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The Netherlands: Climate-adaptive

Accelerating climate adaptation through financial sector/government collaboration

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Deloitte is committed to making a positive impact on society and it does so through the Deloitte Impact Foundation. We believe we can make the biggest difference by sharing our core competences, knowledge and network in social initiatives. With this research, Deloitte wants to raise awareness about the importance and urgency of climate adaptation, bring parties together and make concrete recommendations for practical next steps towards a climate-adaptive Netherlands.

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Management summary

Introduction

IPCC's scientific research and the climate scenarios used for risk estimates published by the Royal Netherlands Meteorological Institute predict an overall increase of temperatures in future years, longer periods of drought, wetter weather with greater flood risks, on top of which sea levels will continue to rise. If we want to keep all regions in the Netherlands safe and attractive, the country must adapt to extreme weather consequences. This takes more than just taking mitigating measures to help prevent further warming. We also need to become climate-adaptive, so as to buffer against changes that can no longer be prevented.

This report results from research into how climate adaptation can be accelerated in the Netherlands. Climate adaptation is a societal challenge with a primary role for government and a need for involvement of, and collaboration with, private parties. The report deals specifically with the financial sector because of its important social role and its influence on our society, partly because the sector finances projects and organisations that contribute to climate mitigation and climate adaptation. At the same time, financial institutions face an increased financing risk due to climate change and the financial sector has a strong interest in keeping the Netherlands attractive, because of issues such as the value of underlying assets, including real estate. This research divides the financial sector into banks, pension funds and insurers, each with its own primary focus: banks in their role as financiers, pension funds in their role as investors, and insurers in their role as risk bearers (and investors).

This report answers the research question of how the financial sector can contribute to accelerating climate adaptation in the Netherlands, in collaboration with the government.
The report's target audience encompasses supervisory boards, management boards and shareholders of banks, pension funds and insurers. And we want to get politicians on board too. So this primarily regards decision-makers and people who can influence long-term policy, strategy and decisions within financial organisations and the government. The Deloitte Impact Foundation has initiated this report, which is based on our ideological belief that both our organisation and the private sector as a whole can and must increase their contribution to a climate-adaptive Netherlands.

Research design

This research is designed with the historical context in mind. The lessons learned by the Netherlands can help in adapting to extreme weather caused by climate change. We specifically analyse what positive contributions the financial sector has already made, what opportunities remain for it to contribute to climate adaptation, and what role the government can play in this respect. Using two case studies, we subsequently expand the research:

- the most recent case research we use regards the floods in Limburg and looks into society's level of preparation, how the floods have been dealt with, and the lessons learned; and
- the second regards the city of Rotterdam, because of its specific location and relationship with water, the associated risks and the climate adaptation required.

Limburg is a case in point of the possible extreme weather consequences and our need for climate adaptation. Likewise, it shows the importance of crisis management and aftercare being better prepared, with a long-term horizon in mind. Rotterdam is the city where we look ahead and draw lessons from this area, where its vulnerable location has put climate adaptation high on the agenda. This report results from desk research, including annual reports of financial institutions, and qualitative interviews with experts from the financial sector, government institutions, and scientists. It can be read as a widely supported report but it's not scientific research. Instead, it aims to raise the urgency of climate adaptation, bring parties together, and make concrete recommendations for practical next steps towards a climate-adaptive Netherlands.

Conclusions

General

The Netherlands is the best protected river delta in the world, but climate change is creating new climate risks. Facing them requires the right balance between mitigation and adaptation. In this report, we share the outcome of our research on how the financial sector can help accelerate climate adaptation in the Netherlands.

Balancing mitigation and adaptation

The financial sector parties are certainly open to climate adaptation, but for now they prioritise climate mitigation. Discussions with people in the financial sector and governments reveal a widely supported need for joining efforts in reinforcing and improving collaboration between the government and the financial sector to accelerate the adaptation process.

A complex issue
In many situations, the much wanted joining of forces between governments and the financial sector is effectively still difficult. It is important for the government and the financial sector to jointly acknowledge the complexity of the task and the proactive collaboration this requires on at least the following themes:

a. Lack of an overarching vision
There is a need for more direction from the national government in an overarching vision that shows the perspectives (economic and otherwise), with clear transition paths that can lead to choices. These paths could, for example, involve climate-adaptive construction.

b. Long-term versus short-term
Although organisations have long-term perspectives, financial models often focus on short-term results.

c. Valuation of profit over value
In this respect, measures producing liveable areas by providing a green, safe and social environment are difficult to quantify. Valuation of profit is chosen over increasing value (quality of life, safety and longevity). With broad prosperity approaches and the UN's 'Sustainable Development Goals' (2015-2030) often missing, business cases are assessed for financial risks instead of social added value.

d. Differentiating on climate risks is complex
One example involves mortgage lenders. They can use different strategies to deal with climate risks and differentiate loans, if they wish. At the same time, the law requires mortgage lenders to act fairly and ethically in this regard. It's a complex issue, where multiple stakeholders, different considerations, and legislation and regulations all need to be considered.

e. Legislation, and how this is interpreted, both boosts and hinders climate adaptation
Financial institutions are facing a host of existing and frequently changing legislation and regulations. Insurers have Solvency II to take into account, banks must heed the Basel Accords, and pension funds must observe national rules. Compliance is mandatory and affects prioritisation. Combined with the interpretation of the leeway and restrictions within existing and changing legislation and regulations, this affects the level of proactivity and progressiveness in business models and services needed to accelerate climate adaptation.

f. Difference between government and financial sector
Private and public interests differ, too, and they are far apart sometimes. Cultural differences, also within the sectors, and differences in business models cause confusion and not everyone always seems to be on the same page.

Public-private financing
Public-private financing is needed to fund climate-adaptive projects. In several projects experience has been gained with DBFM (Design, Build, Finance and Maintain) contracts, a form of contract that raises different opinions. The government feels that this form of contract seems less suitable for highly uncertain projects (which often involve replacement and renovation, or spatial development). The question is how a flexible financial shell can absorb unexpected costs.

The government's role
The government's primary responsibility is the right balance between climate mitigation and climate adaptation, in which role it is responsible for amending legislation and regulations, introducing new legislation and regulations, and initiating public private partnerships. This should boost the opportunities for the financial sector to help accelerate climate adaptation.

Social inequality
One of the effects of climate change is the possibility of this increasing social inequality, as residents with greater financial resources are in a better position to take adaptive measures for safety and damage prevention. As a society, it is important to guard against such a divide and ensure that climate risks are not passed on to those least able to bear them.

Prevention
While the government is essentially responsible for unambiguous communication on climate change risks, banks and insurers believe their social duty includes informing customers about climate change risks that are relevant to their services. This creates opportunities for a broader integration of providing information into society. Collaboration between government and the financial players can improve the provision of climate risk information, so people are better informed about preventive measures and can take the appropriate action in an early stage.

Crisis management and immediate aftercare
One complication is the rather opaque allocation of roles between the government and financial institutions. The Limburg case research shows that for a long time after the floods the injured parties were in the dark about who to turn to for their damage. So, both the government and the financial sector should be clear about where people can turn to for help if they have damage. A so-called a one-stop service desk for damage after disasters could be one of the solutions. Although in several situations this is already being pursued, it's not general practice yet.

Recommendations

These are the three main recommendations, followed by the most relevant recommendations by sub-sector and government. The report includes an overview of all recommendations including their explanations.

1a. Have a clear vision for the future, including transition paths towards being a climate-adaptive country.
Develop a supported, clear vision for the future, including transition paths towards becoming a climate-adaptive country. Be clear about the time path and about the resources the government has available. Only then can the conversation be held about what will be government funded and what is demanded from the market to make the Netherlands climate-adaptive. The goal is to collaborate on a socioeconomic perspective where unbearable costs are prevented and social inequality is counteracted. The government's primary responsibility means they will have to take the initiative for this and they should involve the financial sector in preparing the aforementioned vision for the future and realising the transition paths.

1b. Take a different approach to assessing business cases .
In business cases, organisations are looking for short-term returns. This poses a challenge for climate adaptation because the costs must be paid now while the benefits only materialise over the long term. This requires a different look at business cases, within the framework of imposed international legislation:

- Values (such as safety, climate-adaptive construction, and health) in the living environment should be quantified differently; and
- A shift from a short-term focus (5 years) to a long-term focus (at least 25 years).

1c. A need for innovative leadership.
Setting up and assessing business cases differently requires leadership from decision-makers in both the government and the market. The current short-term focus aligns with the short-term thinking in politics and the business community's short-term focus on shareholders and profit distributions. Addressing the climate adaptation dilemmas, starting the discussion about them, and finding new ways to navigate the transition takes leadership and audacity.

The government

- **Improve or change the Damage Compensation Act (DCA) in collaboration with insurers.**
  Establish clearer criteria showing when the DCA will and will not be used. Examine the possibility of additional insurances and take another look at the distributional impact in light of increasing climate change.

  Continue discussions with insurers on the practical details involved and possible public private partnerships, or both. One example to think of is the development of an improved DCA, with insurers becoming responsible for coordinating the handling of any damage. We may have the Delta Programme in place - a future proof plan -, but it's impossible to guarantee 100% safety. Quick reparation can mitigate the consequences of any residual risks.
- **Explore the introduction of a climate label for buildings.**
  This will encourage all parties in the chain of government, business and residents to be informed in the same way, creating an additional incentive for and control over climate-adaptive construction.
- **Explore new forms of public-private partnerships.**
  Do so together with the market, including the financial sector. Look for appropriate examples or explore whether the evaluation of the DBFM contracts can be given a concrete form. How can these forms of collaboration be strengthened in practice? Engage with banks that have gained experience in working with DBFM contracts and share perspectives and experiences. Examine how this form (or a derivative) can be used for area development where there is a certain degree of uncertainty, by using a flexible financial shell. Likewise, support banks and other parties by providing insight into the great uncertainty involved in spatial planning and replacement and renovation projects.
- **Reduce the information asymmetry between owners and buyers in the housing market and commercial property transactions.**
  This way, risks will gradually be incorporated into prices. But beware, to avoid social inequality ensure that resilient and vulnerable households both interpret risk information correctly and in the same way.

Insurers

- **Interpret the indemnity principle as one through which compensation may always be used for improved climate adaptation.**
  The Dutch Association of Insurers has provided the government with an option in this respect, which is to include a statutory obligation for existing buildings and new housing in the National Benchmark's sections on flooding and excess water.
- **Offer product differentiation that matches the climate-adaptive condition and location of the insured property.**
  This informs policyholders about the climate risk they face and motivates them to take their own climate-adaptive measures. One example is offering a premium discount once the measures have been taken.

Banks

- **Reach agreement with the government.**
  About rules on information regarding valuations and loan applications from individuals, governments, and businesses on the state of collateral and location in relation to climate change and how this affects loan terms.
- **Point out where the opportunities for 'blended finance' are more extensive: public-private partnerships with external financing (other than government).**
  In doing so, evaluate forms like DBFM contracts, as experience has already been gained with these contracts. For instance, what has been the role of banks, why has the government become reluctant, how can this be improved in public-private partnerships, and how can a flexible financial shell be used to absorb unforeseen risks?

Pension funds

- **Position yourself as the sector committed to the Netherlands' long-term welfare.**
  The portfolios of pension funds and pension insurers are sizeable and have a long-term investment horizon. Coupled with the scale and duration of climate adaptation projects, this makes pension funds a party with an economic interest in adapting their assets to climate change. As part of its role, a pension fund can 1) be more vocal in the social debate on climate adaptation and 2) proactively explore related innovations within its portfolio. The National Benchmark offers one example of this, as it states that we should not only be able to retain or drain water during times of abundance in the Netherlands. We should also store it for distribution during periods of drought and scarcity. Investing in the construction of such facilities can be attractive to pension funds.

"The Netherlands has an acclaimed cultural and institutional approach to water. Its comprehensive, inclusive and sustainable approach to climate mitigation and adaptation has the power to inspire the world. In this fragile and beautiful delta this is not only existential for us, it's a much-needed ambition for the world too, for ensuring a safe and secure future for everything and everyone, everywhere." - *Henk Ovink*

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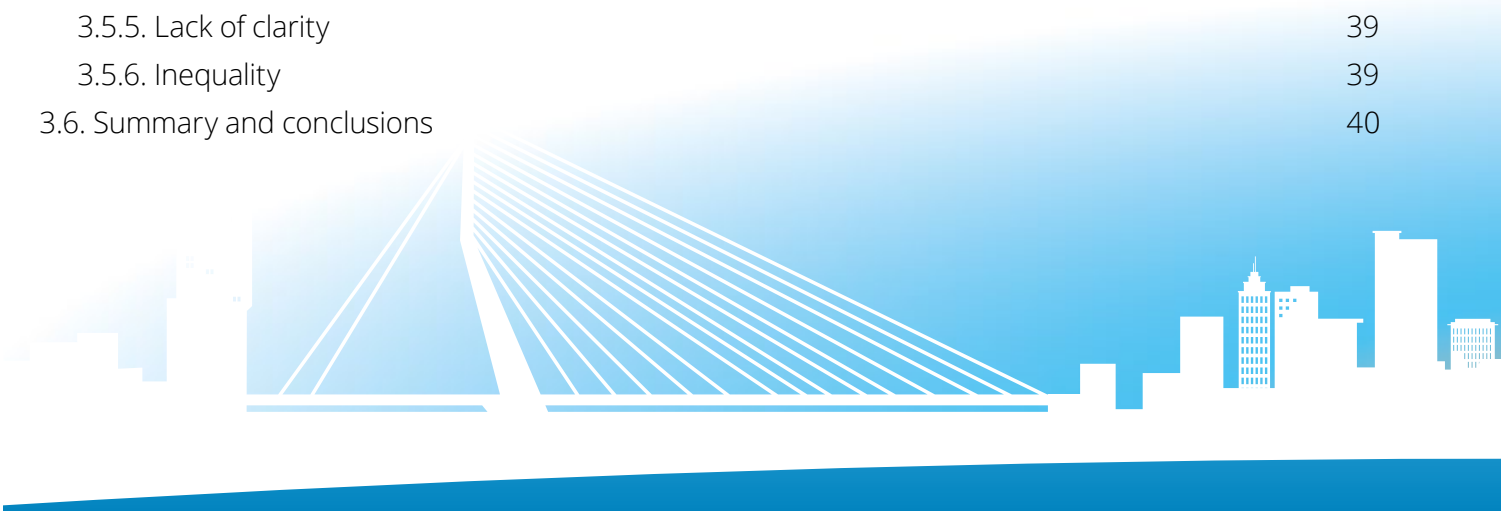

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1. Introduction

Climate change is creating extreme conditions all across the world: floods, heat and drought, forest fires and water scarcity are on the rise. Just in 2023 alone, many heat records have been broken. Most forecasts predict the acceleration and intensification of climate change to continue in the coming years.

One of the reasons is that most countries are not taking sufficient measures to meet the main goal of the Paris Agreement: to prevent global warming from exceeding 2°C and to make an effort to stay below 1.5°C warming by 2050 (UNFCCC, 2015). The IPCC reports that temperatures are most likely to rise by more than 1.5°C in the near future and the World Meteorological Organization estimates that warming will have already exceeded this limit in just a few years (World Meteorological Organization, 2023, p. 1).

Even meeting the goal of less than 1.5°C of warming will not avoid the major consequences of global warming for the living environment (Hoegh-Guldberg, et al., 2018), so we must continue to consider climate change and its harmful effects in the coming decades. This impacts nature and our living environment, as it increases the risk of economic and social inequality and affects people's health. One of the effects will be excess mortality during heat waves and drinking water shortages, especially of the elderly (Hoegh-Guldberg, et al., 2018, p. 14).

Keeping all regions in the Netherlands attractive to live, work and invest in not only requires mitigation measures to prevent further warming. The Netherlands will also need to become climate-adaptive for the unavoidable changes. By applying climate mitigation, we reduce the causes of climate change.

This focuses on reducing greenhouse gas emissions or advancing technologies to remove greenhouse gas emissions from the atmosphere. Through climate adaptation we prepare for the effects of future climate change. In doing so, we particularly focus on extreme weather, for example by adapting the environment accordingly (Climate Adaptation Knowledge Portal, 2023) or by encouraging people to move away from high-risk areas. Raising dykes, storing peak precipitation and ensuring that the risk of climate damage is included in asset prices are examples of climate adaptation. Climate-proof, climate-resilient and water-resilient are also much used terms when this topic is discussed. We will regard these terms as more or less synonymous in this report. Figure 1 shows an overview of measures highlighting the difference between climate mitigation and climate adaptation..

Climate change and a lack of adaptation carries several risks, which can be divided into two categories: physical and transition risks (Bor, Duiker, & Hertog, 2021). Both categories can lead to financial risks.

Events (acute) or longer-term shifts (chronic) in climate patterns can cause physical climate change risks. Acute physical risks are risks caused by events such as the increase in extreme weather events, resulting in hurricanes and floods. Chronic physical risks are longer-term shifts in climate patterns (e.g., persistently higher temperatures) that can lead to sea level rise or chronic heat waves (TCFD, 2017). They can either have direct financial consequences for organisations because of damage to assets, or indirect consequences as a result of supply chain disruption (TCFD, 2017).

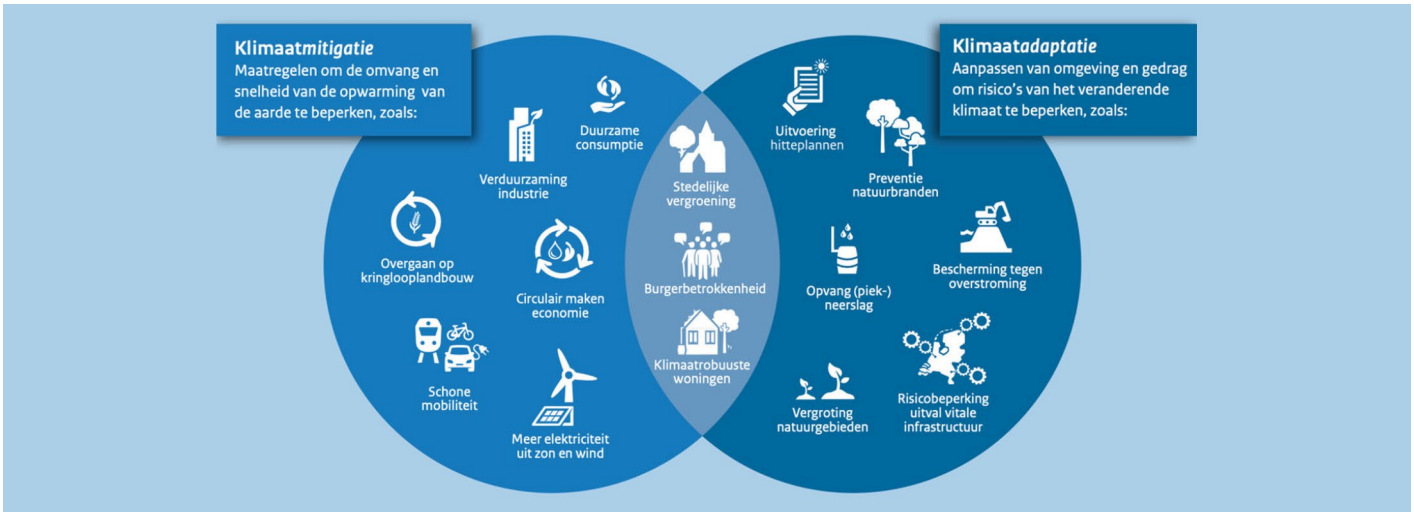

Figure 1. Examples of focus areas climate mitigation and climate adaptation (Ministry of Infrastructure and Water Management, 2022).

Transition risks relate to the economic risk companies face when switching from the current economy to a future-proof economy due to issues such as changes in policy and legislation (TCFD, 2017). Likewise, institutional changes within economic systems, such as climate policies being implemented, may include costs of mitigation and adaptation interventions such as subsidies, building codes or taxes.

Mitigation and adaptation cannot be considered separately. If mitigation is insufficient, the only other option left is (effective) adaptation. However, not every attempt at adaptation has the desired effect and attempts may even result in maladaptation. The latter is a change in natural or human systems to address climate change that (unintentionally) increases rather than decreases vulnerability, thus creating an increased risk of negative climate-related outcomes, such as increased greenhouse gases, increased vulnerability to climate change, and increased social or economic inequality or reduced prosperity, now or in the future (IPCC, 2022).

Implementation of climate adaptation must be carefully considered if maladaptation is to be avoided and should factor in a certain degree of chronic uncertainty. For optimal choices to be made, all available information on future changes and their effects must be considered and this requires open communication. An adaptation may start as a way of dealing with the short-term climate change effects and building incremental improvements, so they can lead to positive long-term adaptation (Schipper, 2020). In the Netherlands, the Delta Programme serves to implement adaptive delta management, which involves using adaptation paths to see up to which circumstance a given measure is sufficient (i.e., instead of being defined in years, e.g., water levels or flood recurrence time are used as benchmarks). Once that point is exceeded, another path should be followed to ensure that disinvestment (maladaptation) is avoided as much as possible (Delta Programme, 2023). Government research (Central Government, 2022) shows that if we fail to take measures to adapt in the Netherlands, climate change damage, including flooding and flood emergencies, could rise to an estimated EUR 77-173 billion by 2050.

Making the Netherlands climate-adaptive and finding the right balance between mitigation and adaptation is the government's primary task. After all, climate adaptation is important for the safety of people currently living in vulnerable areas, for example. The economic importance is considerable, too, and includes keeping flood prone areas economically attractive for investors and for companies to establish themselves in (Expertise Network for Flood Protection, 2017). More than half the built-up area in the Netherlands is privately owned (Pols, Bijlsma, Breedijk, & Van Schie, 2018), while 70% of economic activity takes place in flood prone areas (Central Government, undated), covering 59% of the land area (Rijcken, 2022
).

The financial sector plays an important social role and influences our society in multiple ways, including the financing of projects and companies that contribute to climate mitigation and climate adaptation. At the same time, as climate change increases the financing risks of financial institutions, they have a strong interest in keeping the Netherlands liveable and attractive, one reason being the value of their underlying assets. This is why the financial sector should be more explicitly involved in the necessary further climate adaptation that the Netherlands needs to implement.

We want this research to raise awareness of the need and urgency of climate adaptation, bring together parties within government and the financial sector, and make concrete recommendations for practical next steps towards a climate-adaptive Netherlands. We have focused this research on banks, pension funds and (non-life) insurers within the financial sector.

This report has been written for the supervisory boards, management boards and shareholders of banks, pension funds and insurers. We also want to reach politicians, public administrators and top officials, so primarily decision-makers and people who can influence long-term policy, strategy and decisions within financial organisations and the government.

This report is an initiative of the Deloitte Impact Foundation and has an ideological foundation based on which we believe that we and the private sector as a whole can and should contribute more towards a climate-adaptive Netherlands.

We define the aforementioned research question with two insights from climate science (Martin et al., 2022):

- Coupled with small or incremental changes to how we pursue climate adaptation and deal with adaptation limits, there is a need for deep and fundamental changes. Short-term decisions must factor in long-term consequences and risks.
- If we are to ensure a liveable future for all, adaptation alone is not an alternative to mitigation efforts. Even the most effective adaptation measures are unable to prevent all loss and damage. And (financial and social) support for adaptation measures depends on how successful any mitigation efforts are.

This report answers the question:

How can the financial sector, collaborating with government, contribute to accelerating climate adaptation in the Netherlands?

This report answers the research question and provides insights into and concrete advice for accelerated and high-quality climate adaptation in the Netherlands. The focus in this respect is on extreme weather as a result of climate change, for which we have researched two cases: the 2021 flooding in Limburg and, because of its specific location, the city of Rotterdam.
Rotterdam is located in the delta of the Rhine and Meuse rivers. At 6.78 below sea level, the lowest point in the Netherlands is near Rotterdam, so in this research there is a greater emphasis on flooding. Although all forms of weather extremes increase the need for adaptation, flooding is a particularly important issue for the Netherlands, both historically and into the future (KNMI'23, 2023).

Collaboration with the financial sector's Climate Adaptation Working Group

For this report we collaborated with the Climate Adaptation Working Group of the Platform for Sustainable Finance, with the aim of advising and reinforcing each other in the message to make the Netherlands climate-adaptive.

The report of the financial sector's Climate Adaptation Working Group, prepared in parallel with this report, aims to raise awareness and perspective for actions. It is the result of a year of research in a collaborative effort between participants from banks, insurers, pension funds, ministries and the 'Climate-Proof Together' network. The report highlights both the consequences and opportunities of climate adaptation for the financial sector and discusses what the sector needs to properly play its role. It likewise focuses on preconditions and collaboration opportunities with government, knowledge institutions, and customers.

When the reports were prepared, the Climate Adaptation Working Group was represented in Deloitte's guidance group, while Deloitte authors were part of the Climate Adaptation Working Group.

The research

The research design is historically based. Appendix 6.2 shows a timeline on how the Dutch have dealt with the risks associated with water in the past. The lessons learned by the Netherlands can help in anticipating extreme weather due to climate change. We specifically analyse the positive contribution the financial sector already makes and any opportunities still remaining. Using two case studies, we subsequently deepen the research:

- the Limburg flood is the most recent case, delving into the extent in which society was prepared, how things were handled, and lessons learned; and
- the city of Rotterdam, because of its specific dependence on water, the associated risks and the climate adaptation required.

The Limburg case is emblematic for the extreme weather consequences and our need for climate adaptation. Likewise, it shows the importance of better preparing crisis management. The Rotterdam case provides a look into the future and draws lessons from this area, where climate adaptation features high on the agenda because of its vulnerable location.

This report is the result of desk research (including annual reports of financial institutions), qualitative interviews with financial sector experts, government institutions and scientists, and can be read as a widely supported report. It aims to increase the necessity and urgency of climate adaptation, bring parties together, and make concrete recommendations for practical next steps towards a climate-adaptive Netherlands.

Reading guide

Chapter 2 outlines the context and design of our research and describes the financial sector's current contribution to climate adaptation and the dilemmas that create constraints.

Chapter 3 discusses the Limburg case, outlining the 2021 flooding and the financial sector's related involvement.

Chapter 4 discusses the Rotterdam case and explains the risks, needs and opportunities for climate adaptation.

Chapter 5 contains the conclusions and recommendations.

Following this are the appendices (Climate agreements, legislation and regulations; History of living with water in the Netherlands; Glossary; Interviewees) and, finally, the source references.

2. Background and research design

Several thousand years ago, what would later be called the Netherlands was a river delta with peat bogs and dunes behind a gently rolling hilly landscape (Haring, Wesselingh, & Ahrens, 2023), where people would anticipate what was happening in nature. This natural environment starkly contrasts to today's Netherlands, where polders, sluices and pumping stations provide stable water management throughout the country. The extensive system of dykes, canals, polders and waterworks keeps the Netherlands liveable, protects the country from floods and has drained land for habitation and agriculture. Today's Netherlands is a made country, with people having gained more and more land they need to keep dry by protecting it from floods.

Since the start of this century the Netherlands has seen another paradigm shift towards nature. Part of this shift is visible in programmes such as Room for the River, which no longer just raises dykes to protect the Netherlands from water but also creates room for water in various ways, for controlled water collection. These include river widening, increasing water storage or building modern mounds. Outgoing Infrastructure and Water Management Minister Harbers also shares this realisation: "For centuries, we have used our own hands to shape our country into what it is, for example by building dykes and digging ditches. But intensive use and climate change means we more and more run into the limits. By increasing our water awareness, we can continue to live and work in the Netherlands in the future" (Central Government, 2022). On the back of the above history, this chapter discusses the research method and the results of the desk research carried out.

2.1 Climate risks and adaptation

The climate has already changed and this change will continue. Man-made climate change has increased the extremes in heat, dry periods and precipitation (KNMI'23, 2023). This is why mitigating measures will need to be accompanied by protective measures against the adverse effects of this extreme weather. Greenhouse horticulture is one of the areas where this can be witnessed, as this sector needs investments in greenhouses with thicker glass to protect them from severe hailstorms, with larger hailstones than the Netherlands is used to (Dutch Association of Insurers, 2017).

Water is one of the quintessentially important issues for the Netherlands. Much of our country is below sea level, but our dykes and other seawalls keep it dry. Although sea level rise increases the risk of flooding, we can still mitigate this risk to acceptable levels by raising dykes. But another issue caused by sea level rise is salinisation of agricultural land and groundwater, which is problematic for food production and drinking water supply (Living Environment Information Centre, undated).

Extremely high water volumes of freshwater from major rivers can also lead to emergencies such as flooding. Climate change sometimes results in extremely high precipitation in a short period of time (KNMI, undated). Rivers are sometimes unable to properly drain this water because soil has dried up and hardened, which can lead to landslides and flooding. If water levels in the major rivers are too low because of periods of drought, this not only affects our drinking water and nature, but also the economy. Affected sectors would include agriculture and shipping.
Drought likewise strongly affects groundwater levels, causing issues such as housing subsidence (Deltares, 2020; NOS News, 2021). Several major rivers in the Netherlands drain into the sea, so the risk of flooding, flood emergencies and other negative consequences of drought is higher than in surrounding countries.

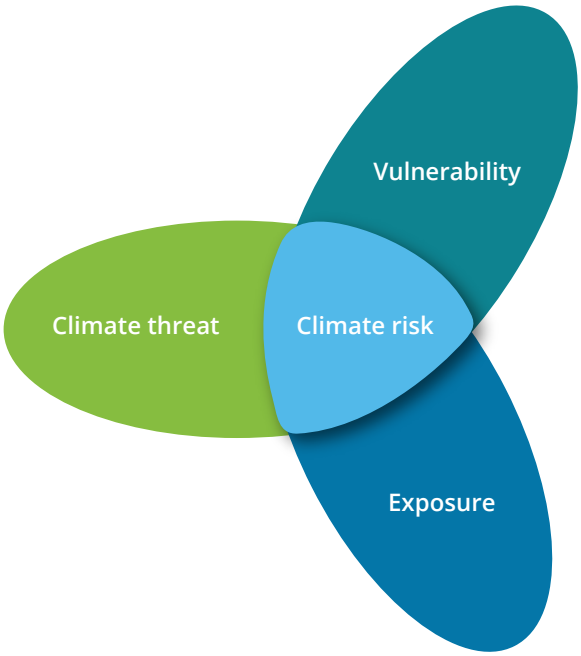

Figure 2. The three factors of climate risk as also used by the IPCC (IPCC, 2012).

The Netherlands can therefore expect several types of increased climate change risks (climate risks). Figure 2 shows the three factors contributing to climate risk as communicated by the IPCC (IPCC, 2012). Table 1 explains these three factors with a flooding related example.

The 1953 flood disaster in Zeeland is the historical epitome when it comes to threats against which the Netherlands has had to protect itself. The Delta Programme and the Delta Works were the response to the threat of flooding from the sea (see also Appendix 6.2).

Risk	Explanation
Threat	The event with a possibly negative impact, such as a flood causing water damage.
Exposure	Objects in an area where the threat could occur, such as a street that is easily prone to flooding during heavy rainfall.
Vulnerability	The propensity of exposed objects to be negatively affected by the threat. One example would be the impossibility to warn all residents in the same street on time, so they are unable to secure their possessions before heavy rainfall can cause water damage.

Table 1. Explanation of the three climate risk factors that IPCC uses (IPCC, 2012).

The Delta Works are a prime example of how to reduce risk exposure by adapting against the threat of flooding from the sea. Keeping the water out makes the threat less relevant, but without the Delta Works, our possessions and ourselves would still be just as vulnerable during high water.

The multilayer safety model introduced as a concept in the first National Water Plan (Central Government, 2009) specifically focuses on flooding. Multilayer safety (Figure 3) assumes measures within both primary1 and secondary2 (also known as regional) flood defences.

This model also plays a role in the cases of Limburg (Chapter 3) and Rotterdam (Chapter 4), which are discussed later in this report. We have slightly modified the model to better align with the context of the report - adaptation for extreme weather due to climate change.

Risk awareness is a key feature of this model, any drive towards the other layers could not do without this.

We define three layers in this respect:

prevention,

consequence mitigation and crisis management during; and,

climate-resilient restoration

[1]The primary flood defences provide high tide protection against flooding from the North Sea, the Wadden Sea, the major rivers Rhine, Maas and Westerschelde, the Oosterschelde, the IJsselmeer, the Volkerak-Zoommeer, the Grevelingenmeer, the tidal part of the Hollandsche IJssel and the Veluwerandmeren (Rijkswaterstaat, undated).

[2]Unlike primary flood defences, secondary flood defences do not directly protect the land from the outside water. Canal dykes, basin dykes and polder separations are considered regional flood defences (Delta Expertise, undated).

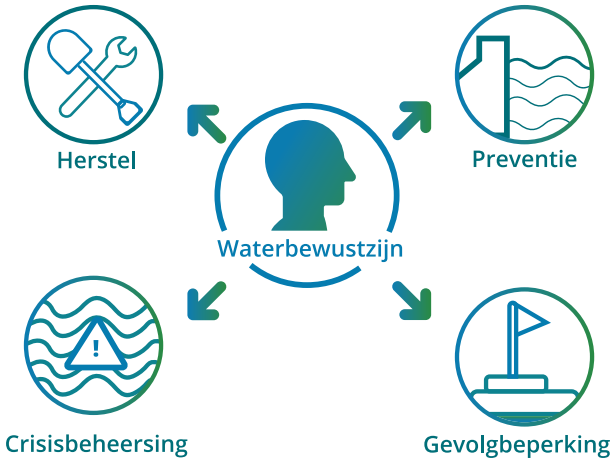

Figure 3. Multilayer safety from the policy round table's advice (Policy Round Table on Flooding and High Water, 2022).

Prevention focuses on the threat itself and reducing its likelihood. While consequence mitigation can be implemented beforehand, another option is to align this with reparation by doing it such that it reduces vulnerability or exposure: climate-adaptive or climate-resilient restoration. Generally, the multilayer safety perspective is enough to also apply to climate risks created by extreme weather, such as drought or heavy rain.

Both existing and new climate risks increase the threats. We are still trying to mitigate the various types of threat, such as extreme precipitation, sea level rise and drought, by mitigating the greenhouse gas emissions, which is one way of prevention. Adaptations are needed for the threats we cannot prevent. Because of the Delta Works, when it comes to sea level rise the Netherlands is still looking good for the foreseeable future, although climate change does increase the likelihood of water from the sea threatening us. Hence, the Delta Works will have to be revamped or replaced sooner than expected (Delta Programme, 2023).

The difference between the adaptations needed to cover increasing climate risks and the adaptations already implemented can be defined as the adaptation gap. This starts at zero in the past (no climate change) and as long as climate mitigation is not complete it will continue into the future. Apart from mitigation targets, natural processes have started that will continue for decades to come. The climate is changing. The adaptation gap is closed when climate change has no effect on us because we have been able to fully compensate for it through adaptations. Using the climate risk factors in Figure 1, we can classify adaptation forms as shown in Table 2, distinguishing between preventive and reconstructive adaptation forms. A preventive adaptation can limit a threat's impact by reducing exposure or vulnerability. A reconstructive adaptation takes place afterwards and aims to repair damage suffered due to climate risks.

ne example would be a financial compensation paid by an insurance company. Should a climate threat lead to an emergency, immediate consequence mitigation and crisis management is still in between these two adaptation phases. Crisis management needs well-functioning emergency services and security regions.
One of the respondents has indicated that private parties, such as insurers, could well help in this regard. You may think of an early warning system and prevention of consequential damage

Type of adaptation	Explanation
After incident (reconstructive)	Reparation, with preference for more climate-adaptive or climate-resilient restoration.
Reducing exposure (preventive)	Area adaptation such as raising dykes, increasing drainage capacity, urban greening.
Reduce vulnerability (preventive)	Measures to mitigate the negative consequences of any threat of exposure. Measures could include placing sandbags or water partitions in case of flooding, or using previously collected water in rain barrels during periods of drought.

Table 2. Adaptation may either be reconstructive, after a threat has occurred, or preventive, which means that the factors of exposure and vulnerability are reduced beforehand.

Following crisis management, an additional intermediate layer may be considered: immediate aftercare. This phase takes place after the immediate crisis is over; it requires attention and coordination but can contribute to climate-adaptive reparation.

All adaptation starts with climate risk awareness and taking measures, so as to be prepared. Taking out insurance is one of those measures, as is collecting and storing water when there is too much of it, so it can be used in times of shortage. Table 3 lists a number of climate risks identified by KNMI (KNMI, 2021) with an example of an adaptation option.

Threat	Adaptation	Where applicable
Higher sea levels	Higher sea dykes, and delta works	National
More extreme summer rainfall	Improved water drainage and higher building	Local
Prolonged drought or heat	Store water locally and create more greenery	Urban environment
Low water in summer and high water in winter for rivers	More forms of water storage to level	Entire delta

Table 3. Threats and preventive adaptations and where they may be applied.

Adaptation may be effective at different scale levels:

- nationally - adaptation may involve large-scale investments in improved infrastructure, such as the Delta Works;
- regionally - their scale is smaller and specific to the environment, such as planting more trees in the city to reduce the heat island effect;
- locally - options include green roofs, which can help at the level of buildings and is one of the adaptations that a homeowner could implement.

Local adaptation can sometimes partially compensate for a possible lack of larger-scale adaptation. In a city with little green space, a green roof may provide some relief (Stone et al., 2014). But sometimes the larger-scale adaptations are crucial. For example, individuals will never be able to reasonably stop a breach of primary flood defences (the exposure). While taking timely precautions against water can reduce vulnerability, here there is a clear contrast in the ability to ensure protection between those involved at the local level and those at the regional/national level. What's more, anti-flooding solutions are also regularly located in a different local area than the area at risk of flooding.
One example is Limburg, where water can be better collected in the Heuvelland tourist area

Minimising the adaptation gap by implementing as many adaptations as possible is clearly important for the Netherlands in the long term. The challenge lies in financing these adaptations.

One way to achieve this is to fully finance these expenditures with government-issued subsidies. One example of the effect of direct government intervention is the popularity of electric cars, which have been made cheaper to buy because of subsidies. If the government is to fully subsidise this, it will either have to increase taxes in the Netherlands or issue more state loans to cover the costs. This would avoid putting the burden entirely on residents and businesses (CPB Netherlands Bureau for Economic Policy Analysis, 2023). Another way is to have the financial sector join the effort of helping society to move away from the risks of climate change.

In managing money flows and making decisions about what to finance and where to invest, the financial sector performs an important function in our daily lives. These functions are largely vested in private institutions such as insurers, commercial banks and pension funds. They can potentially be leveraged (more extensively) to achieve joint solutions (Green Finance Institute, 2023). Likewise, the sector can help customers understand future risks so they can use this knowledge when making decisions.

2.2 Climate risks and the financial sector

The government estimates the cost of climate change damage, including damage to property and infrastructure and damage because of transport delays, to be between EUR 77 billion and EUR 173 billion by 2050 (Central Government, 2022). An ideological issue is whether the current generation should be allowed to pass on the long-term risks and consequences of short-term decisions to future generations.

An economic method to factor in long-term risks and consequences is to price them and determine what is economically responsible for short-term decisions. Both the ideological and economic perspectives require an understanding of the short and long-term risks and consequences and how they should be financed. By issuing more green bonds the government can be directly involved in meeting the need for understanding and financing (Dutch State Treasury Agency, undated). This is a structure where investors provide loans to the government with the government only spending the borrowed money on projects that promote a better climate. The Dutch State Treasury Agency assesses these bonds and they have already provided the Netherlands with some EUR 9 billion since 2019 (Central Government, 2022). On the other hand, the government itself is in great need of new financing models from the financial sector, as this would make it easier for them to join private projects.

Through the money flows managed by the Dutch financial sector, the government also has indirect influence on the financing of climate adaptation. To indirectly finance climate adaptation the government can basically impose rules on both the financial sector and its customers. One example is imposing more climate-adaptive requirements on the services that financial institutions offer their customers, such as resources that demonstrably guarantee safety in case of flooding.

Accelerating adaptation can be done by examining the current constraints delaying adaptation and addressing their causes. This report focuses on further engaging the financial sector and the relevant constraints and possible accelerators involved.

The division into banks, pension funds and insurers was chosen because of their role in society, with each having its own primary focus, as shown in Table 4. This is a simplification of how financial institutions actually interpret their role (in society). For instance, pensions may be regarded as a specific form of income insurance (European Central Bank, 2023) and insurers operate as investors (ESRB, 2015).

Risk	Risk bearer	Financier	Investor
Insurers	●		●
Banks		●	
Pension funds			●

Table 4. Primary roles of the three socially-relevant financial sub-sectors.

In these roles, financial institutions can contribute to accelerating climate-adaptiveness of the Netherlands in their own way:

- financial risk bearers - can promote adaptation by guaranteeing financial protection when threats from climate risks arise (ESRB, 2015);
- financiers - can accelerate adaptation by offering loans that enable residents, businesses and governments to finance or manage physical adaptation (Bank of England, 2020);
- investors - can accelerate adaptation by investing in adaptation projects that require financing (Della Croce, Kaminker, & Stewart, 2011).

Figure 4 is a chart showing how financial sector services fit into the climate risk factor model with preventive and reconstructive adaptation. The basic assumption is that climate risk awareness leads to better preparedness and adaptation, as shown in the Limburg case (Chapter 3), so that damage is prevented or mitigated, or damage suffered is repaired in a sustainable way. Financial sector services align with this and can drive an interaction to promote and accelerate overall adaptation.

First of all, there is a need for financial protection should climate-related negative impacts occur. This is no different from the past, but demand may increase. In addition, when borrowing money climate adaptation may either trigger the demand for finance or be part of the considerations on whether or not to grant the loan. Investing in climate adaptation so that risk is reduced can in itself provide a return. It can also be part of a long-term strategy in which investments will generate a benefit in the longer term

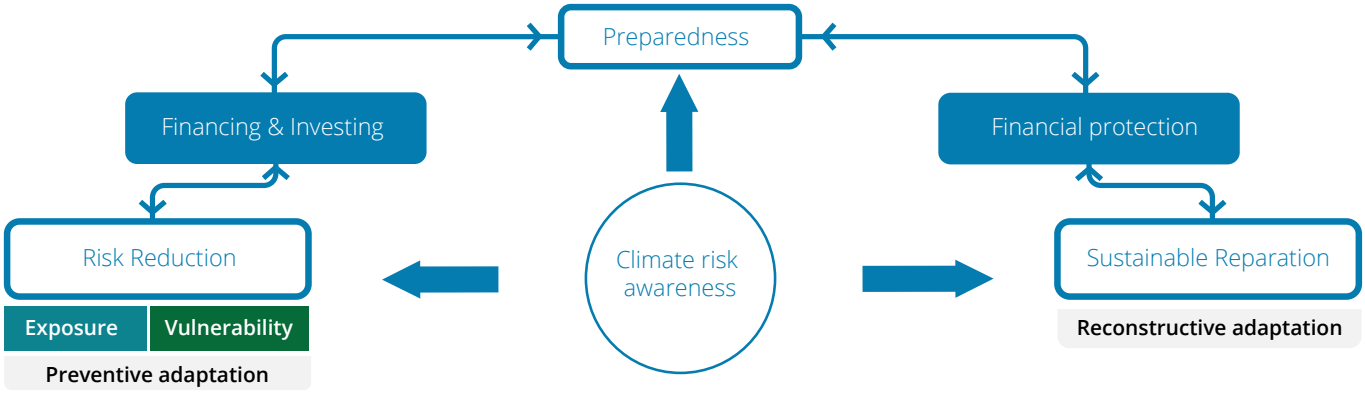

Figure 4. Positioning of financial services within climate adaptation.

The components in this chart interact with each other. Climate-resilient restoration will typically require investment to implement adaptation that reduces exposure or vulnerability to a climate threat. This form of linking avoids future damage (see Figure 5). If preventive adaptation has been implemented, this may also increase the desire to protect it financially. At the core, climate risk awareness and the need to be prepared for the future remain essential. Lacking this, the will for further climate adaptation will stall.

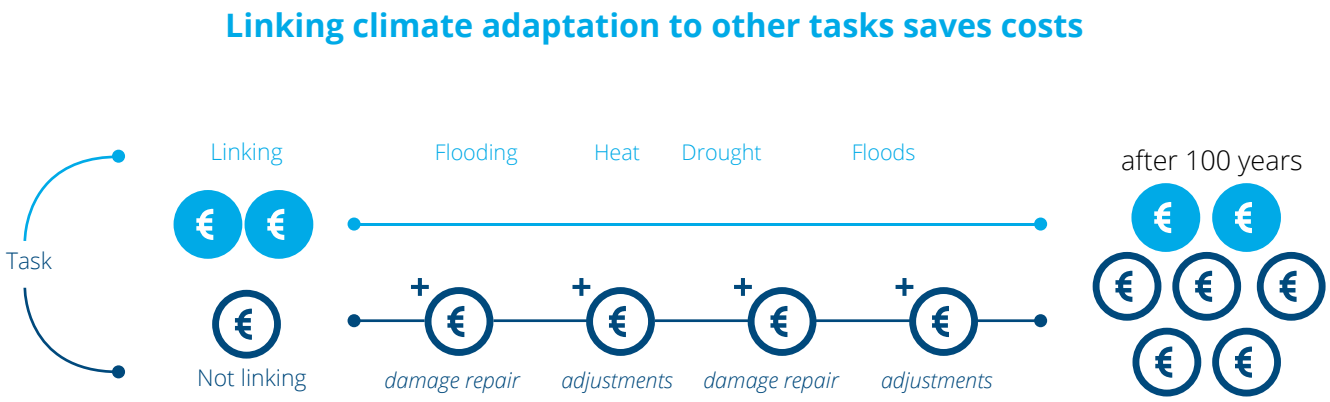

Figure 5. Linking helps avoid costs due to climate adaptation over time (Ministry of Infrastructure and Water Management, 2022).

The essence of commercial financial institutions is to create value for its stakeholders by selling its products and services. Generating profits is crucial in enabling owners and investors to realise returns and invest in talent and innovation. A financial institution could include climate-adaptive initiatives in its positioning, similar to sponsoring charities. A more future-proof option is to make climate adaptation a valid commercial purpose and to align the goals of Dutch society with those of the financial sector. The key issue here is to have a realistic awareness of the short-term climate adaptation costs. Our research shows a lack of scalable examples of positive short-term business cases for climate-adaptive measures. Hence, the financial sector's financing and investment issues mainly revolve around short-term costs versus future avoided costs and thus factoring in the perceived long-term costs of a short-term decision. On top of this, adaptations are not always possible at the individual level.

2.3 he financial sector's current contribution to climate adaptation in the Netherlands

The financial sector comprises thousands of deposit banks, investment product providers, insurance companies, other credit and finance organisations and the providers of the essential financial facilities and services in support of these financial functions. A large number of other service providers, such as financial advisers and estate agents, operate in their periphery. They have an important role in direct contact, advising on risks and providing support in decision-making.

Its size and social importance allow the Dutch financial sector to play a crucial role in promoting climate adaptation. Facilitating the flow of capital towards sustainable and resilient investments and offering financial products and services that promote climate adaptation are among the options available.

The complexities of climate change uncertainties are only partially examined in investment considerations and analysis is mostly limited to profit maximisation of individual companies (Ginbo, Di Corato, & Hoffmann, 2022). So, while the business community widely supports the broad prosperity approaches and the UN's 'Sustainable Development Goals' (United Nations Development Programme, undated), short-term profit maximisation is expected to take precedence (Corporate Citizenship, 2016), even though climate scientists such as Johan Rockström also say that the private sector is needed for the climate transition (The Guardian, 2021).

This research divides the financial sector into three sub-sectors: insurers, pension funds and banks. Insurers are particularly defined as non-life insurers, as they will be the first to be involved in restoring climate damage by making reparation payments. They are also increasingly taking over the entire restoration process (restoration in kind).

These sub-sectors have one great common denominator: they are driven by capital and have a socially relevant position, since a major part of society depends on banks when buying a house, has insurance to protect that house from fire or storm damage, and is affiliated to a pension fund to continue living in that same house after retirement. The modern standard of living depends on the financial sector's services.

This central social position is the key factor in allowing the financial sector to make an important contribution to climate adaptation and keeping its own investments and products profitable at the same time.

In this process, the government is primarily responsible for a climate-adaptive Netherlands and it introduces legislation that is decisive and sets the framework for financial institutions' policies. The collaboration between the government and the financial sector is thus contributory to the speed at which the Netherlands becomes climate-adaptive. The following section outlines the resources the sector is already using to make the Netherlands more climate-adaptive, followed by the opportunities still to be explored.

2.4 Financial sector already has measures in place to promote climate adaptation

The financial sector signed the Climate Commitment in 2019, as part of the Dutch Climate Agreement. This initiative shows their commitment to contribute to the goals of the Paris Agreement by reducing greenhouse gas emissions by 49% by 2030 compared to 1990, with broad support and collaboration from all stakeholders (Financial Sector Climate Commitment, 2023). The financial sector currently focuses on measures promoting climate mitigation and countering climate change, including both greenhouse gas emission reductions by the sector itself and measures encouraging their customers and suppliers to do the same. However, the focus on measures promoting climate adaptation, aimed at adapting to the changing climate, is still fragmented and limited (Bor, Duiker, & Hertog, 2021).

Many financial institutions have only recently placed climate adaptation on the agenda (EerlijkeGeldwijzer, 2023). DNB conducted a thematic research and found that insurers have started paying more attention to climate risks, but that half of the insurers researched need to improve the quality of disclosures and substantiations to accurately determine whether this attention is sufficient (De Nederlandsche Bank, 2021). In 2017, the Dutch Association of Insurers established an issues committee with recommendations, which was scaled up to a platform with a structural agenda for non-life insurers in 2020. The DNB initiated the Climate Adaptation Working Group to generate more climate resilient investments at banks, insurers, and other investors (De Nederlandsche Bank, undated). DNB has also conducted various researches into climate risks within the pension sector, concluding that although climate change is gaining importance at pension funds, as yet the risks are insufficiently integrated into risk management (De Nederlandsche Bank, 2022).

DNB concludes that financial institutions have insufficiently embedded climate risks in their core processes and should do more to identify their own climate risks (Het Financieele Dagblad, 2023

Examples of resources the financial sector can deploy to mitigate climate risks are (Bor, Duiker, & Hertog, 2021):


Informing customers about the risks,


Conducting climate risk analyses,


Issuing price incentives to their customers,


Innovative financing,


Adjusting the terms and conditions of their products, or introducing new products.

Informing customers can reduce risks if this means they are better prepared for what climate change means for them. Climate risk assessments can be used to better assess climate change damage and impairments resulting from transition risks, such as higher insurance claims on the back of more climate-related damage (Bank of England, 2017). In addition, financial institutions can create more awareness among customers, which can reduce damage. Financial institutions could offer financial incentives or newly developed products to encourage customers to make climate-adaptive choices.
Innovative financing may include crowdfunding or purchase discounts. Finally, if financial institutions themselves change their terms and conditions this may encourage customers to adopt policies in which they also include climate adaptation

2.4.1. How legislation, regulations and policies affect the financial sector

The specific financial regulations, such as Solvency II for insurers (European Commission, 2009), the Basel Accords for banks (Bank for International Settlements, undated) and national and international regulations for pension funds (De Nederlandsche Bank, undated), indirectly affect the opportunities that these financial institutions have to invest in and finance climate adaptation.
First, the regulations impose certain capital requirements on financial institutions to ensure that they have sufficient capital available to absorb potential losses. This can be restrictive for investments in higher-risk assets, such as new green or sustainable projects, as they are considered riskier and thus require a higher capital lock-up. Second, financial regulations such as Basel and Solvency take into account the risk involved in assets held by financial institutions. Thus, assets with higher environmental or climate risks may lead to higher capital requirements and this may discourage financial institutions from investing in sustainable projects because, as interviewees explain, they are considered riskier (De Nederlandsche Bank, undated), (Insurance Europe, 2023).

2.4.2 Non-life insurers

Climate change exposes ever more people and businesses to climate-related risks, such as extreme weather, floods, droughts and forest fires. This results in more than just an increasing need to use climate-adaptive measures to mitigate physical risk; to cover the financial consequences insurances need to be taken out as well. Of all sub-sectors, non-life insurers are the first to face the financial climate change consequences, through claims following extreme weather such as intense showers resulting in flooding (Dutch Association of Insurers, undated).
Through their commitment to greenhouse gas emission reductions, non-life insurers, too, are working on mitigation. Insurers recognise their significance in this respect and have joined the Net Zero Insurance Association (NZIA) to, for example, reduce emissions from their existing insurance portfolios and eventually bring them down to zero (Net-Zero Insurance Association, undated) (PCAF, 2022). Measures would include sustainable damage repair, insuring the energy transition, and guiding customers towards cleaner business operations

Insurance companies in the Netherlands have introduced insurance products that provide cover against climate-related risks, such as insurance cover for damage caused by extreme weather conditions such as wildfire, lightning, storm, hail, snow and precipitation. In recent years, insurance cover against flooding and local floods have also become increasingly standard. From the policyholder's perspective, taking out such insurance is a form of adaptation by anticipating possible damage. Not all damage can be insured, for individuals and SMEs this concerns, e.g., subsiding houses and flooding of primary flood defences.

Climate risk assessments are another way in which insurers promote climate adaptation, as our conversations with insurers show. They want to better understand how the potential impacts of climate change affect their policyholders. This may include evaluating the vulnerability of insured assets to climate-related risks and incorporating climate risk assessments into their underwriting processes. Policyholders can use those insights to take measures such as placing water partitions in the event of a flood (Waterklaar, undated) to adapt to a changing climate. Insurers are also increasingly working on warning mechanisms to give their customers additional actionable options just before an event.

Insurers are thus already offering their customers more climate adaptation tools, by expanding their products and initiating climate risk assessments. In accelerating the development of climate-related risk mitigation, society must enhance its awareness of climate risks and its knowledge of how to adapt to them. According to insurers, only when residents are sufficiently aware will there be a rise in demand for the climate risk information that an insurer can provide.

Whether or not awareness about and demand for climate risk information is on the rise, physical risks of climate change continue to increase while, for example, up until the 2021 Limburg flood, the demand for climate catastrophe insurance had been limited. This often stems from insufficient awareness of both the risk and the insurance options. Interviews for this research likewise show the insurers' attempts to increase customers' climate awareness by providing them with information and advice on climate change risks, which can be difficult. For example, following the 2021 Limburg flood many victims were poorly informed about the content of their policy. Also, the extent to which everyone has access to correct information needs to be investigated.

This is why insurers have now included a standard clause on the risk of 'failure of secondary flood defences' for most individuals. SMEs, too, now have a greater choice: some 70% of entrepreneurs are now insured for this.
The Association collaborates with Adfiz and the VNAB to raise awareness in this market. But they are unsuccessful in their attempts to do so for the risk of flooding of primary defences (with a few exceptions). The Dutch Association of Insurers has published a position paper in which it identified three reasons for the limited demand (Dutch Association of Insurers, 2020):

1. Insufficient awareness of the actual flood risk;

2. A misconception in society that the government compensates all flood damage, also referred to as a charity hazard3. The misconception is rooted in the Disasters (Compensation) Act, enacted in 1998 (Dutch government, 2021). In practice, this is applied less widely than citizens expect;

3. Adverse selection, where sellers (or buyers) have information about a particular aspect of the product quality that the other party does not have (Pauly, 1974). Adverse selection also plays a role in low demand and unfavourable terms and conditions and premiums for highest-risk areas, thus compromising solidarity.

The above reasons are why virtually none of the consumers or SMEs are insured against flooding from major rivers, such as the river Meuse, major inland waters, such as the IJsselmeer, or from the sea. This makes them dependent on partial relief from the safety net scheme called the Disasters (Compensation) Act (DCA). The DCA is a Dutch law that provides for a compensation scheme for citizens and businesses in case of disasters, under which the government pays them a financial compensation. The DCA does not cover everything, usually only damage to property and goods. Also, the DCA needs approval from the Dutch House of Representatives before it can become effective. This can take some time and depends on political decision-making. The percentage of damage compensated under the DCA depends on the severity of the disaster and may vary.

The DCA implies uncertainty in advance, not only for citizens and entrepreneurs, but for their financiers as well. What's more, a scheme needs to be set up after the fact, causing many delays. The capacity of private markets for certain risks (flooding of primary flood defences) is too limited. The government can set a lower limit in excess of which the government will compensate any damage and be clearer about which damage the government will and will not compensate. In improving the capacity of private markets, making better arrangements with insurers on the government's handling of the compensation and the government acting as a reinsurer are aspects to be examined.

Improving the DCA is an option. The Expertise Network for Flood Protection (ENFP) recommends to explicitly extend the scope of the DCA to include flooding of inner-dyke areas from the primary system. As yet, the wording in the law is unclear. "An explicit expansion provides clarity to groups such as citizens, the financial sector and parties abroad on how the government regards these risks," says the ENFP (Expertise Network for Flood Protection, 2023). In their advice to the government, the Dutch Association of Insurers has also elaborated on a number of options. The Association spots opportunities, provided there is public-private collaboration, such as a reinsurance pool with a strong risk-bearing role for the government, or implementation agreements entered into between the sector and the government for the current compensation scheme under the DCA, clearly identifying the victims' position in advance. Paying attention to prevention can also help reduce any cost of claims. The public-private system can have both advantages and disadvantages. They are listed below.

The benefits of a public-private system:

- In the event of a flood, claims can be handled quickly through a single point of contact, the insurer, based on pre-agreed terms and conditions and using thousands of experienced staff and efficient software systems.
- For victims, it no longer matters where the water comes from. Damage settlement is adequately handled and settled by the insurer (at the back end).
- Insurers cannot bear the financial consequences of major flood damage alone. This requires reinsurance. The more the government participates, the less the need for reinsurance in the international market.
- Financial participation by the government guarantees a government interest in keeping flood prevention in order.
- It also encourages citizens and SMEs to think about and take measures against flooding. Insurers can further encourage prevention among their customers (and potential customers), e.g., through policy conditions, awareness-raising, and advice.
- In case of an impending flood, they can also advise their customers on emergency measures appropriate to the customer's specific situation.

[3]Charity hazard is the tendency of individuals not to take out an insurance or take other mitigating measures because of their dependence on expected financial assistance from government aid programmes, or donations from other individuals (Raschky & Weck-Hannemann, 2007).

Disadvantages of a public-private system

- The main disadvantage is the high cost of risk diversification and financing the damage. The accumulation of exceptionally high damage in a single year over an unpredictably long period makes private insurance solutions relatively very expensive, and premiums are much higher than the annual expected damage.
- In the Dutch situation, if the damage caused by large-scale flooding is very extensive, government compensation is the most advantageous in macroeconomic terms.
- The government has the option of spreading costs through taxation on all residents or by increasing the national debt.
- Considering the magnitude of disaster damage, the question is whether the private insurance has enough assets to pay out. In addition, ENFP wonders to what extent the private insurance can hold the government liable for the damage suffered.

So, the solution is nuanced and has advantages and disadvantages and they cannot directly cancel each other out. One example is the idea of a single point of contact, which is not dependent on a public-private solution. This is one area where the current DCA could be improved, according to ENFP. ENFP also indicates that it should be easier to insure properties in outer-dyke areas. Clear and transparent communication is essential in this respect: each single party involved must know whether a site is located outside a dyke. This allows people to consciously take a certain risk by living in an area with a higher risk of flooding and, in addition, choose whether or not to insure for this risk (Expertise Network for Flood Protection, 2023).

Insurers must also anticipate and learn how to deal with increasing risks in their portfolios. If insured events will occur with increasing probability, it may not be commercially attractive to continue providing cover for them, unless this is compensated through large increases of the premium to be paid. So other forms of adaptation are needed when better insurance alone proves inadequate. Interviews with the insurance sector indicate the desirability of closer collaboration with the government. The sector signals that situations may arise that are impossible to insure and cannot be covered by the commercial insurance market, such as the uninsured breach of primary flood defences.

In interviews insurers have expressed their wish to extend their efforts in climate-resilient restoration. The common practice is to restore damage to its former state. Nevertheless, making improvements is another option.
Still, interviewees see the current interpretation of legislation in this area (the indemnity principle, see also section 3.5.2 within the context of the 2021 Limburg flood) as an impediment to the related possibilities.

Insurers have to consider a changing market, where climate change risks are on the rise, resulting in the insurance product itself being at risk as well (Dutch Association of Insurers, 2021). Further climate change is expected to increase the claims paid. By taking climate-adaptive measures now and encouraging their customers to do the same to reduce the future total expected cost of claims, insurers can mitigate the consequences. Once again, providing information is another key tool in this respect.

2.4.3 Pension funds

The important social function of pension managers and pension insurers in the Netherlands lies in their work to ensure the financial security of residents after their retirement age. To do so, they must act as asset managers and asset investors. By far the largest share of the total amount of pensions is paid to pensioners through their employers, which have pension funds manage the money deposited. Pension funds collectively have significant capital at their disposal and they invest this to grow their customers' pensions. So their choices on how to use this capital for improved climate adaptation can have a substantial impact. The joint Dutch pension funds have a capital of about EUR 1.700 billion (Statistics Netherlands, 2022), so the Netherlands has the sixth largest pension capital in the world (Consultancy.nl, 2020). While the policies of pension funds in the Netherlands, such as those of the four largest funds (ABP, Pensioenfonds Zorg & Welzijn, BPF Bouw, Pensioenfonds Metaal & Techniek), all include climate adaptation, the various funds have different levels of ambition in terms of climate and the focus on climate adaptation.

Pension funds are aware of the possibly negative impact of climate change on the value of their assets. Extreme rainfall and drought are just two examples of proof that investment assets such as agricultural businesses, real estate and infrastructure can be damaged or even rendered unusable. Besides these physical risks to their own assets, pension funds also refer to transition risks in their rationale for investing in mitigation and climate-adaptive initiatives, indicating that less, if any, investments are made in companies that risk losing their business models due to these transition risks. One example is the General Pension Fund for Public Employees (Algemeen Burgerlijk Pensioenfonds, or 'ABP'), whose climate policy states that it will no longer invest in the fossil industry. The four largest Dutch pension funds are investing in solar and wind energy, hydrogen plants and electric car fleets instead.

The pension funds' plans include actions and ambitions on climate adaptation, for which risk analysis is important in making sensible choices for investments. One such fund, the APG (Algemene Pensioen Groep) has a Real Estate Database containing the climate risks of its own real estate investments (ABP, 2022).
The pension fund for the healthcare and social welfare sectors, Pensioenfonds Zorg & Welzijn, makes its investment decisions based on a climate risk policy by looking at profitable investments in a time of changing climate (Pensioenfonds Zorg & Welzijn, 2022).
The pension fund for the engineering, mechanical and electric contracting sector, Pensioenfonds Metaal & Techniek, analyses climate risks in the investment value chain (Pensioenfonds Metaal & Techniek, 2022).

In their roles as financiers, pension funds can innovate, too. The pension fund for the construction industry has made factories in lower-lying areas waterproof to ensure they are more flood-resistant (BPF Bouw, 2021). The fund has also integrated climate adaptation capacity in their investments in government bonds. APG has financed the renovation of the Afsluitdijk barrier dam through a consortium (Van Oord, 2018).
So, pension funds make their own risk analyses in their role of investors, with their main interest being in the effect on the value of their investments. They also contribute directly to making the Netherlands climate-adaptive by investing in Dutch climate-adaptive projects, although these projects do need to generate sufficient returns for their funds so they can continue to meet their obligations towards customers in the long term.

Pension funds, especially those with a focus on the long term, recognise the risks facing the Netherlands, and acknowledge the importance of socially responsible investments. The funds experience a lack of investment opportunities in climate adaptation projects. The interviewees have attributed this to a lack of structural demand for financing from providers of projects promoting climate adaptation.
Most projects on offer are too small to be attractive to a large investor like a pension fund.

2.4.4 Banks (and other mortgage lenders)

This research follows a three-way division of the financial sector into banks, insurers and pension funds. It is important to note that banks are not the only mortgage lenders and this also encompasses insurers and regulators. Climate change affects the banking sector through physical risks, such as extreme weather events, and transition risks, such as uncertainties about the transition to a sustainable economy (European Central Bank, 2022). With banks being exposed to these risks through financing and investments in public and private parties, they benefit from identifying, managing and accounting for climate risks. DNB's report 'Towards a sustainable balance' shows that compared to insurers and pension funds, banks make less use of scenario analyses (De Nederlandsche Bank, 2021).
Banks focus more on climate mitigation, such as aligning their portfolio with the Paris Climate Agreement, and reducing greenhouse gas emissions. Banks do have an interest in protecting their assets from issues like flooding.

One of the interviewees explained that many banks currently focus on reducing CO2 emissions from investment and loan portfolios and combating criminal activities. Safety against extreme weather is primarily regarded as a government task and the financial sector should not be the first to act.

That said, banks are also directly and indirectly exposed to the climate change consequences. One example is that flooding of primary flood defences is not insurable (Dutch Association of Insurers, 2022). If a borrower is unable to recover, a bank may face losses. If an uninsurable risk affects the collateral for loans (e.g., a house), this may lower the Loan-to-Value (LTV) and thus may require refinancing or additional equity, which may affect the bank. The Dutch Association of Insurers published a position paper in which it identified three reasons for the limited demand for insurance for primary flood defences (Dutch Association of Insurers, 2022)

Mortgage lenders, including banks, have options to adjust and differentiate mortgage loans based on various factors, including location and degree of climate risk. However, there are some nuances to note (De Nederlandsche Bank, 2020):

- Banks can differentiate mortgages by offering different interest rates and conditions based on the risk profile of the borrower. This could result in mortgages for homes in vulnerable areas, such as outer-dyke areas, being subject to higher interest rates or stricter conditions.
- Banks may limit maximum mortgage amounts for homes in certain high-risk areas. This could result in buyers in those areas having to put in more of their own resources to finance the purchase.
- Banks may impose additional requirements on borrowers to adapt to climate risks. This could result in borrowers in vulnerable areas being required to invest in additional protective measures, such as flood-proof improvements to their properties.

And yet practice shows that banks do not currently differentiate by postal code and climate risk. This is due to constraints in their systems, which can affect the practical implementation of such differentiation and lead to technical challenges in managing various mortgage products and requirements. Achieving the said differentiation requires a complex process that must take account of several factors, including financial, regulatory, technical and ethical considerations. In addition, sweeping policy measures are a transition risk factor (De Nederlandsche Bank, 2023).

What's more, financial institutions must comply with legislation and regulations requiring equal treatment and non-discrimination, explains one of the interviewees. Differentiating mortgages based on location may thus raise ethical and legal issues, as it may be seen as discriminatory against certain communities or groups. Banks have a responsibility to look after the interests of their customers. Differentiation based on location may result in some customers, especially those living in vulnerable areas, losing access to financing or having to bear higher costs.

The outcomes of the interviews outline that the actions of banks and the financial sector as a whole to make the Netherlands climate-adaptive should result in the market moving away from risks in a gradual process. The objective of this is to promote stability, predictability and social acceptance, and to mitigate and manage the risks associated with abrupt and unexpected shocks in the market. One example regards the foundation issues in the municipalities of Zaandam, Gouda and Dordrecht, where house prices have been discounted by the cost of whether or not the rotting foundation has already been addressed. If houses need to be strengthened this is the municipality's responsibility, as building safety regulations stipulate that safety is part of its range of tasks. But owners are responsible for the foundation. In practice, many people cannot afford the necessary foundation modifications. Government regulations and market implementation communicate the risks through the sales channels, so a foundation's condition is reflected in the asking price. This provides the buyer with a certain discount on the purchase value based on the foundation's condition, freeing up budget for its adaptation (Deltares, 2020).

A bank may include price incentives in financing products to influence customers to opt for climate-adaptive choices such as planting more greenery to reduce heat in their own gardens. Likewise, a bank can inform its customers about the consequences of climate disasters by educating them about the risks of their financing requests and investment decisions (Bor, Duiker, & Hertog, 2021). The question is whether the bank is best suited for this role or perhaps the estate agent who brings together supply and demand. Unless it is certain that there are no exceptions, flood areas cannot be used as a benchmark. The only alternative is to indicate flood risk for a house at postcode and house number level. And a flood risk may also result in this cover being excluded from the buildings insurance in certain situations, or even in a mortgage not being possible at all.

For now, banks themselves are responsible for estimating climate risks; the regulator expects the banks to be familiar with them. The research shows that banks do have insight into a future loss of value or a diminishing capacity to pay, or both, which they use to determine whether they can bear any losses in different risk scenarios. A related new set of climate risks has recently been adopted. This very recent data originates from Climate Adaptation Services (CAS).

The most recent climate risks being included in a bank's risk analyses is evident from one of our interviews.
These risks include both transition risks, e.g., outstanding loans to companies in the oil and gas industry, and physical risks, e.g., high outstanding loans with collateral located in areas with an increased risk of storm or flooding.
The ECB conducted a climate risk stress test in 2022, examining the risks of climate change and the transition to a society free of greenhouse gases (European Central Bank, 2022). The stress test indicates that the combined credit and market risk losses for the 41 banks under different climate risk scenarios are around EUR 70 billion in the short term. These losses can probably be reduced if the Netherlands is better prepared for climate change.

Dutch banks are currently using price incentives to combat climate change, focusing on reducing greenhouse gas emissions or encouraging the use of green energy. Examples include the Triodos mortgage or the Rabo Green Mortgage, which reward mortgage applicants with lower interest rates if they make their homes more energy efficient or buy a sustainable home. However, these price incentives are less focused on encouraging adaptive measures - although households consuming less energy can be seen as adapting to the transition risk of sharply rising energy prices. Banks increasingly have a better understanding of future climate change-related property value loss and customers' diminished capacity to pay, or both. This includes assessing the accumulation of risks, rather than looking at assets for each risk.

Besides price incentives in certain products, banks also inform customers about climate risks as part of their customer relationships. In doing so, they play a major role in raising their customers' awareness of climate adaptation, as our interviews show.

Nederlandse Waterschapsbank

Nederlandse Waterschapsbank (NWB Bank) is a bank by and for the public sector, which specifically focuses on water and sustainability. In terms of total assets it is the fifth largest bank in the Netherlands. Founded after the North Sea Flood for and by water boards in 1953, the bank has traditionally also financed drinking water companies and by now they finance the wider Dutch public sector. They are under the direct supervision of the European Central Bank and have triple A status. The bank finances 90% of the water boards' financing needs, so including climate-adaptive projects such as dyke reinforcement (a form of climate adaptation).
A water board finances investments through loans from NWB Bank, thus regulating the cash flow of a dyke reinforcement project. The subsidy from the High Water Protection Programme (HWPP) provides for the ultimate financing of the project costs, covering 90% of the total project costs. The water boards have to pay the 10% own contribution (plus the cost of interest and redemption to NWB Bank) from their tax revenues (NWB Bank, undated).

Interviews revealed that the bank changed its strategy to play a bigger role in 2018, given the sustainability challenges facing the Netherlands. It would focus on climate adaptation and mitigation and nature restoration and conservation. Since then, the bank has been active in various projects, including renewable energy projects. The bank has been involved in infrastructure project financing since 2012, such as the renovation of the Afsluitdijk barrier dam or the IJmuiden sea lock. All projects are public-private financings, often as part of a Design Build Finance and Maintain contract (DBFM).
NWB Bank started issuing water bonds in 2014. Because investors are enthusiastic about these 'impact bonds' they are subject to less interest than ordinary bonds. This enthusiasm is explained by the bank's transparency about the impact of the investments it finances with these bonds. Every year, the bank, together with Arcadis and the Association of Regional Water Authorities, releases a report on climate (and biodiversity) impacts and the progress the water boards are making towards energy and climate neutrality, one of the interviewees indicated.

Public-private financing

There are few examples of private financing for spatial planning tasks. The only regularly occurring example is the DBFM contract. Under a DBFM contract, the contractor (often the government) procures services (e.g., realising a safe dyke or an available road). A company or consortium assumes responsibility for the complete project, within predetermined preconditions. Depending on the contract, after design, construction and financing the company is responsible for maintenance for 20 or 30 years. Payments are made each month or each quarter (Pianoo, undated).

This form of contract is mentioned in a number of interviews. After its evaluation in 2016, this contract form is now no longer used. Certain aspects of a number of projects, such as the IJmuiden sea lock and the A15, did not go well and received bad publicity. Another 12 DBFM projects did go well and were delivered within time, budget and according to quality standards. The 2016 evaluation explains the role of banks: private financing provides a strong incentive to have the projects realised on time and to optimise availability, also during the maintenance phase. Banks contribute to the quality of the business case and financial management through the involvement of the Lender Technical Advisor. Views differ on the extent to which banks limit the scope for flexibility and innovation (Koppenjan, 2020).

Various studies on DBFM paint a differentiated picture. Some of the big projects had been bedevilled by major problems and this seemed to have created a distorted picture because they had received extensive media coverage. And still most expectations have been met. It involves complex projects with a high degree of uncertainty and when compared with other, similar projects, the results are no worse.

DBFM contracts seem best suited for contracts whose risk profile is limited. In any case, it is one of the few public-private financings with which extensive experience has already been gained (in the past 20 years). Based on publications, several parties have advised to further explore the contract form and strengthen DBFM projects. (Hueskes, 2016) (Van den Berg & Riemersma, 2021) (Rijkswaterstaat, undated). A specific point of attention is how banks can manage projects with a high degree of uncertainty, either because they take a long time or because of possible issues in the subsoil, without the contractor or customer, or both, facing major financial setbacks in the process.

Public-private collaboration can take various forms. Contracts like spatial contracts can also be linked to companies with an interest in the minerals, or a collaborative alliance can be formed involving a shared risk budget. According to one of the respondents, DBFM is a solution if there is a financing gap, but a DBFM contract offers too little room for flexibility. Spatial planning projects have long lead times and unforeseen issues occur. The question is how to best make this work without exposing the business community to major financial risks.

2.5 Government and the financial sector

As described above, the financial sector can play an important role in promoting climate adaptation. The same goes for the government taking climate policy measures to protect the Netherlands from climate change consequences (Central Government, undated). Since both the government and the financial sector have a major influence on society, and on each other as well, collaboration is of great importance. The government regulates the financial sector, which in turn provides services on which the government depends.

Financing activities

In the past, the government borrowed mainly from pension funds and insurers to finance its activities. Nowadays, Dutch debt securities are offered on the international capital market (Ministry of Finance, undated). Since 2019, the Netherlands has also been issuing green bonds, the proceeds of which are intended for sustainable, green expenditures and investments (Dutch State Treasury Agency, undated).
A green bond is a fixed-income instrument designed to support climate-related or environmental projects. Green bonds are used to finance or refinance investments, projects, expenditures or assets that contribute to addressing climate and environmental issues. The global and EU green bond markets grew at an average annual rate of 50% between 2015 and 2020, although they represented only up to a maximum of 3.5% of total bond issuance in 2020. Meeting the goals of the Paris Agreement and the European Green Deal requires a faster growth of a high-quality green bond market (European Commission, 2023).
The Nederlandse Waterschapsbank has already been issuing such debt securities since 2014 (Nederlandse Waterschapsbank N.V., 2022). Such investment funds benefit climate mitigation, but can also be used specifically for adaptation (Dutch State Treasury Agency, 2022).

Financial institutions already invest in green bonds. Like, ABP which held EUR 171 million in Dutch green government bonds in 2019 (ABP, 2019) and called on the government to enable more investment opportunities (APG and ABP, 2020). The Netherlands issues around EUR 5 billion in green bonds every year (Dutch State Treasury Agency, undated). The government does not oblige the financial sector to invest in green bonds, although it is encouraged (Central Government, undated).

Every year the Dutch State Treasury Agency reports on climate mitigation and climate adaptation expenditures in relation to green bonds issued by the government since 2019 (Central Government, 2023).

This report shows that as part of the Delta Fund EUR 508 million (10.2%) of green bond proceeds were invested in adaptive measures against flood hazards in 2022. Through this, the government directly influences the financing of investments in measures against floods and water scarcity.

The government and the financial sector already collaborate. For example, a number of Dutch banks, including the major banks ABN Amro, ING and Rabobank, have set up a Green Fund (Netherlands Enterprise Agency, 2023). Banks can use a Green Fund to provide loans for sustainable projects at lower interest rates than regular loans. The Ministry of Transport, Public Works and Water Management then tests the project to see whether it meets the requirements, after which a Green Certificate is issued.
Climate adaptation is one of the categories in which approval can be applied for.

Complexity of climate adaptation

Our interviews show that both the government and the financial sector realise that climate adaptation is a system-level problem involving all of society.
The shared view is that the combined complexities of the problem and of society certainly complicate the task.
Responsibility in the Netherlands is fragmented and there are many points of contact to turn to, making it difficult to move beyond individual interests and complicating collaboration. As this increases the distance to the required knowledge and expertise, it hampers small organisations such as municipalities.
On the other hand, a decentralised government is easier to approach. So the general perception of government is that it does not always operate efficiently, making it more difficult to act quickly (one example given was how the problems following the drilling of gas in Groningen are handled). Financial institutions, on the other hand, are said to be more agile.

Knowledge and experience

Interviewees agree that the knowledge and expertise of the financial sector could complement the government. Especially municipalities lack the capacity and knowledge to tackle climate adaptation alone. By sharing insights on climate risks at the municipal level, knowledge sharing can take place, so there is a need for further collaboration at multiple levels of government. One of the prime examples of this is the municipality of Rotterdam, where employees are seconded to the financial sector to gain more insight into the sector. We nevertheless also see reluctance - as practice shows, both the government and the financial sector expect the other party to approach the other.

Corporate Sustainability Reporting Directive	The Corporate Sustainability Reporting Directive (CSRD) amends and replaces the existing Non-Financial Reporting Directive (NFRD) 2014/95/EU, as from the 2024 financial year. The CSRD aims to promote climate adaptation by integrating climate-related risks and opportunities into corporate reporting and encouraging companies to set specific targets and actions for this purpose. This will allow investors and other stakeholders to make informed decisions and support effective climate adaptation strategies (European Parliament, 2022).
EU Taxonomy	The EU Taxonomy is a classification system that creates a list of environmentally sustainable economic activities linked to the six environmental objectives. One of these is climate adaptation. With regard to climate adaptation, this means that under each of the objectives, the criterion of substantial contribution to climate adaptation requires an assessment of climate risks and a plan of measures to address the identified risks (European Parliament, 2020); (Climate Accord, 2021).
Task Force on Climate-related Financial Disclosures	In 2009, the Financial Stability Board, an international financial sector oversight body, launched the Task Force on Climate-related Financial Disclosures (TCFD). The TCFD's 2017 recommendations for both climate mitigation and climate adaptation have had a strong driving role. Many of these recommendations are now being incorporated into legislation and regulations such as those of the ECB, DNB and AFM (TCFD, 2017).

Table 5. Relevant climate-related regulations.

The influence of the European Union

Considering the regulations the EU has issued on climate-adaptive measures, it plays an important role and the government can subsequently use legislation and regulations to encourage the financial sector to implement such measures. Table 5 shows an overview of relevant, EU-imposed sustainability regulations, which financial institutions must also comply with. So there is strong European control over climate legislation and regulations, which came on the back of the 'Green Deal' agreement in 2020 (see also Appendix 7.1).

Amending legislation

The Dutch government has leeway to further amend the legislation, whether or not in consultation with the financial sector. The starting point should always be clear market conditions, so financial institutions and other commercial organisations act correctly. According to interviewees, the government could add this theme to the preconditions to further promote climate adaptation. One example is the government making climate-adaptive measures mandatory in situations where banks grant loans to parties running an increased risk when they will have to adapt their business operations to a more sustainable economy.

Examining how other countries have handled this would be very useful. One example is the UK, where the government has set the flood risk level per region (categorised into 'flood zones'), after which legal frameworks and consequences are attached to this, following which components such as insurance premiums are then aligned (FloodRe, 2023). Australia is another example, where building codes are being amended to include climate resilience and future risk standards (Insurance Council of Australia, 2022).

Business cases for climate adaptation

Another finding from the interviews is that the various governments have a clear understanding about the need of the individual financial sector players to have a business case if they want to start promoting climate adaptation initiatives. Lacking a long-term business case, there is no revenue model for climate-adaptive projects and only the extra costs are visible. At the same time, from the government's perspective future profitability is difficult to estimate and there is a continued focus on quick results with guaranteed outcomes. Companies fearing to lose their own competitive edge over the rest of the market is understandable. Traditionally, if the financial sector is not involved in financial crime the government adopts a hands-off mentality and undertakes no action. Several interviewees suggested that people are reluctant to prepare a business case because the commercial aspects of climate adaptation are difficult to reconcile with prevailing interests, such as the importance of social construction (cheap), which is climate-adaptive at the same time. In this respect it is difficult to complete the financial picture.

Another finding from the interviews shows the financial sector's strong lobby and its capacity to influence policy in the Netherlands. The banks' advice on issues like new legislation have gained them the most exposure (Myriam Vander Stichele (SOMO), 2016). However, there are currently too few policies and regulations to promote climate adaptation in collaboration with the public sector. National standards and agreements are needed for a level playing field, say the interviewees.

Blended finance

While the government defines requirements, the sector itself also has the responsibility to indicate the requirements for their future performance. Financing could be shifted from the government to market players. One option would be to finance new dykes or compensate for droughts and floods under all circumstances. Such forms of blended finance, involving public and private money, could provide a means to finance climate-adaptive projects quickly, possibly faster than is currently the case (De Nederlandsche Bank, 2023). The financial sector can take a leading role and initiate this kind of collaboration (Central Government, 2023).

Short-term agendas versus long-term interest

The research likewise points out the significance of short-term agendas. All parties recognise the long-term importance of climate adaptation, but in practice short-term interests often gain the upper hand. One such situation is the ongoing construction in the floodplains, which carries additional risks because of increasing climate change. This goes against national government policy, which basically no longer allows such construction by making water and soil management choices leading (Central Government, 2022). Not building there will prevent uninsurable flooding in the long run, but the urgent need for more housing makes this particularly problematic for municipalities. This is compounded by the lengthy decision-making processes for housing proposals. They often go on for years. Adapting to the climate requires flexibility and faster decision-making. Financial institutions are going through a similar process. They identify the seriousness in the long term, but the short term is a more familiar terrain with more predictable results, is the interviewees' conclusion.

Social inequality

Another issue of concern expressed during the interviews was the growing social inequality. If people whose financial resources are limited live in areas with an increased risk of flooding from heavy rainfall, they will be unable to take climate-adaptive measures. This puts them at greater risk of damage and loss in extreme weather. Banks, too, acknowledge that households unable to afford the sustainability challenge of their own homes run the biggest macroeconomic transition risks.
Typically, each household will have to invest EUR 15 to 50 thousand to meet this challenge and this can lead to greater social inequality and vulnerability. So far, this is especially visible during extreme heat (NOS, 2022). Poorer neighbourhoods often have more heat-retaining buildings and paved surfaces and thus less greenery, which is precisely what provides natural cooling through shade and the evaporation of water.

It's why local temperatures are typically higher in poorer neighbourhoods, putting residents at higher risk of severe sleep deprivation, headaches and breathing problems.
In addition, these neighbourhoods are more prone to damage to vital infrastructure, such as water pipes and roads. The financial sector has not yet expanded their risk modelling to include these factors.
Respondents refer to housing associations as parties that increase the sustainability of a significant part of the housing stock, without the rent increasing because this is capped, which contributes to social sustainability

The Netherlands Scientific Council for Government Policy (Wetenschappelijke Raad voor het Regeringsbeleid, or 'WRR') distinguishes the costs of three major tasks required because of climate change: mitigation, adaptation and damage repair. The WRR argues that climate policy should systematically consider the fairness of distributions. "Measures should not only be assessed from the perspective of efficiency and legitimacy, but also from the perspective of fairness" (Scientific Council for Government Policy, 2023). They involve high costs, which the council refers to as 'climate costs'.

The WRR has reviewed the DCA in the context of fairness in climate policy. The underlying policies for climate change damage are founded on distribution based on personal responsibility through insurance. The DCA largely aligns with the distribution of principles, which the WRR has formulated, based on existing rights. However, if not everyone has the resources to insure against damages or invest in sustainability, or both, applying these principles may lead to tension with other principles of fairness, such as capacity and solidarity.

The WRR identifies the following effects of the insurance system and the DCA safety net: 1) it can create an incentive to shift responsibility to government, 2) in absolute terms, people with higher incomes often receive more in compensation, and 3) the application of the DCA is unpredictable.

The WRR recommends to 1) establish clear criteria for when the DCA will and will not be applied, 2) further explore the extent to which supplementary insurance could provide opportunities, and 3) reconsider distributional effects in light of increasing climate damage (Hulscher, 2023).

Government climate policies sometimes result in the Matthew effect: affluent people have much easier access to incentive subsidies for solar panels and electric cars, heat pumps and (cooperatives for) wind energy (Leroy, 2021). If the same happens for adaptation, social inequality will be the result.

The WRR likewise spotlights a fairer distribution of climate costs in society (Scientific Council for Government Policy, 2023).

Unclear allocation of roles

The interviews revealed another barrier: the lack of clarity about the allocation of roles between the financial sector, government and residents may hamper climate adaptation if this makes it more difficult to raise financing for initiatives. We can see this both as a market and as a government failure.

Shaping adaptation

Market failure is a situation in which the allocation of goods and services by a free market is inefficient, often leading to a net loss of economic value (Rietveld, 2010).
In some situations the market provides incentives for adaptation, such as shipping in low-water situations or constructing power plants in places with sufficient cooling water. Government intervention is not directly needed in these cases. Many climate adaptation situations do require public intervention in the price mechanism though, because adaptation is not economically advantageous enough for companies - at least not in the short term. Government intervention may also be necessary to enable private parties to implement adaptation strategies (Van Buuren, Driessen, & Teisman, 2010).

Adaptation design is thus primarily a search for an optimal mix of public and private actions (van Buuren, Driessen, & Teisman, 2010). A collaboration between government and the financial sector to acknowledge, specify, and remove market and government failures, can lead to further climate adaptation.

Avoiding market and government failure also requires a clear allocation of roles between government, businesses, and residents. Only with a clear allocation of roles, interviewees say, can the expectations between these parties, whether explicit or not, be tested.

2.6 2.6 Summary and conclusions

The financial sector has a central position in society and can thus accelerate climate adaptation by insuring, financing and investing, thus increasing the social and economic security for its customers. By introducing price incentives, the government and the financial sector can control the gradual factoring in of risks, so the market moves away from these risks without increasing social inequality.

One form of reconstructive adaptation is insurers offering coverage against precipitation, flooding, and failure of secondary flood defences. They also promote climate adaptation by informing their customers, thus raising climate risk awareness.
Pension funds also recognise the importance of climate adaptation and considering the size of the capital they manage, their choices as investors can be essential.

Dutch banks potentially run a climate change risk of EUR 70 billion (European Central Bank, 2022) and the more climate-adaptive the Netherlands becomes, the lower this risk will be. So, banks also benefit directly from promoting climate adaptation. One way they do so is by setting up a green fund, which can finance sustainable projects at favourable interest rates, including those promoting climate adaptation.

Financial institutions thus have their own initiatives whose effects can promote climate adaptation. The insurance sector is in the strongest position in this respect and together with the Dutch Association of Insurers it has now put forward concrete proposals to close the 'insurance gap' (see also the Limburg case in Chapter 3). It seems the business case for pension funds and banks is more difficult to make.

All three sub-sectors have indicated a need for a government role that goes beyond management. One example is the government as risk bearer for risks beyond the market's control, or the government making adaptation more attractive from a financing and investment perspective. The government has indicated a need for input from the financial sector to enable this.

An important condition in this respect is a realistic picture of the climate adaptation costs and the limited number of positive, short term business cases. Together with the financial sector, the government can provide clarity on the total expected climate adaptation costs in a given period. And outline which part of this can be for the account of the government and which part should be for the account of the private sector.
The total price tag can provide the basis for creative financing solutions such as green bonds, and public-private financing such as (derivatives of) DBFM (Design Build, Finance, Maintain). This form needs to be further examined and improved. A point of attention in this respect is how the financial sector can invest in projects with a high degree of uncertainty, without contractors and customers facing major financial setbacks, as in the case of the IJmuiden sea lock. It is important to note that this form often involves a broader group of financial institutions, companies, and the government, which should join efforts to mitigate uncertainties and risks as much as possible.

"Good collaboration between the financial sector and government will lead to an acceleration of climate adaptation that is needed now."
- Gijs Kloek, Achmea

3. Limburg Case

3.1 Introduction

Between 13 and 15 July 2021, the rainfall in South Limburg very quickly reached such extremes that some buffers and streams flooded, while the huge precipitation in Belgium and Germany caused the water level of the river Meuse to rise. The probability of such an occurrence arising increases through climate change (Twardowsky et al., 2023).

Fortunately, there were no fatalities in the Netherlands. The damage suffered can be divided into direct damage, indirect damage and immaterial damage. The Ministry of Justice and Security has calculated the total material damage at EUR 383 million (Ministry of Infrastructure and Water Management, 2023). In this chapter we examine the Limburg case using the national flood prevention strategy, to subsequently make recommendations on accelerating climate adaptation in the Netherlands. As described in Chapter 2, the MLS principle is a method of organising flood prevention. Initially, this principle consisted of prevention, consequence mitigation and crisis management. After the flood disaster in Limburg, the Policy Taskforce added the layers of water awareness and climate-resilient restoration. Although the MLS principle is written from a government perspective, it provides us with a useful structure for our research.

3.2 Water awareness

Water awareness is one of the pillars of the MLS. Its importance became apparent during and after the Limburg flood and from the perspective of MLS, water awareness signifies society's awareness of flood risks and emergencies and that not all extreme weather consequences can be prevented.

Scientists at the VU University of Amsterdam investigated the effects and behaviour of people during the disaster in South Limburg and concluded that risk-aware people show different adaptation behaviour and behaviour during area evacuation (Endendijk, et al., 2022). Because up to 45 per cent of residents in the threatened area had not received flood warnings on time, we researched the impact of this provision of information. One of the outcomes reveals that 80 per cent of the residents who were warned evacuated from the area under threat, as opposed to only 20 per cent of those who were not warned. It also shows that those who were aware of the flood risk in advance were better able to take mitigation measures, including structural and waterproof measures taken in advance and emergency measures implemented during the disaster. People being able to move their cars or place their valuables higher up in their houses prevented 20 to 50 per cent of the damage.

On the back of this research the Dutch Association of Insurers updated its insurance cards, which are used to inform customers about their insurance options (Dutch Association of Insurers, 2022). They now more clearly highlight these options (Dutch Association of Insurers, undated). Collaboration on climate risks with the sector association for financial advisers, Adfiz, has been strengthened as well. In addition, the Association of Regional Water Authorities advocates mandatory measures, such as a compulsory water label. This way new residents will always be aware of the flood risks when buying a new home (Ministry of Infrastructure and Water Management, 2022).

Although climate change has raised water awareness in the financial sector, as discussed in Chapter 2 (e.g., the establishment of the Platform for Sustainable Finance in 2016 by De Nederlandsche Bank (Ministry of Infrastructure and Water Management, 2022), a direct link to the floods in Limburg cannot yet be established. Nevertheless, several insurers now offer policies that provide better insurance against local floods (secondary defences) than before the floods in Limburg. The vast majority of private policies as well as the majority of 'provincial' SME policies now includes a standard insurance for various forms of flooding. And the business market in particular (bourse policies) now offers freedom of choice for entrepreneurs. The parties in this bourse market (insurers and advisers) developed a more suitable policy by the end of 2022. However, the local adviser must advise this and the entrepreneur will need to purchase this. Insurers indicate that towards 2024, policy renewals will give a picture of the extent to which this has happened.

The research shows the government's water awareness is not yet consistent and not fully integrated into policy. A concrete example of this in Limburg is the Municipality of Meerssen issuing a permit for the construction of new padel courts in the inundation area of the Geul and the small Geul one year after the disaster, without involving the Water Board (De Limburger, 2022). The inundation area is outside the dykes and thus typically uninsurable, so the water board felt compelled to intervene by submitting an opinion (an administrative act that can be sent in response to a draft decision) to the Municipality to raise water awareness.

3.3 Prevention

3.3.1 Policies and frameworks

The aforementioned Water Act, which has been in force since 2009, sets out Dutch policy around flood prevention. It requires there to be a national water plan and a regional or provincial water plan. The national government is responsible for the national water plan, while the provinces and water boards are responsible for the regional water plans.

The Act likewise ensures that the Delta Commissioner will issue an annual Delta Programme from which other programmes will follow, such as the Delta Programmes Water Safety and Spatial Adaptation. These in turn provide implementation programmes such as the High Water Protection Programme (HWPP), through which primary flood defences are strengthened.

Apart from these policy documents, safety standards for primary flood defences in 2050 are another important framework. Unlike the 2050 standards, the new standards are risk-based in that all primary defences must guarantee basic protection. If, in addition, the breach of a dyke has major economic consequences or carries the risk of human casualties, the standard for this barrier will be tightened to provide more safety. Research shows that more than half of the primary defences do not yet meet these new safety standards (Rijkswaterstaat, 2023).

3.3.2 The policy round table as a rethinking of governance

After the disaster in Limburg, the Ministry of Infrastructure and Water Management took the initiative to set up the Policy Round Table on Flooding and High Water, to advise on policy for preventing flood disasters like the one in Limburg (Minister of Infrastructure & Water Management, 2021). The Policy Round Table on Flooding and High Water thus follows the example of the Drought Policy Taskforce (Drought Policy Taskforce, 2019).
The policy round table consisted of administrative representatives of stakeholders such as the Limburg Water Board, the province of Limburg, the municipality of Valkenburg aan de Geul, the Association of Regional Water Authorities and more.
This policy round table commissioned Deltares to conduct a water system research, on the back of which two advisory reports were prepared on the precautionary measures to be taken for the Netherlands to enable an adequate response to similar floods.

The first report includes of a number of opinions and recommendations with interpretations by associated responsible parties.
The advice includes raising water awareness and enhancing the quality of monitoring and forecasting, as well as taking better account of high-water periods in summer and major precipitation events. The report likewise advises to work towards resilient main and regional water systems and to obtain a better overview of the entire river basin through better international collaboration.

The second report and also the final advice of the policy round table, titled Prevention is not possible, preparation is has seven main points (Policy Taskforce on Waterlogging and Flooding, 2022).

The first three focus on water awareness and self-reliance among the population; on river basin-wide control based on a risk approach and spatial planning; and an additional approach for protection against extreme flooding. In addition, the policy round table recommends to include extreme precipitation in crisis management plans, climate resilient damage repairs, and to strengthen collaboration with neighbouring countries in respect of all cross-border waters. The policy round table also calls for integrated collaboration and knowledge building.

3.3.3 Newly identified measures

Deltares uses its water system analysis to propose several measures that could help prevent potential flooding within the context of the case research. With most flood defences generally holding up, most floods in the Netherlands have been caused by streams overflowing their banks, such as along the river Geul, by bottlenecks in the flow of the water system, such as in Valkenburg, and by water being pushed up by, for example, blockages such as at the Geul estuary. The measures Deltares has identified fall into four categories: source measures, water buffers, measures tackling bottlenecks, and measures that help prevent damage (Deltares, 2021).

On the back of the 2021 disaster, the Water Safety and Space Limburg (WSS) Programme was prepared, aiming to make adjustments to spatial design such as increasing drainage capacity at Valkenburg and the Geul estuary. But it also promotes to examine specific measures around vulnerable facilities such as the Adelante and Sevagram care homes in Valkenburg. The crisis management involved is complicated by the choice of an, apparently, high-risk location.

The programme consists of three pillars:

- physical measures
- water and soil management
- raising climate awareness and self-reliance

These pillars are closely aligned with multilayer safety: physical measures are about prevention, water and soil management deals with consequence mitigation, and raising climate awareness and self-reliance fits with water awareness.

As explained in section 3.2, informed residents will sooner and better be able to take flood damage mitigation measures: Deltares research has shown that risk awareness can reduce damage by 20 to 50 per cent (Endendijk T., et al., 2022). As far as mitigation measures are concerned we distinguish emergency measures and waterproof, structural measures. The effect of risk awareness in applying both types of measures is shown in Figure 6.

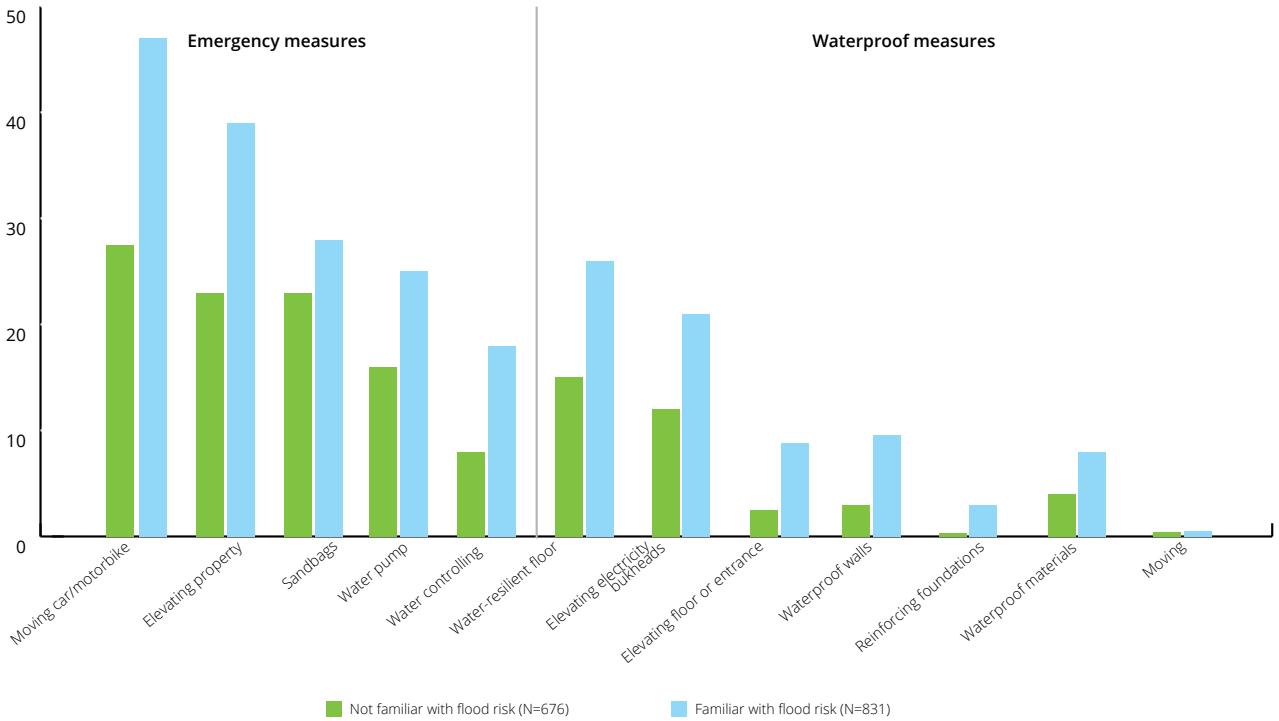

Figure 6. Effect of awareness flood risks (Endendijk T., et al., 2022).

Emergency measures include moving cars, moving and elevating personal property, placing sandbags and bulkheads or using water pumps.

Waterproof structural measures include installing waterproof floors, elevating electrical appliances, elevating the floor or access to the house, waterproof walls, reinforcing foundations, applying other waterproof materials, and moving to areas with less flood risk.

To encourage residents, Limburg municipalities and the water board have collected a selection of structural water-proofing measures at the website waterklaar.nl, which measures people can apply at home. Examples include greening, installing a wadi or a water barrel. It is important with these measures to collect water locally and at source to avoid problems downstream. One option would even be to grant residents subsidies to disconnect rainwater from the sewerage system (Waterklaar, undated).

3.4 Crisis management

Such crisis management is described in disaster response plans, such as the Disaster Response Plan Flooding Limburg 2022-2025 (Safety Regions Limburg-North and South Limburg, 2022). Remarkably, this updated version provides an action perspective for the areas around the most at-risk streams and tributaries in Limburg.

Good crisis management is crucial for preventing damage and social disruption. Under the Security Regions Act (SRA), the responsibility for crisis coordination lies with the security regions (Central Government, 2023).

This Act sets out how the safety services are managed from the safety region, similar to how this was done in Limburg: by the communications room and the fire brigade, which in turn mobilised the Ministry of Defence and the National Rescue Brigade. This resulted in 800 military personnel being deployed for crisis management during the Limburg flood disaster (Ministry of Defence, 2021).

We already saw that risk awareness contributes to behaviour during area evacuation and the emergency measures being taken during crisis situations. To improve the provision of information necessary for this, the KNMI has been working on a weather warning system called the Early Warning Centre (EWC), since 2021 (KNMI, 2021). A warning within 24 hours can reduce damage by 30 per cent (United Nations Office for Disaster Risk Reduction, undated). This system serves to predict the effects of extreme weather events and inform residents accordingly. Unlike colour codes, for example, which are currently used and work on a provincial scale, the EWC must be effective locally as well.
The KNMI has been working closely with three water boards since 2022, including Waterschap Limburg (Waterschap Limburg, 2022). The KNMI's collaboration with the Dutch Association of Insurers to combat climate damage was already started longer ago (KNMI, 2021).

3.5 Climate resilient recovery

The damage following the flooding in Limburg was EUR 383 million. This chapter focuses on compensation of the damage and loss suffered and the extent to which it was used for climate resilient restoration to mitigate the effects of climate change (in Table 6).

Who	What	How much
Association of Insurers (1 year after)	Report of 1 year of claims pay-out	211 million
Disasters (Compensation) Act	Report of 1 year of claims pay-out early 2023	34 million (2022) and 63.5 million (2023) afterwards
Compensation for loss of turnover volume following water damage in Limburg and North Brabant (TOWL)	Report of first round of TOWL. Second round of TOWL coming up (Plas, 2023)	6 out of 24 million requested (total budget) of which 4.9 paid out

Table 6. Summary of envisaged damage/loss and realised benefits in euro amounts..

3.5.1. Recovery financed by the private sector

Following the flood in Limburg and the resulting emergency relief, the payment of compensation - and thus the role of insurance companies - soon became a major issue.
For a long time, flood damage was almost impossible to insure (Dutch Association of Insurers, 2022) but the release of the precipitation clause in 2000 restored insurance possibilities. However, insurers had different interpretations about the concept of precipitation and whether it covered or excluded the river Geul. In a 2018 report, the Association of Insurers criticised this distinction and issued a non-committal advice to insurers to compensate damage for all secondary water systems, opening a path to insurance (Association of Insurers, 2020). This implied that floods from small rivers or waters bounded by a secondary flood defence – e.g., the river Geul - are insured, whereas floods from primary water systems bounded by a primary flood defence – e.g., the river Meuse - are not (Central Government, 2023). Not all insurers had included this extension in their policy conditions at the time of the disaster, so the terms of cover were different for each insurer. Business bourse policies, in particular, provided coverage for direct precipitation but not for flooding from the river Geul. Interviews with insurers showed that these victims ended up arguing with them about the cause of the damage and to what extent it was due to 'water from above' (rainwater) or 'water from the side'. This distinction affected coverage but was very difficult to make due to the extreme weather events. Much other uninsured damage occurred as well, such as gardens, business interruption, crops and vehicles insured only for third-party liability.

The Association of Insurers indicated that the disaster unveiled a lack of clarity about what is and is not insured, and has joined forces with other industry associations to improve insurance offerings and raise awareness. Fortunately, the Meuse dykes remained intact, otherwise no one would have been insured.

The joint insurers have therefore proposed to the government to jointly set up a new insurance organisation to cover floods. One option to do so would be by hedging risks in the international market, like reinsurers. Reinsurance is a form of insurance in which an insurer insures part of the risks it accepts with another insurer (which can also be the government), such as risks above a certain amount or special risks. Insurers do argue that such an insurance fund would require intensive cooperation with the government, given that the scale of possible damages is estimated to be as high as EUR 14 billion (Schade Magazine, 2023).

3.5.2 Adaptive restoration

Besides the ambiguity to be addressed about what is or is not insurable, there is discussion about climate-resilient restoration: not restoring something to its original state, but making it better than before. Interviews with people from the insurance sector show that the indemnity principle (Art. 7:960 of the Civil Code) , a statutory provision states that "the insured will not receive compensation under the insurance policy that would clearly put them in a more advantageous position", is problematic in this respect. It constitutes a barrier to climate resilient and adaptive restoration, leaving the risk of future damage unabated. The interviews show that a possible solution appears to be the inclusion of climate initiatives in the legal framework for insurance. An example of this is the National Benchmark for a green, climate adaptive built environment. If this is embedded in the legal framework, a legal path is available for climate adaptive restoration that is not hindered by (the current interpretation of) the indemnity principle. If climate-adaptive restoration is not implemented, it can be argued that the restoration of damage was inadequate: after all, the risk of future damage has grown with climate change, so only climate-resilient restoration can meet the original risk profile.

3.5.3. Government

Although insurers played an important role in compensating Limburg, not all damage was insured. To provide more security to the affected area, in the Central Government announced the Disasters (Compensation) Act July 2021 Scheme. Under this act, compensation was paid out for uninsured damage in the area, to individuals as well as businesses and other organisations. It is important to note that the Act is meant for uninsurable damages, but the Scheme was used to provide compensation for uninsured damage. Over 2,100 affected people benefitted from this scheme and the government paid out EUR 63.5 million.

Through this scheme, the Central Government provided direct assistance to residents. The various governments also realised that work needs to be done on the flood defences to prevent recurrence. One of the many packages of measures that has been announced, is an investment of EUR 87 million to better protect Maastricht from flooding. This investment will be fully funded by governments and other public institutions (Team Stadszaken.nl, 2022). In addition, the province and water boards called on the national government to take the lead and accelerate plans to make Limburg climate adaptive (Association of Regional Water Authorities, 2021).

3.5.4. Discrepancy between expectation and outcome

When the Damage Compensation Act (DCA) was made applicable, several politicians spoke of generous compensation. But since then, some damage has still only been partially compensated or not compensated at all, leaving individuals and business owners with the perception that this generosity has only been applied piecemeal. The generosity referred to many people who were not formally entitled to compensation still receiving it. But this was interpreted as generous compensation. The official statement was: "the government has declared the extreme flooding in Limburg a disaster. That is why the government is deploying the Disasters (Compensation) Act (DCA). The DCA is a safety net for damages that are not insurable, not recoverable and not avoidable. For cases where current insurance options were not widely known, the government is now being generous. In future disasters, such damages are expected to be insured and will not be covered under the DCA" (Central Government, 2021). Based on interviews and field research in early 2022, the National Ombudsman, Reinier van Zutphen, drew the same conclusion in a letter to the Minister of Justice and Security. In this letter, Van Zutphen stated that "the Central Government has not shown itself to be trustworthy in this matter. And has not acted properly." He also stated that this puts further pressure on citizens' trust in the government (National Ombudsman, 2022). In his annual report, Mr Van Zutphen indicated that the government is making the same mistakes as in the Groningen damage settlement process, and is not applying the lessons learned about the process (National Ombudsman, 2022). Finally, the Ombudsman proposed to modernise the DCA so that the Act is responsive to the type of disasters that occur today and describes more clearly what damage may be recovered and who is responsible for damage and restoration; above all, the victims should be centre stage (De Limburger, 2023).

In the process evaluation commissioned by the Scientific Research and Documentation Centre on the implementation of the DCA, the researchers emphasised the disparity between societal expectations and government action. However, they do indicate that although the DCA was intended to be generous, the inherent legal constraints curtailed implementation. This created a mismatch between the ambition to compensate generously and the instruments available (Scientific Research and Documentation Centre, 2023).

3.5.5. Lack of clarity

The difference between expectations and realisation also has to do with a certain lack of clarity in the process.
"Victims had to keep track of all the schemes, conditions and parties involved. In particular, the interaction between insurance and the DCA is challenging because for most victims the DCA comes into the picture only after they have addressed their own insurance" (Scientific Research and Documentation Centre, 2023).

Conversations with the insurance industry indicate that they are aware of the disaster victims' need for clarity and action perspective. The victims ask themselves what they can do and when they can do it. They need clarity and adequate, quick and timely action. The lack of clarity as a result of the different schemes does not contribute to the action perspective.

Based on interviews on damage settlement in Limburg, there appears to be a lack of clarity on the role of insurers (market) versus that of the government. For example, many residents and entrepreneurs do not know the difference between the water systems from which the complexity of schemes arises. This leaves victims with questions. What can I do? Who will help me? Where will my compensation come from? How will it affect the value of my property? The prolonged lack of clarity can seriously erode trust in the government and damage the mental well-being of citizens (House of Representatives Committee, 2023). This is also known as 'the disaster after the disaster'. To address this, the Association of Insurers already suggested to establish a one-stop shop for damage settlement for flood victims (Scientific Research and Documentation Centre, 2023).

3.5.6. Inequality

Because the DCA does not cover reasonably insurable damage while damage from the breach of primary flood defences is not insurable, interviewees argue that legal inequality arises in Limburg between two types of residents. If a person lives behind a secondary barrier, their insurance only partially covers damage. Conversely, under the DCA those who live behind a primary flood defence receive up to 90 per cent compensation from the government in case of a dyke breach. This percentage is based on the damage regime established for the flood in Limburg (Central Government, 2021). Moreover, the safety standards for primary flood defences have been tightened to better ensure safety.

Confusion about the insurance system and insufficient support in handling claims also creates inequality between persons who are insured with a commercial insurer and those who are not. As soon as a disaster victim receives the benefits of a private insurance, the DCA can no longer be invoked. This has led to situations where residents with insurance received less compensation than their neighbours who were not insured (House of Representatives Committee, 2023).

The payment of compensation under the DCA in Limburg was a political decision of the House of Representatives, as is always the case when damage is compensated under this Act. The 90% compensation threshold set at the time is not a guaranteed percentage, but is determined on a disaster-by-disaster basis. The DCA was initially not applicable to the Limburg flood, but was allocated by politics because of the circumstances. Things may, however, be different if a similar disaster occurs in the future. So, private insurance and the DCA are two different means and are therefore difficult to compare.

3.6. Summary and conclusions

The flood disaster in Limburg highlights the importance of timely and equal information provision about the risk and potential impact of extreme weather. This information provision is a prerequisite for prevention and proper market functioning, where risks are known to relevant parties and are translated into, for instance, the value and fundability of an asset.

During and after the disaster, much of the focus was on capacity for water drainage and limited attention was paid to water storage. Interviews show that a region like Limburg, and the Netherlands as a whole, would benefit from future-oriented solutions and from infrastructure for large-scale water retention in times of abundance and distribution in times of scarcity.

Not only was the flood itself a disaster, there was also 'the disaster after the disaster': the damage and suffering that occurred in the follow-up. Using the Limburg case, the DCA should be evaluated for improvements in its design and implementation. In doing so, the damage settlement in Limburg emphasises the importance of climate-resilient building and climate-resilient restoration so that sustainable, risk-reducing choices are encouraged and are fundable. Unambiguous policy and clarity on the roles within the chain of different layers of government, the business community and residents is crucial to limit damage and address the damage sustained in an efficient and climate resilient way. Both the provision of information and such unambiguity and clarity contribute to social equality and trust in the government and the private sector.

"The government should lose no time in taking the initiative to work with market players and our society to find solutions to prevent another 'disaster after the disaster'."

- Daan Prevoo, Burgemeester Valkenburg aan de Geul


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Oude
Lindestraat
dicht

4. Rotterdam Case

4.1. Introduction

While the Limburg case looks back at a climate disaster that has already occurred, the Rotterdam case looks ahead. We chose the Rotterdam case because it represents a vulnerable area with both the city and the port located below sea level and at the end of the delta. A climate disaster and even relatively small consequences of climate risks can have a great impact on finances, but also on the habitability of the region. And thus on the Dutch economy.

4.1.1 Climate risks and impacts

Rotterdam faces six climate risks directly or indirectly related to water: extreme precipitation, heat, flooding, groundwater, subsidence and drought (Rotterdams Weerwoord, 2020) (Nijhuis, 2013) (Rotterdam Climate Initiative Climate Proof, 2013). These risks and their impact on Rotterdam are mapped in Table 7. Since all the risks have long-term consequences, Rotterdam must factor in all six climate risks in its long-term urban planning (Rotterdam Climate Initiative Climate Proof, 2013). The risks also reinforce each other. For instance, subsidence leads to a higher risk of flooding and drought affects groundwater levels. The heat risk has been the most visible and acute risk for more than a decade because of hot summers (Rotterdam Climate Initiative Climate Proof, 2013).

When we link the risks from Table 7 to the areas in Rotterdam, we see that most risks are relevant in several areas, like the drought and heat risks, which occur in all areas. Extreme precipitation and groundwater are particularly a risk for the city centre and the inner- and outer-dyke city districts, as most people live here in a densely built-up area and flooding can cause major damage. Subsidence is also a particular risk for the city centre, the city harbours and the inner-dyke urban neighbourhoods. Finally, flooding is a major risk. The inner-dyke urban area is largely below sea level. This makes the area vulnerable to high water in the rivers, especially when sea level rise occurs in combination with peak discharge in the rivers. For the areas outside the dykes, despite their higher location, sea level rise is a particular risk because it was not taken into account during construction (Municipality of Rotterdam, 2023).

However, there is a difference between the inner-dyke areas where the probability is low but the possible consequences (damage, casualties) are very substantial, and the outer-dyke areas (outer-dyke urban districts and outer-dyke port area) where the probability is higher but the consequences less substantial. The primary flood defences better protect the inner-dyke areas, but any flood would result in substantial damage due to the high number of inhabitants, the degree of building development and greater water depths.

The outer-dyke areas enjoy less protection, but the impact of a flood is less because they are higher (Rotterdam Weerwoord, 2021).

4.2. Climate adaptation in Rotterdam

The municipality of Rotterdam is a pioneer in the field of climate adaptation. Following the publications by the Rotterdam Climate Initiative (RCI) and Waterplan 2 Rotterdam in 2007 (Miller, 2015) (Municipality of Rotterdam, undated), the city was concerned with climate change relatively early. Since then, the city has implemented several innovative plans and strategies for climate mitigation and climate adaptation. Rotterdam stands out from many other cities in a coastal river delta because it not only looks at the challenges, but also at opportunities (Hölscher, Frantzeskaki, McPhearson, & Loorbach, 2019). On top of that,
the city is a member of Connecting Delta Cities and 100 Resilient Cities, international city networks aimed at sharing knowledge on, i.a., climate change, climate adaptation and water management.

4.2.1 Current situation - initiatives

In the Rotterdam Climate Initiative, Rotterdam worked out its ambition to reduce greenhouse gas emissions by 50 per cent by 2025 compared to 1990 (Rotterdam University of Applied Sciences, undated).
Within this initiative, the focus is on emissions reduction, preparing the city for climate change and reinforcing Rotterdam's economy. Climate mitigation played a bigger role in this initiative than climate adaptation.

In Waterplan 2 Rotterdam 2007 (Municipality of Rotterdam, undated), the municipality of Rotterdam and several water boards showed how they plan to handle water management. A key difference from Water Plan 1 (2000-2005) is higher water levels due to sea level rise, flooding due to increased precipitation and the stricter water quality requirements the city must prepare for.

In 2013, an updated version of Waterplan 2 was published, which saw changes around water not only as challenges but also as opportunities. Instead of fighting against water, there was more emphasis on cooperating with it. Waterplan 2 also distinguished between several main areas: the River City, Rotterdam North and Rotterdam South. As these three areas differ from each other in terms of both the water system and urban characteristics, the solutions for each area also differ. As part of the RCI, the climate adaptation programme Rotterdam Climate Proof (RCP) was adopted by the Rotterdam Municipal Executive in 2008 (Rotterdam Climate Initiative, 2009). The RCP programme contains three lines of action: knowledge development, implementation of climate adaptation measures and profiling Rotterdam as an innovative delta city.

	Risk	Impact in Rotterdam
	Extreme precipitation	Extreme precipitation causes flooding in buildings, residential areas, the sewage system, roads, gardens, outdoor spaces and parks and can cause damage to vital infrastructure such as the energy and electricity grid
	Heat	Extreme heat can lead to several problems for urban health and liveability. People have more difficulty sleeping, their labour productivity is lower and they can suffer health problems due to heat stress. It also affects the functioning of vital infrastructure such as bridges, tram rails, and water pipes. In addition, it may have an impact on water quality through growth of blue-green algae and on ecology.
	Flooding	Rotterdam is vulnerable to high water due to its location by the sea. And, to a lesser extent, it is vulnerable to high water in the rivers Nieuwe Maas and Scheur. During a flood, parts of the city can be flooded by up to six metres.
	Groundwater decrease	Groundwater poses a risk when the level fluctuates too much: high groundwater levels create a risk of water in buildings without foundation, water in the streets, less absorption into the soil and wet parks. At low groundwater levels, there is risk of drought, damage to wooden pile foundations (pile rot) and subsidence.
	Subsidence	Subsidence has consequences for our defences and dykes, as they have to bridge the difference in height between sea level and land: when they subside, they provide less protection. It can also lead to the subsidence of buildings without foundations and new height differences between buildings. This leads to flooding and damage to infrastructure.
	Drought	Drought causes an increase in water demand in the city and affects groundwater levels. The impact is different for each location in the city. A distinction has to be made between drinking water use and rain and canal water, and the effect of drought on rivers in combination with sea level rise. This poses a risk of damage to infrastructure, buildings and nature.

Table 7. Climate risks in Rotterdam (Rotterdams Weerwoord, 2020); (Nijhuis, 2013); (Rotterdam Climate Initiative Climate Proof, 2013).

According to the RCP, an adaptation strategy was necessary to focus on making Rotterdam climate-proof.
By adopting the Rotterdam Adaptation Strategy (RAS) in 2013, Rotterdam was one of the first cities worldwide to follow such a strategy (Nijhuis, 2014). The RAS sets out the course along which Rotterdam intends to prepare for the consequences of climate change. This was the first time that the city was looked at from the climate change perspective. The possible consequences for the city were examined alongside the appropriate adaptation measures. Measures had to fit the city's ambitions: they should create a more attractive city and strengthen the economy. In this way, Rotterdam not only focused on the challenges but also on the opportunities.

The first overarching, integrated plan to make the city resilient, the first version of the Rotterdam Resilience Strategy (RRS), followed several years later in 2016. In 2021, the RRS was updated for the period 2022-2027 (Municipality of Rotterdam, undated). The RRS focuses on six major crises, including the climate crisis. A resilient Rotterdam is able to withstand all six crises through four skills, as also described in multilayer safety: prevention and water awareness, resilience, learning capacity and climate resilience. The idea is to let these four skills feature prominently in all urban systems, laws, programmes and projects.

An important part of the Rotterdam Resilience Strategy is the implementation agenda Rotterdams Weerwoord (Municipality of Rotterdam, 2023), which involves residents and local communities in the adaptation task. Rotterdams Weerwoord focuses on all adaptation themes: extreme precipitation, flooding, drought, heat, subsidence and groundwater. The implementation is divided into four categories: public spaces, existing buildings, new buildings and Rotterdam residents. The core of the implementation is working together with partners such as the regional water board, housing organisations and Rotterdam residents. Rotterdams Weerwoord is working towards a multi-year programme framework and long-term scenarios.

In June 2023, the Rotterdam Weerwoord 2030 programme framework was adopted. Interviewees reveal that within this renewed programme framework, the emphasis is on private space, which requires more collaboration with the private sector. In addition to measures for public space, more requirements are placed on new real estate, while the cooperation with housing corporations to make existing real estate climate adaptive will be increased as well. The approach will become district-specific by publishing district maps showing the various climate risks.

Another key component is the Rijnmond-Drechtsteden Delta Programme (2020-2021), a policy framework focused on flood prevention (National Delta Programme, undated). This plan emphasizes regional cooperation between municipalities, regional water boards, safety regions, the province of South Holland, the Port Authority and the national government. Examples of measures taken and envisaged include raising dykes and stimulating policy development for the outer-dyke area. There is a preferred strategy to also keep the region safe from water in the future, which is updated periodically (every 6 years).

4.2.2 Current situation - concrete measures

With the strategies and initiatives mentioned above and other measures, Rotterdam has been preparing for the consequences of climate change for more than 15 years. What does that look like in practice?

Adaptive building and design is the starting point for increasing climate resilience for the city of Rotterdam. Examples include developments in floating construction, such as the Floating Farm project (Floating Farm, 2019), the floating homes in the Nassauhaven (Top010, 2020), and the Floating Pavilion (Public Domain Architects, 2010). Much attention is also being paid to greening the city, such as the realisation of more than 400,000 m2 of green roofs (Municipality of Rotterdam, undated), the construction of the largest roof park in Europe (Dakpark Foundation, 2013), and the DakAkkers initiative as the first multifunctional roof garden (DakAkker/Wouter Bauman, undated).

On top of that, Rotterdam has an express focus on innovative solutions to water problems. Well-known examples are the construction of water squares. These squares can flood and store a large amount of water, i.a., in the underground water storage facilities under the Museumpark garage and the Sparta Stadium.

This innovative approach sets Rotterdam apart from other delta cities, say interviewees. Experimentation is encouraged, even if the end result is not yet entirely clear. As a result, Rotterdam is realising innovative climate adaptation measures, such as water squares and city water buffers. Unlike a city such as New York, where it often remains limited to artist impressions, or an impression of what something like this could look like.

4.2.3 Future situation

Despite the fact that much is already being done to make the city more climate-resilient, there is still much to be done, interviewees felt. For instance, continuous attention is needed to keep storm surge barriers and dykes at the desired safety (Municipality of Rotterdam, 2021). Financing these expensive adaptation measures requires multi-party cooperation. For dykes, cooperation between water boards, Rijkswaterstaat and the High Water Protection Programme is already in place. More participating parties could be added to secure funding for other measures. There are also neighbourhoods within Rotterdam that need climate-adaptive renovation. The houses are dated and restructuring is needed, requiring a major investment.
This also happened in the 1980s, when the investment was made by the national government.

4.3. Climate adaptation and the financial sector

So several initiatives have already been taken in Rotterdam to increase the region's climate resilience. In this chapter, we specifically focus on the current and future role of the financial sector. Our observations and recommendations for accelerating climate adaptation have again been obtained using MLS and mainly on the basis of interviews with governments and parties in the financial sector.

4.3.1. Water awareness

Water awareness lies at the heart of MLS and plays a crucial role in climate adaptation and the role of the financial sector in Rotterdam. The municipality has expressed the need to engage with relevant partners to promote water awareness. It is important to recognise together that climate adaptation is a joint task that is complex. Currently, the financial sector is having exploratory discussions with public stakeholders and does not have an active role in climate adaptation within the Rotterdam region, say interviewees. Also due to a lack of clarity about the division of roles between the various parties, there are still few concrete joint projects or measures. Interviews reveal that the lack of clarity is caused by differences in culture and the lack of a joint business case for the financial sector and public stakeholders.

Interviews also suggest that increased awareness of climate change impacts among all stakeholders will pave the way for accelerated climate adaptation. For this, first of all, we need initiators to break the current deadlock. Due to the difference in perspective and - sometimes – in positions of cities, provinces and the national government, the financial sector may be more suited to take the initiative as a neutral party, some of the interviewees felt. This ensures that discussions can be organised at a high level, so the parties are more on the same page in terms of language and thinking.
For instance, the water boards expect that banks and pension funds are more likely to join if the discussions are about larger-scale initiatives.

The financial sector has different levels of commitment to climate adaptation in the Rotterdam region, with insurers being the most involved and pension funds the least, interviews reveal. Parties in the real estate and insurance sectors are at the table together with public stakeholders, and insurers are more likely to be involved in processes, for instance through their advice when building a new housing estate.

Non-life insurers more often join conversations on climate adaptation, whereas health insurers are perceived as more distant. Pension funds are less involved in initiatives in the Rotterdam region because they often find the scale too small, say interviewees.

Moreover, how the risk maps of the new programme framework Rotterdam Weerwoord (implementation agenda 2020-2022), which the municipality recently published, will affect residents and the financial sector still seems to be unknown.

4.3.2 Prevention

Our interviews show that the role of the financial sector in making Rotterdam climate adaptive is currently still limited and indirect. Another challenge is to ensure that all the municipality's tasks related to climate adaptation fit together and guarantee affordability. From the financial sector, for instance, there is a need for clear regulations that can promote climate adaptation in different areas. In addition, there is much uncertainty about responsibilities and possibilities in area development. This is partly due to complicated relationships between the parties involved in area development and the different requirements and guidelines for climate-adaptive building. Other limitations are that policy is often still under development and, although the knowledge is there, no clear decisions are made.
The municipality of Rotterdam does realise that the relationship with the financial sector can be important and perhaps necessary. The municipality has taken initiatives to confer with the financial sector to better understand how it operates.

Developments in the real estate sector are a perfect example of the possible result of ambiguities in area development. Interviewees indicated that real estate is one of the main pillars of area development, and this goes for both new housing and renovation of older buildings. The construction of new real estate is an interplay between the financial sector, regional and national governments and real estate developers. For this cooperation to prosper, clearer principles are needed. According to the municipality, this is now slowly getting started, but there are certainly still some steps to be taken.

First of all, the municipality has introduced many policies but not yet a level playing field for property developers. This is desirable for future-proof area development at urban level. Area development in Rotterdam currently focuses on social and low-cost building. At the same time, climate-adaptive building is subject to many new requirements and guidelines. This is a bottleneck for developers who need to make a balanced business case for their building projects.

Because of the uncertain outcome, it currently does not pay to invest in climate adaptation. However, it can be worthwhile with a financial incentive. Such an incentive could also encourage more initiators and, for example, facilitate the introduction of climate mortgages and property risk labels. Discussions currently being held with banks show that there seems to be a market for climate mortgages when building new real estate. Whether the demand will be sufficient is still unclear, but the perception among some interviewees is that regulations could certainly stimulate this demand.

Interviews with government institutions indicate that the biggest challenges for policy-making are prioritising the long-term over the short-term and bridging the cultural differences between the financial sector and other stakeholders.

The political system in the Netherlands complicates long-term prioritisation due to the short term of office (<4 years) of the government and, in part, parliament. This leads to much uncertainty, especially about the financing of climate adaptation-related measures. In this context, Rotterdam needs a national climate adaptation benchmark that is also applicable to existing buildings. At the municipal level, subsidies are available for adaptive measures such as rain barrels (Duurzaam Bouwloket, undated) and there are incentive schemes for new housing and regional deals. Still, the current subsidies for large cities are not sufficient to pay for the necessary adaptive measures.

This short-term investment interest makes business cases for new housing increasingly complicated. Climate-adaptive building is currently not easy for area developers, or even unattractive. One of the issues involves the municipality sometimes refusing to approve plans because of the non assessable risks that innovation entails, for instance when using new materials. In addition, there is currently too little return on climate adaptation investment and the benefits do not reach the investor. These high financial risks put pressure on affordability. Structural financing for climate adaptation could mitigate this challenge, enable certain choices and encourage to take action.
In addition, interests are weighed differently when the perspective is shifted from long-term to short-term. Housing corporations, for example, which own half of the city's housing stock (Central Bureau of Statistics, 2016), have their own (short-term) interests. Investments in climate-adaptive social housing tend not to materialise because corporations consciously choose to build social and thus cheaper housing, stimulated by existing financial incentives.

Cultural differences are another obstacle to climate-adaptive policies, say interviewees. Because of these differences, the financial sector and other stakeholders are often on different wavelengths. They start from a their own (subconsciously) different perspectives and use their own jargon, causing the conversation to falter. However, the municipality and pension funds, mortgage lenders and insurers have now started exploratory talks to better understand each other's worlds. As more cooperation takes place, the more the same language will be spoken. It is important to keep asking questions about the underlying assumptions.

Currently, the municipality plays perhaps the biggest role in making Rotterdam climate adaptive. Although there is a special delta programme for the Rijnmond Drechtsteden (cooperation between regional authorities and the national government), it is primarily about flood prevention (National Delta Programme, undated). More cooperation and clarity on the following topics could further accelerate Rotterdam's climate adaptation, according to interviewees:

- Planning can only be done within the municipality until 2027 based on available funding. This leaves budgeting for climate-adaptive measures highly uncertain.
  So more clarity on a long-term budget would help. Most of the available 97 million goes to outdoor space projects, i.e. public spaces where the municipality itself is in charge.
- The municipality has set a target of 50 climate-adaptive projects in the next four years, of which 15 are water squares. Ambitions for private space are more difficult to achieve because the municipality is dependent on third parties for this. Better arrangements on responsibilities, more collaboration and speaking the same language can help.
- The other transition projects in the city that need to be carried out often also end up with the same people within the municipality. With the limited budget, clear priorities are needed to avoid overburdening these people.

4.3.3. Consequence limitation

Consequence mitigation consists of both physical and indirect elements. Physical consequence mitigation is about renovating and making property and infrastructure more sustainable, but also about, for example, communication around a disaster (if any).

To apply consequence mitigation effectively, existing homes and properties in Rotterdam will need to be preserved and renovated. In their current state, there is a significant risk that a substantial proportion of Rotterdam's properties will become unusable due to future weather extremes. This will have major consequences for homeowners. The city's older neighbourhoods in particular pose a challenge in this regard, because both the properties and the infrastructure are affected by fluctuations in groundwater levels, subsidence or extreme heat.

Yet Rotterdam has found some innovative ways to make even these older neighbourhoods climate adaptive. For example, on the Noordereiland, an outer-dyke isle, where the municipality actively informs residents about the floods that regularly occur there (Municipality of Rotterdam, undated). Because residents are aware that this regularly happens, they are prepared and can choose to leave in time or, for example, rearrange their homes to prevent damage (Municipality of Rotterdam, 2022). Insurers informed us that outer-dyke areas are not insurable because of the reasonable expectation that they may flood.

Another way of mitigation is more indirect and deals with preventing social inequalities caused by climate change. In this respect, a level playing field at the urban level for climate adaptation by residents is vital. For instance, it is possible for private homeowners with sufficient financial means to invest in improving their property. However, a large proportion of private owners in Rotterdam are unable to take measures, so they do have to accept the current stress, nuisance and damage, interviewees reveal. An expense such as sun blinds comes extra and is something the lowest incomes cannot easily afford. This creates inequality in several ways, both in stress and emotions, and in the cost of the long-term consequences of climate change. This can be partially avoided by creating a level playing field where Rotterdammers with slightly less financial and organisational ability are helped.

4.3.4 Crisis management and recovery

Rotterdam has not been hit with a recent disaster such as the one in Limburg in 2021. Since the other two security layers of crisis management and recovery have not yet been addressed, we will not consider them here.

4.4. Summary and conclusions

With most of the city below sea level (Actueel Hoogtebestand Nederland, undated) and one of the world's largest ports, integrated water management and innovative climate adaptation are in Rotterdam's DNA.

To promote climate adaptation in Rotterdam, cooperation should be improved and roles should clearly be divided among all parties. According to interviewees, the financial sector should play a proactive role in this. The financial sector can take the lead in climate adaptation from an organisational role when they take into account the municipality's local knowledge on climate adaptation. For example, insurers indicate that they contribute to the discussion around climate adaptation by quantifying the impact of climate adaptation to raise awareness and prevention.

Below are our main observations that we connect to the first three layers of the multilayer safety model: water awareness, prevention, and consequence mitigation. Layers four and five, crisis management and recovery, will be relevant in case of a flood disaster.

Water awareness

The new programme framework of Rotterdam's Weerwoord (implementation agenda 2020-2022) is committed to open communication about risks per neighbourhood. The city has shared a map of risks at neighbourhood level to make residents more aware of the risks associated with climate change.

The municipality has expressed the need to engage with relevant partners to promote water awareness. Due to a lack of clarity about the division of roles between the various parties, there are still few concrete joint projects or measures. The interviews show that the lack of clarity is caused by differences in culture and the lack of a joint business case for the financial sector and public stakeholders. Due to the difference in perspective and sometimes different positions of cities, provinces and the national government, the financial sector is perhaps best suited to take initiative as a neutral party.

Prevention

The construction of new real estate is an interplay between the financial sector, regional and national governments and property developers. Clear starting points for these parties, in the form of clear and future-oriented policies, are still lacking. In Rotterdam, there is a need for legislation and regulations, coupled with more subsidies from the national government that offer the financial sector more security. It is not easy or attractive for developers to pursue climate-adaptive building with a long-term focus. Currently, there is no level playing field for developers and the emphasis is on social building, while at the same time there are many requirements and guidelines for climate-adaptive building. In addition, the current return on climate adaptation investments is still too little and their benefits do not reach the investor.

Consequence mitigation

The dilemmas and constraints at play nationally are magnified in a metropolitan area like Rotterdam. This makes Rotterdam especially vulnerable as an area where climate risks are emphatic. Rotterdam sees a risk that, in the longer term, homes will become uninhabitable due to the extremes of the future climate. This has major consequences for homeowners. Some districts are already climate adaptive, but city districts with older neighbourhoods pose a challenge. To avoid social inequality, it is important to create a level playing field at the urban level with equal opportunities for residents. Closer cooperation with the financial sector can offer a solution but requires a strong business case to be interesting.

In summary, following the first three layers of the multilayer security model, the financial sector could concretely take (some of) the following steps:

- Insurers and banks can introduce price incentives that reward climate-adaptive initiatives, for instance, to make planting greenery or installing solar panels cheaper. This also helps to raise people their water awareness.
- The financial sector can attach climate labels to houses when mortgages are granted. This also increases residents' awareness. By providing this information in different places, both through the financial institutions and through the government, for example using a risk map, residents become more aware of the consequences of climate change and can better prepare for extreme weather.
- Research can identify ways in which public-private partnerships can be initiated to further climate adaptation in Rotterdam. A strategic focus on the areas where this is most needed, for example because they are at high risk or socially deprived, can overcome various problems.
- However, it is clear from the interviews that the public sector will have to play a leading role in this since the financial sector largely operates at national level and has limited understanding of the local situation.

5. Conclusions and recommendations

The Netherlands is the best protected river delta in the world, but climate change is creating new climate risks. The right balance between mitigation and adaptation is needed to face them. In this report, we examined how the financial sector can help accelerate climate adaptation in the Netherlands.

Balancing mitigation and adaptation

Parties within the financial sector do pay attention to climate adaptation, but prioritise climate mitigation for now. Discussions with the financial sector and governments reveal a widely supported need for rapprochement and reinforcement and improving cooperation to accelerate the adaptation process.

It is complex

In practice, this desired rapprochement between governments and the financial sector is often still difficult. It is important that the government and the financial sector both acknowledge the complexity of the task and that this requires proactive cooperation:

- **Long-term versus short-term**
  Although organisations have a long-term perspective, financial models are often about short-term results.
- **Valuation profit-based rather than value-based**
  The measures that make an area liveable by providing a green, safe and sociable environment are difficult to quantify. They are valued on the basis of profit rather than increased value (quality of life, safety and longevity). Broad welfare approaches and the UN's 'Sustainable Development Goals' (2015-2030) are often missing. As a result, business cases are assessed on financial risks and not on social added value.
- **No overarching vision**
  There appears to be a need for more direction from the national government in an overarching vision that shows the economic and other perspectives, with clear transition paths that can lead to choices, which could, for example, be about climate-adaptive building.
- **Differentiating on climate risks is complex**
  As an example, mortgage lenders can, if they wish, adopt different strategies to deal with climate risks and differentiate loans. At the same time, the law requires mortgage lenders to act fairly and ethically in this respect. It is a complex issue where multiple stakeholders, different considerations, and legislation and regulations need to be taken into account.
- **Legislation, and its interpretation, encourages and curbs climate adaptation**
  Financial institutions face a lot of existing and frequently changing legislation and regulations such as Solvency II for insurers, the Basel Accords for banks, and national rules for pension funds. This affects prioritisation due to the need to be compliant. Combined with the interpretation of the scope and constraints within existing and changing legislation and regulations, this affects the level of proactivity and progressiveness in the business model and services to accelerate climate adaptation.
- **Difference between government and financial sector**
  Private and public interests also differ and are sometimes far apart. Due to cultural differences, even within sectors, not everyone speaks the same language and mutual understanding sometimes seems to be difficult.

Public-private financing

There is a need for public-private financing to fund climate-adaptive projects. One form with which experience has been gained in several projects is DBFM (Design, Build, Finance and Maintain contract). Opinions differ on this type of contract. The government's perspective is that this contract type seems less suitable for projects with a high degree of uncertainty (as is often the case with replacement and renovation or spatial development). The question is how unexpected costs can be absorbed through a flexible financial shell.

Role of the government

The financial sector is looking to the government to adapt legislation and regulations, introduce new ones and initiate public-private partnerships. And thus promote opportunities for the financial sector to help accelerate climate adaptation. The question that needs to be answered here is whether this should be the Dutch or European government. Much of the climate change legislation and regulation comes from the EU. But for the legal embedding of the Parliamentary Paper providing Guidance on Water and Soil Management (Water en Bodem Sturend) and adaptation of the Building Decree, reference is made to the Dutch government. Adapted legislation and regulations would enable the financial sector to better help its customers make climate-adaptive choices. Adapting or broadening the indemnity principle, for instance, could help climate-robust damage repair, as the Limburg case shows. Explicit regulations enforcing adaptation can also remove unhealthy competitive pressures and thus offer commercial parties a level playing field. And introducing climate risk labels or certificates can make the risks to be run understandable to the general public. It is also noted that legislation can create constraints.

Social inequality

One possible problem is increase social inequality caused by the effects of climate change. An example of this is the Rotterdam case, showing entire neighbourhoods with outdated houses and residents who are unable to make climate-adaptive adjustments. Residents with more financial resources are better able to take adaptive measures, such as purchasing sunscreens or installing rain gutters, which will reduce the damage caused by extreme weather events. They also experience less stress about financing these measures or possible damage. In an extreme case, they can move to a more favourable region, an option not available for residents with less financial means. As a society, it is important to guard against such a dichotomy and ensure that climate risks do not become divisive.

Prevention

The government is primarily responsible for unambiguous communication on climate change risks. Banks and insurers believe it is part of their social responsibility to inform customers about climate change risks that are relevant to their services. There are opportunities to integrate this task more broadly into society. For instance, the government can require a mortgage lender to have a thorough climate risk analysis carried out, and insurers benefit from informing their customers before providing cover on a property that has an increased flood risk. Collaboration between government and financial players can improve climate risk disclosure.

Financing climate adaptation

Financing climate adaptation in area development and existing buildings is complex. Although organisations have a long-term perspective, financial models are often about short-term results. In these models, the measures that make an area liveable by providing a green, safe and social environment are difficult to quantify. They are valued on the basis of profit rather than increasing value (quality of life, safety and longevity). Broad welfare approaches and the UN's 'Sustainable Development Goals' (2015-20130) are often missing. As a result, business cases are assessed on financial risks instead of on social added value. There appears to be a need for more direction from the national government in an overarching vision showing what economic and other perspectives there are, with clear transition paths that can lead to choices, which could, for instance, be about climate-adaptive building.

Crisis management and immediate aftercare

One complication is the lack of a clear division of roles between the government and financial institutions. The Limburg case shows that for a long time, victims did not know where to turn to for their damage after the flood. The government and the financial sector should be clear where people can be helped in case of damage. A so-called one-stop-shop scheme for damage after disasters could be a solution for this. This is already being pursued in several situations, but is not yet a general practice.

5.1. Recommendations

If we want to keep our living environment in the Netherlands attractive to live, work and invest in, the Netherlands must invest more and faster in becoming climate adaptive for the changes that can no longer be prevented. This should be done in parallel with mitigation measures to prevent further warming, creating a powerful interplay between mitigation and adaptation to close the current adaptation gap as far as possible. Our main recommendation in this respect consists of three elements: a) a clear vision of the future with transition paths, b) a different look at financial business models and c) innovative leadership. Below, we first describe our main recommendation in three corresponding sections. We then set out the recommendations that emerge from the survey by sub-sector.

1a. Create a clear future vision with transition paths for climate adaptation of the Netherlands

Develop a broad-based, clear vision of the future with transition paths towards a climate-adaptive Netherlands. Be clear about the time path and what government resources are available. This is the only way to discuss what part the government will pay and what the market will be asked to do to make the Netherlands climate adaptive. The goal is to jointly work on a socio-economic perspective in which we prevent unbearable costs and counteract social inequality. The initiative for this will have to lie with the government because of its primary responsibility. It should involve the financial sector in the creation of the aforementioned vision of the future and the realisation of the transition paths.

1b. Assess business cases differently

To adaptively design the physical environment, positive business cases are currently being sought. This is a challenge because the costs are short-term and the benefits long-term. There are opportunities to make more use of green bonds, subsidies and public-private partnerships.

In this context, redesigning business cases within the framework of imposed international legislation is a particular requirement. This can be done by:

- Quantifying values (e.g. safety, climate-adaptive building or health) in the living environment differently.
- Focusing these on the long-term (at least 25 years) rather than on the short-term (5 years). An investment in climate adaptation does not pay out in 5 years. However, it can be a strong, positive business case in 25 years by having prevented a lot of damage.

1c. Innovative leadership is needed

Setting up and assessing business cases differently requires different leadership by decision-makers and people with influence over long-term policy, strategy and decisions within financial organisations and government. By this we mean the supervisory and executive boards of banks, pension funds and insurers as well as their shareholders. This also requires a new perspective from politicians, administrators and top officials.

The current focus is largely on the short-term. This is in line with the short-term thinking of politics and the business community's focus on voters/elections, shareholders and profit distributions. And it is thus explainable. It takes audacity and leadership to put the dilemma of climate adaptation on the table, make it discussable and navigate through the transition in a new way. It also requires everyone to take responsibility and not point to someone else to take the first step. It is important to recognise that making the Netherlands climate adaptive is a complex challenge with many interests that can also conflict with each other. And that parties, due to the language and cultural differences between the government and the financial sector, do not always have the same understanding of the issues at stake and understand how the other party views them.

Administrators should also seek cooperation at the European level by engaging with each other. Financial institutions benefit from Europe becoming climate adaptive because of the impact climate change will have on assets in Europe and thus on the value of the euro. Climate does not stop at national borders, so when there is too much rainfall or, on the contrary, extreme drought, it is important to cooperate across national borders as well. Climate adaptation is many times more effective if worked on per region. The European Union is already playing a leading role in this respect by enacting new legislation and regulations, including the CSRD. A lobby at European level might be an effective instrument.

2. The government

National government:

- Currently, most consumers and businesses are not insured against flooding of primary flood defences. The Delta Programme is a future-proof plan but 100% safety cannot be guaranteed, due to sea level rise and heavier peak discharges in major rivers.
- The existing residual risk should also be considered, also where the consequences can be mitigated with quick recovery. This necessitates further exploration of a public-private partnership with insurers. For instance, in the form of a reinsurance pool with a strong risk-bearing role for the government or with implementation agreements between the sector and the government for the current compensation scheme under the Disasters (Compensation) Act. In this context, it must be clear in advance where victims stand. The advice is to improve or change the DCA in cooperation with insurers and in line with the advice of the WRR. Clearer criteria should be established which indicate when the DCA will and will not be used. Also, it should be investigated to what extent additional insurance is possible and the distributional effects increasing climate change should be examined. Discussions with insurers on practicalities should be continued, such as developing an enhanced DCA with insurers being responsible for handling.
- A climate label promotes that everyone is informed in the same way and provides an extra incentive on climate-adaptive building. The final advice of the Policy round table on Flooding and High Water included the recommendation to explore a water label for homes and buildings. This could be expanded to a climate label for extreme weather. The possibilities of introducing a climate label should be investigated. For instance, the Netherlands could be divided by municipality into low-, medium- and high-risk areas for extreme weather. For example, building in an area identified as a high-risk area would then only be allowed if there is a demonstrable climate-adaptive proposal such that a climate label can be issued with which a mortgage and insurance can be obtained.
- Explore new forms of public-private partnerships together with the market, including the financial sector. Good examples should be identified or it should be explored whether the DBFM evaluation can be concretised. How can these forms of cooperation be strengthened in practice? It should be investigated how (a derivative of) this form can be used for area development with a certain degree of uncertainty by using a flexible financial shell. In doing so, engage with banks to hear experiences with DBFM and share perspectives. In addition, the government can help parties understand the high degree of uncertainty within spatial planning and replacement and renovation projects.
- Ensure more information symmetry between owners and buyers in the housing market and in commercial property transactions. Thus, risks gradually find their way into prices. A point of attention in this respect is that resilient and vulnerable households should interpret risk information correctly and equally to avoid social inequality.
- Expand the multilayer climate change safety model to make it applicable to other weather-related risks such as drought, heat, hail, etc. Currently, the model is used in the context of flooding and flood emergencies through various adaptation and protection layers. It is a dynamic model that could very well be applied more broadly. Water awareness can then become climate risk awareness, for example. It is also important that the different layers are not separate but interconnected.

Regional governments:

- Increase government knowledge and expertise on climate adaptation. Water boards have this knowledge and can play a greater role in this. This can be done by making climate risks transparent at district level.
- Inform residents about the risks of extreme weather due to climate change and what residents themselves can do to make homes more climate adaptive. Actively inform about existing subsidies.

3. Insurers

- The indemnity principle should be interpreted as a principle in which compensation may always be used for improved climate adaptation. A possibility the Association of Insurers suggested to the government in this respect is to make the sections on flooding from the National Benchmark (basis for climate-adaptive construction and part of the National Plan for Climate Adaptive Construction) legally applicable to existing buildings and new housing.
- Offer product differentiation appropriate to the climate-adaptive condition and location of the insured property that informs policyholders about the climate risk they face and motivates them to take climate-adaptive measures themselves. For example, by offering a premium discount when the measures have been taken (subject to solidarity).
- Continue discussions on simplifying the DCA implementation process by adopting a single public-private desk for all forms of damage. This will involve creating clear communication and a single point of contact.

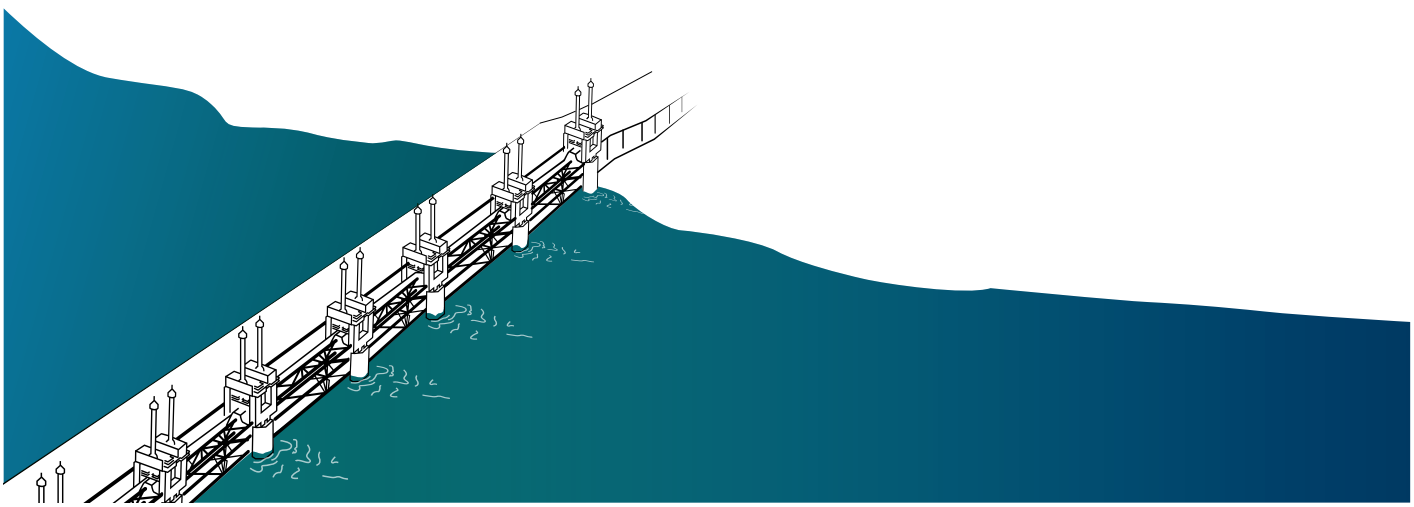
4. Banks

- Agree with the government on regulations for providing information on collateral condition and location in relation to climate change. And its influence on loan conditions in valuations and loan applications from individuals, governments and companies. One example is a mandatory climate label for houses as a counterpart to the energy label.
- Indicate where there are more opportunities for blended finance: public-private partnerships with external funding (other than government). In doing so, evaluate the forms with which experience has been gained, such as DBFM contracts. What was the role of the banks, why did the government become reluctant, how can this be improved in public-private partnerships and how can a flexible financial shell be used to absorb unforeseen risks?

5. Pension funds

- Position yourself as the sector committed to the long-term well-being of the Netherlands. Due to the size of pension funds' portfolios and the scale of climate adaptation projects, pension funds are a party with a sharply defined major economic interest in adapting their assets to climate change. From this role, a pension fund can 1) show itself more clearly in the public debate on climate adaptation and 2) proactively explore which innovations within the portfolio can accelerate climate adaptation. An example can be found in the National Benchmark, which states that in the Netherlands we should not only be able to retain or drain water when there is an abundance, but also to store water on a large scale for distribution during periods of drought and scarcity. In consultation with the government it should be investigated how this would be an interesting investment for a pension fund in order to speed up that development and construction.

These recommendations are partly practical in nature, but also give impetus to a systemic change in how we can accelerate climate adaptation in the Netherlands. The financial sector can make an important contribution to climate adaptation and thus take the next step in permanently protecting our country from the effects of extreme weather and, in particular, flooding.



6. Appendix

6.1 Climate agreements, legislation and regulations

Global attention is now being paid to the ill effects of climate change. Efforts to improve international cooperation to mitigate climate change have long been underway: in 1997, for instance, 181 countries signed the Kyoto Protocol. This treaty was an elaboration of the United Nations Framework Convention on Climate Change (UNFCCC) drawn up in 1992. The main goal in the Kyoto Protocol was to reduce greenhouse gas emissions by eight per cent over the period 2008-2020 compared to 1990 (SustainabilityLaw.nl , undated). Also, since 1995, the United Nations Framework Convention on Climate Change (UNFCCC) has organised the Conferences of Parties (COP), one of the most important international panels on climate change, where agreements on international cooperation on climate mitigation and climate adaptation are made and leading reports are presented, especially the IPCC reports (UNFCCC, undated).

To anticipate climate change and combat global warming, in 2015 world leaders agreed on ambitious new targets in the fight against climate change, enshrined in the Paris Agreement. This was a follow-up on the Kyoto Protocol that expired in 2020. Although IPCC reports show that not all of these new targets were met by a long shot, it is still important to list the key elements of the Paris Agreement (European Council, 2023):

- Long-term goal - governments decided to limit the average global temperature increase compared to the pre-industrial era to significantly less than 2°C, and to make efforts to limit it to 1.5°C.
- Contributions - before and during the Paris conference, countries submitted comprehensive National Climate Action Plans (Nationally Determined Contributions, or NDCs) to reduce their emissions.
- Ambition - governments decided to announce their action plans every 5 years, with increasingly ambitious targets.
- Transparency - governments agreed, for the sake of transparency and monitoring, to report to each other and to the general public on how they are progressing towards their targets.
- Solidarity - EU member states and other developed countries will continue to financially assist developing countries in reducing emissions and building resilience to the impacts of climate change.

The Paris agreement has been signed by 195 countries and is binding on them, although it does not allow sanctions to be imposed if adequate action is not taken by signatories. Instead, countries have their own mandate to set climate targets, which leads to major differences in approach and decisiveness.

Moreover, the aviation and shipping industry were kept out of the agreement, even though these sectors are responsible for about 5% of all global greenhouse gas emissions (Climate Agreement, 2022). In addition, a number of studies have argued that the targets contained in the Paris agreement are not sufficient to limit global warming to 1.5°C or even 2°C (Sokolov, Paltsev, Chen, & and Monier, 2016; Hoegh-Guldberg, et al., 2018).

To fulfil the mandate of the Paris Agreement within the European Union, Europe has concluded the Green Deal: "the blueprint for the transformation to a new economic model" (European Commission, 2023). By 2050 at the latest, Europe aims to be the first climate-neutral continent. The European Green Deal covers all sectors of the economy, such as transport, energy, agriculture and infrastructure, but also ICT, for example. To achieve the objectives of the European Green Deal, substantial investments are needed. Every year, an estimated EUR 260 billion extra (European Commission, 2023) will have to be invested. For instance, to support and accelerate the greening of European industry, as the Commission proposed the Green Deal Industrial Plan in February 2023. A relaxation of state aid rules and EUR 70 billion from existing European funds should contribute to this (European Commission, 2023).

On top of that, a series of regulations prescribe in detail how greenhouse gas emissions should be handled and reported. The EU Taxonomy (European Commission, 2020), for instance, is a classification system to gain insight into what part of the activities and resulting turnover of companies is sustainable. Related to the Taxonomy is the Sustainable Finance Disclosure Regulation (SFDR) (European Commission, 2019), which stipulates that investments are classified on how sustainable they are. The aim is to create more transparency about the sustainability of financial products.

In the coming years, the EU will make the Corporate Sustainability Disclosure Regulation (CSDR) (European Commission, 2021) and possibly the Corporate Sustainability Due Diligence Directive (CSDDD) (European Commission, 2022) mandatory for all large companies. With this, the reporting requirements will be tightened further and the sustainability of economic activity encouraged by providing detailed insight into the sustainability of European companies and promoting sustainable corporate behaviour.

Mitigating climate change or adapting to the effects of climate change are key goals in all these regulations. In particular, the regulations focus on steering money flows towards sustainable activities and discontinuing investments in the polluting activities, with climate change mitigation as the main goal.

6.2 History of living with water in Netherlands

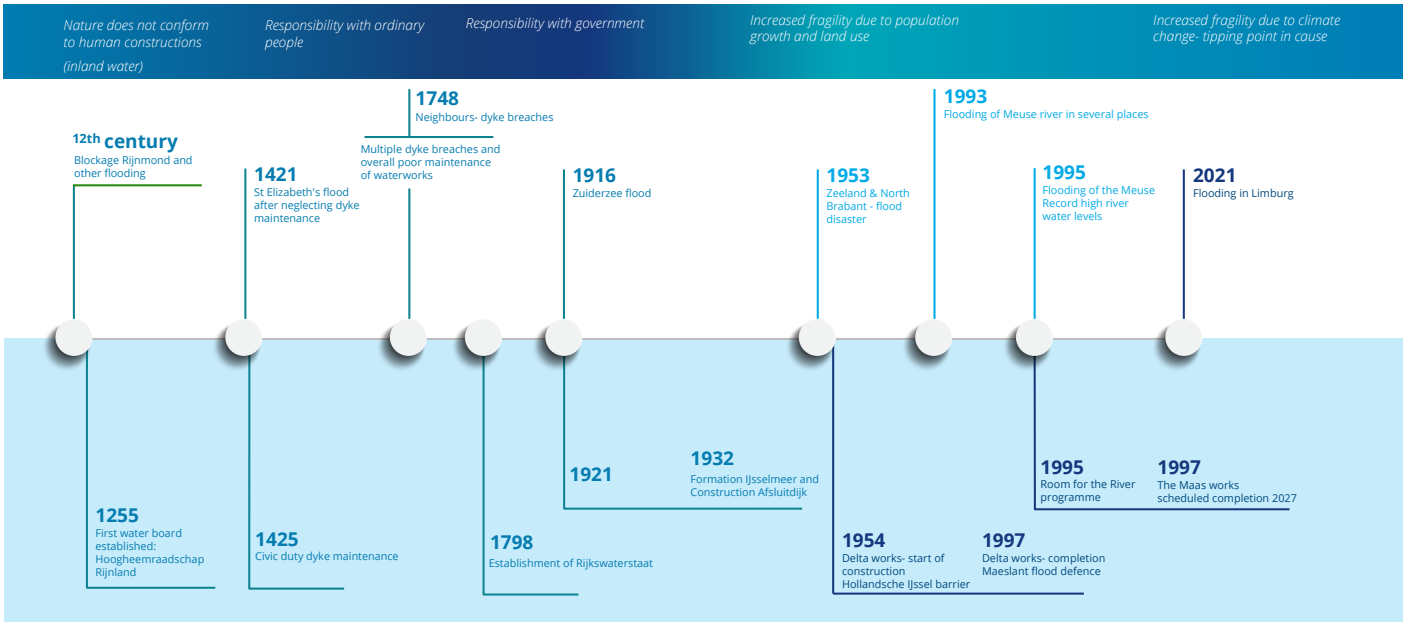


Figure 7. The Dutch history of water has several course-defining incidents in how water was dealt with. The timeline indicates a number of incidents as well as the related responses.

1000 - Leap to the peatlands

Residents of our country moved to the wet peatlands. To make the land suitable for agriculture, the area had to be drained. The dry peat settled and gradually the land fell below sea level. With this, the land became prone to flooding and deep pools and lakes formed in our country.[4]

1255 - Establishment of water boards

A practical and local solution for farmers and landowners. They benefited from the construction, management and maintenance of waterways and dykes. By working together and using joint resources, water management could be carried out more effectively than individually.[5]

1421 - St. Elisabeth's Flood

One of the earliest known water disasters. This flood hit the provinces of Zeeland and South Holland and led to the collapse of many dykes, flooding large parts of the country. Dozens of people drowned and new waters such as the Hollands Diep were created.[6]

1425 - Establishment Hoogheemraadschap Krimpenerwaard

To prevent a flood disaster like the St. Elisabeth's Flood, the ruling count felt that dyke maintenance should be improved. To this end, the Hoogheemraadschap Krimpenerwaard was established. This obliged residents to cooperate in dyke maintenance to prevent neglect.[7]

1570 - All Saints' Flood

During this storm surge, the water rose higher than in the 1953 flood disaster. The consequences were therefore enormous. Numerous dykes failed, flooding large areas. The total death toll must have exceeded 20,000.[8]

1579 - Tractaet van Dyckagie

Andries Vierlingh (1507-1579) was a Dutch hydraulic engineer who combined his work with administrative activities. With his treatise Tractaet van Dyckagie, he explained how dykes could be built and criticised mistakes made in water management. His ideas are still applied in the present day and have made water management more professional.[9]

[4]https://www.geologievannederland.nl/landschap/landschappen/veenlandschap
[5]https://www.rijnland.net/over-rijnland/archieven-en-erfgoed/artikelen-uitgelicht/acht-eeuwen-waterschapsorganisatie/
[6]https://www.rijkswaterstaat.nl/nieuws/archief/2021/09/600-jaar-elisabethsvloed-de-feiten-en-mythes-op-een-rijtje
[7]https://www.rijkswaterstaat.nl/nieuws/archief/2021/09/600-jaar-elisabethsvloed-de-feiten-en-mythes-op-een-rijtje
[8]https://www.knmi.nl/kennis-en-datacentrum/achtergrond/watersnoodramp-1953
[9]https://www.bhic.nl/ontdekken/verhalen/andries-vierlingh-ca-1507-ca-1579

17th century - Land reclamation

In the 17th century, several lakes and marshes in the Netherlands were drained with windmills to create agricultural land and reduce flood hazards. Examples include the Beemster polder in 1621 and the Schermer polder in 1635.[10]

1798 - Establishment of Rijkswaterstaat

So far, initiatives to control water in the Netherlands are mostly local and fragmented. However, the state of the dykes is inadequate. Floods, large and small, continue to occur. Much damage occurs and there is a demand for a national approach to water management. The Bureau of Water Management is therefore established.

1916 - Zuiderzee Flood

A storm and spring tide caused high water levels, resulting in flooding of the Zuiderzee. The vulnerability of low-lying areas and the high impact of such a type of flood were again brought to the fore. This flood therefore led to a new approach to water management in the Netherlands.[11]

1920-1967 - Zuiderzee works

The Zuiderzee flood was the decisive factor in starting the Zuiderzee works, which were initially intended mainly for land reclamation. Plans to seal off the Zuiderzee had been rejected earlier, but were now relevant again, as besides land reclamation, the low-lying land around the Zuiderzee would also be protected. An era was then dawning in which water management was more coordinated and more proactive. Various stakeholders collaborated and pooled their resources and knowledge to realise the Zuiderzee works.

The Zuiderzee Works are among the largest hydraulic works in the world and include closing off the Zuiderzee with the Afsluitdijk barrier dam (1932) and creating the Noordoost Polder (completed in 1942) and Flevoland (completed in 1968).[12]

1953 - Flood disaster

A severe storm combined with high water levels due to a spring tide caused dykes to break and flood the hinterland in more than 150 places in the Netherlands. This resulted in the deaths of more than 1,800 people and caused enormous damage to agriculture, buildings and infrastructure. The dykes could not handle the amount of water due to extremely high water levels and overdue maintenance, as repair work after World War II had been prioritised. However, the flood disaster was a turning point for Dutch water management.[13]

1958-1998 Delta Works

After the disaster, great efforts were made to improve flood prevention in the Netherlands. A committee was set up to investigate the causes of the disaster and make recommendations for improvements. Based on these recommendations, the Delta Plan was developed, which aimed to protect the coastline of the Netherlands from flooding.

1993 & 1995 - River floods

After a period of persistent rain, the river Meuse flooded in several places just before Christmas 1993. Areas in Limburg were hit hard. In the disaster, six people died and 12,000 were evacuated.[14] In 1995, it happened again. Snow and rainfall caused the water levels of the rivers Meuse and Rhine to rise to record levels. In Limburg, the river overflowed its banks and in the river region, the winter dykes of the rivers Meuse and Rhine barely broke.[15] However, the alarm was raised. Some 250,000 people in the river area were evacuated from the area.[16]

1995 - Room for the River & the Meuse Works

In response to the events of 1993 and 1995, Prime Minister Kok's government came up with a new approach to living with water in the Netherlands: Room for the River (*Ruimte voor de Rivier)*.
The project was finished in 2017 and literally made room for the river. In addition, plans to improve flood protection along the Meuse started in 1997. These are scheduled for completion in 2027. Experts say that during the 2021 flood in Limburg, the village of Borgharen near Maastricht remained dry, which was unfortunately not the case in 1995. This is partly because part of the river was dug deeper in more than 10 places.[17]

2021- Flooding in Limburg

Heavy rainfall led to major flooding in the Netherlands, Germany, Belgium and Luxembourg with many casualties. There were no fatalities in the Netherlands, but the damage amounted to over EUR 400 million. Within a few days, more rain fell in some places in southern Limburg than what was normal for an entire summer. This caused major problems. Water ran into houses, rivers flooded and people had to evacuate.

[10]https://www.cultureelerfgoed.nl/binaries/cultureelerfgoed/documenten/publicaties/2017/01/01/droogmakerijen/Droogmakerijen_RONC.pdf

[11]https://www.nemokennislink.nl/publicaties/1916-de-watersnoodramp-die-nederland-veranderde/

[12]https://geografie.nl/artikel/100-jaar-zuiderzeewerken-spiegel-van-een-veranderend-nederland

[13]https://www.rijkswaterstaat.nl/water/waterbeheer/bescherming-tegen-het-water/watersnoodramp-1953

[14]https://venlovanbinnen.nl/historie/de-maas-slaat-toe-watersnoodramp-1993-2/

[15]https://www.knmi.nl/over-het-knmi/nieuws/hoogwater-rijn-en-maas-1995

[16]https://mijngelderland.nl/inhoud/canons/buren/rampzalige-overstroming

[17]https://nos.nl/collectie/13869/artikel/2389754-sinds-de-jaren-90-geven-we-het-water-meer-ruimte-en-dat-betaalt-zich-nu-uit

6.3 Glossary

Adaptation gap: The gap between the need for measures to adapt to climate change (adaptation) and the actual actions taken and investments made to achieve these adaptations.

Adverse selection: A term used in the insurance industry that refers to the process by which higher-risk policyholders are more likely to purchase insurance than those with lower risk.

Balance sheet total: The total amount of assets and liabilities of a financial institution, often used to indicate the size of a bank.

Blended finance: A financing model with a mix of public and private capital and investors with different risk appetites, that can be used to finance a project together. Blended finance can also be used to set up climate projects that would otherwise be difficult to finance.

Subsidence: A process by which the soil in a given area gradually decreases in height. This happens when the soil settles, compresses or sinks, usually as a result of human activity. Subsidence can have significant impact on the physical environment, the infrastructure and the environment.

Flooding and high water policy round table: A consultative body set up by the Ministry of Infrastructure and Water Management to develop policies to prevent flood disasters. Other participants include several water boards, provinces and municipalities, and other ministries.

Drought policy round table: A consultative body set up by the Ministry of Infrastructure and Water Management to develop policies to prevent heat and drought. Other participants include water companies, water boards and other ministries.

Charity hazard: A term used in the insurance industry to describe a situation where policyholders may become less cautious because of the belief that they will still be covered by insurance.

Corporate Sustainability Reporting Directive (CSRD): An EU directive designed to promote sustainability by requiring companies to include climate-related risks and opportunities in their reporting. The aim is to provide investors and other stakeholders with relevant information for decision-making.

Crisis management: Planning and implementing activities and measures to respond to emergencies and disasters with the aim of preventing or minimising damage and protecting society. Crisis management is part of the multilayer safety principle.

Delta Fund: A fund aimed at flood prevention and management of delta areas in the Netherlands to safeguard the long-term importance of flood prevention and freshwater supply. Investors are the state and other public authorities such as water boards, provinces and municipalities.

Delta Programme: A national programme focused on water management, flood protection and climate resilient land use.

Deltares: A Dutch research institute specialising in water management and delta technology.

Delta Works: A series of large-scale hydraulic engineering projects in the Netherlands to protect the country from flooding from the sea, created in response to the 1953 flood disaster.

Design Build Finance and Maintain (DBFM): A form of contract in which the contractor is responsible for the design, building, financing and maintenance of a project.

Dykes: Raised barriers built to protect land from flooding. See also flood defences.

Dyke reinforcement: Measures to strengthen dykes and flood defences to prevent flooding, a form of climate adaptation.

EU Green Deal: A European Union initiative to make the economy sustainable and tackle climate change, aiming to be climate neutral by 2050.

EU Taxonomy: A system released by the European Union to classify economic activities as sustainable or unsustainable. The taxonomy was created to support the 2050 climate goals and is based on scientific reasoning.

Financial sector: The sector that provides financial services. Within this study, the focus is mainly on banks, insurers and pension funds.

Physical risks: Risks created by events (acute) such as extreme weather events, floods and storms, or long-term shifts (chronic) such as warming.

Area development: The development of spatial environments, often part of adaptive measures, such as adapting property and infrastructure. It can also include the development of green space and recreation.

Level playing field: A situation where all parties involved have the same opportunities and conditions.

Consequence mitigation: Consequence mitigation refers to the set of measures and strategies applied to minimise the impact and damage of an emergency, crisis or disaster. Consequence mitigation is part of the multilayer safety principle. Consequence mitigation assumes that the risk, such as flooding, can no longer be prevented through preventive measures, such as flood defences.

Reinsurer: A financial institution that takes over risks from insurance companies to provide financial stability and risk diversification. Essentially, reinsurers insure the insurers themselves.

Green bonds: Bonds issued to support environmental projects and climate-related initiatives.

Perspective for action: A plan or strategy that provides those involved in a crisis or emergency with the information and guidelines needed to respond and act effectively.

Heat and drought: Periods of extremely high temperatures and low rainfall, which can lead to drought and drought-related problems.

High Water Protection Programme (HWPP):
The High Water Protection Programme is an implementation programme to strengthen primary flood defences, such as reinforcements needed to meet new safety standards.

Intergovernmental Panel on Climate Change (IPCC):
The Intergovernmental Panel on Climate Change (IPCC) is a UN organisation that provides scientific assessments and reports on climate change.

Capital: The total assets or cash available for investment by investors such as banks and pension funds.

Climate adaptation: Measures to prepare for the effects of climate change, such as extreme weather, for example through infrastructure adaptations, area development and policies.

Climate awareness: Climate awareness is the awareness and understanding among individuals, groups and organisations, of the human impact on climate and the resulting risks. Climate awareness is often cited as a prerequisite before climate mitigation or climate-adaptive measures can be taken.

Climate exposure: The presence of vulnerable items or areas prone to the climate threat, such as streets that flood rapidly during heavy rainfall.

Climate threat: The danger that could lead to negative consequences, such as flooding from heavy rainfall.

Climate vulnerability: The propensity of exposed things to be negatively affected by a threat, e.g. lack of resident warning systems.

Climate label: A label or mark that provides information on the climate performance of a product, service, or building. It offers consumers and stakeholders insight into the climate impact and sustainability characteristics, allowing them to make more conscious choices that are beneficial for the environment and climate. See also water label.

Climate mitigation: Measures to reduce greenhouse gas emissions and mitigate climate change.

Climate neutral: Means that total greenhouse gas emissions are offset or reduced to zero to have no net impact on the climate. The goal of being climate neutral is an example of climate mitigation.

Climate risks: The Netherlands faces various climate risks, such as extreme precipitation, flooding, heat, groundwater decrease, subsidence, and drought. The IPCC and PBL Netherlands Environmental Assessment Agency use the same methodology in defining climate risk, looking at threat, exposure and vulnerability of a system.

Climate change: A long-term change in the earth's average weather pattern, including increases in average temperature and changes in precipitation patterns.

Climate-resilient restoration: The process of repairing and adapting damaged areas and infrastructure, with the aim of mitigating the effects of climate change and minimise future damage. Prevention is part of the multilayer safety principle.

KNMI Early Warning Centre (EWC): A system developed to provide warnings and information about upcoming extreme weather events, with the aim of reducing damage and protecting lives.

KNMI Climate Scenarios: Forecasts from the Royal Netherlands Meteorological Institute (KNMI) on how the climate in the Netherlands will change, including information on temperature changes and precipitation patterns.

Maladaptation: Actions or measures intended to adapt to climate change, but which unintentionally result in increased vulnerability or other adverse impacts.

Socially responsible investing: Integrating environmental and social considerations into investment decisions, often focusing on sustainability and climate.

Market failure: Market failure is an economic concept where free market mechanisms do not lead to an efficient allocation of goods and services in society.Within the context of climate adaptation, it refers to situations where the free market does not adequately respond to the challenges and risks of climate change. This can result in insufficient investment in climate-resilient infrastructure, limited innovation in environmentally friendly technologies and a lack of attention to climate-related risks by private companies. Government intervention, such as financial incentives, regulation and investment in research, may be needed to correct market failures and bring the market in line with climate adaptation targets.

Matthew effect: A phenomenon in which those who are already privileged or successful benefit from further advantages, while those who are already disadvantaged struggle to achieve improvement.

Interconnected opportunities: Referring to the possibility of planning and implementing projects or policies to simultaneously realise other goals or benefits. These additional benefits can range from environmental and climate benefits to social and economic gains. The idea behind co-benefits is to exploit synergies and promote efficiency by integrating multiple objectives in a single effort.

Multilayer safety (MLS): The concept of multilayer safety encompasses water awareness, prevention, consequence mitigation, crisis management and climate resilient recovery. It focuses on awareness of climate risks and taking action at different levels to address these risks.

Wildfires: Uncontrollable fires in forests, moorland and other vegetation, often fuelled by drought and high temperatures.

Nederlandse Waterschapsbank (NWB Bank):
A Dutch bank serving the public sector with a focus on water and sustainability.

National Benchmark: The National Benchmark for a green, climate-adaptively built environment provides a framework as a basis for climate-adaptive and future-proof building. This is part of the National Plan for Climate Adaptive Construction and has been presented to the House of Representatives by the Minister for Housing and Spatial Planning, the Minister for Infrastructure and Water Management and the Minister for Nature and Nitrogen.

Inequality: Differences in treatment, compensation or protection between individuals or groups, especially with regard to insurability and financial support after a disaster.

Floods: The temporary flooding of land areas due to heavy rainfall, melting snow or the failure of dykes and dams.

Flood warnings: Information provided to residents to warn them of potential flood hazards.

Pension funds: Pension funds manage significant capital reserves and can promote climate adaptation through their investment choices. The decisions they make as investors matter a lot.

Paris Agreement: An international climate agreement concluded in 2015 (UNFCCC) with the aim of reducing the global warming limit to less than 2°C above pre-industrial levels and a target of no more than 1.5°C warming by 2050.

Polders: Low-lying areas artificially drained and reclaimed to allow habitation and agriculture.

Prevention: Measures taken to reduce climate-related risks, such as the construction of dykes and water buffers to prevent flooding. Prevention is part of the multilayer safety principle.

Price incentive: Mechanism that affects the prices of goods or services to promote or discourage a specific behaviour or action. In the context of climate adaptation, price incentives can be used to encourage climate-adaptive action.

Primary waters: Primary waters, unlike regional waters, are larger in nature and are managed by Rijkswaterstaat. These include the North Sea, Wadden Sea, major rivers such as the Rhine and Maas, and the IJssel and Markermeer.

Public-private financing: collaboration between the public and private sectors to provide financial resources for projects and infrastructure.

River delta: An area where a river flows into the sea and where landforms are created by the deposition of sediment by the river.

Regional waters: Regional waters, unlike primary waters, are smaller in nature and are managed by a water board. These include small lakes, rivers and streams or canals. The river Geul that flooded in Limburg was also a regional water system.

Rijkswaterstaat: The Dutch Directorate-General for Public Works and Water Management is an implementing organisation of the Ministry of Infrastructure and Water Management. Within the context of water management it is responsible for managing primary waters.

Rotterdams Weerwoord: A programme in Rotterdam focused on climate adaptation that addresses all aspects of climate change, including extreme precipitation, flooding, drought, heat and more.

Room for the River: Een programma dat ruimte geeft aan water en rivieren om overstromingen te voorkomen, naast traditionele dijkversterking.

Stresstest: A programme that gives space to water and rivers to prevent flooding, alongside traditional dyke reinforcement.

Secondary water system: See regional water system.

Sustainable Development Goals (SDGs): A set of 17 Sustainable Development Goals set by the United Nations. They focus on issues such as poverty reduction, clean water, climate action and more to create a just and more sustainable world by 2030.

Task Force on Climate-related Financial Disclosures (TCFD):
An initiative that encourages financial institutions and companies to disclose information on climate-related financial risks. This task force has made recommendations for both climate mitigation and climate adaptation. These recommendations are now being integrated into legislation and regulations, including regulations of financial institutions such as the ECB, DNB and AFM.

Transition risks: Risks arising from the transition to a more sustainable economy, particularly the impact on investments in fossil fuel-dependent sectors.

Association of Regional Water Authorities: The umbrella organisation of the Dutch water boards involved in water management and flood prevention.

Bogs: Wet, marshy areas where organic material, such as peat, accumulates and preserves.

Salinisation: The accumulation of salt in the soil, which can cause problems for agriculture and drinking water supply.

Verbond van Verzekeraars: Dutch association of insurers, a trade association representing the interests of insurers in the Netherlands.

Insurers: Verzekeraars bieden dekking tegen klimaatgerelateerde schade, zoals neerslag, wateroverlast en falen van waterkeringen. Ze dragen ook bij aan bewustwording door klanten te voorzien van informatie over klimaatrisico's.

Safety standards: Standards set to ensure the safety of flood defences, such as dykes.

Water and soil to be leading: The idea that water and soil underpin many aspects of the environment and human activities. This means that they have a major influence on the design and behaviour of ecosystems, land use and society as a whole. The decision memorandum of the same name from the government informed the House of Representatives that water and soil become leading in spatial planning decision-making.

Water storage: The deliberate retention of water in areas to prevent flooding.

Water awareness: Awareness of risks related to flooding and flood emergencies and recognition that not all consequences of extreme weather can be prevented. Prevention is part of the multilayer safety principle. See also climate awareness.

Flood defences: The term for structures and systems deployed to manage water flows such as to prevent flooding. Flood defences include dykes, dams, locks, coastal reinforcements and storm surge barriers.

Water label: A label or mark that provides information on the extent to which a plot is made water-resilient, for instance, by retaining water for longer periods that can prevent flooding. This can be done by rocking tiles and installing a water barrel.

Water Plan 2: A policy document in Rotterdam covering water management and climate adaptation in the city. It is a follow-up to the first Water Plan and aims to make Rotterdam more resilient to climate change, especially to the effects of heavy rainfall and rising sea levels.

Water square: An urban space designed to temporarily flood during heavy rainfall or floods, and acts as part of the urban water management system.

Water scarcity: A lack of sufficient freshwater resources to meet the needs of the population.

Water boards: Government organisations in the Netherlands responsible for water management in their respective regions. The responsibilities of water boards include flood prevention, quality and quantity. Water boards have a democratically elected board. There are currently 21 water boards in the Netherlands.

Waterworks: Infrastructure and facilities designed to ensure water management and safety, such as locks, pumping stations and canals. See also flood defence.

Heat records: Records of unusually high temperatures compared with historical data.

Disasters (Compensation) Act (DCA): *Wet tegemoetkoming schade bij rampen (WTS)*, a statutory scheme that provides financial compensation for damages caused by disasters and emergencies.

Security Regions Act (SRA): *Wet veiligheidsregio (Wvr)*, statutory regulation governing the organisation and coordination of security regions in the Netherlands and how they should handle crisis management and disaster response.

Sea level rise: The rise in sea level, due to climate change.

Self-reliance: The ability of individuals and communities to help and protect themselves from the effects of climate-related disasters.

6.4 6.4 Interviewees

Logo	Naam	Positie
Gemeente Rotterdam	**Arnoud Molenaar**	Chief Resilience Officer at Municipality of Rotterdam and Lead Cities at Global Centre on Adaptation Municipality of Rotterdam
	Johan Verlinde	Programme manager Rotterdam Weerwoord Municipality of Rotterdam
	Corjan Gebraad	Urban Development Rotterdam Weerwoord Municipality of Rotterdam
	Maartje Visser	Climate Change Adaptation Specialist Rotterdam Weerwoord Municipality of Rotterdam
Rabobank	**Bouke de Vries**	Management consultants Sustainability for public affairs at Rabobank
Rabobank	**Tom Daamen**	Professor of Urban Planning & Real Estate Delft University, Red&Blue research
a.s.r. de nederlandse verzekerings maatschappij voor alle verzekeringen	**Esther Egeter**	Sustainability Manager at a.s.r.
Hoogheemraadschap van Delfland	**Carl Paauwe**	Programme manager climate adaptation at the Water Board of Delfland
VU Vrije Universiteit Amsterdam	**Wouter Botzen**	Director Institute for Environmental Studies at the Free University of Amsterdam
	Thijs Endendijk	PhD candidate at the Institute for Environmental Studies at the Free University of Amsterdam
	Max Tesselaar	PhD candidate at the Institute for Environmental Studies at the Free University of Amsterdam
Ministerie van Infrastructuur en Waterstaat	**Wieke Tas**	Department head of Climate adaptation and Governance at the Ministry of Infrastructure and water management
Pensioen Federatie	**Will-Jan Jacobs**	Sustainable Investment Policy Advisor at the Pension Federation
waterschap limburg met de omgeving, voor de omgeving	**Josette van Wersch**	Member of the executive board of the Limburg
Unie van Waterschappen	**Wijnand Dekking**	Policy advisor at the Association of Regional Water Authorities
	Mark van Kruining	Policy advisor on water policy at the Association of Regional
NWB Bank	**Lidwin van Velden**	Chairman of the Board of the Dutch Water
	Merel Hendriks	Sustainability Officer at Nederlandse Waterschapsbank

7. Source references

ABP. (2019). *ABP belegt in eerste groene Nederlandse staatsobligatie.* Opgehaald van https://www.abp.nl/over-abp/actueel/nieuws/2019/mei/abp-belegt-in-eerste-groene-nederlandse-staatsobligatie

ABP. (2022). *Klimaatbeleid ABP 2022 - 2030: Versnellen met beleggingen die verschil maken.* Opgehaald van https://www.abp.nl/content/dam/abp/common/documents/klimaatbeleid-abp-15-december-2022.pdf

ABP. (undated). *ABP.* Opgeroepen op May 08, 2023, van ABP: https://www.abp.nl/

Actueel Hoogtebestand Nederland. (undated). *AHN Viewer.* Opgeroepen op 08 07, 2023, van https://www.ahn.nl/ahn-viewer

Agentschap van de Generale Thesaurie. (undated). *Groene obligaties.* Opgeroepen op 08 04, 2023, van https://www.dsta.nl/onderwerpen/groene-obligaties

APG en ABP. (2020). *ABP en APG roepen overheid op tot meer investeringsmogelijheden in Nederland.* Opgehaald van APG: https://apg.nl/nl/publicatie/abp-en-apg-roepen-overheid-op-tot-meer-investeringsmogelijkheden-in-nederland/

Bank for International Settlements. (undated). *History of the Basel Committee.* Opgeroepen op 10 24, 2023, van https://www.bis.org/ bcbs/history.htm

Bank of England. (2017). *The Bank of England's response to climate change. Quarterly Bulletin.* Opgehaald van https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2017/the-banks-response-to-climate-change.pdf

Bank of England. (2020). *What do banks do?* Opgehaald van bankofengland.co.uk: https://www.bankofengland.co.uk/explainers/what-do-banks-do

Beleidstafel droogte. (2019). *Nederland beter weerbaar tegen droogte, Eindrapportage Beleidstafel Droogte.* Opgeroepen op Juni 2023, van https://open.overheid.nl/documenten/ronl-749b44a3-8e4b-427b-ad23-9be64203a619/pdf

Beleidstafel wateroverlast en hoogwater. (2022). *VVoorkomen kan niet, voorbereiden wel.* Opgehaald van https://open.overheid.nl/documenten/ronl-cddbc01e11cbe749215a9adde1803b2f346f50e0/pdf

Bor, A.-M., Duiker, J., & Hertog, I. (2021). *Nederland Klimaatbestendiger maken: Welke rol spelen financiële instellingen en welke kansen liggeen er in samenwerking met overheden?* Samen Klimaatbestendig.

BPF Bouw. (2021). *Klimaatactieplan.* Opgeroepen op May 08, 2023, van https://www.bpfbouw.nl/content/dam/bpfbouw/documents/pdf/bpfbouw-klimaatactieplan.pdf

BPF Bouw. (undated). *BPF Bouw.* Opgeroepen op May 08, 2023, van BPF Bouw: https://www.bpfbouw.nl/

Centraal Bureau voor Statistiek. (2016). *Corporatiebezit neemt af.* Opgehaald van https://www.cbs.nl/nl-nl/nieuws/2016/50/corporatiebezit-neemt-af

Centraal Bureau voor Statistiek. (2022). *KKerngegevens sectoren; nationale rekeningen.* Opgeroepen op May 08, 2023, van Centraal Bureau voor Statistiek: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/84097NED/table?ts=1607329979735

Centraal Planbureau. (2023). *KKlimaatverandering en intergenerationele verdeling van financiële lasten.* Opgehaald van https://www.cpb.nl/sites/default/files/omnidownload/CPB-Publicatie-Klimaatverandering-en-intergenerationele-verdeling-van-financi%C3%ABle-lasten.pdf

Consultancy.nl. (2020). *Nederland heeft zesde grootste pensioenkapitaal ter wereld.* Opgeroepen op May 08, 2023, van Consultancy.nl: https://www.consultancy.nl/nieuws/17289/nederland-heeft-zesde-grootste-pensioenkapitaal-ter-wereld

Corporate Citizenship. (2016). *Advancing the Sustainable Development Goals: Business action and Millennials' views.* Opgehaald van https://corporate-citizenship.com/wp-content/uploads/Advancing-the-Sustainable-Development-Goals-Business-Action-and-Millennials-Views.pdf

DakAkker/Wouter Bauman. (undated). *DakAkker.* Opgeroepen op 08 07, 2023, van https://dakakker.nl/site/

De Limburger. (2022). *Waterschap Limburg in het geweer tegen de aanleg van padelbanen in Meerssen.* Opgehaald van De Limburger: https://www.limburger.nl/cnt/dmf20220922_93972566

De Limburger. (2023). *Rampenwet heeft een make-over nodig, vindt Nationale Ombudsman: 'De overheid heeft gouden bergen beloofd'.* Opgehaald van De Limburger: https://www.limburger.nl/cnt/dmf20230706_95011033

De Nederlandsche Bank. (2020). *DNB toepassing van de ECB Gids inzake klimaat- en milieurisico's voor banken.* Opgehaald van De Nederlansche Bank: https://www.dnb.nl/voor-de-sector/open-boek-toezicht-sectoren/banken/prudentieel-toezicht/factsheet/dnb-toepassing-van-de-ecb-gids-inzake-klimaat-en-milieurisico-s-voor-banken/

De Nederlandsche Bank. (2021). *De impact van klimaatrisico's op verzekeraars.* Opgehaald van De Nederlansche Bank.

De Nederlandsche Bank. (2021). *Op weg naar een duurzame balans.* Opgeroepen op Juli 2023, van https://www.dnb.nl/publicaties/publicaties-onderzoek/occasional-study/nr-3-2021-op-weg-naar-een-duurzame-balans/

De Nederlandsche Bank. (2022). *Uitkomsten ESG (Environmental, Social, Governance) onderzoeken bij pensioenfondsen.* Opgehaald van De Nederlansche Bank: https://www.dnb.nl/nieuws- voor-de-sector/toezicht-2022/uitkomsten-esg-environmental-social- governance-onderzoeken-bij-pensioenfondsen/

De Nederlandsche Bank. (2023). *Gids voor de beheersing van klimaat- en milieurisico's.* Opgehaald van https://www.dnb.nl/media/igyppcta/gids-voor-de-beheersing-van-klimaat-en-milieurisico-s.pdf

De Nederlandsche Bank. (2023). *Wat 'blended finance' kan betekenen voor de energietransitie.* Opgehaald van dnb.nl: https://www.dnb.nl/algemeen-nieuws/nieuwsberichten-2023/wat-blended-finance-kan-betekenen-voor-de-energietransitie/

De Nederlandsche Bank. (undated). *Werkgroep Klimaatadaptatie.* Opgeroepen op 09 06, 2023, van https://www.dnb.nl/groene- economie/platform-voor-duurzame-financiering/werkgroep-klimaatadaptatie/

De Nederlandsche Bank. (undated). *Wet- en regelgeving pensioenfondsen.* Opgeroepen op 10 24, 2023, van https://www.dnb.nl/voor-de-sector/open-boek-toezicht/wet-regelgeving/wet-en-regelgeving-pensioenfondsen/

De Nederlandsche Bank. (undated). www.dnb.nl/toezichtprofessioneel/ regelgeving/solvency-ii/index/. Opgehaald van www.dnb.nl/ toezichtprofessioneel/regelgeving/solvency-ii/index/

Della Croce, R., Kaminker, C., & Stewart, F. (2011). *The role of pension funds in financing green growth initiatives.* Paris: OECD Publishing.

Delta Expertise. (undated). *Secundaire waterkering.* Opgeroepen op Augustus 8, 2023, van Delta expertise: https://www.deltaexpertise.nl/wiki/index.php/Secundaire_waterkering_VN

Deltaprogramma. (2023). *Versnellen, Verbinden, Verbouwen Nationaal Deltaprogramma.*

Deltares. (2020). *Impact droogte op funderingen. Deltares.*

Deltares. (2021). *Analyse overstroming Valkenburg: Watersysteemevaluatie Waterschap Limburg.* Opgehaald van https://www.deltares.nl/expertise/publicaties/analyse-overstroming-valkenburg-watersysteemevaluatie-waterschap-limburg

Dutch State treasury Agency. (2022). *State of the Netherlands.* Opgehaald van https://www.dsta.nl/documenten/publicaties/2022/05/10/green-bond-framework

Eerlijke geldwijzer. (2023). *Beleidsbeoordeling Nederlandse banken 19e update.* Eerlijke Bankwijzer. Opgeroepen op Aug 2023, van https://eerlijkegeldwijzer.nl/media/498287/2023-05-19e-beleidsupdate.pdf

Endendijk, Botzen, De Moel, Aerts, Duijndam, Slager, . . . Kok. (2022). *Experience From the 2021 Floods in the Netherlands: Household Survey Results on Impacts and Responses. Journal of coastal and riverine flood risk.* Opgehaald van https://essopenarchive.org/users/564629/articles/621989-experience-from-the-2021-floods-in-the-netherlands-household-survey-results-on-impacts-and-responses

Endendijk, T., Botzen, W., Slager, K., De Moel, H., Aerts, J., Kok, M., & Kolen, B. (2022). *Resultaten vragenlijst Hoogwater Limburg 2021: Ervaren waterstanden, schades, en genomen risicoreductiemaatregelen. Deltares.* Opgehaald van https://deltares-deltares-p01-website.s3.eu-central-1.amazonaws.com/app/uploads/2022/10/Onderzoek-limburg_2410.pdf

ESRB. (2015). *Report on systemic risks in the EU insurance sector.* Opgehaald van https://www.esrb.europa.eu/pub/pdf/reports/2015-12-16_esrb_report_annex_1.pdf

European Commission. (2009). *Directive 2009/138/EC.* Opgehaald van https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02009L0138-20210630

European Commission. (2019). *REGULATION (EU) 2019/2088 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. 317(1).*

European Commission. (2020). *Regulation (EU) 2020/852. Official Journal of the European Union.* Opgehaald van https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0852

European Commission. (2020). *REGULATION (EU) 2020/852 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. 198(13).*

European Commission. (2021). *Document 52021PC0189: Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2013/34/EU, Directive 2004/109/EC, Directive 2006/43/EC and Regulation (EU) No 537/2014, as regards corporate sustainability reporting.* Opgehaald van https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0189

European Commission. (2022). *Directive (EU) 2022/2464. Official Journal of the European Union.* Opgehaald van https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464

European Commission. (2022). Document 52022PC0071: *Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on Corporate Sustainability Due Diligence and amending Directive (EU) 2019/1937.* European Lexicon.

European Commission. (2023). *Werk maken van de Europese Green Deal.* Opgehaald van https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_nl

Europese Centrale Bank. (2022). *Macro-financial scenarios for the 2022 climate risk stress test.* Opgehaald van https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.macrofinancialscenariosclimateriskstresstest2022~bcac934986.nl.pdf

Europese Centrale Bank. (2023). *Pension funds.* Opgehaald van ecb.europa.eu: https://www.ecb.europa.eu/stats/financial_corporations/pension_funds/html/index.en.html

Europese Raad. (2023). *Europese Raad.* Opgehaald van Klimaatovereenkost van Parijs: https://www.consilium.europa.eu/nl/policies/climate-change/paris-agreement/

Expertise Netwerk Waterveiligheid. (2017). *Grondslagen voor hoogwaterbescherming.* Opgehaald van https://www.enwinfo.nl/publish/pages/183541/grondslagen-druk2-lowres-spread.pdf

Expertise Netwerk Waterveiligheid. (2023). *Verzekeren van overstromingen vanuit het primaire systeem aantrekkelijk?* Opgehaald van https://www.enwinfo.nl/publish/pages/221759/enw-23-06b-bijlage-bij-advies-aan-dgwb-inzake-verzekerbaarheid-overstromingsrisico-s.pdf

Floating Farm. (2019). *Floating Farm.* Opgeroepen op 08 07, 2023, van https://floatingfarm.nl/

FloodRe. (2023). Floodre. Opgehaald van *floodre.co.uk:* https://www.floodre.co.uk/

Gemeente Rotterdam. (2021). *Rotterdamse strategie voor klimaatadaptatie.* Opgeroepen op 08 07, 2023, van https://duurzaam010.nl/verhalen/rotterdamse-strategie-voor-klimaatadaptatie/

Gemeente Rotterdam. (2022). *Noordereiland.* Opgeroepen op augustus 07, 2023, van Noordereiland: https://www.noordereiland.org/2022/stormseizoen-2022/

Gemeente Rotterdam. (2023). Rotterdams weerwoord. Opgehaald van https://rotterdamsweerwoord.nl/

Gemeente Rotterdam. (z.d.). *Buitendijks.* Opgeroepen op 08 07, 2023, van https://www.rotterdam.nl/buitendijks

Gemeente Rotterdam. (z.d.). *Groene daken.* Opgeroepen op 08 07, 2023, van https://www.rotterdam.nl/groene-daken

Gemeente Rotterdam. (z.d.). *Resilient Rotterdam.* Opgehaald van https://www.resilientrotterdam.nl/

Gemeente Rotterdam. (z.d.). *Waterplan 2.* Opgeroepen op May 10, 2023, van Gemeente Rotterdam: https://www.rotterdam.nl/waterplan-2

Ginbo, T., Di Corato, L., & Hoffmann, R. (2022). *Investing in climate change adaptation and mitigation: A methodological review of real-options studies. 50, 229–24.* Opgehaald van https://link.springer.com/article/10.1007/s13280-020-01342-8

Green Finance Institute. (2023). *Mission climate ready.* Opgehaald van https://www.smithschool.ox.ac.uk/sites/default/files/2023-06/Mission-Climate-Ready-Unleashing-finance-and-investment-REPORT.pdf

Haring, P., Wesselingh, F., & Ahrens, H. (2023). *Geologie van Nederland.* Opgehaald van Rivierlandschap: https://www.geologievannederland.nl/landschap/landschappen/rivierlandschap

Het Financieele Dagblad. (2023). *DNB wil meer inspanningen financiële sector op klimaat- en milieurisico's.* Opgeroepen op Augustus 2023, van fd.nl: https://fd.nl/financiele-markten/1472223/dnb-wil-meer-inspanningen-financiele-sector-op-klimaat-en-milieurisicos

Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., . . . Zhou, a. G. (2018). *Impacts of 1.5°C of Global Warming on Natural and Human Systems. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. Shukla, . . . a. T. (eds.), Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, (pp. 175-312).* Cambridge, UK and New York, NY, USA,: Cambridge University Press.

Hogeschool Rotterdam. (undated). *Rotterdam Climate Initiative.* Opgehaald van https://www.hogeschoolrotterdam.nl/samenwerking/andere-samenwerkingsvormen/allianties--convenanten/rotterdam-climate-initiative/

Hölscher, K., Frantzeskaki, N., McPhearson, T., & Loorbach, D. (2019). *Tales of transforming cities: Transformative climate governance capacities in New York City, U.S. and Rotterdam, Netherlands. Journal of Environmental Management, 843-857.* Opgehaald van: https://doi.org/10.1016/j.jenvman.2018.10.043

Hueskes, M. K. (2016). *Publiek private samenwerking in Nederland en Vlaanderen: Een review van veertien proefschriften. 12, 30-34.*

Hulscher, S. J. (2023). *Rechtvaardigheid in klimaatbeleid. Over de verdeling van klimaatkosten. Den Haag: Wetenschappelijke Raad voor het Regeringsbeleid.*

Informatiepunt Leefomgeving. (undated). *Informatiepunt Leefomgeving.* Opgeroepen op juli 21, 2023, van Verzilting - oorzaken, gevolgen en maatregelen: https://iplo.nl/thema/water/beheer-watersysteem/verzilting-oorzaken-gevolgen-maatregelen/

Insurance Council of Australia. (2022). *Building a more resilient Australia:.* Opgehaald van https://insurancecouncil.com.au/wp-content/uploads/2022/02/220222-ICA-Election-Platform-Report.pdf

Insurance Europe. (2023). *www.insuranceeurope.eu.* Opgehaald van www.insuranceeurope.eu

IPCC. (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.* Opgehaald van https://www.ipcc.ch/report/managing-the-risks-of-extreme-events-and-disasters-to-advance-climate-change-adaptation/

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report.* New York, NY, USA: Cambridge University Press. doi:doi:10.1017/9781009325844

Kennisportaal Klimaatadaptatie. (2023). *Kennisportaal Klimaatadaptatie.* Opgehaald van Aanbevelingen voor meer samenhang tussen klimaatadaptatie en klimaatmitigatie: https://klimaatadaptatienederland.nl/actueel/actueel/nieuws/2023/aanbevelingen-samenhang-adaptatie-mitigatie/

Klimaatakkoord. (2021). *EU Taxonomie definieert wat duurzaam is.* Opgeroepen op September 2023, van Klimaatakkoord.nl: https://www.klimaatakkoord.nl/actueel/nieuws/2021/04/22/eu-taxonomie-definieert-wat-duurzaam-is

Klimaatakkoord. (2022). *Klimaatakkoord.* Opgehaald van Ook lucht- en scheepvaart hebben nu klimaatambities: https://www.klimaatakkoord.nl/actueel/nieuws/2022/04/22/ook-lucht--en-scheepvaart-hebben-nu-klimaatambities

Klimaatcommitment Financiële Sector. (2023). *Klimaatcommitment Financiële Sector.* Opgehaald van www.klimaatcommitment.nl

KNMI. (2021). *KNMI Klimaatsignaal'21.* Opgeroepen op September 11, 2023, van knmi.nl: https://www.knmi.nl/kennis-en-datacentrum/achtergrond/knmi-klimaatsignaal-21

KNMI. (2021, 07 13). *KNMI verbetert komende jaren de weerwaarschuwingen.* Opgeroepen op Augustus 2023, van KNMI: https://www.knmi.nl/over-het-knmi/nieuws/knmi-verbetert-komende-jaren-de-weerwaarschuwingen

KNMI. (2021). *Krachtenbundeling KNMI en Verbond van Verzekeraars om klimaatschade tegen te gaan.* Opgeroepen op Juli 2023, van KNMI: https://www.knmi.nl/over-het-knmi/nieuws/krachtenbundeling-knmi-en-verbond-van-verzekeraars-om-klimaatschade-tegen-te-gaan

KNMI. (z.d). *Klimaatverandering.* Opgeroepen op Augustus 06, 2023, van https://www.knmi.nl/producten-en-diensten/klimaatverandering

KNMI'23. (2023). *KNMI'23 klimaatrisico's. KNMI.*
Koppenjan, J. F. (2020). Leren van 15 jaar DBFM-projecten bij RWS: Eindrapport. Rijkswaterstaat en Bouwend Nederland.
Leroy, P. (2021). Zonder sociaal beleid faalt het klimaatbeleid. Opgehaald van wbs.nl: https://wbs.nl/publicaties/zonder-sociaal-beleid-faalt-het-klimaatbeleid

Martin et al. (2022). *Ten new insights in climate science 2022. Global Sustainability, 5, e20.* Opgehaald van https://www.cambridge.org/core/journals/global-sustainability/article/ten-new-insights-in-climate-science-2022/62C90D59C9F9890791B64762EAA06B8D

Miller, G. (2015). *Rotterdam: Adapting to climate change.* Opgeroepen op May 10, 2023, van ICE: https://www.ice.org.uk/engineering-resources/case-studies/rotterdam-adapting-to-climate-change

Minister van Infrastructuur & Waterstaat. (2021). *Beleidstafel Wateroverlast en Hoogwater.* Opgehaald van https://open.overheid.nl/documenten/ronl-76b696d0-c28a-436e-9f31-508cda89797b/pdf

Ministerie van Defensie. (2021). *Militaire ondersteuning Limburg beëindigd.* Opgehaald van Ministerie van Defensie: https://www.defensie.nl/actueel/nieuws/2021/07/19/militairen-ondersteuning-limburg-beeindigd

Ministerie van Financiën. (undated). *5.1 Artikel 11: Financiering staatsschuld.* Opgeroepen op 08 04, 2023, van https://www.rijksfinancien.nl/memorie-van-toelichting/2016/OWB/IX/onderdeel/d16e20505

Ministerie van Infrastructuur & Waterstaat. (2022). *Evaluatie NAS: Aanbevelingen voor versnelde uitvoering van de Nationale klimaatadaptatiestrategie, publieksversie oktober 2022.* Opgehaald van https://www.rijksoverheid.nl/documenten/rapporten/2022/12/16/bijlage-evaluatie-nas-hoofdrapport

Ministerie van Infrastructuur en Waterstaat. (2022). *Beleidstafel Wateroverlast en Hoogwater.* Opgeroepen op May 10, 2023, van https://open.overheid.nl/documenten/ronl-63ef3f6ee7ec67053759c6901eefa10240dcf004/pdf

Ministerie van Infrastructuur en Waterstaat. (2023). *Nu voor later - Nationaal Deltaprogramma 2024.* Opgehaald van https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2023/09/19/deltaprogramma-2024/deltaprogramma-2024.pdf

Myriam Vander Stichele (SOMO). (2016). A structural problem in the shadows. Opgehaald van https://www.somo.nl/nl/wp-content/uploads/sites/2/2016/11/A-structural-problem.pdf

Nationaal Deltaprogramma. (undated). *Deltaprogramma.* Opgehaald van https://www.deltaprogramma.nl/deltaprogramma

Nationaal Deltaprogramma. (undated). *Rijnmond-Drechtsteden.* Opgeroepen op 08 07, 2023, van https://www.deltaprogramma.nl/gebieden/rijnmond-drechtsteden

Nationale Ombudsman. (2022). *Brief: Watersnood Zuid-Limburg.* Opgeroepen op Juli 2023, van Nationale Ombudsman: https://www.nationaleombudsman.nl/nieuws/nieuwsbericht/2022/overheid-komt-beloften-schadeafhandeling-watersnood-limburg-niet-na

Nationale Ombudsman. (2022). *Jaarverslag 2022: Tijd voor de burger.* Opgeroepen op Augustus 2023, van Nationale Ombudsman: https://www.nationaleombudsman.nl/system/files/bijlage/Jaarverslag%202022_0.pdf

Nederlandse overheid. (2021). *Wet tegemoetkoming schade bij rampen.* Opgeroepen op May 03, 2023, van Overheid.nl: https://wetten.overheid.nl/BWBR0009637/2021-07-01

Nederlandse Waterschapsbank N.V. (2022). *NWB Bank (Nederlandse Waterschapsbank N.V.) Green Bond Framework 2022.* Opgehaald van https://nwbbank.com/application/files/2316/5692/6870/NWB_Green_Bond_Framework_2022.pdf

Net-Zero Insurance Alliance. (z.d.). *Statement from the UN Environment Programme on the Net-Zero Insurance Alliance.* Opgeroepen op 08 04, 2023, van United Nations Finance Initiative: https://www.unepfi.org/net-zero-insurance/

Nijhuis, L. (2013). *Bouwstenen voor Adaptatiestrategieën in de Regio Rotterdam.* Rapport voor Kennis voor Klimaat. Opgeroepen op May 10, 2023, van https://edepot.wur.nl/326799

Nijhuis, L. (2014). *Een sterke en aantrekkelijke stadsregio Rotterdam.* Opgeroepen op May 10, 2023, van Kennisportaal klimaatadaptatie: https://klimaatadaptatienederland.nl/@158781/sterke/

NOS. (2022). *Heet, heter, heetst, vooral in de steden. Hoe moet dat in de toekomst?* Opgehaald van nos.nl: https://nos.nl/artikel/2437511-heet-heter-heetst-vooral-in-de-steden-hoe-moet-dat-in-de-toekomst

NOS Nieuws. (2021). *NOS.* Opgeroepen op juli 17, 2023, van Droogte leidt tot grote schade aan woningen in hele land: https://nos.nl/artikel/2375471-droogte-leidt-tot-grote-schade-aan-woningen-in-hele-land

NWB Bank. (undated). *NWB Bank.* Opgehaald van NWB Bank: www.nwbbank.com

Pauly, M. (1974). *Overinsurance and public provision of insurance: The roles of moral hazard and adverse selection.* The Quarterly Journal of Economics, 88, 44-62. doi: https://doi.org/10.2307/1881793

PCAF. (2022). *Insurance-Associated Emissions - The Global GHG Accounting & Reporting Standard Part C.* Opgeroepen op May 10, 2023, van https://carbonaccountingfinancials.com/files/downloads/pcaf-standard-part-c-insurance-associated-emissions-nov-2022.pdf

Pensioenfonds Metaal & Techniek. (z.d.). *Pensioenfonds Metaal & Techniek.* Opgeroepen op May 08, 2023, van PMT Pensioenfonds Metaal & Techniek: https://www.pmt.nl/deelnemer/

Pensioenfonds Zorg & Welzijn. (2022). *Klimaatplan PFZW.* Opgeroepen op May 08, 2023, van https://www.pfzw.nl/content/dam/pfzw/web/over-ons/zo-beleggen-we/klimaatplan/klimaatplan-pfzw-juli_2022.pdf

Pensioenfonds Zorg & Welzijn. (z.d.). *Pensioenfonds Zorg & Welzijn.* Opgeroepen op May 08, 2023, van Pensioenfonds Zorg & Welzijn: https://www.pfzw.nl/particulieren.html

Pianoo. (z.d.). *Pianoo.* Opgehaald van Pianoo: www.pianoo.nl/nl/sectoren/gww/bouworganisatievormen/designh-build-finance-maintain-contracten

Plas, R. v. (2023). *Provincie maakt werk van tweede schaderegeling voor ondernemers die inkomen misliepen na watersnood.* (Dagblad de Limburger) Opgeroepen op 09 2023, van https://www.limburger.nl/cnt/dmf20230718_94251723.

Pols, L., Bijlsma, L., Breedijk, M., & Van Schie, M. (2018). *Van wie is het landschap? Ruimte en Wonen. Planbureau voor de Leefomgeving.*

Public Domain Architects. (2010). *Floating pavilion,* Rijnhaven, Rotterdam. Opgeroepen op 08 07, 2023, van https://publicdomainarchitects.com/floating-pavilion-rijnhaven-rotterdam/

Raschky, P., & Weck-Hannemann, H. (2007). *Charity hazard - A real hazard to natural disaster insurance? Environmental Hazards, 321-329.* Opgeroepen op May 10, 2023, van https://www.sciencedirect.com/science/article/abs/pii/S174778910700049X

Rijcken, T. (2022). *Laat het wassende water maar komen: Nederland kan het aan.* Opgeroepen op 09 07, 2023, van https://www.gebiedsontwikkeling.nu/artikelen/laat-het-wassende-water-maar-komen-nederland-kan-het-aan/

Rijksdienst voor Ondernemend Nederland. (2023). *Banken met een groenfonds.* Opgeroepen op 09 11, 2023, van rvo.nl: https://www.rvo.nl/subsidies-financiering/regeling-groenprojecten/banken-met-groenfonds

Central Government. (2009). *Nationaal Waterplan.*

Central Government. (2021). *Kabinet presenteert schaderegeling wateroverlast Limburg en Noord-Brabant.* Opgehaald van Actueel: https://www.rijksoverheid.nl/actueel/nieuws/2021/08/13/kabinet-presenteert-schaderegeling-wateroverlast-limburg-en-noord-brabant

Central Government. (2021). *Rijksoverheid.* Opgehaald van Afhandeling schade wateroverlast Limburg en Noord-Brabant: https://www.rijksoverheid.nl/onderwerpen/afhandeling-schade-wateroverlast-limburg-en-noord-brabant

Central Government. (2022). *Kabinet maakt water en bodem sturend bij ruimtelijke keuzes.* Opgehaald van rijksoverheid.nl: https://www.rijksoverheid.nl/actueel/nieuws/2022/11/25/kabinet-maakt-water-en-bodem-sturend-bij-ruimtelijke-keuzes

Central Government. (2022). *Nationale aanpak klimaat adaptatie gebouwde omgeving, Fase 1: 2022-2024. Rijksoverheid.*

Central Government. (2023). *Minister Kaag ziet een sleutelrol voor financiële sector bij belangrijke maatschappelijke transities.* Opgehaald van Rijksoverheid: https://www.rijksoverheid.nl/actueel/nieuws/2023/03/16/minister-kaag-ziet-sleutelrol-voor-financiele-sector-bij-belangrijke-maatschappelijke-transities

Central Government. (2023). *Overheid.* Opgehaald van Wet veiligheidsregio's: https://wetten.overheid.nl/BWBR0027466/2023-06-20

Central Government. (2023). *State of the Netherlands Green bond report. Ministerie van Financiën.* Opgehaald van https://www.dsta.nl/binaries/dsta/documenten/publicaties/2023/05/26/groene-obligatie-rapportage-2022/Groene+obligatie+rapportage+2022.pdf

Central Government. (2023). *Waterveiligheid.* Opgehaald van Helpdesk Water: https://www.helpdeskwater.nl/onderwerpen/waterveiligheid/

Central Government. (undated). Opgeroepen op 08 11, 2023, van https://www.rijksoverheid.nl/onderwerpen/water/maatregelen-tegen-overstromingen

Central Government. (undated). *Klimaatbeleid.* Opgeroepen op 09 08, 2023, van rijksoverheid.nl: https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatbeleid

Central Government. (undated.). *Stimuleren duurzamere financiële sector.* Opgehaald van https://www.rijksoverheid.nl/onderwerpen/verduurzaming-financiele-sector/stimuleren-duurzamere-financiele-sector

Rijkswaterstaat. (2023). *Eerste landelijke beoordelingsronde primaire waterkeringen afgerond.* Opgehaald van Rijkswaterstaat.nl: https://www.rijkswaterstaat.nl/nieuws/archief/2023/01/eerste-landelijke-beoordelingsronde-primaire-waterkeringen-afgerond

Rijkswaterstaat. (undated). *Helpdeskwater.* Opgeroepen op augustus 8, 2023, van Primaire keringen: https://www.helpdeskwater.nl/onderwerpen/waterveiligheid/primaire/

Rotterdam Climate Initiative. (2009). *Rotterdam Climate Proof, 2009 Adaptation Programme. Rotterdam Climate Initiative.* Opgeroepen op Juni 2023, van https://www.cakex.org/sites/default/files/documents/RCP_adaptatie_eng.pdf

Rotterdam Climate Initiative Climate Proof. (2013). *Rotterdamse adaptatiestrategie. Rotterdam: Rotterdam Climate Initiative Climate Proof.* Opgeroepen op May 10, 2023, van https://www.publicspaceinfo.nl/media/bibliotheek/None/ROTTERDAM%202013%200001.pdf

Rotterdams Weerwoord. (2020). *Rotterdams WeerWoord Uitvoerings Agenda 2020-2022.* Opgeroepen op May 10, 2023, van Rotterdams WeerWoord: https://rotterdamsweerwoord.nl/app/uploads/2021/01/Uitvoeringsagenda-2020-2022.pdf

Rotterdams weerwoord. (2021). *Denken buiten kade(r)s.* Opgehaald van https://rotterdamsweerwoord.nl/app/uploads/2021/03/RWW_Handreiking_Denken-Buiten-Kaders_ext.pdf

Schade Magazine. (2023). *Verzekeraars willen iedereen verzekerd tegen grote overstroming. Schade Magazine.* Opgeroepen op May 10, 2023, van https://www.schade-magazine.nl/nieuws/archief/2023/02/verzekeraars-willen-dat-iedereen-verzekerd-is-tegen-grote-overstromingen/9318

Schipper, E. L. (2020). *Maladaptation: When Adaptation to Climate Change Goes Very Wrong. One Earth, 3(4), 409-414.*

Sokolov, A., Paltsev, S., Chen, H., & and Monier, E. (2016). *Climate Impacts of the Paris Agreement. EGU 2016-8016, 18.* Opgehaald van https://news.mit.edu/2016/how-much-difference-will-paris-agreement-make-0422

Stichting Dakpark. (2013). *Dakpark Rotterdam.* Opgeroepen op 08 07, 2023, van https://www.dakparkrotterdam.nl/

Stone et al. (2014). *Avoided Heat-Related Mortality through Climate Adaptation Strategies in Three US Cities. PLoS One, 9 (6).* doi: https://doi.org/10.1371/journal.pone.0100852

TCFD. (2017). *Recommendations of the Task Force on Climate-related Financial Disclosures - Extract.* Opgeroepen op May 10, 2023, van https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf

Team Stadszaken.nl. (2022). *Investments of 87 million euros to protect Maastricht against flooding. Stadszaken.* Opgeroepen op May 10, 2023, van https://stadszaken.nl/artikel/4744/investeringen-van-87-miljoen-moeten-maastricht-beschermen-tegen-overstromingen

The Guardian. (2021). *Interview Johan Rockström.* Opgehaald van https://www.theguardian.com/environment/2021/may/29/johan-rockstrom-interview-breaking-boundaries-attenborough-biden

Top010. (2020). *Havenlofts drijvende woningen Nassauhaven.* Opgeroepen op 08 07, 2023, van https://nieuws.top010.nl/havenloft-drijvende-woningen-nassauhaven-rotterdam.htm

Twardowsky et al., J. (2023). *Attribution of the heavy rainfall events leading to severe flooding in Western Europe during July 2021. Climate Change, 176(7), 1573-1480.* Opgehaald van https://link.springer.com/article/10.1007/s10584-023-03502-7

Tweede Kamercommissie. (2023).
Rondetafelgesprek: Afhandeling waterschade Limburg. Den Haag.
UNFCCC. (2015). Paris Agreement.
Opgehaald van http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

UNFCCC. (undated). *UNFCCC.*
Opgehaald van Conference of the Parties (COP): https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop

Unie van Waterschappen. (2021). *Waterschappen: 'Watersnood Limburg geen incident, nationale regie nodig'.*
Opgeroepen op May 10, 2023, van Unie van Waterschappen: https://unievanwaterschappen.nl/waterschappen-watersnood-limburg-geen-incident-nationale-regie-nodig/

United Nations Development Programme. (undated). *What are the Sustainable Development Goals?* Opgehaald van https://www.undp.org/sustainable-development-goals

United Nations Office for Disaster Risk Reduction. (undated). *UNDRR.* Opgeroepen op 09 01, 2023, van Early warnings for all: https://www.undrr.org/early-warnings-for-all

Van Buuren, A., Driessen, P., & Teisman, G. (2010). *Inleiding: Klimaatbestendigheid als ruimtelijke en maatschappelijke opgave. B en M, 4-8.*

Van den Berg, H., & Riemersma, T. (2021). *Hoe krijg je controle over de megabouwprojecten? NRC.*

Van Oord. (2018). *Rijkswaterstaat gunt project Afsluitdijk aan consortium Levvel.* Opgehaald van https://www.vanoord.com/nl/updates/rijkswaterstaat-gunt-project-afsluitdijk-aan-consortium-levvel/

Veiligheidsregio's Limburg-Noord en Zuid-Limburg. (2022). *Rampbestrijdingsplan Hoogwater Limburg 2022-2025.*
Opgeroepen op Juni 2023, van https://www.vrzl.nl/application/files/3416/7179/0173/Rampenbestrijdingsplan_Hoogwater_Limburg_2022-2025_definitief.pdf

Verbond van Verzekeraars. (2017). *Hoofd boven water. Issuecommissie Klimaat 2017.* Opgeroepen op Augustus 2023, van https://www.verzekeraars.nl/media/3643/hoofd-boven-water-verzekeren-van-schade-in-een-veranderend-klimaat.pdf

Verbond van Verzekeraars. (2020). *Position Paper Overstoming - Hoe ga je om met het verzekeren van het restrisico tegen overstoming? Verbond van Verzekeraars.* Opgeroepen op Mei 2023, van https://www.verzekeraars.nl/media/8163/vvv-popa_overstroming_2020.pdf

Verbond van Verzekeraars. (2021). *Financieel jaarverslag verzekeringsbranche. Verbond van Verzekeraars.*
Opgeroepen op Juni 2023, van https://www.verzekeraars.nl/media/10243/financieel-jaarverslag-verzekeringsbranche-2021.pdf

Verbond van Verzekeraars. (2022). *Een veranderend klimaat, de verzekeringssector verandert mee.* Opgeroepen op 08 14, 2023, van https://www.verzekeraars.nl/publicaties/actueel/een-veranderend-klimaat-de-verzekeringssector-verandert-mee

Verbond van Verzekeraars. (2022). *Waarschuwen voor overstromingen helpt schade verminderen.*
Opgehaald van Verbond van Verzekeraars: https://www.verzekeraars.nl/publicaties/actueel/waarschuwen-voor-overstromingen-helpt-schade-verminderen

Verbond van Verzekeraars. (undated). *Klimaat.*
Opgeroepen op 08 04, 2023, van https://www.verzekeraars.nl/verzekeringsthemas/klimaatbestendig-nederland/klimaat

Verbond van Verzekeraars. (undated). *Waarschuwen voor overstromingen helpt schade verminderen.*
Opgeroepen op May 10, 2023, van Verbond van Verzekeraars: https://www.verzekeraars.nl/publicaties/actueel/waarschuwen-voor-overstromingen-helpt-schade-verminderen

Waterklaar. (undated). *Houd water buiten de deur.* Opgeroepen op 09 07, 2023, van waterklaar: https://www.waterklaar.nl/oplossing/houd-water-buiten-de-deur/handmatig-waterkerende-schotten-plaatsen

Waterschap Limburg. (2022). *Intentieverklaring samenwerking tussen KNMI, Hoogheemraadschap de Stichtse Rijnlanden, Hoogheemraadschap Hollands Noorderkwartier en Waterschap Limburg getekend.*
Opgeroepen op Juli 2023, van Waterschap Limburg: https://www.waterschaplimburg.nl/@7664/intentieverklaring-samenwerking-tussen/

Wetenschappelijk Onderzoek- en Documentatiecentrum. (2023). *Procesevaluatie afhandeling waterschade Zuid-Nederland. Rijksoverheid.* Opgeroepen op Juli 2023, van https://www.rijksoverheid.nl/documenten/rapporten/2023/03/16/tk-bijlage-eindrapport-afhandeling-waterschade-zuid-nl

Wetenschappelijke Raad voor het Regeringsbeleid. (2023). *Rechtvaardigheid in het Klimaatbeleid. Den Haag: WRR.*
Opgehaald van https://www.wrr.nl/publicaties/rapporten/2023/02/16/rechtvaardigheid-in-klimaatbeleid

World Meteorlogical Organization. (2023). *Global Annual to Decadal Climate Update. World Meteorlogical organization.*

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