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What are the implications of implementing comprehensive flood insurance in the Netherlands, and is it a desirable strategy?

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Preface

Dear reader,

I am grateful to have the opportunity to present this thesis, which is the culmination of almost a year of research. My interest in this topic was sparked by my personal experiences as an enthusiast for challenges surrounding our livable world. Especially when it comes to the large infrastructure and the Dutch future and history. I wanted to learn more about the system of flood defenses and delve deeper into climate change and how it affects people like me.

This thesis is written for a general audience, but it will be of particular interest to those who are interested in governmental policy, flood risk management, and the insurance market. I hope that this thesis will provide a better understanding of flood insurance and its implications for society.

I would like to thank my advisor, Dr. Duncan Liefferink for his guidance and support throughout this project. I know it has been a long journey and helping me was a difficult task but I am very grateful and even think I wouldn't have come to this without Duncan, so thank you.

The research for this thesis was conducted in Nijmegen. I used a variety of methods, including desk research and interviews.

I hope you find this thesis insightful and enjoyable to read.

Luuk van Os

Abstract

The Netherlands is globally renowned for its proactive flood management policies and extensive governmental initiatives and infrastructure. However, climate change and the increasing frequency of extreme weather events are challenging the system. This thesis explores the implications and feasibility of implementing comprehensive flood insurance in the Netherlands, addressing both its desirability and potential challenges from the perspective of key stakeholders. Interviews and literature research were conducted, the study examines government policy, societal attitudes, insurance models, and the practical pros and cons of adopting flood insurance. The main research question of the thesis is: ''What are the implications of implementing comprehensive flood insurance in the Netherlands, and is it a desirable strategy in the views of key stakeholders?''

Key findings indicate that Dutch society has a deep-rooted trust in government-led flood management strategies, which makes the transition to a private insurance model challenging. The introduction of flood insurance causes a shift in approach from flood prevention to damage mitigation. This could also make room for public-private partnerships. Public perception is a significant barrier, as many Dutch citizens believe the government will handle flood-related damages. Insurance models, ranging from public to market-driven, were assessed to see if they fit with Dutch societal values and economic viability. The study found that while flood insurance could offer advantages like better risk assessment and faster compensation, it could also escalate premiums, particularly in flood-prone areas, which could lead to inequality.

Recommendations for the future include conducting public awareness campaigns, looking at public-private collaborations, establishing clear legal frameworks, and innovating in insurance design. The conclusion underscores that implementing flood insurance is feasible but would require a careful good relationship between government and private insurers. The desirability of flood insurance therefore is dependent on the implementation and the design that would be chosen.

The study also reflects on its limitations, including the restricted number of interviews and challenges in research. Future research could explore public willingness to accept flood insurance and offer comparative analyses of insurance models across countries.

In summary, the thesis reveals that the introduction of comprehensive flood insurance in the Netherlands is a complex endeavor that necessitates adjustments in government policy, societal attitudes, and insurance practices.

Keywords: Flood Management, Netherlands, Government Policy, Societal Attitudes, Insurance Models, Public-Private Partnerships, Risk Assessment, Damage Mitigation

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1. Introduction

The Netherlands faces several climate risks, including rising sea levels, droughts, and more extreme storms. To mitigate these risks, the country has implemented various preventative measures such as widening riverbanks, building coastal protections, and constructing a network of dikes and levees (PBL, n.d.). The risk of flooding increases due to more extreme rainfall, rising sea levels, higher river water discharges, and more intense storms. As a result, scholars are actively debating the fundamental principles of the current approach to managing flood risk. Historically, the Dutch approach to flood risk management has focused mainly on prevention (Molenveld & van Buuren, 2019; van Buuren et al., 2016). The Delta Works, the country's largest flood defense system, is particularly designed to protect against flooding from the North Sea. Despite these efforts, it is still important to identify at-risk areas as flood events can still occur. For example, in the summer of 2021, the Netherlands experienced the wettest summer on record and experienced significant flooding in various regions, including Limburg, where both public and private property was damaged (ENW - expertise centrum waterveiligheid, 2021). The flooding also led to around 25,000 damage reports to insurers and insured damages estimated to be between 160 and 250 million euros, mostly related to private damage to homes and vehicles (UNDRR, 2022). Deltares suggests that the damages were 350 to 600 million (Slager, 2021). But the damage all occurred in the secondary flood system. This is all insurable. If the flood defenses of the Meuse itself had been broken it would be a different story. That is because it is still not possible to insure flooding of the primary flood defense systems. In the recent decade, the Netherlands' governance around flood risk management has shifted from flood defense to being more resilient when a flood does happen (Molenveld & van Buuren, 2019; van Buuren et al., 2016).

One way to mitigate the impact of flooding in the Netherlands is using flood insurance. Flood insurance is a type of insurance policy that provides financial protection to homeowners and businesses in the event of a flood. It is important to note that standard home insurance policies in the Netherlands do not cover flood damage (Esteban et al., 2011), so it is necessary to purchase a separate policy if you live in an area prone to flooding (Surminski, 2014). But this is only possible for secondary flood defense flooding.

For now, it is not possible to get flood insurance in the Netherlands for primary river and sea systems according to Verbond van Verzekeraars (2022b). The fact that this isn't possible has been discourse for decades and still is up for debate (NOS, 2017). So, whether flood insurance for primary flood defense systems should become available is the discussion between the stakeholders that has been going on for the last 20 years (Verbond van Verzekeraars, 2022a). Right now, when flooding happens such as the one in Limburg in 2021 The law (Wet tegemoetkoming schade bij rampen (WTS), 2016) was used. The law in the Netherlands provides for the compensation of individuals and businesses who suffer damage due to a disaster. The act applies to disasters that are declared by the government to be "large-scale," which typically includes events such as floods, storms, and large fires. Under the act, individuals and businesses may be eligible to receive compensation for damages to their property, as well as for loss of income or additional expenses incurred as a result of the disaster. This only applies when the government declares the flood as a national emergency. In the case of the flood events in Limburg the parts that flooded were not the primary river systems but the secondary. The Meuse River was close to overtipping but eventually held. If the primary system had flooded there wouldn't have been a safety net. Only the Dutch government could've helped by calling in the WTS.

If we look at the European level you can see a difference between flood coverage between the nations (Bouwer et al., 2007).

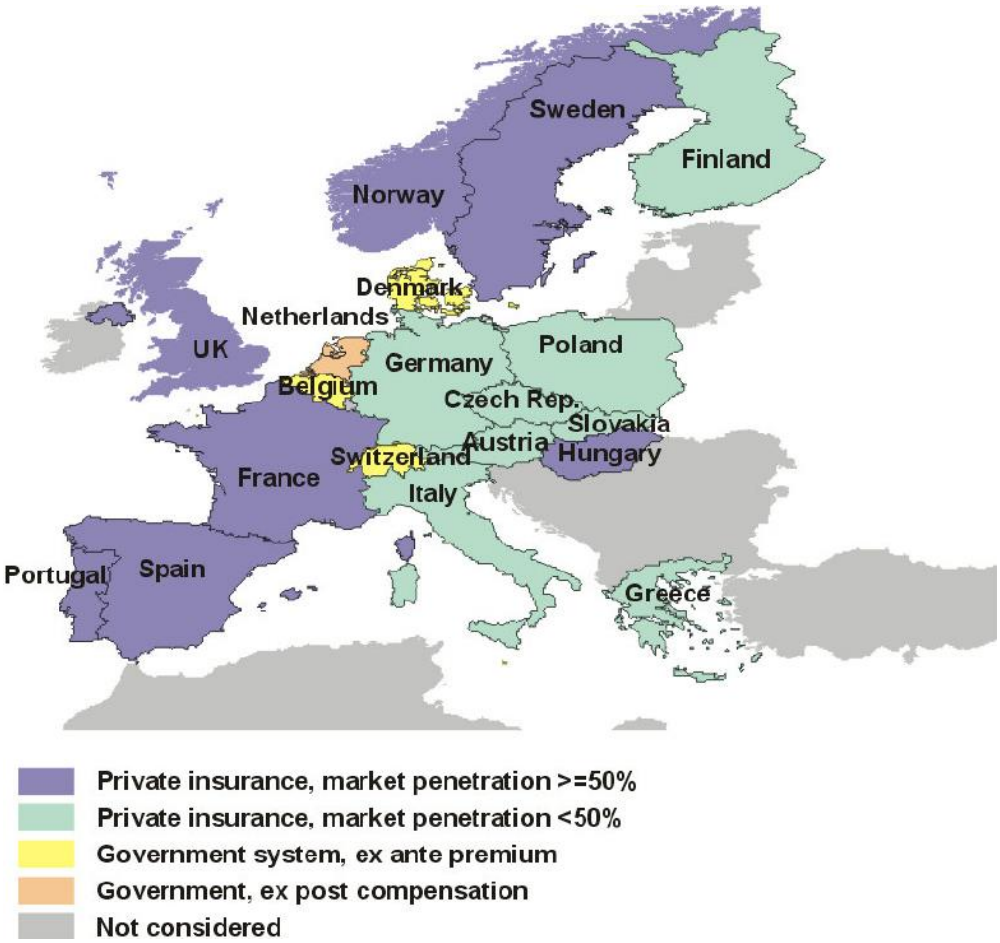


Figure 1: Overview of national flood insurance and compensation schemes in Europe (Bouwer et al., 2007).

The figure above shows the national flood insurance and compensation schemes within Europe. Governments in Europe have different systems to deal with flood risk. Most countries have a system where the government plays a role in covering flood losses. This is mostly done by compulsory or prescription flood coverage that is sold together with commercial fire coverage (Bouwer et al., 2007). Another option is that the government has a system that is more traditional and where the funds for the insurance are collected before the event happens, this is called ex-ante. The funds are collected through premiums or taxes. The last system is where the compensation is funded from tax money or borrowings on an ad hoc basis after an event has happened (Bouwer et al., 2007).

Figure 1 presents the countries studied and their respective insurance systems. Commercial insurance is classified into two categories: those with a market penetration of 50% or more, and those below 50%. While private flood insurance is in most European countries, the penetration rate is highly variable. Only in seven countries do at least half the population have flood insurance. There are countries like Hungary and Germany, where the government compensated for losses even when commercial insurance was available. Governments in Belgium, Denmark, and Switzerland are actively involved in insurance mechanisms. The Netherlands has a system initiated in 1998 following natural disasters in the early 1990s (Bouwer et al., 2007).

In the map above it is visible that the Netherlands has no insurance in place. As already described earlier, only compensation from the government in case of a declared national crisis. The Dutch way of dealing with flood risk is mainly focused on protection or flood defense (Wiering, 2019). According to Wiering (2019, p. 7), The Dutch are path-dependent or dike-dependent which can be seen as an institutional lock-in of the social-ecological system''. This clarifies that the Dutch governance system

of dike- and dam protection is very effective in reducing the risk of flooding. But the chance that flooding will occur is never zero.

An examination of how flood insurance works in other countries, those with similar flood risk profiles, could provide additional insights into potential challenges and successful strategies.

Germany: In Germany, flood insurance is not mandatory and is typically offered as part of an extension to home insurance policies. Coverage rates can vary, particularly between flood-prone and less flood-prone areas. The German flood risk management approach includes a combination of infrastructural measures, land use planning, and risk communication (Seifert et al., 2013; Tesselaar et al., 2022).

Belgium: Like the Netherlands, Belgium does not have a standardized flood insurance scheme. Flood coverage is generally included in standard fire insurance policies for homes, with the government playing a significant role in managing and financing flood risk. Belgium's flood risk management approach consists of a mix of prevention, protection, and preparedness measures (Bouwer et al., 2007).

France: France has a unique flood insurance system, with a state-backed natural disaster insurance scheme known as "CatNat". This system is mandatory as part of home insurance policies and provides coverage for a range of natural disasters, including floods. France's flood risk management approach involves both structural measures and non-structural measures (Hegger, Driessen, et al., 2016; Wiering et al., 2017).

United Kingdom: In the UK, flood insurance is typically included as part of standard home insurance policies, but the high risk and cost of flooding led to the creation of a special scheme called Flood Re in 2016. This is a not-for-profit fund that provides flood insurance to homes at high risk of flooding, with premiums at certain levels. The UK's flood risk management strategy combines flood defenses, flood forecasting and warning systems, land use planning, and community resilience measures (Surminski et al., 2015).

United States: In the US, flood insurance is provided through the National Flood Insurance Program (NFIP), managed by the Federal Emergency Management Agency (FEMA). It is typically separate from standard home insurance policies and is mandatory for properties in designated high-risk flood areas with a federally backed-mortgage. The US flood risk management approach includes flood mapping, infrastructure, and land use planning measures (de Ruig & Koekoek, 2022; Van Alphen et al., 2011).

According to Klijn et al, (2012) climate change will also affect the policy of the Netherlands. It may require revision since the current climate models are already outdated. Sea level rise and an increase in river discharges and changing precipitation patterns are named courses of concern for the Netherlands (Doorn-Hoekveld et al., 2022; Koninklijk Nederlands Meteorologisch Instituut, 2021). According to the IPCC, (2020) an increase in river discharges or sea level rise cannot be stated as an increase in flood risk. For instance, the damage caused by floods can be mitigated, even if the frequency of flooding rises, through measures that decrease the exposure and/or vulnerability of the affected systems.

The national delta program (Ministry of Infrastructure and Water & Management, 2020) is a program created by Water safety measures that aim to protect the Netherlands against flooding by strengthening coastal and river dikes, improving flood forecasting and warning systems, and enhancing emergency response capabilities. The program also aims to create more room for rivers, by widening riverbeds and creating new floodplains. This is mainly aimed at flood defense rather than other means of defense.

The Star-flood model is a model that dives deeper into the multi-layered safety approach and puts the Dutch way of dealing with flood risk on the flood defense part of the model (Hegger, Bakker, et

al., 2016). Although Keessen (2013) states that a multi-layered flood risk approach is necessary in the future to better cope with floods if they occur.

''The desirability of an approach that was predominantly focused on the prevention of floods and not on the potential consequences of flooding"

(Keessen et al., 2013, p. 5)

Since the room for the river project (Waterstaat, n.d.) the Dutch government has moved more to flood mitigation. The room for the river project makes more room for the river which allows it to have a higher discharge of water in peak moments. This shows that the Dutch government is willing to create a more multi-layered approach. What is still missing is a good safety net. How and if this should be implemented is still under investigation (Verbond van Verzekeraars, 2022a).

One of the key themes that emerges in the discourse surrounding flood insurance in the Netherlands is the idea of risk management. The Dutch government has long been recognized for its efforts to manage flood risk through a combination of infrastructure investments, land use planning, and emergency management (Kaufmann et al., 2018). The introduction of flood insurance can be seen as a further extension of this risk management approach (Hudson & Thieken, 2022; Kousky & Shabman, 2015). Opponents of flood insurance, on the other hand, often argue that it is an unnecessary and expensive burden on individuals and businesses. They may point out that the risk of flooding is relatively low in many parts of the country, and that existing government efforts to manage flood risk are sufficient (Thompson, 2013).

In light of the increasing unpredictability of climate patterns and the potentially catastrophic consequences of primary flood system failures, the discussion around introducing primary flood insurance in the Netherlands has never been more important. This research aims to look at the pros and cons, look into stakeholder perspectives, and propose a way forward for the nation's flood risk management.

1.1 Research problem statement

Despite the successful use of flood defense systems including dikes, barriers, and spatial planning strategies, the Netherlands continues to face considerable risk due to the threat of flooding, especially climate change and its associated impact on sea level rise (Ministry of Infrastructure and Water & Management, 2020). Increased river discharges and higher average river discharges are also predicted (Ministry of Infrastructure and Water, 2019). While the existing protective measures are globally renowned, their ability to cope with future changes and unprecedented flooding events is under question. In the present framework, secondary systems are insurable, providing homeowners and businesses with financial protection against potential losses. However, primary systems, which serve as the country's first line of defense against flooding, are not covered by insurance policies. This lack of insurance exposes the country to significant financial risk in the event of failure of the primary defense systems. The diversification of flood protection not only by flood defense but also insurance may be necessary for the Dutch flood risk management. This highlights a critical gap in the Netherlands' current flood risk management strategy. Research in this direction could provide insights for policymaking and improve the country's readiness and resilience against escalating flood risks This research will look further at how flood insurance for primary defense systems is desirable and what implications it has on stakeholders. The results of this could be considered by policymakers, insurance companies, and citizens.

1.2 Research aim

This research aims to critically analyze the potential benefits and challenges associated with the introduction of comprehensive flood insurance in the Netherlands. This includes an examination of the desirability of a strategy by key stakeholders such as the government, insurance companies, and the Dutch population. The goal is to provide a balanced assessment that weighs the expected advantages against potential drawbacks, providing a comprehensive overview that can guide policy decisions and strategies for flood risk management in the country.

At first, the direction will be on the advantages of flood insurance in the Netherlands. Is it a plausible idea to introduce flood insurance in the Netherlands? Looking at the multi-layered approach and how flood insurance could help reduce the vulnerability of flooding. Potential downsides to the introduction of flood insurance compared to governmental intervention will be discussed. If flood insurance should be arranged by private companies or publicly.

1.3 Research Question & Sub-questions

Research question

What are the implications of implementing comprehensive flood insurance in the Netherlands, and is it a desirable strategy in the views of key stakeholders?

Sub questions

- How will flood insurance influence the way the Dutch government deals with flood risk in the future?

- How do attitudes and perceptions towards flood risk and insurance impact its desirability and feasibility as an alternative in the Netherlands?

- What are the possible insurance designs for the Netherlands?

- What are the potential benefits, challenges, barriers, and opportunities of introducing flood insurance in the Netherlands?

So, considering these questions, the goal is to see the implications of introducing comprehensive flood insurance in the Netherlands. How would this impact current flood management strategies, government policies, and citizens' perceptions of flood risk? Furthermore, is such an introduction desirable based on the predicted costs and benefits for both individuals and the Dutch government, and what potential challenges and barriers could be encountered in its implementation?

1.4 Societal relevance

Flood insurance is a highly relevant topic in the Netherlands due to the country's geography and history of devastating floods (Molenveld & van Buuren, 2019). Furthermore, the country is a delta, which means that many rivers and canals are susceptible to flooding, making it particularly vulnerable to flood-related disasters. The forecast is that flood protection measures need to be increased due to climate change (Ministry of Infrastructure and Water & Management, 2020).

The threat of flooding from the sea and rivers in the Netherlands has increased over the years due to climate change (EEA, 2021, 2022), which has led to rising sea levels, heavier rainfall, and increased river discharge. These factors make it more likely that the country will experience flooding, which can result in significant economic and social damage (Abcouwer et al., 2020; Vergouwe, 2014).

Whether flood insurance for primary flood defenses in the Netherlands is important is something that should be investigated to help individuals and businesses recover from flood-related losses. Even in the Netherlands, which has no insurance scheme the government will compensate for the loses (Bouwer et al., 2007; Wet tegemoetkoming schade bij rampen, 2016). However because the government won't compensate for everything and the time until this happens usually takes long and not everyone will get the compensation (Salden & Sas, 2022). In the event of a flood, insurance policies can help cover the cost of property damage and other losses. Without flood insurance, individuals and businesses may face financial ruin, which can have a significant impact on the broader economy (OECD, 2016).

Overall, flood insurance may be an important step in the Netherlands due to the country's vulnerability to flooding and the significant economic and social consequences of flood-related disasters. Whether the insurance should come from public or private parties should be investigated.

Lastly, a critical look at the risk perception of stakeholders, especially in risk-prone areas will lead to a better understanding of the desirability of flood insurance (Roder et al., 2019).

1.5 Scientific relevance

The focus of flood risk management in the Netherlands has always been to lower the probability of a flood event by preventing it. This has been done by building extensive protection infrastructure and adaptation measures (Kolen & Helsloot, 2012).

This research on the desirability of flood insurance in the Netherlands would provide insight into the complex social and political factors that influence the adoption and implementation of flood management policies.

There is a gap in the literature on the desirability and the possibilities of flood insurance. This is largely because citizens' and companies' perception is that they are safe and that they are already insured against flooding (Doll & Mattheussens, 2022). So not much literature is written about this subject because it wasn't seen as a necessity.

Given the Dutch government's significant role in flood protection, the introduction of flood insurance for primary water defenses is relevant for research into policy and governance. It can shed light on how governments can best share risks with private entities and individuals and how insurance can complement other flood management strategies (Verbond van Verzekeraars, 2022a). The Dutch government is one of the most proactive governments on flood defense (de Ruig & Koekoek, 2022; Ministry of Infrastructure and Water & Management, 2020). This is why flood insurance for primary water defenses was not seen as necessary and not high on the agenda. Especially because the WTS can be used whenever there is a disaster (Doll & Mattheussens, 2022; Verbond van verzekeraars, n.d.).

An analysis of flood insurance in the Netherlands could shed light on issues such as the role of insurance in managing flood risk, the relationship between individual and collective responsibility for

flood protection, the effectiveness of government intervention in the insurance market, and the impact of flood insurance on social equity and environmental sustainability.

Overall, an analysis of the introduction of flood insurance in the Netherlands would be relevant to a range of disciplines, including environmental policy, governmental policy, risk management, and communication studies.

There is a public discourse about the affordability and availability of flood insurance (Kaufmann et al., 2018) and a gap in understanding the implications of current and future flood risk trends on the offering of flood insurance (Wiering, 2019).

- Effective prevention (mitigation) is expected to play a significant role in the future affordability and availability of flood insurance, but it is unclear how the relation between flood insurance and flood prevention should be (Surminski et al., 2016).
- Risk reduction efforts are essential in maintaining the insurability of these risks, and effective adaptation may become a condition for granting insurance coverage in the future. However, there will always be some residual risks that cannot be expected, and these can leave people exposed to significant financial gaps and increase poverty (Surminski et al., 2016).
- Progress in this area will depend on increased evidence and understanding of underlying risk issues, better collaboration among stakeholders, and openness about limitations and costs. This issue spans many dimensions, making innovation and reform challenging for political decision-makers and private companies. Reforming is challenging, which is why discussions about new schemes in developing countries are important, as it is an opportunity to avoid repeating past mistakes in established markets, particularly regarding the missing link between risk transfer and risk reduction (Surminski et al., 2016).
- Impact of climate change. The risk of flooding is increasing but how will respond to this evolving risk. Are the premiums and coverage levels adjusted to reflect the changing risk landscape? (AFM, 2021)

So, based on the insights from literature flooding in the Netherlands has always been there.

“Although the probability of flooding may have been reduced considerably, it remains. And the potential consequences would be huge.”

(PBL, n.d.).

The effect of flood insurance in the multi-layered approach is not yet clear. This is the aim of the research, investigate whether or not implementing flood insurance in the Netherlands is a good or bad idea.

2. Literature review and theoretical framework

Writing a literature review involves a systematic and critical evaluation of the existing literature (Snyder, 2019). On the topic of flood insurance, it is notable that most literature is from sources outside the Netherlands. This is because flood insurance in the Netherlands is not as present as it is in other countries (Abcouwer et al., 2020; Doorn-Hoekveld et al., 2022). However, the Netherlands has been able to develop economically and socially the way it has partly because of its good flood defense system of dikes, dunes, and structures (Netherlands US Water & Crisis Research Network, 2012). This has been the result of flood risk management that originated after the flood of 1953 (Avoyan, 2022; Correljé & Broekhans, 2015; Ministerie van Infrastructuur en Waterstaat, n.d.; Ministry of Infrastructure and Water & Management, 2020; PBL, n.d.). This led to the world-famous delta plan (PBL, n.d.) which makes the Dutch delta the safest in the world.

The relevance of the theoretical framework and the literature review to the research question "What are the potential benefits and challenges associated with the introduction of comprehensive flood insurance in the Netherlands, and what are the possible designs?" is multifold.

Firstly, understanding flood insurance from the perspective of international literature and the newer interest within the Netherlands gives an overview of its potential benefits and the challenges that may help in its possible adaptation. The literature allows for an analysis of other regions, contributing to the design of a comprehensive flood insurance system suitable for the Netherlands.

Secondly, the shift from flood prevention to flood resilience in the Netherlands shows a change in attitude towards flood management, especially the use of flood insurance as a recovery tool. This highlights the potential benefit of preparedness in response to floods, versus the potential challenge of ensuring good coverage and affordability when implementing this.

Thirdly, the principle of multi-layered safety emphasizes including more non-structural measures like flood insurance in the overall flood risk management. Understanding how flood insurance fits within this layered approach can help with the design.

Furthermore, understanding concepts like adverse selection, moral hazard, and equity theory is important when looking at the potential challenges in implementing flood insurance. They offer insights into the potential behavior of citizens and businesses, and these must be considered in the design phase to create a good and efficient system.

Finally, the growing concerns about climate change make the literature review highly relevant. As climate change is likely to increase flood risks, comprehensive flood insurance could provide a tool against financial losses.

The literature review for this study centers on the understanding of flood insurance, the shift from flood prevention to flood resilience in the Netherlands, the role of multi-layered safety in flood risk management (Bosoni et al., 2021), and the application of the STAR-FLOOD model (Hegger, Bakker, et al., 2016) and flood insurance design.

Literature review

Flood insurance, while largely sourced from literature outside of the Netherlands, is considered an important part of flood risk management, as can be seen in the works of Abcouwer et al. (2020) and Doorn-Hoekveld et al. (2022). A growing interest in flood insurance within the Netherlands calls for a transformation in its flood management policies. It is also the Netherlands' unique delta plan, underlined by references from sources such as Avoyan (2022), Correljé & Broekhans (2015), and PBL (n.d.), that has led to its reputation as having the world's safest delta.

The Dutch have been successful at preventing floods due to a combination of historical necessity, technological innovation, and a strong commitment to planning and infrastructure (Molenveld & van Buuren, 2019). This was a long process which was caused by the following factors:

1. **Geographical Location**: A large part of the Netherlands is below sea level. The Dutch made their own land by reclaiming it from the sea (Mostert, 2020). This geographical location has forced the Dutch to create innovative solutions to deal with water management and its risks. The water is coming in from all sides. On the one hand from the sea and the other hand from the rivers making it a delta area (Abcouwer et al., 2020; Doorn-Hoekveld et al., 2022; H.F.M.W. Van Rijswick et al., 2016).

2. **History of Water Management**: The Dutch have been dealing with flood risk for centuries (Hoeksema, 2007; Mostert, 2009). This long history has allowed them to develop techniques and technologies over generations. According to Abcouwer (2020), this caused the Dutch to have ''a love-hate relationship with water for centuries'' (p. 3). And Mostert (2020) said: ''According to a popular Dutch theory, water has shaped the Dutch national identity'' (p. 312). This shows why the Dutch are seen as a water authority worldwide (OECD, 2014).

3. **Infrastructure and investment**: The Netherlands has an extensive network of dikes, dams, and other water defenses (PBL, n.d.). This contributed to a strong economy and gave the Netherlands space and safety to develop (OECD, 2014). This gives the Netherlands a flood defense-orientated view because of these large investments (Hegger, Bakker, et al., 2016). Investments in the room for the river project with a cost of 3.2 billion (Van Alphen et al., 2011) shows the willingness.

So, the Dutch are good at preventing floods because it was necessary to develop into a developed country. Their geographical situation has caused a long history of innovation and investment in this area, leading to a world-famous approach to water management. However, due to climate change and higher standards, it is necessary to look further than only risk prevention.

Multi-layered safety

The shift from flood prevention to flood resilience in the Netherlands is a critical aspect of the theoretical framework, it is important because of the change in attitudes towards flood insurance (Doorn-Hoekveld et al., 2022; Molenveld & van Buuren, 2019; van Buuren et al., 2016). The research of this shift gives a new perspective on flood management, including the discussion on flood insurance as a recovery measure. Additionally, flood insurance policies may also require homeowners to take certain precautions, such as elevating their homes or installing flood-resistant barriers, as a condition of coverage. This can help to reduce the potential for damage and lower the overall costs of flood insurance (Hudson & Berghäuser, 2023; Hudson & Thieken, 2022; Mol, Botzen, & Blasch, 2020).

Moreover, multi-layered safety, a principle important to the Netherlands' flood risk management, is another part of the theoretical framework. This approach, detailed by Bosoni et al. (2021), PBL (n.d.), and van Buuren et al. (2016), seeks to implement multiple layers of protection, structural measures, non-structural measures, and emergency management procedures. The theory of multi-layered flood risk management can help with answering the sub-question: ''How will flood insurance influence the way the Dutch government deals with flood risk in the future?'' By analyzing the current and possible future situation in the Dutch approach to flood risk.

STAR-FLOOD Model

Looking back at the multi-layered safety approach, the model that comes back in the literature which can be seen as an operationalization of the multi-layered safety approach is the STAR-FLOOD model. In summary, the multi-layered safety approach is a comprehensive framework for water safety in the Netherlands, focusing on prevention, spatial planning, crisis management, and recovery. The STAR-

FLOOD model, on the other hand, originates from a research project that examines flood risk governance in urban areas, providing strategies and tools to enhance resilience. Both approaches contribute to the overall goal of protecting against flood risks (Hegger, Bakker, et al., 2016). But multi-layered safety is a more general look at how to arrange the flood defense as a country or region. Resilience is a part of the multi-layered safety approach and the STAR-FLOOD model is a way to interpret the multi-layered safety approach. Resilience is where flood insurance comes in, this will be the main focus of the research. But taking a look at how the STAR-FLOOD model works gives guidelines for the rest of the research.

The STAR-FLOOD model provides an essential theoretical foundation. The STAR-FLOOD model gives a comprehensive approach to flood risk management across the prevention, defense, mitigation, preparation, and recovery phases. The model, referenced in works by Hegger et al. (2016) and Wiering et al. (2017), provides a way to evaluate and propose policies that effectively manage flood risk.

To better understand the link between Multi-layered safety, the STAR-FLOOD model and insurance the theoretical framework for this research is supported by a body of literature that provides an in-depth understanding of flood insurance, the shift towards flood resilience, the concept of multi-layered safety, and the implementation of the STAR-FLOOD model. Flood risk management in the Netherlands is formed by multi-layered safety since flood risk management has been a part of the governance in the Netherlands for some time. Multi-layered safety has seen a shift from flood prevention to flood resilience has been made over the last decade (Doorn-Hoekveld et al., 2022; Molenveld & van Buuren, 2019; van Buuren et al., 2016). This has led to a more open mindset towards flood insurance. Flood risk management in the Netherlands is based on the principle of multi-layered safety (Bosoni et al., 2021; Doorn-Hoekveld et al., 2022; Paudel, 2014; PBL, n.d.). Multi-layered safety consists of 3 layers. Multi-layered safety flood risk refers to an approach to reducing the risk of flooding in a particular area. This approach involves the implementation of multiple layers of protection to prevent or mitigate flood damage, rather than using a single measure. The layers of protection include a combination of structural measures, non-structural measures, and emergency management procedures (Bosoni et al., 2021; PBL, n.d.; van Buuren et al., 2016). Flood insurance is seen as a non-structural measure for when a flood does happen, the costs can be recovered. The discourse in the Netherlands revolves around the introduction of this measure by insurers (Kaufmann et al., 2018; Kaufmann & Wiering, 2022; Surminski et al., 2015, 2016).

The Delta Program, which was launched in 2011, aimed to create a long-term strategic plan to prepare the Netherlands against floods, extreme rainfall, and droughts due to climate change. It helped with the participation of stakeholders in drafting policy strategies regarding flood risk management. The main results of the program called the Delta Decisions, were published in 2014 and included the ideas of land-use adaptation and 'smart combinations,' which refers to strategies that replace dike enforcement with a mix of measures across the three safety layers (Molenveld & van Buuren, 2019; Van Herk et al., 2014).

As described earlier another theory that is used is the STAR-FLOOD model (Hegger, Bakker, et al., 2016; Wiering et al., 2017) which stands for: “STrengthening And Redesigning European FLOOD risk practices: Towards appropriate and resilient flood risk governance arrangements”. Which will be explained more in-depth here with the steps taken in the model. The objective of this project is to analyze, explain, assess, and formulate policies that can effectively manage flood hazards posed by rivers in European urban clusters. The STAR-FLOOD study has discovered a complex relationship between flood recovery, prevention, and mitigation measures. In certain instances, robust recovery strategies may discourage prevention and mitigation efforts, and recovery systems should prioritize preventive and mitigation measures for individual properties. For example, in France, the CAT-NAT system has been found to deter prevention measures. Similarly, in Belgium, the legislative insurance

framework promotes risk prevention by discouraging construction in high-risk areas. (Hegger, Driessen, et al., 2016)

Figure 2: STAR-Flood model (Hegger, Bakker, et al., 2016).

STAR-Flood model: Risk prevention is addressed in the first two steps of the model, which involve system analysis and target setting. By identifying flood-prone areas and setting targets for flood protection, the model aims to prevent future flood risks.

Flood defense and mitigation are addressed in the third step of the model, which involves analyzing different flood protection measures and selecting the most appropriate ones. This step aims to defend against floods by implementing physical interventions such as flood walls and to mitigate flood impacts by implementing measures such as green infrastructure that can absorb and slow down water.

Flood preparation is addressed in the fourth step of the model, which involves implementing the selected flood protection measures. This step may involve preparing emergency plans and training staff to respond to floods, as well as implementing physical interventions.

Finally, flood recovery is addressed in the fifth step of the model, which involves evaluating the effectiveness of the implemented measures and adapting the approach as needed. This step may involve repairing damage caused by floods, improving communication and response protocols, and ensuring that the flood risk management approach remains effective over time (Hegger, Bakker, et al., 2016).

Insurance and Recovery

The Dutch have been effective in flood risk management because of the high standards and their prevention strategy. The Dutch government has focused on engineering solutions and spatial planning rather than on instruments like, for instance, flood insurance (Hegger, Driessen, et al., 2016). However, with the effects of climate change and sea-level rise, the role of flood insurance in the Netherlands' approach could change (Molenveld & van Buuren, 2019). What flood insurance can contribute to the multi-layered flood risk management is the following:

Risk Reduction and Behavioral Change

Flood insurance can serve as a risk mitigation strategy by encouraging and rewarding flood-resistant behaviors. For example, insurance companies could incentivize local flood-proofing measures through reduced premiums (Aerts & Botzen, 2011; Barendrecht et al., 2020; Suykens et al., 2016; Williams et al., 2023).

Financial Recovery and Speedy Compensation

Despite the Netherlands' good flood defenses, there remains a small risk of significant flooding events (PBL, n.d.). Flood insurance provides financial recovery in such scenarios. Insurance

compensation is usually faster than governmental support, enabling quicker rebuilding and recovery for affected homeowners and businesses (Bruggeman & Faure, 2018; Tuijn, 2021; P. Hudson & Thieken, 2022; Kousky & Shabman, 2016; Tesselaar et al., 2022). It also provides the financial means to replace lost belongings, further expediting the recovery process (Surminski & Eldridge, 2017).

Responsible Land Use and Financial Resilience

Flood insurance can also influence spatial planning. Insurance companies will give higher premiums on properties in high-risk zones, thereby encouraging responsible land use and building practices (de Ruig & Koekoek, 2022; Hegger, Driessen, et al., 2016; OECD, 2019). For the Dutch government, having an insurance system in place could help with some of the financial burden when a flood does occur (Bruggeman & Faure, 2018).

Building Back Better and Resilience

Insurance companies have the opportunity to promote "building back better," focusing on constructing more flood-resistant structures instead of just replacing what was damaged. This contributes to increased resilience in flood-prone areas (Hallegatte et al., 2018; Hampton & Curtis, 2022).

Reducing Dependence on Government and Preparedness

Flood insurance can make the reliance on government compensation less, which is often limited and can decline public resources (Botzen & Van Den Bergh, 2008; Regelink et al., 2017). Furthermore, just having a flood insurance policy encourages citizens and businesses to think more proactively about their flood risk, which can make recovery faster and easier when disasters do occur (Botzen et al., 2009b; P. G. M. B. Hudson, 2017).

By understanding these multiple aspects, it becomes clear that flood insurance can play a complex but valuable role in the Netherlands' flood risk management.

Flood recovery is the last step of multi-layered safety management when we look at the STAR-FLOOD model (Hegger, Driessen, et al., 2016). This is the part where when a flood does happen flood insurance could play a larger role in the Dutch flood risk management than it does now. For instance, in the context of the recovery phase of the multi-layered flood risk approach, flood insurance can help relieve the people who are struck by flooding.

Even with the advanced flood management systems in place, the Netherlands, like any other country, is not entirely immune to the risks posed by flooding (PBL, n.d.). A severe enough event could even damage and fail the high-standard protection infrastructure in the Netherlands (Abcouwer et al., 2020; Robinson & Botzen, 2022). If a large flood does happen insurance can be an important part of recovering from such an event by helping financially (OECD, 2016).

As said earlier the insurance design can also lead to the adoption of flood risk mitigation measures. For example, lower premiums can be offered to those who invest in flood-proofing their homes (de Ruig & Koekoek, 2022). Moreover, long-term insurance could be more effective in promoting damage mitigation than short-term insurance contracts. Homeowners may be reluctant to invest in mitigation when they have short-term insurance contracts, because of uncertainty about both whether they will stay in the same house in the future and whether the insurer will charge lower premiums that reflect reduced risk for a long period (Aerts & Botzen, 2011). A long-term insurance contract can be connected to the property instead of the individual. This provides benefits for the insured, such as premium discounts, for the duration of the contract if citizens invest in risk-reducing measures. With such a contract, investments in mitigation may be financed with mortgage loans which spread the investment costs for individuals over time. Undertaking a cost-effective mitigation measure would then reduce yearly insurance premiums by more than the yearly increase in mortgage payments used to finance the investments, which benefits consumers (Aerts & Botzen, 2011). Insurance companies

and banks that offer mortgages also benefit since the vulnerability of the property to natural hazards has been reduced, so that a win-win situation can be created for all involved parties (Aerts & Botzen, 2011). Moreover, according to Barendrecht et al., (2020) private mitigation measures can significantly contribute to mitigating flood risk and should be considered a part of flood risk management strategies.

Barendrecht et al., (2020) shows some ways to better understand systems and how things connect. It's crucial to learn about systems by looking at what happened in the past. This includes things like water flow patterns, when protective measures didn't work, early warnings. Seeing how we have handled flood risk management in the past can help us get a better picture of how the system works and how different parts affect it. Understanding systems through historical data on water flow patterns, failure of protective measures, and early warnings can contribute to more accurate risk assessment for flood insurance. Insurance companies can use this historical data to calculate premiums that accurately reflect the risk profile of a particular area or property. Knowing where protective measures have previously failed can help insurance companies identify high-risk zones, which could result in higher premiums or even refusal to insure in some cases.

Barendrecht et al., (2020) suggest using different models based on real-life data to get why floods happen, how these reasons interact and affect each other, and how they all influence the system. These models should show real life and be helpful for the people using them. They also highlight the need to check these models against real-life data. Barendrecht et al., (2020) emphasize the use of models based on real-life data to understand the factors that contribute to flooding. Such models can be tools for insurance companies to predict future flood risks. Accurate models help insurers to simulate scenarios, enabling them to better anticipate potential losses and set premiums. This kind of predictive analysis could also inform adaptive strategies, such as rewarding risk-reducing behaviors among policyholders.

The research states it is crucial to get everyone involved to help put private mitigation into action. This includes the public and private sectors, insurance companies, local and national governments, individuals, and homeowners. It is also important to understand how private mitigation plays a part in managing flood risks and how this might change over time (Barendrecht et al., 2020).

In summary, while the Netherlands' multi-layered flood risk approach aims more at prevention of a flood from happening. Flood insurance can play a critical role in helping people recover when a flood does occur. It provides compensation and helps rebuild in a way that will increase resilience. Flood insurance is more than just a financial safety net, it's an instrument for resilient recovery and preparation. By offering immediate compensation, helps with post-flood recovery allowing citizens to rebuild more efficiently than only being dependent on government aid. The concept of "building back better" is key to this. Smartly designed insurance policies can further incentivize homeowners to adopt flood mitigation measures, making communities less vulnerable to flooding. Barendrecht et al. (2020) highlight the importance of understanding past events and using comprehensive models to guide future strategies.

Government and Regulation

To give an overview of the Dutch legislative framework, governmental institutions, and unique approaches to flood risks the Government and Regulation should be looked at further. Additionally, the absence of private flood insurance and current compensation mechanisms will be discussed. By looking into these aspects, we gain insight into the Dutch water management system and its efforts to protect against flooding. The legislation and governmental organization are the source of this research because of the way the Dutch legislation is organized it is not possible to have insurance for flooding of primary water defenses.

The Dutch government has a long history of flood prevention and management (Mostert, 2020). The Netherlands has a comprehensive set of laws, regulations, and public institutions designed to manage and mitigate flood risks (*Het Nationaal Water Programma*, 2022; Ministry of Infrastructure and Water, 2019; Ministry of Infrastructure and Water & Management, 2020).

- **Legislation and Government Institutions**: There are many pieces of legislation and several government institutions that are responsible for flood management in the Netherlands. The Water Act is one of the most important legislative acts (Van Alphen, 2016).
    - The Water Act (2009) is an act that consists of several water management laws into one legislation. It covers water quantity, water quality, and flood management (Van Alphen, 2016; Water Act, 2010).
- **Role of Water Boards**: One aspect of the Dutch flood and water management is unique, which is the water boards. These are regional governmental institutions with responsibilities regarding water management (Slomp, 2012; Van Alphen, 2016).
- **Flood Insurance**: Despite the Netherlands's vulnerability to flooding, private flood insurance is not common (Botzen & Van Den Bergh, 2008; Doll & Mattheussens, 2022). This is largely because the risk is managed at a national level with large-scale infrastructure projects and comprehensive water management policies (Bouwer et al., 2007).
- **Compensation:** A decision about the compensation would have to be made by the government. Right now, there is the WTS which in case a large disaster happens can be called upon to compensate the affected citizens and businesses (Doll & Mattheussens, 2022; Verbond van verzekeraars, 2022a). If an insurance scheme were introduced the WTS would not be applicable anymore.

Insurance market failure

To better understand how the design of flood insurance should look it is notable that the following theories about insurance are described in the literature. This can help this research in better designing the insurance and answer the research question ‘’What are the possible insurance designs for the Netherlands?’’. Adverse selection, Moral Hazard Theory, and Equity theory are important subjects for this research because they address crucial aspects related to risk management, fairness, and the behavioral dynamics of insurance systems. This knowledge can guide the development of effective insurance policies. The following shows why these theories are relevant:

Adverse selection: The article "Voluntary purchases and adverse selection in the market for flood insurance" by (Bradt et al., 2021) examines the problem of adverse selection in the market for flood insurance. Adverse selection occurs when individuals with a higher risk of experiencing a loss are more likely to purchase insurance, leading to higher premiums and lower participation in the insurance market by those with lower risk.

The article focuses on the voluntary nature of the market for flood insurance in the United States, which means that individuals can choose whether or not to purchase insurance. Using data from the National Flood Insurance Program, the authors find that adverse selection is a significant problem in this market, with high-risk properties more likely to be insured than low-risk properties.

The authors propose several policy solutions to address adverse selection in the market for flood insurance, including targeted subsidies to encourage low-risk properties to purchase insurance, risk-based pricing, and mandatory insurance requirements. The article highlights the importance of addressing adverse selection in the market for flood insurance to ensure that the costs of natural disasters are spread fairly across society (Bradt et al., 2021; Wagner, 2022).

According to Cohen & Siegelman (2010), selection is a phenomenon in insurance markets where buyers have more information about their own risks than insurers and use this knowledge in purchasing insurance.

Moral Hazard Theory: Flood insurance refers to the idea that people may behave differently when they are insured against flood damage. Specifically, they may take on more risks and engage in behaviors that increase their exposure to potential flood damage, since they know they will be protected by insurance if a flood occurs (Hudson & Thieken, 2022; Mirrlees, n.d.).

For example, a homeowner may build their house in a flood-prone area or fail to take adequate precautions against flood damage, such as elevating their home or installing flood-resistant barriers, if they know they are insured against flood damage. This can result in increased losses for insurance companies and higher premiums for policyholders.

To mitigate the effects of moral hazard, flood insurance policies often include measures such as deductibles or co-payments, which require policyholders to pay a portion of the damage costs out of pocket. This can incentivize policyholders to take preventative measures and avoid risky behaviors that increase their exposure to flood damage.

In summary, the key difference between the two concepts is their timing and the kind of lack of information.

Adverse selection happens before the insurance contract is signed and is about hidden information that one party has and the other doesn't have.

Moral hazard happens after the contract is signed and is about changes in behavior that one party can't observe.

Both concepts result in higher risk and potential financial losses for the party with less information, which is often the insurer in these cases.

Equity theory: According to Yanjun & Mulder (2021) the relationship between home equity and flood insurance demand, finding that homeowners with higher levels of home equity are more likely to purchase flood insurance. They also find that income and education levels play a role in flood insurance demand. According to Darlington & Yiannakoulis, people are more likely to choose higher coverage levels when given information about the potential costs of flooding and the benefits of insurance. They also find that people who have experienced flooding in the past are more likely to purchase flood insurance and opt for higher coverage levels. The authors of both papers suggest that educating individuals about the risks and benefits of flood insurance and providing financial incentives could increase uptake and improve coverage levels.

Climate change

Finally, one of the biggest discourses surrounding flood insurance is the unpredictability of climate change. This chapter explores the role of climate change in flood insurance design. By incorporating climate change considerations, insurance policies can effectively address the challenges posed by a changing climate and contribute to long-term resilience in the face of increasing flood risk.

It is predicted that the weather will be more extreme and that the sea level will rise (Doorn-Hoekveld et al., 2022; EEA, 2021, 2022; ENW - expertisecentrum waterveiligheid, 2021; Klijn et al., 2012; Minnen et al., 2013). This will have an effect on flood risk management in the Netherlands but what has become clear after the flooding in Limburg in 2021 (ENW - expertisecentrum waterveiligheid, 2021) is that the way the Netherlands deals with water has to be overlooked. What becomes clear from the literature is that the way to do this is to diversify the approach. Overall, flood risk insurance is an important tool for protecting individuals and communities from the financial burden of flood damage. However, it is important to balance the competing theories surrounding flood insurance to ensure that it remains accessible and affordable for all. Climate change is relevant for the theoretical framework because it proves to be a challenge for flood risk management and has influence on the sub question ‘’What are the potential benefits and challenges barriers and opportunities of introducing flood insurance in the Netherlands?’’. The primary flood defenses are influenced by this due to higher river discharges and a higher sea level.

The theoretical framework examined in this research includes multiple perspectives and concepts of flood insurance, the transition from flood prevention to resilience in the Netherlands, multi-layered safety, and the STAR-FLOOD model (Bosoni et al., 2021; Hegger, Driessen, et al., 2016; van Buuren et al., 2016) The Netherlands' transformation towards resilience, reveals a more open look on flood insurance, in an example of the shift in flood risk management (Keessen et al., 2013; Molenveld & van Buuren, 2019; Surminski et al., 2016). Meanwhile, the principle of multi-layered safety shows another approach that combines structural measures, non-structural measures, and emergency management procedures. The STAR-FLOOD model aims for the integration of prevention, defense, mitigation, preparation, and recovery phases (Hegger, Driessen, et al., 2016). As flood insurance becomes more of an essential non-structural measure, challenges such as adverse selection and moral hazard need to be addressed to ensure a good system (Bradt et al., 2021; Cohen & Siegelman, 2010; Hudson & Berghäuser, 2023; Mol, Botzen, & Blasch, 2020; Wagner, 2022). With regard to the increased implications of climate change and its unpredictability, it is necessary to keep evolving flood risk management in the Netherlands. Diversity in approaches is key to maintaining the position as the world's safest delta and ensuring accessibility and affordability.

2.1 Key concepts

Exploring the introduction of flood insurance for primary water defenses in the Netherlands is a complex issue. It involves the study of several key concepts, which will be explained in the following 6 concepts. These concepts will be the basis of the conceptual model that follows. The key concepts are derived from the literature review. Which gave an overview of the subject at hand and will be worked out further in the key concepts. These concepts will form the basis of the research and give more meaning to the conclusion and recommendations in the end.

This thesis is guided by sub-questions that each connect to key academic and practical concepts, which are important to understanding the landscape of flood risk management and insurance in the Netherlands. These will then lead to the main research question. Here is an explanation of why these key concepts were chosen and in what way they are connected to the research questions.

1. **How will flood insurance influence the way the Dutch government deals with flood risk in the future?**
    - **Key Concepts: Role of the Government in insurance, Risk Analysis for flood risk management**
        - Understanding the role of the government is crucial for predicting how the introduction of flood insurance might shift public policy or management strategies related to flood risk.
        - Risk Analysis provides the basis for how governments evaluate and respond to risks, including the adoption of insurance as a risk management strategy.

2. **How do attitudes and perceptions towards flood risk and insurance impact its desirability and feasibility as an alternative in the Netherlands?**
    - **Key Concepts: Perception & acceptance, Climate Change Impact**
        - Public perception and acceptance are key variables in determining whether flood insurance will be seen as a viable and attractive solution.
        - The impacts of climate change shape public perceptions of risk and may influence attitudes toward the necessity and feasibility of flood insurance as a resilience factor.
3. **What are the possible insurance designs for the Netherlands?**
    - **Key Concepts: Insurance Design, Legal and Regulatory Framework**
        - Different insurance designs have their strengths, weaknesses, and legal obstacles; understanding these can help implement a system that is both effective and follows laws and regulations.
4. **What are the potential benefits, challenges, barriers, and opportunities of introducing flood insurance in the Netherlands?**
    - **Key Concepts: Risk Analysis for flood risk management, Legal and Regulatory Framework, Role of the Government in insurance, Climate Change Impact**
        - This broad question is explained by looking at it through various perspectives: legal frameworks determine what can be done; government involvement implements how it might be done; risk analysis provides a foundation for evaluating options; and the impact of climate change shows why new solutions might be needed.

Key concepts:

Risk Analysis for flood risk management**:** Assessment of the level of risk associated with flooding in different parts of the Netherlands. The design of a potential insurance scheme is highly dependent on the risk analysis. An understanding of flood risk in the Netherlands can provide important insights

into the potential cost of such insurance, and the potential benefits for policyholders. In essence, risk analysis provides the foundation upon which a robust and sustainable flood insurance scheme is built. Without a clear understanding of the risks involved, insurers might face unexpectedly large claims, policyholders might be inadequately covered, and the entire scheme might become financially unsustainable (Surminski, 2014). The main literature used to get to know the risk of flooding is from reports of several Dutch and European authorities on water management. The National Delta Program (Ministry of Infrastructure and Water & Management, 2020) in the Netherlands is a strategic and comprehensive program to protect the Netherlands from flooding and ensure a sufficient supply of fresh water. The program was started in response to climate change, which is leading to sea-level rise, changing rainfall patterns, droughts, and higher discharges in the rivers, causing significant risks to this low-lying country. Three key areas of the National Delta Program include: flood risk management which involves which measures are being taken to protect the population from flooding. The second is the freshwater supply for ensuring the supply of fresh water. The third is spatial adaptation which aims to make urban areas more resilient to the impacts of climate change (Ministry of Infrastructure and Water & Management, 2020). The risk analysis of the VNK which is an initiative of the Ministry of Infrastructure and Environment, the Union of Water Boards, and the Interprovincial Consultation. Rijkswaterstaat carried out the project in close collaboration with the water barrier managers, provinces, research institutes, and engineering firms and analyzed all primary water barriers in the Netherlands. It has shown a risk approach by giving an overview of the flood risks in the Netherlands. Flood risk can be calculated by taking the probability of a flood happening in a certain area times the impact or consequences it has/ how much damage the flood will cause. This leads to the flood risk as shown in the figure below:

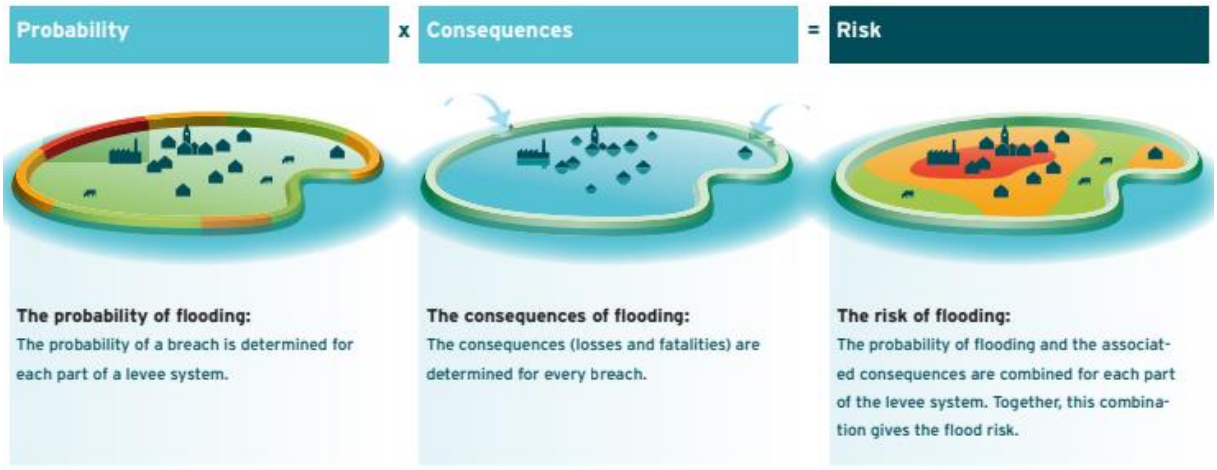


Figure 3: (Vergouwe, 2014).

The flood probabilities given by VNK aren't the same as the standards in the law, which uses a higher norm for the probability approach (Vergouwe, 2014). The potential consequences of flooding are very different between and within dike rings. A map in the report shows the annual expected economic damage per hectare, showing the economic risk, with the highest risk in built-up areas and the lowest in rural areas (Vergouwe, 2014). Together with the report of (Kolen & Nicolai, 2023) and the interactive maps about flooding and flooding scenarios of the LIWO (*LIWO*, n.d.), it is possible to get an overview of the current and future flood risk management policy and see what challenges regarding flood probability there are. The PBL states that the probability of flooding in the Netherlands is low but the consequences are high, so a lot of damage could be done, and the scale could be very large. That's why a new flood management strategy is being implemented which is focused on the multi-layered concept (PBL, n.d.). At the most crucial points, dikes and levees will be reinforced, others will be maintained, and some systems will be reinforced not because of the extra probability but because of the potential number of victims. An annual investment of 1 billion will be set from 2016 until 2028, Which accounts for 15,2 billion euros in investment (PBL, n.d.). Finally, the

room for the river program is an example of the diversification of the Dutch flood risk management where the shift from flood defense to adaptation is clear (Waterstaat, n.d.).

Academic literature tries to analyze flood risk management in the Netherlands. According to Wiering (2019), Dutch resilience is mainly focused on system resilience (the robustness of the collective system to defend against floods) rather than community resilience. Despite the strong Dutch flood risk infrastructure, it has become dependent on its system's resilience and struggles with increasing its flexibility and adaptability. The Dutch governance of flood risks is affected by a strong flood infrastructure that generates public trust; this could lead to a lack of awareness of the system's limitations (Wiering, 2019). Furthermore, regional economic differences raise questions about future solidarity, even though the need for diversification in risk strategies is important in the light of resilience. Despite these challenges, it's acknowledged that the Dutch system's resilience is strong, though adaptability should be increased to handle future risks better (Wiering, 2019). The diversification of flood risk management is backed up by the article of (Hegger, 2019) which states that context-sensitive planning and implementation are necessary for flood risk management. Diversification is desirable but is dependent on the history of previous strategies and actors.

According to Hegger (2019), flood management should not only rely on water managers, but also include spatial planners, contingency agencies, insurance companies, and private actors, including citizens. Building "bridges over troubled waters" helps engaging these actors in dialogues about desired levels of flood protection and the good strategies to achieve them (Gilissen et al., 2016).

Finally, Hegger (2019) emphasizes the need for more practical experience with diversification of flood risk management modes and multi-actor collaboration and suggests that these experiences should be monitored for learning and sharing between countries (Hegger, 2019). The use of multiple actors in flood risk management is backed up by the article of (Doorn-Hoekveld et al., 2022). It states that historically, the Netherlands' focus was primarily on minimizing the probability of flooding and preparedness in case of a flood. However, strategies aimed at mitigating potential flood effects, have become more attention. This shift makes it more important to give more space and involvement from diverse actors, leading to a more complex system in the responsibilities of flood risk management. There's a higher need for communication, coordination, and collaboration among various public and private actors to ensure the effectiveness of flood risk management. It is still clear that Dutch flood risk management is very path-dependent (van Buuren et al., 2016) The Dutch focus on structural flood protection is expanding to include water planning and risk reduction, improving the resilience of flood risk management and reducing dependency on hard infrastructure. This shift is mainly caused by internal policy factors, beginning with the Delta Program. While external factors like climate change and the economy have created an environment for this shift. The historical success of flood protection has locked the Dutch into a path dependency, which holds future changes. Despite the emergence of new insights, significant institutional changes are not yet there, this causes only a small increase in the Dutch flood risk management resilience, largely due to regional and local authorities' efforts (van Buuren et al., 2016).

In conclusion, risk analysis serves as a basis for addressing each of the research questions and sub-questions. It plays an important role in understanding the complexities and challenges of implementing a comprehensive flood insurance system in the Netherlands. By studying the risk factors and associated government and public response, the research can develop an answer to your question about the implications and desirability of flood insurance in the context of Dutch flood risk management.

Climate Change Impact**:** With climate change expected to increase the severity and frequency of flooding this could impact the risk assessment and the cost of insurance. The risk assessment part is important for insurance companies as the premiums and total risk will be calculated. For long-term insurance contracts, offering consistency and damage mitigation incentives, but setting accurate premiums is challenging due to future uncertainties (Aerts & Botzen, 2011).

In the past century, the sea level along the Dutch coast has risen by about 20 cm without an increase in the rate of rise being observed. This rise is attributed to the expansion of seawater due to higher temperatures and the melting of the Greenland and Antarctic ice sheets. Since 1993, the global average sea level rise rate has increased to about 3mm per year. However, it is unclear whether this increase represents a trend break or a temporary occurrence. Future changes in sea levels remain uncertain due to gaps in our understanding of the climate system and future greenhouse gas emissions. Projections suggest an increase in the rate of sea level rise, which may continue for centuries even if global temperature rises slow down. The KNMI'06 scenarios project a sea level rise along the Dutch coast of 15-35 cm by 2050 and 35-85 cm by 2100. Regarding river discharges, no significant change in the average annual discharge of the Rhine and Meuse rivers has been observed over the past century. However, monthly river discharges have seen increases of 9% during winter and decreases of 9% during summer. There has been no observed trend in extreme low and high discharges due to large natural variability (Minnen et al., 2013).

River discharges are projected to increase further in winter and decrease in summer according to the KNMI'06 scenarios. These changes are because of rising temperatures and changing precipitation patterns. A clear increase in average winter discharges is projected for both the Rhine and the Meuse. For summer and autumn, it is more varied due to differences in projected precipitation (Minnen et al., 2013).

This is backed up by (EEA, 2021) which states that from 1960 to 2010 climate change resulted in a rise in annual river floods in north-western and sections of central Europe, whereas a decline was observed in southern and north-eastern Europe. Future changes are projected to intensify the frequency of once-per-century river floods across most of Europe, except for parts of northern Europe, southern Spain, and Turkey. Pluvial and flash floods, which are caused by local intense precipitation events, are predicted to increase across Europe.

River floods represent some of the most extreme climate events in Europe. In a scenario of high emissions, the direct damage from river floods could potentially triple during the 21st century if adaptive measures are not implemented. This is due to the impacts of climate change (EEA, 2021).

In light of increasing flood risks due to climate change, flood insurance in the Netherlands is becoming more important. Rising sea levels and changing river discharge patterns complicate risk assessments for insurance companies, potentially driving up premium costs. Given the uncertainties and increasing risks, flood insurance is increasingly important not only financially, but also as an incentive for implementing adaptive measures.

Legal and Regulatory Framework**:** An understanding of the existing legal and regulatory framework related to flood management and insurance is very important. The introduction of such an insurance scheme probably requires changes to laws and regulations. Without the approval of the government and its governing bodies insurance companies wouldn't have full support and would stand alone. Because the WTS would still be in place next to the insurance schemes of the insurance companies. According to Kaufmann (2018), there are two key issues: the uneven distribution of flood risk due to varying hydrological circumstances and the burdens of flood risk management, including the distribution of responsibilities and the financing of management and recovery strategies. For now, the Dutch government is responsible for the safety of the Dutch society from flooding, and this is in the constitution (Water Act, 2010). In 1995, the Flood Protection Act (Water Act since 2009) provided a legal basis for these flood protection standards and introduced a 6-year assessment of the flood defenses by the water boards. If this assessment reveals that these legal standards are not met, the water board has to take measures to improve its defenses to meet up with the standards. The results of the assessment and the related improvement plans are reported to the Parliament (Van Alphen, 2016).

An overview of the roles, responsibilities, and legal instruments is shown below.

<table>
<tr><th></th><th>Prevention</th><th>Protection</th><th>Preparation</th><th>Response</th><th>Recovery</th></tr>
<tr><td rowspan="2">Legislation</td><td>Spatial Planning Act (SPA)</td><td>Water Act (WA)</td><td colspan="3">Safety Regions Act (SRA)</td></tr>
<tr><td>Provinces Act
Municipalities Act</td><td>Water Boards Act</td><td colspan="2">Municipalities Act</td><td>Disaster Compensation Act (WTS)</td></tr>
<tr><td>Administrative Level</td><td colspan="2">Ministry of Infrastructure and Environment</td><td colspan="3">Ministry of Security and Justice</td></tr>
<tr><td rowspan="4">State</td><td colspan="5">National Water Plan accent on protection (WA), also zoning (SPA)</td></tr>
<tr><td>National Spatial Strategy (SPA)</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2"></td><td>National Flood protection program (WA)</td><td colspan="3"></td></tr>
<tr><td></td><td colspan="3">National floods crisis plan and large-scale evacuations (SRA)</td></tr>
<tr><td>Provinces</td><td colspan="2">Provincial Water Plan, zoning (urban, nature, industry, agriculture) (SPA)</td><td colspan="3"></td></tr>
<tr><td>Water Boards</td><td colspan="2">Water management Plan (WA)</td><td colspan="2">Flood Disaster Management Plan (WA)</td><td></td></tr>
<tr><td>Safety Regions</td><td colspan="2"></td><td colspan="3">Crisis Coordination Plan (SRA), Disaster Management plan (SRA)</td></tr>
<tr><td>Municipalities</td><td>Land use plan (SPA)</td><td colspan="4"></td></tr>
</table>

Figure 4: Flood risk management instruments in the Netherlands (Slomp, 2012).

The figure gives an overview of the roles, responsibilities and legal instruments different authorities have. These include spatial planning and water management. At the national level, the key legislative instruments include the Spatial Planning Act, the Water Act, and the Safety Regions Act. The Spatial Planning Act is all about spatial planning and development. It makes sure that all activities take into account the impact on water management. The Water Act sets the rules for actions that have to do with water and flood risk. The act sets the norms and standards and as said earlier has to be up to date every 6 years. The Safety Regions Act is for disaster management and looks at the preparation, response, and recovery ability before and after, for example a flood (Van Alphen et al., 2011).

The authorities who are responsible for managing flood risk are the Ministry of Infrastructure and Environment and the Ministry of Security and Justice (Slomp, 2012).

Provinces and municipalities handle regional and local spatial planning and risk management. The waterboards are funded through taxes and manage regional waterways, maintain flood defenses, and manage disasters. Finally, the safety regions deal with the coordination of disasters such as flooding and operate at a provincial or sub-provincial level (Ministerie van Algemene Zaken, 2017; Van Alphen et al., 2011).

In conclusion, introducing flood insurance for primary flood defenses in the Netherlands is not just about crafting an insurance policy. It requires a comprehensive understanding of and potentially significant changes to the existing legal and regulatory framework related to flood risk management.

Role of the Government in insurance**:** There are high risks when it comes to flooding. That's why it is unlikely that private insurers would offer flood insurance without some government support. This could give possibilities, from the government acting as a reinsurer, to the government directly providing flood insurance (Bouwer et al., 2007).

Flood risk management involves both preventive measures and dealing with the aftermath of floods, such as compensation for any losses. Governments play a key role in flood protection by implementing flood protection programs to ensure public safety and provide good conditions for economic growth (Bouwer et al., 2007).

Three roles can be identified for governments regarding the management of flood losses. They can regulate the private insurance sector market, create their own primary insurance or reinsurance systems, or provide relief as a last resort insurer. Some countries, such as Belgium and the Netherlands, think that their liability for flood losses is too high and are trying to transfer a larger portion of the risk to the private sector (Bouwer et al., 2007).

According to Jongejan & Barrieu (2008) the possible roles of government in relation to the insurance industry, with a focus on flooding. Two roles are considered: the government as a "reinsurer" and the government as a "backstop".

Government as a Reinsurer: This is a scheme where the government would act as a reinsurer by selling Excess of Loss (XOL) contracts to insurance companies. An XOL contract is a contract where the government will take on the excess of losses when it exceeds a pre-determined amount. The insurance companies will pay for the losses up to that level (Jongejan & Barrieu, 2008). This could lead to a reinsurance market that does not have to make a large profit and give a fair price (Bruggeman et al., 2010). These contracts could lead to the development of a private insurance market for large-scale losses with the backup of the government (Jongejan & Barrieu, 2008).

Government as a Backstop: The government would absorb all losses exceeding a pre-determined level, essentially providing a free upper layer of insurance coverage, but here the insurance companies don't have to pay a premium. This would mean that the insurance companies don't have to ask for very high premiums because a large part of the losses are accounted for. This won't be an issue as long as moral hazard is managed (Jongejan & Barrieu, 2008).

Government as insurer: In France, flood insurance operates through a public-private partnership. All buildings and everything inside of a home have mandatory insurance policies including flood and natural hazard coverage. This gives everyone almost universal coverage (Botzen & Van Den Bergh, 2008; Surminski, 2014). Private insurers manage premium collection, claims, and payouts. However, if flood damages surpass the insurer's payment capacities the government offers a state guarantee and also legally determines insurance coverage. The state-backed "Caisse Centrale de Réassurance" offers affordable reinsurance with unlimited coverage, backed by an unlimited state guarantee. No premium differentiation is permitted, which causes fewer incentives for loss reduction. Therefore, extra policies promote construction in safer areas (Botzen & Van Den Bergh, 2008; Surminski, 2014).

Flood damages are compensated if the government sees the flood as a disaster and the affected region as a disaster area. A drawback is the lack of transparency in the system, as the disaster definition is a bit vague. While the standard system relies on government recognition for a disaster, individuals can get separate private flood insurance. Overall, the French approach has been effective,

with both insurers and policyholders generally content with the system's operation (Botzen & Van Den Bergh, 2008; Surminski, 2014).

Perception & acceptance**:** It's important to check the public perception and acceptance of such an insurance scheme. Will people see it as necessary and beneficial or will they see it as another tax or cost and not find it necessary.

The article of Mol et al., (2020) studies flood risk misperceptions among Dutch citizens, it tries to understand and quantify them to design effective risk communication campaigns and insurance designs. The study shows that individuals who remember high water levels are less likely to misperceive flood risks and that affective feelings, such as worry may lead to overestimations of probability and water level. Experience of a flood and trust in dike maintenance can decrease flood risk misperceptions. What is apparent from the study of (Mol, Botzen, Blasch, et al., 2020) is that citizens know that there is a threat but underestimate it.

The study finds that many Dutch homeowners underestimate the water level of a flood. This shows that they may underestimate the cost-effectiveness of damage reduction measures. The Dutch government could consider information campaigns targeted at homeowners in the river delta. Especially those in low-lying areas who are more likely to underestimate flood risks. Another study from Seifert et al., (2013) compares flood insurance demand in the Netherlands and Germany which have different flood risks. The Netherlands faces low-probability high-impact flood risks. But Germany deals with medium-probability medium-impact risks. This influences the flood loss compensation schemes in each country.

The research findings confirm that the Willingness To Pay (WTP) for flood insurance in Germany, where the risk is medium-probability and medium-impact is higher than in the Netherlands where the risk is low-probability but high-impact.

According to Seifert et al. (2013), a few factors contribute to this:
Intense experiences like evacuation or damage can explain the higher WTP in Germany.
Flood insurance demand is related to individual risk perceptions, which are higher in Germany than in the Netherlands.
In the Netherlands, where there is no private flood insurance and flood risk has a high impact, the citizens expect the government to compensate for flood damages. This expectation explains the lower WTP in the Netherlands.

Although flood risks are not generally covered by property insurance policies in the Netherlands, many Dutch homeowners have a positive WTP for flood insurance, which indicates the potential for introducing insurance (Seifert et al., 2013). This suggests that government compensation through the WTS for flood damage discourages demand for private flood insurance in the Netherlands, which is known as a charity hazard. One solution could be to make insurance compulsory (Seifert et al., 2013).

The study also shows that awareness campaigns could increase insurance uptake by enhancing individual flood risk perceptions. This strategy could be beneficial for the Netherlands, where actual flood experiences are rare, leading to bad preparedness from citizens (Seifert et al., 2013).

The study explained that worry about flooding may increase flood risk perceptions but also lead to overestimations. So, communicating factors of risk such as damage estimates and the maximum water level could be a more effective approach.

Another study by Botzen et al., (2009) investigates individual perceptions of flood risks in the Netherlands by surveying 1000 homeowners. Statistical models were used to identify factors

influencing flood risk perceptions, such as geographical risk indicators, experience and knowledge about flood risks, and socioeconomic characteristics.

The study revealed that people underestimated flood probability compared to other risks and to the national average. While they tended to underestimate the probability of floods, their estimates of potential damage were similar to the predictions by experts.

These findings show significant implications for policymakers. Given the low perception of flood risk, the public may not be supportive of flood risk reduction policies and investments. An enhanced awareness of flood risk might promote investment in mitigation measures such as flood-proofing buildings. The government may have to consider a communication campaign to increase awareness of flood risks (Botzen et al., 2009).

Furthermore, it was observed that risk perceptions vary among individuals. People living close to main rivers in low-lying areas usually have higher risk perceptions, while those in flood-prone areas unprotected by dikes often underestimate their risk. Prior experience with flooding and evacuation affects the perception of risk but in different ways for probability and damage. Individuals with limited knowledge about the causes of flooding have lower risk perceptions, showing that providing information about flooding may increase risk perceptions (Botzen et al., 2009).

Socioeconomic factors also play a role in perceived risk. The study found a negative correlation between education level and perceived risk (Botzen et al., 2009).

In the literature about flood risk and flood insurance, the word solidarity comes back a lot. Solidarity, in the context of flood insurance, is the principle that risks are shared collectively among all members of a group (in this case a country) (de Ruig & Koekoek, 2022; Jongejan & Barrieu, 2008; Kaufmann et al., 2018). This makes flood risk management more effective and lowers costs because every homeowner and business pays for the costs. For flood insurance, this can cause the premium to go down (Botzen & Van Den Bergh, 2008; Kaufmann et al., 2018).
The concept of solidarity is not new to Dutch flood risk management because the expenditure of all flood protection is paid through solidarity (Kaufmann et al., 2018).

Solidarity could influence the design of a flood insurance system in the Netherlands with the following:

- **Risk Pooling**: Solidarity can be applicable for flood insurance by sharing the risk in a larger pool with high and low risk put together. Insurance companies do this rather than only insuring those directly at risk of flooding. This could mean that all citizens in the country are included in the insurance system with no regard for their individual flood risk (Hudson et al., 2019; OECD, 2016, 2021).
- **Cross-Subsidization**: Linked with risk pooling above, a solidarity-based insurance system can have cross-subsidization, where those at lower risk effectively subsidize the premiums of those at higher risk. This could help to keep premiums cheaper even for the citizens who are living in high-risk areas (Hampton & Curtis, 2022; Surminski, 2018).
- **Equity Considerations**: According to O'Neill & O'Neill (2012) in a solidarity-based system, equity and fairness would have to be taken into consideration. This could influence decisions about premium pricing and help citizens with a low income.

Public perceptions of flood risks in the Netherlands vary, with many underestimating the dangers. However, the Dutch value of solidarity where everyone shares the risk and cost, can help in designing

an effective flood insurance system. By combining this principle with clear communication about the real risks and perhaps making insurance mandatory, the Netherlands can create a simple, cost-effective, and widely accepted flood insurance plan. This approach would not just offer financial protection but also unite citizens in facing flood challenges.

Insurance Design**:** The modeling of insurance coverage can contribute significantly to multiple objectives of disaster resilience, but it must be well-designed. For instance, well-structured insurance design can not only provide immediate financial resources to accelerate the post-disaster recovery process, but they can also ensure policyholders undertake additional risk management activities (Hudson & Berghäuser, 2023). These principles are in the European Climate Change Adaptation Strategy, which underscores improving disaster insurance coverage as a key objective (Hudson & Berghäuser, 2023). Similarly, initiatives to enhance disaster insurance coverage are gaining traction in developing countries.

Nonetheless, expanded insurance coverage can potentially introduce negative impacts, such as moral hazard, which is a key topic within disaster risk research (Hudson & Thieken, 2022).

Moreover, there are unique elements to natural disaster insurance markets, including significant challenges in uptake and a lack of adverse selection on unobservable. Additionally, the pricing of natural disasters such as flood insurance is very complex, with issues related to political interests, fiscal solvency, and affordability introducing additional layers of difficulty (Wagner, 2022). Insurance market design for natural disasters including floods is a critical area for research and policy intervention, because of the high cost of extreme weather events and the intensification of events due to climate change (Wagner, 2022).

In the study of (Tesselaar et al., 2022) it has become clear that there is a dilemma where welfare state governments are often expected to provide disaster relief, reducing the demand for insurance and reducing the insurance market's ability to effectively spread risks. This can lead to higher premiums, further reducing the demand for insurance as more households rely on potential government aid.

Government compensation looks very helpful but can be unpredictable and unreliable for households. As the compensation often depends on political will and economic circumstances. This inconsistency can create double standards for uninsured households and uncertainty for public budget planning (Tesselaar et al., 2022).

Existing studies show that the impact of government compensation on insurance demand is different depending on the risk context and the likelihood and extent of compensation. There is a consensus that anticipation of government disaster relief can reduce the demand for insurance (Tesselaar et al., 2022). However, some studies have reported an increase in insurance demand due to government disaster relief, which the authors attribute to endogeneity and other factors (Tesselaar et al., 2022).

According to Hudson (2019), Key features for insurance market reform include limited premium cross-subsidization between high- and low-risk households, involvement of a governmental reinsurer, incentives for floodproofing homes, and stronger requirements for insurance purchase. While there is no one solution it can guide discussions on reforming flood insurance markets. One is public-private partnerships (PPPs) that involve multiple stakeholders to support both households in purchasing insurance and the insurance industry in providing wide coverage (Hudson et al., 2019).

2.2 Conceptual framework

Overall, flood insurance in the context of Dutch primary water defenses is an interdisciplinary issue, relevant to a wide range of scientific fields, including climate science, engineering, urban planning, policy and governance studies, socio-economic studies, and economics. That is why a conceptual framework is important to maintain focus and keep an overview of the subject. This thesis, therefore, tries to provide a comprehensive exploration of flood insurance in the context of the Netherlands.

The key concepts are explored, and which will determine the desirability of flood insurance in the Netherlands and answer the main research question. The conceptual framework gives an overview of the key concepts that lead to the possible designs of an insurance scheme. In the coming chapters these key concepts will be described further and will be followed up by the desirability of primary flood insurance in the Netherlands where the main research question will be answered. The key concepts all have influence on the different possible insurance designs which in turn will have influence on the desirability of flood insurance in the Netherlands. The visual below shows what the buildup of the research is about and is derived from the University of Utrecht.

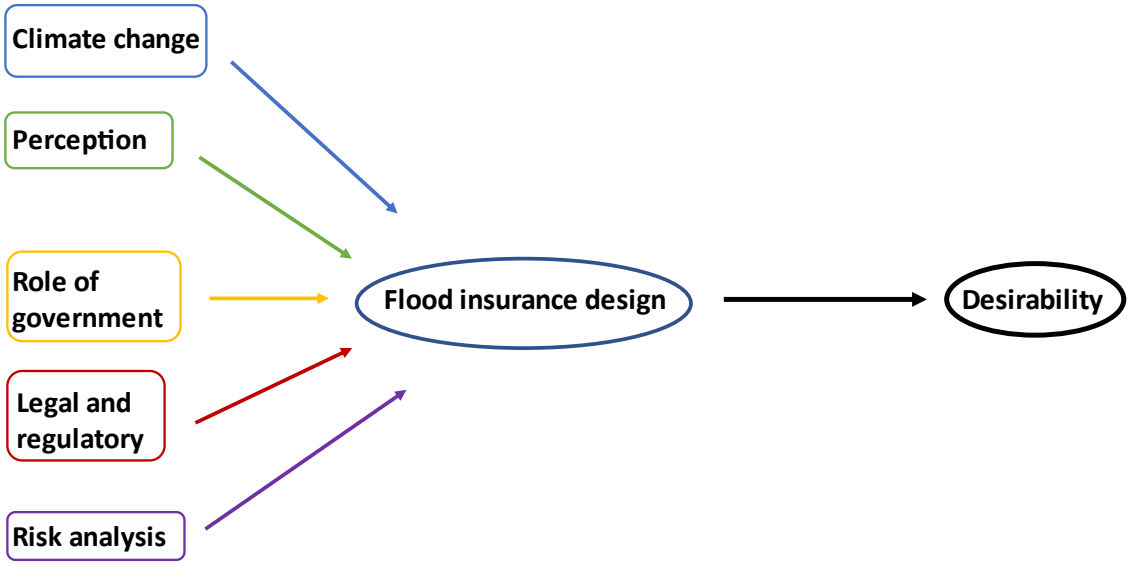


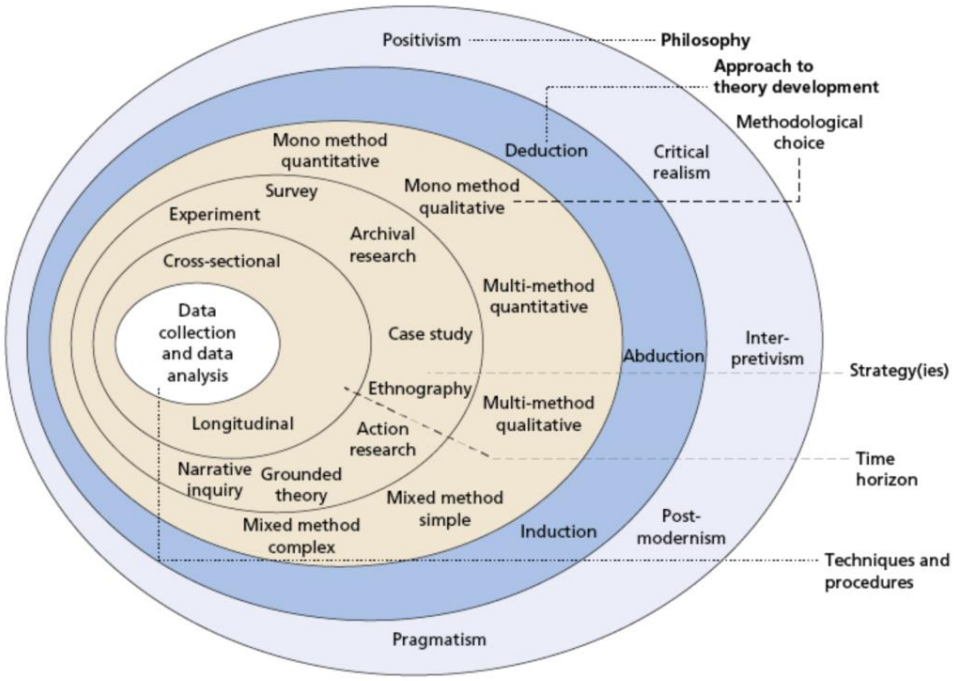
Figure 5:

(Based on Utrecht University, n.d.)

3. Methodology

The research has a research strategy as its core. According to van Thiel (2014), research strategy, method, and technique are often confused with each other. Applying a certain strategy is decided after a few considerations (Thiel, 2014). First, the general knowledge and subject will be important. The more knowledge there already is the more study can be included in the subject. From this a strategy can be chosen. Secondly, a method should be chosen such as observation, questionnaire, interview and content analysis (Thiel, 2014). They can be specified into semi-structured interviews, discourse analysis, focus groups, etc. According to Moses & Knutsen (2012), one useful way to consider the relationship is to think of methods as tools, and methodologies as toolboxes. Therefore, first the research strategy has to be considered before moving on to the tools.

To give a better understanding of the methodology used in this research the research onion by Saunders is used (Saunders et al., 2019). Saunders' research onion is a tool that guides the development of research methodology for dissertations, theses, or other formal research projects. As you move inward from the outer layers of the onion, the model presents various decision points that shift from philosophical to practical. It also aligns with the general structure of a methodology chapter. Saunders' research onion, though not flawless, is beneficial in offering a comprehensive view of methodology. It clarifies the necessary decisions in research design and methodology (Jansen, 2021; Saunders et al., 2019).



Source: ©2018 Mark Saunders, Philip Lewis and Adrian Thornhill

Figure 6: Research onion (Saunders et al., 2019).

The choices that were made during the research can be traced back to the research onion which makes the methodology easier to understand.

3.1 Research philosophy

The research onion gives a good overview of the research philosophy which will be described in this chapter (Saunders et al., 2019).

This study wants to find out what people in the Netherlands think about flood insurance. It's guided by something called a research philosophy, which includes the personal opinions and beliefs of the

person doing the research. These opinions and beliefs can change how the study is done (Guba & Lincoln, 1994).

When doing research, there are three important parts to think about. The first part is called 'ontology', and it's about what we believe is real. The second part is called 'epistemology', and it's about what we can learn and how we can learn it. This includes thinking about how the person doing the research and the thing they're studying work together, and if there is only one truth or many. The third part is 'methodology', and it's about how to study something (Guba & Lincoln, 1994; Thiel, 2014).

There are four main ways to think about research, according to Guba and Lincoln (1994): Positivism, post-positivism, critical theory, and constructivism. For this study, constructivism will be used. This means that every situation makes its own reality, and different people can see the same thing in different ways. The person doing the research and the thing they're studying can also change each other. This seems like the most logical considering the subject of the research. The subject will make use of expert interviews and literature research which by itself has multiple people and opinions in it.

Constructivism uses a way of studying that lets the researcher in a conversation with the people in the study. This helps them understand each other better. This is a good fit for this study because it wants to understand how people think about flood insurance in the context of the Netherlands (Guba & Lincoln, 1994; Harrison et al., 2017).

The way of studying chosen for this research is something called an abductive approach. There are three ways of conducting research deductive, inductive, and abductive. Deductive research tests a pre-existing theory through experiments or observations, aiming for conclusive results. Inductive research starts with observations to create a new theory, offering probable but not certain conclusions. Abductive research uses incomplete observations to form the most likely explanation for a phenomenon. Each approach varies in its starting point and objectives: deductive confirms theories, inductive constructs them, and abductive explains phenomena based on available information. This means going beyond just the information and ideas we already have. It can mean changing old ideas, putting them together in new ways, or coming up with new ways to look at the information. The abductive approach lets you move between the information and ideas and look for patterns. These patterns can be derived from literature and interviews. In this way, the research can find common ground or similar opinions about flood insurance (Kennedy & Thornberg, 2018).

3.2 Research Strategy

The beginning of research should start with finding out what kind of strategy would fit the research questions formulated in Chapter 1.

Bryman (2012) emphasized the critical nature of choosing an appropriate research strategy when initiating a study. This strategic decision provides a foundational framework, guiding the overall direction of the research. These strategies can be classified into two categories: quantitative, which emphasizes numerical data, and qualitative, which focuses on non-numerical, descriptive data. The latter is what this research is all about. It dives deeper into the theories that were already written in other research and look further into them by combining them with expert interviews.

For this research, which dives into the desirability of primary flood insurance in the Netherlands as stated earlier qualitative methods were chosen because this approach prioritizes the examination of non-numerical data, from sources like interviews or written content. In this case, a large number of sources were used to get to grips with the subject and back it up with expert interviews. Such an

approach is particularly suited for getting the details of a given phenomenon, allowing researchers to unearth deep insights and perspectives (Van Thiel, 2014).

Van Thiel (2014) underscores the primary goal of qualitative research as a deep exploration of the research's central theme or subject. In this instance, the main point is the desirability and practicability of primary flood insurance within the Dutch context. This chosen research approach aligns seamlessly with the study's overarching aim of exploration. This research wants to explore if primary flood insurance is desirable which Van Thiel (2014) states as exploratory research which focuses on real-life scenarios and concepts.

3.3 Research methods

In this research, qualitative data collection techniques were used as described by Van Thiel (2014) and Harrison et al. (2017) who advocate the use of interviews within qualitative case studies, especially when these studies are in the constructivist paradigm. With this recommendation expert interviews were organized with individuals specializing in flood insurance, as well as those that have expertise in flood risk and the governance of flood management.

Before identifying suitable interviewees, desk research was undertaken. The goal was to see which stakeholders typically play a role in flood risk management and flood insurance and who could help in seeing patterns in the research. This preliminary investigation helped to see the potential respondents. Additionally, during the interview process, current participants often suggested other potential respondents and individuals who were in the domains of flood risk management and insurance. Another method which is called snowballing was used as well. Snowball sampling is utilized when individuals with the desired characteristics are challenging to locate. This study characterizes snowball sampling as a deliberate approach to gathering data in qualitative investigations (Naderifar et al., 2017). As a result of these combined efforts, a total of 8 respondents were interviewed. These 8 respondents all had different backgrounds which led to the total coverage of the field on the subject. In Appendix 1 the respondents are shown and their function/ institution. The respondents can be put into 3 categories: insurance experts, policy experts, and researchers. Some of the respondents have a bit of overlap but in the insurance expert category Lars de Ruig (Royal Haskoning), Timo Brinkman (Verbond van Verzekeraars), and Rogier de Jong (SwissRe) are represented. Policy experts are Bas Kolen (HKV), Jeroen Doornekamp (Rijkswaterstaat) and Ron Franken (PBL). Researchers on this subject are Maurice Doll (DNB) and Max Tesselaar (VU). All respondents have researched this topic so the overlap between them is the general knowledge they represent on the subject.

Expert interviews in a semi-structured interview setting are the best option as this is abductive research (Thiel, 2014). The combination of literature review and expert interviews will give good results for this research. The literature review helped to build the foundation of the research and see where the gaps in knowledge were. It helped in framing the expert interviews and offering background for a good interview dialogue.

For the sake of a good analysis, each interview was recorded. The design of these interviews was semi-structured, built around a pre-established interview guide. The interview guide can be seen in Appendix 2. Such a format, as noted by Van Thiel (2014) and Farthing (2016), aligns well with the objectives of exploratory research. Bryman (2012) expands on this, highlighting that semi-structured interviews offer a balance between structure and flexibility. The interviewer has a predetermined set of questions or topics to navigate, but the format also permits respondents to share additional insights, enriching the data collection process. The interviewer, therefore, can glean unexpected but valuable insights that might not have been anticipated at the outset. In this research, it became clear that this was the best method because the experts knew a lot more than could be asked. Choosing a

semi-structured approach allowed them to expand on these questions and start more of a conversation rather than an integration.

For this research the interview guide was used for every interview but with a different approach. Questions for the flood insurance experts looked more into insurance-specific subjects. While those experts in flood risk management zoomed in on their expertise. This ensured comprehensive data gathering, addressing the research. Yet, the semi-structured nature of these interviews meant that there was room for spontaneity, enabling the inclusion of unique questions that emerged organically during the interviews, as highlighted by Van Thiel (2014).

3.4 Data collection

Literature research involves a careful review of existing literature relevant to your topic. This includes academic articles, books, reports, and other authoritative sources that provide context, theories, and findings related to your research (Thiel, 2014).

Steps in literature research:

- **Identify Relevant Literature:** Use academic databases to find literature related to each concept of your conceptual model. Look for recent studies to ensure your research is relevant.
- **Read and Take Notes:** As you read, take notes of the key arguments, methods, and findings from each source. Look for areas of agreement or disagreement between sources.
- **Analyze Literature:** Identify themes or patterns across the literature. Look for gaps in the existing research that your study might fill.
- **Write the Review:** Present your analysis of the literature in a coherent way. Discuss the main findings, debates, and gaps in the literature. Explain how your research fits into this landscape.

(Snyder, 2019).

Used in an abductive way the findings of earlier studies can create a pattern (Thiel, 2014) that can be further investigated with qualitative research.

The second phase will involve qualitative research, specifically interviews, building on the extensive preliminary research already conducted on the topic. Out of the eight interviews conducted, one recording was unfortunately lost due to technical issues, and another participant chose to remain anonymous, excluding their quotes from the research. Each interview followed a pre-defined guide, ensuring consistent and replicable conversations. Engaged with leading figures in the water management and insurance sectors, lending greater significance to the interview insights.

3.5 Data analysis

The methods of data analysis used depend on the data collection (Harrison et al., 2017). In this research the first step is to analyze the literature and find patterns in the literature. With this knowledge the interviews can be conducted and analyzed. This research is focused on literature analysis to order the concepts policy development regarding flood risk management and flood insurance (Thiel, 2014). Develop a coding scheme: A coding scheme is a set of categories that are used to analyze the data. The categories should be relevant to the research question and cover all the key themes and perspectives related to flood insurance. Then analyze the data to identify patterns and trends in the language used to describe flood insurance (Thiel, 2014). To analyze the data collected in this research, various methods were implemented. Recording the conducted interviews enabled these interviews to first be transcribed for analysis purposes. According to Van Thiel (2014), a transcript provides the researcher with the most accurate and full report of the interview. After

transcription, these transcripts were ordered systematically for each case within Atlas.ti, a program to code and file the data collected (Van Thiel, 2014). The coding of these transcripts was done as suggested by Linneberg & Korsgaard (2019) who suggest first beginning with descriptive coding. This entails coding each paragraph of a transcript according to the main theme central to that paragraph. After open coding, axial coding was applied, which means assigning general categories to the codes identified in the open coding process. Then, selective coding was implemented, to identify and sort relationships between codes. This process offered the option to compare data systematically and to identify similarities and differences between them (Van Thiel, 2014; Mills et al., 2012). Fitting to the constructivist approach in this study, coding also offered the possibility to add notes and memos describing their subjective interpretations of interview outputs (Harrison et al., 2017). Not only were codes deducted and assigned through analyzing the transcripts. Abductive coding with pre-defined codes was applied in Atlas.ti as well.

The patterns can be used to steer the interviews in the right direction. The interviews will be done in an open setting and give room for discussion. The interviews will be recorded and coded to see whether another pattern appears, and conclusions can be made (Thiel, 2014).

3.6 Reliability and validity

Validity refers to the credibility and generalizability of research. Internal validity relates to the credibility of research, while external validity concerns the generalizability of findings (Thiel, 2014). Generalizability is enhanced by relevant cases. With the set of respondents used there is a certain generalizability because the experts that were interviewed have their expertise and opinions which they did a lot of research on. Together with the literature review this creates a good generalizability. The respondents that were interviewed represented the most knowledge possible on this subject in a brought spectrum of insurance policy and risk management. It is important to explain that the results are from the experience and perceptions of the experts that were interviewed. They did so in their own experience and the results can't be generalized for every individual, but they offer valuable insights into the desirability of flood insurance within the specific context of the Netherlands.

Reliability pertains to consistency in data collection, and internal reliability is achieved when different researchers reach the same conclusions. Procedures such as using an interview guide can increase reliability while maintaining openness is crucial for qualitative research (Thiel, 2014). To ensure the reliability of qualitative expert interviews, it is important to have a clear and consistent coding system that is applied consistently across all the materials being analyzed. Additionally, it is important to ensure that the coding system is aligned with the research question and objectives to ensure that the analysis is relevant and meaningful. To ensure the reliability of interviews, it is important to have a standardized interview protocol that is followed consistently across all participants. Additionally, it is important to use open questions that allow participants to provide good responses, rather than leading or closed questions that may lead to biased responses (Thiel, 2014).

4. Results

This chapter provides a comprehensive description of the findings from this research. The findings of the expert interviews are used as a key component of the qualitative research methodology in studying the desirability of flood insurance in the Netherlands. Following the framework of Snyder's that was used earlier for qualitative analysis in the form of a literature review, the data were examined to identify themes and patterns that emerged from conversations with experts.

The chapter is structured so that it is clear and logical what came forth out of the interviews. Each section will be around a specific topic that came out of the key concepts. To help with the validity and reliability of the results, direct quotes from the interviewees are used extensively to underpin the findings and give a more in-depth approach to the findings.

The results of this chapter form the basis for the conclusion and discussion in Chapters 5 & 6, where the key themes will be combined with the existing literature on the subject. Ultimately, these results will lead to the complicated discussion surrounding the desirability of flood insurance in the Netherlands, thereby contributing to the broader academic conversation on this topic.

This chapter will give an overview of the findings from the interviews that have been conducted. Eight experts have been interviewed with one interview not in the data set due to technical difficulties. The experts were from different fields with experience in flood insurance/ flood management. The respondents who participated in the interviews are in an overview in Appendix 1.

The key concepts form the basis of the chapter. The results of the expert interviews are organized under the concepts discussed in the theoretical framework and conceptual framework. Six primary themes related to the desirability of flood insurance in the Netherlands: Climate Change, Perception, Role of Government, Legal and Regulatory, and Risk Analysis and Insurance Design. Each contributes to a comprehensive understanding of the research topics that were discussed in the interviews. The research question and sub-questions will be addressed.

4.1.1 Risk Analysis

The interviews touched on risk analysis, both in terms of how insurers assess risk and what the risks are. How risk analysis can influence the discourse on responsibilities in flood management, and its role in creating a feasible insurance system. This analysis will also guide us toward answering our core research question: "What are the implications of implementing comprehensive flood insurance in the Netherlands, and is it a desirable strategy in the view of key stakeholders?" It is necessary to know the risk that is posing the Dutch delta and what implications it may have on further risk management and possible flood insurance.

This key concept will dive deeper into the risk, resilience, and response in the field of flood management in the Netherlands. It will also help in answering the sub-question: ''How will flood insurance influence the way the Dutch government deals with flood risk in the future?''
What became apparent from the interviews was a consensus that when a primary defense floods the consequences would be devastating.
Rogier de Jong (SwissRe):

"It's not really a natural system anymore. It is very difficult to model. When you almost move towards man-made natural disasters, then natural disasters, because you assume that the water is always at a level where you have floods, and that's what you build upon."

Bas Kolen (HKV):

"From a multi-layer safety perspective, this is the best strategy for us. There is a lot of value everywhere here, so it's interesting to protect that. If you have to protect a farm, you look at what you can do to the farm. But if you have to protect the city of Amsterdam, you'd rather build a dike around it than have to elevate the whole city."

Lars de Ruig (Royal Haskoning):

"Setting up a good system for the Netherlands is specific because we are dealing with a unique situation. The chance of flooding within the primary system is extremely small, but if it happens, we are faced with a very large problem."

"But of course, the Netherlands is still a bit of Europe's drainage basin. All those rivers end up with us. This already exposes us to a huge risk, plus we have the entire coast, and we are very low and sinking, so this makes our risks quite substantial."

Jeroen Doornekamp (Rijkswaterstaat):

"These measures cost billions, and imagine, for example, the Randstad area being flooded - then the whole of the Netherlands is disrupted, right? Your economy comes to a standstill for the most part. That's going to have such a huge impact that you are dependent on the IMF and big international agreements to get things back on track, and many assets that you have lost."

What came out of the interviews as well was that the risk itself wouldn't necessarily increase because of climate change because the norms are adjusted to the larger chance of flooding in the future. This means that the government is already building better defenses to cope with additional high-water levels. So, the government will not stop investing in flood defense even with the introduction of flood insurance. So, flood risk management in the Netherlands cannot stop investing in the primary flood defense.

According to Bas Kolen (HKV), the risk remains the same in the coming decades:

"Floods may become slightly larger, but most of the damage is already there. Therefore, climate change will not lead to a different consideration in this regard. And we maintain our water barriers, so the flood risk remains the same. The risk remains a function of probability times consequence."

He adds:

"The risk increases slightly because the consequences can rise slightly, but it's not dramatic. We can now look at the differences between a scenario that occurs, for example, once in 1,000 years and once in 10,000 years. There's a factor of 10 difference in probability, and the consequences increase by less than a factor of two."

This is then backed up by Lars de Ruig (Royal Haskoning) who states that:

''But in principle. Let those standards increase so they can sort of compensate for that and thus come out the same at the bottom line.''

"Of course, the high-water protection program and such things are all running until 2050, and after that we want to choose such a strategy, I think that's the idea now. And precisely if you start looking at those maps and comparing 2022 with 2050, you actually see that all those standards or your risk are actually going down, because all those standards are going up."

Ron Franken (PBL): said the same thing:

"If it turns out that the standards are not sufficient, then they are adjusted."

The interviews explore risk analysis in relation to flood insurance in the Netherlands, addressing how such an insurance system might affect future risk management. The interviewed experts agree that despite the low probability, the impact of a major flood would be catastrophic due to the Netherlands' unique geographic situation. Despite this, they also assert that the risk is not increasing due to climate change as flood defenses are being improved in anticipation of higher water levels. The adoption of flood insurance does not mean the government will cease investment in flood defenses. Experts also noted that the risk remains of probability times impact as described earlier in Chapter 4, and while impacts might slightly increase, it isn't dramatic. The ultimate goal is to balance the risk by enhancing standards and implementing an effective strategy by 2050.

4.1.2 Climate Change

The key concept of climate change is related to the sub-question of ''How will flood insurance influence the way the Dutch government deals with flood risk in the future?''. So, the results came forth out of the interviews conducted with experts in flood risk management and insurance policy.

Effect of climate change on flood risk management

What is apparent is that there isn't a broad consensus on whether or not there will be an effect on flood risk management due to climate change. What is apparent is that while everyone thinks climate change is going to affect flood risk management, some say the risk won't increase because the government will adapt and won't let the risk increase. According to Rogier de Jong (SwissRe):

"We know it's coming, and you can say, yes, climate change. Everyone's shouting it. It's an empty cry, but we adapt to it."

In which he states that climate change is going to have an effect, but this won't necessarily mean that the risk increases because of adaptation to it. He later states that the most difficult part is the uncertainty in discharges during winter and summer.

This was backed up by Bas Kolen (HKV lijn in water) who states that:

"Climate change affects the sentiment with which we view these situations. But when I look at the risks, the change in risks is limited."

This is because the Dutch government keeps maintaining the primary water defenses and heightens the dikes so the probability of a flood will not increase. Ron Franken (PBL) says:

"If it turns out that the standards are not sufficient, then they will be adjusted."

Also, Lars de Ruig (Royal Haskoning) thinks that the risk will not increase due to protection measures:

"It's true that due to climate change, norms are going to change. The chance of a certain storm just becomes higher and therefore your risk naturally increases. The only thing is that the process is relatively slow, and we are actively investing in our entire dike system."

However, Lars de Ruig (Royal Haskoning) makes an additional comment by saying there always will be weak points in the system. And when the discharge in the rivers increases so does the risk of the weak spots.

This shows that climate change will not influence the probability of a flood. But only if the current flood defenses are kept up to date to manage the higher river discharges and sea level rise. In the end, this means that climate change does have an effect on flood risk management but not on the probability of a flood happening.

4.1.3 Legal and Regulatory

A clear understanding of the legal and regulatory structures governing flood management and insurance is essential for the design of an insurance system. Especially when responsibilities and cooperation are needed. The interviewees are part of or know the legal and regulatory system that is in place. A better understanding of the legal and regulatory will help answer the sub-question: ''What are the possible insurance designs for the Netherlands?'' and the main research question What are the implications of implementing comprehensive flood insurance in the Netherlands, and is it a desirable strategy in the views of key stakeholders? To answer these questions, the legal and regulatory context in the Netherlands may have to be changed and stakeholders will have to bear the implications of the introduction of flood insurance in the Netherlands.

The results of the following question will be discussed:

''How can the introduction of flood insurance affect various stakeholders, including individuals, businesses, and the government?''

According to Jeroen Doornekamp (Rijkswaterstaat), the effect of introducing flood insurance in the Netherlands would cause a lot of legal issues whenever there is a point when flooding occurs:

> "If you work this through, you have those contracts where you have those public-private partnerships. Well, you can also start thinking about that for those flood risks. It's a much more complex interplay of it happening. How the government reacts to that, in my opinion, if the moment is there, then you will just end up in trouble. Then you get a lot of legal issues."

Regulatory obstacles with regard to compensation after flooding are also addressed by Rogier de Jong (SwissRe):

> "The Netherlands is a delta that is entirely built by people, so you're almost talking about an urban flooding situation, and that's just so much more difficult to build good models for."

Jeroen Doornekamp (Rijkswaterstaat) adds to this:

> "In a collaboration with insurers, of course, you have to provide good guarantees in advance about who does what, and I think that because those situations can be so different and the political reaction to it as well, you cannot provide those guarantees."

This shows that it is difficult with certain laws and regulatory obstacles with regard to flood insurance in the Netherlands. Jeroen Doornekamp (Rijkswaterstaat) states that these issues arise when the flood insurance system is a public-private partnership/ collaboration. This has to do with the design of the insurance system, which will be discussed further in this chapter. For the legal and regulatory framework, a public-private partnership between the government and private parties will cause a change in the system of waterboards and governmental institutions. Now there are no private parties involved in the process, which will change when insurance companies help with flood insurance. This is stated by Lars de Ruig (Royal Haskoning):

> "There are now plans to devise a system for the primary system. This would probably be a combination of a public-private partnership. This means that the government and the insurance industry would work together so that they can join forces."

Timo Brinkman (Verbond van Verzekeraars) goes further into this by stating that:

"It's important to realize that these types of processes take time and that we need to have thorough conversations with the government and other stakeholders before we can arrive at a final solution."

The introduction of comprehensive flood insurance in the Netherlands raises legal and regulatory challenges. The fact that the compensation system in the Netherlands is so focused on the WTS and not privately accessible makes it more difficult to introduce this type of flood insurance. Who would be responsible, and would the regulatory and recovery tasks as described in Figure 4 change? Interviews with key stakeholders show the complexity of these issues, particularly when considering the introduction of public-private partnerships for flood management. Legal questions arise concerning responsibilities and compensations during flooding events.

4.1.4 Role of Government

The role of the government in managing flood risks and facilitating flood insurance was another important concept. In terms of flood insurance, the Netherlands have not widely relied on individual flood insurance policies. This is largely because the risk of catastrophic flooding is so large and widespread due to a significant part of the country being below sea level that it would be difficult for a private insurer to cover it. Instead, the government has assumed the primary responsibility for flood risk, investing heavily in infrastructure to prevent floods and in programs to evacuate and provide aid if a flood does occur.

Role of the government in flood insurance

Among all interviewees, there was a broad consensus that the government should always keep the flood defense to a high standard. Updating and improving all parts of the primary system and secondary system. This is important to keep the probability of a flood occurring low, especially with climate change and changing weather patterns. Bas Kolen (HKV) thinks the strategy of the Dutch government to keep focus on flood defense is the best option:

"But if you have to protect the city of Amsterdam, you will rather build a dike around it than raise the whole city. That's the path we have long taken in the Netherlands. Some call it a lock-in, but I think it's a sensible strategy."

Regarding flood insurance Lars de Ruig (Royal Haskoning) thinks that flood prevention should still be a priority with an addition:

"On the one hand, we must continue to build our adaptation measures in the Netherlands. The danger is that if you implement an insurance system, especially from the government's side. Okay, we have our backup now, so to speak. Such plans are no longer needed. Well, we should not do that at all, because it should complement your adaptation, not replace it."

So, flood prevention should still be the main goal of the Dutch government, which is emphasized by Jeroen Doornekamp (Rijkswaterstaat):

"The Netherlands is truly a Waterland. It's in our culture, that is the dikes. That's also in our culture. I can't imagine a government delegating its primary task, which is ensuring safety for citizens, to the market."

With regard to the role of the government in flood insurance. From literature and interviews, it is clear that the role of the government will always be there. The three most viable options for the role of the government are the following:

- State as reinsurer, this was discussed in Chapter 2 where the state would act as a reinsurer instead of a private company that wants a larger profit. The government would take on the role of a reinsurer, stepping in to cover losses that exceed a certain threshold that private insurers are unable to handle. This would make it more feasible for private insurers to offer flood insurance, as they would be protected from the catastrophic losses that could result from a major flood. But Bas Kolen (HKV) has a different view on this system:

  "And you also have to look at who the reinsurer is. Because if it's still the state, then the state is essentially bearing all the risk instead of the insurance companies. And then of course it's very nice to be the insurer, right? Yes, your risks are covered, so you can just sell unlimited premiums. That's a golden business, right?"

  This shows that while it would become easier for insurance companies to offer insurance, the cost of bearing all the risk would still lie with the government. So, in the end, the government still has to pay for the damage when the costs are too high.
- State as Insurer, in this setup, the government could run its own insurance program, with private companies serving as intermediaries, managing the policies and handling claims. This would give the government more control over pricing and coverage decisions while leveraging the operational expertise and customer service capabilities of private insurance companies. This model could help ensure broad access to flood insurance since the government could potentially offer coverage at rates that private insurers would find unprofitable. However, it would also represent a major shift in the role of government and would likely require significant resources to implement and manage. This is explained by Timo Brinkman (Verbond van verzekeraars):

  "One of the options is for the government to handle only the damage claims, so people have a central point to report their damage. In this way, they can be helped quickly, and the settlement will be reconciled with the government later."

  This way the compensation is quicker and gives the citizens certainty about their compensation. This was discussed in chapter 2 as well. Bas Kolen (HKV) agrees with Timo Brinkman (Verbond van verzekeraars) in regards to insurance companies being faster in compensation than the government:

  "For example, you could consider insurers as an executive organization. After all, insurers can pay out very quickly."

  This would be one of the benefits, the role of the government could be the compensation payment but not the management of it. This causes the compensation to be paid quicker and gets people back on their feet faster as was explained in chapter 2.

- Fully privatized, the Dutch government would not directly provide or backstop flood insurance. Instead, private insurance companies would manage all aspects of flood insurance, from setting premiums and determining coverage to managing claims. This is the preference of Timo Brinkman (Verbond van verzekeraars) who says:

  "Another option is to explore fully private solutions, where we form a pool with other insurers. This could, for example, also prevent consequential damage and warn people about risks in time. That is my preference."

  Here is a divide between the interviewees because most of the interviewees see an insurance scheme only in the form where a public-private partnership is set up and government and private parties work together. Lars de Ruig (Royal Haskoning) for instance reckons that:

  "This would probably be a combination of a public-private partnership. This means that the government and the insurance industry would work together so that they can join forces."

And according to Bas Kolen (HKV):

"There will always be one role for the government."

This is partly because when a flood happens it could lead to damage too great for insurance companies to bear. Which is something that most interviewees agree on.

In conclusion, in the Netherlands, due to its unique geographical challenges, there's a shared belief that the government should play a central role in flood risk management and insurance. While there's room for private sector involvement, especially in expediting compensation, the primary responsibility, particularly for catastrophic events, remains a government concern. The Dutch model advocates for a blend of public and private efforts to ensure citizen safety and resilience against future floods.

4.1.5 Perception & acceptance

As said earlier in chapter 2.1 it's important to check the public perception and acceptance of an insurance scheme and flood risk management in the Netherlands. Will people see it as necessary and beneficial or will they see it as another tax or cost and not find it necessary. And how do they look at their own risk? This will answer the sub-question: How do attitudes and perceptions towards flood risk and insurance impact its desirability and feasibility as an alternative in the Netherlands?

Perception of flood risk

According to Mol et al.,(2020), citizens know that there is a threat but underestimate it as was discussed in Chapter 2. This is apparent from the interviews as well as there is a lack of risk perception. The Dutch citizens feel very safe because of the food defense from the government. This is backed up by Jeroen Doornekamp (Rijkswaterstaat) who said:

"The risk perception has always been low. But for a citizen, it's very natural that the government ensures safety and that everything is just okay."

So, citizens feel safe because of the prevention methods and prevention strategies discussed earlier in Chapter 2. Also, Lars de Ruig thinks this way:

"The awareness in the Netherlands that we can flood is so small - everyone trusts in the dikes and the government."

The multi-layered flood risk approach adopted by the Dutch government appears to have achieved significant success. It is evidenced by the overall sentiment of safety expressed by the Dutch citizens regarding flood risks. This result is an example of the effectiveness of the comprehensive flood risk management strategies implemented in the Netherlands. In conclusion, the multi-layered flood risk approach of the Dutch government has successfully created a culture of safety regarding flood risks among its citizens.

Perception of flood insurance

From the literature, it became clear that adverse selection and solidarity would become a problem for flood insurance in the Netherlands. The research examined the issues of adverse selection and solidarity in the context of flood insurance in the Netherlands, with findings suggesting potential challenges. Both the literature review and primary data gathered through interviews reinforced the hypothesis. The interviews that were conducted further confirmed this. Rogier de Jong (SwissRe) expressed his concerns:

"If only people who live near water take such insurance, then you get that adverse selection, and then your diversification suffers as a result."

Adverse selection causes people with the highest risk to take insurance and the people with the lowest won't. This will eventually lead to higher premiums. Which is backed up by Timo Brinkman (Verbond van verzekeraars) who states:

"And then there is the problem of 'adverse selection'. People who live in higher areas do not insure themselves, while those living in lower areas do want to do so. People living near the dike may want to insure themselves, but the premiums would then become enormously high."

The principle of solidarity suggests that the burden of risk should be shared among all policyholders as was discussed in chapter 2. However, this principle can be undermined if low-risk citizens feel they are unfairly paying for high-risk citizens. The interviewees expressed this concern. Timo Brinkman (Verbond van verzekeraars) asks the following:

"We also have to think about solidarity. There are questions such as: Is it fair that someone who has specifically moved to the Veluwe because of the low risk of flooding pays the same premium as someone who wants to live by the dike?"

However according to the literature solidarity in the Dutch society has always been there because of the way the tax for water security is set up (Kaufmann et al., 2018) which was discussed in chapter 2. Everybody pays the same amount for flood safety but not everyone has the same flood risk. This is formulated by Bas Kolen (HKV):

"A large part is paid for by everyone and a small part by the area itself. The water board does not differentiate based on where people live. People who live on high ground also contribute. There's a principle of solidarity involved. We spend something like half a billion on water safety in the Netherlands, so it costs all of us."

This shows that there is already a large solidarity between Dutch citizens. The problem, however, is just that everyone already pays taxes for the defense against water. Lars the Ruig (Royal Haskoning) questions if citizens who already pay for flood defense will pay for additional flood insurance:

"So that is one of the things that needs to be critically examined. I think public opinion will become an issue. Of course, we are now paying water board tax. Suppose we also have to pay a flood premium now. What is the difference, or why is this suddenly necessary?"

This shows that the willingness to pay for flood insurance may be low. But there is a second reason why the Dutch willingness to pay is low, which is the WTS as discussed earlier in chapter 2. The WTS is called in by the Dutch government whenever a catastrophe is deemed as a national disaster. The government decides if the WTS should be called upon. According to the interviewees, this causes the Dutch citizens to believe the WTS will be called upon every time a flood happens. This feeling is not only in for the primary system but also the secondary system. As stated by Lars de Ruig (Royal Haskoning):

"The business market was lagging, and as a result, at some point, the government stepped in. Everyone started complaining, 'We are not insured, we have damage.' Then they also said 'well, you know what? We are now invoking the WTS, the Compensation for Damage Act. We will compensate you, but this is the last time we do that.' Well, it's always the question of whether it is the last time."

Because it is possible to insure against flooding in the Netherlands for flooding of the secondary system the WTS should not have been used at all because according to Timo Brinkman (Verbond van verzekeraars) it can only be used if:

"If it's not insurable, not recoverable, and not avoidable. Well, look, it was insurable."

So, the government uses the WTS even when it does not apply to the situation. This causes the public to think that the government will always step in and they don't need insurance. This is backed up by Rogier de Jong (SwissRe) who states that the public is not stimulated to take on insurance because of the WTS:

"If as a government you show that yes, if something happens, we will step in, then why would you take out insurance?"

This was discussed earlier in chapter 2; the Dutch citizens believe the government will compensate no matter what. This shows the significant challenges that confront the implementation of flood insurance in the Netherlands, primarily from issues of adverse selection and solidarity. Adverse selection leads to imbalances in risk distribution, with only high-risk individuals opting for insurance, causing an increase in premium costs. Such a scenario could compromise the principle of solidarity, which advocates for equitable risk sharing among all policyholders, regardless of their location or individual risk factors. While solidarity is a common concept in Dutch society, especially within the context of water tax, its extension to flood insurance appears complex due to existing flood defense.

Moreover, the role of the government and the deployment of the WTS present additional complexity. The perceived belief among Dutch citizens that the government will always use the WTS in the event of a flood leads to no motivation for them to take out insurance. Notably, this is despite the fact that the WTS is intended for circumstances that are uninsurable, non-recoverable, and unavoidable, and thus, should not technically be applicable to flood situations given the availability of insurance. For primary flood defense, this is different because it is not possible to get insurance but when insurance is implemented this would create the same effect.

4.1.6 Insurance Design

The concept of insurance design emerged as an important theme that combines all previous concepts. The design of an insurance system has parts of the other concepts in it to answer the main research question.

Starting with Rogier de Jong's statements, he asserts that flooding is insurable in Europe, including the Netherlands, but he also highlights some of the challenges. He states:

"In principle, we say that flooding is insurable in Europe. We absolutely believe in this, and the Netherlands is no exception."

This is backed up by Bas Kolen who states:

"Technically, financially, and administratively, it is all possible. It's mostly a matter of willingness."

Bas and Rogier both think primary flood insurance is possible in the Netherlands, but both see challenges. Bas Kolen thinks the government always will need to play a role in flood insurance where the government still acts as the reinsurer, meaning they would backstop the financial risk. He sees the role of insurance companies as implementing agencies that could potentially assess damage and make payments on behalf of the government, essentially adding an additional link without really changing the fundamental risk structure. He says:

"In my opinion, the state is still the reinsurer. Essentially, an additional link is introduced, and nothing changes for the government. The risk premium might even increase because they are taking on an obligation. Another role of the insurers could be that they assess the damage and make the payments instead of RVO on behalf of the government."

And further backs this up by saying:

"Perhaps the government is even the insurer, but the insurance companies are more the implementing agency."

Timo Brinkman has a few insurance designs which in his eyes would be possible.
A design could be that the insurance companies would act as a middleman between the insured and the government that offers the insurance this further backs up the statements of Bas Kolen as Timo Brinkman says:

"One of the options is to handle only the damage settlement on behalf of the government so that people have a central place to report their damage. This way, they can be helped quickly, and the settlement is reconciled with the government at a later stage."

Rogier de Jong also thinks a hybrid solution is feasible by saying:

"That's something that needs to be more widely supported, that's why I don't really believe in stand-alone voluntary flood insurance, those just become very expensive. But I think other solutions, like some hybrid solutions in between, are probably quite feasible."

Lars the Ruig thinks that insurance is possible but is not sure about the design. Lars de Ruig looks at the balance between risk management and solidarity in flood insurance systems. He highlights the pitfalls of both the French and American models, suggesting a more individual risk-based model could provide incentives for individuals to undertake preventative measures, although this presents its challenges. He also proposes the use of "climate labels" to better inform homeowners about their flood risk and potentially encourage preventative action.

He gives the example of a solidarity system:

"There are different ways to set up flood insurance. France is a typical example of a solidarity system. This means that it doesn't matter where you live in France, everyone pays the same premium. This premium is spread across the entire country, keeping the premium low and ensuring everyone is insured."

He then discusses that there are downsides to this system because people are not stimulated to make use of adaptation measures:

"Of course, that's a nice idea. The only downside is that it does not provide a stimulus for adaptation measures. If you have a cheap premium and you know you will get paid out if you flood, there is little motivation to buy sandbags to stop the water, for example. You just let it happen and get the payout. This is a major downside of the solidarity system. Another thing this system encourages is building in high-risk areas without regret because you know it's covered anyway. Of course, that's something you want to prevent."

Lars de Ruig then discusses a fully risk-based system where the individual can reduce their own risk and get a discount:

"You can transition to a fully risk-based system. As an individual, you then bear your own risk. The advantage of this is that if you reduce your risk and the system allows it, you can get a discount that reflects your actual risk. The idea is nice, but its implementation is always a bit more difficult. For example, it's questionable how much you reduce your risk when you take certain measures."

According to Lars de Ruig first evidence from the floods in Limburg suggests that some form of adaptation still does work:

"De Vrije Universiteit has conducted empirical research into the situation in Limburg, looking at people who had taken adaptation measures. This research produced significant results: the people who had taken measures had significantly less damage. So this can work very well for some areas."

So, if it does work Lars thinks the challenge would be to motivate people to take these measures. He thinks a label on flood risk with every house same as an energy label would help:

"The tricky part, of course, is how you're going to motivate people to take these measures. I recently bought a house myself and I noticed that the energy labels, which were introduced a few years ago, really have helped. Maybe we should switch to a system with climate labels, so you know what the flood risk of a house is."

According to Timo Brinkman insurance companies can't handle the flood risk alone. There is a lack of awareness among households about the risk and whether they are insured or not. Timo Brinkman states that reinsuring would cost a lot of money and it would be better to reinsure in cooperation with the government:

"An insurer cannot handle this alone. There is a lack of awareness many people mistakenly think they are already insured. And then there's the issue of 'adverse selection'. People who live in higher areas do not insure themselves, while those who live in lower areas want to do so. People who live close to the dyke may very much want to insure themselves, but the premiums would then become enormously high."

"We can reinsure ourselves, but given the enormous amounts involved, it is better to collaborate, for example with the government."

Timo Brinkman sees solidarity as a challenge, and it would be difficult to find a solution to that as he states:

"We also have to think about solidarity. There are questions such as: Is it fair that someone who specifically moved to the Veluwe because of the low risk of flooding, pays the same premium as someone who wants to live by the dike?"

Another option could be the fully private option where all insurance companies form a pool where they back each other. He states that:

"Another option is to explore fully private solutions, where we form a pool with other insurers. This could, for instance, prevent consequential damage and timely warn people about risks."

This would be also possible with a cap at, for example, 5 billion and the government would step back in at that point of losses:

"There is a private reinsurers solution, but then you just cap it at a certain amount, for example, up to 5 billion, and then the government has to step in again."

According to Timo Brinkman, the challenge is the fact that reinsurance is expensive at the moment:

"The price of reinsurance is very high right now, so that doesn't help, but you could, for example, cap it. But if you were to redistribute a few billion now at market price, well, you would be out €200 million in premium every year without government participation. But on the other hand, you have 8 million households here, so you end up at €25 per year."

The insurance companies could also cap the amount of damages the insurers could insure. For instance, your TV and couch could be insured but not your luxury pool Timo Brinkman says:

"So yes, you can play around with it and if the government participates for a different percentage. Well, if you say we are going to cap the contents, so that you get a maximum of €15,000, for example, then you can get basic things reimbursed, but not your luxury kitchen and your swimming pool."

In summary, the discussion here is on how to best implement flood insurance in places like the Netherlands, which are particularly susceptible to such risks. The goal is to find a balance that allows for reasonable premiums, fair risk distribution, and effective claim handling, all while not overburdening the government or the insurers. The interviewees agree that it is technically possible to have flood insurance for the flooding of primary defenses however, see challenges that have to do with affordability and the willingness of stakeholders to do so.

5. Conclusion and recommendations

The Netherlands' history, together with its battle against water, provides a good beginning for the exploration of the implications of introducing comprehensive flood insurance. Throughout the centuries, the Netherlands has shown that it is a nation that can live with water and fight back the threat with sophisticated defense mechanisms as a shield. Yet, as times evolve and challenges rise and the Netherlands looks at other countries, there is the question: "Is introducing comprehensive flood insurance in the Netherlands a desirable strategy?"

Addressing the main research question: Despite geographical vulnerabilities that cause the country to be susceptible to floods, the Dutch have largely been sheltered from the financial consequences of such events thanks to their trust in the government's commitment to compensation. This very trust, however, complicates the road of integrating flood insurance into society.

When we look at the sub-questions:

1. **Governmental Shift in Flood Risk Management:** The integration of flood insurance might necessitate a new look at the way the Dutch government approaches flood risk. This shift could range from a different focus on infrastructure investments to more proactive community engagement in flood preparedness. The Dutch government could focus its investment more on the impact of a flood rather than the probability. Traditionally, the Netherlands has invested heavily in preventive measures like dikes, levees, and storm surge barriers to reduce the probability of flooding. This approach has been largely effective but also costly. The advantage is that it protects the entire population, including those who might not be able to afford flood insurance.

   If flood insurance were to become widespread in the Netherlands, it's theoretically possible for the government to shift its focus to mitigating the impact of floods rather than their likelihood. In such a scenario, insurance could cover the financial losses.

   Also, the government's view on flood insurance and private companies could be more seen as an addition rather than a private company that wants to make a profit. Cooperation with private parties could save time and money in the process and even add to the mitigation and

2. **Attitudes and Perceptions:** A dominant belief within Dutch society, rooted in history, is that flood-related damages will be compensated by the government. Introducing flood insurance would require a shift in these perceptions. Challenging beliefs and letting citizens re-evaluate the personal responsibilities associated with flood risks and mitigate the impacts flooding could have. This could help the government in introducing flood insurance and mitigation measures for citizens to take themselves.

3. **Insurance Design Possibilities:** A variety of models exists, from solidarity-based systems which would be similar to the way Dutch people put up a defense against the water now, to the more market-driven ones. The challenge is in sculpting a model that resonates with societal values while ensuring economic viability. Solidarity is a key term, which was described in Chapter 4 and backed up by the respondents. If all households and companies participated the cost of insurance would go down due to the spreading of risk. Additionally, the influence of insurance companies on the behavior of citizens and companies would be greater. Mitigation measures and faster compensation can be very helpful for citizens. Which is also possible without private insurance. If the private companies, take over the compensation actions such as assessing the damage and actual post-flood damage settlement. The insurance company could still have a positive effect on flood risk

management but without the need for insurance premiums and compensation. Another possibility is a cap on total compensation in case of flooding. So, when insurance companies can provide insurance and a flood does happen the government would jump in at a certain threshold and help with the compensation from that point on. This doesn't seem viable for primary flood insurance because of the large impact it would have and the high costs of compensation. Similar to the cap on compensation would be to use the government as a reinsurer in case a flood would happen. So, the insurance companies would be responsible for the compensation and premiums but the government acts as a reinsurer. The benefits would be that the premiums would be lower because the government has room to take on more debt against lower prices than a private reinsurer. The desirability of these designs would be influenced by public perception and how they are managed and implemented. A contributing factor would be the cooperation between government and private parties which is emphasized by the respondents in this research.

4. **Pros and Cons of Introduction:** The benefits of flood insurance, such as enhanced personal security and potential financial relief for the government are against challenges like public resistance, legal barriers, and potential inequities.

   What has become apparent is that the Dutch way of looking at flood risk and flood risk management has always been prevention rather than compensation. For a good reason because the impact would be very high in the densely populated country. However, the lack of compensation and the following steps is a problem as has been shown in the recent flooding in Limburg. So, introducing flood insurance and private companies would help solve the problem of slow compensation and help with adequate compensation. This is because insurance companies have a better understanding of compensation and risk assessment than the government has. You could even argue that citizens could have a choice in their level of coverage because the insurance could be market-driven. Also, cooperation between the market and government would help with affordability.

   The cons would be the potentially high premiums in flood-prone areas, which could give higher social inequality by making insurance unaffordable for some citizens. The cost of the premiums can be calculated to some point but in practice could be more expensive. This issue of affordability could also contribute to underinsurance, as people may either avoid purchasing insurance due to the cost or not fully understand the extent of coverage needed, which would lead to financial vulnerability in case of flooding. Moreover, the presence of insurance coverage could create a moral hazard, encouraging people to take greater risks like building or investing in flood-prone areas, which in turn could lead to higher damages.

In essence, the underlying thread weaving through the research is balance. The balance between individual responsibility and governmental support, between market and public, and between proactive adaptation and preserving the defense strategies.

Recommendations

To navigate the landscape of flood insurance integration in the Netherlands, the following recommendations for the Dutch government, insurance companies, and stakeholders in the administrative process will be made:

1. **Public Awareness and Education:** Campaigns can bridge the perceptual gap between state responsibilities and personal flood insurance advantages. Also, the influence of flood mitigation on the impact of a flood could be educated. This is better with or without private flood insurance because it would decrease the impact either way.

2. **Public-Private Collaboration:** A harmonious partnership can help create a flood insurance model that seamlessly melds efficiency, effectiveness, and equity. The private sector brings risk management expertise and operational efficiency, while the public sector provides a safety net and ensures good coverage. This collaboration could lead to more accurate risk assessments and better policies. The government could subsidize premiums for low-income households and cap overall costs. This helps with social inequality and affordability issues. Meanwhile, insurance companies could provide individual risk mitigation and offer a speedy claim process. By combining the speed and specialization of the private sector an approach could create a more equitable, efficient, and sustainable flood insurance system. So, the stimulation of a good collaboration between public and private parties is key even without the introduction of primary flood insurance.

3. **Legal Clarity:** Before the introduction of flood insurance, legal clarity in introducing flood insurance in the Netherlands is essential for the roles, responsibilities, and liabilities of all parties involved. Clear regulations must outline what is covered, who is liable, and how disputes are resolved. This legal clarity ensures smoother implementation.

4. **Insurance Design Innovation:** To better design the insurance in detail drawing inspiration from both global best practices and Dutch societal perceptions can lead to an effective insurance model. This could be the follow-up research for policymakers and insurance companies. Studying other nations can provide enlightening insights, helping avoid potential pitfalls and capitalize on successes.

To conclude, the Netherlands stands at a crossroads. As it contemplates the integration of flood insurance which is logical looking at the potential impact flooding can have on the Netherlands. But the key here is the collaboration between public and private to ensure that when things do go to plan and according to the path that is chosen. It is clear that primary flood insurance in the Netherlands is possible but what is sure is the fact that government and insurance companies need each other for it to work. Not only that but the only way for an insurance scheme to work would be either the government would reinsure the insurance companies, or the government would be the insurer. The insurance companies would act as a party that handles the claims for the government to speed up the process which gives the citizens that are affected more financial security. In the end, there is too much value on a small piece of land that is vulnerable to flooding. That’s why all stakeholders need to work together for this to work.

6. Reflection

In any research journey the way from the beginning to the end is full of obstacles. Reflecting on the experience during this master's thesis, several hurdles and deviations from the initial planning were encountered. This chapter delves into these challenges, the limitations they posed, and the implications for the overall research.

Theoretical reflection

This research builds upon the theories that were discussed in Chapter 2. The result of this research shows that the Netherlands is a difficult country to implement primary flood insurance. What is different in this research from other research is that the design is never discussed in other research. What is very similar to other research is that the key for flood insurance to work is cooperation. The new gaps that were found in the literature were the lack of possible design models for flood insurance in the Netherlands and the actual design in detail. Furthermore, the implementation of these insurance schemes into a market has not yet been investigated.

Methodological reflection

A significant limitation of this study was the number of interviews used for data collection. Out of the eight initially planned, I was only able to use data from six because one interviewee didn't want to be quoted and another lost the recording which the interviewee made. This poses an obvious limitation in terms of the perspectives and richness of data. For a master's level research, relying on a smaller dataset may not provide the comprehensive insights that a more extensive set of interviews might have offered. However, it's crucial to note that while the quantity was not very high, the depth of insights derived from those six interviews remains valuable. Each interview provided unique and insightful perspectives that enriched the research, even if their number was smaller than originally intended. The experts that were interviewed were really valuable and had a great knowledge of the subject.

Another challenge was the sequencing of the theoretical framework's development in relation to the interviews. Some of the interviews were conducted before the theoretical framework was fully refined. This sequencing might have influenced the direction and depth of the questions posed during those initial interviews.

A well-defined theoretical framework provides guidance for research. It influences the questions to ask, the data to collect, and how to interpret that data. The conduction of some interviews before the theoretical framework was in place, there's a potential that certain perspectives may have been overlooked. This does not invalidate the data from these interviews but highlights a limitation in the insights.

The issues faced didn't make the research useless. They show that being flexible and ready to learn is key when researching. Every study has its flaws. By openly talking about them, we get a clearer picture of what the results really mean. The information from the six interviews was really helpful, even with the problems faced. Future researchers should take note of these issues to plan better, especially when setting up the main ideas for the study.

Personal reflection

The first noticeable challenge was not strictly adhering to the research timeline. As any researcher would time management is a skill, but due to the search for a good subject and interview respondents. The timeline was not met. The reasons for such deviations ranged from methodology

issues, scheduling conflicts with the interviewees, and personal challenges. While I made every effort to get back on track, these deviations did impact certain aspects of the research.

Looking back, this thesis research didn't go perfectly. But I learned a lot and grew from the experience. The challenges I faced, like changing the plan or setting up main ideas, taught me a lot about how to do research properly and the need to be flexible. Even with these bumps in the road, the information I found is a big help to the discussion about flood insurance in the Netherlands. It's a good starting point for future research in this area.

Further research

Further recommendation for future research would be to investigate the willingness of Dutch citizens in different parts of the Netherlands to get flood insurance. This could be valuable for insurance companies and the government in making policies and insurance designs. Also, to better design the insurance model a comparative study of other insurance designs in other countries would be a good option as well as the implementation phase which is lacking in the literature for now.

7. References

Abcouwer, M., Erasmus, L., & Phlippen, S. (2020). *ECONOMIC IMPACT ASSESSMENT OF FUTURE FLOODING IN THE NETHERLANDS*. ABN AMRO. https://assets.ctfassets.net/1u811bvgvthc/2esFD3ceYP32geq2fLtsbz/b9ffbd9e30d6fbaddc7589ee7a4fa3b7/201207-Economic-impact-assessment-of-future-flooding-in-the-Netherlands-1.pdf

Aerts, J. C. J. H., & Botzen, W. J. W. (2011). Climate change impacts on pricing long-term flood insurance: A comprehensive study for the Netherlands. *Global Environmental Change*, *21*(3), 1045–1060. https://doi.org/10.1016/j.gloenvcha.2011.04.005

AFM. (2021, October 28). *Damage and losses caused by climate change are increasingly uninsurable*. https://www.afm.nl/en/sector/actueel/2021/oktober/schade-klimaatverandering-vaker-onverzekerbaar

Avoyan, E. (2022). *Understanding the performance of collaborative governance: An analysis of conditions for successful collaboration in Dutch flood risk management* [S.l. : s.n.]. https://repository.ubn.ru.nl/handle/2066/285121

Barendrecht, M. H., Sairam, N., Cumiskey, L., Metin, A. D., Holz, F., Priest, S. J., & Kreibich, H. (2020). Needed: A systems approach to improve flood risk mitigation through private precautionary measures. *Water Security*, *11*, 100080. https://doi.org/10.1016/j.wasec.2020.100080

Bosoni, M., Tempels, B., & Hartmann, T. (2021). Understanding integration within the Dutch multi-layer safety approach to flood risk management. *International Journal of River Basin Management*, 1–7. https://doi.org/10.1080/15715124.2021.1915321

Botzen, W. J. W., Aerts, J. C. J. H., & van den Bergh, J. C. J. M. (2009). Dependence of flood risk perceptions on socioeconomic and objective risk factors. *Water Resources Research*, *45*(10). https://doi.org/10.1029/2009WR007743

Botzen, W. J. W., & Van Den Bergh, J. C. J. M. (2008). Insurance Against Climate Change and Flooding in the Netherlands: Present, Future, and Comparison with Other Countries: Insurance Against Climate Change and Flooding in the Netherlands. *Risk Analysis*, *28*(2), 413–426. https://doi.org/10.1111/j.1539-6924.2008.01035.x

Bouwer, L. M., Huitema, D., & Aerts, J. C. J. H. (2007). *Adaptive flood management: The role of insurance and compensation in Europe*. Dept. of Spatial Analysis and Decision Support.

Bradt, J. T., Kousky, C., & Wing, O. E. J. (2021). Voluntary purchases and adverse selection in the market for flood insurance. *Journal of Environmental Economics and Management*, *110*, 102515. https://doi.org/10.1016/j.jeem.2021.102515

Bruggeman, V., Faure, M. G., & Fiore, K. (2010). The Government as Reinsurer of Catastrophe Risks? *The Geneva Papers on Risk and Insurance. Issues and Practice*, *35*(3), 369–390.

Cohen, A., & Siegelman, P. (2010). Testing for Adverse Selection in Insurance Markets. *Journal of Risk and Insurance*, *77*(1), 39–84. https://doi.org/10.1111/j.1539-6975.2009.01337.x

Correljé, A., & Broekhans, B. (2015). Flood risk management in the Netherlands after the 1953 flood: A competition between the public value(s) of water: The Netherlands' flood risk management after 1953. *Journal of Flood Risk Management*, *8*(2), 99–115. https://doi.org/10.1111/jfr3.12087

de Ruig, L., & Koekoek, D. (2022, November 7). *Lars de Ruig and Detmer Koekoek about flooding*. https://www.verzekeraars.nl/en/publications/longreads/lars-de-ruig-and-detmer-koekoek-about-flooding

Doll, M., & Mattheussens, S. (2022, November 16). *Overstromingen: Onverzekerbaar?* https://www.dnb.nl/algemeen-nieuws/nieuwsbericht-2022/overstromingen-onverzekerbaar/

Doorn-Hoekveld, W. J. van, Rijswick, H. F. M. W. van, Gilissen, H. K., & Groothuijse, F. A. G. (2022). *Adaptation to Climate Change in Dutch Flood Risk Management: Innovative Approaches and Related Challenges* (2). *18*(2), Article 2. https://doi.org/10.36633/ulr.860

EEA. (2021, November 18). *River floods—European Environment Agency* [Indicator Assessment]. Indicator Assessment River Floods. https://www.eea.europa.eu/data-and-maps/indicators/river-floods-3/assessment

EEA. (2022, December 16). *Extreme sea levels and coastal flooding*. Extreme Sea Levels and Coastal Flooding. https://www.eea.europa.eu/ims/extreme-sea-levels-and-coastal-flooding

ENW - expertisecentrum waterveiligheid. (2021). *Hoogwater 2021 Feiten en Duiding*. ENW. https://www.enwinfo.nl/publish/pages/183541/211102_enw_hoogwater_2021-dv-def.pdf

Esteban, J. F., Izquierdo, B., Lopez, J., Molinari, D., Menoni, S., De Roo, A., Deeming, H., Walker, G., & Eftichidis, G. (2011). Current Mitigation Practices in the EU. In S. Menoni & C. Margottini (Eds.), *Inside Risk: A Strategy for Sustainable Risk Mitigation* (pp. 129–186). Springer Milan. https://doi.org/10.1007/978-88-470-1842-6_4

Gilissen, H. K., Alexander, M., Beyers, J.-C., Chmielewski, P., Matczak, P., Schellenberger, T., & Suykens, C. (2016). Bridges over Troubled Waters: An Interdisciplinary Framework for Evaluating the Interconnectedness within Fragmented Domestic Flood Risk Management Systems. *Journal of Water Law*, *25*, 12–26.

Hampton, S., & Curtis, J. (2022). A bridge over troubled water? Flood insurance and the governance of climate change adaptation. *Geoforum*, *136*, 80–91. https://doi.org/10.1016/j.geoforum.2022.08.008

Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). Case Study Research: Foundations and Methodological Orientations. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *Vol 18*, No 1 (2017). https://doi.org/10.17169/FQS-18.1.2655

Hegger, D. (2019, May 28). Diversification of flood risk management modes: Lessons from Europe. *HazNet*. http://haznet.ca/diversification-flood-risk-management-modes-lessons-europe/

Hegger, D., Bakker, M., Driessen, P., Alexander, M., & Buijze, A. (2016). *A view on more resilient flood risk governance: Key conclusions of the STAR-FLOOD project*. https://doi.org/10.13140/RG.2.1.4402.6001

Hegger, D., Driessen, P. P. J., Bakker, M., Alexander, M., Beyers, J.-C., Buijze, A., Bruzzone, S., Choryński, A., Crabbé, A., Deketelaere, K., Delvaux, B., Dieperink, C., van Doorn-Hoekveld, W., Ek, K., Fournier, M., Ganzevoort, W., Gilissen, H. K., Goytia, S., Gralepois, M., & Wiering, M. (2016). *A view on more resilient flood risk governance: Key conclusions of the STAR-FLOOD project*. http://dx.doi.org/10.13140/RG.2.1.4402.6001

Het Nationaal Water Programma. (2022, March). Helpdesk water. https://www.helpdeskwater.nl/onderwerpen/wetgeving-beleid/nationaal/nationaal-water-programma-2022-2027/

H.F.M.W. Van Rijswick, M. Kaufmann, W. Van Doorn-Hoekveld, & H.K. Gilissen. (2016). *Analysing and evaluating flood risk governance in the Netherlands: Drowning in safety*. https://doi.org/10.13140/RG.2.1.2197.4167

Hoeksema, R. J. (2007). Three stages in the history of land reclamation in the Netherlands. *Irrigation and Drainage*, *56*(S1), S113–S126. https://doi.org/10.1002/ird.340

Hudson, P., & Berghäuser, L. (2023). Investigating moral hazard and property-level flood resilience measures through panel data from Germany. *International Journal of Disaster Risk Reduction*, *84*, 103480. https://doi.org/10.1016/j.ijdrr.2022.103480

Hudson, P., Botzen, W. J. W., & Aerts, J. C. J. H. (2019). Flood insurance arrangements in the European Union for future flood risk under climate and socioeconomic change. *Global Environmental Change*, *58*, 101966. https://doi.org/10.1016/j.gloenvcha.2019.101966

Hudson, P., & Thieken, A. H. (2022). The presence of moral hazard regarding flood insurance and German private businesses. *Natural Hazards*, *112*(2), 1295–1319. https://doi.org/10.1007/s11069-022-05227-9

IPCC. (2020). *The concept of risk in the IPCC Sixth Assessment Report: A summary of crossWorking Group discussions*. IPCC. https://www.ipcc.ch/site/assets/uploads/2021/01/The-concept-of-risk-in-the-IPCC-Sixth-Assessment-Report.pdf

Jansen, D. (2021, January 26). Saunders' Research Onion Explained (+ Examples). *Grad Coach*. https://gradcoach.com/saunders-research-onion/

Jongejan, R., & Barrieu, P. (2008). Insuring Large-Scale Floods in the Netherlands. *The Geneva Papers on Risk and Insurance - Issues and Practice*, *33*(2), 250–268. https://doi.org/10.1057/gpp.2008.10

Kaufmann, M., Priest, S. J., & Leroy, P. (2018). The undebated issue of justice: Silent discourses in Dutch flood risk management. *Regional Environmental Change*, *18*(2), 325–337. https://doi.org/10.1007/s10113-016-1086-0

Kaufmann, M., & Wiering, M. (2022). The role of discourses in understanding institutional stability and change – an analysis of Dutch flood risk governance. *Journal of Environmental Policy & Planning*, *24*(1), 1–20. https://doi.org/10.1080/1523908X.2021.1935222

Keessen, A. M., Hamer, J. M., Van Rijswick, H. F. M. W., & Wiering, M. (2013). The Concept of Resilience from a Normative Perspective: Examples from Dutch Adaptation Strategies. *Ecology and Society*, *18*(2), art45. https://doi.org/10.5751/ES-05526-180245

Klijn, F., de Bruijn, K. M., Knoop, J., & Kwadijk, J. (2012). Assessment of the Netherlands' Flood Risk Management Policy Under Global Change. *Ambio*, *41*(2), 180–192.

Kolen, B., & Helsloot, I. (2012). Time needed to evacuate the Netherlands in the event of large-scale flooding: Strategies and consequences. *Disasters*, *36*(4), 700–722. https://doi.org/10.1111/j.1467-7717.2012.01278.x

Kolen, B., & Nicolai, R. (2023). *Overstromingsrisicomodel voor ruimtelijke en financiële keuzes*. HKV. https://www.hkv.nl/wp-content/uploads/2023/05/RO0917.10_Overstromingsrisicomodel_voor_ruimtelijke_-investeringsvraagstukken.pdf

Koninklijk Nederlands Meteorologisch Instituut. (2021). *KNMI Klimaatsignaal '21—Hoe het klimaat in Nederland snel verandert*. https://cdn.knmi.nl/knmi/asc/klimaatsignaal21/KNMI_Klimaatsignaal21.pdf

Wet tegemoetkoming schade bij rampen, Pub. L. No. BWBR0009637, Website (2016). https://wetten.overheid.nl/BWBR0009637/2016-01-01

Kousky, C., & Shabman, L. (2015). *A Proposed Design for Community Flood Insurance*. Resources for the future. https://media.rff.org/archive/files/document/file/RFF-Rpt-KouskyShabman-CommunityFloodIns.pdf

LIWO. (n.d.). https://basisinformatie-overstromingen.nl/liwo/#/viewer/3?center=52.06481,4.07947&zoom=3

Ministerie van Algemene Zaken. (2017, August 2). *Water management in The Netherlands—Water management—Government.nl* [Onderwerp]. Ministerie van Algemene Zaken. https://www.government.nl/topics/water-management/water-management-in-the-netherlands

Ministerie van Infrastructuur en Waterstaat. (n.d.). *The flood of 1953* [Webpagina]. http://www.rijkswaterstaat.nl/en/water/water-safety/the-flood-of-1953

Ministry of Infrastructure and Water. (2019). *Water management in the Netherlands*.

Ministry of Infrastructure and Water & Management. (2020). *National Delta Programme 2021*. https://english.deltaprogramma.nl/binaries/delta-

commissioner/documenten/publications/2020/09/15/dp2021-eng-printversie/DP2021+ENG+printversie.pdf
Minnen, J. G. van, Ligtvoet, W., Franken, R., & Bree, L. van. (2013). *The effects of Climate Change in the Netherlands: 2012*. PBL. https://www.pbl.nl/sites/default/files/downloads/PBL_2013_The_effects_of_climate_change_in_the_Netherlands_957.pdf
Mirrlees, J. A. (n.d.). The Theory of Moral Hazard and. *REVIEW OF ECONOMIC STUDIES*.
Mol, J. M., Botzen, W. J. W., & Blasch, J. E. (2020). Risk reduction in compulsory disaster insurance: Experimental evidence on moral hazard and financial incentives. *Journal of Behavioral and Experimental Economics*, *84*, 101500. https://doi.org/10.1016/j.socec.2019.101500
Mol, J. M., Botzen, W. J. W., Blasch, J. E., & Moel, H. (2020). Insights into Flood Risk Misperceptions of Homeowners in the Dutch River Delta. *Risk Analysis*, *40*(7), 1450–1468. https://doi.org/10.1111/risa.13479
Molenveld, A., & van Buuren, A. (2019). Flood Risk and Resilience in the Netherlands: In Search of an Adaptive Governance Approach. *Water*, *11*(12), 2563. https://doi.org/10.3390/w11122563
Moses, J. W., & Knutsen, T. L. (2012). *Ways of knowing: Competing methodologies in social and political research* (2nd ed). Palgrave Macmillan.
Mostert, E. (2009). From value to finance: Making IWRM work. *Journal of Contemporary Water Research and Education*, *135*. https://doi.org/10.1111/j.1936-704X.2006.mp135001012.x
Mostert, E. (2020). Water and national identity in the Netherlands; the history of an idea. *Water History*, *12*(3), 311–329. https://doi.org/10.1007/s12685-020-00263-3
Naderifar, M., Goli, H., & Ghaljaei, F. (2017). Snowball Sampling: A Purposeful Method of Sampling in Qualitative Research. *Strides in Development of Medical Education*, *In Press*. https://doi.org/10.5812/sdme.67670
Netherlands US Water & Crisis Research Network. (2012). *Flood preparedness in The Netherlands a US perspective*. Netherlands US Water Crisis Research Network. https://publicwiki.deltares.nl/download/attachments/40796169/NUWCReN_2012_Flood%20preparedness%20in%20The%20Netherlands.pdf?version=1&modificationDate=1336740058000&api=v2
NOS. (2017, September 15). *Een overstromingsverzekering, hoe zit dat in andere landen?* https://nos.nl/artikel/2193064-een-overstromingsverzekering-hoe-zit-dat-in-andere-landen
OECD. (2014). *Water Governance in the Netherlands: Fit for the Future?* OECD. https://doi.org/10.1787/9789264102637-en
OECD (Ed.). (2016). *Financial management of flood risk*. OECD Publishing. https://doi.org/10.1787/9789264257689-en
OECD. (2021). *Enhancing Financial Protection Against Catastrophe Risks: The Role of Catastrophe Risk Insurance Programmes - OECD*. https://www.oecd.org/daf/fin/insurance/Enhancing-financial-protection-against-catastrophe-risks.htm
O'Neill, J., & O'Neill, M. (2012). *Social Justice and the Future of Flood Insurance*. Joseph Rowntree Foundation.
Paudel, Y. (2014). *Catastrophe Risk Management through Public-Private Partnerships: An Actuarial Assessment* [PhD-Thesis - Research and graduation internal]. https://research.vu.nl/en/publications/catastrophe-risk-management-through-public-private-partnerships-a
PBL. (n.d.). *Low probabilities—Large consequences*. Low Probabilities - Large Consequences. https://themasites.pbl.nl/flood-risks/

Robinson, P. J., & Botzen, W. J. W. (2022). Behavioral insights into the causes of underinsurance against flood risks: Experimental evidence from the Netherlands. In *Coastal Flood Risk Reduction* (pp. 119–136). Elsevier. https://doi.org/10.1016/B978-0-323-85251-7.00010-X

Roder, G., Hudson, P., & Tarolli, P. (2019). Flood risk perceptions and the willingness to pay for flood insurance in the Veneto region of Italy. *International Journal of Disaster Risk Reduction*, *37*, 101172. https://doi.org/10.1016/j.ijdrr.2019.101172

Salden, J., & Sas, S. 't. (2022, May 26). *1 jaar na de watersnood in Limburg nog steeds geen compensatie: "Overheid laat gedupeerden in de steek."* EenVandaag. https://eenvandaag.avrotros.nl/item/1-jaar-na-de-watersnood-in-limburg-nog-steeds-geen-compensatie-overheid-laat-gedupeerden-in-de-steek/

Saunders, M. N. K., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (Eighth Edition). Pearson.

Seifert, I., Botzen, W. J. W., Kreibich, H., & Aerts, J. C. J. H. (2013). Influence of flood risk characteristics on flood insurance demand: A comparison between Germany and the Netherlands. *Natural Hazards and Earth System Sciences*, *13*(7), 1691–1705. https://doi.org/10.5194/nhess-13-1691-2013

Skjott Linneberg, M., & Korsgaard, S. (2019). Coding qualitative data: A synthesis guiding the novice. *Qualitative Research Journal*, *19*(3), 259–270. https://doi.org/10.1108/QRJ-12-2018-0012

Slager, K. (2021, September 9). *Hoogwater Limburg zomer 2021 ingrijpender dan rivieroverstromingen in 1993 en 1995 | Deltares*. https://www.deltares.nl/nieuws/hoogwater-limburg-zomer-2021-ingrijpender-dan-rivieroverstromingen-in-1993-en-1995

Slomp, R. (2012). *Flood risk and water management in the Netherlands*. Ministry of Infrastructure and the Environment. https://www.helpdeskwater.nl/publish/pages/132274/hr_3845545_binnenwerkflood_risk_and_water_management_drukversievk.pdf

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Surminski, S. (2014). The Role of Insurance in Reducing Direct Risk—The Case of Flood Insurance. *International Review of Environmental and Resource Economics*, *7*(3–4), 241–278. https://doi.org/10.1561/101.00000062

Surminski, S. (2018). Fit for Purpose and Fit for the Future? An Evaluation of the UK's New Flood Reinsurance Pool: Fit for Purpose and Fit for the Future. *Risk Management and Insurance Review*, *21*(1), 33–72. https://doi.org/10.1111/rmir.12093

Surminski, S., Aerts, J. C. J. H., Botzen, W. J. W., Hudson, P., Mysiak, J., & Pérez-Blanco, C. D. (2015). Reflections on the current debate on how to link flood insurance and disaster risk reduction in the European Union. *Natural Hazards*, *79*(3), 1451–1479. https://doi.org/10.1007/s11069-015-1832-5

Surminski, S., Botzen, W., & Hudson, P. (2016). Insurance instruments and disaster resilience in Europe: Insights from the ENHANCE project. In J. C. J. H. Aerts & J. Mysiak (Eds.), *Novel Multi-Sector Partnerships in Disaster Risk Management*. VU Univeristy Press.

Tesselaar, M., Botzen, W. J. W., Robinson, P. J., Aerts, J. C. J. H., & Zhou, F. (2022). Charity hazard and the flood insurance protection gap: An EU scale assessment under climate change. *Ecological Economics*, *193*, 107289. https://doi.org/10.1016/j.ecolecon.2021.107289

Thiel, S. van. (2014). *Research in public administration and public management: An introduction*. Routledge/Taylor & Francis Group.

Thompson, K. (2013). *Flood Insurance: Public or Private?* [University Twente]. https://essay.utwente.nl/63721/1/Thesis_Final_Version_Kelvin_Thompson.pdf

UNDRR. (2022, June 1). *Flooding, climate change, and limited insurance coverage in the Netherlands*. https://www.preventionweb.net/news/flooding-climate-change-and-limited-insurance-coverage-netherlands

Utrecht University. (n.d.). *Theoretical Framework & Conceptual Model*. Academic Skills Human Geography and Spatial Planning. Retrieved June 19, 2023, from https://handboeksgpl.sites.uu.nl/reporting/theoretical-framework-conceptual-model/?lang=en

Van Alphen, J. (2016). The Delta Programme and updated flood risk management policies in the Netherlands: The Delta Programme in the Netherlands. *Journal of Flood Risk Management*, *9*(4), 310–319. https://doi.org/10.1111/jfr3.12183

Van Alphen, J., Bourger, L., Elliott, C., Fujita, K. I., Riedstra, D., Rooke, D., & Tachi, K. (2011). Flood risk management approaches: As being practiced in Japan, Netherlands, United Kingdom and United States. *IWR Report 2011-R-08, Published on Behalf of US ACE, Rijkswaterstaat, MLIT and Environment Agency*. https://repository.tudelft.nl/islandora/object/uuid%3Ac9995920-75a7-4e1a-ae6e-0f09d473e34e

van Buuren, A., Ellen, G. J., & Warner, J. F. (2016). Path-dependency and policy learning in the Dutch delta: Toward more resilient flood risk management in the Netherlands? *Ecology and Society*, *21*(4), art43. https://doi.org/10.5751/ES-08765-210443

Van Herk, S., Zevenbergen, C., Gersonius, B., Waals, H., & Kelder, E. (2014). Process design and management for integrated flood risk management: Exploring the multi-layer safety approach for Dordrecht, The Netherlands. *Journal of Water and Climate Change*, *5*(1), 100–115. https://doi.org/10.2166/wcc.2013.171

Verbond van verzekeraars. (n.d.). *Watersnood Limburg*. Retrieved June 6, 2023, from https://www.verzekeraars.nl/verzekeringsthemas/klimaatbestendig-nederland/overstroming-en-droogte

Verbond van verzekeraars. (2022a, February 10). *Zijn overstromingsrisico's verzekerbaar?* https://www.verzekeraars.nl/publicaties/actueel/zijn-overstromingsrisico-s-verzekerbaar

Verbond van verzekeraars. (2022b, December 15). *Verzekeraars zetten volgende stap in verzekeren overstroming door grote rivier of zee*. https://www.verzekeraars.nl/publicaties/actueel/verzekeraars-zetten-volgende-stap-in-verzekeren-overstroming-door-grote-rivier-of-zee

Vergouwe, R. (2014). *The National Flood Risk Analysis for the Netherlands*. VNK. https://repository.tudelft.nl/islandora/object/uuid%3A52035faa-43ab-4dd0-a5b0-099119085356

Wagner, K. R. H. (2022). Adaptation and Adverse Selection in Markets for Natural Disaster Insurance. *American Economic Journal: Economic Policy*, *14*(3), 380–421. https://doi.org/10.1257/pol.20200378

Water Act, (2010). https://www.helpdeskwater.nl/publish/pages/130656/wateract_total.pdf

Waterstaat, M. van I. en. (n.d.). *Room for the River* [Webpagina]. Retrieved March 6, 2023, from http://www.rijkswaterstaat.nl/en/about-us/gems-of-rijkswaterstaat/room-for-the-river

Wiering, M. (2019). *Understanding Dutch Flood-Risk Management: Principles and Pitfalls*. 115–124. https://doi.org/10.1002/9781119383567.ch8

Wiering, M., Kaufmann, M., Mees, H., Schellenberger, T., Ganzevoort, W., Hegger, D. L. T., Larrue, C., & Matczak, P. (2017). Varieties of flood risk governance in Europe: How do countries respond to driving forces and what explains institutional change? *Global Environmental Change*, *44*, 15–26. https://doi.org/10.1016/j.gloenvcha.2017.02.006

Yanjun, L., & Mulder, P. (2021). *What's at Stake? Understanding the Role of Home Equity in Flood Insurance Demand*. https://assets.firststreet.org/uploads/2021/08/Whats-at-Stake-Understanding-the-Role-of-Home-Equity-in-Flood-Insurance-Demand.pdf

8. Appendices

Appendix 1

List of interviewees

Name:	Function:	Company/ institution	Date:
Timo Brinkman	Policy advisor on climate change and catastrophes related to non-life insurance	Verbond van verzekeraars	1-5-2023
Maurice Doll	Senior Economist	De Nederlandsche Bank	3-5-2023
Max Tesselaar	PHD candidate VU	VU University Amsterdam	3-5-2023
Lars de Ruig	Consultant water management, Flooding and environmental economics	Royal HaskoningDHV	16-5-2023
Rogier de Jong	Natural Hazard Specialist	Swiss Re	17-5-2023
Ron Franken	Policy researcher	PBL	26-5-2023
Jeroen Doornekamp	Advisor Water safety	Rijkswaterstaat	30-5-2023
Bas Kolen	Director of Research and Development	HKV in lijn	22-6-2023

Appendix 2

List of interview questions

- What is your understanding of flood insurance and its role in managing flood risk?
- How has the Dutch government historically approached flood risk management, and how does flood insurance fit into that approach?
- What are some potential benefits of introducing flood insurance in the Netherlands? Conversely, what are some potential drawbacks or challenges?
- How might the introduction of flood insurance impact different stakeholders, including individuals, businesses, and the government?
- How might flood insurance interact with other existing measures for managing flood risk in the Netherlands, such as infrastructure investments or land use planning?
- Are there other countries or regions that have implemented flood insurance schemes that could serve as a model or comparison for the Netherlands?
- What possible design for flood insurance in the Netherlands are the most desirable?
- How might the effectiveness of flood insurance be evaluated or measured in the context of Dutch flood risk management?
- What are some potential barriers to implementing flood insurance in the Netherlands, and how might they be addressed?
- What role, if any, do you think private insurance companies should play in providing flood insurance in the Netherlands?
- Looking to the future, how do you see the issue of flood insurance evolving in the context of Dutch flood risk management?