meets its goals through multiple iterations, as humans and computers alternatively test each other's conclusions about futures and strategies. Four key elements determine these interactions:

- Consider a multiplicity of plausible futures. The ensemble of futures should be as diverse as possible to adequately stress test proposed policies. The ensemble can also facilitate group processes by including futures that cor- respond to different groups' worldviews.
- Seek robust, rather than optimal strategies. Robust strategies perform well, compared to the alternatives, over a wide range of plausible futures.
- Employ adaptive strategies to achieve robustness. Adaptive strategies are designed to evolve over time in response to new information. Generally, such strategies reflect decision-making rules and in practice are often organised around near-term actions, signposts to monitor, and contingency actions to take in response to those signposts.
- Use the computer to facilitate human deliberation over explorations, options, and trade-offs, not as a device for recommending a particular ordering of strategies.

A crucial step in RDM is is scenario discovery(Bryant & Lempert, 2010). Using statistical machine learning algorithms, the results of the exploratory modelling are analysed to reveal the conditions under which strategies perform poorly. These conditions reveal vulnerabilities of the strategies, in light of which they can be modified. The fourth step is trade-off analysis, in which the performance of the different strategies are compared across the different outcome indicators, thus providing an additional source of information that can be used in redesigning strategies. The steps can be iterated until a robust strategy emerges. RDM has been applied to strategic planning problems various fields, including climate change (Lempert et al., 1996)), flood risk management (Fischbach, 2010), sea level rise (Sriver et al., 2018), and water resources management (Groves, 2005)

However, RDM still builds on one key assumption: the definition of optimality. Giuliani and Castelletti (2016) found that the subjectivity of the optimality definition is of significant influence to the model results. The concept of robustness is neither unique nor static. Multiple robustness metrics, such as maximin, minimax regret and optimism-pessimism[2], have been used in the RDM field, reflecting diverse optimistic/pessimistic attitudes by the decision-maker and/or modeller. Furthermore, these attitudes can evolve in time as a response to sequences events, which can induce dynamic changes in the robustness metrics. They therefore recommend that the definition of robustness should be included as an uncertain parameter in climate change impact assessment studies.

Adaptive planning

Marchau et al. (2019) summarises the core concepts of adaptive planning. Adaptive planning based in part on concepts related to Assumption-Based Planning (ABP) (Dewar et al., 1993). In ABP, an assumption is an assertion about some characteristic of the world that underlies a plan. A critical assumption is an one whose failure would mean that the plan would not be successful. An assumption

[2] see: section 2.2.1

is vulnerable if plausible events could cause it to fail within the expected lifetime of the plan. In short, adaptive planning involves specifying goals and objectives, developing an initial plan to meet these goals and objectives, identifying the vulnerabilities of the plan, adding to the plan a set of initial actions to be taken immediately to protect it against some of these vulnerabilities, and establishing signposts to monitor the remaining uncertain vulnerabilities. The elements of flexibility, adaptability, and learning enable the plan to adjust to new information as it becomes available and therefore to deal with deep uncertainty. The Dynamic Adaptive Policy Pathways (DAPP) (Haasnoot et al., 2013) approach is based on the concept that, in light of deep uncertainties about the future, one needs to design dynamic adaptive plans. Such plans contain a strategic vision of the future, commit to short-term actions, and establish a framework to guide future actions. It is a fusion of adaptive policymaking and adaptation tipping points (Haasnoot et al., 2012; Kwadijk et al., 2010.

No-regret

No-regret measures are most commonly defined as measures that yield benefits in all possible future scenarios. Hallegatte (2009) discusses several practices to adapt to global climate change:

- No-regret strategies
- Reversible strategies
- Safety margins strategies
- Soft strategies
- Strategies that reduce decision-making time horizons

In a later article Hallegatte et al. (2012) added that no-regret strategies yield benefits even in forecasts reveal wrong, and no-regret measures therefore should also be beneficial in the absence of climate change.

Hourcade and Chapuis (1995) discussed no-regret potentials and technical innovation, arguing that a 'sequential approach' is necessary. Most notably, they stress that decision-making under deep uncertainty forces us to clarify the links between the efficiency principle and precautionary principle. This statement implies that both principles are inherently conflicting, and that several the magnitude of the risks, the level of uncertainty and the urgency of the problem determine what approach is most suited for a specific problem. Their main argument is that only a 'sequential approach' can create a synergy between the precautionary and efficiency principles. They argue that no-regret measures can be implemented on the short-term to 'take care of inertia constraints'. In other words, no-regret measures should be relatively small measures with no externalities and risks, that can be implemented on the short term to generate social support for a larger strategy.

Van Rhee (2012) defined four recommendations for adaptive delta management in the Netherlands:

- Aim for synergies with goals and development initiatives by other public and private parties, which reduces the likelihood of regret because of the other benefits achieved.
- Seek and value flexibility in individual measures and comprehensive strategies in order to allow for speeding up or slowing down and to prevent regret of under-performance or over-investment and related to this.
- Search for adaptation pathways with successive decision points in time rather than aim for a final situation at some point in the future ('blue-print planning') to allow for adaptation over time.
- Short-term decisions should contribute to long-term objectives.

These recommendations have some notable implications. The first statement implies that the likelihood of regret can be reduced through synergies with other goals, because other benefits are achieved. The second statement adds a new dimension to adaptivity: the possibility to easily speed up or slow

down the implementation of individual measures. This also relates to the previously mentioned discussions by Hallegatte (2009) and Hourcade and Chapuis (1995). They all imply that no-regret measures can be implemented on a short-term basis and should be flexible and reversible. Another important implication of the third statement is over-investment as a source of regret. This poses new questions: what investments are valuable? At what point does a non-zero (flood) risk no longer require any investment? How do investments in qualitative factors relate to this? The third statement implies adaptivity should be valued on a long-term basis instead of a long-term rigid plan, which seems somewhat contradicting compared to the final statement.

A recent report by Deltares has investigated the question of what no-regret means in practice (de Jonge et al., 2022), the main research question being: *What leads to regret in practice and how can it be prevented?* By interviewing six experienced professionals in water governance, several important insights were summarised that provide answers to this question. The main identified causes for regret were:

1. a too narrow substantive scope of the project, i.e. designing mono-functional solutions
2. insufficient attention to maintenance costs and long-term social costs and consequences, including ecological damage
3. insufficient attention to spatial quality itself and the spatial perception
4. insufficient involvement of directly concerned parties

This report has been used to write most of the statements that were presented to experts in the Q-methodological study, described in the next chapter.

2.3. Integrated water management in The Netherlands

The purpose of this section is to discuss the relevant context that defines integrated water management in The Netherlands. This is done by providing an overview of the historical developments and governance structure, followed by a review of the current situation. The current situation the describes the ongoing challenges, projects and developments at the time the research was conducted.

2.3.1. History

Historical context is relevant for two reasons. First, it explains how the current state of integrated water management came to be. Several important historical events, most notably floods, led to changes in policy directions. The second reason is that large projects, like the Delta Works, can take several decades to complete. This means that decisions made more that ten years ago can still be at the beginning of the implementation phase right now. Historical context helps us to understand the motivation behind those decisions. Four different historical periods can be distinguished in Dutch water management, as summarised by Lintsen (2002). We will only discuss the last two periods as they are the most relevant for this research.

1. Decentralised management (up to 1798)
2. The Autocratic-Traditional period (1798-1850)
3. The Democratic-Mechanised period (1850-1930)
4. The Technocratic-Scientific period (1930-1995)
5. The Integrated-participatory period (1995-present)

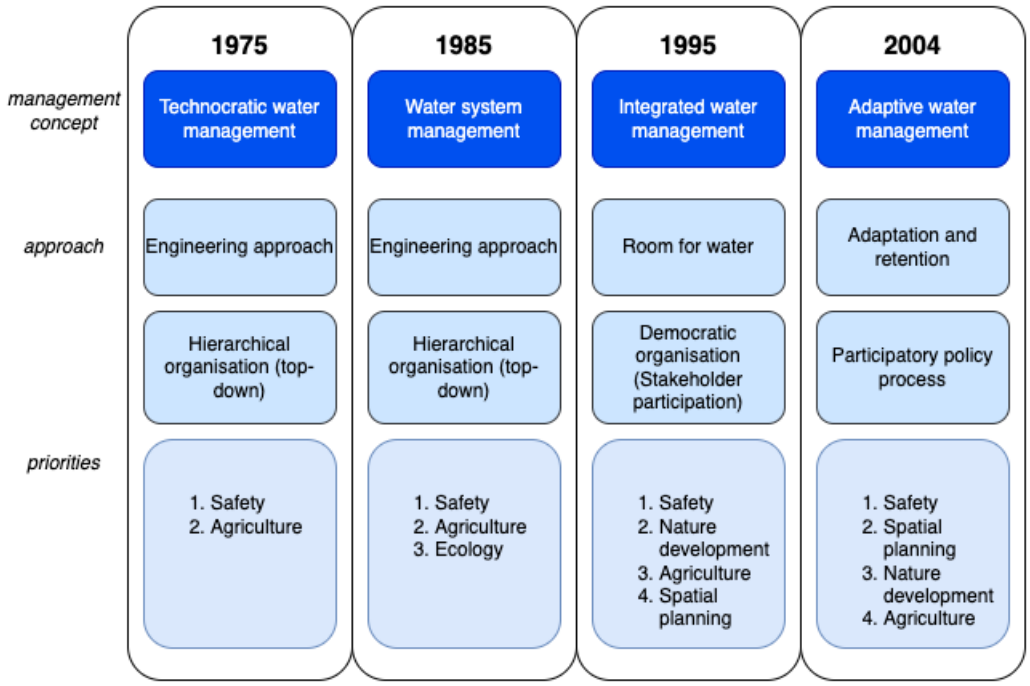

Figure 2.2: Developments in system states in Dutch water management. Adapted from Van der Brugge et al. (2005)

The Technocratic-Scientific period (1930-1995)

Four important developments took place in this period: reorganisation and growth, integrated water management, social dynamics and criticism, and the transformation of water boards. In the 1930s, the Rijkswaterstaat underwent reorganisation, establishing specialised departments for bridges, sluices, and different reaches of rivers, leading to improved functionality and increased political trust. During the depression years, it invested heavily in infrastructure projects, making it the largest public employer in the country, and adopted new techniques to benefit from scientific advancements. The Rijkswaterstaat developed an approach in the 1930s that viewed the big rivers, canal network, IJsselmeer, and sea inlets as part of a single large-scale system to regulate Dutch domestic water supplies. It became the ruler of the delta, effectively predicting the disastrous flood of 1953. In the 1950s and 1960s, the Rijkswaterstaat gained significant control over water management, building projects according to its plans. However, it faced opposition and criticism from environmentalists and intellectuals in the 1970s due to concerns about landscape destruction, environmental pollution, and the agency's perceived authoritarian approach. The flood of 1953 highlighted the shortcomings of several small water boards, leading to a transformation in the 1970s. The number of water boards was reduced, and their responsibilities extended to include tasks related to environmental research, nature, landscape, and water purity.

The integrated-participatory period (1995-present)

A transition took place, fuelled by a growing environmental awareness and awareness for man-made global climate change. It concerns a gradual transition and not a specific turning point, as suggested by the 'end' of the Technocratic-Scientific period by Lintsen (2002) suggests. Van der Brugge et al. (2005) described this transition in detail, which took place between 1975 and 2004. It can be summarised into a scheme of developments at various levels (macro, meso, micro) that influenced the system state of Dutch water management. The system states are described in terms of management concept, approach and priorities. These are shown in figure 2.2. Important events om a macro/supranational scale that fuelled the transition were growing environmental awareness, economic growth, limits to growth (Club of Rome) and the Rio (1992) & Johannesburg (2002) summits. On a national scale,

the 2nd, 3rd and 4th National Policy Memorandum Water Management were highly influential. Protests against water management approach, floods in 1993 & 1995, and the re-organisation of Rijkswaterstaat & regional water boards were of significant influence. A more detailed description of theses events can be found in Van der Brugge et al. (2005).

The point of this history lesson is to show that a dominant perspective exists in water management and has changed throughout history due to political, organisational, cultural, scientific, economical, military, even geopolitical influences. It also illustrates the influence the dominant perspective has on decision-making. This context is necessary to understand the perspectives that have been identified in Dutch Water Management, that will be discussed in section 2.4

2.3.2. Governance structure

The institutional framework for water management in the Netherlands is designed to ensure effective governance and coordination among different levels of government and stakeholders involved in managing water resources. The framework involves various institutions and entities responsible for policy development, planning, implementation, and maintenance of water systems. At the national level, the Ministry of Infrastructure and Water Management (previously known as the Ministry of Transport, Public Works, and Water Management) plays a central role in formulating water policies, setting strategic goals, and coordinating water-related activities (Lintsen, 2002). The ministry oversees the implementation of national policies and provides guidance to regional and local authorities. One key feature of the Dutch water management framework is the presence of water boards, known as ”Waterschappen” (Toonen, 1993). Water boards are the oldest democratic institutions in The Netherlands. These are autonomous public entities responsible for managing water systems at the regional level. There are 21 water boards in the Netherlands, each covering a specific geographic area. Water boards are governed by elected representatives, known as ”dijkgraven” and ”hoogheemraden,” who oversee water management operations, flood protection measures, maintenance of dikes and canals, and water quality management. The water boards levy taxes, known as water taxes, to fund their activities. In addition to national and regional institutions, the framework involves collaboration with local authorities, including municipalities and provincial governments. Local governments have a role in land-use planning, urban development, and ensuring compliance with water management regulations within their jurisdictions.

2.4. Perspectives

Perspectives can be defined as perceptual screens through which people interpret the world (the world view) and which guides them in acting (the management style) Van Asselt, 2000. We define a Perspective as a consistent and coherent description of how the world functions and how policy should be carried out. In this definition, a Perspective has two dimensions: a World View and a Management Style. The World View is a coherent description of how (one believes) the world functions. The Management Style is a coherent set of preferred policy options, based on one’s understanding of how the world functions. Several methods have been developed to empirically identify perspectives. Max Weber for instance defined several ’styles of life’, each having a particular world view and certain moral values. He identified three ’pure’ styles: traditional, charismatic and legal domination. In the traditional style, people put a high value on what had always existed. In the charismatic style, people value leadership. In legal domination, rationality is valued the most (Joosse, 2014). Another example is the 6D model, developed by Hofstede (2011). It is a framework that aims to understand and compare cultural differences across countries based on six dimensions. These dimensions are:

- Power Distance: Measures the extent to which less powerful members of a society accept and expect unequal distribution of power.
- Individualism vs. Collectivism:Reflects the degree to which individuals prioritise their personal goals and interests over those of the group or community.
- Masculinity vs. Femininity: Examines the distribution of gender roles in society, with masculin-

ity emphasising assertiveness and competitiveness, and femininity emphasising nurturing and cooperation.
- Uncertainty Avoidance: Reflects the level of comfort or anxiety individuals have towards ambiguity, uncertainty, and risk.
- Long-Term Orientation vs. Short-Term Orientation: Focuses on the extent to which a society values future-oriented behaviours, such as persistence and thrift, or prefers immediate gratification.
- Indulgence vs. Restraint: Explores the degree to which individuals indulge in gratifying their desires and impulses or exercise self-control and restraint.

The Perspectives Method is an analytical framework derived from Cultural Theory (Douglas, 1970) that explores how individuals and groups perceive and interpret risks and uncertainties. It suggests that people have distinct worldviews or perspectives that shape their attitudes towards risk. The method helps understand how different perspectives influence risk perception, decision-making, and policy preferences. It provides insights into the diversity of values and beliefs that underlie societal debates on risk and helps facilitate dialogue and negotiation among stakeholders with contrasting perspectives. Douglas (1970) and later Thompson et al. (1990) defined four perspectives that include individualists, hierarchists, egalitarians, and fatalists. This typology has been used to analyse different views on religion, nature and resources, uncertainty and climate change (Offermans, 2010). It has also been used to interpret and classify perspectives on water (Offermans, 2016). Offermans (2010) studied the social robustness of water management policies in The Netherlands, and contributed to the application of cultural theory to integrated water management. Based on previous work by Hoekstra et al. (1998) and Van Asselt et al. (2001). Three active, stereotypical perspectives were distinguished:

- the Hierarchist
- the Egalitarian
- the Individualist

Hierarchists believe in controlling water and nature, high government responsibilities, the importance of research and expert knowledge. Water is mainly seen as a threat to human safety. A sustainable water system highlights safety and flood control and leaves space for some economic and natural development. As a consequence, preferred water policy options are: building dikes, levelling up or widening dikes, and channelling. In the Hierarchical perspective, people are sinful by nature. However, people can be controlled (and educated) by a proper government and institutions. Regulation, management and control must prevent large problems. This management style can be characterised by an attitude of accepting some risks. In this perspective, nature is robust within certain limits: nature is able to overcome small disturbances. However, crossing certain limits causes serious trouble for the way in which nature functions. The hierarchical perspective emphasises the relation between humans and nature where the mutual dependence and balance between both parties is important. In this perspective, an attempt is made to guarantee this balance.

Egalitarians on the other hand, prioritise ecological recovery and natural development. They urge for more space for nature, water and natural developments. Humans went too far in controlling nature, or even thinking they are able to control. They call for participatory decision making processes with a more equal voice for everyone. Also the needs of animals and plants should be seriously considered. As a consequence, preferred water policy options are space for the river, decreasing human demands, relocation at higher areas, and precautionary actions. In the Egalitarian perspective, it is assumed that people are, in principal, good, but that they can be influenced easily. These might be negative influences but humans can be guided positively by means of intimate relationships with other people and nature. Personal development can be obtained by spiritual growth rather than by consumption of goods. The Egalitarian world view implies an attitude of risk avoidance. The management style belonging to this can, therefore, be characterised as being a preventative strategy. The Egalitarian perspective advocates drastic and structural social, cultural and institutional changes in the current

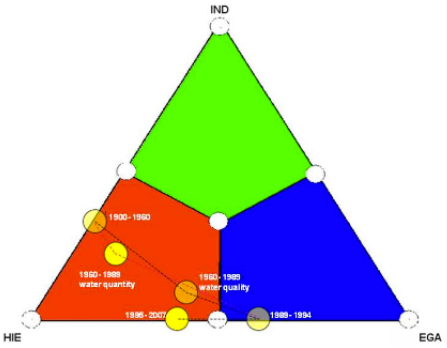

Figure 2.3: Dominant perspectives in water management policies. Source: Offermans (2010)

capitalistic economic system. Nature is considered extremely vulnerable and small disturbances can have catastrophic consequences. Human activities which affect the natural environment must therefore be avoided.

Individualists adhere to a more optimistic point of view. They do not see water as being a threat; on the opposite: water offers great opportunities in terms of economy, images, creativity, self development and recreation. They claim for an adaptation approach, great trust in technology and a liberal market. On correspondence with their beliefs, their preferred water management policies focus on innovative projects, like amphibian living, living on water, and building off shore-islands. In the Individualistic perspective, human nature is egocentric and based on personal gains. In this perspective, people are considered as rational, self-assured actors trying to satisfy their material needs. Changes and uncertainties are interpreted as challenges and can, in principle, be solved. This perspective is characterised by a large belief in market mechanisms and technology. The management style can be characterised as being adaptive. Nature is assumed to be extremely robust and is able to survive a few disturbances. Anthropogenic influence, even if large, results in mild and harmless disruption. In this perspective people are considered the centre of the world and natural resources are at the service of people and can be exploited.

Offermans (2010) applied this framework to identify the underlying dominant perspectives in water management in the Netherlands between 1900 and 1997. The most dominant perspectives was the Hierarchist perspective, with a shift to the egalitarian perspective between 1989 and 1994. These findings are visually represented in figure 2.3. This observation is consistent with those of Van der Brugge et al. (2005), who identified a transition towards a more integrated and participatory 'style' of water management.

2.5. Theoretical framework

The findings and discussions in this chapter lead tot the conclusion that describing regret is complex and ambivalent. Therefore, to identify and describe perspectives on no-regret measures made under deep uncertainty, one requires a theoretical framework that synthesises:

- Psychological theory
- Decision theory
- Relevant contextual factors in water management
- Perspectives - Cultural theory

...into one framework that explains relevant themes/choices/trade-offs, preferred policies and perspectives on no-regret measures in integrated water management. The framework is presented below:

Theme	**Description**
Uncertainty	Perception of uncertainty and risk
Timing	Perceptions and preferences for long-term and short-term planning
Qualitative	Perceptions on qualitative factors
Adaptivity	Perceptions on adaptivity, flexibility and path-dependency
Process	Perceptions on the relationship between process and results

3

Methodology

The methodology used to study perspectives on no-regret measures in water management is described in this chapter. The theoretical context drafted in the previous chapter has revealed several important themes, ambiguities, and contradictions that prevail in various perceptions of regret, and therefore also on what constitutes a no-regret measure. This chapter describes how Q-methodology is applied to study subjectivity and identify perspectives. This chapter starts with relevant background information on Q-methodology, and why it is an appropriate method for the research goals described in section 1.2. Q-methodology is performed in six distinct steps, first mentioned in 3.1. The sections hereafter follow this structure, where each section describes how every step of Q-methodology has been implemented to study perspectives on no-regret measures.

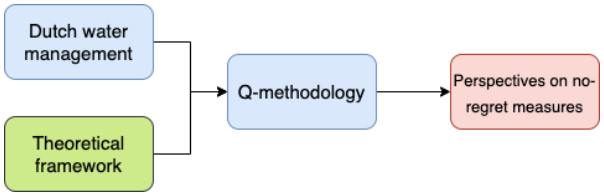

Figure 3.1: The role of Q-methodology within the research process

3.1. Explaining Q-methodology

Q-methodology is a research methodology developed by psychologist William Stephenson in the 1930's(Stephenson, 1935). It combines qualitative and quantitative techniques to study subjective opinions or viewpoints, and has been used in a variety of fields, including psychology, sociology and political science (Minkman & Molenveld, 2020). It is a method that can find shared perspectives by correlating individuals instead of variables. Correlations between individuals do actually provide an image of the patterns of attitudes (perspectives) of subjects. This chapter focuses on *how* the methodology has been applied. The majority of the theoretical background on Q-methodology and how it should be implemented derived from Stenner and Watts (2012) and Brown (1980). These are excellent recommendations for anyone that desires a deeper understanding of the methodology.

3.1.1. The Q-dictionary

All important definitions that can be viewed as Q-methodology 'jargon' have been summarised in this section, based on the definitions provided by Stenner and Watts (2012).

- Concourse: the collection of statements, ideas and concepts about a certain topic from the observed populations. In this case, everything that has been said about no-regret measures in water management.
- Q-set: the concourse summarised and synthesised into a finite set of statements
- P-set: a strategically selected group of individuals that represent a specific group, in this case actors involved in water management decision-making
- Q-sorting: the process of sorting and ranking the statements from the Q-set, based on a guiding question into a grid
- Q-sort(s): The Q-set as ranked by one participant (Q-sort), or the collection of all rankings by all participants (Q-sorts)
- Factor: identifies a group of persons who have rank ordered the provided items an a similar fashion and thus share a similar perspective. They are extracted through factor analysis, which is based on correlations between Q-sorts.
- Perspective: a set of interconnected beliefs (arguments, attitudes, emotions) that enable individuals to give meaning to reality. In this case, the set of interconnected beliefs that influence how individuals view no-regret measures.

3.1.2. Theoretical foundations of Q-methodology

Q-methodology combines qualitative and quantitative approaches to study individual subjective views and capture individual perspectives on a given topic. While it is primarily a qualitative research method, it incorporates statistical techniques to analyse and interpret subjective data (Stenner & Watts, 2012). The methodology is thus built upon theoretical and mathematical foundations, both of which will be discussed in the following two sections.

Social sciences

Brown (1980) thoroughly explains the theoretical foundations of Q-methodology. This sections provides a short summary. The theoretical foundation of Q-methodology lies in the fields of psychology and phenomenology. It draws on the assumption that individuals hold unique subjective viewpoints that are shaped by their experiences, beliefs, and values. These subjective viewpoints are often difficult to capture using traditional quantitative methods, which focus on objective measurements. Q-methodology provides a systematic approach to understanding subjectivity and studying the subjective experiences of individuals. A fundamental assumption is the principle of contextuality: *The meaning of any detail depends upon its relation to the whole context of which it is part.* These theoretical foundations can be summarised in two principles:

1. Every position *within* a perspective gets its meaning within the *whole* of positions
2. (subjective) perspectives can be objectified: their shape and structures can be analysed

Mathematical - statistical

The mathematical foundation of Q-methodology involves the use of factor analysis, a statistical technique that identifies patterns and structures within a dataset (Stenner & Watts, 2012). First, participants' rankings or sorts of statements are converted into scores by analysing the correlations between variables. In Q-methodology, the participants *are* the variables. More precisely, their rankings of the

statements (Q-sort) are the variables that are studied. Each statement receives a score that reflects its correlation with other statements across participants. This correlation-based scoring allows for the quantification of subjective viewpoints.

Second, factor analysis is applied to the scores derived from the correlations. Factor analysis aims to identify the underlying factors that explain the commonalities in the Q-sorts. By extracting factors, which are latent constructs, it reveals shared patterns of agreement and disagreement among participants. These constructs are not directly measured or observed but are deduced from the relationships between the observed variables. The factor loadings resulting from the factor analysis represent the strength and direction of the associations between the statements and factors. High factor loadings indicate strong relationships between specific statements and factors, suggesting that those statements are influential in defining the factor.

3.1.3. General steps

The application of Q-methodology can be summarised in six steps. The remaining sections of this chapter describe how these steps have been executed.

1. Identification of the concourse
2. Selection of Q-set
3. Selection of P-set
4. Q-sorting
5. Factor analysis
6. Interpretation of perspective

3.2. Identification of the concourse

The concourse is defined as *"the flow of communicability surrounding any topic in the ordinary conversation, commentary, and discourse of everyday life"* (Brown, 1980). It may be no surprise that no-regret measures in water management are very rarely part of ordinary conversations and the have no place in the discourse of everyday life. The concourse will therefore be derived from the report by de Jonge et al. (2022), where several Dutch water management experts were interviewed. The findings of this report have been discussed in section 2.2.2. In semi-structured interviews, the subjects look back on their careers stating what regrets they have and what they would recommend to prevent future regret. This report provided many starting points to identify the concourse and work towards creating the Q-set. The concourse is furthermore supplemented by quotes, ideas and concepts found in academic literature from various fields, all of which has been reviewed in chapter 2. The identification of the concourse has resulted in a list of 87 quotes, concepts and ideas surrounding the topic of regret, that are relevant to no-regret in water management. The complete list has been added to appendix A.

3.3. Q-set

The Q-set is the collection of statements presented to participants. The participants rank the statements based on how much they agree or disagree with the given statement. The ranking is done in a fixed grid that resembles a normal distribution. A more elaborate description of this process and design choices in the sorting methods will be provided in section 3.3.4. This section focuses on the iterative process of drafting and selecting the statements for the definitive Q-set.

3.3.1. Structuring the Q-set

Q-set design is an intensive process that requires effort and rigour. The final set of items must demonstrate good coverage in relation to the research question. Its contents must be broadly representative of the opinion domain or concourse at issue (Brown, 1980). Q-sets can be developed in a structured or unstructured fashion. Structured Q-sets break a subject matter down into a series of component sub-themes or issues and aim to include a roughly equal number of items relative to each demarcated sub-theme. Unstructured Q-sets treat the subject matter as a single whole and aim to produce a representative sample in relation that whole. Both approaches have strengths and weaknesses (Stenner & Watts, 2012).

Choosing a structure

In this research, a mixed approach was used. The main reason is the fact that the contents of the theoretical framework and the identification of the concourse mostly overlap. As mentioned before, there is barely any communication on this topic in everyday life. Research has been done on regret in general, but the research on regret in water policy is still in an exploratory phase. The sources for identifying the theoretical context and concourse therefore have large overlap.

Existing frameworks Another reason for using a mixed approach is the absence of an appropriate framework to structure the sub-themes. Three frameworks were considered as the basis of a structured approach: People-Planet-Profit, Hofstede's 6D model of cultural dimensions, and the Vitruvian triad. The People-Planet-Profit (PPP) framework is a sustainability concept that balances social, environmental, and economic considerations. It recognises that decisions should benefit people, protect the planet, and generate profits, promoting a holistic and long-term approach to policymaking and business practices. However, the 'profit' component of this framework is limited in its applicability to water management, as profit is rarely the main goal. The 6D model (Hofstede, 2011) of cultural dimensions is a widely used framework to understand cultural differences across countries. It identifies six key dimensions that help analyse and compare cultural values. The model provides insights into cultural differences and can help individuals and organisations understand and navigate cross-cultural interactions, management practices, and global business strategies. It allows for comparisons between countries and helps identify potential challenges and opportunities in international contexts. However, the model describes cultural dimensions on a national scale and compares across countries, while this research focuses on one country. The Vitruvian triad is mentioned in de Jonge et al. (2022) as a framework to asses the quality of an hydraulic construction. It is therefore suggested that a construction that has all three elements of the Vitruvian triad, is more likely to be no-regret. However, this only applies to constructions, and is less or not applicable to for example spatial planning, floodplains, drainage, groundwater management or any policy that does not require one specific construction.

Application of the theoretical framework The theoretical framework described in section 2.5 has revealed several sub-themes that play a substantial role in describing and explaining regret. The themes are listed below, together with the rationale behind it.

- Uncertainty: without it, there would be no regret. This sub-theme aims to explore how the subjects perceive uncertainty, in relation to risk and regret.
- Timing: uncertainty increases over time. Anticipated regret however is felt more intensely over short-term effects. This sub-theme aims to explore how the subjects perceive (no-)regret when planning on different temporal scales.
- Qualitative: various approaches in decision theory only see regret as a loss of utility caused by a decision made under uncertainty. This sub-theme aims to explore the relationship between regret and qualitative factors, i.e. factors that cannot be valued.

- Adaptivity: adaptivity, flexibility and no-regret are often mentioned together. The purpose of this sub-theme is to study the relationship between regret and irreversibility.
- Process: in policy analysis, these cannot be seen independently. Both influence each other. This sub-theme aims to explore this relationship, and how focusing on one can influence the other.

3.3.2. Selection and iteration of statements

At this point we still have a list of 87 quotes related to regret in water management, but no coherent set of statements that can be presented to participants. This section describes the iterative process that has reduced this list to a collection of 29 statements that represent the concourse on (no-)regret in water management. This process involved discarding, merging or re-phrasing the statement from the initial list. This was done based on several 'selection criteria' listed below. The process of reducing the 87 quotes to a more workable 29 statements took a total of nine iterations. In the first iterations, mostly quotes that were too similar were merged or one of them was discarded. For example, several quotes contained examples of qualitative factors such as landscape and historical value. Quotes that contained examples were summarised into a general definition of the exemplified. Next, several quotes, mainly from literature on the psychology of regret were often deemed too abstract. Several of the cognitive biases discussed in chapter 2 cannot be reduced to a single statement. Some however can: omission bias[1] could be phrased into statement S26. Lastly, the statements had to be understandable for a wide range of experts from various disciplines. This means they cannot contain too much policy analysis jargon, and attention should be paid to words that have different meanings in the context of integrated water management. This last step required input from experts in integrated water management that reviewed and provided feedback on the preliminary statements[2]. The implications and limitations of this process and the statements themselves will be discussed in chapter 5.

1. The statements have to be applicable to as many fields of water management as possible (e.g. not only flood risk management or fresh water supply)
2. The Q-set must balance theoretical and practical statements
3. The Q-set should balance the five themes as much as possible, but not strictly
4. 'open-door-statements'[3] should be avoided
5. a good balance between 'nuanced' and 'extreme'[4] statements
6. By aiming to make the statements as applicable as possible, they tend to become too vague. After presenting several statements to experts, some of the statements were re-phrased for this reason.

3.3.3. Definitive Q-set

The iterative process described in section 3.3.2 has resulted in a set of 29 statements, listed below with their corresponding themes. All statements have been based on quotes, ideas and concepts from literature discussed in chapter 2. The sources used for each statement can be found in appendix A. The statements were originally written in Dutch and presented to the participants in Dutch. Since some nuance is always lost in translation, the original (Dutch) version of the statement has also been added to appendix A.

1. Preventing all regret is impossible and should therefore not be the goal. (Uncertainty)

[1] anticipated regret can lead to decision paralysis and inaction

[2] Reviewers: Ellen Minkman (TU Delft), Frans Klijn (TU Delft / Deltares), Kees van Ginkel (Deltares) Tom van der Wekken (Rijkswaterstaat / Delta Futures Lab) and Erik van Berchum (Arcadis / Delta Futures Lab)

[3] Open-door statements are statements that are very difficult to disagree with. They should be avoided as it is very likely most participants will rank them similarly, creating less variance in the results.

[4] Extreme statements contain words such as 'always', 'must', 'strictly' and are therefore not nuanced. The reactions to such statements are usually: 'it depends', and extreme statements motivate participants to more explicitly deliberate on what it depends

2. Adding an extra safety margin for sea level rise to the design is no-regret. (Uncertainty)
3. The design process of a no-regret strategy should be fully transparent. (Process)
4. Investments in communication and transparency towards all stakeholders are no-regret investments. (Process)
5. A no-regret solution should pay equal attention to other factors such as landscape, cultural history, and spatial quality. (Qualitative)
6. Too much focus on no-regret can slow down innovation. By sometimes taking more risk opportunities arise for innovation and new knowledge. (Uncertainty)
7. A no-regret measure should rely on knowledge and methods that have been proven to be effective in practice. (Adaptive)
8. A no-regret strategy requires a grand approach to avoid needing additional measures afterwards. (Adaptive)
9. The advantages of long-term planning outweigh the risks related to uncertainties in the future. (Timing)
10. No-regret measures are just way of preventing reputational damage. (Qualitative)
11. No-regret measures should take on every opportunity to integrate other purposes into its design, next to its own goals. (Qualitative)
12. The choice for a no-regret solution is a trade-off between efficiency and precaution, where the degree of uncertainty is the determining factor (Uncertainty)
13. Analysing problems as early as possible and a wide exploration of scenarios are strictly necessary to identify no-regret solutions. (Uncertainty)
14. No-regret measures should be measures implemented on a short-term basis, to create momentum for a larger strategy. (Timing)
15. A no-regret solution cannot depend too heavily on technology. (Adaptive)
16. All stakeholders should be heard in the design process of a no-regret strategy. (Process)
17. A no-regret measure cannot depend too heavily on information technology and therefore also cybersecurity. (Adaptive)
18. Mono-functional solutions (e.g. only safety) are by definition regret-solutions. (Qualitative)
19. The choice for a no-regret solution is a trade-off between efficiency and precaution, where the magnitude of the risk is the determining factor. (Uncertainty)
20. For an investment to be no-regret, one should look beyond the minimal lifespan of the measure. (Timing)
21. No-regret solutions should be flexible and adaptive. (Adaptive)
22. An hydraulic construction cannot be constructed at the expense of other functions without compensation. (Process)
23. The social costs and benefits of a measure should be distributed as equally as possible. (Process)
24. Adaptive policies are not by definition no-regret, because because they rule out some alternatives beforehand. (Adaptive)
25. Investments in the aesthetic design of a construction are no-regret investments. (Qualitative)
26. Too much focus on no-regret can lead to postponing important decisions. (Timing)
27. The choice for a no-regret solution is a trade-off between efficiency and precaution, where the urgency of the problem is the determining factor. (Timing)
28. A measure is only no-regret if it is beneficial in all future scenarios, in the worst-case as well as the best-case (climate) scenarios. (Uncertainty)
29. It is not possible to design long-term no-regret solutions, because the future is too uncertain. (Timing)

After Q-sorting and factor analysis, we can see how these statements have been ranked by the different factors. The process of factor analysis will be described and discussed in section 3.5. Table 3.1 shows how all statements have been ranked by each factor[5].

[5]Factors are groups of individual responses grouped by correlations that therefore represent shared views and perspectives.

Table 3.1: Composite Q-sort values for each Factor

SN	Factor 1	Factor 2	Factor 3
1	2	3	4
2	2	-1	2
3	0	3	3
4	3	1	-3
5	1	2	-1
6	3	-2	4
7	0	0	2
8	-2	-4	-2
9	4	2	0
10	-4	-4	-3
11	0	0	1
12	1	-1	1
13	4	4	3
14	0	0	3
15	-1	-1	-4
16	1	2	-1
17	-3	1	-2
18	-3	-2	-3
19	0	-1	1
20	1	1	-1
21	-2	4	-1
22	-3	0	-2
23	-1	3	0
24	-1	1	0
25	-2	-3	-4
26	3	-3	0
27	-1	-2	2
28	2	0	0
29	-4	-3	1

3.3.4. Surveying method, pre-sorting, guiding question and grid

The participants will rank the 29 statements defined in the previous section. Four factors play an important role in this process: the surveying method, pre-sorting, the grid and the guiding question.

Online Q-sorting Q-sorting can be done physically, by giving participants the statements on cards and the grid on paper. This method has some benefits: it allows participants to 'think out loud', creating more valuable insights for the researcher to use in the interpretation of the factors. However, it is a time-intensive method that takes a significant amount of time from both the researcher and the participants. Therefore, the surveying was done using an online tool designed by Banasick (2019). This application allowed various options, that will be discussed next.

Opening statement After clicking the link, participants see the first screen that provides general information. This screen contains a general introduction on the topic, important definitions, a general description of Q-methodology and the relevant privacy statements. This first screen is called the opening statement. As all participants were Dutch, the opening statement was written and presented in Dutch. A copy of the opening statement and screenshots from the online surveying tool have been added to A. Concerning privacy, the surveying method has been adapted to ensure anonymity in the results and the Data Management Plan has been approved by the TU Delft Human Research Ethics

Committee.

Pre-sorting The first step in the survey, after the ”Welcome” screen. The statements are presented to the participant one by one, in random order. The participant can then choose of they agree, disagree or are undecided about a statement. Only after having read all statements and divided into three categories (agree, disagree, neutral), will the actual Q-sorting begin. In Q-methodology, this step is optional and strictly speaking not necessary. However, it has two major benefits. First, it makes is easier for participants to only choose between three options when presented with statements they have never seen before. Consequently, they will have seen all the statements already once when they start placing the statements in the grid. This will make it easier for them determine how they judge the statements *relative* to each other. On top of that, the pre-sorting steps creates some additional insights. It allows the researcher to see how many statements each participant has valued as 'agree', 'disagree' or 'neutral'. In this research, participants placed more statements in the box 'agree' than in the box 'disagree'. On average, participants agreed with 13 statements, were neutral on 6 statements and disagreed with 10 statements. This partly explains the high correlations found between the extracted factors, which will be discussed in section 3.5.3.

Forced sorting This brings us to the next important factor: the grid. The statements will be ranked by placing them in a grid, as shown in figure 3.2. The grid can be seen as a table with rows and columns. Two important design choices determine the shape of the grid. First, the grid can be 'fixed' or 'free'. Free sorting means only the number of columns is set. In free sorting, the participants can place the statements in any column, with no limit to how many statements are in each column. In fixed sorting (also called 'forced' sorting), there is a maximum number of statements for each column. Figure 3.2 is an example of a grid with forced sorting and also the exact grid that has been used in this research. The shape of the grid should resemble a normal distribution (Brown, 1980). Forced sorting has two advantages. First, free sorting has the risk that participants (either intentionally or unintentionally) no longer make explicit deliberations when allowed to rank freely (Brown, 1980). Second, forced sorting encourages participants to more explicitly deliberate their choice. The vast majority of Q-methodological research therefore uses forced sorting (Minkman & Molenveld, 2020).

Grid shape Second, the researcher is free to choose the shape of the fixed grid. While it should resemble a normal distribution (Brown, 1980), the researcher is free to choose the wideness and kurtosis of the distribution. The shape does not influence the results of the statistical analyses (Brown, 1980). However, the researcher can adjust the shape of the distribution according to the knowledge the participants are expected to have on the topic. Stenner and Watts (2012) suggest a more skewed distributions when participants have large knowledge on the subject and are expected to know very well what statements to place at the extremes. If that is not the case, a more 'flat' distribution is preferred (Brown, 1980).

Definitive grid design

As can be seen in figure 3.2, the grid that was used in this research is fixed and flat. The grid is fixed because it motivates participants to deliberate more explicitly, which allows a better interpretation when the size of the P-set is limited. This is also one of the reasons the grid is relatively flat. Participants have the option to explain their choices for the statements placed in the 'most agree' and 'most disagree' columns. Having two statements in the extreme columns, provides four written explanations per participants, if they choose to elaborate on their choice. Again, this creates additional data to interpret results with a smaller sample size. The third reason is that the subjects are not expected to have a large knowledge on the subject and therefore a more compact distribution is preferred (Brown, 1980). The expected knowledge does not relate to their knowledge of water management, as all participants are professionals in either the public, private or research sector of water management. They are however

less likely to be highly knowledgeable on no-regret measures, as it is a relatively new concept that is still not well defined. The fact that it is not well defined has been made clear in chapters 1 and 2.

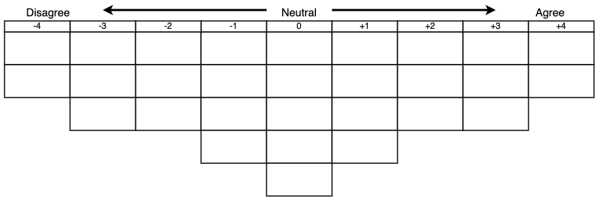

Figure 3.2: Example of a grid with forced sorting

3.4. P-set

Every participant in a Q-methodological study serves as a variable. This means that strategic, rather than opportunistic[6], sampling of participants is usually preferable (Stenner & Watts, 2012). The viewpoints of participants must matter in relation to the studied topic.

3.4.1. Contacting participants

Participants were selected based on their roles within an organisation. The list of relevant organisations includes public institutions (Rijkswaterstaat, Ministry of Infrastructure and Water Management, Water boards), private (engineering) companies (Arcadis, Witteveen + Bos, Sweco, Royal HaskoningDHV) and research institutes (TU Delft, Deltares, WUR). Over the course of approximately one month, a total of 85 participants were contacted directly, based on the aforementioned profile. This yielded 29 responses, which means the response rate for this research is 34%. Participants have been contacted:

- Directly and personally by e-mail
- Indirectly through ambassadors[7]
- Indirectly by sharing the research in newsletters (VPDelta+) and LinkedIn (Delta Futures Lab LinkedIn page)

The e-mail addresses of directly contacted participants were obtained through the professional networks of TU Delft and Deltares. The participants have been pseudonymised to ensure privacy, but some information is required to determine it the P-set is diverse enough to accurately represent the group that is studied. All participants were asked several personal questions at the end of the survey. The personal questions concerned:

- Gender: male; female; other
- Age group 20-30; 31-40; 41-50; 51-60; 60+
- Type of organisation public/government; private; research/knowledge
- Educational background: alfa; beta; gamma[8]

The main purpose is to determine the diversity of the P-set, to verify sample of individuals that participated represent the population that is studied. For the type of organisation and educational background

[6] opportunistic in this case refers to a sample definition that 'easily' yield a large number of participants

[7] Ambassadors refer to individuals that shared the invitation within their organisation with relevant colleagues, based on a provided 'participant profile'

[8] This typology is used frequently in Dutch to describe various sciences. Alfa sciences are liberal arts (e.g. history, literature, philosophy), Beta sciences are both natural and applied sciences (e.g. physics, chemistry, engineering), Gamma sciences are social sciences (e.g. psychology, law, economics)

the participants could choose multiple options, as it is possible for participants to work for several organisations simultaneously. It also possible to have an educational background in for example both engineering and economics.

3.4.2. Definitive P-set

The 29 participants that form the definitive P-set are shown below in table 3.2. This table also shows that factor they have the strongest association with. The survey allowed participants to choose multiple

Table 3.2: Definitive P-set

P	Gender	Age group	Organisation type	Educational background	Factor
1	Male	60+	Research	Engineering | Social sciences	1
2	Male	51-60	Research	Engineering	2
3	Female	41-50	Research	Liberal arts | Engineering | Social sciences	2
4	Female	51-60	Government | Research	Liberal arts | Engineering	1
5	Female	20-30	Government	Social sciences	3
6	Male	31-40	Private	Engineering	1
7	Male	41-50	Research	Engineering	3
8	Male	41-50	Government	Engineering | Social sciences	1
9	Male	41-50	Private	Engineering	2
10	Female	31-40	Private | Research	Engineering	2
11	Male	20-30	Research	Social sciences	1
12	Male	20-30	Private	Engineering	3
13	Female	20-30	Research	Engineering	1
14	Female	41-50	Government	Social sciences	3
15	Male	41-50	Government	Engineering	2
16	Male	31-40	Private	Engineering	2
17	Male	60+	Government	Engineering	2
18	Male	60+	Research	Engineering	2
19	Male	51-60	Private	Engineering	3
20	Male	20-30	Government	Engineering	3
21	Male	41-50	Research	Engineering | Social sciences	1
22	Male	41-50	Private	Engineering	3
23	Female	41-50	Research	Social sciences	2
24	Female	20-30	Private	Engineering	2
25	Male	41-50	Government	Engineering	1
26	Male	60+	Government	Engineering	1
27	Male	51-60	Government	Engineering	2
28	Male	41-50	Private	Engineering	3
29	Female	31-40	Research	Social sciences	1

options for the questions on type of organisation and educational background. We can therefore see some participants with multiple organisations. We also see several participants with multiple educational backgrounds. The participants are 69% male and 31% female. The distribution of age groups is: 20-30 (21%), 31-40 (14%), 41-50 (38%), 51-60 (14%) and 14% 60 years or older. The organisation type is 32% public/government, 29% private and 39% research. The educational backgrounds are 3% alfa/liberal arts, 72% beta/science & engineering, and 25% gamma/social sciences.

While all the groups in the categories are not balanced perfectly, the diversity of the sample seems representative of the population (i.e. professionals in water management). The gender distribution is almost exactly the same as Rijkswaterstaat reported for their organisation in 2020[9]. In the same year they also reported that the age groups 35-44 and 45-54 were the most represented at this organisation

[9]https://www.magazinesrijkswaterstaat.nl/rwsjaarbericht/2020/01/h4-–-ontwikkelingen-in-de-organisatie

with 2023 and 3117 *fte* respectively.

3.5. Factor Analysis

Factor analysis is a method that aims to reveal patterns of association between a series of measured variables. In Q-methodology, the factor analysis procedure begins with the intercorrelation of all the gathered Q-sorts. This yields a person-by-person correlation matrix. Such correlations indicate the degree of agreement, or disagreement, between the entire set of item rankings produced by any two individuals. In other words, we can conduct a direct and holistic comparison of their respective Q-sorts (Stenner & Watts, 2012). A factor in Q-methodology identifies a group of persons who have ranked the statements in a similar fashion or, in other words, a group of persons who share a similar perspective or viewpoint on the topic at. The factors in Q methodology are categories of operant subjectivity (Stephenson, 1977) that were inherent in the concourse originally, for it was these separate attitudes (the existence of which the factor analysis demonstrates) that gave rise to all the conversation initially.

3.5.1. Factor extraction

This section describes how the factor extraction has been applied to extract a workable number of factors that will later be translated into perspectives. This is done by applying Principal Component Analysis for factor extraction and Varimax rotation for factor rotation.

Principal Component Analysis Principal Component Analysis (PCA) is a factor[10] extraction method available in almost every statistical analysis program and is probably used more than any other method in statistical analysis (Akhtar-Danesh, 2017). It works by extracting uncorrelated linear combinations of the Q-sorts. This method analyses all the variance in the Q sorts: it uses 1's in the diagonal of the correlation matrix for factor extraction. When using PCA, the goal is to explain the maximum variance for each factor from the Q-sorts. As a result, the first factor extracts the most variance and the second factor extracts the most variance from the remaining variability among the dataset. This process continues until all of the variance is explained by the factors. However, in practice a small number of the extracted factors, pre-specified according to some guidelines are used.

Initial factor extraction The initial PCA extracted 8 factors with a total 78% of explained variance, as shown in table 3.3. The eigenvalues for each factor have also been plotted in 3.3.

Table 3.3: Unrotated factors

-	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Eigenvalues	8,9443	3,4780431	2,2172	1,9256	1,6542	1,5699	1,3390	1,2189
% Expl. Var.	31	12	8	7	6	5	5	4
% Cum. Expl. Var.	31	43	51	58	64	69	74	78

3.5.2. Factor selection

The selection of the number of factors to keep for rotation and further analysis is an iterative process where selection decisions are ultimately made by the researcher. There are however several guidelines

[10] Technically, these are not factors but components. In this context the difference is negligible and the terms 'component' and 'factor' are used interchangeably

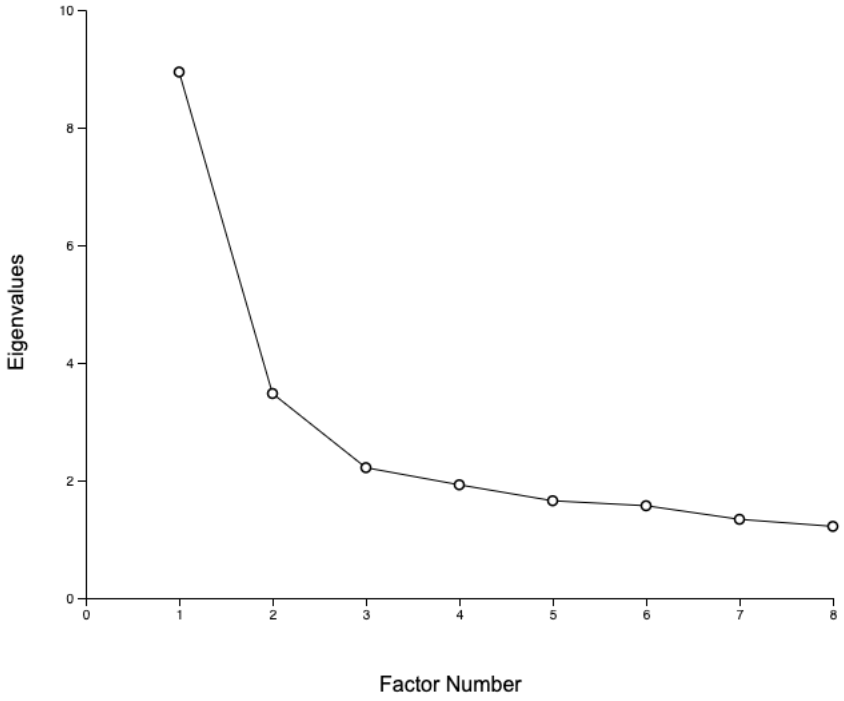

Figure 3.3: Scree plot of the initial factor extraction

to determine the number of factors to keep for further analysis and rotation. This section describes this iterative process and shows how eventually the eight factors shown in table 3.3 were narrowed down to the three factors that were kept for further analysis.

Eigenvalues An eigenvalue is indicative of a factor's statistical strength and explanatory power. The first guideline is to discard components with eigenvalues lower than one, also known as the Kaiser-Guttman criterion (Kaiser, 1960; Guttman, 1954). As we can see in table 3.3, all extracted factors have eigenvalues above one. From his more than noteworthy experience doing Q-methodological research, (Brown, 1980) argued that "the magic number 7" is "generally suitable" as a sensible estimation of the maximum number of factors to extract. There are however several reasons why working with seven factors is not desirable in this context.

Significant factor loadings Brown (1980) highlights two other parameters to consider when choosing the number of factors to work with. The first is to only accept factors with two or more significant loadings. This is only the case when six factors are extracted, where Factor 6 meets the 'bare minimum' requirement of 2 significant loadings. This is also the case when five factors are extracted, and one of those also has 2 significant loadings[11]. A similar method is Humphrey's rule (Brown, 1980), where a factor can be assumed significant if the cross product of its two highest loadings exceeds twice the standard error.

Scree test The second method is the so-called 'scree test' (Cattell, 1966), where the numbers of factors to use is determined based on the slope in the scree plot (shown in figure 3.3). We analyse the

[11] showing these results in this report would take at least three pages, but this can easily be checked by doing a PCA on the Q-sorts provided in appendix B

scree plot to identify the point the ”elbow.” The elbow is the point at which the eigenvalues decrease more gradually after a significant drop. In the plot we clearly see the eigenvalues start decreasing more gradually after factor 3 *or* factor 4. When extracting four factors, the factor with the lowest amount has 3 significant loadings. However, out of those three Q-sorts only one elaborated on the choices in the open questions. This would mean the entire narrative around this factor will be constructed based on the explanation by only one participant.

Three factors Considering all aforementioned guidelines and principles, we proceed to the interpretation phase with three factors. In short, the reasons to work with three factors are:

- the Kaiser-Guttman criterion, Brown's magic number 7, and Humphrey's rule point to using 6 or 5 factors
- Cattell' scree test points to using three or four factors
- Using four factors would require interpretation based on only one elaboration

The three factors that will be used in further analysis and their loadings are presented in table 3.4. We can also see that all factors satisfy Humphrey's rule. The products of the two highest factor loadings for each factor exceed twice the standard error[12], which is: $S.E. = 1 \div \sqrt{29}$, twice the standard error therefore amounts to $0,371$, and the products of the highest factor loadings in table 3.4 exceed this.

Rotation The three factors were rotated using Varimax rotation. Varimax rotation is a technique used in factor analysis to make the extracted factors easier to interpret. It aims to maximise the variance of the squared loadings within each factor by redistributing the loadings across factors, resulting in clearer and more distinct factor structures.

3.5.3. Factor characteristics

The factor characteristics of the three factors used in further analysis are shown in tables 3.5 and 3.6. The number of defining variables refers to the number of Q-sorts (or participants) that have a significant ($p<0.05$) loading on a particular factor. The average reliability coefficients and composite reliability are both measures of internal consistency within factors, where 1 is the highest possible degree on internal consistency. The correlations between the factors, shown in table 3.6, are an indications of the level of agreement between factors. In other words, to what extent their views overlap. The correlations are relatively high. This indicates that the factors share a significant amount of views with each other. This is important to keep in mind when interpreting the factors and translate them into perspectives. When different perspectives are described, keep in mind that they also share many opinions, especially Factor 1 and Factor 3.

3.6. Factor interpretation

This section describes the process of factor interpretation. The three factors that were extracted through the process described in the previous section are only statistical objects, based on correlations between Q-sorts. Factor interpretation is a process in which these statistical objects are put into context and translated into narratives that describe the underlying views we call perspectives. Factor interpretation is more of an art than a science. However, the goal remains to interpret the factors as systematically as possible to ensure transparency in the interpretation of the results. The process of factor interpretation that was applied in this research can be summarised in a number of steps.

[12]The standard error (S.E.) is calculated as one divided by the square root of the number of items in the Q-set

Table 3.4: Factor loadings table

Part. No.	Factor Group	Factor 1	F1	Factor 2	F2	Factor 3	F3
1	F1-1	0,7236	Flagged	-0,0228		-0,0481	
21	F1-2	0,7228	Flagged	0,1426		0,1922	
25	F1-3	0,6702	Flagged	0,1404		0,5216	
26	F1-4	0,6618	Flagged	0,126		0,1077	
6	F1-5	0,6615	Flagged	-0,1757		0,3283	
8	F1-6	0,6391	Flagged	0,1738		0,2291	
11	F1-7	0,6304	Flagged	0,2278		-0,0792	
4	F1-8	0,5894	Flagged	0,3068		0,2324	
13	F1-9	0,5857	Flagged	0,1264		0,0158	
29	F1-10	0,5497	Flagged	0,4691		0,1125	
9	F2-1	-0,0628		0,8427	Flagged	-0,1487	
24	F2-2	0,0314		0,7973	Flagged	0,289	
3	F2-3	0,1521		0,7195	Flagged	-0,1616	
27	F2-4	0,3455		0,6678	Flagged	0,1289	
2	F2-5	0,0698		0,6666	Flagged	-0,0195	
18	F2-6	0,1505		0,6032	Flagged	0,1851	
23	F2-7	0,4135		0,6004	Flagged	0,231	
10	F2-8	0,4374		0,596	Flagged	0,2918	
15	F2-9	0,1304		0,5768	Flagged	0,4863	
17	F2-10	0,2297		0,5016	Flagged	0,3459	
16	F2-11	0,1666		0,45	Flagged	0,3954	
19	F3-1	0,2043		-0,0946		0,635	Flagged
5	F3-2	-0,0119		0,3303		0,6279	Flagged
20	F3-3	0,3777		0,0391		0,6056	Flagged
12	F3-4	0,0356		-0,4386		0,5699	Flagged
14	F3-5	-0,1367		0,373		0,548	Flagged
7	F3-6	0,2362		0,1944		0,5004	Flagged
28	F3-7	0,4372		0,068		0,453	Flagged
22	F3-8	0,037		0,0426		0,3642	Flagged

Table 3.5: Factor characteristics for all three factors

Factor Characteristics	Factor 1	Factor 2	Factor 3
No. of Defining Variables	10	11	8
Avg. Reliability Coef.	0,8	0,8	0,8
Comp. Reliability	0,976	0,978	0,97
S.E. of Factor Z-scores	0,155	0,148	0,173

Table 3.6: Factor score correlations

Correlation	Factor 1	Factor 2	Factor 3
Factor 1	1	0,3921	0,4676
Factor 2	0,3921	1	0,3049
Factor 3	0,4676	0,3049	1

The first step is to generate a composite Q-sort[13]. The composite Q sort of a factor represents how a hypothetical respondent with a 100% loading on that factor would have ranked all the statements of the Q-set (Van Exel & De Graaf, 2005). The statements ranked at both extremes (-4 and +4 in this case) are used to produce a first description of the aggregated view represented by that factor. These statements are referred to as *characterising statements* (Van Exel & De Graaf, 2005). It is important to note that the composite Q-sort is an *aggregated* view of the combined views from participants with

[13] Stenner and Watts (2012) refer to this as a Factor Array, but it refers to the same thing

a significant loading on that factor. Some nuance and information is always lost in aggregation and it is therefore also important to take into account the individual responses from participants. This is done by looking at distinguishing statements. These statements are called 'distinguishing; because their ranking within a factor differs significantly from the ranking in other factors. For example, one statement about adaptivity (S21) is ranked +4 in Factor 2, while it is ranked -2 in Factor 1 and -1 in Factor 3. By looking at distinguishing statements we can understand what sets these perspectives apart.

Furthermore, qualitative data in the form of open questions have been used to construct the narratives that describe perspectives. The are three types of open questions. First, participants have the option to provide an explanation on why they placed statements at the extremes. Both extremes (-4 and +4) have two places, allowing participants to provide a total of four explanations for their choices. Twenty-one participants explained their choices, generating a total of 84 qualitative data points that can be used in the interpretation. Second, an option is provided at the end of the survey to answer the open question *How would you define a no-regret measure?*, which was answered by 22 participants. Third, at the end of the survey participants could answer an open question on what they felt was missing in the statements or other remarks, which has been answered by 10 participants. Overall, this yielded a total 116 additional qualitative data points that can be used to interpret the results.

The final step is to summarise the views of the perspectives in the theoretical framework. Describing all perspectives according to the same framework has two purposes. First, it allows us to systematically compare perspectives according to important theme. Second it allows us to reflect on the perspectives and compare them to the literature the framework is based on.

4

Results

This chapter describes the results that were produced in a Q-methodology study with 29 participants from public, private and research organisations in integrated water management in The Netherlands. The goal is to identify perspectives on no-regret measures, by analysing the rankings (Q-sorts) of the 29 statements described in chapter 3. All other methodological parameters and design choices are also described in chapter 3. Three factors were extracted, as described in section 3.5. Using the interpretation methodology, described in section 3.6, three perspectives were identified:

- Perspective A:technocratic design
- Perspective B: adaptive egalitarian
- Perspective C: minimalist innovation

First the general results will be discussed that apply to all perspectives in section 4.1. After this, the three perspectives are each discussed in a separate section. At the end of each section, the findings are synthesised into a perspective using the theoretical framework described in section 2.5. The final section (4.5) of this chapter contains an overview of the three perspectives, described using the theoretical framework. The implications and limitations of these findings will be discussed in chapter 5. The perspectives will be discussed one by one, starting with Perspective A. While the aim is to allow an understandable reading of the individual perspectives notwithstanding the sequence, it is best to read this chapter in this order. References to previously mentioned results are frequently made in this chapter, and reading it in this order allows the most complete understanding, especially of the differences between perspectives.

4.1. General results

This section presents and discusses all results that are not related to the interpretation of individual factors/perspectives themselves. First, we will discuss the Z-score variance. This is followed by an overview of how the statements have been ranked by each factor. Section 4.1.3 discusses consensus statements that are generally agreed upon and do not distinguish between any pair of factors.

4.1.1. Z-score variance

The z-score is a weighted average of the values that the Q-sorts most closely related to the factor give to a statement. It is standardised and can therefore be used to compare factors. Figure 4.1 shows the Z-

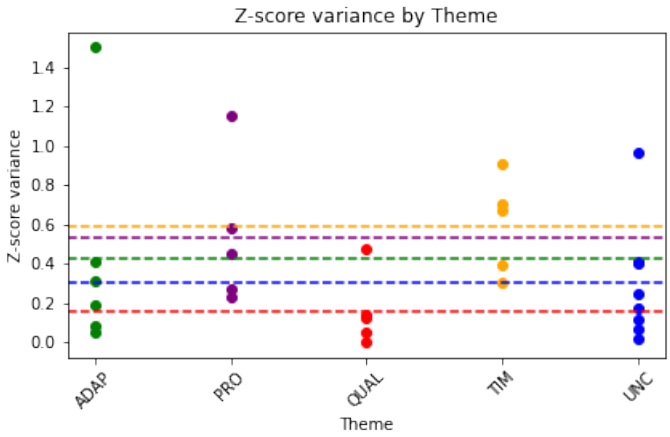

Figure 4.1: Z-score variance of statements per theme

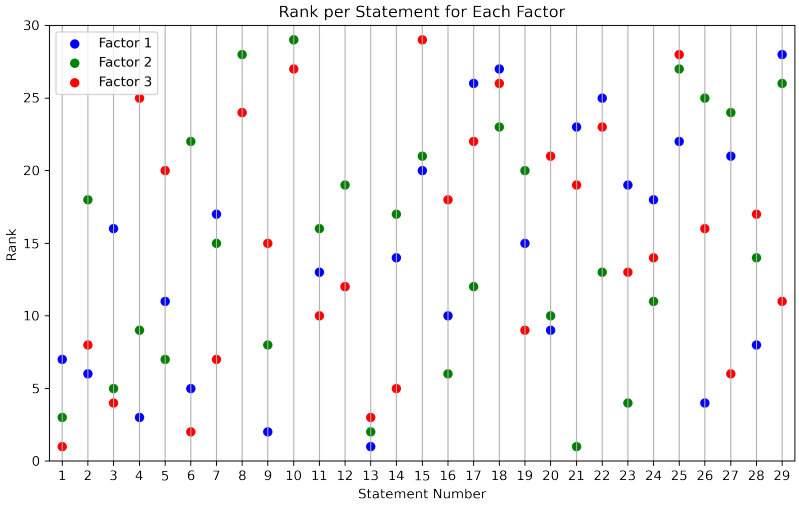

Figure 4.2: Statements ranked per factor

score variance of each statement grouped by theme. The coloured dashed lines represent the *average* Z-score variance per theme. This figure thus shows that themes are more heavily debated than others, as a higher z-score variance means that the rankings of statements are less similar in the different factors. The points in the plot show the z-score variance for individual statements. the purpose of this plot is not to show these individual values, but to illustrate what themes are most heavily debated. The theme 'Timing' has the highest z-score variance, followed closely by the 'Process' theme. The 'Qualitative' theme has a significantly lower average z-score variance. This indicates that there are shared views amongst all perspectives on the statements about qualitative factors.

4.1.2. Statement ranks per factor

Figure 4.2 is a visual representation of how each statement has been ranked per factor (table 3.1), where a low rank means the Q-sorts in this factor agree most with this statement (i.e. rank 1 means 'most agree' of all statements). This figure shows that for some statements, like statement S13, the views are very similar and all factors find this important. We also see some large differences, for example in statement S21.

4.1.3. Consensus statements

A consensus statement is defined as a statement that does not distinguish between *any* pair of factors. In other words, all factors have similar opinions on these statements and these statements can therefore not be used to distinguish between factors. Four consensus statements have been identified, shown in table 4.1.

Table 4.1: Consensus statements with composite Q-sort value (Q-SV) and Z-score per factor

SN	F1 Q-SV	F1 Z-score	F2 Q-SV	F2 Z-score	F3 Q-SV	F3 Z-score
8	-2	-1,02	-4	-1,54	-2	-1,06
10	-4	-1,607	-4	-1,577	-3	-1,574
11	0	0,084	0	-0,15	1	0,42
13	4	1,699	4	1,347	3	1,611

S8 *A no-regret strategy requires a grand approach to avoid needing additional measures afterwards.* Participant P3 explained that *it is not just about avoiding regret about the fact that a measure not has turned out effective enough, but for example also the ecological impact of a measure. The chance of irreversible negative impact is larger with a grand approach.* Participant P15 explained that *being adaptive and flexible should be the goal so additional measures afterwards remain possible, because there are to many uncertainties and future developments to account for in the initial design. Designing everything now based on the most extreme scenarios will always cause regret.* This notion is also shared by participant P18, who explained that *means and ends should be separated in this statement. The goal is not to prevent requiring additional measures. In the context of adaptive policy, this is actually a good thing.*

S10 *No-regret measures are just way of preventing reputational damage.* Participant P8 explained that *reputational damage to me, is something different than 'no-regret' measures. Such measures are implemented for substantive reasons rather than preventing reputational damage.* Participant P11 also added that *reputational damage does no justice to the importance of no-regret measures. Reputational damage might also occur here.* Participant P14 explained that *decisions can sometimes be difficult and controversial. Proper argumentation and transparency are then essential.*

S11 *No-regret measures should take on every opportunity to integrate other purposes into its design, next to its own goals.* This statement has been ranked mostly in the centre of the grid and therefore no explanations have been provided, as this is only done for statements at the extremes of the grid. It does however contrast with the findings of de Jonge et al. (2022), which will be discussed in section 5.1.3.

S13 *Analysing problems as early as possible and a wide exploration of scenarios are strictly necessary to identify no-regret solutions.* Participant P8 explained that *taking the appropriate time for a broad analysis results in possible solutions where the chance of 'no-regret' is the highest* Participant P26 explained that *predicting the future is impossible. Scenario's contribute to verifying the robustness of decisions.*

4.2. Perspective A: technocratic design

This section discusses Perspective A, which is based on the Q-sorts with a significant factor loading on factor 1. Perspective A has been named *technocratic design*, which will be explained later on in this section. The composite Q-sort is shown in figure 4.3. This aggregated view shows that statements have

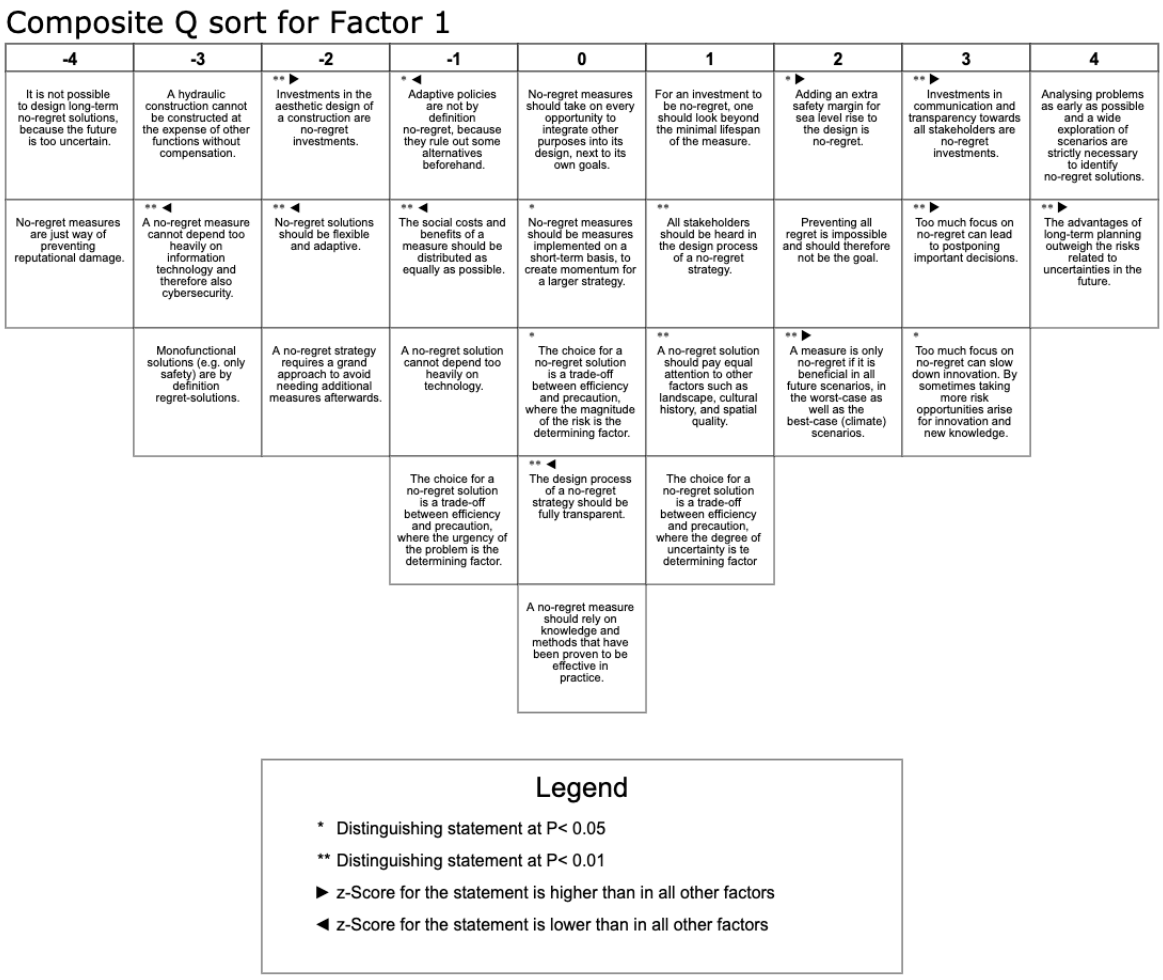

Figure 4.3: Composite Q-sort for Factor 1 - Perspective A: Technocratic design

been ranked the highest (far-right column) and lowest (far-left column). Perspective A values thorough research, scenario analysis and designing with a long-term horizon, as these statements have been ranked the highest. This indicates that Perspective A sees research as an essential tool to deal with the uncertainty of the future. Proper in this view research and scenario analysis allows us to design solutions that remain robust in an uncertain future. This argument is also supported by the low ranking of statement S29, which states that it is not possible to design long-term no-regret solutions because the future is too uncertain. The low ranking of statement S10, stating that no-regret measures are just a way of preventing reputational damage, does not provide any significant insights on this perspective, as it is a consensus statement viewed similarly in other perspectives (see section 4.1.3).

It is important to note that this is an *aggregated* view and some of the nuances are lost in aggregations. The composite Q-sort provides a meaningful holistic overview of the viewpoint in Perspective A, but constructing a complete narrative should also consider the important nuances which can be found in the individual Q-sorts and the explanations provided along with the rankings. We will take a closer look at this in section 4.2.2, but first we will discuss the Q-sorts most significantly associated with this

viewpoint.

4.2.1. Factor loadings

A total of 10 Q-sorts have a significant ($p<0.05$) loading on this factor, which means that the participant's responses align strongly with the underlying perspective represented by that factor. The participant's sorting patterns and preferences reflect a clear association with the specific viewpoint identified through factor analysis. The weights per Q-sort for Factor 1 are listed in table 4.2. The weight is indicative of how much each Q-sort contributes to the definition of a specific factor. Higher factor sorts weights suggest that certain Q-sorts are more representative of the underlying viewpoint, while lower weights indicate less relevance. We furthermore see that the Q-sorts in this factor either work for a government organisation or a research organisation, with two exceptions. The educational background skews towards engineering and social sciences, but not significantly more or less than in other perspectives.

Table 4.2: Factor 1 Q-sorts weight, professional backgrounds and educational backgrounds

P	Weight	Org	Edu
1	10	3	2|3
4	5,94605	1|3	1|2
6	7,74362	2	2
8	7,11296	1	2|3
11	6,88746	3	3
13	5,86962	3	2
21	9,96471	3	2|3
25	8,01052	1	2
26	7,75264	1	2
29	5,18622	3	3

4.2.2. Distinguishing statements

The distinguishing statements for Factor 1 are shown in table 4.3. This section discusses distinguishing statements based on their ranking within Perspective A, their ranking relative to Perspectives B and C, and the explanations provided by the Q-sorts with a significant loading on Factor 1 (shown in table 4.2).

S9 *The advantages of long-term planning outweigh the risks related to uncertainties in the future.* The composite Q-sort value (+4) and the high z-score (1.45) indicate this perspective agrees that the benefits of long-term planning outweigh the risks. Perspective A is furthermore significantly more positive about this statement than other perspectives, as implied by the differences in rankings and z-scores with perspectives B and C. Three individuals elaborated on why they ranked statement S9 the highest. Participant P1 explained that *this statement is only true if proper methods are used in the design*. Participant P4 explained that *designing is not about one particular design, but multiple possibilities. This is needed to 'incrementally' shape our collective future.* Participant P11 explained that *uncertainties always exist in the future but precisely because of this investing in long-term planning is necessary to keep our delta habitable for humans and animals.* The shared narrative is one of a strong belief in our ability to research problems and design robust decisions that remain robust in the future. The design should also pay attention to landscape and spatial quality, as suggested by the composite Q-sort value for statement S5[1]

[1] S5: *A no-regret solution should pay equal attention to other factors such as landscape, cultural history, and spatial quality.*

Table 4.3: Distinguishing statements Factor 1. *=significant at p<0.05

SN	F1 Q	F1 Z	F2 Q	F2 Z	F3 Q	F3 Z
9	4	1,45*	2	0,816	0	0,1
4	3	1,38*	1	0,734	-3	-1,145
26	3	1,22*	-3	-1,111	0	0,042
6	3	1,16	-2	-0,584	4	1,723
2	2	1,09	-1	-0,44	2	0,58
28	2	1,02*	0	-0,079	0	0,018
16	1	0,58*	2	1,179	-1	-0,091
5	1	0,52*	2	1,126	-1	-0,546
14	0	0,03	0	-0,428	3	1,097
19	0	-0,04	-1	-0,506	1	0,525
3	0	-0,24*	3	1,2	3	1,168
24	-1	-0,41	1	0,283	0	0,107
23	-1	-0,54*	3	1,301	0	0,109
25	-2	-0,79*	-3	-1,478	-4	-1,666
21	-2	-1,01*	4	1,911	-1	-0,149
17	-3	-1,21*	1	0,154	-2	-0,559

S4 *Investments in communication and transparency towards all stakeholders are no-regret investments.* In Perspective A, communication and transparency with all stakeholders are valued more than in Perspective B which ranked it at +1. Meanwhile perspective C generally disagrees with this statements and ranked it at -3. Only one participant (P29) in Perspective A elaborated on why this statement was ranked the highest, with a simple explanation: *this is good en every case*. The high ranking of this statement S4, together with the previously discussed importance of long-term planning, implies that this perspective views communication and transparency as a means of creating social support for long-term plans that might not show immediate (positive) results.

S26 *Too much focus on no-regret can lead to postponing important decisions.* At the same time the high ranking of statement S26 indicate that Perspective A views the (precautionary) no-regret approach as a potential threat to efficiency and the postponing of important decisions. Participant P1 explained that *difficult choices are, by definition, 'regret'.* Participant P21 furthermore noted that *this statement is especially true if it is not clear what no-regret measures are.* Especially interesting is how this view contrasts with Perspective B, which generally disagrees that the no-regret approach is a potential threat to efficient and decisive decision-making. Perspective C remains neutral on this statement.

S2 *Adding an extra safety margin for sea level rise to the design is no-regret.* The ranking of this statement indicates that Perspective A sees increased safety margins as an appropriate measure to deal with uncertainties in the future. Participant P11 explained that *that sea level rise is already unavoidable and requires us to re-design our delta in the coming years. Adding an extra safety margin for sea level rise is therefore no-regret.* When comparing the ranking of this statement with that in other perspectives, we see that Perspective C has ranked this statement similarly. However, Perspective B tends to disagree that increasing safety margins for sea level rise are no-regret.

S21 *No-regret solutions should be flexible and adaptive.* We have seen before that Perspectives A and B disagreed on statements S26 and S2. Another very explicit difference in views between those perspectives can be seen in the rankings of statement S21. The composite Q-sort value of -2 for this statement indicates no-regret measures do not need to be adaptive and flexible. This sharply contrasts the views found in Perspective B, which will be discussed in section 4.3 In Perspective B, adaptivity is highly valued with a composite Q-sort value of +4, and the highest absolute z-score (1.836) of the distinguishing statements. When fitting this view into the narrative that has been established so far, it

seems that Perspective A believes robust design which has been thoroughly tested in various scenarios, would allow us to design solutions that remain robust in an uncertainty future. It designed and tested well, the measures therefore do not deed to be adaptive.

S17 *A no-regret measure cannot depend too heavily on information technology and therefore also cybersecurity.* This statement provides insight on how participant view the role of technology. Perspective A tends to heavily disagree with this statement (-3). Participant P13 explained that *we should not be afraid of information technology but embrace is and improve our role in it; information technology has the same risks as 'regular' technology.* The same participant also ranked statement S15 about the dependence on technology the lowest and explained that *technology is a solution rather than a risk.* Again, we see opposing views with Perspective B which tends to slightly agree with this statement S17 (ranked +1). These opposing views are more explicitly shown win the rankings of statement S6, which is about how the no-regret approach can slow down innovation. In Perspective A strongly agrees (+3) that the no-regret approach can be a threat to innovation, and Perspective C agrees even more strongly with this statement (+4) However, Perspective B tends to disagree (aggregated rank -2). This is also one of several examples where Perspective A and C have similar views, which also explains the high correlations between the underlying factors (see section 3.5.3).

4.2.3. Synthesis Factor 1 - Perspective A

The previous discussion in interpretation of the views in Perspective A has been summarised in the theoretical framework, shown in table 4.4. The shared views indicate that Perspective A has a strong belief in technology and our ability to use it. The design process should be scientifically based with a long-term perspective, where the strategy is implemented incrementally. If the (technical) design process is of high quality, the measures does not necessarily have to be adaptive. Increasing safety margins however is necessary to account for uncertain sea level rise. This perspective has therefore been named *technocratic design.* The term technocratic refers to the strong belief in science and technology. The term designers refers to the preferred approach of long-term planning with an incremental implementation. The preferred approach is more top-down, rather than bottom up, similar to the hierarchist perspective described by Offermans (2016). The answers to the open question *"How would you define a no-regret measure?"* tend toward long-term robustness under a wide range of future scenarios.

Table 4.4: Application of the theoretical framework on Factor 1 / Perspective A: technocratic design

Theme	Perception	Relevant statements
UNC	Uncertainty can be 'tamed' with good research, technology and increased safety margins	S9, S2
TIM	Preference for long-term planning	S9, S26, S29, S20
QUA	Landscape and spatial quality are important, the design of a single construction is not	S5, S25
ADA	Adaptivity is not strictly necessary but depends on the measure itself	S21, S24, S17
PRO	Good communication is more important than absolute transparency	S4, S3

4.3. Perspective B: adaptive egalitarian

This section discusses Perspective B, which is based on the Q-sorts with a significant factor loading on Factor 2. Perspective B has been named *adaptive egalitarian*, which will be explained later on in section 4.3.3. The composite Q-sort for Perspective B is shown in figure 4.4.

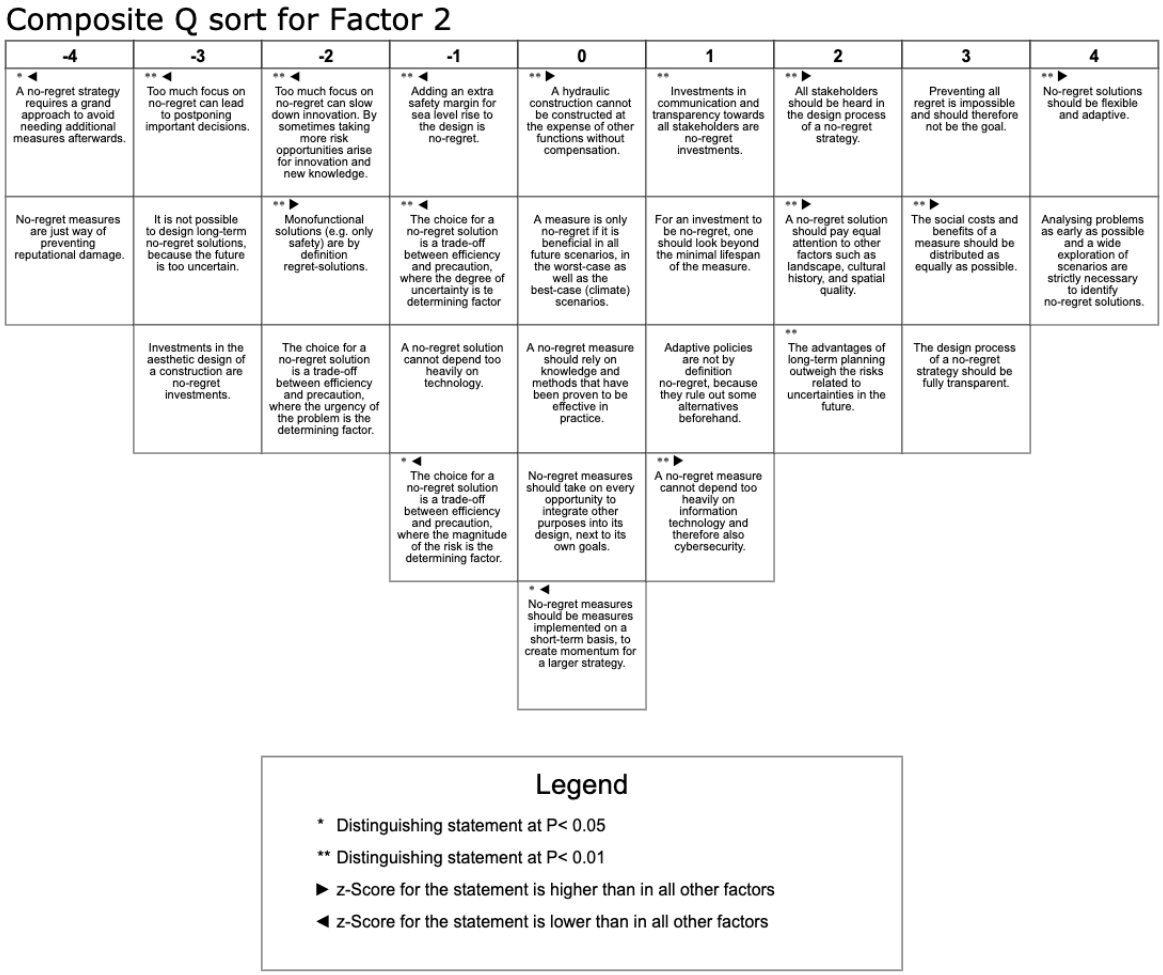

Figure 4.4: Composite Q-sort for Factor 2 - Perspective B: Adaptive egalitarian

This aggregated viewpoint shows that Perspective B highly values adaptivity. This view on adaptivity explicitly distinguishes Perspective B from the others, who ranked statement S21 negatively. The adaptive egalitarian perspective does view the importance of research and scenario discovery (statement S13) in a similar fashion as Perspectives A and C, which also explains why this statement has been identified as a consensus statement (see 4.1.3). Another consensus statement that has been ranked in the extremes of this aggregate view is statement S8, which is about the 'grand' approach. Still, this statement has been ranked lower (-4) in Perspective B than in the other two (both -2). The fourth extreme position in this aggregates Q-sort is the statement on reputational damage, which also has been ranked in the -4. This statement is also a consensus statement and can therefore not distinguish this perspective from any other.

4.3.1. Factor loadings

A total of 11 Q-sorts have a significant loading on this factor and therefore also perspective B. Seven out of those provided an additional explanation on their choices for the highest and lowest ranked statements. We see that the private sector is slightly more represented in this viewpoint than in Perspective A. The distribution of educational backgrounds does not vary significantly from other factors.

Table 4.5: Factor 2 Q-sorts weight

P	Weight	Org	Edu
9	19,1408	2	2
24	14,4087	2	2
3	9,8213	3	1|2|3
27	7,9356	1	2
2	7,8985	3	2
18	6,2427	3	2
23	6,1810	3	3
10	6,0857	2|3	2
15	5,6909	1	2
17	4,4126	1	2
16	3,7150	2	2

4.3.2. Distinguishing statements

The distinguishing statements for Factor 2 are shown in table 4.6. This section discusses distinguishing statements based on their ranking within Perspective B, their ranking relative to Perspectives A and C, and the explanations provided by the individuals with a significant loading on Factor 2 (shown in table 4.5).

Table 4.6: Distinguishing statements Factor 2.*=significant at p<0.05

SN	F1 Q	F1 Z	F2 Q	F2 Z	F3 Q	F3 Z
21	-2	-1,01	4	1,91*	-1	-0,149
23	-1	-0,54	3	1,3*	0	0,109
16	1	0,58	2	1,18*	-1	-0,091
5	1	0,52	2	1,13*	-1	-0,546
9	4	1,45	2	0,82*	0	0,1
4	3	1,38	1	0,73*	-3	-1,145
17	-3	-1,21	1	0,15*	-2	-0,559
22	-3	-1,17	0	-0,01*	-2	-0,723
14	0	0,03	0	-0,43	3	1,097
2	2	1,09	-1	-0,44*	2	0,58
12	1	0,29	-1	-0,48*	1	0,222
19	0	-0,04	-1	-0,51	1	0,525
6	3	1,16	-2	-0,58*	4	1,723
18	-3	-1,36	-2	-0,61*	-3	-1,346
26	3	1,22	-3	-1,11*	0	0,042
8	-2	-1,02	-4	-1,54	-2	-1,063

S21 *No-regret solutions should be flexible and adaptive.* The high z-score and high composite Q-sort value indicate that Perspective B values adaptivity most, and values it significantly more than other perspectives. The high z-score can even be labelled as an 'extreme' statement according to Brown

(1980)'s definition. Participant P3 explained *that flexibility and adaptivity are necessary to deal with an uncertain future.* Participant P15 added do this that *solutions should also be 'socially' adaptive, allowing them to adapt to changes in social perceptions that can also be unpredictable.* These views are in sharp contrast to those found in Perspectives A and B, where S21 was generally disagreed upon. Considering the other 'extreme' positions were consensus statements, this further emphasises that adaptivity is the defining view of this perspective.

S23 *The social costs and benefits of a measure should be distributed as equally as possible.* The high ranking of this statement shows that a 'fair' distribution of social costs and benefits is highly valued, significantly more that in other factors. Participant P23 elaborated that *a fair distribution is an ethical principle that should always be applied, not only to no-regret measures. A fair distribution furthermore increases social support and the resilience of (currently) forgotten/neglected actors and ecosystems.* This view aligns with the egalitarian perspective described by Offermans (2016).

S3 *The design process of a no-regret strategy should be fully transparent.* The high composite Q-sort value (+3) for this statement further show that 'fairness' and participation are highly valued within this factor, significantly more than in other factors. Although it is not flagged as a distinguishing statement, it is of significant influence in understanding the narrative. The importance of transparency further illustrates the egalitarian approach that is valued in Perspective B, which can also be seen in the views on statement S23. Participant P16 added another layer of transparency: *being honest about the no-regret approach. Transparency applies to all measures, but for no-regret strategies one should be honest about the fact that no-regret is the goal. Otherwise, it can lead to confusing conclusions.* Again, these views are in conflict with the views in Perspective A, which is neutral on this statement. Comparing the views of Perspective A and Perspective B on this statement imply that the former views communication as key to social support, and the latter views transparency as *one of the keys* to social support.

S16 *All stakeholders should be heard in the design process of a no-regret strategy.* The other key to social support is stakeholder participation, based on the high ranking of this statement in Perspective B. This again reinforces the previously mentioned 'egalitarian' narrative that designing no-regret measures requires input from all possible perspectives and that a 'fair' distribution is important. Participant P17 explained that *involving and gathering support from as many stakeholders as possible is important, since highly complex situations make it difficult to create consensus among stakeholders for long-term goals.* Participant P23 added that *adaptivity/flexibility in a future environment can only be achieved by capturing as many perspectives as possible.* This view does not oppose Perspective A, as the composite Q-sort value for S16 for that perspective is +1. This indicates a possible area of agreement that can be used in optimising the decision-making process. It does however oppose the views in Perspective C, that tend to slightly disagree with statement S16 (-1).

S8 *A no-regret strategy requires a grand approach to avoid needing additional measures afterwards.* All perspectives disagree with this statement, but the adaptive egalitarian perspective disagrees most. This fits will in the established narrative where adaptivity is highly valued. Participant P15 explains that *additional measures afterwards are actually good: it means the design is adaptive and flexible, which is good when considering the amount on uncertainties in the future.* Participant P18 noted that *means and ends should be separated in this statement. A 'grand' integrated approach with respect to all interests related to water and the impact on the environment should be the goal. The goal should not be to prevent requiring additional measures, which is actually a good thing in the context of adaptive policies.*

S26 *Too much focus on no-regret can lead to postponing important decisions.* As discussed earlier, the technocratic design perspective (A) agrees with this statement (ranked +3). The adaptive egalitarian

perspective has an opposing view (-3). Participant P27 ranked this statement with -4 and explained that *the focus of no-regret should be on the strategy, which contains precisely those choices that are possible now*. In this view, no-regret measures are measures we know we can take now, that won't be regretted later. This is in line with the views found in literature (see section 2.2.2), most notably from Hourcade and Chapuis (1995) who argued for a 'sequential' approach where no-regret measures are implemented on a short-term basis. The different views between Perspective A and B on this statement suggest that both view no-regret differently. Perspective A views it more as a no-regret *approach*, where the entirety of the strategy is designed to minimise regret. On the other hand, Perspective B view individual no-regret *measures* that are implemented sequentially into a larger, but not strictly defined strategy. The strategy is not strictly defined as it should above all remain adaptive.

4.3.3. Synthesis Factor 2 - Perspective B

The shared views in Perspective B indicate that the adaptive egalitarian perspective values both adaptivity and equality, significantly more than other perspectives. Both concepts can even be mutually beneficial, as an adaptive strategy requires participation from a wider range of stakeholders with different views. A fair distribution of social costs and benefits is regarded as a principle that should apply to any policy, not just no-regret measures. The explanations provided on the statements about adaptivity suggest strong consciousness on the magnitude of future uncertainties, which motivates the call for adaptive measures. Changing social views and values are also seen as an uncertainty that influences the outcome of a decision, similar to the findings of Offermans (2010). A transparent, participatory and egalitarian decision-making process is therefore necessary to yield socially robust policies. These views are summarised in the theoretical framework, shown in table 4.7. The importance of adaptivity also comes forward in the open question on the definition of a no-regret measure. Out of seven responses of Q-sorts flagged as significant for Factor 2, all but one mention adaptivity and/or flexibility in their definition of a no-regret measure.

Table 4.7: Perspective B: adaptive egalitarian

Theme	Perception	Relevant statements
UNC	Adaptivity accounts for uncertainty, social uncertainties are relevant and should be accounted for	S21, S16
TIM	Adaptivity allows long-term planning	S21, S16, S9, S27, S26
QUA	Social robustness is highly valued, spatial quality also	S23, S3, S16
ADA	No-regret measures should be adaptive	S21
PRO	Participation, transparency and equity in the process ensure positive results	S3, S16, S23

4.4. Perspective C: minimalist innovation

This section discusses Perspective C, which is based on the Q-sorts with a significant factor loading on Factor 3. Perspective C has been named *minimalist innovation*, which will be explained later on in section 4.4.3. The composite Q-sort for Perspective C is shown in figure 4.5.

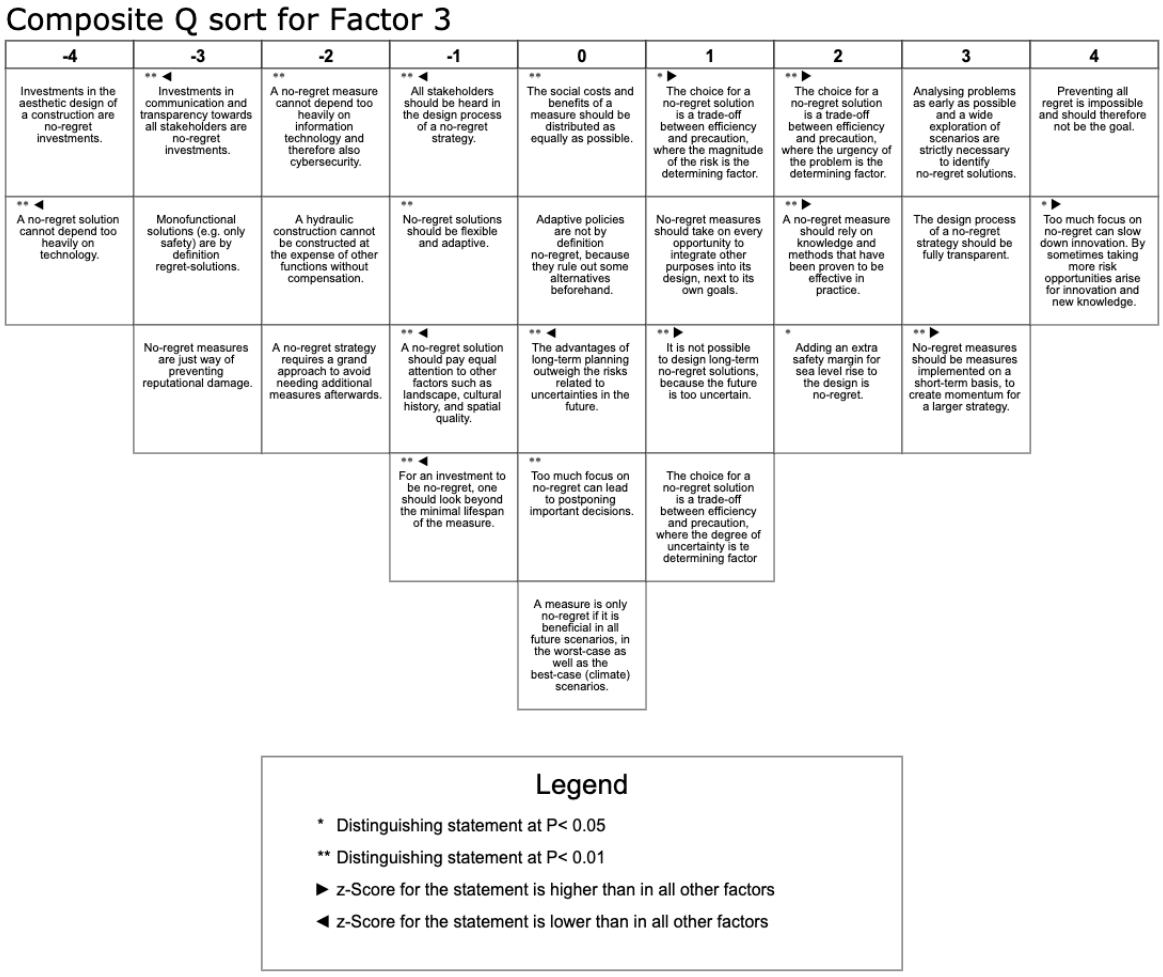

Figure 4.5: Composite Q-sort for Factor 3 - Perspective C: Minimalist

Perspective C above all agrees that preventing all regret is impossible and should therefore not be the goal. This statement is generally agree upon (+2 for Perspective A and +3 for Perspective B), but Perspective C agrees the most with this statement. Participant P28 explained that *if the risk analysis is done well, a residual regret probability is acceptable.* The view that the no-regret approach can slow down innovation is what defines this perspective the most. It puts the views in the minimalist innovation perspective (+4) in sharp contrast with the adaptive egalitarian view (-2), while showing overlap with the technocratic design view (+3). All perspectives furthermore disagree with the statement (S25) that investing in aesthetics is no-regret, but Perspective C disagrees the most. Participant P12 explained that *aesthetic design is also subjective uncertain: what is popular now might not be popular in twenty years, or vice-versa. Participant P5 put it more simply: function goes above form in case of flood protection.* Another defining view of this perspective is the view on the role of technology. All perspectives disagree with the statement that no-regret measures cannot depend too heavily on technology, but Perspective C disagrees (-4) significantly more with this statement than the other perspectives (both -1).

4.4.1. Factor loadings

A total of 8 Q-sorts had a significant factor loading in Factor 3. Five of those provided an additional explanation on their choices after ranking the statements. The private sector appears to be most represented in this perspective, compared to other perspectives. The opposite can be said for the research sector, where only one Q-sort (P7) loads significantly of this factor. This difference is significant, considering the majority (39%) of the P-set work for a research organisation.

Table 4.8: Factor 3 Q-sorts weight

P	Weight	Org	Edu
19	7,00551	2	2
5	6,82459	1	3
20	6,29631	1	2
12	5,55689	2	2
14	5,15633	1	3
7	4,39505	3	2
28	3,75248	2	2
22	2,76445	2	2

4.4.2. Distinguishing statements

The distinguishing statements for Factor 3 are shown in table 4.9. This section discusses distinguishing statements based on their ranking within Perspective C, their ranking relative to Perspectives A and B, and the explanations provided by the Q-sorts with a significant loading on Factor 3 (shown in table 4.8).

Table 4.9: Distinguishing statements Factor 3. *=significant at p<0.05

SN	F1 Q	F1 Z	F2 Q	F2 Z	F3 Q	F3 Z
6	3	1,16	-2	-0,58	4	1,72
14	0	0,03	0	-0,43	3	1,1*
27	-1	-0,69	-2	-1,06	2	0,87*
7	0	-0,31	0	-0,12	2	0,69*
2	2	1,09	-1	-0,44	2	0,58
19	0	-0,04	-1	-0,51	1	0,53
29	-4	-1,43	-3	-1,38	1	0,33*
23	-1	-0,54	3	1,3	0	0,11*
9	4	1,45	2	0,82	0	0,1*
26	3	1,22	-3	-1,11	0	0,04*
16	1	0,58	2	1,18	-1	-0,09*
21	-2	-1,01	4	1,91	-1	-0,15*
5	1	0,52	2	1,13	-1	-0,55*
17	-3	-1,21	1	0,15	-2	-0,56*
20	1	0,85	1	0,67	-1	-0,56*
4	3	1,38	1	0,73	-3	-1,15*
15	-1	-0,62	-1	-0,51	-4	-1,92*

S6 *Too much focus on no-regret can slow down innovation. By sometimes taking more risk opportunities arise for innovation and new knowledge.* The high ranking of this statement shows that Perspective C views the no-regret approach as a potential threat to innovation. Participant P5 explains that *the no-regret approach is often risk-averse, which can have a dampening effect on innovation.* Participant

P12 also ranked this statement in the far-right column and explained that *it is not desirable to minimise all risks ex-ante. The risks of the contemporary technology and society might be fully mitigated through new technology, and it is therefore important to continue stimulating innovation.* This view is in line with the previously discussed views in Perspective A, which also explains the high correlation between both perspectives (see section 3.5.3). We have also seen that the adaptive egalitarian perspective does not view no-regret as potential threat to innovation. Perspectives B and C also have the lowest correlation, which indicates that these perspectives have the least overlapping views[2].

S14 *No-regret measures should be measures implemented on a short-term basis, to create momentum for a larger strategy.* The high composite Q-sort value for this statement indicates that the minimalist innovation perspective sees more potential for short-term no-regret measures than for long-term no-regret strategies, significantly more than other perspective. The values for S8 (-2) support this interpretation that no-regret measures should be designed on a smaller scale. The position of this statement within the underlying view of Perspective C however is difficult to describe further, as no elaborations on this statement were given.

S27 *The choice for a no-regret solution is a trade-off between efficiency and precaution, where the urgency of the problem is the determining factor.* The high ranking of this statement indicates that efficiency should go above precaution, when matters are urgent. Participant P28 explained that *in urgent situations it is acceptable to take measures that might be regretted later. It the problem is solved temporarily, the goal is achieved.* Compared to other perspectives, the minimalist innovation perspective is the only perspective that agrees with this statement (-1 for Perspective A and -2 for Perspective B).

S4 *Investments in communication and transparency towards all stakeholders are no-regret investments.* The low ranking of this statement suggests that communication and transparency are viewed as of minor importance. The composite Q-sort value of this statement (-3) distinguishes it from perspective A and B (values of +3 and +1 respectively). The explanation provided by participant P12 is more nuanced: *in (large) projects it is impossible to always please everyone. It is however important to inform stakeholders at early stage, to create a clear picture of the goals of the project. This way you won't regret later decisions.* Participant P5 stresses the importance of scientific transparency when discussing S7[3]: *scientifically proven methods create more social support and certainty when implementing long-term strategies. Combined with the explanation from P12, this indicates a narrative where the goal of the communication with stakeholders is to inform, in order to gain support.*

S15 *A no-regret solution cannot depend too heavily on technology.* This statement has one of the highest absolute z-scores (-1.808) across all factors, and the composite Q-sort value suggests that Perspective C strongly disagrees that a no-regret solution cannot depend too heavily on technology. While the other perspectives also tend to disagree with this statement (both -1), the minimalist innovation perspective disagrees significantly more. This finding fits the narrative that resulted from the discussion of Perspective C so far, which indicated that the minimalist innovation values technology and innovation to adapt to an uncertain future. Participant P7 clearly explains the role of technology: *almost all imaginable measures require technology.*

4.4.3. Synthesis Factor 3 - Perspective C

The minimalist innovation perspective has been summarised using the theoretical framework, shown in table 4.10. This perspective is characterised by a strong belief in the role of technology and innovation.

[2] It should be noted that the correlation between Perspective B and C is 0.3049, which is still relatively high

[3] S7:*A no-regret measure should rely on knowledge and methods that have been proven to be effective in practice*.

Similar to the technocratic design perspective (A), the preferred management style tends towards top-down. This also explains the strong correlation between the two factors (0.4676). The minimalist innovation perspective however distinguishes itself from Perspective A by its view on the planning horizon. The views on long-term planning in Perspective C show fit the narrative where the future is too uncertain to allow long-term planning. No-regret measures can therefore only be designed and implemented on a short-term basis. The individual definitions of no-regret measures are similar to those found in Perspective A, and mostly mention robustness under a vast array of future scenarios. Several definitions also emphasise the importance of the scientific substantiation of a measure. Participant P28 provided simple but very powerful definition of a no-regret measure: *"if you don't do it, you are stupid"*. This definition shows a different angle on no-regret measures: those measures we will regret *not* taking.

Table 4.10: Perspective C: minimalist innovation

Theme	Perception	Relevant statements
UNC	Uncertainties in the future are too large to all account for, but research, technology and innovation can contribute to robust and future-proof solutions	S15, S6, S13
TIM	Preference for short-term implementation of no-regret measures, long-term planning is too uncertain to be no-regret	S14, S27, S12, S29
QUA	Qualitative factors are of minor importance, compared to its primary (safety) functions	S25, S5, S22
ADA	Adaptivity is not strictly necessary, but can be useful	S21, S24
PRO	Communication and transparency are important, but investing in it is not strictly necessary	S3, S16, S23

4.5. Summary of identified perspectives

All three identified and discussed perspectives have been summarised in table 4.11. This table combines the description of the perspectives as presented at the end of each section in this chapter. Describing all perspectives using one framework allows a more systematic comparison of the perspectives. It also allows reflecting on the findings in the literature discussed in chapter 2. This table also highlights

Table 4.11: Summary of all identified perspectives

Theme	Perspective A: technocratic design	Perspective B: adaptive egalitarian	Perspective C: minimalist innovation
UNC	Uncertainty can be 'tamed' with good research, technology and increased safety margins	Adaptivity accounts for uncertainty, social uncertainties are relevant and should be accounted for	Uncertainties in the future are too large to all account for, but research, technology and innovation can contribute to robust and future-proof solutions
TIME	Preference for long-term planning	Adaptivity allows long-term planning	Preference for short-term implementation of no-regret measures, long-term planning is too uncertain to be no-regret
QUAL	Landscape and spatial quality are important, the design of a single construction is not	Social robustness is highly valued, spatial quality also	Qualitative factors are of minor importance, compared to its primary (safety) functions
ADAP	Adaptivity is not strictly necessary but depends on the measure itself	No-regret measures should be adaptive	Adaptivity is not strictly necessary, but can be useful
PROC	Good communication is more important than absolute transparency	Participation, transparency and equity in the process ensure positive results	Communication and transparency are important, but investing in it is not strictly necessary

the most important differences between the technocratic design, adaptive egalitarian and minimalist innovation perspectives. Both perspectives A and B have a similar, 'controllable' view on uncertainty, the difference being in *how* in can be controlled. This contrasts with the view on uncertainty of Perspective B, which sees it as uncontrollable and therefore calls for adaptivity. The views on the perception of time also have similarities and differences. Perspective A believes designing measures that remain robust in the long-term future is possible with good research and careful planning. Perspective B also believes this is possible, but only if measures are flexible and allow adaptation over time to an uncertain future. Perspective C sees uncertainties in the future as too large to design long-term no-regret solutions. No-regret solutions should therefore be simple measures that can be implemented on the short term. Perspectives A an B agree on the importance of qualitative factors such as landscape and spatial quality, while Perspective C disagrees. Another significant difference can be found in the views on statements about the design process and how stakeholders should be involved. Perspectives A and C show a preference for a top-down approach, based on a scientific design process that should be transparent and communicated with stakeholders to ensure social robustness. It tends towards informing stakeholders, rather than involving stakeholders. The latter is significantly more important in Perspective C, which values a participatory process where stakeholders are involved to incorporate as many views as possible in the decision-making process. The main argument here is that this is necessary to allow adaptive measures to also remain adaptive in an evolving social environment.

5

Discussion

The results presented in the previous chapter will be discussed in this chapter. By interpreting the factors based on distinguishing statements, characterising statements, and the individual elaborations, these three factors were translated into perspectives:

- Perspective A: technocratic design
- Perspective B: adaptive egalitarian
- Perspective C: minimalist innovation

This chapter is divided into three main sections: reflection, limitations and implications. Section 5.1 reflects on the perspectives identified in chapter 4, by comparing them to the findings in literature discussed in chapter 2. This will be done by comparing the results to the main topics of the theoretical context: the psychology of regret, regret in decision-making models and perspectives in water management. Section 5.2 then reflects on the methodological and theoretical limitations of the results. The methodological limitations will focus on the application of Q-methodology. The theoretical limitations will focus on general research design choices and the applicability of the results. After the results have been put into context and the limitations have been discussed, the findings will be translated into implications in section 5.3.

5.1. Reflection

The section discusses the implications of the identified perspectives by comparing them to the theoretical context described in chapter 2. We will first compare the results to the 'classical' theory on regret in the field of psychology. Section 5.1.2 compares the results to the perspectives found in literature. The same will be done for novel decision-making models in section 5.1.3.

5.1.1. The psychology of regret

Four major themes were identified in literature that describe how regret influences decision-making (see section 2.1.4). The themes of timing, uncertainty, action/inaction and process/results were found. This section discusses how each regret theme comes forward in the results of the Q-methodological study.

Timing and inaction While this research focuses on anticipated (ex-ante) regret, there are other temporal dimensions that describe how regret influences decision-making. Anticipated regret is felt more intensely if the decision-maker expects the outcome of the decision to be known soon, which can lead to inaction. This finding comes forward most explicitly in Perspective A, where the statement on no-regret leading to postponing important decisions is ranked the highest (+3), compared to perspectives B (-3) and C (0). Perspective A furthermore agrees significantly more (+4) with he statement: *"The advantages of long-term planning outweigh the risks related to uncertainties in the future"*(S9) than perspectives B (+2) and C (0).

Uncertainty Probabilities are subjective and often not agreed upon by decision-makers. The varying rankings of statement S29 (A: -4, B, -3, C, 1) supports this view that probabilities are subjective and uncertainty is not perceived in the same way by all participants. The views of the technocratic design perspective show a more 'controllable' perception of uncertainty where risks can be mitigated with robust design and rigorous research. The adaptive egalitarian perspective shows a less controllable perception of uncertainty where risks can be mitigated by staying flexible and adaptive, so we can adapt quickly to changing circumstances. The minimalist innovation perspective shows some of both perceptions, but the focus lies on the role of technology and innovation that should continue to develop to allow technology to remain robust into the future.

Process / result Regret can be experienced from the processes ("process regret") and decision outcomes ("outcome regret"). A 'bad' outcome is less regrettable if the decision-making process was 'good'. The responses show that all perspectives acknowledge process regret as a potential cause for regret, but still view it differently. Perspective A focuses more on the scientific and technical process that should be good in order to ensure positive outcomes. By communicating properly in the scientific design choices with stakeholders, social support will be robust. Perspective B also acknowledges the importance of scientific transparency, but also values stakeholder participation. The underlying belief there is that participation allows multiple views and interests to be included in the decision-making process, which will produce the most socially- and technically robust solutions. The view of the minimalist innovation perspective is similar to that of Perspective A, but values transparency more than communication. Perspective C views transparency (+3 for S3) as important, but not something worth investing in (-3 for S4). All perspectives however agree that no-regret has nothing to do with (damage to) reputation, as long as the process is good.

The consensus statement about reputational damage (S10) also says something about how the relationship between process and results are viewed. Most of the responses mentioned in 4.1.3 explain that 'regret' and damage to reputation should be viewed separately, and no-regret measures should focus on the substance. Concluding that damage to reputation is not relevant at all might go too far. The interpretation of this consensus statement requires some nuance, considering the way it has been phrased. The phrasing implies that the main goal of no-regret measures is to prevent damage to reputation. It is not surprising that almost all Q-sorts disagreed with this statement[1]. Discarding the importance of damage to reputation however solely on this statement therefore goes too far. As demonstrated by Offermans (2010), social robustness of measures are of high importance to it's effectiveness. The historical analysis discussed in section 2.3.1 also showed that the reputation and credibility of Rijkswaterstaat was of significant influence to its successes and failures. The conclusion that can be drawn from the consensus on statement S10 is that no-regret measures are *not just* a way to prevent reputational damage, and not that reputation is not relevant at all.

[1]All Q-sorts disagreed with statement S10 and ranked in -1 or lower, with four exceptions: two Q-sorts ranked in 0, one +1 and one +2

5.1.2. Perspectives found in literature

Several perspectives have been found in literature that apply to integrated water management in The Netherlands. This section reflects on how the results of this research compare to the findings of Offermans (2016) and Van der Brugge et al. (2005). Offermans (2016) identified three perspective, that can be applied to integrated water management in The Netherlands: the hierarchist, the egalitarian and the individualist.

The hierarchist believes in controlling water and nature, high government responsibilities, the importance of research and expert knowledge. Water is mainly seen as a threat to human safety. The technocratic design perspectives shows the most similarities with the hierarchist perspective. While all perspectives agree on the importance of research and expert knowledge, the technocratic design perspective shows the most controllability of water and nature. This view is also expressed in the ranking of statements about stakeholder involvement, which focuses of communication rather than participation.

Egalitarians prioritise ecological recovery and natural development. They urge for more space for nature, water and natural developments. Humans went too far in controlling nature, or even thinking they are able to control. They call for participatory decision making processes with a more equal voice for everyone. The call for a participatory decision-making process is also present in perspective B, the adaptive egalitarian perspective. The importance of adaptivity in Perspective B also fits will the egalitarian perspective from Offermans (2016). The adaptivity can be seen as a response to natural development that we should not want to control. The importance of ecological impact also comes forward in the answers to open questions in perspective B.

If Perspective A is more hierarchist, and Perspective B more egalitarian, does that mean perspective C must be Individualist? The minimalist innovation can to some, very limited, extent be associated with the individualist perspective. It must be emphasised that similarity between Perspective C and the individualist perspective is limited to a strong belief in technology and innovation. Further associations between Perspective C and the individualist can only be made through speculation, as the statements do not cover market mechanisms or other characteristics of the individualist perspective. The views of the minimalist perspective are actually more in line with the hierarchist perspective that can also be associated with Perspective A. The high correlation between Factor 1 and Factor 3 (0,4676) indicate that there is significant overlap in the views of Perspectives A and C.

Van der Brugge et al. (2005) identified a transition in Dutch water management from a hierarchical, top-down approach towards a more democratic organisation with a participatory policy process (see section 2.3.1). This transition was driven by natural (floods), social (protests) and political (reorganisation) factors. This context is relevant and should be taken into account when discussing the implications of the perspectives identified in this research. The political situation in the Netherlands is relatively unstable at the moment, compared to past decades. The same can be said for social factors, especially the increase in the number of protests we have seen in recent years (Geurkink & Miltenburg, 2023). In the recent years we have also seen more extreme weather. Heavy rainfall even caused significant floods in 2021, which caused more damage than similar floods in 1993 and 1995 (Jonkman, 2021). The point is not to say that the identified perspectives are not applicable because the circumstances are changing fast, but precisely that the circumstances *that are* changing are similar to the driving factors of the transition described by Van der Brugge et al. (2005). These developments did not change the perspectives themselves, but shifted the *dominant* perspective (i.e. the perspective that ultimately shapes policies).

5.1.3. Novel approaches

We will first discuss how the perspectives relate to contemporary decision-making models used in decision-making under deep uncertainty. The results of this research will then be compared to the findings of de Jonge et al. (2022).

The fact that statement S13 is a consensus statement shows that all perspectives agree that early research and scenario analysis are essential. This poses a new question: what *kind* of research? In novel decision-making approaches and models, an explicit difference was found in how regret was conceptualised between Robust Decision-Making (RDM) and Dynamic Adaptive Policy Pathways (DAPP). RDM models regret as a loss of utility, while DAPP models regret as a loss of opportunity or adaptivity (see section 1.1.2). This distinction also comes forward in the perspectives. Q-sorts with a significant loading on the technocratic design perspective frequently mention robustness in their answers and in their definition of a no-regret measure. Individual definition in the adaptive egalitarian perspective almost all mention adaptivity, flexibility and/or reversibility in their answers. The distinction is less clear in the views of the minimalist innovation perspective, and the fact that innovation and technology are highly valued in this perspective can also go both ways. The different views in the perspectives found in this research furthermore support the argument made by Giuliani and Castelletti (2016), who emphasised that most robustness metrics are based on subjective definitions of optimality and the subjective preferences of the decision-maker should therefore be included as an uncertain parameter in the model.

The recent report by de Jonge et al. (2022) already explored the role of regret in Dutch water management. Since a substantial part of the statements were based on quotes from this report, the responses can be used to validate the findings. The main identified causes for regret were:

1. a too narrow substantive scope of the project, i.e. designing mono-functional solutions
2. insufficient attention to maintenance costs and long-term social costs and consequences, including ecological damage
3. insufficient attention to spatial quality itself and the spatial perception
4. insufficient involvement of directly concerned parties

Statements S11 and S18 were directly derived from the first finding. Statement S18[2] is a direct quote from one of the interviewees. However, the responses in this research tend to disagree with this statement notwithstanding their perspective. Perspectives A and C both ranked it -3 and Perspective B ranked it -2. All three perspectives show a neutrality (0,0,+1) towards the statement about taking all possible opportunities to include other goals in the design. The third finding is explored in statements S5 and S25. Perspective A (+1) and Perspective B (+2) agree that no-regret measures should pay equal attention to spatial quality (S5). Perspective C however disagrees (-1), and argues that such qualitative factors are subjective and change over time. Stakeholder involvement has been explored in statements S3, S4, and S16. The results of this research show that most agree that communication with stakeholders and transparency are important, but disagree on *how* stakeholders should be involved.

When comparing the results from both researches it is important to keep in mind the research questions. de Jonge et al. (2022) asked interviewees with a vast experience in integrated water management *what* they regretted or what they were proud of. In our research, we asked participants *what we will* regret and how it can be *prevented*. Both research goals are more nuanced in reality but it is important to see that the interviews focused more an experienced regret and the Q-methodological study focus more on anticipated regret.

5.2. Limitations

The research method, process and the results have several limitations that should be discussed before conclusions can be drawn. We will first discuss the general limitations of the scope and the theoretical framework. Section 5.2.2 will then discuss the limitations of Q-methodology itself and the limitations of design choices made in the application of Q-methodology in this research.

[2] S18: *Mono-functional solutions (e.g. only safety) are by definition regret-solutions.*

5.2.1. Theoretical limitations

The theoretical limitation mostly relate to the size of the scope. As explained in section 1.3, the scope of this research is the entire decision-making arena of integrated water management in the Netherlands, which includes the public sector, private sector and research institutes.

Scope

One important limitation is that the scope of this research is very broad. This has several implications. First, it makes it difficult to create statements that embody all challenges and potential measures in water management, from flood risks to fresh water supply. This has become clear from feedback received by several participants that found the statements to be vague and abstract. The main reason was that the question ”What is no-regret?” heavily depends on the type of measure, and cannot be defined without discussing a specific measure. However, the theoretical framework remains applicable notwithstanding the dimension of the scope. The themes that describe a perspective on no-regret measures can be applied to research with a smaller scope, for example by focusing specifically on coastal defence or spatial adaptation in flood-prone areas. The perspectives that were identified in this research are also likely to be found in research with a smaller scope. The P-set included various organisations that have to deal with varying water-related challenges.

Limitations of the theoretical framework

The framework for the identification of perspectives on no-regret measures, that has been constructed in this research has a strong theoretical basis. It synthesises several decades of academic research across different disciplines into one framework to describe perspective on no-regret. It is however still a *model*: a simplified conceptualisation of reality, which has its limitations. One important limitation is that the framework does not explicitly include opportunity costs that result from an (over-)precautionary approach. In general, the framework does not account for economic factors and costs in general. It could potentially be valuable to extend the framework with an economic dimension where the perception of (opportunity)costs are described. Opportunity costs are generally defined as the costs of non-chosen alternatives. However, some economic insights were included through statements about investing in communication, design and the distribution of costs and benefits. Furthermore, researching the valuation of specific costs is less suitable to Q-methodology. It could theoretically work, but only if all the statements are about specific costs, for them to be compared. This should also be done with a smaller scope where specific measures can be compared. Several participants also noted that they found the aspect of ecological damage and loss of biodiversity to be missing. The Q-set did indeed not contain any explicit statements on this topic. However, individuals that were concerned with the effects on nature of water policies were still able to share their opinion implicitly through statements about reversibility, participation, externalities and qualitative factors. The role of the ecological impact of measures is however still highly relevant, and should definitely be explored further in a more specific study where the (potential) impact can be studied for specific measures.

5.2.2. Methodological limitations

This section discusses the limitations related to the methodology itself and the design choices in the implementation of Q-methodology.

Limitations of Q-methodology

Although forced sorting is the most commonly used design in Q-methodology (see 3.3.4), it also has its limitations. On average, participants agreed with more statements[3]. This first of all partly explains

[3]Agree: 13, Neutral 6, Disagree 10

the high correlations between factors. The forced sorting obliged participants to place statements they initially agreed with in columns more to the left. Although forced sorting motivates making more explicit deliberations, it also distorts their pure, personal views. The fact the sorting is forced *and* that participants agreed with more statement implies that there is a strong probability that the statements that were put in the columns centre (0) or just left of the centre (-1) were statements the participants actually agree with. This should be taken into account when discussing statement that have been placed in the 0 and -1 columns. While the composite Q-sort suggests that perspectives are neutral or slightly disagree with theses statements, they might actually agree with the statement in reality.

Limitations of the Q-set

Q-methodology heavily depends on the quality of the statements presented to participants (Q-set). The Q-set used in this research contains 29 statements that are based on largely on the report by de Jonge et al. (2022), together with additional insights from other literature discussed in chapter 2. While this literature review yielded an initial 87 statements, the availability of literature on this topic remains limited. This knowledge gap after all is the underlying motivation for this research itself. The fact that most of the main conclusions in de Jonge et al. (2022) are not agreed upon in the responses of this study shows that many more opinions exist. This could be addressed by using the new opinions found and exploring them further in qualitative research by for example interviewing. This would provide a more diverse basis for the concourse that is used to design the Q-set. In short, the limited availability of literature to base the Q-set on could not have been addressed *within* this research, but it has made a significant contribution to further exploring the role of no-regret measures in integrated water management.

The size of the Q-set, 29 in this case, also has its limitations. According to Stenner and Watts (2012), a Q-set containing between 40 and 80 items is standard. If the number of statements must be reduced in order to simplify the sorting task, the statements have to be phrased in a more general manner. Simplifying the sorting task was definitely important in this research due to time constraints. It is plausible that a sorting task with more statements would yield a lower response rate, as it simply takes more time for the respondents that do the sorting voluntarily. In this research, it took more than an entire month to obtain the 29 responses. However, a larger Q-set size is definitely recommended for further research. This would also allow further research to include the views found int this research. Although a sample size of n=29 participants may sound small, a P-set slightly lower than the size of the Q-set is generally recommended for statistical reasons (Stenner & Watts, 2012).

5.3. Implications

This section discusses the implications of the identified perspectives. In other words: what do the perspectives mean in practice? We start by discussing the implications of the consensus statements.

The majority of the responses agree that no-regret measures are not just a means to prevent reputational damage. However, considering the way statement S10 has been phrased, this does not mean reputation is not important. The ranking of other statements, especially about stakeholder participation, show that social support is valued. This is especially true for the adaptive egalitarian perspective. The findings of Offermans (2010) also highlight the importance of social robustness of policies.

The notion that analysing problems as early as possible and a wide exploration of scenarios is essential in identifying no-regret measures, is shared in all perspectives. This poses new questions: what problems are worth analysing? What scenarios are worth exploring? Wilby (2008) has pointed out that the no-regret is practically impossible due to opportunity costs that also exist in research. Put more simply, having invested in exploring the impact of events that did not take place can also be counted as 'regret'. Some disagreement is also found between the perspectives on how the research and design process of a measure should be shaped. Both the technocratic design and the minimalist innovation perspective tend to highly value the scientific and technical part of the design process. The adaptive egalitarian perspective however also highly values the participatory process, where measures should

remain (socially) robust in the future. This is only possible if as many views as possible are taken into account. Furthermore, the different views on uncertainty and adaptivity found in the perspectives contribute to the debate of subjectivity in decision-making models. The fact that none of the responses disagree with statement S13 should further stimulate the debate on the role of theses subjectivities in mathematical models, as theses models are ubiquitous in the DMDU field and especially in scenario analysis.

The vast majority of responses disagreed that a no-regret strategy requires a grand approach to avoid requiring additional measures afterwards. This does not discard the grand, holistic approach. Participants that elaborated on their choice explained that they disagree with this statement because the goal should not be to prevent needing additional measures. The individual explanations support this: an holistic approach is preferred, and having the flexibility to allow additional measures is beneficial int the context of adaptive policymaking.

Another consensus statement is S11: *No-regret measures should take on every opportunity to integrate other purposes into its design, next to its own goals.* This is not a consensus statement because the perspectives agree with the statement, but because they agree on *its ranking*. This statement is ranked similarly in the composite Q-sorts of all three perspectives (0,0,1). The individual Q-sorts however show more variance with rankings varying between +3 and -3. It is therefore too early to conclude that all perspectives are undecided on this statement. Furthermore, as discussed in section 5.2.2 there is a significant probability that participants actually agree with this statement, but ranked it lower due to the forced sorting.

The view on the role and importance of adaptivity clearly distinguished the technocratic design perspective from the adaptive egalitarian perspective, and to some extent also from the minimalist innovation perspective. While the participants in Perspective A clearly value robustness, and the Q-sorts in Perspective B value adaptivity, this does not necessarily mean they disagree. Adaptive planning is an emerging field and the term adaptivity itself is vague. Clarifying the arguments for adaptive policies can contribute to a better shared understanding of adaptivity itself. In short, it is probable that there are fundamental disagreements on whether or not measures need to be adaptive. The findings of this research however cannot confirm this. It could also be a simple case of miscommunication. If that were the case, this disagreement can be clarified relatively easily.

The personal information on participants[4] was useful in verifying the diversity of the P-set, but can not be used to produce further meaningful interpretations. No significant correlations were found between the perspective and any personal characteristics of the participants, with one exception. The private sector appears to be most represented in this Perspective C, compared to other perspectives. The opposite can be said for the research sector, where only one Q-sort loads significantly. This difference is significant, considering the majority (39%) of the P-set work for a research organisation.

[4] age, gender, professional background and educational background

6

Conclusions

This chapter reflects on the entire research process and its outcomes, by reflecting on the research questions. The research goals have been translated into the main research question: *What different perspectives on no-regret measures exist that can influence the decision-making process of policies for integrated water management?* The main research question is answered through four sub-questions:

SQ1 What perspectives on regret in decision-making have previously been identified in academic literature and other relevant sources?

SQ2 What perspectives on no-regret measures can be identified in actors involved in strategic decision-making of policies for water management?

SQ3 How can the identified perspectives influence the decision-making process and solution space?

SQ4 How can actors account for these perspectives in future decision-making processes?

This chapter discusses the outcome of each sub-question in separate sections. The recommendations for further research will be discussed in section 6.5. The final sections will reflect on the research goals an the main research question, followed by a brief summary of the most important findings and final remarks.

6.1. Perspectives identified in literature

Perspectives can be defined as perceptual screens through which people interpret the world (the world view) and which guides them in acting (the management style). Based on research from various disciplines, a framework was synthesised that can be used to identify *and* describe perspectives on no-regret measures. It is not only applicable to water management, but can be applied to any decision-making challenge under deep uncertainty and problems that can be categorised as 'wicked problems'.

Table 6.1: Theoretical framework for the identification and description of no-regret measures

Theme	Description
Uncertainty	Perception of uncertainty and risk
Timing	Perceptions and preferences for long-term and short-term planning
Qualitative	Perceptions on qualitative factors
Adaptivity	Perceptions on adaptivity, flexibility and path-dependency
Process	Perceptions on the relationship between process and results

The review of the state-of-the-art has revealed three perspectives have been identified from Cultural Theory that most apply to water. In the hierarchist perspective, nature is controllable and the government should take responsibility for controlling it, relying on expert knowledge and technology. Water is mainly seen as a threat to human safety. A sustainable water system highlights safety and flood control and leaves space for some economic and natural development. As a consequence, preferred water policy options are: building dikes, levelling up or widening dikes, and channelling. In the Egalitarian perspective, nature is not and should not be controlled. They urge for more space for nature, water and natural developments, and call for participatory decision making processes with a more equal voice for everyone. In the individualist perspective, water is not seen as being a threat: water offers great opportunities in terms of economy, images, creativity, self development and recreation. They claim for an adaptation approach, great trust in technology and a liberal market. On correspondence with their beliefs, their preferred water management policies focus on innovative projects, like amphibian living, living on water, and building off shore-islands. Changes and uncertainties are interpreted as challenges and can, in principle, be solved. This perspective is characterised by a large belief in market mechanisms and technology.

6.2. Perspectives identified in participants

A Q-methodology study with 29 participants has resulted in the extraction of three factors with a total explained variance of 50%. The three factors were translated to narratives and perspectives, that can be described using the aforementioned theoretical framework.

Table 6.2: Summary of all identified perspectives

Theme	Perspective A: technocratic design	Perspective B: adaptive egalitarian	Perspective C: minimalist innovation
UNC	Uncertainty can be 'tamed' with good research, technology and increased safety margins	Adaptivity accounts for uncertainty, social uncertainties are relevant and should be accounted for	Uncertainties in the future are too large to all account for, but innovation can contribute future-proof solutions
TIME	Preference for long-term planning	Adaptivity allows long-term planning	Preference for short-term implementation of no-regret measures
QUAL	Landscape and spatial quality are important, the design of a single construction is not	Social robustness is highly valued, spatial quality also	Qualitative factors are of minor importance, compared to its primary (safety) functions
ADAP	Adaptivity is not strictly necessary but depends on the measure itself	No-regret measures should be adaptive	Adaptivity is not strictly necessary, but can be useful
PROC	Good communication is more important than absolute transparency	Participation, transparency and equity in the process ensure positive results	Communication and transparency are important, but investing in it is not strictly necessary

Four consensus statements were found, that do not distinguish between any pair of perspectives. However, one step further it becomes clear that all three perspectives interpreted the consensus statements differently. Most importantly, all perspectives agree that researching problems as early as possible and a wide exploration of future scenarios are strictly necessary to identify no-regret measures. This poses new questions of *how* and *on what* research should be conducted. Perspective A, the technocratic design perspective values (technically) robust decisions that remain robust under a wide range of future scenarios. Research should therefore focus on robustness testing and scenario analysis. Perspective B, the adaptive egalitarian perspective, also values a participatory research and design process. Their main starting point is that policies should remain socially robust in the future, and that this is only possible through stakeholder participation at an early stage to capture as many

views as possible. Perspective C, the minimalist innovation, highly values technological advancement and innovation. They see the no-regret approach as sometimes over-precautionary and a potential threat to innovation. No-regret measures should be safe, simple measures on a small scale that can be implemented on the short term.

All perspectives furthermore agree that a no-regret strategy does not require a grand approach to prevent requiring additional measures afterwards. The most common explanation is that requiring additional measures afterwards is actually desirable. Especially participants in Perspective B explain that measures should be adaptive and flexible, to *allow* additional measures afterwards.

Almost all of the responses also agree that preventing reputational damage is not the main purpose of no-regret measures. However, this does not mean reputational damage is not important. In the adaptive egalitarian perspective, social robustness is highly valued. History has shown that the reputation of water management institutions is of significant influence to the social robustness and to the success of a policy. How should the reputation and social robustness be ensured? All perspectives value transparency in decision-making. Perspective A also highly values clear communication with stakeholders, which is something worth investing it. In Perspective B, the social robustness is ensured through stakeholder participation and an egalitarian approach towards the distribution of costs and benefits.

The views on adaptivity form a clear contrast between the technocratic design perspective and the adaptive egalitarian perspective. The own definition of a no-regret measure by participants in Perspective A frequently mention robustness as the key design principle. In Perspective B, adaptivity and flexibility are most frequently mentioned.

6.3. Implications of perspectives on the decision-making process

A significant level of consensus has been found among the participants of this research. The correlations between the perspectives is relatively high, indicating that the perspective have overlapping views. While views are shared, there is also significant disagreement. The variance in rankings of statements related to uncertainty and adaptivity show that the interpretation of these concepts are subjective. As all participants agree that research and scenario exploration are essential, these different views further support the argument that subjectivity in decision-making models should be made more explicit.

The results also show that all perspectives agree on the importance of communication with stakeholders and transparency of the decision-making process. However, the adaptive egalitarian perspective also highly values stakeholder participation and calls for active involvement of stakeholders in the decision-making process. Other perspectives disagree and believe the process should focus on the scientific and technical design, which should be communicated with stakeholders to ensure social robustness.

Historical analysis has furthermore shown that the dominant perspective can change due to events in the political and societal arena, and due to natural events. These changes are also happening right now. This does not mean that the perspectives themselves will change rapidly, but it further supports the argument that considering them is important, especially now.

6.4. Managing different perspectives

The level of consensus among participants is a good starting point for the decision-making process. We have seen that the role of adaptivity is heavily debated, but since adaptive policy-making is relatively new and the term itself can be vague, the disagreement could be solved by clarifying arguments. Although the consensus is relatively large, the differences between the identified perspectives in their views of uncertainty, the controllability of nature and how the design process should be shaped, imply

fundamentally different world views similar to previously identified perspectives from Cultural Theory. Put more simply, if the entire sector of integrated water management policymaking was staffed with only technocratic designers, adaptive egalitarians or minimalist innovators the designed policies would be vastly different. Previous studies on perspectives has shown that the utopias of one perspective are dystopian in other perspectives. While reality is more nuanced, fundamental differences in world views remain difficult to change. This research has identified these perspectives for no-regret measures and provided their *general* world views and preferred management styles, but this remains an exploration. The goal of this research was to identify perspectives that *can* influence the (outcome of) the decision-making process. The fact that they can influence is has become clear, but exactly how requires more research. Being aware that they exist is the important first step in creating a better understanding of the different views, which is the relevant contribution of this research.

6.5. Further research

This research is exploratory and therefore used a wide scope without did not focus on any specific part of integrated water management. The first recommendation to further research is to conduct similar research with a more specific scope which allows the comparison of specific measures, for example by focusing on coastal defence in a specific area. This would allow researchers and policy analysts to provide more concrete recommendations on how no-regret measures can be defined for a specific project. The theoretical framework can also be applied on a smaller scale. If similar research is do The second recommendation is to conduct similar research on the role of adaptivity. Clarifying the arguments for adaptive policies can be of significant contribution to the decision-making process. Several responses, especially in Perspective A, mentioned that whether or not a measure should be adaptive depends on the measure itself. By conducting similar research on adaptivity we can gain insight on exactly *what* it depends on to gain a better picture of the adaptive planning in climate adaptation. Here it can also be valuable to first conduct research with a large scope for exploration, and later narrow it down to specific cases to allow researchers to present more concrete recommendations. Research on the role of adaptivity should furthermore more explicitly include the themes of reversibility and (irreversible) ecological impact, as these are important themes that several participants in this study mentioned were missing in the statements. The third recommendation is to also take into account the different perspectives in research itself. A significant part of the participants in this study were researchers, but their perspective cannot be significantly correlated with the fact that they are researchers. Thus, perspectives also vary among researchers. We have also seen that subjectivities are very much present in decision-making models. As they have become more powerful and more important in the past decades, the findings of this research show that the perspectives can also be of influence to the policy analysis and the models used for it. Further research is therefore recommended into how these perspectives influence the models and their outcomes.

6.6. Final remarks

The goals of this research were to:

A identify perspectives on no-regret measures
B define possible implications on decision-making in integral water management
C present recommendations for actors to account for these perspectives in the decision-making process

The most important contributions of this research are the theoretical framework, a contribution to the debate on no-regret measures and adaptive policies, and the (partial) validation of previous findings on perspectives in Dutch water management. The theoretical framework for the identification and description of no-regret measures is grounded in literature from a vast array of disciplines and is therefore also applicable in various fields. The framework can generally be applied to all policy problems concerning decision-making under deep uncertainty and wicked problems. The debate on no-regret measures and what they actually mean is still at an early stage, and this research has contributed to the debate by mapping the different views and arguments of experts in integrated water management. The views of the participants in this study are different from the views in a previous report, which creates more food for thought and debate. The perspectives identified in this research show significant similarities with perspectives identified in previous research. The goal was not see if the 'old' perspectives hold true for no-regret measures, but the results of this research show that they, to a significant extent, do. The basic, underlying question of this research was: what does regret mean in water management? The goal has never been to provide a deterministic answer, but to map the different views on this question. The different views have been explored and identified, but also pose new questions that hopefully will be explored further by other researchers.

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A

Appendix A

This appendix contains all the relevant methodological background information. They are relevant because they can be used to reproduce this research in a different context.

A.1. Q-set

A.1.1. Concourse on (no-)regret

1. Vooraf: het streven naar geen-spijt vind ik een laffe redenering. Want het betekent er voor waken dat je je ergens een buil aan kunt vallen, en dat doe je alleen maar als je bang bent (de Jonge et al., 2022)
2. Ten éérste: voor geen-spijt moet het volgens mij nieuw zijn, dus geen routine. (de Jonge et al., 2022)
3. En ten tweede: het moet duurzaam zijn op de echt lange termijn. (de Jonge et al., 2022)
4. Denk erom, als er techneuten in de buurt zijn, dan versmalt de wereld. Dan zoeken ze alleen naar technische innovaties. Maar als je het aan de achterkant niet goed geregeld hebt, als er geen budget is en geen draagvlak, dan heb je tegenwerking en krijg je niets gedaan (de Jonge et al., 2022)
5. Het is wel belangrijk dat iemand die leiding geeft aan zo'n project ook van de inhoud weet, die de essentie snapt. Die weet wat belangrijk is en waar je wel je nek op kunt breken en wanneer niet, vakmanschap. Anders kom je er niet (de Jonge et al., 2022)
6. Maar er zwelt een klimaatprobleem aan: de te keren hoogwaterstanden worden steeds hoger. Eens komt er een moment dat het kerend vermogen te klein is. En dan heb je hier een constructie van beton en staal die misschien niet of heel moeilijk te versterken valt. (de Jonge et al., 2022)
7. Dat is precies het verschil tussen no-regret door uit voorzorg niks te doen en enige kans op regret te accepteren. Ik denk dat een veiligheidsfactor meenemen voor zeespiegelstijging altijd no- regret is. (de Jonge et al., 2022)
8. Maar bij de Oosterscheldekering twee meter erbij optellen was niet gelukt. Wij hadden chronisch geld tekort. Er was ten eerste te laag geraamd, anders hadden we überhaupt niet aan de kering mogen beginnen. (de Jonge et al., 2022)
9. Maar het was nog niet verankerd in het denken. En verder mochten we het er ook niet over hebben; dat waren de orders. (de Jonge et al., 2022)
10. Dus dat het eigenlijk gaat om goed onderhoud van infrastructurele werken. Dàt is no-regret. (de Jonge et al., 2022)

11. In een dijkversterkingsproject moet je soms natuurlijk kiezen tussen twee partijen. Het blijft een afweging. Maar in evaluaties van dijkversterkingsprojecten die ik heb gedaan heeft men durven opschrijven dat het draagvlak onder de bewoners, landschapsbeheerders en natuurbeschermingsorganisaties niet is kwijtgeraakt. Ze hebben altijd hun zegje kunnen doen. En daar ben ik best een beetje trots op. (de Jonge et al., 2022)
12. Dat betekent dus dat het buitengewoon belangrijk is dat je de bevolking en direct belanghebbenden laat zien wat je doet. Dat je transparant bent en je verhaal durft te vertellen en gaat vertellen. (de Jonge et al., 2022)
13. Het vraagt wel dat bij het ontwerpen met meer respect moet worden gekeken naar hoe een dijk in het landschap ligt: is het een natuurgebied of gebouwde omgeving, liggen er cultuurhistorische monumenten, hoe kunnen we die sparen? (de Jonge et al., 2022)
14. In die tijd werd er ook niet transparant gewerkt. Terwijl dat juist zo belangrijk is (de Jonge et al., 2022)
15. Ik durf wel te zeggen dat we bij het waterschap regelmatig onze nek hebben uitgestoken om meer dingen mee te nemen om om het mooier te doen dan voor de veiligheid strikt nodig was. Daar ben ik trots op. (de Jonge et al., 2022)
16. In het algemeen geldt: waar er belangrijke waarden gespaard kunnen worden – dat kan landschap zijn of een mooi historisch pand –, kun je er voor kiezen veel geld te besteden. Dan heb je èn een stabiele dijk èn een cultuurhistorisch monument gespaard (de Jonge et al., 2022)
17. Als je adviesbureaus de ruimte geeft om over niet-conventionele oplossingen na te denken en zelf bereid bent wat risico te nemen leer je ervan. (de Jonge et al., 2022)
18. Als je met de auto over de oude dijk rijdt, kun je niet op de rivier kijken en is dus een stuk uitzicht weggenomen. (de Jonge et al., 2022)
19. Als je in één keer een forse maatregel neemt, dan hoef je een heleboel kleine maatregelen voor een hoge afvoer achteraf niet te doen en hoeven die minder ingrijpend te zijn. (de Jonge et al., 2022)
20. Mijn standpunt blijft dat je het lef moet hebben wat verder in de toekomst te kijken (de Jonge et al., 2022)
21. En ten tweede dat je het lef moet hebben transparant te zijn over je plannen. (de Jonge et al., 2022)
22. Eigenlijk is het in het algemeen heel belangrijk dat je meekoppelkansen zo veel mogelijk probeert te grijpen. (de Jonge et al., 2022)
23. Het zit hem in natuurontwikkeling of kleine recreatievoorzieningen: een fietspad, een wandelstructuur. Je krijgt er eigenlijk nooit spijt van, maar wel veel meer draagvlak (de Jonge et al., 2022)
24. Je moet van te voren alvast nadenken over wat fout kan gaan, en daar strategieën voor bedenken. Ik merk vaak dat het denken in scenario's toch nog heel weinig gebeurt. (de Jonge et al., 2022)
25. En dan nog één: probeer het project zo vorm te geven dat je zo min mogelijk van techniek afhankelijk bent. Je ziet vaak bij projecten dat er zoveel technische eisen zijn, dat er bijna niet meer aan te voldoen is. Daar moeten we veel kritischer op worden, dat het te zeer stapelen van technische eisen projecten financieel onhaalbaar maakt. (de Jonge et al., 2022)
26. Er wordt al veel geïnvesteerd in cybersecurity, maar daarvan moet je eigenlijk niet afhankelijk willen zijn. (de Jonge et al., 2022)
27. Ik heb dus spijt van het feit dat ik het management niet heb kunnen overtuigen om de hele Waal aan te pakken om bodemerosie tegen te gaan. (de Jonge et al., 2022)
28. Bij Ruimte voor de Rivier is scheepvaart het ondergeschoven kindje gebleven. (de Jonge et al., 2022)
29. En toegegeven: dat is niet nu, maar begint al wel nu en wordt de situatie pas over goed dertig jaar, maar dan zijn de kosten gauw orde een miljard. Zet dat geld nu maar weg voor onderzoek en reservering voor maatregelen! (de Jonge et al., 2022)
30. Nou ja, spijt .... ik heb er jaren voor gepleit tot op het hoogste niveau. En het is me een raadsel waarom er nooit wat mee is gedaan. Wellicht is een verklaring dat er te weinig experts hoog in de top zitten. (de Jonge et al., 2022)

31. Ik heb er spijt van dat dat probleem niet is opgepakt, onder het mom van ‘het kost geld’. Gebrek aan geld is niet erg, gebrek aan visie is erg. Geld komt altijd wel als je een goed verhaal hebt. (de Jonge et al., 2022)
32. Waar ik dan vervolgens ‘maatschappelijke spijt’ van heb, is dat die modellen niet worden ingezet voor de verkenning van strategieën om erosie tegen te gaan. (de Jonge et al., 2022) ”
33. Monofunctionele oplossingen zijn per definitie regret-oplossingen. (de Jonge et al., 2022)”
34. Kijk, bij projecten gaat het vaak om het spelletje tussen opdrachtgever en opdrachtnemer. Soms heeft spijt in een project er mee te maken dat dat samenspel niet goed gaat. Het kan ook met de aanbestedingsvorm te maken hebben. Of iets wel of niet slaagt – en of je er dan dus spijt van hebt – heeft dus te maken met de relatie tussen opdrachtgever en opdrachtnemer. (de Jonge et al., 2022)
35. Ik heb er spijt van dat het me toen niet gelukt is het integraal aan te pakken. (de Jonge et al., 2022)
36. Ik ben allergisch voor de Haagse kreet ‘sober en doelmatig’. (de Jonge et al., 2022)
37. Ik vind, als je investeert moet je vijftig jaar vooruit kijken. Want infrastructuur heeft minimaal die levensduur. (de Jonge et al., 2022)
38. Daarnaast moet je niet alleen kijken naar de kosten van het project zelf, maar ook naar de maatschappelijke kosten. (de Jonge et al., 2022)
39. Kijk, je kunt niet alles voorspellen, maar je kunt wel flexibel en adaptief zijn. Timmer niet alles dicht, maak een beetje overcapaciteit zodat je flexibel bent. (de Jonge et al., 2022)
40. Ik ben dus trots op projecten als ze toekomstvast zijn, maar ook de vormgeving is belangrijk. Als je iets doet, doe het dan in één keer goed, daar heb je later plezier van. (de Jonge et al., 2022)
41. Daarnaast, zoals ik al eerder zei, als iets mooi is dan onderhoudt het zichzelf (de Jonge et al., 2022)
42. De rol van zo’n sluis is niet alleen functioneel – bootjes schutten–, maar heeft ook een belevingscomponent. Daar ben ik trots op dat dat gelukt is. (de Jonge et al., 2022)
43. Dat is weer dat ‘sober-en- doelmatig denken’ vanuit Den Haag. (de Jonge et al., 2022)
44. Een van de lessen waarom het bij grote projecten fout kan gaan, is dat in de uitvoering nog allerlei lieden iets bedenken, en dat dat er nog ingefrommeld moet gaan worden. Je moet vanaf het begin zeggen wat je allemaal wel wil. (de Jonge et al., 2022)
45. Maar ik had ook een heel grote communicatie-afdeling. Waarom doe je dat nou? Nou, dan creëer je dus trots bij de bewoners. Vier successen, ook tijdens het proces. (de Jonge et al., 2022) ”
46. Ik heb overigens wel spijt van het feit dat bewoners en bedrijven vanaf de start van het project zo’n tien jaar in onzekerheid hebben gezeten over wat er met het gebied zou gebeuren. Al die tijd kunnen ze niet investeren, en dat doet wat met mensen; (de Jonge et al., 2022)”
47. Denk vanuit de lange termijn en neem beheer en onderhoud ook mee in je afweging; dat kan door life-cycle costing. Als je alleen naar de aanlegkosten kijkt en dan de goedkoopste kiest, ben je verkeerd bezig. Want als je de lange-termijn onderhoudskosten meeneemt, zie je dat je vaak op meerkosten uitkomt. (de Jonge et al., 2022)
48. Bij een kosten-batenanalyse kun je niet alles in cijfers beoordelen. Kwaliteit kun je ook scoren met een plus, min of nul. (de Jonge et al., 2022)
49. Het is verstandig om je ontwerp multifunctioneel te maken. Monofunctionele oplossingen zijn bijna per definitie regret-oplossingen, omdat die ten koste gaan van andere functies. Dat krijg je later met een boemerang nog een keer terug. Dit betekent ook dat je eigenlijk altijd interdisciplinair moet werken. En wees je bewust van tegenstrijdige belangen, neem die mee en wees transparant over waarom je dingen wel en niet doet. (de Jonge et al., 2022)
50. En waarom moet er expliciet ruimtelijke kwaliteit bij, maar zonder extra geld? Maar later ben ik het gaan zien als een legitimatie voor dat wat je ontwerpt en aanlegt er dus ook okay uit moet zien. (de Jonge et al., 2022)
51. Er zijn duidelijke kaders van wat rivier is, wat land is; wat natuur mag worden, waar gerecreëerd wordt. Ondanks dat het een geïntegreerd ontwerp is, zijn de lijnen heel helder. (de Jonge et al., 2022)
52. De bottom-line is: hou het simpel, maar denk toch groot. (de Jonge et al., 2022)

53. Ik denk dat Ruimte voor de Rivier dan een betere oplossing is dan hogere dijken. Ik zie dat wel als no-regretstrategie. (de Jonge et al., 2022)
54. Alles wat adaptief is, gaat gewoon heel veel ruimte vragen. En in Nederland is het natuurlijk al een wedstrijdje ruimte claimen. Hoe ga je dat vormgeven? Dat wordt de volgende opdracht. (de Jonge et al., 2022)
55. Waarom wordt geld uitgeven voor duurzaamheid zo ingewikkeld gevonden? Omdat men er in zijn eigen leven geen last van zal hebben. Als het urgentiebewustzijn er niet is, gaan mensen het doel ter discussie stellen. (de Jonge et al., 2022)
56. Dat is de reden dat Ruimte voor de Rivier goed gefunctioneerd heeft: er lag een hard getal. Het doel, 16 duizend kuub water per seconde veilig afvoeren, met een doorkijk naar 18 duizend kuub, was heel belangrijk. Het doel moet helder en communiceerbaar zijn en een realiteitszin hebben. (de Jonge et al., 2022)
57. Als ik ergens spijt van heb, is het van dingen die niet gebeurd zijn, in plaats van van dingen die wel gebeurd zijn. (de Jonge et al., 2022)
58. Dat is een les: je moet het scherp houden, je moet kiezen. Je moet naar de burgers het eerlijke verhaal vertellen, geen schone schijn ophouden, dus gewoon eerlijk je intenties laten zien. En dan een keuze maken en je daar aan houden. (de Jonge et al., 2022)
59. Over die morfologie gesproken, waar ik nooit uitgekomen ben met mijn scheepvaartcollega's, is dat zij alles met techniek willen oplossen. (de Jonge et al., 2022)
60. Dat is dus escalerende techniek, en daar gaan we later spijt van krijgen. (de Jonge et al., 2022)
61. Als ik er zo over nadenk: sleutelwoorden voor no-regretmaatregelen zijn toch wel adaptief, simpel en robuust. (de Jonge et al., 2022)
62. One reason why regret may be deemed irrational is because it can be viewed as a sunk cost. A sunk cost is a cost made in the past. According to rational choice theory, only incremental costs and benefits should affect decisions about future events. Honouring sunk costs is considered to be irrational (Zeelenberg, 1999)
63. There are several ways in which anticipated regret may inflence our decisions. First, we may avoid deciding as a consequence of anticipated regret. We can do this simply in order to avoid making the wrong decision. (Zeelenberg, 1999)
64. Another way in which anticipated regret may influence decisions is related to post-decisional feedback. Since regret stems from comparisons between outcomes of the chosen and non-chosen options, decision makers can try to avoid regret by avoiding feedback about non-chosen options. (Zeelenberg, 1999)
65. Is it rational for our decisions to be influenced by anticipated regret? (Zeelenberg, 1999)
66. Is it rational for our decisions to be influenced by experienced regret? (Zeelenberg, 1999)
67. The influence of experienced regret cannot be considered rational, but it can sometimes be functional. (Zeelenberg, 1999)
68. A bad outcome resulting from action seemed to be more regrettable than the same bad outcome when it was the result of inaction. (Connolly & Zeelenberg, 2002)
69. These results suggest that people are less susceptible to regret than they imagine, and that decision makers who pay to avoid future regrets may be buying emotional insurance that they do not actually need. (Gilbert et al., 2004)
70. Subjects reacted more strongly to adverse outcomes caused by action, whether the status quo was maintained or not, and subjects preferred inaction over action even when inaction was associated with change. (Ritov & Baron, 1992)
71. People regret outcomes that could have been changed in the past but can no longer be changed and for which people experience low psy- chological closure. (Beike et al., 2009)
72. No-regret strategies yield benefits even in the absence of climate change (Hallegatte, 2009)
73. favouring reversible and flexible options (Hallegatte, 2009)
74. buying "safety margins" in new investments (Hallegatte, 2009)
75. promoting soft adaptation strategies, including long-term prospective (Hallegatte, 2009)
76. Strategies that reduce decision-making time horizons (Hallegatte, 2009)
77. No-regret strategies yield benefits even if forecasts reveal wrong. (Hallegatte et al., 2012) "

78. Decision-making 'on actions in a sea of uncertainties' forces us to clarify the links between the 'efficiency principle' and the 'precautionary principle' both retained in the drafting of the 1992 Rio Climate Convention. (Hourcade & Chapuis, 1995)"
79. a moderate amount of no-regret potentials launched over the short-term in connection with research and development programs would totally alter the perception of our capacities to face an important but controversial risk without entailing extremely high costs in either the short- or the long- term. (Hourcade & Chapuis, 1995)
80. Beyond, the importance of short-term decisions for managing a precautionary strategy in the face of an uncertain risk, is all the more critical that, symmetrically with the 'no-regret' strategies, one should account for 'regret behaviours'. (Hourcade & Chapuis, 1995)
81. Adaptive management planning should rely on a sound ex-ante policy analysis which encompasses a future outlook, establishing whether a policy transition is required, an assessment of alternative flood risk management strategies, and their planning in anticipation without running the risk of regret of doing too little too late or too much too early. (Klijn et al., 2015)
82. Aim for synergies with goals and development initiatives by other public and private parties, which reduces the likelihood of regret because of the other benefits achieved. (Van Rhee, 2012)
83. Seek and value flexibility in individual measures and comprehensive strategies in order to allow for speeding up or slowing down and to prevent regret of under-performance or over investment and related to this. (Van Rhee, 2012)
84. Search for adaptation pathways with successive decision points in time rather than aim for a final situation at some point in the future ('blue-print planning') to allow for adaptation over time. (Van Rhee, 2012)
85. Short-term decisions should contribute to long-term objectives. (Van Rhee, 2012)
86. This calls for a broader view on the aims of flood risk management: not only a focus on immediate economic benefits and the repairing of thoughtless or badly informed planning in the past by better flood protection but also attention for how we should ensure a more sustainable future by really anticipating developments in the next decades and even centuries and act upon these insights. (Klijn et al., 2015)
87. In particular, people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty. This tendency, called the certainty effect, contributes to risk aversion in choices involving sure gains and to risk seeking in choices involving sure losses. (Kahneman & Tversky, 1982)

A.1.2. Definitive Q-set in Dutch

1. Alle spijt willen voorkomen is onmogelijk en moet daarom niet het doel zijn.
2. Een extra veiligheidsmarge voor zeespiegelstijging meenemen in het ontwerp is no-regret.
3. Het ontwerpproces van een no-regret strategie moet volledig transparant zijn.
4. Investeringen in communicatie en transparantie met alle stakeholders, zijn no-regret investeringen.
5. Een no-regret oplossing moet net zoveel aandacht besteden aan andere factoren zoals landschap, cultuurhistorie en kwaliteit van de leefomgeving.
6. Te veel focus op no-regret kan vooruitgang beperken: juist door af en toe wat meer risico te nemen komt er ruimte voor innovatie en nieuwe kennis.
7. Een no-regret maatregel moet berusten op kennis en methodes die in de praktijk bewezen effectief zijn gebleken.
8. Een no-regret strategie moet een grootse aanpak hebben, om te voorkomen dat aanvullende maatregelen achteraf nodig zijn.
9. De voordelen van ontwerpen voor de lange termijn wegen op tegen de risico's m.b.t. onzekerheden in de toekomst.
10. No-regret maatregelen zijn vooral een middel om reputatieschade, en daarmee spijt, te voorkomen.

11. No-regret maatregelen moeten alle mogelijke kansen aangrijpen om andere doelen, naast het hoofddoel, in het ontwerp te integreren.
12. De keuze voor een no-regret oplossing is een afweging tussen efficiëntie en voorzichtigheid, waarin de mate van onzekerheid de bepalende factor is.
13. Het zo vroeg mogelijk onderzoeken van problemen en een brede verkenning van scenario's zijn voorwaarden om tot no-regret oplossingen te komen.
14. No-regret maatregelen kunnen het beste op de korte termijn ingezet worden om een grotere strategie op gang te krijgen.
15. Een no-regret oplossing mag niet te afhankelijk zijn van techniek.
16. In het ontwerpproces van een no-regret strategie moeten alle stakeholders gehoor krijgen.
17. Een no-regret oplossing mag niet te afhankelijk zijn van informatietechnologie en daarmee ook cybersecurity.
18. Monofunctionele oplossingen (bijv. alleen veiligheid) zijn per definitie regret-oplossingen.
19. De keuze voor een no-regret oplossing is een afweging tussen efficiëntie en voorzichtigheid, waarin de grootte van de risico's de bepalende factor is.
20. Om no-regret te zijn moet bij een investering verder vooruit gekeken worden dan de minimale levensduur van een maatregel.
21. No-regret oplossingen moeten adaptief en flexibel zijn.
22. Een waterbouwkundige constructie of maatregel mag niet ten koste gaan van andere functies, tenzij deze gecompenseerd worden.
23. De maatschappelijke kosten en baten van een maatregel of strategie moeten zo gelijk mogelijk verdeeld worden.
24. Adaptief beleid is niet per definitie no-regret, omdat bepaalde oplossingsrichtingen en bestemmingen dan op voorhand worden uitgesloten.
25. Investeringen in de vormgeving van een constructie zijn no-regret investeringen.
26. Door te veel focus op no-regret worden moeilijke en urgente keuzes uitgesteld.
27. De keuze voor een no-regret oplossing is een afweging tussen efficiëntie en voorzichtigheid, waarin de urgentie de doorslaggevende factor is.
28. Een maatregel is alleen no-regret als het waardevol is in alle toekomstscenario's, dus zowel de worst-case als best-case (klimaat)scenarios.
29. Het is niet mogelijk om no-regret oplossingen te bedenken voor de lange termijn, vanwege de te grote onzekerheden in de toekomst.

A.2. Surveying techniques

A.2.1. Software

The web-app was built using the EQ Web configurator by Shawn Banasick (2022)[1]. The data analysis and factor extraction was done using the Ken-Q Analysis Desktop Analysis Desktop Edition (Banasick, 2019). Both software tools are free to use, redistribute and/or modify under the GNU General Public License as published by the Free Software Foundation.

A.2.2. Opening statement (Dutch)

Afgelopen jaar publiceerde Deltares het rapport 'Trots en spijt in de waterbouw'. Hierin is een verkenning gemaakt van wat 'spijt' en 'no-regret' betekenen in de waterbouw, en hoe we in de toekomst spijt kunnen voorkomen. Voor mijn afstudeerscriptie Engineering & Policy Analysis aan de TU Delft ben ik dit verder gaan onderzoeken. Het doel van dit onderzoek is om perspectieven over spijt en no-regret in kaart te brengen, onder personen die meewerken aan het maken, uitvoeren en onderzoeken van

[1] Available for free at: https://github.com/shawnbanasick/eq_web_configurator

ons waterbeleid. Dit gebeurt door middel van de Q-methode, waarbij respondenten een set stellingen beoordelen en sorteren (Q-sorts). Daarna kunt u een aantal van uw keuzes kort toelichten. Tot slot volgen enkele persoonlijke vragen. Door middel van factoranalyse op de Q-sorts kunnen gedeelde perspectieven geïdentificeerd worden. De persoonlijke vragen helpen bij het verklaren van de gevonden perspectieven. Het onderzoek wordt uitgevoerd vanuit de TU Delft. Deltares heeft een hierin adviserende rol. De resultaten worden gepubliceerd volgens de TU Delft richtlijnen. De data die gepubliceerd worden bestaan uit:

- Q-sorts
- Leeftijdscategorie
- Gelsacht
- Opleidingsachtergrond
- Professionele achtergrond
- Antwoorden op de open vragen (geparafraseerd indien deze persoonlijke informatie bevatten)

Er worden dus geen namen of contactgegevens gepubliceerd. Voor de administratie van het onderzoeksproject worden deze wel bewaard, maar verwijderd zodra het onderzoek is afgerond. **Door op 'Ga verder' de klikken gaat u hiermee akkoord.**

A.2.3. HREC approval

The research has been carried out according to the guidelines of the TU Delft Human Research Ethics Committee (HREC). A Data Management Plan has been submitted to, reviewed and approved by the HREC[2].

[2] http://hrec.tudelft.nl

B

Appendix B

Table B.1: Complete Q-sorts table

P	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29
1	0	0	0	3	1	2	3	-3	4	0	-3	-2	2	-2	1	2	-2	-4	-1	1	-4	-3	-1	0	1	4	-1	3	-1
2	1	0	0	-2	2	-3	-2	1	2	-3	-1	0	3	3	2	0	1	-1	1	4	4	-1	3	-1	-3	-4	-2	0	-4
3	2	3	0	1	1	-3	-2	-4	1	-2	0	-1	3	-4	0	1	0	-1	-3	4	4	2	2	3	-1	-3	-2	0	-1
4	2	0	-1	0	3	2	-3	-2	4	-4	3	2	4	1	-1	0	-3	0	-1	3	-2	1	-1	1	-4	-2	0	1	-3
5	3	0	0	1	-2	4	4	-2	-1	-3	1	0	2	0	-3	3	2	-2	1	-3	3	-1	-1	-1	-4	-4	0	2	1
6	3	3	-1	1	0	1	0	0	2	-3	0	0	4	-3	-4	-1	-1	-2	2	2	-4	-3	-2	-1	1	1	4	3	-2
7	4	3	4	0	1	1	-1	-4	-2	-3	2	-1	3	-2	-4	2	-1	-2	0	1	0	1	-1	-3	0	2	0	-3	3
8	2	3	0	1	-1	3	-2	-4	2	-4	1	0	4	-3	3	1	-1	0	0	4	-2	-3	-2	1	-3	2	0	-1	-1
9	3	-2	3	2	4	-3	0	-1	1	-1	1	0	1	-2	0	2	0	-1	-4	0	4	3	2	1	-3	-3	-4	-1	-2
10	0	-2	1	1	1	1	-3	-1	3	-4	-2	0	4	3	-3	4	0	-3	0	3	2	-1	2	0	-4	-1	-1	2	-2
11	-3	4	-2	3	-1	1	-1	0	4	-4	3	-2	2	1	-2	1	-1	-3	0	3	-1	0	2	1	0	2	-3	0	-4
12	0	-1	-2	-4	-2	4	-1	1	-2	0	1	4	3	3	-3	-1	-3	0	2	0	-1	2	-3	1	-4	0	3	1	2
13	2	1	1	3	3	1	-3	-3	0	2	0	4	1	-2	-4	-1	-4	-2	0	0	2	-1	-1	0	-1	3	-2	4	-3
14	1	2	4	-3	-1	3	1	-1	3	-4	0	-2	2	2	-1	-3	3	0	0	-4	1	0	4	1	-2	-1	0	-2	-3
15	4	0	3	3	-2	1	2	-4	1	-4	-1	2	2	-1	-2	1	3	-3	0	-3	4	-1	0	1	-2	0	0	-1	-3
16	1	-1	4	-4	0	2	-1	0	-1	-4	-1	-3	4	0	0	3	1	-3	-2	2	1	0	2	3	-3	3	-2	1	-2
17	2	1	3	1	0	-1	2	-4	3	-2	2	0	0	0	-1	4	-3	-1	-3	1	3	-2	-1	0	-4	-2	4	1	-3
18	3	-3	3	4	1	0	-1	-4	4	-4	0	-2	1	1	-3	2	-1	3	0	-2	2	-1	2	0	1	0	-1	-3	-2
19	4	0	3	-4	-1	0	4	0	2	1	-2	1	3	2	-3	-2	-3	-3	1	0	-1	-4	1	-1	-2	2	3	0	-1
20	2	3	3	1	-1	2	-1	-3	0	-4	2	0	1	4	-2	1	-2	-3	-2	-1	-4	-1	0	4	-3	0	3	1	0
21	4	3	-2	3	2	3	0	-2	1	-4	1	1	2	2	-1	1	-3	-3	-1	-1	-1	0	0	-3	0	4	-4	0	-2
22	0	-4	0	-2	0	2	-3	0	-3	-1	3	-2	0	2	-2	2	-1	-4	1	4	4	-3	1	-1	-1	3	3	1	1
23	0	-1	3	2	3	1	-2	-4	1	-4	-2	1	3	1	-2	4	0	0	2	0	0	-1	4	-1	-3	2	-3	-1	-3
24	3	-1	1	1	3	0	2	-4	0	-3	1	-4	3	-2	-2	2	1	0	2	0	4	-1	4	0	-3	-2	-1	-1	-3
25	4	3	1	1	1	4	-2	-3	2	-4	0	0	1	3	-1	2	-1	-2	0	2	-1	-3	-3	-2	-4	3	0	0	-1
26	0	-1	0	3	1	1	0	2	2	-1	-2	3	4	1	-3	3	-3	-3	2	-1	-2	-4	1	0	-1	0	-2	4	-4
27	3	-1	3	2	1	0	1	-4	2	-2	-3	0	2	-1	0	1	0	-3	0	4	3	-3	1	-1	-2	-4	-2	4	-1
28	4	2	0	-2	2	3	1	-3	3	-4	-1	1	3	0	-3	-3	-1	-1	4	0	-2	-2	1	0	0	1	-4	-1	2
29	3	1	1	4	-1	-1	1	-1	2	-4	0	0	4	3	2	0	0	-1	-2	2	1	-2	-2	-3	-4	0	-3	3	-3