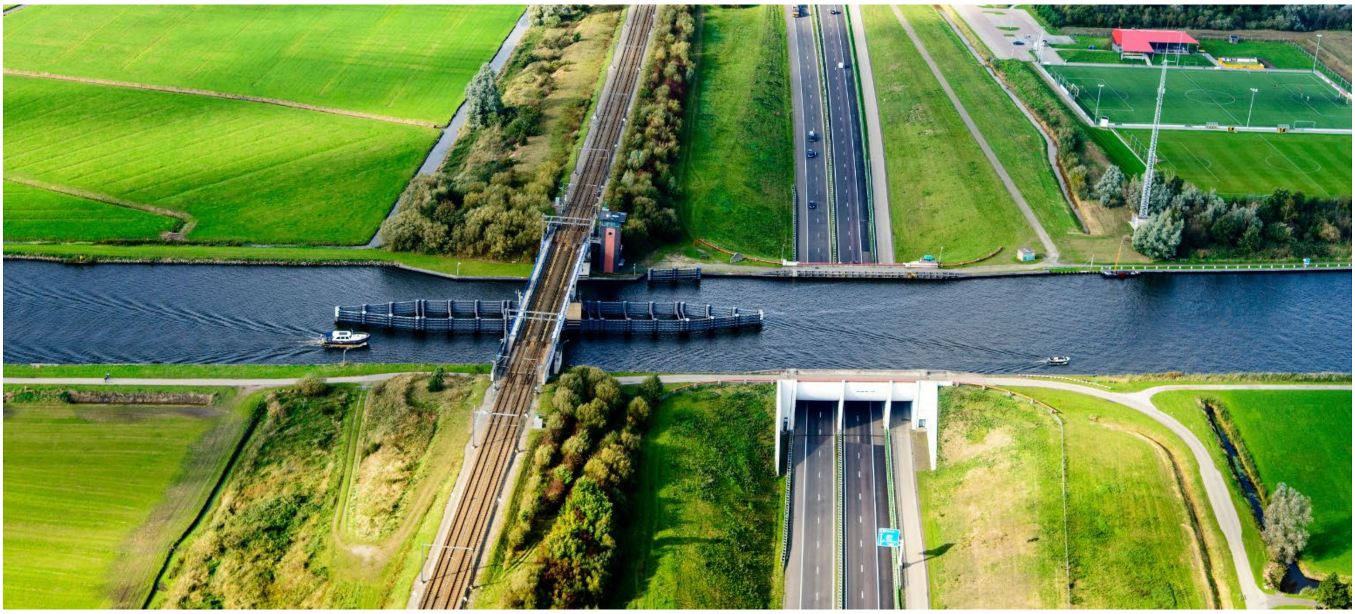
How Epistemic Communities Shape Dutch Flood Risk Management

An Analysis of Knowledge, Power, and Institutional Structures within Rijkswaterstaat



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Preface

This is my Master's thesis ‘How Epistemic Communities Shape Dutch Flood Risk Management? *An Analysis of Knowledge, Power, and Institutional Structures within Rijkswaterstaat*. It is the final step in concluding the Master's Program Spatial Planning with the specialization Cities, Water and Climate Change at Radboud University. This is also the final step in finishing my final year as a student.

Living in the Netherlands, I took the extensive system that keeps the country safe from flooding for granted. Like many others, I trusted that protection was ensured. However, I did not fully understand the complexity behind it. During my studies, I learned more about what it entails, and I became more and more interested in flood risk management. This interest in the scale and institutional coordination inspired me to choose this topic and combine it with working at Rijkswaterstaat. Combining this academic interest with my work at Rijkswaterstaat provided a unique opportunity to study these processes from within.

I would like to thank everyone who contributed to the contents of this thesis. Firstly, I want to thank my supervisor, Dr. Corinne Vitale, for her advice and guidance during the process of writing the thesis. Your support and guidance helped achieve this final result and helped take it to the next level. I would also like to thank my colleagues at Rijkswaterstaat for taking part in the interviews and their contributions to the study. Finally, I want to thank my friends and family for their support during this time.

I hope you enjoy reading this thesis.

Bram de Bruin
April, 2026

Abstract

The Netherlands is threatened by floods due to its low-lying geography and increasing climate change impacts. Dutch flood risk management has traditionally relied heavily on technical and engineering approaches that emphasise structural protection measures. However, in recent shifts toward integrated and risk-based flood risk management, the importance of understanding how epistemic communities shape decision-making is highlighted. This study examines how epistemic communities influence flood risk management strategies within Rijkswaterstaat. Using the Policy Arrangement Approach as a framework, it explores how knowledge is legitimised and how power and resources are distributed. The study uses a qualitative case study design and combines semi-structured interviews with experts with a document analysis of key policy reports.

The findings show that flood risk management within Rijkswaterstaat is strongly shaped by the technical-engineering epistemic community. The combination of the epistemic community framework and the Policy Arrangement allowed the analysis of how decisions regarding flood risk management are shaped. A qualitative case study was conducted at Rijkswaterstaat. This work is based on semi-structured interviews with experts and a document analysis. The study shows that the influence of epistemic communities is embedded in institutional arrangements at Rijkswaterstaat.

Keywords: Epistemic Communities; Flood Risk Management; Rijkswaterstaat; Policy Arrangement Approach; Decision-Making

Summary

This study examines how epistemic communities shape flood risk management (FRM) decisions at Rijkswaterstaat (RWS), which is one of the key authorities in the Dutch flood risk management system. Formally, the FRM has shifted towards a risk-based approach, but in practice it remains oriented on technical and engineering solutions. This study tries to gain an understanding of how different forms of expertise influence the interaction between policy ambitions and institutional practices. The research combines the Epistemic Community Framework (ECF) and the policy arrangement approach (PAA). This combination is used to analyse how actors, rules, resources, and discourse interact with epistemic communities. A qualitative case study was used, based on interviews with experts from different epistemic communities within RWS.

The findings show that the technical-engineering, ecological, and spatial planning communities coexist within RWS. They differ in how problems are framed, how they legitimise knowledge, and what kind of solutions they prefer. However, these communities are not fully integrated and operate mostly alongside each other. The differences in 'language', perspectives, and organisational roles lead to limited interaction and them talking past each other.

Additionally, the findings show that the technical-engineering epistemic community is dominant in shaping FRM decisions. This is not only the result of their numerical presence within RWS, but also how this community is embedded within the institutional arrangement. Technical safety standards and cost-effectiveness criteria define what is feasible and legitimate. Alternative approaches, such as nature-based solutions and spatial adaptation, are increasingly recognised. However, they are less institutionally embedded. This results in integrative concepts serving more as a normative reference point than as operational frameworks. An example is the multi-layer safety (MLS) approach; the implementation is constrained by fragmented responsibilities and sectoral governance structures.

In conclusion, the findings show that epistemic communities shape FRM through their embeddedness in institutional structures, in addition to ideas and expertise. This explains why the technical-engineering community persists and remains dominant. This study highlights the fact that achieving more holistic flood risk management requires more than only discursive change. It also encompasses structural adjustments in governance and institutional structures.

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1: Introduction

1.1: Introduction to the research field

Climate change is one of the major worldwide challenges that has to be overcome. The current rapid global warming is mainly caused by human activity through the emission of greenhouse gases. Even though the main cause of global warming is very clear, the amount of greenhouse gas emissions is still rising. This increase in emissions is the result of unsustainable energy use, land use, lifestyles, and consumption- production patterns (IPCC, 2023). One of the impacts of increasing greenhouse gas emissions is a change in weather and climate extremes, which has led to losses and damage to nature and people. The human influence has caused the global sea level to rise by 0.20 m, and the yearly rise is still increasing. Together with an increase in the compound and the frequency of extreme events, this will cause a growing problem for society (IPCC, 2023).

The Netherlands particularly faces a significant challenge in addressing sea level rise and extreme weather events due to its location in a river delta and the fact that a large portion of the total land lies below sea level. However, the geographical location is not the only thing that plays a part in the increase in losses because of natural hazards. The main reasons for the increase in losses from disasters are population growth, increases in wealth, and accumulation of assets in areas at risk (Bouwer et al., 2007; Changnon et al., 2000; Crompton and McAneney, 2008; Feyen et al., 2009; Pielke et al., 2008). It is expected that losses caused by natural hazards are likely to increase independently of climate change. Among the many types of natural hazards, floods are the most common (World Health Organisation, 2019). While coastal floods pose a significant threat, this study specifically focuses on river floods in the Netherlands, as they represent a growing risk due to changing precipitation patterns and the concentration of people and assets in the river floodplains. The core of the problem is on the one hand an increase in the frequency and magnitude of river floods due to climate change (IPCC, 2023), and on the other hand an increase in losses caused by river floods because of a concentration of assets in areas at risk (Changnon et al., 2000, Crompton and McAneney, 2008, Pielke et al., 2008).

The Netherlands has, in recent years, formally embraced the transition to the risk-based approach in dealing with flood risks. This approach acknowledges that protecting society is not only about building higher and stronger dikes and reducing the probability of floods, but also about reducing the potential consequences of flooding to people, infrastructure, and economy (Sayers et al., 2013; Vitale, 2023). However, in practice, the Dutch flood risk management still relies on structural measures, such as large-scale dike reinforcement programmes as the HWBP from 2014 (Hoogwaterbeschermingsprogramma) (Van Buuren et al., 2016; Ministerie van

Infrastructuur en Waterstaat, 2025). Rijkswaterstaat, as an originally engineering-oriented organisation, plays a dominant role in shaping this emphasis (Avoyan & Meijerink, 2020). While structural measures are vital for the Netherlands, they show that the ambitions of the risk-based approach have not yet been fully put into practice (Hegger et al., 2020).

An often-cited risk of relying heavily on structural measures is the dike paradox. Reinforcing dikes may create a false sense of safety, which can foster a collective underestimation of residual risks (Terpstra 2009; Burton and Cutter 2008; Kousky and Kunreuther 2009; Ludy and Kondolf 2012). Such protective measures reinforce a societal sense of safety, which can stimulate continued settlement and investment in flood-prone areas. Over time, when more people and assets are concentrated in the flood-prone area, the potential damage from an extreme flood can be colossal (Irwin, 2021).

The risk-based approach combines five strategies: prevention, defence, mitigation, preparation, and response/recovery. This combination requires the involvement of multiple policy domains, such as engineering, spatial planning, emergency management, and disaster relief (Paauw et al., 2024). Within these domains, epistemic communities play a key role in shaping how flood risks are understood and addressed. These epistemic communities are networks of professionals who share common beliefs, values, and the criteria used to assess and legitimise knowledge, within a specific field of expertise (Bukowski, 2017; Haas, 1992; Mabon et al., 2019). The experts involved in FRM are no longer from a single epistemic community but differ in background, knowledge base, and approach. For example, engineers might emphasise technical solutions (O'Hare & White, 2018) while spatial planners adopt a more multidisciplinary stance (Hartmann & Driessen, 2017). Recent studies show that effective and equitable FRM requires an integrative approach that combines different forms of knowledge and expertise. The way different epistemic communities influence policy determines which risks are prioritized and whose interests are recognized (Paauw et al., 2024).

Although flood risk management requires coordination between national, regional, and local authorities (Dieperink et al., 2018), the national level is the primary focus of this study. This is the layer where national policies are determined and where Rijkswaterstaat operates (Ministerie van Infrastructuur en Waterstaat, 2025). Rijkswaterstaat is selected because of its central role in flood risk management, which makes it a key organization where different forms of expertise and epistemic communities interact and influence decision-making. The study specifically looks into the epistemic communities within Rijkswaterstaat and how their knowledge and expertise shape flood risk management.

1.2: Problem Statement

Even though the Netherlands has formally adopted a risk-based approach to flood risk management, in practice, the focus remains strongly on structural measures such as dike reinforcement. This engineering-focused orientation has historically been embedded within Rijkswaterstaat, which shapes its decision-making practices. As an organization rooted in hydraulic engineering, Rijkswaterstaat has traditionally approached flood risk management through quantitative modelling and probabilistic risk management (Wiering & Immink, 2006; Van Buuren et al., 2016). This background of technically framing flood risks leads to floods being seen as controllable phenomena that can be managed through structural interventions (Hegger et al., 2020). While structural measures will always remain important, relying too heavily on them could result in risks such as the dike paradox.

The integrative orientation, which is vital for the risk-based approach, requires the involvement of many policy domains and epistemic communities. However, the experts who are specialized in engineering, spatial planning, and ecology differ in their knowledge bases and perspectives. These differences shape how risks are defined and whose vulnerabilities are recognized. In the Dutch context, national-level decision-making is strongly influenced by RWS (Rijkswaterstaat). RWS is not just the executive agency of the Ministry of Infrastructure and Water Management, but also plays an important advisory role in policy development (Ministerie van Financiën, 2026). However, little is known about how different epistemic communities within this organization shape these policy developments and flood risk strategies.

While the risk-based approach needs a balanced integration of knowledge, the continued dominance of the engineering perspective can limit the integration of other expertise and perspectives. A technical framing tends to prioritise structural safety measures, while overlooking social vulnerability and spatial planning (Hegger et al., 2020; Van Buuren et al., 2016). Some dimensions will receive less attention, which can ultimately lead to less effective flood risk management policies as they do not address the full range of factors influencing flood risks.

1.3: Research Objective and Research Questions

The aim of this study is to gain an understanding of how different epistemic communities within Rijkswaterstaat shape decision-making in Dutch flood risk management. This takes place in close interaction with the Ministry of Infrastructure and Water Management, which is formally responsible for national policy-making. Rijkswaterstaat acts as its executive agency and provides strategic advice to support policy development. By examining how epistemic communities within Rijkswaterstaat legitimise certain forms of knowledge and shape the prioritisation of flood risk strategies, this study aims to uncover how and why certain perspectives become dominant and some perspectives are being excluded. In doing so, it aims to explain how epistemic communities influence the implementation of the risk-based approach in practice. By examining how different forms of expertise shape policy decisions within an organization, the study contributes to understanding the institutional conditions under which diverse approaches can be integrated into national flood risk management.

To analyse this, the study uses the Policy Arrangements Approach (PAA) as its analytical framework. The PAA enables an examination of how epistemic communities operate within Rijkswaterstaat by analysing the configuration of actors, discourses, resources, and rules. This framework helps to reveal how different expert groups gain influence, legitimise specific forms of knowledge, and shape flood risk management practices.

The following central research question has been formulated:

"How do epistemic communities within Rijkswaterstaat shape decisions regarding flood risk management in the Netherlands?"

In order to be able to answer this question, the following sub-questions were made:

1. How are epistemic communities within Rijkswaterstaat defined and identified?
2. How do these epistemic communities influence the dominant discourses surrounding flood risk management?
3. How are resources and power distributed among epistemic communities within Rijkswaterstaat, and how does this distribution influence decisions regarding flood risk management?
4. How do formal and informal rules and routines within Rijkswaterstaat structure how epistemic communities are involved in decision-making processes?

1.4: Societal Relevance

Flooding poses a significant threat to the Netherlands, with 59% of its surface area being flood-prone (PBL, z.d.). The potential consequences as a result of floods make them one of the worst disasters that could happen. Additionally, the consequences of a flood could be socially disruptive, as almost 70% of the population lives in flood-prone areas. The percentage of people living in flood-prone areas will only increase because the flood-prone Randstad attracts a lot of people, and the population of the high-lying eastern and southern rural areas is shrinking (PBL, z.d.). This concentration of assets and people in large cities exposed to flood risks could lead to thousands of deaths during floods (De Moel et al., 2011). The 2021 floods in Limburg highlighted the vulnerability of the Netherlands to extreme rainfall. The floods caused 433 million euros in damage and, while no lives were lost in the Netherlands (Deltares, 2023), the event resulted in more than 180 deaths in Germany (Duitsland Instituut, 2022).

The rising frequency and magnitude of flood events due to climate change, alongside urbanization and asset accumulation in flood-prone areas, highlight the importance of effective flood risk management strategies. The Netherlands has established a set of targets for flood risk management by 2050, which are outlined in the Delta Decision. The main goal is to strengthen and heighten the dikes in order to ensure that the local individual risk of dying due to flooding does not exceed 1 in 100,000 per year, rather than guaranteeing complete protection. The second goal is to widen the rivers to enable them to cope with heavy rainfall. However, if they want to achieve these targets in time, they must make haste (Ministerie van Infrastructuur en Waterstaat, 2023). Currently, only 67% of the dikes and 63% of the coastal defenses meet the standards of 2050. It is expected that in order to achieve this, €41 billion will be needed. However, only € 28 billion is available (Ministerie van Infrastructuur en Waterstaat, 2023). When these standards are not met, there will be a possibility for a disastrous flood, such as in 1953. This flood claimed over 1800 lives and caused 700 million euros worth of damage. Nowadays, the damage will be even more as a result of the concentration of people and assets in flood-prone areas (PBL, z.d.).

Understanding how different epistemic communities within Rijkswaterstaat shape flood risk management is crucial for improving the resilience of Dutch society to flood risks. National programmes such as the Hoogwaterbeschermingsprogramma (HBWP) and the Delta Program depend on decisions that set priorities and allocate resources (Ministerie van Infrastructuur en Waterstaat, 2022 & Ministerie van Infrastructuur en Waterstaat, 2025). When certain fields of expertise dominate this decision-making, alternative perspectives may be overlooked. Narrowing down the diversification of perspectives could limit the implementation of a more diversified set of measures.

1.5: Scientific Relevance

Research on flood risk management has recognized the central role of expert knowledge in shaping policy. Traditionally, structural measures led by engineering communities dominated flood risk management in countries such as the Netherlands (Wiering & Immink, 2006). This approach achieved significant hazard reduction, but also fostered path-dependency and resistance to change (Van Buuren et al., 2015; Hegger et al., 2018). Recent studies have highlighted the diversification of flood risk management expertise. In addition to the engineering community, new epistemic communities, such as ecologists and spatial planners, are bringing in new perspectives (Wiering & Immink, 2006; Paauw et al., 2024; Busscher et al., 2018; Meijerink, 2005). These include nature-based solutions and attention to social vulnerability. This knowledge shift contributed to the change in flood risk policy discourse from "fighting" to "living with" water. This thesis builds on this literature by focusing on an understudied angle: instead of examining broad multi-actor networks, it investigates how epistemic communities operate within a single key organization and influence strategic choices. The study diverges from existing studies that treat organizations such as Rijkswaterstaat as large actors by instead focusing on their internal knowledge dynamics.

This thesis combines the Epistemic Community Framework (ECF) with the Policy Arrangement Approach (PAA). While other research applies the ECF and PAA separately (Wiering & Immink, 2006; Paauw et al., 2024; Meijerink, 2005), this study integrates the two to examine how expert knowledge intersects with institutional structures. Using the ECF, the study identifies knowledge-based networks and shared narratives within RWS, and the PAA is then used to place these communities within the broader policy arrangement. The study builds on earlier works that analysed epistemic communities or policy structures alone by linking them together. This offers a more nuanced view on how and why certain FRM strategies are more dominant than others in an organisation.

Existing literature on flood risk governance and epistemic communities often has a broad or comparative scope. Often, multiple regions or countries are compared to explain differences (Klijn et al., 2004; Paauw et al., 2024; Wiering et al., 2017). Other studies investigate multi-level governance arrangements where local, national, and international actors are involved (Van Buuren et al., 2016). They have a national or regional governance system as a whole as their unit of analysis. In contrast, this thesis focuses on a single organisation on the national level. Rijkswaterstaat plays a central role in Dutch flood risk management in close interaction with the Ministry of Infrastructure and Water Management, but is often treated as part of a larger governance framework. By focusing solely on RWS, this study addresses the gap of how organisations such as RWS internally adopt and interpret flood risk management paradigms. The study links the macro-level trends in flood risk management to the micro-level institutional processes within RWS. In doing so, it contributes to a deeper understanding of the internal knowledge dynamics and institutional preferences that shape which forms of expertise gain traction within RWS.

1.6: Reading Guide

The structure of this thesis is as follows. In chapter 2, with the theoretical framework, the fundamental concepts and theories will be described. These different concepts and theories will form the basis of the conceptual framework. In Chapter 3, the methodology will be discussed. This chapter will include the research design, data collection, and data analysis. In Chapter 4, the empirical results will be presented. Chapter 5 discusses the findings in relation to the broader literature on FRM. Finally, chapter 6 concludes the thesis by answering the research question and reflecting on the implications.

2. Theoretical Framework

In this section, the most important concepts and theories will be defined and explained. These concepts will form the foundation for this study and are crucial for answering the research questions. The different concepts and theories that will be addressed are floods and risks, flood risk perception, flood risk management, the multi-layer safety approach, institutionalism, and a framework to analyse institutional decision-making. This section concludes with an operationalization and a conceptual framework based upon concepts and theories.

2.1: Floods and Flood Risk

Floods are the most common type of natural hazard and are responsible for half of all fatalities due to natural forces, and for a third of the economic losses (Wilby & Keenan, 2012). Flooding is defined as a temporary covering of land by water as a result of heavy precipitation. There are three different types of flooding: storm surge, river flood, and flash flood (Munich Re, 1997). This study will only focus on river flooding. River floods are the result of intense or enduring rainfall, which is sometimes combined with snowmelt. When the ground is saturated, and the soil is not able to store any more water, then the water runs directly into creeks and rivers. Floods can have big effects on wide valleys but are more damaging in narrow valleys because of mechanical forces and sediment transport (Kron, 2005).

Flood risks are the product of a hazard and its consequences. The flood risk consists of three components. The first one is the hazard, which is the probability of the flood's occurrence and its magnitude. The second one is the exposure, which is the people or assets that are present in the affected area. Finally, the vulnerability, which is the resistance to damaging forces. In conclusion, flood risk is the potential loss as a consequence of a hazard and its consequences (exposure/vulnerability) (Feyen et al., 2011; Kron, 2005; Schanze, 2007). Flood risks have been increasing as a result of an increase in each of the three components. Hazards have been increasing in frequency and magnitude because of climate change. The assets at risk have increased as a result of the growing world population and the concentration in flood-prone areas. The vulnerability is increasing as possessions and infrastructure in areas exposed to floods become more susceptible to damage by water (Kron, 2005).

2.2: Flood Risk Management

The definition of flood risk management is the process of managing an existing flood risk situation. It includes the creation of a system that reduces flood risk and aims to control and mitigate the impact of a potential flood (Plate, 2002). Flood risk management has various goals that relate to different time and space scales. The first goal is to reduce the impacts of floods on people and communities from all flood sources, which is often achieved through protective infrastructure such as dikes in combination with evacuation planning and emergency response. The second goal is to reduce flood exposure and support economic development, often taken care of through spatial planning and building regulations. The third goal is to promote social well-being by protecting cultural heritage and landscape while being as equitable and fair as possible, which requires participatory planning processes and special attention to vulnerable groups. The final goal is to promote ecosystem goods and services by working with the function and processes of the natural system (Sayers et al., 2013).

To achieve these goals, FRM needs to adopt a holistic view that considers all relevant flood sources, pathways, and receptors across spatial and temporal scales. It should also use knowledge of risk and uncertainty to guide its decisions about prioritization of effort. Finally, it should implement a portfolio of measures and instruments to deliver multiple objectives, such as the reduction of all factors that influence flood risk. Flood risks are shaped by the hazard (flood probability), exposure (capital and population in flood risk areas), and vulnerability (unpreparedness for a disaster and its consequences) (Van Drimmelen & Van Der Vlist, 2005). Traditionally, FRM has concentrated on hazard reduction, for example, through the construction of dikes to lower flood probability. A more comprehensive approach would also consider the reduction of exposure and vulnerability. Finally, there is a need to monitor, review, and adapt. The strategy has to continually adapt to new knowledge (Sayers et al., 2013).

According to Schanze (2007), flood risk management activities can be organised into three main components (Fig. 1). The first component is **(1) risk analysis,** which describes previous, current, and future flood risks. It is based upon (a) hazard determination, (b) vulnerability determination, and (c) risk determination itself.

The second component is **(2) risk assessment**. This component is influenced by (a) risk perception and (b) risk weighing. Firstly, the outcomes of scientific flood risk analysis can be interpreted very differently because of individual and collective perception. People and institutions also judge for themselves whether a certain level of risk is tolerable (cf. Wildavsky 1993). In paragraph 2.3, this concept will be described more extensively. However, risk assessment goes beyond perception alone and takes into account risk weighing. This considers that the perception of risk does not include the decision on how to deal with it. It stresses that risk depends on options of behaviour (WBGU, 1999).

The last component is **(3) risk reduction**. This is about certain interventions that aim to reduce the risk. In order to reduce the risk, a difference can be made between measures and instruments. Measures are direct physical interventions, such as dikes and levees. At the same time, instruments are indirect interventions that are mechanisms that enable measures or influence human behaviour. This could, for example, be done through spatial planning regulations, financial incentives, or risk communication (Olfert and Schanze 2005). The terms measures and instruments are often replaced with the terms structural measures and non-structural measures. Structural measures are interventions of flood defence, such as dikes and dams, and non-structural measures are all the other interventions that are used that do not involve direct construction. These may include land-use planning, insurance systems, forecasting and warning systems, or public awareness campaigns (e.g., White 1975, Hooijer et al. 2004).

The component of risk reduction is split into (a) pre-flood reduction, (b) flood event reduction, and (c) post-flood reduction. The first pre-flood reduction interventions are those that cover prevention. The purpose is to decrease the magnitude of floods and the number of vulnerable elements in flood-prone areas. This is achieved by measures such as zoning, dykes, and the preparation of people at risk. Secondly, flood event reduction consists of the forecasting and warning of a flood. It also covers the structuring of an emergency response. An example is flood forecasting and warning. The final component is about the recovery and reconstruction after a flood in preparation for a new one. An example is the effectiveness of the coverage of flood damages by insurance (Schanze, 2007).

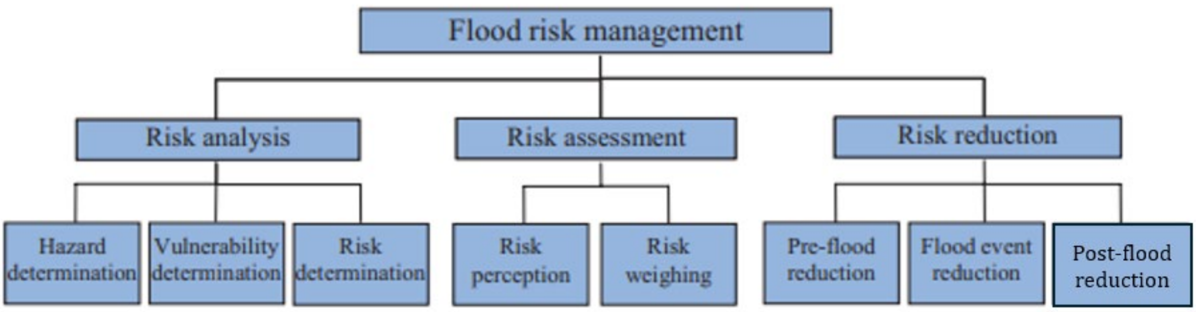

Figure 1. Tasks and components of FRM (Schanze, 2007)

2.2.1: Standards- & Risk-based Approach

Flood risk management has been evolving in recent years; it is moving away from the standards-based approach to the risk-based approach. The standards-based approach focuses on what the flood defence should be able to withstand. This approach primarily addresses the hazard component of flood risk by reducing the probability of flooding through structural measures (Sayers et al., 2002). The risk-based approach not only pays attention to the hazard but also to the exposure and vulnerability. Additionally, the risk-based approach stresses the importance of the collaboration between spatial planners and water managers in the field of flood risk management (Vitale, 2023). The standards-based approach puts more emphasis on pre-flood reduction, while the risk-based approach spreads its attention over all three components.

The risk-based approach emphasises the importance of collaboration between different fields, such as water managers and spatial planners (Sayers et al., 2002). In this approach, decision-making is not just dependent on modelling but also on how actors evaluate and perceive risk. Expert communities play a critical role in shaping which types of knowledge are deemed legitimate.

A practical application of the risk-based approach is the multi-layer safety (MLS) approach. The MLS was introduced in 2009 and integrates multiple intervention levels to address both the probability and the consequences of flooding. The MLS reduces the hazard, exposure, and vulnerability through a single management framework (Kaufmann et al., 2016; Van Buuren et al., 2016; van Herk et al., 2014). MLS distinguishes three layers of safety (fig 2). Firstly, the prevention layer, which encompasses the reduction of the probability of flooding through structural measures such as dikes, levees, and dunes. The second layer is about spatial adaptation and reduces the potential consequences through spatial planning, such as compartmentalisation and restricting construction. Finally, the crisis management layer, which reduces flood impacts through preparedness and response measures such as warning systems and evacuation plans (Klostermann et al., 2014).

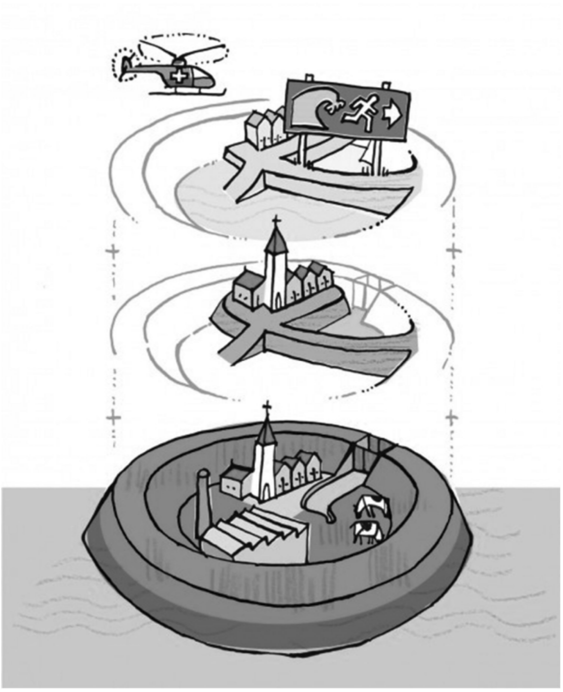

Figure 2: Schematization of the layers of the multi-layer safety approach (Ministry of Infrastructure and Water Management, 2009)

While the prevention layer remains dominant in Dutch flood risk policy and public perception (Neuvel & Van Der Knaap, 2010; Van Buuren et al., 2016), MLS emphasises the need to align water management with spatial planning and emergency management. This approach ensures more resilient and comprehensive flood risk management (Zandvoort & Van Der Vlist, 2014).

2.3: Epistemic Communities

The concept of epistemic communities is essential in understanding how expert knowledge and disciplinary background shape decision-making in flood risk management. According to Haas (1992, p. 3), epistemic communities are a network of professionals with recognized expertise and competence in a particular domain. This group of experts shares normative beliefs, causal understandings, criteria of validity, and a common policy enterprise (Bukowski, 2017; Haas, 1992; Mabon et al., 2019). Policy outcomes are shaped by epistemic communities through framing problems, legitimizing types of knowledge, and deciding which strategies are prioritized (Meijerink, 2005; Bukowski, 2017; Mabon et al., 2019).

The epistemic communities that are involved in flood risk management have diversified over the last few decades. Historically, the field has been dominated by flood risk engineers, relying on calculative modelling and eliminating flood risks with the use of structural measures (Hartmann & Driessen, 2017; Wiering & Immink, 2006; Tate et al., 2021). However, as flood risk strategies diversified, different policy domains, such as spatial planning, emergency management, and disaster relief, needed to get involved (Karrasch et al., 2021; Kaufmann et al., 2016). These different epistemic groups do not just differ in expertise but also in how they interpret vulnerability, justice, and effective risk reduction. For example, engineers often prioritize technical modelling and probability reduction (Wiering & Immink, 2006; Tate et al., 2021). While spatial planners prioritize spatial integration, participation, and the recognition of social vulnerability (Boussauw & Lauwers, 2020; Hartmann & Driessen, 2017).

Each epistemic community has its own flood risk perception. Flood risk perception refers to the way in which individuals and groups interpret and evaluate the likelihood and consequences of flooding (Schanze, 2007; Lechowska, 2018). This perception is not only shaped by technical calculations but also by values, experiences, cultural norms, and institutional practices. As such, perception is not neutral or purely objective, but socially constructed and can differ from measurable reality (Schanze, 2007; Lechowska, 2018). Epistemic communities interpret and value risk through their disciplinary lenses. These interpretations influence how vulnerability and fairness are understood, and which policy choices are made (Paauw et al., 2024).

Typology of epistemic communities:

The following section outlines the epistemic communities that play a role in flood risk management. The first and traditionally dominant epistemic community is the **engineering epistemic community**. This community can be split into civil engineers and hydrologists, who are focused on reducing hazards through structural measures. Traditionally, this community led flood risk management emphasizing technical and infrastructure-based interventions (van Buuren et al., 2018). In the Netherlands, a strong engineering network in the water sector became linked to the state and formed a technocratic community that reinforced traditional approaches of flood protection (Wiering et al., 2017). This dominance of the engineering community can create path dependency as their big investments into infrastructure tend to make shifts difficult (Wiering et al., 2017). In the case of the Netherlands, they continue to prioritize dike upgrades and structural projects, indicating the influence of the engineering community (Paauw et al., 2024).

As flood risk management has diversified, other epistemic communities were introduced. Expertise from ecology, urban planning, and social sciences expanded from just preventing floods to mitigating their impact and living with water. From these new fields of knowledge, two types of epistemic communities were developed. Firstly, the **ecological epistemic community**, which consists of ecologists and biologists, has theoretically influenced flood risk management significantly by promoting nature-based solutions and advocating “making space for water”. This epistemic community influenced a shift to ecosystem approaches and green infrastructure in flood risk management (Meijerink, 2005). The second important epistemic community is the **spatial planning community**. This epistemic community focuses on land-use planning and risk prevention strategies. They try to reduce exposure and vulnerability by preventing development in flood-prone areas and integrating flood risks into urban planning. This community adopts a broader multi-sector perspective, emphasising that floods can not only be managed by engineering but also by zoning, preparedness, and public awareness (Paauw et al., 2024). Where engineers aim to "keep the floods out" the ecological and planning experts want to "coexist with floods by enhancing resilience and reducing societal vulnerability" (Meijerink, 2005; Paauw et al., 2024)

Balancing and integrating the knowledge from the different epistemic communities is crucial for effective flood risk management, as each of the groups brings its own strengths and perspectives. It combines defending against water with managing risk in an equitable and adaptable way. This integration ensures that structural safety, spatial resilience, and social vulnerability are all considered in flood governance (Paauw et al., 2024). The different types of epistemic communities are shown in Table 1.

Table 1: Typology of epistemic communities in FRM

Epistemic community	**Core disciplines**	**Primary focus**	**Preferred strategy**
Engineering	Civil engineering, hydrology	Hazard reduction through structural measures	Dikes, levees, and technical standards
Ecological	Ecology, biology	Ecosystem-based flood management	Nature-based solutions, space for rivers.
Spatial Planning	Urban planning, social sciences	Reducing exposure and vulnerability through land-use planning	Zoning, spatial adaptation, participation

2.3.1: Epistemic Community Framework (ECF)

The Epistemic Community Framework (ECF) was originally developed by Haas (1992). It provides an overview of the elements that characterize epistemic groups. The original framework encompasses four elements: (1) a shared set of normative and principled beliefs, meaning the community members have similar values to guide their actions; (2) shared causal beliefs, which means they agree on how the world operates and which policies are required to reach desired outcomes; (3) shared notions of validity, which means members have the same criteria to assess what is valid knowledge; and (4) a common policy enterprise, which means members use their set of expertise and skills to inform policy. Since then, it has been further developed to study policymaking in environmental governance and flood risk management (Bukowski, 2017; Mabon et al., 2019).

The framework shown in Table 2 builds on the framework used by Haas (1992) and incorporates new dimensions from recent applications in the flood risk management context (Paauw et al., 2024). The newly added dimensions are actor type and disciplinary background, which are critical for identifying how epistemic communities operate within organizations such as Rijkswaterstaat.

Table 2: Overview of the main elements that characterize epistemic communities (Paauw et al., 2024).

Characteristic	**Explanation and relevance for identifying epistemic communities**
Type of actors	Characterising epistemic communities first requires identifying their members or the type of experts involved. Members can include policy makers, politicians, other public authorities, natural and social scientists, and private experts (e.g., consultants) from various disciplinary backgrounds (Dunlop, 2012)
Disciplinary background	As epistemic communities are knowledge-based expert groups (Haas, 1992; Meijerink, 2005), characterising them requires looking into the educational and professional background of their members. Disciplinary backgrounds will influence someone's knowledge base and can be seen as lenses through which experts perceive the world around them.
Shared normative and principled beliefs	Community members have similar norms and values that guide their actions (Bukowski, 2017; Haas, 1992; Mabon et al., 2019). Understanding epistemic communities' normative and principled beliefs is crucial, as they will ultimately determine what experts consider as 'good' or desirable outcomes of policy, and therefore what experts will strive for
Shared causal beliefs	Members also share beliefs about the causes of the problem at hand, which serves as a basis for identifying the links between potential policy actions and how this will contribute to the desirable outcome (Bukowski, 2017; Haas, 1992; Mabon et al., 2019). Understanding the shared causal beliefs of epistemic communities will inherently draw attention to their understanding of the problem, which actions they believe will contribute to ameliorating the problem, and the preferred policy actions to achieve

	that goal. This can be understood as the main approach of epistemic community members.
Shared notions of validity	Shared notions of validity refer to the criteria used by members to weigh and legitimise knowledge. In other words, it draws attention to the types of knowledge seen as valid in their domain of expertise (Bloodgood, 2008; Haas, 1992). This links back to the disciplinary background of epistemic community members and highlights the types of knowledge on which decisions are based
Common policy enterprise	Epistemic community members also share a common policy enterprise, referring to a set of practices or standard operating procedures that are often used to deal with the problem at hand, and ultimately inform policy (Bukowski, 2017; Haas, 1992; Mabon et al., 2019). It includes the practices and instruments most commonly employed by epistemic communities, and therefore further describes their approach to a problem

The epistemic community framework offers a lens for understanding how expert groups influence the formulation of FRM policies. As Paauw et al. (2024) emphasize, balancing the roles of technical and multidisciplinary epistemic communities is crucial. Applying this framework allows us to explore how varying communities within Rijkswaterstaat have differing degrees of influence over decision-making processes.

2.4: Institutionalism

Institutionalism is a political science approach that emphasizes the role of institutions in shaping political outcomes and conduct. Institutions are the rules, regularities, structures, and the context in general (Bell, 2002; Schmidt, 2010). Within institutionalism, there is a distinction between old institutionalism and neo-institutionalism. Old institutionalism refers to the traditional method of studying politics, which emerged in the late nineteenth century. Political science started describing and mapping formal institutions and the modern state. It focused on the formal-legal and administrative arrangements of government (Shepsle, 1989; Easton, 1971; Eckstein, 1979). It focuses on the description rather than on the explanation or theory building. After World War II, the state-centred focus shifted away towards informal political behaviour and individual decision-making (Rhodes, 1995). However, since the 1980s, there has been a renewed emphasis on institutions that shaped new institutionalism. This renewed attention was driven by the growing complexity of social, political, and economic institutions (March & Olsen, 1984). New institutionalism is more explanatory-focused, rather than descriptive.

There are four different types of neo-institutionalism: rational choice institutionalism, historical institutionalism, sociological institutionalism, and discursive institutionalism (Schmidt, 2010). Among the other neo-institutionalisms that were identified in the early 1990s was rational choice institutionalism (Schmidt, 2014). Rational choice institutionalism assumes that actors are rational, selfish, and utility-maximizing individuals. These individuals are all in an institutional context which exists of behavioural incentives and disincentives that are shaped by formal and informal rules and practices of the institutional setting (Bell, 2002). This deductive approach offers explanations for the reasoning of actors for certain actions (Schmidt, 2014). Historical institutionalism addresses the development of political institutions, describing these patterns and routinized practices subject to path dependence. On the other hand, sociological institutionalism focuses on social agents who act based on the 'logic of appropriateness'. This appropriateness is based on the socially and culturally framed rules and norms (Schmidt, 2010). The final type is discursive institutionalism, which uses ideas and discourse to explain political change. It focuses on the role of ideas, discourse, and communication (Schmidt, 2010).

As mentioned above, institutions are not static entities but can be understood as the rules, norms, and shared strategies that organize structured interactions (Ostrom, 1990). They shape and constrain political behaviour and decision-making. A distinction can be made between formal and informal institutions that range from formal organizational arrangements to patterned behaviour (Bell, 2002). Similarly, Hall (1986, p. 19) defines institutions as: “the formal rules, compliance procedures, and standard operating practices that structure the relationship between individuals in various units in the polity and economy.” At the same time, institutions only shape and influence behaviour and do not explain everything. This implies that institutionalism is a middle-range theory as institutions stand above actors but below wider structural forces such as macro-level structures (Pontussen, 1995).

Institutions shape public policies by structuring how information is produced, shared, and interpreted, and by defining what is considered appropriate or legitimate policy action (Peters, 2016). It is important to distinguish institutions from organizations, as institutions are the rules, norms, and strategies that structure interaction, while organizations are the groups of individuals who act within these rules and norms (Polski & Ostrom, 1999). In FRM, organizations such as waterboards and Rijkswaterstaat operate within their own institutional framework, and these frameworks influence which priorities and strategies are adopted. These frameworks consist not only of formal arrangements but also of internal culture, norms, and routines. For example, an engineering-focused institution such as Rijkswaterstaat may emphasize structural solutions, potentially underestimating social vulnerability. Institutionalism provides a valuable lens to study how the engineering-focused institutional framework of Rijkswaterstaat shapes flood risk management, and how this affects the integration of other forms of expertise.

2.5: Policy Arrangement Approach

Institutionalism provides an understanding of how institutions shape behaviour and decision-making, but it remains relatively abstract. To explain and analyse how institutional dynamics are organized within a specific policy domain, this study adopts the Policy Arrangement Approach.

A policy arrangement is the temporary stabilization of the content and organization of a policy domain (Van Tatenhove et al, 2000). Interactions between actors will gradually develop into patterns. These patterns are shaped by the formal and informal rules and processes of give-and-take. These structures, which are formed to shape behaviour, are not fixed. This concept of policy arrangement is the temporary stabilization of processes of institutionalization (Giddens, 1984). The objective of the policy arrangement is to analyse and understand change and stability. In this study, this theory will be used to analyse and understand a state of stability in the policy domain of flood risk management.

Policy arrangement structures can be analysed through four interconnected dimensions. The first three dimensions refer to the organizational aspects, and the last dimension to the substantial aspects of policy. The first dimension is the actors and their coalitions involved. The second dimension is the division of resources between the actors, which leads to differences in power and influence. The third dimension is the rules of the game, which entail the formal procedures of decision-making as well as informal routines of interaction. The final dimension is the policy discourse. This includes the views and narratives of the actors, such as norms, values, and definitions of problems (Leroy & Arts, 2006). However, these different dimensions do not sum up to define a policy arrangement. They are interconnected, which is shown in the tetrahedron in Figure 3. For example, a change in one dimension could affect the other dimensions (Leroy & Arts, 2006).

The PAA is relevant to this study as it provides a framework to analyse how different forms of expertise within Rijkswaterstaat are institutionalised. The four dimensions provide insight into which perspectives dominate, and which types of knowledge are marginalised in Dutch flood risk management. The PAA enables the understanding of how expert knowledge at Rijkswaterstaat is integrated into decision-making.

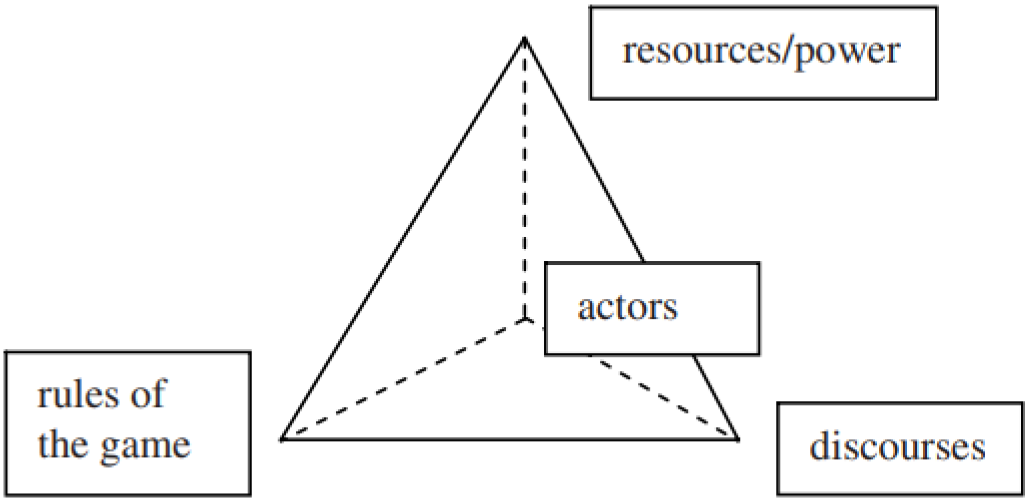

Figure 3: The tetrahedron, symbolising the interconnectedness of the four dimensions (Leroy & Arts, 2006).

Actors

The first dimension is the actors, which is the set of key players in a given policy domain. These stakeholders exist in various spatial levels in society and include governmental organisations, experts, NGOs, businesses, civilians, etc. The interaction patterns between actors are important as they might show coalitions or oppositions (Veenman et al., 2009). These coalitions of actors are often grouped around certain points of view, interests, and policy perspectives. Discourse will often be important in shaping these coalitions. However, coalitions do not always refer to shared discourses (Wiering & Immink, 2006). Analysing this dimension starts from identifying the relevant actors and their influence on the policy process. This analysis can be done through the study of policy documents. In this process, it is important to distinguish the more important actors from the rest and cluster actors together (Leroy & Arts, 2006).

Resources and Power

The dimension of resources and power is about the distribution of resources over different actors (Giddens, 1984). Resources are the assets that actors can use to exercise power over others. Examples of relational power are authority, money, knowledge, and technology. These relational powers are often not equally distributed, which results in not all actors having the same abilities to reach outcomes. This difference in capacities is called structural power (Park, 2015). It results in interdependencies as different actors are dependent on each other for resources. Some actors might need to work together as they share control over these resources (Leroy & Arts, 2006).

Rules

The third dimension is the dimension of rules, which are mutually agreed procedures and informal routines of interaction. This dimension is tightly connected to the actors and resource and power dimension through regulatory power (Leroy & Arts, 2006). These rules consist of the regulations, legislation, and procedures of a policy domain (Giddens, 1984; Ostrom, 1999). Rules determine the boundaries wherein actors can operate by determining their access to policy arenas and their involvement in decision-making (Veenman et al., 2009).

A distinction can be made between formal and informal rules. Formal rules are procedures, substantive norms, and divisions of power. On the other hand, there are informal or political rules of the game, such as the political negotiation culture of the Dutch 'polder model'. This mix of formal and informal rules forms the arrangement for a certain policy domain. In flood risk management, formal rules are mostly represented through different laws such as the Embankment Act (Wiering & Immink, 2006).

Discourse

Policy discourse, the final dimension, is a shared way of understanding the world. It is a set of ideas, concepts, and narratives that give meaning to a certain phenomenon or issue (Park, 2015). The discourse dimension is important on two different levels. The first level entails the general ideas about the organisation of society and the preferred mode of governance. The second level refers to concrete ideas about the policy problem at stake. For example, the character of the problem, its causes, and solutions (Leroy & Arts, 2006). In general, a policy arrangement can be characterized by one dominant policy discourse. The content of this discourse is constantly being challenged by competing discourses (Arts, Van Tatenhove, & Leroy, 2000).

Application to epistemic communities in flood risk management

In this study, the focus will be on how epistemic communities influence decision-making within Rijkswaterstaat. According to Leroy & Arts (2006), entering the tetrahedron through the actors' dimension is interesting for the analysis of the roles and positions of actors or groups. Epistemic communities are conceptualised as a collective group of actors. Starting the analysis from the actor dimension allows the identification of these expert communities. The position of the epistemic communities within the actors' dimension shapes their influence in decision-making and framings of flood risk.

However, epistemic communities do not operate in isolation but are connected to the other three dimensions of the policy arrangement. The different dimensions are interconnected, and a change in one dimension could affect the other dimensions (Leroy & Arts, 2006).

1. In the discourse dimension, epistemic communities shape dominant discourses. Their shared beliefs and perceptions influence how problems and solutions are framed in debates. Competing epistemic communities may promote different narratives.
2. In the resource and power dimension, the influence of epistemic communities is dependent on their access to authoritative knowledge, legitimacy, and decision-making resources. Some epistemic communities may have privileged positions, allowing them to dominate planning processes.
3. In the rules dimension, epistemic communities are embedded and shaped by formal and informal procedures and routines. These rules structure how knowledge is incorporated into policymaking. They determine how advisory processes are designed and whose expertise is consulted.

By integrating epistemic communities within the PAA framework, this study explores not only who the influential actors are, but also how their knowledge shapes discourses, gains legitimacy, and is institutionalised through formal and informal rules. The combination of frameworks allows the analysis of both the epistemic communities as well as the institutional context in which they exist.

2.6: Conceptual Framework and Operationalization

In this research, the role of epistemic communities in shaping decision-making processes related to flood risk management within Rijkswaterstaat will be examined. The conceptual framework combines the ECF with the PAA to analyse how these communities interact in the institutional structures for FRM at RWS (see Figure 4). Within this broad context of the PAA, the ECF is used to analyse the role of expert communities. The application of the ECF offers a more detailed lens to analyse specific characteristics. This way, epistemic communities can be examined within the existing policy arrangement. In Dutch flood risk management, there are three distinct epistemic communities: the technical-engineering community, the spatial planning community, and the ecological community.

While the actor dimension serves as the starting point, it is closely interconnected with the other dimensions of the policy arrangement. Through their expertise and authority, epistemic communities shape policy discourse by influencing how flood risks and solutions are framed. At the same time, they affect the distribution of resources and power, as certain forms of expertise gain greater influence in decision-making. Their role is shaped by the rules of the game, including both formal procedures and informal practices.

The relationship between epistemic communities and the broader policy arrangement is dynamic. Epistemic communities contribute to shaping discourse, resource distribution, and institutional rules. However, these same institutional structures simultaneously enable and constrain their influence. Analysing this interaction provides insight into how expertise is embedded in flood risk management within Rijkswaterstaat.

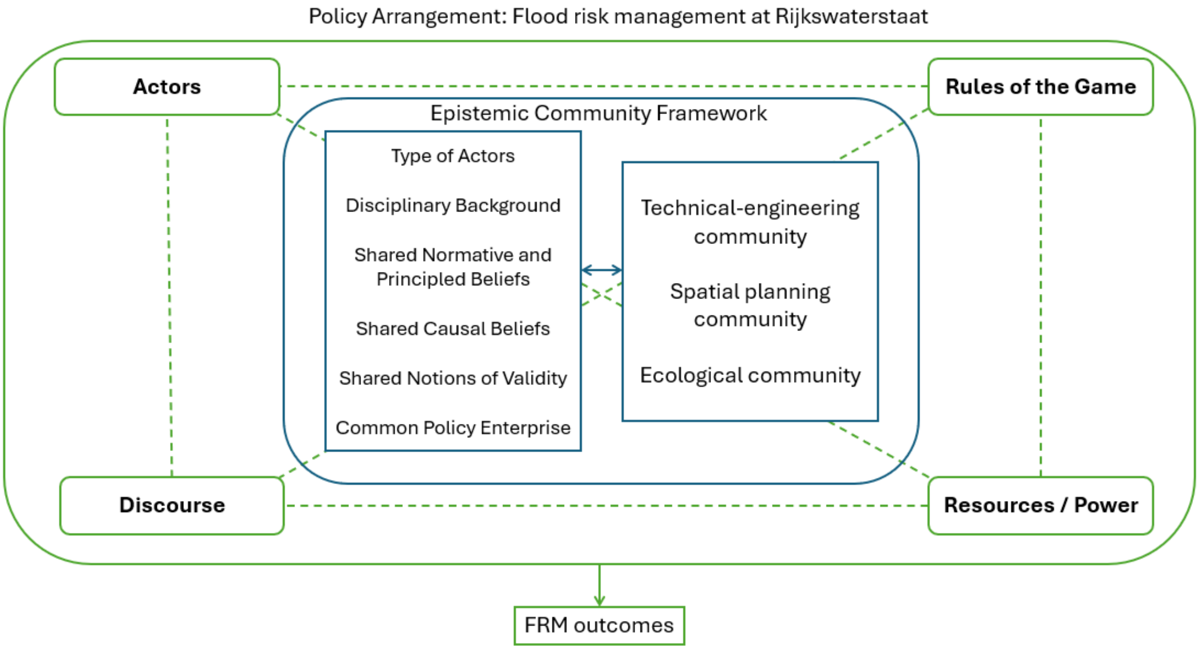

Figure 4: Conceptual Framework (Author's design, 2026)

Operationalization

The abstract theoretical concepts from the conceptual framework need to be operationalized for the data collection. The concepts will be operationalized following the dimensions of the PAA: actors, discourse, resources/power, and rules of the game (Table 3).

Table 3: Operationalization

Concept	Dimensions	Primary factors/definition	Indicators
Actors: Epistemic communities (Paauw et al., 2024).	Type of actors	characteristics of epistemic community members within Rijkswaterstaat, who share disciplinary backgrounds and approaches in flood risk management. (Dunlop, 2012).	Institutional affiliation Professional role - Engineer - Spatial planner - Hydrologist - Ecologist (Dunlop, 2012)
	Disciplinary background	Educational and professional background shaping the expertise of community members (Haas, 1992; Meijerink, 2005).	Field of education - Hydrology - Civil engineering - Social sciences - Spatial planning Level of degree Career trajectory (Haas, 1992; Meijerink, 2005)
	Shared normative & principled beliefs	Common values and principles that define which outcomes are legitimate and desirable (Bukowski, 2017; Haas, 1992).	Preferred flood risk management objective Time preference: - Short-term risk reduction - Long-term adaptation. Definition of policy success (Paauw et al., 2024)

	Shared causal beliefs	Common understanding of causal relationships that shape assumptions (Haas, 1992; Mabon et al., 2019).	Problem framing: - technical hazard - probabilistic event - a land-use issue - a socio-environmental challenge Risk reduction logic: - Reduce the probability - Intervention where probability × damage is highest - Reduce exposure - Reduce vulnerability Preferred strategy: - protective infrastructure - zoning regulations - flood-resilient adaptation (Paauw et al., 2024)
	Shared notions of validity	Criteria used by the community to decide what is credible and legitimate knowledge (Bloodgood, 2008).	Preferred evidence: - Engineering and hydrological data - Cost-benefit analyses - Modelling outputs - Contextual knowledge - Multidisciplinary evidence Legitimacy of knowledge: - Engineering expertise - Planners' multidisciplinary knowledge - Collaborative knowledge (Paauw et al., 2024)
	Common policy enterprise	Shared policy goals and practices (Haas, 1992; Mabon et al., 2019).	Preferred policy instruments: - Hydrological modelling tools - Flood risk maps - Zoning regulations

			- Multi-criteria analysis - Stakeholder engagement (Paauw et al., 2024)
Discourse (Vitale, 2023; Paauw et al., 2024).	Engineering	Discourse focusing on hazard reduction through structural measures and water control. Associated with the engineering community. Corresponds with the standards-based approach.	Focus: - Reliance on hard structural measures - Dominance of engineers - Top-down decision-making - Hazard reduction - The idea of stability (Vitale, 2023)
	Ecological	Discourse emphasising living with water and the role of natural systems. Associated with the ecological community. Corresponds with the risk-based approach.	Focus: - Reducing vulnerability and exposure - Ecologically-oriented measures - Concerns for ecological conditions - Based on the idea of stability (Vitale, 2023)
	Socio-ecological	Discourse emphasising social vulnerability, spatial exposure, and participatory governance. Associated with the spatial planning community. Corresponds with the risk-based approach.	Focus: - Reducing vulnerability and exposure - People as "agents of the ecosystem." - Public participation - Community awareness (Vitale, 2023)
Rules (based on Ostrom, 1999).	Position Rules	Specify a set of positions and how many participants hold each position.	Amount and type of actors occupying positions (based on Ostrom, 1999)
	Boundary rules	Specify how participants enter or leave these positions.	Membership Requirements Inclusion and exclusion criteria that determine which types of actors participate in flood risk management decision-making. Presence of formal or informal mechanisms that gatekeep access to decision-making spaces.

			(based on Ostrom, 1999)
	Authority rules	Defines who has the right to do what. Aligns actions to roles	Decision-making roles assigned to specific actors or organizational levels. Actions or decisions permitted or prohibited under institutional mandates or policy frameworks. (based on Ostrom, 1999)
	Aggregation rules	Define how decisions are made collectively.	Decision-making procedures used within the arrangement Mechanisms in place to resolve conflicting perspectives among actors or epistemic communities. (based on Ostrom, 1999)
	Scope Rules	Defines boundaries about what outcomes can and cannot be affected by decisions.	Boundaries defining which outcomes are possible or permitted. Legal constraints that define permissible outcomes or interventions in flood risk management. (based on Ostrom, 1999)
	Information rules	Determine what information is available to whom.	What information must or may be shared among actors? Accessibility of technical or procedural information. (based on Ostrom, 1999)
	Payoff Rules	Determine who gets what or who deals with the costs. Influence, incentives, and consequences.	How benefits and sanctions are distributed among actors. Financial or non-financial incentives and penalties. (based on Ostrom, 1999)
Resources (based on Leroy & Arts,	Financial (Leroy & Arts, 2006)	Funds available to implement, promote, or resist policy measures	Available funding

2006; Ostrom, 1999).			Financial dependency (based on Leroy & Arts)
	Expertise/knowledge (Leroy & Arts, 2006)	Expertise that supports and legitimizes policy choices	Availability of expertise: number of experts within the team In-house or outsourced knowledge Access to knowledge institutes (based on Leroy & Arts)
	Authority / Political (Leroy & Arts, 2006)	Formal rights to make, implement, and enforce rules and regulations	Jurisdictional mandates: Formal responsibility over specific domains of flood risk management Legal authority to push policies, approve plans, or block proposals. Regulatory control, such as writing legislation or setting standards (based on Leroy & Arts)
	Social/ Discursive (Leroy & Arts, 2006)	Ability to shape how issues are framed and understood	Ability to shape issue framing through dominant narratives Visibility of an actor's discourse in policy documents Other actors supporting the framing (based on Leroy & Arts)
	Human (Ostrom, 1999)	Personnel and organizational infrastructure	Number of staff Staff composition Organisational capacity (based on Ostrom, 1999)

3. Case Selection and Methodology

In this chapter, the case selection and methodology are discussed. The chapter starts off with the research philosophy and paradigm. Then the research design, data collection, data analysis, and case selection will be addressed. Finally, the chapter ends with the validity and reliability.

3.1: Research Philosophy & Paradigm

A paradigm is a set of basic beliefs that represents the worldview of its holder. They are based on ontological, epistemological, and methodological assumptions. The ontological question is about the form and nature of reality. It tries to answer the questions of how the real world is assumed and how things really are. The epistemological question is about the relation between the researcher and what is known. The methodological question is about how the researcher tends to use and acquire knowledge. These three questions together offer an answer to any research question (Guba & Lincoln, 1994).

There are four major paradigms that can be distinguished: positivism, post-positivism, critical theory, and constructivism (Guba & Lincoln, 1994). Positivism assumes that reality is objective and can be measured. Post-positivism maintains this but recognizes that this reality can never fully be captured, as observations can always be wrong. On the other hand, critical theory emphasizes that reality is shaped by social, political, cultural, and economic forces. Finally, constructivism believes that reality is socially constructed and multiple. Knowledge is shaped by shared meanings, culture, and language.

In this study, the constructivist paradigm is used, which is based on a relativist view. This means that multiple realities exist that are each shaped by cultural and social context. These realities can change over time as individuals and groups gain new perspectives. According to this perspective, knowledge is created through interactions, and the goal is to gain knowledge by consensus construction that incorporates various viewpoints (Guba & Lincoln, 1994). This study fits the constructivist paradigm as it acknowledges that expert understanding is not an objective truth but an outcome of shared experiences, backgrounds, and norms. This constructivist view enables an examination of how different expert communities frame problems and legitimate knowledge.

3.2: Research Design

The central element of the research design is the choice of which strategy to follow and what methods and techniques to apply. The research strategy is the overall design or procedure that will be followed. Given the strategy, several methods for data collection can be used. The technique is the way in which the data will be analysed (Van Thiel, 2014).

In the literature, the distinction is made between qualitative and quantitative methods. However, in practice, this difference refers to the nature of the data (Van Thiel, 2014). In this study, the data were collected using a qualitative research design. Qualitative methods are fit for characteristics to which no numerical values can be assigned, such as feelings, perceptions, and experiences (Kumar, 2019). This study fits a qualitative research approach as it focused on how expert communities interpret and legitimise knowledge.

The research strategy that is used is the case study strategy, which enabled the in-depth study of a limited number of situations. This results in richly detailed and extensive descriptions of the phenomenon (Van Thiel, 2014). Given the complexity of epistemic communities and their impact on flood risk management, a single case study provided the opportunity to investigate how expert communities within Rijkswaterstaat interpret and legitimise knowledge.

Case selection:

The case of the Netherlands has been selected as it has a long history of flood risk management and a unique socio-political context, which offers an ideal setting to explore how epistemic communities shaped flood risk management practices. The first factor that makes the Netherlands a suitable case is its geographical characteristics. As a low-lying country with almost 59% of its surface area prone to flooding, the Netherlands faces significant flood risks (PBL, z.d.). Secondly, the Netherlands has a multi-level governance structure involving national, regional, and local actors of flood risk management (Dieperink et al., 2018). This study does not analyse these levels comparatively, but this structure forms the broader governance context within which national-level decision-making takes place. The national level plays a central and coordinating role in the development and implementation of flood risk management strategies. Focusing on the national level allows this study to examine how epistemic communities shape policy formulation and strategic decision-making.

Moreover, the Netherlands has a long history of dealing with floods (Jak & Kok, 2000). One of the most impactful floods was the flood disaster in 1953, which led to the Delta works and extensive dike and levee reinforcement (PBL, z.d.). The prevention layer is still considered to be the most effective in the general perception in the Netherlands (Neuvel & Van Der Knaap, 2010; Van Buuren et al., 2016). This historical emphasis on prevention and engineering solutions provides an insightful context for examining how engineering and multidisciplinary epistemic communities compete with other epistemic communities and influence the evolution of flood risk management strategies.

This study focuses on Rijkswaterstaat, which plays a central role in national water management and flood protection. In this institutional setting, various epistemic communities interact. Rijkswaterstaat represents a focused case for the exploration of how knowledge and expertise are legitimised and embedded in policies.

3.3: Data Collection

In this study, the data is collected through different methods of data collection. The use of different sources of data is recommended when performing a case study. The use of data from different sources allows the researcher to compare and check them (Van Thiel, 2014). In the case of this research, semi-structured interviews were combined with document analysis.

3.3.1: Document Analysis

The document analysis provides insights into the current state of flood risk management in the Netherlands. The documents for the document analysis were selected based on the different governmental layers in order to gain a comprehensive view of the policy landscape. The selection of these documents is based on their relevance to the research objectives and the conceptual framework. Some examples of documents that were analysed are: the Delta Programme, Advisory Reports from RWS, Government websites, and internal projects.

3.3.2: Semi-structured Interviews

In addition to the document analysis, data were collected through 14 semi-structured interviews with participants. The number of interviews was sufficient, as data saturation was achieved, and additional interviews only confirmed what was already mentioned. In a semi-structured interview, the researcher uses an interview manual or topic list as a guideline. This list of topics will all have a set of questions prepared beforehand. The questions are based on the operationalization of the variables in the conceptual framework (Van Thiel, 2014). The operationalization was used as a guideline on which the interview questions were based. It focuses on the four dimensions of the PAA. This design allows for in-depth exploration of how experts construct and legitimise knowledge within their institutional and disciplinary contexts while ensuring that all core topics are addressed (Kumar, 2019).

Participants were selected using a purposive sampling strategy. This ensured representation across different departments and expertise relevant to flood risk management. The selection includes experts from different aspects of water safety (Tab 4). The specific participants were selected with the assistance of my supervisor at Rijkswaterstaat. The selection was made based on the three epistemic communities in order to ensure as much equal representation as possible. They are all anonymous, as this allowed them to talk more openly about the organisation they work for. Mentioning the departments and background of the respondents may lead to them being traceable. The participants were informed about what data would be collected, what would be done with this data, and for what purpose it would be used. The participants had to give explicit consent to participate in the research.

Table 4: Overview of respondents

Nr	Epistemic community	Referral
1	Engineer	E1
2	Engineer	E2
3	Engineer	E3
4	Engineer	E4
5	Spatial planner	SP1
6	Spatial planner	SP2
7	Spatial planner	SP3
8	Spatial planner	SP4
9	Spatial planner	SP5
10	Ecologist	EC1
11	Ecologist	EC2
12	Ecologist	EC3
13	Ecologist	EC4
14	Ecologist	EC5

3.4: Data Analysis

The data analysis combines the findings from the interviews and the document analysis to provide an understanding of how epistemic communities influence flood risk management. The analysis shows how different epistemic communities construct, legitimise, and institutionalise knowledge, and how this influences decision-making.

In order to analyse the interviews, they were recorded and transcribed. These transcripts were analysed through coding, using Atlas.ti. The codebook was made using a deductive approach, based on the operationalization of the conceptual framework (Van Thiel, 2014). During the coding process, recurring patterns of themes were grouped together.

3.5: Validity

3.5.1: Internal Validity

Validity can be split up into internal and external validity. A study has strong internal validity when it draws the right conclusions with no bias using the described methods and instruments (Yin, 2017). Multiple data sources were used to verify findings and enhance credibility. The use of interviews in combination with policy documents provided a more nuanced understanding (Timney Bailey, 1992). Finally, the internal validity is ensured by including as many actors as possible from various communities and backgrounds. This ensures representativeness and contributes to triangulation (Van Thiel, 2014).

3.5.2: External Validity

External validity in qualitative research is about whether the results of a study can be generalized to other situations or groups (Riege, 2003). Qualitative data is often based on small numbers that do not allow it to be generalizable like quantitative studies, as the case that has been studied is very context dependent, based on the situation, time, and place. Although qualitative studies are context-dependent, the concept of transferability allows findings to be applied to similar contexts (Van Thiel, 2014). According to Lincoln & Guba (1985), transferability can be strengthened by using thick description. This study uses thick description by providing detailed insights into the epistemic communities within. Finally, the study ensures external validity by using triangulation, which provides different perspectives to gain a better understanding of the situation (Van Thiel, 2014).

3.6: Reliability

Reliability addresses the possibility of the research being repeated and then achieving similar findings. It is about the extent to which the findings can be replicated. This can often be a problem in case study research as people are not static, and the result may always differ (Riege, 2003). In qualitative research, reliability can be measured through dependability, which indicates stability and consistency (Riege, 2003). In this study, reliability is ensured through the usage of interview guides that allow each interview to be replicable, and a clearly organized methodology chapter. Additionally, getting your work commented on by other researchers or experts can ensure a degree of reliability. In the process of conducting this research, my supervisor checked the work multiple times, which ensures this degree of reliability (van Thiel, 2014). Finally, this study enhances its reliability by keeping a database. The documentation of all steps and data sources to enable reviews and verification of the research process (Yin, 2017).

4: Results

In this chapter, the results of the document analysis and the analysis of the interviews conducted within Rijkswaterstaat will be presented. The interviews have been deductively coded using the indicators from the operationalization (Table 3) derived from the concepts of epistemic communities and the Policy Arrangement Approach.

The results are presented thematically to highlight dominant patterns and shared understandings in flood risk management. In order to answer the sub-questions, the analysis is structured according to the four dimensions of the Policy Arrangement Approach (PAA). First, it identifies the relevant epistemic communities within Rijkswaterstaat (actors). It then examines the discourse, focusing on how flood risk management is framed and understood. Thirdly, the analysis examines the rules. Finally, it explores the resources.

4.1: Actors: Epistemic communities within Rijkswaterstaat

This section describes the different epistemic communities identified within Rijkswaterstaat. It focuses on the characteristics of the actors, including their professional roles, disciplinary background, shared beliefs, causal understanding, knowledge validity, and preferred policy instruments. The analysis aligns with the theoretical framework as there are three distinct epistemic communities: a technical-engineering community, a spatial planning community, and an ecological community.

It is important to place the interviewed respondents within the organization of RWS. The respondents can be positioned within the three epistemic communities. **The engineering community** is the traditional core of FRM and is associated with departments and programs that are responsible for designing and maintaining flood protection infrastructure. These include the Hoogwaterbeschermingsprogramma (HWBP), which is responsible for large dike reinforcements, as well as the department Grote Projecten en Onderhoud (GPO), which focuses on the design of large hydraulic structures such as storm barriers. Additionally, the Water Management Centre Netherlands (WMCN) plays a role in the coordination of water levels and storms. Finally, at the advisory department of Water, Verkeer en Leefomgeving (WVL), technical experts work on research, modeling, and guidelines. Overall, these are the departments where the technical-engineering community is rooted.

The ecological community has emerged and focuses on integrating natural systems into FRM. This community is associated with projects that apply nature-based solutions. Examples are coastal maintenance programs such as the Sand Motor, which uses the principle of "building with nature”. The ecological community is also represented in floodplain management projects where nature conservation is combined with FRM. Ecologists are mainly in advisory roles, such as at the WVL department.

Finally, **the spatial planning community** focuses on spatial and governance dimensions of FRM. This community has its professionals working on initiatives such as the Room for the River program, which combines flood safety with spatial quality. This is also the case for the Delta Program for Spatial Adaptation, which focuses on climate adaptation in urban planning. Within RWS, this perspective is present in WVL as well as in the regional RWS offices, which play an important role in the regional collaboration.

The interviews indicate that epistemic communities within Rijkswaterstaat should not be understood as rigid or exclusive categories. Several respondents occupy positions that are between different communities. In some cases, their professional role does not align with their epistemic community, while in other cases, their educational background differs from the community that they currently represent. For example, a respondent has a technical background but now operates in a more ecological role despite being technically trained. These hybrid positions highlight that epistemic communities are not fixed classifications. However, they provide a useful analytical lens. Figure 5 illustrates this and positions the respondents within the overlapping epistemic communities.

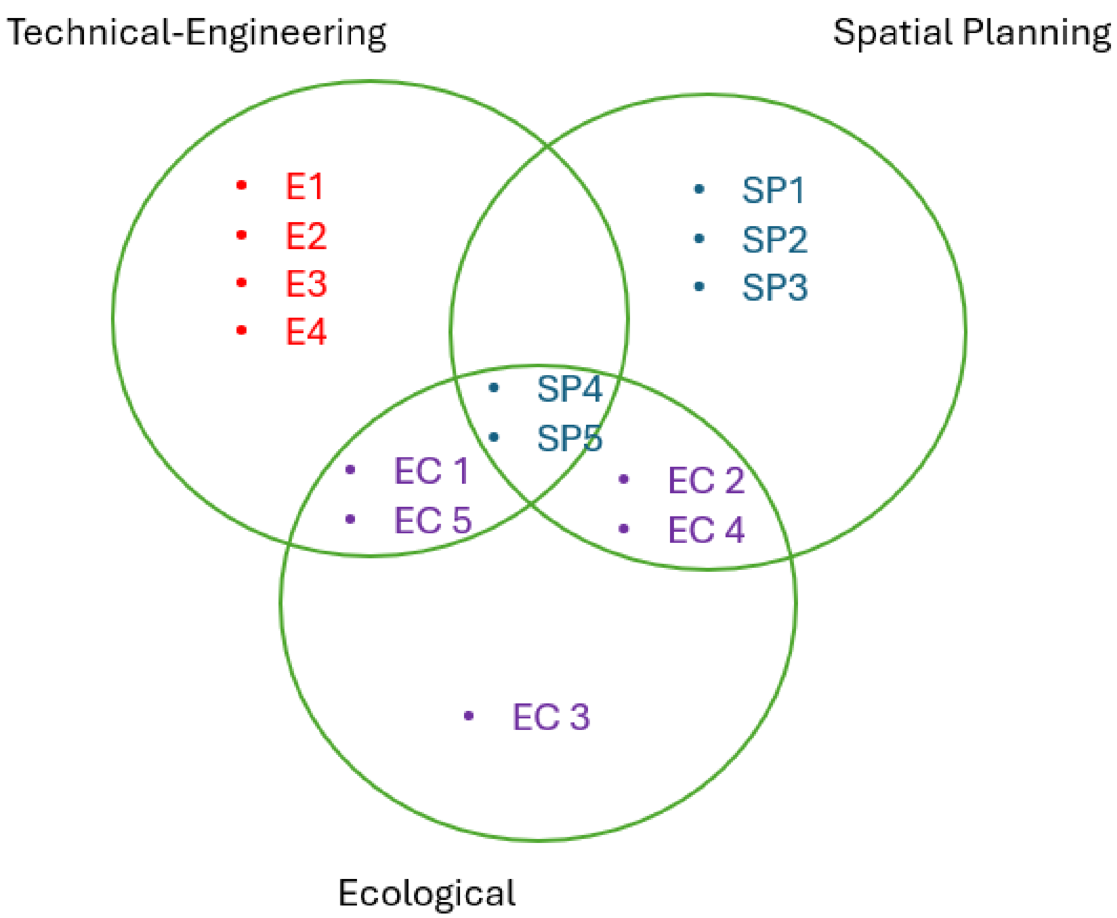

Figure 5: Positioning of the interviewed respondents within the three epistemic communities in flood risk management at Rijkswaterstaat

4.1.1: Professional roles and disciplinary backgrounds

Clear differences between the epistemic communities emerge with regard to professional roles and disciplinary backgrounds. Respondents belonging to the technical-engineering community work in departments related to water safety, river management, and flood defense. Most respondents are senior-level professionals with extensive experience at RWS. Their educational backgrounds are rooted in civil engineering, hydraulic engineering, or physical geography, and they have spent most of their careers within RWS or related public-sector organizations, sometimes combined with experience in consultancy.

Respondents from the spatial planning community primarily work in departments concerned with: spatial planning, policy development, and governance. Their professional roles include spatial planners, policy advisors, and legal advisors. Most are involved in translating flood risk considerations into broader policy and spatial planning processes. Educational backgrounds within this community are more diverse than in the technical community. Respondents have degrees in spatial planning, law, geography, and social sciences.

Respondents belonging to the ecological community work in departments concerned with nature-based solutions and environmental integration within flood risk management. Their professional roles include ecologist and advisor on nature-based solutions. Their educational backgrounds are diverse but are rooted in environmental and natural sciences. The respondents often combine educational training with project environments. This creates a system-oriented perspective on flood risk management.

4.1.2: Shared normative and principled beliefs

Technical-engineering community

The epistemic communities differ significantly in how they define the objectives and underlying principles of flood risk management. Within the technical-engineering community, flood risk management is primarily understood as a matter of ensuring protection through probability reduction. The core objective is to guarantee a basic level of safety through flood defenses. The dominant belief is that Rijkswaterstaat's core responsibility is to guarantee safety by preventing floods from happening. As one respondent explained, the objective is to provide "protection against high water and make the probability sufficiently small that something goes wrong," after which "we have done our job" (E1, 2:37 ¶35).

This emphasis on probability reduction recurs across multiple respondents. For example, one respondent explicitly framed the objective as "reducing the probability of flooding." (E2, 4:05 ¶66). In contrast, consequence reduction is often acknowledged but positioned as secondary and questioned in terms of feasibility and cost-efficiency. One respondent argues that consequence reduction is difficult to treat as "a driving factor" because it may imply "spending years raising entire cities instead of simply carrying out a dike reinforcement." (E4, 7:31 ¶128–130).

A second pattern is that success is strongly linked to compliance with legal standards. Meeting the standards is treated as a key benchmark to test whether Rijkswaterstaat has fulfilled its responsibility. As a respondent stated, "we have to comply with the standards … legally established … required to meet them by 2050," (E4, 7:30 ¶94). Another respondent similarly concluded that if there is a standard and it can be shown that "we can demonstrably comply with it, then we have done our job properly." (E1, 2:38 ¶42–43).

Spatial planning community

In contrast, the spatial planning community often describes flood risk management as a matter of managing risks rather than preventing floods. Respondents often indicate that flood risk should be understood as a combination of probability and consequences. This implies that absolute prevention is not realistic and residual risk is unavoidable. One respondent explicitly supports this understanding of the combination of probability and consequences, arguing that "preventing floods altogether … is not possible" as "risk is probability times consequence, which means there will always remain a probability" (SP1, 1:28 ¶53–58). This difference in problem framing also creates tension between communities as the respondent noted a "real difference in perspective" between engineers and spatial-planning professionals, especially when discussing spatial development (SP1, 1:28 ¶53–58).

This risk-based perspective is connected to a broader understanding of FRM. Rather than treating flood risk as a technical matter, flood risk is placed in a wider set of long-term practices as climate adaptation and planning challenges. One respondent framed FRM as entailing "climate adaptation," ensuring defences meet standards, and "the spatial redesign of areas that may also be subject to flooding" (SP2, 10:25 ¶65). In this framing, technical prevention remains necessary, but it is not sufficient as the sole guiding principle for policy.

Accordingly, successful flood risk management is often described in broader terms than compliance with safety standards. Respondents acknowledge that meeting standards matters, but they problematize the focus on flood defences alone, and emphasise that spatial planning responsibilities remain essential to preventing the creation of new risks. One respondent argues that the standards are "really focused on flood defences", which caused "the spatial planning perspective to largely fall out of view," while responsibilities such as "where you build and how you build" are "not always fully recognised" (SP1, 1:29 ¶83–84). Another interview similarly considered FRM to be successful when impact remains manageable and "things do not go terribly wrong" and "the consequences are limited," which they described as a "trade-off between risk, probability, and consequences" (SP3, 5:29 ¶130–140).

Ecological community

Respondents in the ecological community often describe the primary goal of flood risk management as long-term resilience rather than maximizing protection through control. Flood risk is seen as a broader socio-ecological system in which water safety, ecological quality, and spatial development are interconnected. While ensuring safety remains a core responsibility, respondents emphasize the need to reconsider the rigid flood protection strategies. One respondent linked future flood risk management success to the recognition that "at some point we will have to decide that, in certain areas, we should not continue to protect everything," and instead "learn to live with the fact that flooding will occasionally occur" (EC3, 9:27 ¶131–141).

Rather than challenging the importance of safety, respondents challenge the interpretation of safety as absolute protection. Several respondents argue that the Dutch water management culture of keeping "our feet dry" is often treated as evident, while the broader objective should be to accommodate multiple societal interests. From this perspective, flood risk management should aim to balance water safety with ecology, navigation, economic activity, and recreation, instead of prioritising one dimension above all others (EC2, 12:33 ¶41–42).

Consequently, they emphasize concepts such as coexistence with water, adaptability, and robustness. Preventing floods by increasing technical rigid measures is potentially unstable in the long term. One respondent described a preference for "dealing with flood risks in an adaptive way over the long term," arguing that while short-term technical solutions may be effective, they risk leading to a situation in which policy ends up "fighting against nature indefinitely" (EC3, 9:28 ¶191–195). Ecological considerations, therefore, need to be integrated at an early stage, rather than being added later as secondary objectives. This requires making the notion of "integration" more concrete by explicitly considering the impacts of flood risk management decisions on river and coastal landscapes (EC2, 12:34 ¶51).

4.1.3: Shared causal beliefs

The epistemic communities internally share understandings of what causes flood risk. Within the technical-engineering community, respondents mostly identify climate change, hydraulic loads, and structural weaknesses in flood defences as causes of flood risks in the Netherlands. Respondents connected risk to maintaining flood defences at their intended safety level. One respondent emphasized that the key cause is "we do not sufficiently ensure that our flood defences maintain the level of safety they are supposed to provide." (E1, 2:39 ¶81). In addition to these, new insights into failure mechanisms, such as piping, were often mentioned. This refers to increased knowledge of how and why flood defences can fail. These mechanisms gave an explanation for why defences are assessed as being less robust than previously assumed. One respondent described that "more insight into failure mechanisms" (including piping) revealed that defences were "much weaker than we had always thought." (E3, 13:32 ¶57–58).

Spatial planning respondents tend to locate the causes of flood risk not just in climate and hydrological change. They also stress the importance of long-term spatial choices that shape exposure and vulnerability. Climate change is acknowledged as a driver, but these risks are amplified through land-use decisions. One respondent stressed that “climate change is an important driving factor,” but linked increasing risks to “building in the wrong places,” noting that constructing homes or businesses in inappropriate locations can increase flood consequences. The example of placing “a chemical plant in a deep polder” illustrated how land-use decisions can transform risk profiles (SP2, 10:26 ¶64–65). When spatial development continues without changing the consequences, exposure will increase over time, creating a self-reinforcing trend. This was described as a “vicious circle” in which consequences keep rising “unchecked,” driven mainly by socio-economic developments, because construction proceeds in many locations without sufficient long-term consideration (Interview SP1, 1:30 ¶97–99). This makes FRM a governance and planning problem rather than a technical problem.

Ecological respondents similarly identify climate change as an important driver for increasing flood risks. Flood risks are described as being worsened by system interventions such as the loss of floodplains and river confinement. Flood risk is seen as a cumulative issue shaped by historical choices and long-term development. One respondent explained that the existing layout of the Netherlands “largely determines the strategy that I experience as realistic,” as past land development decisions constrain and determine which flood risk strategies are feasible today (EC4, 8:20 ¶118–126). At the same time, respondents recognize that the preventive strategy is deeply embedded within Dutch water management. It is historically rooted and culturally entrenched, which means it is hard to simply scale it back without broader acceptance. As one respondent noted, preventive measures have been embedded for centuries and “really are the structural measures that need to be continued”, you cannot just do a bit less *(EC1, 6:31 ¶126–128)*.

According to respondents who strongly identify with the ecological epistemic community, are highly engineered river systems a contributing factor to flood risks. From this perspective, the assumption comes that landscapes are fully controllable. One respondent argued that Rijkswaterstaat places “very high regard” on controllability and advocated “moving back towards a more natural system,” which would involve creating more space for rivers and coastal dynamics rather than further technical optimisation (EC2, 12:35 ¶66–68).

4.1.4: Shared notions of validity

Despite their differences, the epistemic communities share a recognition of the importance of technical and model-based knowledge in FRM. Technical expertise is rarely questioned as legitimate and is generally accepted as the baseline from which further considerations are made. The differences do not lie in rejecting technical knowledge, but in how this knowledge is prioritised and complemented.

Technical-engineering respondents consistently indicate that technical and model-based knowledge forms the foundation of decision-making. Respondents referred to hydrological models, safety assessments and cost-effectiveness as the starting point which structures what is considered feasible or desirable. While considerations such as nature development are acknowledged, they are often framed as secondary or complementary. As one respondent explained, although natural developments can be considered, "you do not want to opt for the most expensive solutions" given the scale of the challenges, making reinforcement the most cost-efficient option (E4, 7:32 ¶72–74). Another respondent also stressed that flood risk management "starts with the technical aspects, this is necessary to understand what is possible and what you can actually put into the ground" (EC1, 6:30 ¶180–181).

The spatial planning community has a broader understanding of what constitutes valid knowledge. Technical knowledge is recognized and seen as important. However, at the same time, there is also emphasis on contextual judgement, legal frameworks and area-specific knowledge. This knowledge perspective is shown in how respondents describe the order of considerations. One respondent explained that FRM begins with "the technical aspect", then requires assessing the consequences, which is "more of a spatial-planning perspective". Finally, when moving to solutions, ecological and spatial planning expertise becomes increasingly relevant (SP3, 5:30 ¶280–284). Another respondent similarly argues that no perspective is sufficient on its own. The need to place technical knowledge along with other challenges, such as spatial development and ecological objectives, is essential (SP5, 11:29 ¶117–118). Additionally, respondents treat local knowledge as a form of expertise, suggesting that "you really have to look at each area individually" and that understanding how things are organised administratively can be crucial for workable solutions (SP2, 10:28 ¶117–118).

Ecological respondents similarly recognise the importance of technical models, particularly as a basis for decision-making. However, they also emphasise the importance of ecological knowledge. This knowledge is complementary to technical knowledge as it entails long-term ecological dynamics and system feedbacks. This integrative understanding is reflected in how they describe the relation between technical and ecological knowledge. One respondent argued that flood risk management "naturally starts with technical expertise about dikes" but that this knowledge must be considered alongside spatial integration and the need to create more space to deal with uncertain and extreme future conditions, and therefore combined with ecological objectives (EC5, 3:28 ¶113–115). This perspective was supported by a respondent who argued that while technical knowledge remains important, it is often framed too narrowly around established practices. Innovation, from this viewpoint, requires closer collaboration between technical experts, ecologists, and biologists, rather than maintaining rigid disciplinary boundaries (EC 2, 12:36 ¶85–86).

4.1.5 Common policy enterprise

Finally, despite differences in emphasis, all communities share the view that structural measures remain a necessary component of the Dutch system. They differ in how measures are prioritised and complemented with spatial and ecological strategies. Technical-engineering respondents primarily advocate technical infrastructure measures to reduce flood risks. Particularly, dike reinforcements are the core strategy for flood risk management. Some respondents acknowledge climate change mitigation as a long-term strategy, but this is framed as conceptually distinct from flood protection. One respondent distinguished mitigation as a sustainability issue and flood risk reduction as a technical matter. Reducing flood probabilities ultimately "comes down to proper management and maintenance, and reinforcing dikes when you find that they no longer meet the established standards" (E2, 4:09 ¶190–200).

Spatial planning respondents emphasise spatial planning instruments such as zoning regulations and coordination with regional and local authorities. One respondent described the core task as ensuring that areas which can flood "are not developed in such a way that they could cause extensive damage", requiring the designation of flood-prone areas and corresponding measures (SP2, 10:27 ¶70). At the same time, respondents indicated that their influence on flood risk measures is often indirect as formal responsibilities for spatial planning largely lie outside Rijkswaterstaat. As a result, their role relies on coordination and persuasion rather than direct authority. One respondent described this difficulty as she has to deal with "the policies of municipalities and provinces," while Rijkswaterstaat has "very little say over that," meaning outcomes ultimately depend on how principles are implemented in municipal and provincial plans and on "how far ahead they dare to look" (SP1, 1:31 ¶146–148).

Respondents from the ecological community frequently refer to nature-based solutions and ecosystem-oriented measures. These include the integration of river widening, floodplain restoration, and building with nature into infrastructure projects. The idea is to create ecological and spatial co-benefits in infrastructure projects. Rather than rejecting technical solutions, respondents advocate for hybrid strategies in which "grey" and "green" measures are combined. One respondent described this as a strategic balancing exercise, asking where reinforcement is necessary to ensure safety and where it may be possible to allow partial flooding or reduce protection, while actively combining technical and nature-based interventions in practice (EC3, 9:29 ¶231–239). Similarly, respondents indicate that within existing reinforcement programmes such as the HBWP, there is room for nature-inclusive designs. Dikes can be raised or widened, but also integrated with forelands, double-dike constructions, or "room for the river" solutions. Nonetheless, respondents acknowledge that, despite this flexibility, the flood defence itself "remains the bottom line," illustrating how ecological ambitions are still situated within the broader framework of technical safety requirements (EC5, 3:10 ¶106–109).

4.2: Dominant FRM discourses within Rijkswaterstaat

This section analyses how epistemic communities within RWS shape the dominant discourses concerning flood risk management. Building on the theoretical distinction between engineering, ecological, and socio-ecological discourses, this section examines how they manifest in practice and how they are positioned in relation to each other.

4.2.1: Engineering discourse

The engineering discourse is the most dominant discourse across the interviews and is the central framework through which flood risk management is understood and discussed. Within this discourse, flood risk is defined as a technical hazard that can be calculated and managed through structural measures and system control. Respondents from the technical-engineering community frame flood risk management as a matter of reducing the probability by compliance with safety standards and norms.

Respondents operating in the technical discourse consistently emphasize hard structural measures, such as the HWBP, as the backbone of flood risk management. While they acknowledge that dike reinforcements can take place in different forms, including ecological designs, the presence of the water barrier itself is non-negotiable. As one respondent stated, FRM ultimately depends on "knowing which standard needs to be met and how to calculate it," as compliance with safety norms defines whether a solution is acceptable (EC5, 3:29 ¶121). Within the engineering discourse, prevention is frequently framed as the most efficient and rational approach. One respondent contrasted conventional dike reinforcement with more radical alternatives, such as raising entire landscapes, arguing that while these options could theoretically reduce risk, they are far less practical or efficient in the Dutch context. A dike is "a very efficient local way of raising the land" and therefore the most practical solution (EC4, 8:21 ¶106–114). This framing reinforces the idea that technical efficiency and cost-effectiveness are central criteria for decision-making.

Technical analyses, models, and safety assessments serve as the starting point for policy processes, with other perspectives being incorporated in later stages after the technical feasibility is established. Respondents repeatedly framed policy success in terms of demonstrable compliance with standards, suggesting that once compliance can be shown, Rijkswaterstaat has fulfilled its responsibility (E1, 2:38 ¶42–43). As a result, technical norms not only guide engineering design but also structure the broader decision-making process by delimiting which options are considered realistic

Another characteristic of the engineering discourse is its strong belief in stability and control. Although uncertainty related to climate change is recognised, respondents tend to frame uncertainty as something that can be managed through robust technical design and adaptive standards. One respondent articulated this belief from a technical perspective, "no matter how crazy the idea, there is always a technical solution that can be devised" (E2, 4:27 ¶531). At the same time, this strong belief in controllability is also critically reflected upon by some respondents, who observe that within Rijkswaterstaat the idea that the landscape is fully controllable "is held in very high regard" (EC2, 12:37 ¶66–67).

4.2.2: Ecological discourse

The ecological discourse is also present in the interviews. Within this discourse, FRM is framed in connection with natural systems. It emphasizes the importance of working with natural processes and enhancing resilience, rather than just controlling them. A feature of the ecological discourse is its focus on nature-based measures, such as floodplains and forelands. The measures are framed as providing multiple benefits, including ecological and spatial quality. From this perspective, FRM is not limited to preventing floods but also making choices about how society can adapt to living with water. One respondent described success as reaching a situation in which it becomes "acceptable for some areas to be flooded occasionally," implying a fundamental shift in how risk and safety are understood (EC3, 9:30 ¶181–183).

As mentioned before, ecological considerations are often introduced after technical safety requirements have been established. As a result, ecological measures tend to be evaluated in terms of their compatibility with predefined safety norms, rather than as alternative starting points for problem definition. This is reflected in respondents' descriptions of the challenges of integrating ecological objectives into infrastructure projects. Coupling dike reinforcements with nature development is described as “very challenging,” particularly because technical projects are already complex in themselves (EC2, 12:38 ¶148–149).

Within the ecological discourse, stability is framed as the adaptive capacity of natural systems. This refers to the way a system responds to changes and shocks. However, this interpretation is rarely seen as an alternative to technical safety. It is rather seen as a complementary perspective that can enhance the technical system. One respondent captured this by describing the need to balance “grey” and “green” measures depending on location, while acknowledging that in many places technical measures inevitably take precedence due to spatial constraints (EC3, 9:31 ¶343–359).

4.2.3: Socio-ecological discourse

The socio-ecological discourse appears less frequently in the interviews and is mainly applied by the respondents from the spatial planning epistemic community. Flood risk is not only a result of a physical hazard but also of vulnerability, exposure, and governance arrangements. It puts more emphasis on land use and societal choices. The central element of the socio-ecological discourse is its focus on limiting consequences through land-use planning rather than exclusively reducing flood probabilities. Respondents emphasise that if flooding does occur, it should do the minimal damage to homes, businesses, and critical infrastructure. This involves creating retention areas and flood-prone zones where water can be given space “in locations where it causes minimal harm” (SP2, 10:29 ¶59). Flood risk management is framed as a long-term planning issue rather than a purely technical challenge.

The discourse also puts emphasis on the permanence of spatial decisions. It is stressed that where and how buildings are constructed have lasting implications for flood risk, particularly because residential structures are effectively built “for eternity.” As a result, present-day spatial choices can lock in future vulnerabilities that are difficult to reverse (SP1, 1:32 ¶100–102).

Public participation, communities and awareness are more important in this discourse than in the other discourses. The responsibility of flood risk management is framed as shared and involves different governance levels and societal actors, such as local governments and residents. Citizens are active participants and not just passive receivers of protection. Respondents argue that spatial planning should involve making residual risks explicit and ensuring that people understand where they live and what risks they face. However, this is described as a dimension of flood risk management that remains underdeveloped, leading to continued reliance on prevention as the dominant strategy (EC1, 6:32 ¶230–234).

4.2.4: Relations between the FRM discourses

The interviews show that the three discourses coexist within Rijkswaterstaat. However, they are positioned asymmetrically to each other. The engineering discourse constantly functions as the reference point for defining flood risk and acceptable solutions. Ecological and socio-ecological perspectives are presented but are set within the boundaries of technical safety requirements.

Rather than being a competing framework, they form a layered system in which technical safety serves as the foundation. Within this system, ecological and socio-ecological considerations are incorporated according to their compatibility with the technically established norms.

This layered and asymmetrical relationship between the flood risk management discourses is also reflected in how respondents discuss the multi-layer safety (MLS) approach. Although the MLS approach is formally accepted as a guiding principle for Dutch flood risk management, the interviews show that it does not land as an integrated decision-making framework in practice. Respondents across all epistemic communities recognise the importance of MLS and frequently refer to it. However, in practice MLS functions more as a reference point rather than an operational framework.

The MLS is widely acknowledged in principle, but the different layers are not equally embedded within organisational routines. One respondent characterised MLS as a useful concept that nevertheless "remains very much stuck in the conceptual phase," suggesting limited translation into concrete decision-making processes (EC1, 6:34 ¶290). Another respondent similarly described MLS as a "core value," but emphasised that it is not embedded "in an equal way within Rijkswaterstaat," with the different layers receiving unequal attention and institutional support (EC2, 12:43 ¶238). As a result, MLS functions more as a normative aspiration than as a structuring framework within the dominant flood risk management discourse.

4.3: Institutional rules shaping FRM within Rijkswaterstaat

This section analyses the institutional rules that structure FRM. Building on Ostrom (1999), the section examines which types and how rules shape decision-making in Rijkswaterstaat. The analysis distinguishes position rules, boundary rules, authority rules, aggregation rules, scope rules, information rules and payoff rules.

4.3.1: Position rules

Position rules define which expert groups occupy positions within FRM and how these positions are distributed across the organization. The interviews indicate that not all epistemic communities are equally represented at Rijkswaterstaat. Technical expertise is overrepresented, while ecological and spatial expertise is more limited in both number and institutional embedding. Respondent repeatedly emphasized that proportional representation is not the case in practice. One respondent noted that, “in numerical terms, certainly not,” as the organisation’s core tasks result in a much larger presence of technical experts, making the distribution inherently unequal (EC4, 8:22 ¶395–397). This imbalance is mostly visible for ecological expertise. Respondents described ecologists and biologists as “dramatically underrepresented,” with existing teams being overstretched and therefore unable to participate consistently in broader flood risk management discussions (EC2, 12:40 ¶107–109). Spatial planning expertise is also described as underrepresented, although to a lesser extent.

Formal decision-making positions are generally located at higher organisational levels. Technical experts do not necessarily occupy these formal decision-making roles, yet they are consistently involved in early project phases where problems are defined and solution spaces are delineated. One respondent described their role as being firmly located on “the project side,” focusing on doing “what we think needs to be done” rather than engaging in formal policy decisions (E1, 2:40 ¶104–105). Another respondent explained that while technical experts may not make final decisions, they have substantial influence by shaping what decisions are available in the first place. Final choices are often made by spatial planning or managerial actors, unless issues are escalated beyond RWS to ministerial or parliamentary decision-making levels (EC2, 12:39 ¶131). As a result, position rules contribute to an imbalance in which technical expertise has a strong influence without necessarily holding formal authority.

4.3.2: Boundary rules

Boundary rules determine who is included or excluded from flood risk management processes. The interviews show that participation is shaped by a combination of formal responsibilities and informal organisational practices. In practice, flood risk management processes typically start from a technical foundation. Ecological and spatial planning actors are being included only after initial safety assessments and feasibility analyses have been conducted, and once the technical scope of the project has largely been defined.

Respondents described this as a layered structure in which technical standards and assessment instruments function as a “first ring” that defines the initial problem framing. Other considerations are introduced only in a “second ring,” once the technical basis has been established. As one respondent explained, standards and assessment tools are “very much formulated from a technical perspective,” and those working with models are deeply rooted in the technical domain (EC5, 3:30 ¶163–167). Although ecological and spatial planning actors are eventually involved, their participation is constrained by the stage at which they enter the process and by the relative weight assigned to their input. One respondent noted that they are often included, but that decisions are "not always taken with the primacy of ecology in mind" (E3, 13:33 ¶154).

In addition to formal rules, informal procedures and personal networks play an important role in shaping access to decision-making processes. Participation often depends on your experience and familiarity with organizational processes. One respondent described this as a process in which a programme or project is initiated, a manager is appointed, and staff are brought together based on availability and perceived relevance (SP2, 10:30 ¶147–148). These informal boundary rules reinforce existing power relations by favouring actors who are already well embedded in organisational routines.

4.3.3: Authority rules

Authority rules define who is formally authorized to make decisions and take actions in flood risk management. The interviews indicate that formal decision-making authority is mostly located at higher organizational and political levels, such as senior management within Rijkswaterstaat and political decision-makers. These actors are responsible for approving plans, allocating resources and taking final decisions.

At the same time, the interviews reveal a clear distinction between formal authority and substantive influence. In practice, decision-making follows a hierarchical trajectory in which project teams develop proposals and technical options, which are then submitted "up the line" for formal approval. Although managers hold formal authority, they often lack detailed substantive expertise and therefore rely heavily on the advice, analyses and problem framings provided by experts (EC5, 3:31 ¶178–181). Within projects and knowledge programs, this creates considerable room for manoeuvre for technical experts, who occupy much of the available decision-making space at this level.

Substantive influence is associated with technical expertise. Technical actors define problems, propose solutions and decide which options are considered feasible. This indirectly influences decisions by structuring the range of available options. Ecological and spatial planning actors are limited by this feasibility and have a more limited authority. Their influence is set within the technically set boundaries. The ecological experts have a hard time getting their beliefs across. Several respondents noted that ecological expertise is often brought in later and remains structurally weaker, both numerically and institutionally. This results in a situation where ecological perspectives “feel less like something that truly belongs to you,” partly because fewer people from these disciplines are involved (SP5, 11:30 ¶173).

Respondents also pointed to a perception that ecology is included primarily due to regulatory requirements rather than as an equal partner in decision-making. One respondent argued that technology tends to lead, with ecology being given “a voice” mainly because regulations demand it, suggesting that without these rules, ecological considerations might be sidelined entirely (E2, 4:28 ¶300–304). As a result, ecological actors often have to actively assert themselves to gain a seat at the table, while technical actors must be willing to create space for their input (SP4, 14:29 ¶240).

4.3.4: Aggregation rules

Aggregation rules define how collective decisions are made. The interviews indicate that consensus-building is a central mechanism in decision-making processes. Particularly in situations where different epistemic perspectives meet. Conflicts most commonly arise around the balance between technical safety requirements and ecological or spatial ambitions. An example is when they determine the extent to which nature-inclusive measures can be combined with flood protection objectives. Such conflicts are typically managed through compromise, reformulation or technical clarification. Rather than being resolved through confrontation or formal voting. Respondents described decision-making processes in which disagreements are addressed by searching for solutions that all parties can “live with,” even if no actor is fully satisfied. In practice, this often involves adjusting the balance between technical and ecological measures, resulting in outcomes that combine elements of both perspectives (EC3, 9:32 ¶648–657).

However, respondents also noted that consensus-building can strengthen underlying power dynamics. When there are disagreements, technical actors may respond by re-explaining their reasoning, implicitly framing other perspectives as misunderstandings rather than as legitimate alternative viewpoints (SP1, 1:35 ¶313–315). This reinforces the authority of technical expertise.

4.3.5: Scope rules

Scope rules define what outcomes are possible or permissible in flood risk management. The interviews indicate that safety norms and legal standards strongly limit the range of acceptable outcomes. Alternative strategies, such as the retreat or the removal of flood defenses, are described as politically or institutionally sensitive. These kinds of options are rarely treated as realistic options. Respondents described that measures such as land take-back or setting dikes further inland, although technically feasible and potentially compatible with safety standards, are “not always appreciated” because they involve giving up land (EC5, 3:32 ¶213–214). This sensitivity is especially shown in regions such as Zeeland. There is ‘the return of land to water’, described as both politically and socially delicate. One respondent observed that even the language used shifts in these contexts, with terms like “room for the river” being replaced by the more controversial notion of “retreat” (EC2, 12:41 ¶162–164). These scope rules limit the consideration of transformative flood risk strategies.

4.3.6: Information rules

Information rules determine what information is available to whom. As mentioned above, technical information plays a big role in the flood risk management process. Respondents indicated that within the organization, there are few formal restrictions on information sharing. In principle, all information can be discussed. Under open government requirements all information can also be made public. At the same time, respondents stressed that information communicated to external audiences must be carefully framed to prevent misinterpretation. One respondent noted that without proper narrative framing public communication could easily lead to misleading headlines, such as claims that Rijkswaterstaat “wants to remove all weirs in the Meuse.” This illustrates the sensitivity surrounding technical information when shared with public audiences (E3, 13:34 ¶202–203).

4.3.7: Payoff rules

Payoff rules play a limited role within the flood risk management process at Rijkswaterstaat. The interviews show that incentives are not directly structured around incentives and sanctions for individual actors. Instead, FRM operates with public budgets which function as enabling or constraining conditions rather than payoff mechanisms. This will be further discussed in the resources and power chapter (4.4).

4.4: Resources and power

This section analyses how different types of resources shape power relations in FRM within Rijkswaterstaat. This is examined using the dimensions based on Leroy and Arts (2006) and Ostrom (1999): financial, knowledge, political, discursive and organizational resources.

4.4.1: Financial resources

Financial resources play a largely indirect role in shaping FRM. Funding for projects is mostly organized through predefined programs, which shape the range of feasible outcomes. Structural flood protection measures have a stable and predictable funding arrangement through the HWBP. Respondents consistently described the HWBP as providing a financial backbone for technical flood protection measures. One respondent explained that stable funding for dike reinforcements makes flood safety “always better organised” than alternatives such as river widening. These alternatives require additional research and separate financial arrangements. As a result, technical measures can be implemented continuously, while other types of measures struggle to gain momentum (EC5, 6:33 ¶470–478). This financial asymmetry reinforces the position of technical actors. Their preferred solutions align closely with existing funding structures.

Spatial and ecological measures are not excluded, but they are typically financed through external budgets, such as municipal and provincial budgets, nature development programmes, or integrated spatial planning initiatives, rather than through dedicated flood protection funding like the HWBP. Respondents emphasised that the engineering domain “automatically receives more financial support” through the HWBP, while within the spatial planning domain, it is often difficult to clearly identify and allocate costs associated with more integrative or transformative choices (SP1, 1:37 ¶358). As a result, consequence-reducing measures are frequently framed as co-benefits rather than as core objectives.

This is also the case for ecological and spatial measures. However, these are often from additional funding sources. Overall, financial resources mainly function as enabling or constraining rather than direct incentives or sanctions. Access to big predefined budgets, such as the HWBP, increases the feasibility of certain measures and strengthens the position of the actors associated with those measures.

This co-benefit logic constrains integrative approaches. Respondents noted that when objectives are linked, nature or spatial benefits tend to be attached to dike reinforcements. The consequence reduction then becomes a by-product of other spatial developments. This makes it difficult to see different responsibilities and funding streams, thereby limiting the financial viability of non-technical measures (SP1, 1:36 ¶371–372). Although large budgets are available for guaranteeing flood safety, integrated designs that combine safety with ecological or spatial functions are not automatically funded through the HWBP and require coordination with other authorities and budget holders (EC5, 3:24 ¶230–232). Overall, financial resources primarily function as enabling or constraining conditions that strengthen the position of actors aligned with technically funded programmes.

4.4.2: Expertise and knowledge resources

Expertise and knowledge form a central resource in flood risk management. Technical expertise is widely available and strongly institutionalized within Rijkswaterstaat. Ecological and spatial planning expertise is present, but as they are limited in number, respondents have a hard time mobilizing it. They frequently pointed to capacity constraints within ecological teams, describing ecology as "even more understaffed" and highlighting difficulties in being involved "in time and with sufficient capacity" (SP4, 14:30 ¶343). Others suggested that while ecological expertise exists, it is not always positioned "in the right place at the right time," limiting its impact on early decision-making (SP3, 5:32 ¶563).

In addition, respondents expressed concern about the loss of specialised technical knowledge due to retirements and organisational downsizing. The increasing reliance on private-sector contractors was described as reducing Rijkswaterstaat's internal control over complex projects. One respondent argued that this loss of in-house expertise has already weakened the organisation's capacity to manage large-scale interventions. According to this respondent, responding to a disaster comparable to the 1953 floods would be considerably more difficult today, because Rijkswaterstaat no longer retains the same level of internal technical knowledge and implementation capacity (E2, 4:29 ¶627–631).

This loss of expertise is also evident in relation to modelling knowledge. Respondents warned that a detailed understanding of how models are constructed is disappearing as experienced staff retire, while younger professionals increasingly focus on applying complex models without fully understanding their underlying assumptions (E4, 7:33 ¶507–509). These developments affect organisational capacity and reinforce dependence on existing technical frameworks, thereby limiting reflexivity and innovation.

4.4.3: Authority and political resources and social and discursive resources

As discussed in Section 4.3.3, formal authority over flood risk management decisions is concentrated at higher organisational and political levels, while Rijkswaterstaat primarily fulfils an advisory role. Political resources therefore, play a limited role within Rijkswaterstaat itself, as decisions regarding approval, prioritisation and resource allocation are largely taken outside the organisation. Analysing political resources as a separate category would thus add little empirical insight beyond the authority relations already discussed.

Discursive and social resources are not distinct empirical categories in the interview material. Discursive influence is predominantly exercised through the dominant engineering discourse analysed in Section 4.2, which structures how flood risk problems are defined and which solutions are considered legitimate. As a result, analysing discursive and social resources separately would largely reproduce earlier findings without adding analytical depth. For this reason, they are not treated as standalone categories in this section.

4.4.4: Human and organizational resources

Human and organizational resources encompass the personnel and the knowledge these personnel have. Technical departments generally have enough organizational capacity, while ecological and spatial planning teams are smaller and experience higher workloads. This limits their ability to participate consistently across multiple projects. Some respondents described national spatial planning services as "somewhat understaffed," noting that limited capacity can affect both the visibility and perceived quality of their contributions (SP2, 10:31 ¶217–218). In contrast, respondents described the technical community as the organisational core, with "sufficient capacity" to operate at both strategic and operational levels (EC2, 12:42 ¶258). Other respondents suggested that capacity across departments is "not generous" but generally manageable, indicating some variation in perceptions (EC5, 3:33 ¶237).

Respondents across the different epistemic communities point to organizational fragmentation and the existence of separate departments. Interaction between expert groups depends on individual connections, and there is a lack of a 'collective language'. In combination with the loss of experienced staff, this reduces organizational capacity for integrated floor risk management.

Additionally, respondents pointed to organisational fragmentation as a key constraint on integrated flood risk management. The existence of separate departments and siloed expertise limits interaction between epistemic communities and harms the development of a shared language. One respondent argued that while technical experts focus primarily on probability reduction, consequence reduction remains largely situated within the spatial planning domain, creating a need for a "shared language" that is currently lacking (SP1, 1:38 ¶60–61).

Several respondents emphasised that integration requires early interaction between expert groups. While working separately is not necessarily problematic for purely technical designs, integrative solutions demand close collaboration within shared design teams. Respondents expressed uncertainty about whether such interaction currently occurs sufficiently during early planning phases (E2, 4:31 ¶398–402). Others argued that interaction across silos could be significantly strengthened, warning that fragmented organisational structures increase the risk that advice from different expert groups does not align. This could force decision-makers to choose between competing perspectives (E4, 7:34 ¶343–347)

5: Discussion

This chapter discusses the results presented in Chapter 4. The discussion is structured around five interrelated themes that together capture the main tensions emerging from the analysis. These themes are linked to the broader literature on flood risk management from the theoretical framework.

5.1: Engineering dominance despite integrative ambitions

The findings show that flood risk management within Rijkswaterstaat is strongly shaped by the engineering epistemic community. Nonetheless, there have been policy ambitions to move towards a more integrated and adaptive approach. Although concepts such as climate adaptation, nature-based solutions, and multi-layer safety are widely acknowledged within Rijkswaterstaat, the engineering discourse continues to function as the primary reference point for defining flood risk problems and legitimate solutions. This dominance is in line with the epistemic community theory and translates into safety reduction, defense performance, and knowledge being grounded in technical models and standards. It provides coherence and stability, but also contributes to a prevention-oriented paradigm.

To understand why this dominance persists, the PAA is used as an analytical lens to show how different dimensions interact. The findings show that there is a consistent orientation towards technical flood defense across all dimensions:

- Discourse: flood risk is framed as a probabilistic hazard
- Rules: safety standards and legal norms define acceptable outcomes
- Resources: stable funding streams privilege structural measures
- Actors: technical experts are numerically and historically embedded in key positions

Altogether, the dimensions show that the engineering community does not just dominate because of professional preference, but this dominance is structurally embedded in the organization of RWS. The current policy arrangement has historically been developed around technical flood protection. This creates reinforcing conditions that strengthen this configuration and make alternative approaches difficult to institutionalize.

Specifically, technical standards, assessment, and cost-effectiveness criteria function as structuring measures within the policy arrangement. They shape decision-making from the earliest stages of projects, which only allows alternative perspectives to be incorporated as they fit within the predefined technical parameters. This limits the extent to which different perspectives can influence decision-making processes.

Ecological and socio-ecological discourses are present, but rather than replacing the engineering paradigm, they coexist in a layered manner. These discourses function as complementary rather than foundational. This can be explained by their relatively weak institutional embedding. Rijkswaterstaat's main role is the construction and maintenance of flood defenses. This has historically shaped it into a technical organization. This institutional orientation not only structures its operational activities but also shapes its advisory role, leading to a tendency to frame flood risk issues through a technical lens. Within the policy arrangement, this layered coexistence indicates an adaptation rather than a change. It explains why integration often ends up in the form of adding elements to existing technical projects rather than rethinking flood risk management objectives fundamentally.

5.2: Multi-layer safety as aspiration rather than practice

The multi-layer safety (MLS) approach is the key example of the gap between policy ambition and institutional practice. The MLS approach is formally acknowledged as a guiding principle for Dutch flood risk management and recognized across all epistemic communities within Rijkswaterstaat. However, the findings show that the MLS approach does not function as an integrated decision-making framework in practice. This can be explained by its limited institutional embedding. Firstly, there is no clear ownership as the MLS approach is not embedded in a dedicated and funded program. This is the result of the fact that the MLS approach cuts across multiple policy domains, and funding is often sectorally organized. Secondly, the authority is fragmented as spatial planning and emergency management responsibilities largely lie outside RWS. The authority is distributed across different governance levels and actors, such as municipalities, provinces, and safety regions. Finally, the resources are asymmetrically divided across different layers. The strong focus on the preventive layer makes it the layer that receives most of the funding.

As a result, MLS functions as a normative reference point. The different layers are not equally embedded in organizational routines, authority structures, and resource allocations. This mismatch illustrates a broader institutional phenomenon: discursive change does not automatically translate into institutional change. There are different obstacles that cause this. For example, the existing institutional structures create path dependence and the divided responsibilities of the MLS approach that complicate coordination and weaken ownership. This results in the engineering paradigm being structurally embedded, while MLS remains conceptually embraced but operationally secondary.

The MLS approach challenges the dominance of technical flood defense by acknowledging residual risk and the need for spatial and societal adaptation. However, the MLS approach lacks the institutional support that is required to function as a structuring principle, because not all layers are equally embedded within RWS. While the prevention layer is embedded, the other layers depend on actors and mandates that largely lie outside RWS. For example, spatial adaptation falls under the responsibility of municipalities and provinces, while disaster response and crisis management are organized by regional safety authorities. The MLS approach supposes integrated responsibility, but the institutional architecture remains sectoral. This creates misalignment between the integrative ambition and the fragmented structure through which it must be integrated. The implication is that integration is difficult to realize in practice. As a result, the MLS approach is functioning more as an aspirational concept at Rijkswaterstaat, rather than an operational governance framework. Addressing this mismatch requires stronger coordination across sectors and governance levels. This could lead to a clearer allocation of resources and responsibilities for all layers of the MLS approach.

5.3: Talking past each other

It is indicated that different epistemic communities operate alongside each other at Rijkswaterstaat rather than with each other. Each community contributes to flood risk management, but their interaction is limited and structured by disciplinary boundaries. Differences in language, knowledge standards, and organizational roles reinforce this separation. Engineers frame flood risk in terms of probability and compliance with safety norms. Spatial planners emphasize exposure and governance trade-offs, and ecologists focus on long-term resilience and environmental dynamics. These are not just different terminologies but different ways of defining what the problem is. This results in discussions not starting from a shared problem framing but from different starting points.

Additionally, the communities rely on different notions of validity. As the technical side remains the reference point, the other perspectives have to be translated into technical terms to be positioned in existing technical frameworks. Flood risk management is shaped by fragmented expertise in which the communities talk past each other rather than engaging with one another. “Talking past each other” implies limited epistemic integration, rather than directly implying conflict. Actors participate in the same process but often operate from different departments and different underlying assumptions. Coordination between communities is procedural and may lead to compromise solutions, but the underlying assumptions, which are the core problem, remain intact.

Changing this requires an intervention in the stages where problem definitions and decisions take shape. Creating space for epistemic integration is necessary in both the decision-making process and in the organization as a whole. This involves enabling different epistemic communities to engage earlier and more directly with one another. Different epistemic communities should develop a broader set of evaluation criteria beyond technical risk reduction.

5.4: Expertise as authority: strength or limitation?

The findings highlight expertise as a major resource shaping power relations in FRM. Modelling expertise and safety assessments inform and structure the decisions that are made by defining what is realistic, responsible, and legitimate. Flood safety standards are based on modelling and risk calculations. This means that those who produce and interpret these assessments play a key role in determining which options meet safety requirements and are therefore considered feasible, while others are excluded at an early stage. This gives the technical experts authority in the absence of formal decision-making power. While final decisions are formally taken by managers and political actors, these decisions are based on technical assessments. Expertise functions as a form of epistemic authority and influences the decision-making process by defining viable or unrealistic options.

At the same time, the findings reveal vulnerabilities in this system driven by expertise. Concerns about the loss of specialized knowledge and increasing reliance on external contractors suggest that the important expertise that has authority might be eroding. This raises questions regarding the long-term robustness of the technical system that relies on technical expertise while struggling to sustain in an institutional setting.

The dominance of technical expertise is not inherently problematic. In a domain which resolves around safety, such as FRM, engineering knowledge provides stability, reliability, and legitimacy. This enables decision-making on a higher level in politics. The strong position of technical expertise within Rijkswaterstaat has historically led to effective flood protection and is still essential for guaranteeing minimum safety standards. However, the findings show that when technical expertise functions as the main source of authority, it limits reflection and learning.

Because decision-making is structured around probability reduction and technical feasibility, alternative understandings, such as vulnerability reduction and socio-ecological resilience, may receive less attention. These alternative perspectives often involve qualitative uncertainties, long-term considerations, and societal trade-offs that are difficult to capture within technical assessment frameworks. As a result, these perspectives play a limited role in decision-making. This shows the trade-off in which the expert system that ensures safety may constrain the organizational capacity to reflect on alternative strategies and adapt to changing climate and societal conditions.

5.5: Managing probability or managing consequences?

Finally, the results show a tension between managing flood probability through technical control and managing risk through spatial choices. It is the difference between short-term probability reduction and long-term exposure and vulnerability reduction. These approaches coexist with a lot of tension in the current policy arrangement. Spatial planning is often positioned as a supporting and procedural instrument rather than a central element of FRM. This is the result of scope rules and political sensitivities that limit the consideration of spatial strategies such as retreat and land-use change. A consequence is that flood risk management continues to focus on controlling water rather than shaping spatial development in flood-prone areas.

This tension shows deeper normative questions regarding flood risk governance concerning responsibility and the limits of control. The reliance on technical control alone may become a risk, as climate change increases uncertainty and extremes. However, shifting the direction of the "containership" towards spatial and societal adaptation requires a change in deeply embedded assumptions within the existing epistemic communities and institutional structures. These include the expectation that the state guarantees flood protection everywhere, the preference for technical solutions, and the belief that safety is achieved through controlling water rather than adapting land use and societal vulnerability. If these tensions are not addressed, FRM will most likely continue to prioritize managing water instead of managing space.

6: Conclusion

This chapter answers the central research question:

How do epistemic communities within Rijkswaterstaat shape decisions regarding flood risk management in the Netherlands?

Firstly, the chapter answers the four sub-questions. Then the findings are joined together to answer the main question. No new arguments will be introduced in the conclusion, as it builds directly on the results presented in Chapter 4.

6.1: How are epistemic communities within Rijkswaterstaat defined and identified?

The analysis shows there are three epistemic communities that can be identified within Rijkswaterstaat: a technical-engineering community, an ecological community, and a spatial planning community. These communities are not formal organizational departments, but are networks of professionals. They share similar disciplinary backgrounds, normative beliefs, and approaches to FRM.

The technical-engineering community is the most dominant and is deeply embedded in the organization. Its members are often trained in civil engineering or hydrology and understand flood risk primarily as a problem of probability reduction. Safety is defined as meeting the legally established standards. Success is associated with demonstrable compliance and cost-efficient implementation of structural measures. The spatial planning community views flood risk as a combination of probability and consequences. It puts emphasis on exposure and vulnerability by viewing flood risk as a governance and land-use issue. FRM is seen as managing risks in a broader societal context, rather than eliminating floods. This includes societal awareness, zoning, and long-term spatial decisions. Finally, the ecological community approaches flood risk from a system perspective. They interpret flood risk in relation to ecological processes and long-term resilience. Nature-based solutions and ecosystem-based approaches are emphasized. The approaches they aim for work with natural processes rather than controlling them.

These three communities can analytically be distinguished, but are empirically not rigid or exclusive categories. For example, some experts operate on the border between communities. However, the typology still offers a lens to understand how different forms of expertise shape FRM within RWS.

6.2: How do these epistemic communities influence the dominant discourses surrounding flood risk management?

Epistemic communities shape FRM through the discourses they promote. There are three main discourses which can be distinguished: the engineering discourse, the ecological discourse, and the socio-ecological discourse.

The engineering discourse is the dominant discourse within RWS. This discourse understands flood risk as a technical hazard that can be quantified and controlled through structural measures, such as dikes and other infrastructure. Safety standards and modelling play a central role in defining acceptable levels of risk, which determine policy choices. This results in FRM being framed as a matter of reducing the probability through technical interventions. Alongside the dominant discourse, the ecological discourse places emphasis on the natural system and nature-based solutions. This discourse seeks to balance safety and ecology with measures such as floodplain restoration. Using these approaches, they tend to contribute to both water safety and environmental objectives. Finally, the socio-ecological discourse, which is associated with spatial planning actors, puts more emphasis on vulnerability reduction and community awareness. FRM is understood as a governance challenge that requires coordination between water management, spatial planning, and societal actors.

The analysis shows that these discourses are not equally influential. The engineering discourse is the main reference point for decision-making. Ecological and socio-ecological perspectives are incorporated after safety requirements have been established. Rather than challenging the engineering discourse, these other discourses operate within the technical boundaries.

6.3: How are resources and power distributed among epistemic communities within Rijkswaterstaat, and how does this distribution influence decisions regarding flood risk management?

The analysis shows that the influence of epistemic communities within RWS is strongly shaped by the distribution of resources and power. The types of resources that are most relevant are: financial resources, expertise and knowledge, and discursive influence.

Firstly, financial resources play an important role in shaping decision-making. Structural flood risk protection measures often benefit from stable funding through large programs such as the HBWP. This funding further strengthens the position of the engineering community. In contrast, ecological and spatial measures depend on external funding sources or must be integrated as co-benefits within existing projects, which makes them more difficult to realize. Secondly, knowledge and expertise function as a central resource. Technical expertise is well represented and strongly institutionalized within RWS. This reinforces the influence of the engineering community. Ecological and spatial planning expertise is present but is less numerous and embedded within project teams. Thirdly, discursive resources also shape power relationships. Technical knowledge is perceived as being objective and having more authority. This gives the engineering community a strong influence in defining problems and possible solutions.

Overall, this resource distribution reinforces an advantage for the engineering community. While the other communities are participating in the decision-making process, their influence is limited to the extent that their perspectives fit into technical solutions.

6.4: How do formal and informal rules and routines within Rijkswaterstaat structure the involvement of epistemic communities in decision-making?

Formal and informal rules play a significant role in shaping how epistemic communities participate in the decision-making process. These rules structure who is involved, at what stage they participate, and how decisions are made.

The analysis shows that technical expertise structures the early stages of project development. Ecological and spatial planning experts are involved later in the process. Only when environmental or spatial considerations become relevant. They can still influence the project design, but their input is limited by technical requirements that have been established in earlier stages. Formal authority in decision-making lies at higher organizational and political levels. However, the experts play a strong influential role in defining the options and the knowledge base underlying the decisions. Informal routines also play a role in shaping the decision-making process. This process relies on consensus-building and negotiating between disciplines. This often results in disagreements being resolved through compromise solutions.

In conclusion, the formal and informal rules and routines tend to reinforce the role of technical expertise in decision-making processes.

6.5: How do epistemic communities within Rijkswaterstaat shape flood risk management decision-making?

Altogether, the findings show that epistemic communities shape flood risk management within Rijkswaterstaat through three different paths.

First, epistemic communities shape how flood risks are understood and framed. The engineering community plays a dominant role in defining flood risk, a technical hazard that is managed through structural measures and compliance with safety standards. Second, epistemic communities influence which options and solutions are considered feasible. The technical expertise functions as the starting point for the decision-making process and thereby structures the range and scope of the solutions that are considered. Thirdly, epistemic communities influence how knowledge is institutionalised in an organizational structure such as RWS. Through the distribution of resources, expertise, and the design of procedures, the engineering perspective is embedded within RWS's framework. The ecological and spatial planning communities are being recognised more and more, but are for now set within the boundaries created by technical requirements. The perspectives that these communities bring do not replace the engineering perspective but complement it.

In conclusion, FRM within Rijkswaterstaat is shaped by the interaction between the different epistemic communities. However, as a result of the distribution of resources, institutional rules, and dominant discourses, the technical-engineering community occupies a dominant position in defining flood risk and shaping policy choices.

7: Reflection and recommendations

This chapter critically reflects on the research process and discusses the implications for future research. It starts by reflecting on the theoretical framework and its application. Then the strengths and limitations of the research methods are discussed. Finally, the chapter ends with recommendations for future research and practical recommendations for flood risk management.

7.1: Reflections

7.1.1: Reflections on the theory

This research combined the Epistemic Community Framework (ECF) (Haas, 1992) with the Policy Arrangement Approach (PAA) (Leroy & Arts, 2006). The combination of the two frameworks allowed the analysis of how expert communities influence flood risk management decision-making within Rijkswaterstaat. Using the ECF, multiple epistemic communities were identified together with their shared beliefs. On the other hand, the PAA was used to analyse how these communities are embedded in the institutional structure. Combining the frameworks proved to be useful. The ECF helped explain how disciplinary backgrounds shape problem definitions and preferred solutions. Additionally, the PAA complemented this by putting this in a broader institutional perspective, which revealed how the communities are embedded within organisational structures. It allowed the analysis of the interaction between actors, discourses, rules, and resources. This helped reveal that the dominance of the engineering epistemic community is not only related to the fact that they are well represented, but also how technical expertise is institutionally embedded in funding, safety standards, and decision-making procedures.

However, the PAA also has its limitations. The framework captures how resources and institutional rules affect the policy arrangement, but pays no attention to the role of individual actors and agency. The findings showed that individual experts can influence the decision-making process through their personal networks, reputation, or drive to promote certain perspectives. This type of influence is not represented in the PAA framework, which focuses on power as the reason for the distribution of institutional resources. Secondly, the ECF tends to portray expert communities as rigid groups with shared beliefs. The findings show that in practice, these boundaries are blurred. Several respondents operated in between communities, which suggests that epistemic communities should be understood as overlapping networks of expertise rather than fixed groups.

Overall, the combination of the ECF and PAA proved to be a useful framework. It allowed us to go beyond and combine the analysis of how knowledge, institutions, and power relations interact in shaping decision-making.

7.1.2: Reflection on the research methods

The research used qualitative methods and combined semi-structured interviews with document analysis. This approach had several strengths but also proved to have some limitations. The first strength of the research design is the use of semi-structured interviews with experts from all the predefined epistemic communities. This enabled the gain of insight into how they interpret and perceive their role in the decision-making process. However, the predefined epistemic communities proved to be less rigid than expected. This made it difficult to have an equal representation of all communities as some people were placed right in between to communities.

Second, even though the number of interviews was limited as a result of time constraints. It proved to be enough for a qualitative analysis. Data saturation was achieved as the final interviews reinforced the prior interviews. The fact that the interviews were conducted confidentially encouraged openness and allowed the interviewees to really tell what they thought, even if this criticized the organization that they worked for.

There are also some limitations that should be acknowledged. Firstly, the exclusive focus on RWS as a single organisation. This focus allowed for the in-depth analysis of the internal dynamics, but also meant that perspectives from other actors that are involved in FRM were not included. The image that is created of the epistemic community configuration is only applicable to RWS and should not be generalised to the broader FRM field in the Netherlands. At the same time, RWS plays a central role in the Dutch FRM system, which means that the findings provide indicative insights into broader institutional patterns, although these should be carefully interpreted.

Additionally, the analysis of the discourse dimension relies on the interpretation of the researcher. The identification of the dominant discourses requires the analysis of how actors frame problems and solutions in the interviews, which always involves a degree of subjectivity. Efforts have been made to systematically code the interviews and triangulate them, but the interpretation might still reflect the researcher's perspective.

Finally, the use of deductive coding may have influenced the data analysis. The coding scheme was created based on the theoretical framework. This enabled a structured analysis, but might have limited the exploration of new themes that were not included in the predefined concepts.

Despite the limitations, the approach provided insights into the role of epistemic communities within RWS. It allowed a nuanced understanding of how this expertise shapes FRM decision-making.

7.2: Recommendations

7.2.1: Recommendations for future research

There are several opportunities for future research. First, future research could put the epistemic communities in a broader perspective and examine how they interact across organizations and governance levels. This study focused on RWS, but FRM in the Dutch context involves many actors, such as water boards, municipalities, ministries, and knowledge institutes. The investigation of epistemic communities across these organizations could provide a broader understanding of how epistemic communities influence national flood risk governance.

Second, future research could look into how these epistemic communities change over time. FRM is a changing field due to climate change, new technologies, and emerging approaches. Research that takes into account the time component could investigate how the epistemic community configuration changes as new knowledge and approaches emerge.

Thirdly, the role of policy entrepreneurs could be further explored. This study analyzed epistemic communities as collective groups of experts, but the findings show that individual professionals sometimes play important roles in bridging the disciplinary boundaries between communities. Research into these integrative actors that exist on the borders between communities could provide valuable insights into how knowledge integration takes place within organizations.

Finally, comparative research could investigate how the configuration of epistemic communities influences flood risk management in other countries or governance contexts. Comparing the Dutch case with other countries could show how policy arrangements in other contexts shape the configuration of the epistemic communities in flood risk governance.

7.2.2: Recommendations for practice

The findings also provide several recommendations for FRM in practice at RWS. Firstly, it would be valuable to strengthen the integration of different forms of expertise in the decision-making process. The ecological and spatial perspectives are recognized within RWS, but they are being incorporated later into project development. If these perspectives could be involved at earlier stages of the decision-making process, it could help to explore a broader range of potential solutions.

Secondly, there should be more space for interdisciplinary collaboration. Currently, the organizational structure does not allow for enough interdisciplinary interaction. This knowledge exchange between different epistemic communities could support the development of integrative approaches to FRM. Creating platforms where engineers, spatial planners, and ecologists collaborate may help to bridge these boundaries and create a shared understanding of flood risk challenges.

Finally, organizational structures and project funding currently favor the technical-engineering community. Developing a funding system that explicitly supports integrative solutions could help in the implementation of measures that combine technical safety with ecological and spatial objectives.

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9: Appendix

9.1: Interview Guide

Introduction:

Thanks again for making the time to speak with me today. My name is Bram de Bruin, and I'm currently a master's student at Radboud University, where I'm writing my thesis on flood risk management. Alongside my studies, I also work at Rijkswaterstaat within the WVL department, in the flood risks team with Jeroen Doornekamp as my supervisor. That's also how I came across your name as someone with valuable insights for this research.

My thesis aims to better understand how different forms of expertise within Rijkswaterstaat shape decision-making around flood risk. Each of the expert communities within flood risk management has its own perspective and knowledge base. I'm particularly interested in how certain perspectives become dominant, how knowledge is legitimized, and what that means for the implementation of flood risk strategies.

Before we begin, I want to emphasize a few important things:

- This conversation will remain strictly confidential. Your name and details will be anonymized in all documents and results, unless you explicitly state otherwise.
- There are no right or wrong answers. I'm simply interested in your perspective and experience.
- You are welcome to stop the interview at any time, or ask me for clarification if anything is unclear.
- Lastly, would it be okay with you if I record the interview? This is purely for transcription purposes so I can accurately capture what's being said.

Do you have any questions before we start?

Actors: Epistemic Communities

Type of actors

1. What department within Rijkswaterstaat are you currently working in?
2. What is your professional role
   Examples: engineer, planner, ecologist)?
3. What is your current position level (junior, senior, advisor, manager)?

Disciplinary background

4. What is your field of education and highest degree obtained?
5. What type of institutions have you worked for in the past?

Shared normative & principled beliefs

6. What do you believe should be the primary goal of flood risk management?

Examples: maximum protection, long-term resilience, coexistence with water

7. How do you define a successful flood risk management policy or project?
8. Do you think flood risk management should focus more on short-term control or long-term adaptation? And why?

Shared causal beliefs

9. What, in your view, are the main causes of flood risks in the Netherlands?
10. What strategies do you think are most effective in reducing this risk

Examples: technical infrastructure, spatial planning, public participation

11. Which types of measures do you usually advocate for in policy discussions?

Shared notions of validity

12. What types
 of knowledge do you consider most credible or useful when making decisions?

Examples: models, data, expert advice, stakeholder input

13. What research methods or tools do you commonly use in your work

Examples: hydrological models, stakeholder input, policy analysis

Common policy enterprise

14. What kinds of policy instruments do you mostly use or promote in your work? Examples: hard infrastructure, spatial planning, nature-based solutions, public awareness
15. How do these tools reflect your preferred approach to dealing with flood risk?

Discourse

16. Which guiding principles or strategies (examples: Room for the River, multi-layered safety) influence your work?
17. How would you describe your approach to flood risk: more technical, ecological, or socio-ecological?

Rules

Position Rules

18. What are the primary expert communities that are involved in flood risk management? Are these groups equally represented within RWS?

Boundary Rules

19. What types of actors are usually included in flood risk decision-making processes, and who tends to be excluded?
20. Are there formal or informal criteria that determine who gets involved in policy planning?

Authority Rules

21. Who has the final say in your team or project when it comes to key decisions?

22. Are there types of decisions you are not permitted to make, even if you have expertise in the area?

Aggregation Rules

23. How are collective decisions made in your team or department?
24. What happens when there is disagreement between experts with different views?

Scope Rules

25. Are there legal or institutional boundaries that limit what policies or measures you can pr opose?
26. What types of solutions are considered off-limits or not feasible? Why so?

Information Rules

27. What data or information is accessible to you in your work?
28. Are there any restrictions on sharing this information within or outside your organization?

Payoff Rules

29. Are there incentives or disincentives that shape strategic decisions?

Examples: funding allocations, political support

Resources

Financial

30. Are there differences in available funding for different types of epistemic communities

Expertise / Knowledge

31. What kinds of expertise are considered most valuable in your department?
32. To what extent is each of the epistemic communities represented in your department?

Authority / Political

33. What formal responsibilities do you or your team hold in the flood risk policy process?
34. Do you contribute to setting legal standards or ensuring their enforcement?

Social / Discursive --> mostly through document analysis

35. How often do your ideas or narratives influence the broader flood risk debate?

Human Resources

36. How many people are in your team?
37. Do you feel your epistemic community has sufficient capacity (staff and support) to carry out its flood risk responsibilities?