INTEGRATING ***PHYSICAL CLIMATE RISKS*** IN ***REAL ESTATE DEVELOPMENT***

A Systemic Analysis of Dutch Developer Decision-Making

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ABSTRACT

As climate risks become more frequent and severe, real estate developers are increasingly expected to incorporate climate adaptation into their projects. However, within Dutch practice, it remains unclear whether – and how – physical climate risks such as heat stress, water nuisance, flooding, and foundation issues are accounted for in development decisions. This thesis investigates how climate risks are currently addressed in Dutch real estate development and identifies the key factors shaping developers' responsiveness. Based on twelve semi-structured interviews with developers, investors, a municipality, and a bank, the research reveals a fragmented governance context, where stakeholder priorities diverge and early-stage incentives for adaptation are often lacking.

A synthesis of stakeholder perspectives shows that while public and financial actors are becoming more aware of climate risks, their capacity and willingness to act vary significantly depending on the risk in question. A stakeholder–risk matrix was developed to illustrate these diverging positions. In addition, a visualisation of the developer's trajectory identifies critical phases in which climate risks could be embedded more proactively. The findings indicate that adaptation is rarely considered during the initiative and feasibility stages – when flexibility is highest – unless it is enforced through regulation or financial conditions.

The research concludes that successful integration of climate risks requires not only technical solutions or financial means, but timely alignment across key actors. Developers can play a pivotal role by initiating early engagement with municipalities, investors, and banks, tailored to their respective concerns regarding specific climate risks. By embedding adaptation measures early in the process, developers can avoid costly late-stage revisions and external pressures. The study offers practical recommendations for developers and public actors to improve early-stage climate risk integration in the built environment.

Keywords: climate adaptation, real estate development, physical climate risks, governance, stakeholder dynamics, feasibility, investment, urban planning, the Netherlands

PREFACE

You might have noticed that in recent years, the weather in the Netherlands has changed quite a bit. I have noticed it too. When I was younger, I could ice skate on frozen lakes almost every winter. Now, that has become the exception. We have summers in April or weeks of nonstop rain. Early on at TU Delft, I learned that this isn't just about the weather. Climate change affects everything, from our daily routines to the way we design and develop the built environment.

Climate risks are becoming more visible, and real estate plays a key role in how we prepare for and respond to these risks. During my studies, I became interested in how we can make the built environment more resilient, not just through technical solutions but also through the way decisions are made early in the process. This thesis looks at how climate risks are considered (or not) in Dutch real estate development.

The topic came from a mix of personal curiosity and a sense of frustration. There's a lot of talk about sustainability, and there is great effort in making buildings energy efficient. But when it comes to adapting to physical risks like heat stress, flooding or soil movement, there seems to be a disconnect. I personally believe that making our built environment resilient is not optional, it is inevitable. I wanted to understand what's actually happening in practice, what's standing in the way, and where opportunities might be missed. Along the way, I realised that we may be at a tipping point, where awareness is growing but action is catching up.

This research doesn't offer ready-made answers, but I hope it contributes a small piece to the bigger puzzle, something others can build on.

I would like to thank Michaël for his guidance, and his inexhaustible ideas, which made this research possible. I'm also very grateful to Maged and Maria for helping me find the right structure and narrative. That made all the difference. A big thanks as well to Esra for her mentorship during my internship at Dev_ real estate. While the company did not influence the content of this thesis, her advice on how to organise and present my findings was very helpful.

Lastly, I want to thank my friends and family for always being there. Whether it was to hear me rant about climate risks, brainstorm half-baked ideas or simply drag me outside for a much-needed break.

Many thanks.

Sincerely,

Marieke Algie
Delft, June 2025

Marieke Algie
Delft, June 2025

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2 Methodology	The second chapter outlines the research methodology, detailing the various methods employed to address the research question. It provides a clear overview of the data collection and analysis processes.
3 Desk research	The third chapter presents the theoretical framework of the research. It elaborates on the key concepts and provides an overview of the overall context. This chapter establishes the basis for addressing the sub-questions.
4 Empirical research	The fourth chapter presents the empirical research approach and its findings. Further building on the desk research.
5 Synthesis	The fifth chapter combines findings from the desk research with findings from the empirical research.
6 Discussion and Conclusion	The sixth chapter brings discussion points and presents a conclusion to the sub-questions and the main research question. Limitations and recommendations are also included.
7 Reflection	Lastly, the seventh chapter presents the personal experiences while creating this master thesis.

PART 1 | RELEVANCE

1. INTRODUCTION

1.1 Problem statement

Climate change poses a growing risk to the built environment. In the Netherlands, temperatures are rising faster than the global average and show no signs of stopping (Compendium voor de Leefomgeving, 2023). Physical climate risks resulting from heat stress, drought, flooding, and land subsidence are becoming more frequent and intense (Klimaateffectatlas, n.d.; van Gaalen, 2024). These risks affect the value, operation, and lifespan of real estate, as well as create indirect effects such as increased insurance costs and more challenging access to financing (Attoh et al., 2022; Piazolo, 2022).

The potential impact of physical climate risks is not hypothetical. In 2021, floods in Limburg alone caused an estimated €350–600 million in damages, with additional business interruption losses of up to €135 million (Kok et al., 2023). Jongman et al. (2014) note that flood-exposed property in the Netherlands is valued at approximately €409 billion, with exposure increasing more than 300% since 1960, and they set an insurance payout cap at €5 billion. Droughts already cause average annual losses of €372 million, a figure projected to rise to €611 million by 2050 (Mens et al., 2022). In total, physical risks pose serious financial consequences for real estate and public infrastructure.

In response, regulations surrounding sustainable investments are tightening, particularly through the SFDR, which requires financial institutions to disclose the sustainability of their investments (European Commission, 2020). The European Commission is not the only entity pushing for transparency; Dutch banks, investors, insurance companies, and even the head of a Dutch contractor company's development branch are advocating for climate risk labels (De Nederlandsche Bank (DNB), 2023a; Duintjer Tebbens, 2025; Schuttenhelm, 2023). Knowing this, one might argue that it is becoming increasingly important for real estate developers to incorporate climate risks into their decision-making.

In the early phases of development – when location selection and feasibility assessments are made – the potential to integrate climate risks is most feasible (Shearer et al., 2013). However, in reality, decision-makers often prioritise land dynamics, political feasibility, and short-term financial returns over these risks (Pelzer et al., 2023). A study by Sweco et al. (2021) showed that 31% of the housing construction planned up to 2030 (or 300,000 homes) was planned in vulnerable locations, which presupposes either a different choice of location or adaptation measures (Pelzer et al., 2023).

Still, it remains unclear how developers respond to these risks in their development decisions. Do they act only in response to external pressures, such as financing conditions and regulations? Or are there also internal incentives or strategic considerations that lead to proactive adaptation? Which actors or conditions influence these decisions – and at what stage of the development process?

To better understand these dynamics, this study focuses on the following main research question:

> *"To what extent do physical climate risks influence decision-making in real estate development?"*

This question is explored through three sub-questions:

> *RQ1 – What physical climate risks are most relevant for real estate development in the Netherlands?*
>
> *RQ2 – Which actors play a role in integrating climate risk into real estate development?*
>
> *RQ3 – How do developers address physical climate risks in real estate development?*
>
> *RQ4 – What leverage points exist to enhance climate risk integration in real estate development?*

1.2 Societal relevance

Despite its international recognition for its leadership in delta technology, the Netherlands remains one of Europe's most climate-vulnerable locations. Without adequate adaptation, areas located outside the dikes, peatlands, and densely built urban zones are at high risk of damage from flooding, subsidence, or heat stress (Klimaateffectatlas, n.d.; Rijkswaterstaat, 2022). Since developers decide where and how to build, they play a crucial role in preventing future climate-related damage.

However, developers often face few direct incentives to integrate climate risks into their decision-making. The costs of damage or adaptation are often passed on to end users, municipalities, or future property owners (Pelzer et al., 2023; Ten Brinke et al., 2022). This scenario creates a risk that private decisions result in public consequences.

Moreover, the regulatory and financial landscape is changing rapidly. Under pressure from EU legislation, banks and investors increasingly demand transparency about climate risks in project financing. At the same time, climate risk information is increasingly becoming open data. One example is the Klimaateffectatlas (Climate Impact Atlas), which provides spatial insight into regional climate hazards such as heat stress, flood probability, and land subsidence. As an open-access tool coordinated by the Climate Adaptation Services (CAS) Foundation on behalf of the Ministry of Infrastructure and Water Management, it plays a key role in making climate risk data publicly accessible for use in spatial planning and real estate development.

This research helps policymakers and market actors better understand what truly drives climate-conscious development behaviours. Are transparency and access to information sufficient to integrate climate risks in the development process? Or are more forceful instruments – such as regulatory norms or financial incentives – required?

1.3 Scientific relevance

Although there is considerable academic attention for mitigation in the built environment (such as energy performance), the role of adaptation remains underexplored – especially when it comes to decision-making by developers. The question of how and when physical climate risks are incorporated into development decisions has barely been studied empirically in the Dutch context.

Existing literature tends to focus on the need for climate adaptation or technical solutions; this study adopts a behavioural and institutional lens. By combining interviews with established frameworks from real estate development governance, this research contributes in three key ways:

- **Conceptual contribution:** it connects physical climate risks to the Dutch development market structure, focussing on the different stakeholders that directly influence development decisions.
- **Empirical contribution:** it provides new insights into how developers in the Dutch context respond to risk information and external pressures.
- **Policy relevance:** it offers practical knowledge for designing future policy instruments.

This study aligns with the growing societal and academic need for actionable perspectives on integrating climate risk impact in real estate and contributes to the broader debate on risk-informed development in a changing climate.

1.4 Definitions and terms

In literature, terms and definitions of terms and concepts are frequently used interchangeably. Therefore, it is important to state the definitions of the different terms and concepts, which are used in the research. Terms derived from the research questions and the research purpose are defined in this clause.

Climate risks (CR)	The potential negative impacts of climate-related hazards such as flooding, heat stress, drought, or land subsidence. This study focuses on physical risks, as opposed to transitional or liability risks.
Climate hazard	A climate hazard is a potentially damaging physical event or process resulting from climate variability or long-term climate change, such as extreme heat, droughts, heavy precipitation, storms, sea level rise, or soil subsidence. Hazards can be either chronic (gradual and ongoing) or acute (sudden and extreme), and they represent the natural component of climate-related risk
Climate mitigation (CM)	This refers to measures aimed at reducing or preventing the emission of greenhouse gases, with the goal of limiting global warming (European Commission, 2021).
Climate adaptation (CA)	This includes actions designed to reduce or prevent the negative effects of current and future climate conditions on human activities, nature, or property. The objective is to enhance resilience to climate change and reduce vulnerability (European Commission, 2021).
Real estate development	The process of planning, financing, and constructing new buildings or redevelopment projects, including site selection, feasibility studies, and investment decision-making.
Climate risk integration in real estate development (CRiRED)	Using the knowledge of climate risks to guide the process of planning, financing, and constructing new buildings or redevelopment projects.
Initiative phase	The initial phase in which a development vision is formulated based on perceived demand. Key activities include market and risk analysis, stakeholder engagement, and, in some cases, land acquisition.
Feasibility phase	The phase in which spatial, technical, and financial viability is assessed. It involves aligning the concept with planning frameworks, estimating costs and revenues, and determining whether the project fits within municipal policy and market demand.
Leverage points	Strategic opportunities within systems (in this case, the development process) where targeted interventions – such as regulation, pricing, or governance changes – can result in better outcomes.

PART 2 | METHODOLOGY

2. METHODOLOGY

This study employs a qualitative, exploratory research design to investigate how physical climate risks are integrated into decision-making in real estate development, with a focus on developers. Given that such decision-making is often tacit, iterative, and influenced by institutional and political dynamics, an interpretative approach is adopted to uncover the rationale behind actors' choices.

2.1 Research design

The research process consists of three sequential phases:

1. **Desk research**: A literature and regulatory framework review was conducted to identify relevant climate risks, the actors involved in real estate development, and institutional and financial mechanisms that may support or hinder climate risk integration in decision-making.
2. **Empirical research**: Semi-structured, interactive interviews were carried out with a variety of developers and financial actors. This phase explores how decisions are made in practice and what factors shape integration of climate risks in decision-making.
3. **Synthesis**: A system analysis aggregates findings across interviews and literature, resulting in an actor-based systemic overview of leverage points and governance gaps. Additionally, the research proposes an action plan for real estate developers to enhance climate risk integration into the development process.

This structure enables the study to bridge the gap between theoretical knowledge and practical behaviour and to offer recommendations for targeted (policy) intervention.

2.2 Research methods

Primary data were collected through semi-structured interviews. In order to create the semi-structured interview, the framework of (Kallio et al., 2016) is used. This framework contains 5 stages:

1. **Identifying the prerequisites for using semi-structured interviews**
   First, it is essential to determine whether the research question is fit for semi-structured interviews. Due to the research requiring detailed open answers about motivation, prioritisation, and experiences, a conclusion was drawn that it is.

2. **Retrieving and using previous knowledge**
   Desk research is done to review both academic literature and regulatory frameworks relevant to the topic of climate risks in the built environment. These are essential to define the independent variables that will be asked of developers in their decision-making.

3. **Formulation of the preliminary semi-structured interview guide**
   In this phase the interview questions are formulated, balancing complexity with user friendliness, for both the researcher and the participants.

4. **pilot testing the interview guide.**
   The preliminary interview was pilot tested to ensure its effectiveness, relevance, and clarity before conducting the actual interviews. As a result, the initial fictitious case was omitted, as it proved to be insufficiently tangible for developers, who demonstrated greater engagement when discussing their own real-life projects.

5. **presenting the complete semi-structured interview guide**

Sample size

Given the exploratory nature of this study, the aim is not to produce statistically representative findings, but to develop an in-depth understanding of how physical climate risks influence development decisions in real estate development. Following Ritchie et al. (2013), purposive sampling was applied as it allows for the deliberate selection of individuals who are especially knowledgeable about the subject matter and can provide rich, detailed data. This strategy is particularly suitable in exploratory studies where the goal is to capture variation in experience and perception, rather than to generalise.

The sample consists of twelve participants: eight developers – four operating independently and four affiliated with construction firms – alongside two institutional investors, one bank representative, and one municipal official. This composition enables a focused yet diverse exploration of how climate-related risks are addressed across key stakeholder roles. Within the group of developers, diversity was ensured based on three dimensions:

1. scale of operations (regional vs. national),
2. project type (housing, mixed-use, urban development), and
3. investment structure (equity-financed vs. investor-driven).

Ritchie et al. (2013) note that qualitative research emphasises depth over breadth, with small sample sizes being sufficient to identify key themes and patterns, provided the sample includes a range of relevant perspectives. Similarly, Subedi (2021) states that sample sizes in qualitative research typically range from 6 to 20 participants, depending on the purpose, context, and analytical needs of the study. This study's sample size of twelve is therefore appropriate, as it balances analytical depth, diversity of viewpoints, and practical feasibility.

Interview transcripts were thematically analysed using Atlas.ti. The analysis was both deductive (based on the five interview layers and literature) and inductive (emerging themes and actor narratives). This resulted in a typology of developer responses to physical climate risks and the identification of system-wide feedback gaps and leverage points. Figure 1 shows the entire research design.

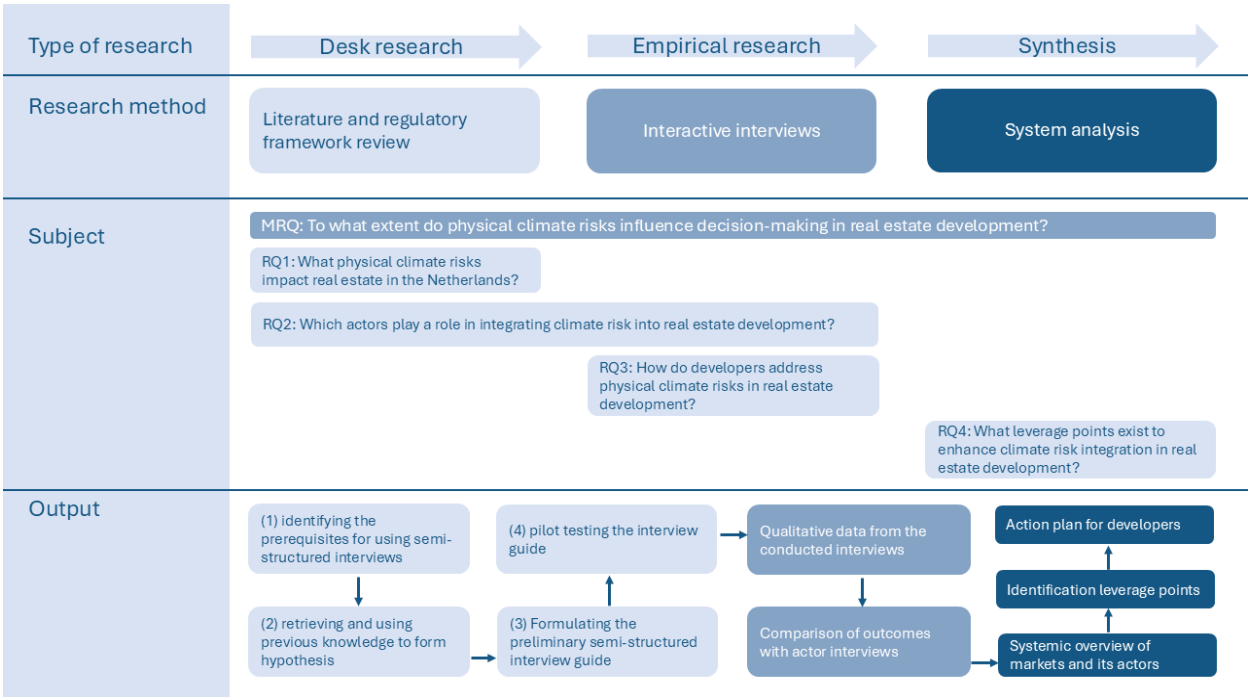

Figure 1 Research design (own work, 2025)

2.3 Ethical considerations

This research uses human participants to get practical insights of the decision-making process of real estate developers. Therefore, as stated in the TU Delft Regulations on Human Trials (2016), mandatory approval for Human Research is retrieved from the Human Research Ethics Committee (HREC). Due to the human participation all participants must sign a consent form before notes and recordings are gathered.

The interviews recordings, notes, transcripts, and coding are owned and used by the researcher. The researcher takes full responsibility for processing, anonymising, and storing the data during the research. After the research the anonymised data will be deleted. The final report will be uploaded on the publicly accessible TU Delft repository. The data management plan (DMP) is included in Appendix III: Data management plan.

2.4 Audience of the research

This research is intended for both academic and professional audiences:

- **Academic audience**: Scholars in urban planning, real estate governance, and climate risk studies can use the findings to deepen theoretical insights into institutional and behavioural drivers of climate risk integration in real estate development (CRiRED).
- **Policy audience**: Municipalities, water boards, and national policymakers can use the insights to refine adaptation instruments such as national spatial zoning, tender criteria, or revised valuation models.
- **Private sector stakeholders**: Developers, investors, and financial institutions may benefit from understanding how climate risks affect investment logic and from identifying which signals or incentives effectively trigger adaptive behaviour.

PART 3 | DESK RESEARCH

1. LITERATURE AND POLICY STUDY

3.1 Climate risks in the Netherlands

To begin with, climate change gives rise to two distinct categories of risk. First, physical climate risks, which stem from direct exposure to the physical consequences of climate change – such as extreme weather events, sea-level rise, and changes in precipitation. Second, transition risks, which arise from the societal and economic shift towards a low-carbon economy (Gallo et al., 2020). This chapter focuses specifically on physical climate risks, as these require direct adaptation measures within the built environment.

The Netherlands is particularly vulnerable to such risks due to its low-lying geography and reliance on intricate water management systems. The consequences range from sea-level rise to changing rainfall patterns and increasingly extreme weather events (van Gaalen, 2024).

3.1.1 Heat

The temperature in the Netherlands has increased with 1.1 °C in only the last thirty years, as seen in Figure 3 (van Gaalen, 2024).

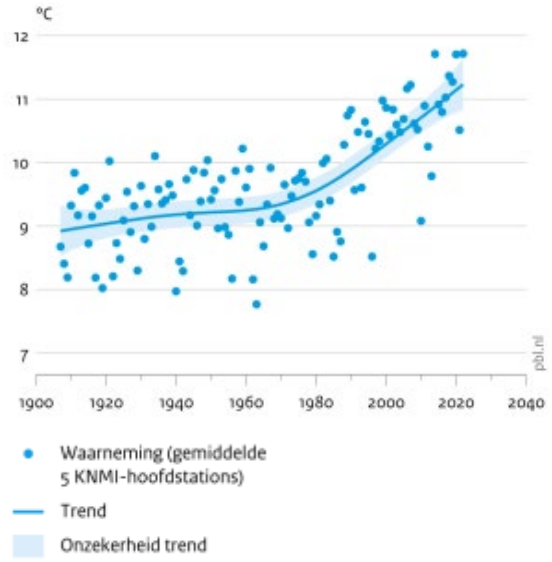

Figure 3 Temperature increase in the Netherlands (van Gaalen, 2024)

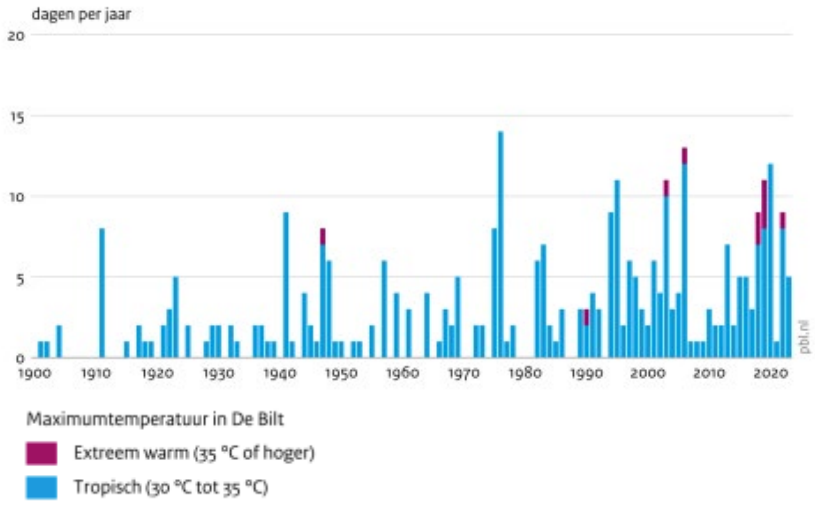

Figure 2 Days with an average temperature of 30°C or higher (van Gaalen, 2024)

Additionally, there has been a significant increase in the number of extremely hot days, as illustrated in Figure 2.

The frequency of tropical nights has also risen; while such nights were rare prior to the year 2000, they now occur much more frequently. This trend is partly due to rising average temperatures and partly influenced by the urban heat island effect, where nighttime temperatures in cities can be up to 7°C higher than in surrounding rural areas (van Gaalen, 2024). It is important to note that the sharp increase in heatwaves is largely attributable to human activity. For instance, the extreme heatwave of 2019 now has an estimated return period of 50 to 150 years. In contrast, without anthropogenic climate change, such an event would have had a return period of over 1,000 years – based on climate conditions from around the year 1900 (Vautard et al., 2020). This raises the concern that buildings constructed before that era were never designed to withstand the intensity of today's heatwaves and may therefore lack sufficient resilience.

3.1.3 Drought and Soil Subsidence

In addition to heat, prolonged periods of drought are becoming more frequent due to increased sunlight exposure (van Gaalen, 2024). Drought leads to declining groundwater levels, resulting in freshwater shortages and allowing saltwater intrusion, which further degrades groundwater quality. Drought-related water scarcity in the Netherlands is often summarised in three forms: too little (te weinig), too salty (te zout), and too tight (te krap) (van Gaalen, 2024).

In many Dutch cities, drought contributes to soil subsidence, which introduces additional challenges such as structural damage to foundations and dikes (van Doorn-Hoekveld et al., 2022). As groundwater levels drop, clay soils shrink and peat soils oxidise—leading to both land subsidence and the deterioration of wooden foundations (van Gaalen, 2024). Restoring these foundations is highly expensive, and the division of financial responsibility remains unclear, creating uncertainty for property owners.

Moreover, financial institutions – such as banks and insurers—are increasingly factoring drought and foundation risks into their assessments, which may have long-term financial consequences (van Gaalen, 2024). In drought-sensitive areas, additional measures such as water buffering systems or alternative foundation techniques are required to make real estate development viable. These interventions add to the direct costs of development and long-term asset management (Attoh et al., 2022; van Gaalen, 2024).

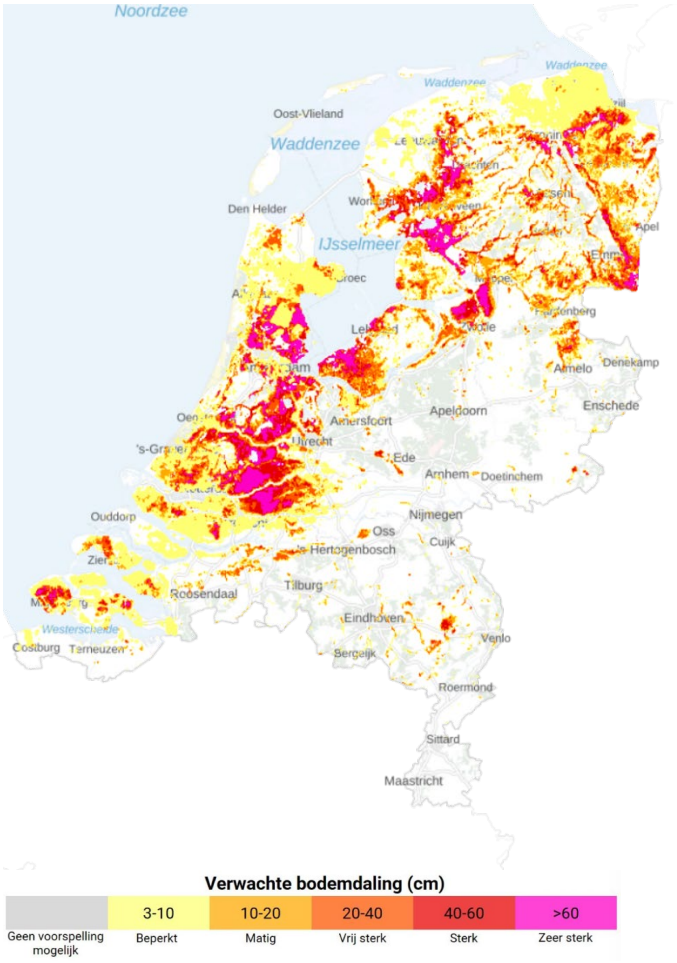

Figure 4 Expected soil subsidence scenario: strong climate change and groundwater extraction (Klimaateffectatlas, 2025a)

Soil subsidence is further exacerbated by human interventions, including groundwater extraction, agricultural drainage, and urban development. Additionally, placing heavy loads on soft soils – such as buildings or infrastructure – can result in ongoing settlement over time. The cumulative impact of these processes increases the risk of structural damage and flooding, particularly in low-lying areas where the relative elevation of the land continues to decline (Klimaateffectatlas, 2025a; van Gaalen, 2024).

3.1.2 Water nuisance

Heat and drought are not the only intensifying effects of climate change; the Netherlands is also experiencing increasingly wetter conditions, characterised by more frequent and extreme rainfall events (van Gaalen, 2024).

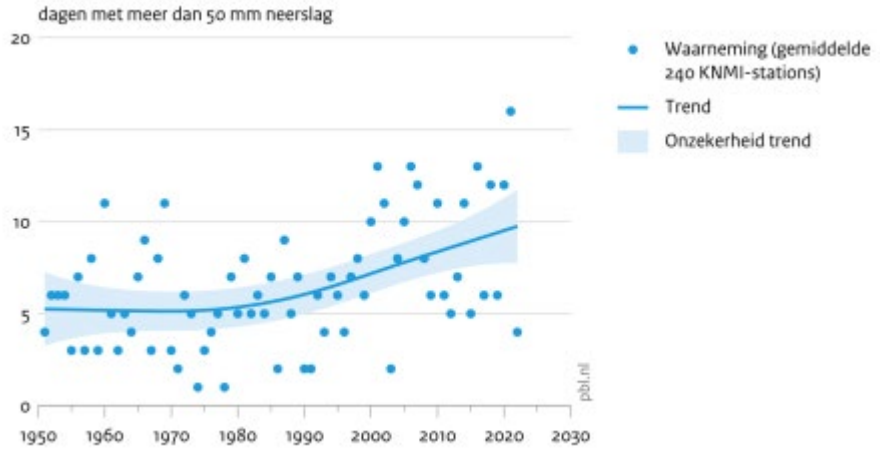

Figure 5 Days with heavy precipitation (van Gaalen, 2024)

Since 1951, the number of days with heavy rainfall has increased by approximately 85% (van Gaalen, 2024). Currently, around ten percent of buildings in the Netherlands are at risk of flooding during an extreme downpour – an event with an average return period of once every 1,000 years. Due to climate change, the likelihood of such events is projected to double by the end of the century (Klimaateffectatlas, 2025b).

3.1.4 Flooding

Flooding in the Netherlands is not solely caused by heavy rainfall. Climate change also contributes to sea level rise, driven by the melting of polar ice caps and the thermal expansion of ocean water. This significantly increases flood risks for low-lying areas such as the Netherlands (UNESCO et al., 2020; van Doorn-Hoekveld et al., 2022). Without proactive water defence systems – such as dikes, locks, and pumping stations – up to 60% of the country's land area would be vulnerable to flooding (Attoh et al., 2022). The consequences of flooding extend beyond property damage. They include disruptions to critical infrastructure, degradation of natural ecosystems, and serious public health risks due to the potential spread of contaminated water (UNESCO et al., 2020; van Doorn-Hoekveld et al., 2022; van Leerdam et al., 2019). Moreover, a portion of Dutch real estate lies outside the dike systems, often constructed on elevated terrain. In the event of a combined storm surge and river overflow, even these elevated developments may face significant risk (Attoh et al., 2022).

All extreme weather events – such as heavy rainfall, storms, droughts, and heatwaves – are increasing in frequency as a result of climate change (van Gaalen, 2024). This trend poses significant risks to urban infrastructure, drainage and sewer systems, and commercial real estate (CRE),

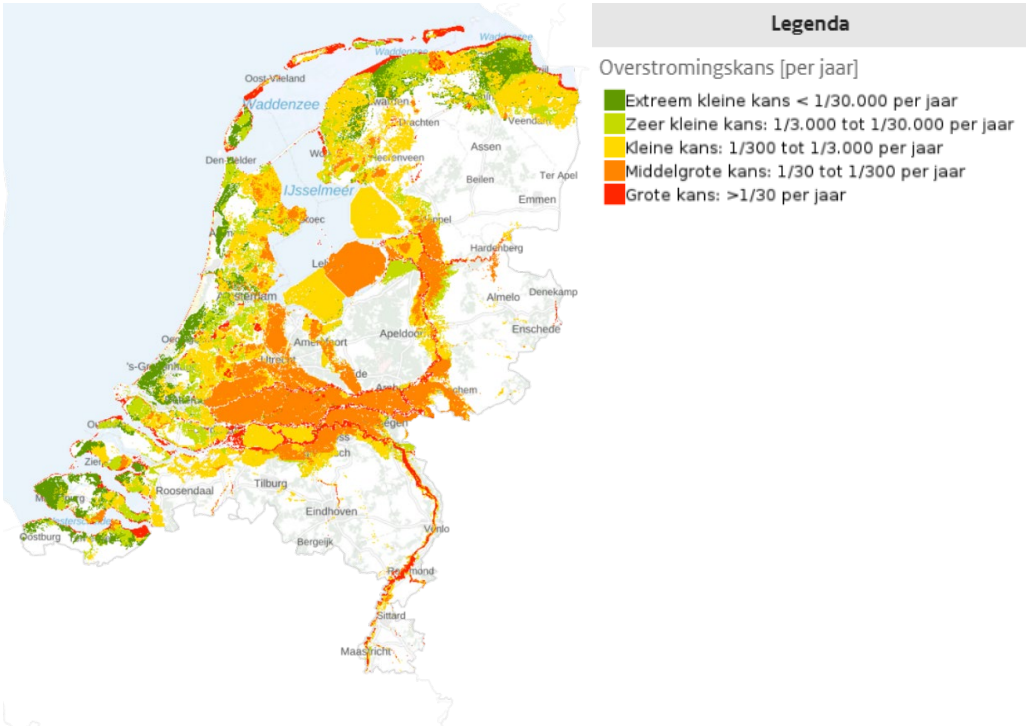

Figure 6 Current chances for flooding (Landelijk Informatiesysteem Water en Overstromingen, 2024)

including flood-related damage and rising cooling demands during heatwaves. (Attoh et al., 2022).

3.1.5 Climate adaptation strategies in the Netherlands

The Netherlands launched the National Climate Adaptation Strategy (NAS in 2016, which serves as the overarching framework for climate adaptation in the Netherlands (see Figure 7). It identifies the country's primary climate risks – flooding, drought, heat stress, and sea level rise – and outlines strategic responses (Dijksma, 2016). The NAS emphasises proactive risk assessment, encouraging the use of climate scenarios to anticipate future impacts and guide decision-making. By prioritising risk dialogues and stress tests, the NAS aims to ensure that national and local authorities, businesses, and civil society actors can collectively identify vulnerabilities and implement adaptive measures. This structured approach supports both regional and sector-specific initiatives, helping align local action with broader national objectives.

To further operationalise the NAS, the *National Adaptation Plan* (*Nationaal Uitvoeringsprogramma Klimaatadaptatie*, NUP KA) was published in 2023. This plan focuses on accelerating implementation and reinforcing cooperation between government levels and societal partners (Klimaatadaptatie Nederland, n.d.)

Figure 7 Coherence of policy developments in the Netherlands (De Nederlandsche Bank (DNB), 2023b)

Due to the fact that a large part of the Netherlands lies below sea level, water management is a joint responsibility shared by various levels of government and organisations (Rijkswaterstaat, 2022). At the national level, the Ministry of Infrastructure and Water Management (IenW) oversees policy, with Rijkswaterstaat responsible for execution. This includes flood protection, riverbed management, and freshwater supply. The National Water Programme (NWP) provides guidelines and includes the Delta Programme, while international cooperation is essential for managing transboundary rivers such as the Rhine and Meuse (Rijkswaterstaat, 2022).

In response to climate change, sea-level rise, and land subsidence, the Netherlands – initially focused on dike reinforcements – has shifted toward nature-based solutions, such as the *Room for the Rivers* initiative, which enhances flood resilience by giving rivers more space to safely discharge excess water. (Rijke et al., 2012; Van der Brugge et al., 2005). Programmes like the Flood Protection Programme continue to address these risks (Rijkswaterstaat, 2022). Additionally, the Water and Soil Guiding principal aims to ensure that water availability and soil quality become leading principles in spatial planning, by preventing construction in flood-prone areas, reducing soil sealing, increasing freshwater storage, and maintaining higher groundwater levels where necessary (Rijksoverheid, 2022).

At the regional level, provinces translate national policies into spatial plans and oversee groundwater management, while water boards (waterschappen) handle regional flood protection, water level regulation, and wastewater treatment (Rijkswaterstaat, 2022). Municipalities are responsible for urban water management, including drainage, flood prevention, and integrating water safety into new developments through the water assessment process (Rijkswaterstaat, 2022).

Table 1 shows the different actors in the Dutch water management and their responsibilities.

Actor	*Responsibilities*
National Government (IenW)	Develop national water policy. Coordinates cross-border water management and EU directives
	Oversees flood protection, sea-level rise strategies, and freshwater supply programs
	System responsibility for water system functioning
Rijkswaterstaat	Manages national waterways (rivers, North Sea, Ijsselmeer
	Maintains and strengthens flood defences, riverbeds, and coastlines
	Implements measures against salinisation and ensures freshwater supply
	Conducts water safety and quality monitoring, risk assessments, and stress tests
Provinces	Develop regional water programmes and spatial plans.
	Manage groundwater in rural areas
	Translate national policies into regional frameworks
Water boards	Operate regional water systems (dikes, canals)
	Control water levels and prevent flooding
	Ensure water quality and wastewater treatment
Municipalities	Manage urban water (rainwater drainage, groundwater issues)
	Integrate water management into urban planning

Table 1 Dutch water management actors and responsibilities (own work, 2024)

3.2 Climate risk data and disclosure

At different scales, there are multiple parties aiming to make information about climate risks more available. The Klimaateffectatlas was brought into life by Climate Adaptation Services (CAS), commissioned by the Ministry of Infrastructure and Water Management. The Klimaateffectatlas provides accessible data of climate risks, created in collaboration with multiple knowledge institutions and consultancy firms. With a top-down approach, the EU taxonomy was created, to eventually force companies to disclose what climate risks are relevant for their economic activity and what their mitigation and adaptation strategies are. At more local levels, municipalities can inform real estate developers on relevant climate risks for new developments. However, there is no strict national regulation apart from the national guidelines mentioned earlier.

3.2.1 Data

For developers to effectively address climate risks, access to reliable climate risk data is essential. The foundation for such data lies in accurate climate projections, which are provided by the Royal Netherlands Meteorological Institute (KNMI). In 2023, the KNMI published updated climate scenarios that offer detailed projections of climate change impacts specific to the Netherlands (Van Dorland et al., 2023). These scenarios play a crucial role in informing climate risk assessments and developing effective adaptation strategies (Dijksma, 2016; Dutch Green Building Council, 2022a; Witmer, 2023).

While there is extensive data and scientific literature confirming the reality of climate change, developers – and the financial sector more broadly – require practical tools for risk assessment (Gallo et al., 2020; Hubert et al., 2021). In response to this need, the European research project *ClimINVEST* (2017–2021) was established, aiming to bridge the gap between climate scientists and investors by collaboratively defining physical climate risks relevant to the financial sector (Dutch Green Building Council, 2022b). One of the key outputs of this project was the study *Assessing Climate Physical Risks for Financial Decision Makers* by Gallo et al. (2020), which conceptualises physical climate risks as the combination of three core components:

- The climate hazard
- The exposure to the climate hazard, and
- The vulnerability to the climate hazard

Physical climate change can have a strong impact on the financial sector. This has also been shown in the real estate sector of the Netherlands (Attoh et al., 2022). Gallo et al. (2020) created a method to assess climate risk on a real estate portfolio, as well as other portfolios. For the real estate portfolio the physical risk depended on the building's vulnerability to climate hazards, and its exposure to climate hazards. Both factors get a rating, which combined give a physical climate risk value.

The final report of ClimINVEST mentions the black box of climate services (Hubert et al., 2021). One of the key challenges in physical climate risk analysis is the absence of a standardised methodology for assessing such risks. Although open climate data is increasingly available – enabling both financial actors and developers to take action – processing this information and translating it into meaningful risk assessments for specific portfolios remains highly complex (Hubert et al., 2021). Therefore CAS is currently developing the Dutch Climate Risk Portal in request of the Ministry of Infrastructure and Water management (Climate Adaptation Services, n.d). This portal is meant to become a central place in which international and national private sector professionals from financial institutions can inform themselves about the physical climate risks in the Netherlands (Climate Adaptation Services, n.d). This portal is created in collaboration with banks, investors, pension funds, insurance companies, multiple ministries and the staff of the Delta commission (Climate Adaptation Services, n.d). The goal of this portal is to enhance transparency regarding climate risks in the Netherlands by

making relevant information publicly accessible, allowing individuals and organisations to make more informed decisions (Climate Adaptation Services, n.d). The portal will include sources that an investor can use to assess the risks on their portfolio (De Ruig, personal communication, 4th March 2025). One of the sources used will be the Klimaateffectatlas, which is a platform already in use.

As said above, for the Netherlands, the Klimaateffectatlas (n.d.) can be used as references to assess climate risks (Dutch Green Building Council, n.d.). The Klimaateffectatlas focusses on climate changes in the following themes: water nuisance, drought, heat, flooding and water quality. Within these themes there are multiple maps, each with a specific climate risk. The most important maps, according to Klimaateffectatlas, can be seen in Table 2. The many maps on the site have multiple different sources, and the website is managed by CAS (Klimaateffectatlas, n.d.).

Water nuisance	*Heat*	*Drought*	*Flooding*	*Water quality*	*Base maps*
Water depth during short-term heavy precipitation	Perceived temperature	Lowest groundwater levels	Map viewer	Warming of surface water	Base map natural system Netherlands
Groundwater nuisance	Night heat	Surface water shortage	Flooding depth	Salinisation due to sea level rise	Opportunity map for natural climate buffers
Oxygen stress	Distance to cool areas	Subsidence prediction maps	Location-specific flood risk		Base map green and grey
Urban infiltration opportunities	Social vulnerability to heat	Subsidence signal maps	Options for impact reduction		Neighbourhood typology
	Shade on walking and cycling paths	Risk maps for foundation damage	My Water Risk Profile		
	Heatwave	Drought stress	Rising water levels		
		Drought sensitivity of nature			
		Wildfire			

Table 2 Most important maps per climate risk theme (Klimaateffectatlas, n.d.)

3.2.2 Disclosure

The EU Taxonomy provides a standardised classification system to determine whether an economic activity is environmentally sustainable. Its main goal is to steer capital toward activities that support the EU's climate and environmental objectives, including both climate mitigation and adaptation (European Commission, 2020).

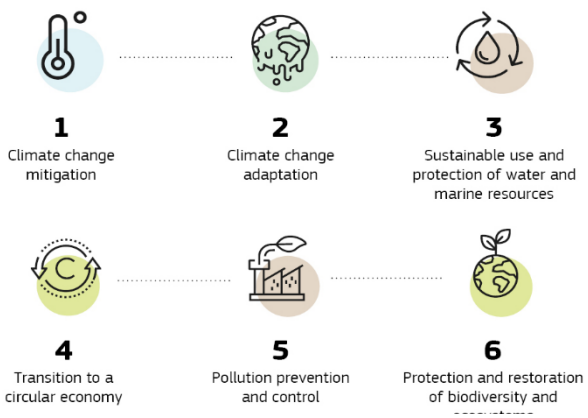

Figure 8 EU-taxonomy (European Commission, n.d.-a)

For a construction-related activity to be classified as sustainable under the taxonomy, it must meet technical screening criteria. For climate adaptation, this involves:

- Implementing physical and/or non-physical measures that immediately and substantially reduce relevant climate risks.
- Conducting a climate risk and vulnerability assessment.
- Evaluating impacts on the durability, robustness, and resilience of structures (Dutch Green Building Council, n.d.; European Commission, 2023).

The Taxonomy lists both chronic and acute climate hazards (see Table 3), and requires adaptation solutions to be tailored to the expected lifecycle of a building (Dutch Green Building Council, n.d.). For example, developers must assess whether the building remains safe and operable under future conditions of heatwaves or heavy rainfall. To facilitate this, the previously mentioned Klimaateffectatlas can be used to assess climate risks. The assessment must consider various climate scenarios, with RCP 8.5 being the minimum reference scenario if the risk is considered negligible. RCP 8.5 is the scenario with the highest emissions, in other words: worst case scenario (European Commission, 2023).

	Related to temperature	*Related to wind*	*Related to water*	*Related to solid mass*
Chronic	Changing temperature (air, fresh water, sea water)	Changing wind patterns	Changing precipitation patterns and types (rain, hail, snow, ice)	Coastal erosion
	Heat stress		Precipitation and/or hydrological variability	Soil degradation
	Temperature variability		Ocean acidification	Soil erosion
	Melting of permafrost		Salt intrusion	Landslides
			Sea level rise	
			Water stress	
Acute	Heat waves	Cyclone, hurricane	Drought	Avalanche
	Cold wave/frost	Typhoon	Heavy precipitation (rain, hail, snow, ice)	Landslide
	Wildfire	Storm (including snowstorms, dust storms, and sandstorms)	Flooding (coastal, river, rainwater, groundwater)	Subsidence
		Tornado	Glacial lake outburst	

Table 3 List of climate hazards from the EU taxonomy Climate Delegated Act (Dutch Green Building Council, z.d.; European Commission, 2023)

Sustainable Finance Disclosure Regulation (SFDR)

The Sustainable Finance Disclosure Regulation (SFDR) is a European regulation that aims to increase transparency on the sustainability of financial investments. It came into effect on 10 March 2021. Under this regulation, financial market participants – including banks, pension funds, and asset managers – are required to disclose whether, and how, their investments align with environmental, social, and governance (ESG) criteria, including their impact on the environment and climate (European Parliament and Council, 2019). "By setting out how financial market participants have to disclose sustainability information, it helps those investors who seek to put their money into companies and projects supporting sustainability objectives to make informed choices."- (European Commission, n.d.-b). The SFDR strengthens the role of the EU Taxonomy as an assessment framework and forces financial institutions to actively include climate risks in their investment choices. This means that real estate development that depends on external financing might have to take these sustainability criteria into account, depending on whether the financial institution aims for sustainability.

Corporate Sustainability Reporting Directive (CSRD)

The CSRD is a European directive that requires companies to report extensively on their ESG impact (European Parliament and Council, 2022). This directive replaces and expands the previous Non-Financial Reporting Directive (NFRD). Whereas previously only large, listed companies had to report, the CSRD applies to a much larger group of companies – including medium-sized companies, banks and insurers. The CSRD requires companies not only to describe their sustainability strategy, but also to quantify climate risks, environmental effects and social impacts (European Parliament and Council, 2022). In doing so, they must also demonstrate to what extent their economic activities meet the requirements of the EU Taxonomy. However, in April 2025, the European Parliament agreed to delay the application of the CSRD's second and third wave. This would mean that the largest companies, as well as medium-sized firms, now have until 2028 to comply, while smaller listed enterprises may report as late as 2029 (European Parliament, 2025). As a result, the implications of the CSRD for real estate development, particularly in terms of data transparency and risk disclosure, might also be delayed.

3.2.3 Climate risk tools

Commissioned by the Delta Programme for the Built Environment (DGWB) and the Regional Coastal Consultation (BRK), Deltares conducted an exploratory study into climate risk labels in the Netherlands, with a special focus on water-related risks. The reason for this study is the growing urgency to gain insight into the vulnerability of the built environment to climate change and to stimulate adaptation measures by citizens, real estate managers and policymakers (Hoogvliet et al., 2023).

The study focused on existing and potential labels that provide information about climate risks stemming from water nuisance, flooding, drought, heat and storm. Although the emphasis was on water labels because of their direct relevance to the Delta Programme, other types of climate risk labels were also included to gain a broader insight into possible applications, target groups and methods (Hoogvliet et al., 2023).

The study shows that there are various labels in circulation that vary in scope, detail and target group. Some labels focus on raising awareness among private individuals and encouraging individual measures, while others are specifically aimed at professional parties such as municipalities, investors and real estate corporations, to improve strategic decision-making and policy support (Hoogvliet et al., 2023).

Label/ method	*Flooding*	*Water nuisance (rain)*	*Drought (foundation)*	*Heat*	*Other*	*Scale*
Vlaanderen perceel en gebouwscore	X					House
UK	X					House
VS, FEMA	X					House
BlueLabel	X	X focus	X	X	-	House
FCAB	X	X, and groundwater	X, and natural fires	X	Storm	Building
KIM tool		X		X		Building
Staat van je straat	X	X	X	X		Street
Mijn Waterrisicoprofiel	X	X				'location'
Waterlabel.net					Storage capacity	Plot
IkBenWaterproof	X	X				House
Energielabel				X	Energy usage	House
Calcasa Woningcheck	X		X			House
Fundermaps			X			House

Table 4 Climate labels investigated by Deltares (Hoogvliet et al., 2023)

For real estate development the following tools can be useful:

Framework for Climate Adaptive Buildings (FCAB)

This framework is developed by the Dutch Green Building Council (DGBC) together with financial institutions, knowledge institutes, consultants, and the government. This framework uses the data of the Klimaateffectatlas (Dutch Green Building Council, 2022b). The FCAB evaluates climate vulnerabilities on four key themes: heat, drought, flooding, and the consequences of extreme weather events. The FCAB contains three documents:

- Part 1: Environmental Score – Assessing the climate effects on the environment surrounding a building (Dutch Green Building Council, 2022b).
- Part 2: Building Score – Determining the specific vulnerabilities of the building (Dutch Green Building Council, 2023).
- Part 3: Area & Building Measures – Defining measures at the area and building levels (Dutch Green Building Council, 2024).

By applying a standardised scoring system, the framework allows stakeholders to assess risks at both the building and neighbourhood levels, ensuring that measures are implemented to address specific vulnerabilities (Dutch Green Building Council, 2022a). The FCAB emphasises adaptive measures, such as enhancing water infiltration through green infrastructure, improving building insulation to mitigate heat stress, and implementing flood-resilient designs. It complements national strategies by

translating broader climate risk assessments into actionable guidelines for the construction sector (Dutch Green Building Council, 2022a).

Figure 9 Framework for climate adaptive buildings (Dutch Green Building Council, 2022a)

KIM-tool

The Climate Risk Identification & Management tool was developed by Sweco in collaboration with residential investor Vesteda. The aim of the KIM tool is to provide insight into heat and water nuisance risks for residential portfolios. The output helps investors such as Vesteda and Bouwinvest to implement sustainability measures and communicate them to financial institutions and residents (Hoogvliet et al., 2023).

Staat van je straat

This advisory service from Sweco provides municipalities with insight into climate risks at street level. The aim is to raise awareness among residents and to support municipalities in formulating ambitions and risk dialogues. Labels are determined based on climate themes such as water nuisance, flooding, drought and heat stress (Hoogvliet et al., 2023).

BlueLabel

This commercial online platform, developed by Achmea, Royal HaskoningDHV and Nelen & Schuurmans, provides insight into four different climate risk themes: Water Nuisance, Heat Stress, Drought, and Flooding. The method of BlueLabel follows the FCAB method, and uses data from the Klimaateffectatlas (BlueLabel, 2025). The BlueLabel contains eight different climate labels varying from individual building level to street and district level. Although the environmental score (Part 1) has already been developed and can be requested, the building score (Part 2) is not yet in practical use. The main users are municipalities and real estate portfolio owners who want to take measures to reduce the effects of climate risks in neighbourhoods (Hoogvliet et al., 2023).

The study concludes that despite the diversity of labels, there is room for further integration and standardisation. This will enable a more effective response to climate challenges and enable stakeholders to make better-informed choices about the management and adaptation of real estate to climate risks (Hoogvliet et al., 2023). The study also showed that the current labels have limitations, such as a lack of clarity and comparability. In addition, it showed that labels on their own are insufficient to fully support complex decision-making and that they function better in

combination with additional measures, such as financial incentives and targeted communication (Hoogvliet et al., 2023).

3.2.4 Effect of data disclosure

The Sustainable Finance Disclosure Regulation (SFDR), though originally designed for financial markets, increasingly influences climate adaptation in the real estate sector with standardised sustainability disclosures.

While the regulation does not directly target real estate development, it indirectly influences development choices by shaping investor expectations. As real estate is particularly vulnerable to physical climate risks – such as heatwaves, flooding, and drought – SFDR prompts asset managers to assess and disclose how their portfolios respond to these risks. This includes reporting on adaptation measures like improved insulation, flood-resilient design, or heat mitigation, which in turn can affect development priorities and feasibility (INREV, 2023).

Products under SFDR must be classified under Article 6, 8, or 9, with Article 8 referring to products that promote environmental or social characteristics, and Article 9 reserved for those with a clear sustainable investment objective (INREV, 2023). Although these categories aim to enhance comparability, they are often misinterpreted as simplistic sustainability labels. In practice, many real estate assets struggle to qualify under Article 9 due to the focus on current operational emissions rather than long-term resilience or adaptation value. As a result, the regulation may inadvertently disincentivise investment in older, less efficient buildings – despite their significant potential for transformation through renovation and climate adaptation (INREV, 2023).

This limited scope is further complicated by the SFDR's lack of attention to embodied carbon or circular construction. By prioritising operational performance, the framework risks signalling a preference for new development over renovation, even though adapting the existing built environment is vital for a climate-resilient future. This misalignment may delay or distort capital flows that would otherwise support adaptive reuse, or water-sensitive urban design (INREV, 2023).

Additionally, SFDR currently lacks sector-specific guidance tailored to real estate. Originally developed for public equity markets, the regulation struggles to accommodate the long-term, dynamic nature of real estate assets and their adaptation trajectories. Without clear standards for evaluating and disclosing adaptation performance, there is a risk of superficial reporting or misclassification of projects with genuine climate resilience goals (INREV, 2023).

Although no concrete studies exist on how climate risk disclosure affects property value in the Netherlands, research into sustainability labels provides useful insights on the potential impact. For example, Gerassimenko et al. (2024) found that EPC labels increased home values in the Flemish owner-occupied housing market, even without direct financial incentives. Buyers appeared to recognise the intrinsic value of energy efficiency. By contrast, tenants in the rental market only valued better labels when they led to lower energy or housing costs. The study concluded that while EPC labels can incentivise efficiency investments, their format may require reform to be fully effective.

In the Dutch commercial sector, van van Overbeek et al. (2024) showed that BREEAM-NL-certified office buildings achieved average rent premiums of 10.3%, with significant variation across cities. The better the BREEAM score, the higher the rent – a strong signal that tenants and investors reward visible environmental performance, as long as the location is favourable.

While these studies don't directly cover physical climate risk labels or adaptation, they demonstrate that transparent environmental labelling can impact market behaviour.

In this context, the Dutch Central Bank (DNB) highlights the need for more targeted measures to accelerate climate adaptation in the financial and real estate sectors (De Nederlandsche Bank (DNB), 2023b). In its 2023 report *Klimaatadaptatie in een stroomversnelling*, the DNB proposes several key recommendations. These include the introduction of a mandatory climate label for buildings—complementary to the existing energy label – which would make risks such as heat stress and subsidence more visible to investors and occupants. The report also urges stronger regulation through the Environmental Planning Act (Omgevingswet) and clearer spatial guidelines to identify suitable locations for climate-resilient construction. Moreover, financial actors are encouraged to develop adaptation-focused investment products, conduct vulnerability assessments, and engage more actively with companies and developers on resilience strategies (De Nederlandsche Bank (DNB), 2023b).

3.3 Real estate development

This section outlines how real estate development has evolved in the Netherlands and the governance models that shape decision-making. To understand the roles of different stakeholders in the decision-making of real estate and area development projects, it is first necessary to define area development itself. In this research the following description is used (Zeeuw, 2018): "Area development is about bringing together different functions, disciplines, stakeholders, interests, and financial flows with the goal of developing or transforming an area."

3.3.1 Real estate development in the Netherlands

Real estate development in the Netherlands is a dynamic process in which collaboration between public and private parties plays a crucial role. Throughout the years, a shift from government led development to private sector led development has taken place (Heurkens, 2012). Additionally urban development has shifted from large scale development, to smaller scale development after the crisis, to again more large scale developments this day (Zeeuw, 2018). Private parties gained a lot more control during the phase after the economic crisis in 2008, but with that an increased responsibility in new developments (Heurkens, 2012; Zeeuw, 2018). However, a lot of developments still start from government initiative (Zeeuw, 2018).

Project development is about bringing together seven means of production: location, planning, design capacity, building capacity, financing, use, and ownership (Peek & Gehner, 2018).

Means of production	
Land development	All activities for acquiring and preparing land for construction
Design	All activities for designing the project
Construction	All activities for building the project
Entitlement	All activities for acquiring the needed approvals in the form of zoning plan and permits
Leasing	All activities for finding a user
Sales	All activities for selling the building to a (new) owner
Financing	All activities for temporarily financing all these six means of production

Table 5 Seven means of production of a developer (Gehner & Peek, 2008; Peek & Gehner, 2018)

The seven means of production all have their attached markets and market players. In this complex field, the project developer is a 'spider in the web', see Figure 10 (Peek & Gehner, 2018). The ultimate goal of a developer is to gain confirmation on each market, which would mean that the project is realised, used, and sold (Peek & Gehner, 2018).

Development is not a linear process, and each urban area development differs strongly due to the market, government of the area and local people in the area (Zeeuw, 2018). In the 'traditional way' of project development the developer would do the work in following order: buy the land, acquire a design, fix the financing and permits, and make sure the building is rented out and sold. However, in today's world multiple other strategies are used. In some projects, for instance, the building is sold before they start designing. It is made for the end user or as an investment (Aalbers, 2019; Heurkens, 2012; Peek & Gehner, 2018). Assuring each market is taken care of is decreasing the risk for the developer (Peek & Gehner, 2018).

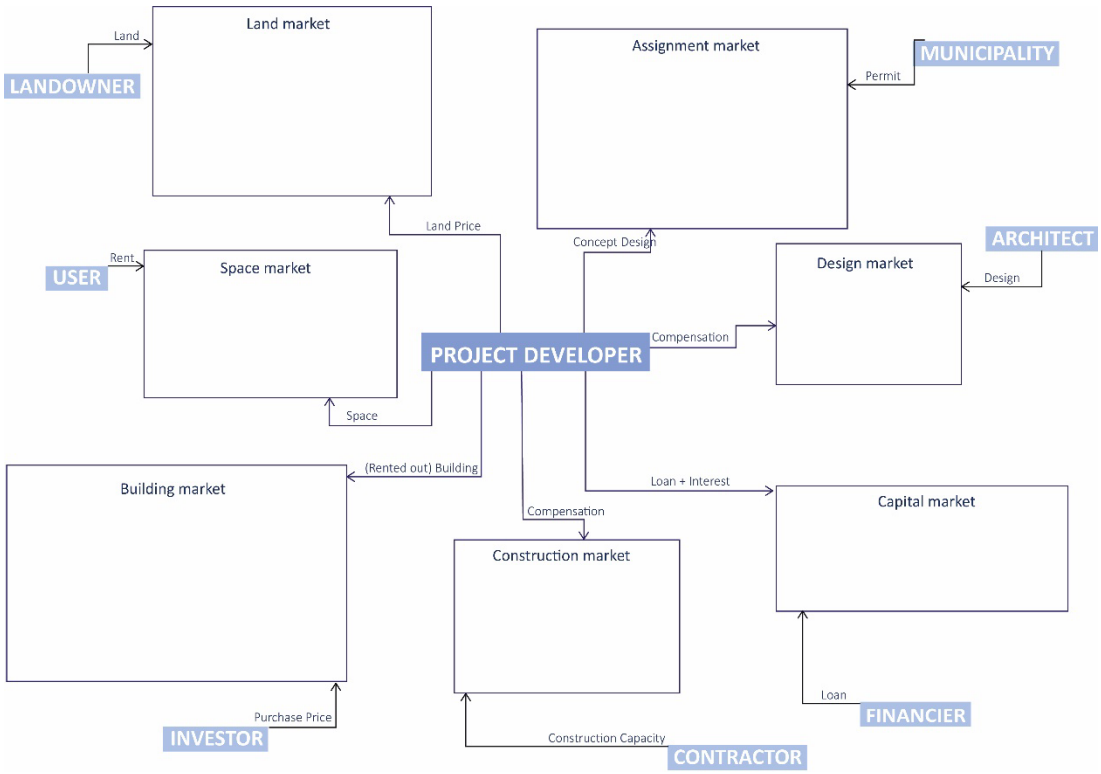

Figure 10 Project development market structure based on Peek and Gehner (2018)

3.3.2 The profession real estate developer

Developers act as intermediaries between end users and contractors while balancing the supply and demand of real estate (Ten Have et al., 2010). Their main objective is to create and finance projects while ensuring they remain profitable within an acceptable risk level (Heurkens, 2012). The profit of a developer is the difference between building costs and the sales price. In return they bear risks in processes, markets and costs (Zeeuw, 2018). However, developers differ in their organisational structures, financial approaches, and legal responsibilities.

Types of Developers

Developers vary significantly, from small family-owned businesses to large multinational firms (Boanada-Fuchs & Fuchs, 2022). Table 6 (Heurkens, 2012) categorises them into independent developers, construction-affiliated developers, investors, banks, non-real estate companies, and master/land developers. Their priorities and strategies depend on whether they focus on short-term profits, long-term investments, or strategic urban planning.

Type of developer	*Characteristics*
Independent Developers	Small-scale firms focusing on niche markets like housing, offices, or retail. Successful ones may be acquired by larger construction firms.
Developers Related to Construction Firms	These developers have a strong link to the construction sector and prioritise continuous cash flow to maintain operations.
Developers Related to Investors	Primarily develop or acquire properties for institutional investment portfolios. Their focus is on long-term value growth and maintaining steady cash flow, often with end-user involvement.
Developers Related to Banks	Large-scale firms linked to banks that act as financiers. With strong access to capital, these developers have historically acquired significant land holdings.
Other Developers	Companies from different industries, such as railways or retail, which engage in real estate development due to business opportunities related to their core activities.

Table 6 Different types of developers (Heurkens, 2012)

Despite these differences, all developers share core responsibilities such as land acquisition, feasibility analysis, securing finance, project management, and stakeholder consultation (Heurkens, 2012; Putman, 2010). Successful developers require expertise in markets, construction, and finance, alongside soft skills like decision-making, risk management, and adaptability (Heurkens, 2012).

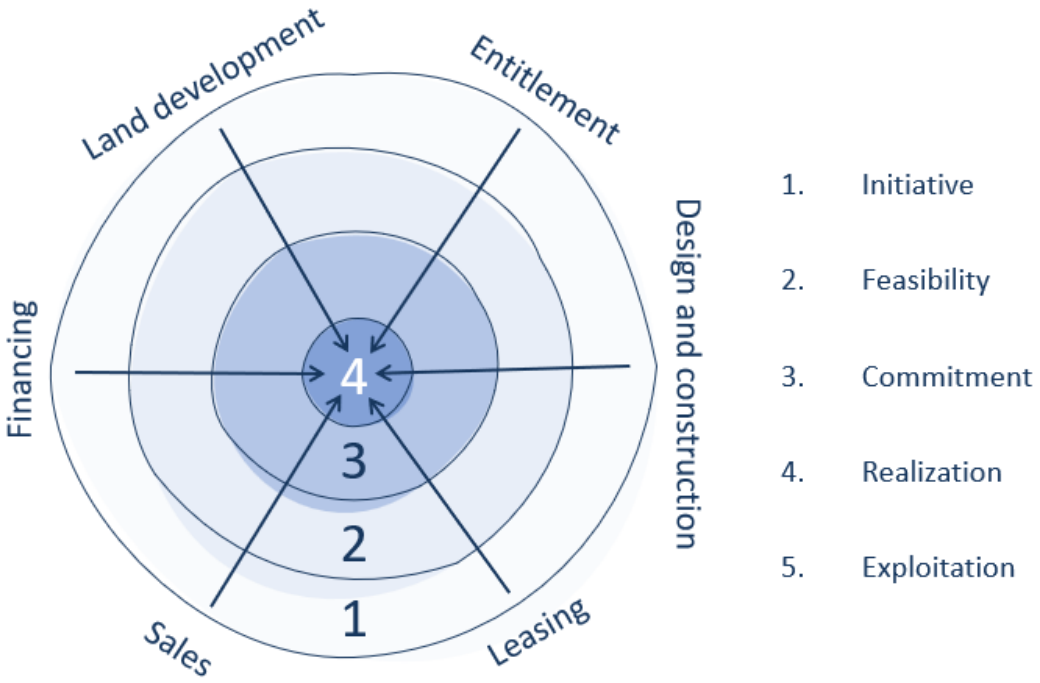

Figure 11 Project development phases (Peek & Gehner, 2018; Zeeuw, 2018)

To get a grip on the complexity or to coordinate the activities in these six markets, the project is cut into 5 different phases (Peek & Gehner, 2018; Zeeuw, 2018).

Initiative

The initiative for a project typically originates from a (latent) demand in the space market that certain actors seek to address. While most initiatives come from municipalities or other government bodies, real estate developers are the second most common initiators, focusing on locations they perceive as promising (Zeeuw, 2018). Marketing related aspects are very important in this phase (Peek & Gehner, 2018). Activities in the initiative phase are for instance (Zeeuw, 2018):

1. Define a vision.
2. Define the context of users, governmental bodies, ownership, obstacles, and potential.
3. Create a rough concept.
4. Carry out a market analysis.
5. Carry out a risk analysis.
6. Start stakeholder conversations.

This phase can also include the buying of the land. Real estate developments often start with a spatial vision, made by public and/or private parties. In the Netherlands, municipalities traditionally have a strong position in the land policies. This means that they take in strategic land positions to steer urban development (Heurkens, 2012). This could either be through active land policy or facilitating land policy. With active land policy, the municipality buys the land, ensures it is ready to develop, and sells the land to a developer, possibly under conditions. In facilitating land policy the land is already owned by private parties, however, the municipality steers through the masterplan, zoning plan and additional conditions (Heurkens, 2012). This phase should end with a promising concept (Peek & Gehner, 2018).

Feasibility

The feasibility and planning phase is to gain clarity in what is possible when looking at production and marketing (Peek & Gehner, 2018; Zeeuw, 2018). Costs of location and construction are weighed against rental and sales revenue, while researching the market demand (Peek & Gehner, 2018). The principles and preconditions of the project are determined. Municipalities use spatial frameworks and policy plans that determine what can be built, and under what conditions. In public private partnership projects, agreements about spatial quality, sustainability and social objectives can be recorded in contracts (Heurkens, 2012). A developer has to determine whether their plans fit in the municipalities vision. An important aspect in this phase is the degree of flexibility in the collaboration. Heurkens (2012) states that successful projects often find a balance between strict public guidelines and sufficient flexibility for market parties to respond to changing circumstances.

Commitment

Following, there is the commitment phase. The goal of the commitment and governance phase is to create a feasible concept and acquire securities from other parties regarding production (Peek & Gehner, 2018). In each of the six means of production mentioned earlier there has to be some form of intermediate product. This means that many stakeholders are involved at this stage, with customer participation in particular playing an increasingly important role in the process (Peek & Gehner, 2018; Zeeuw, 2018).

There are multiple collaboration models. The decision for a collaboration model depends on factors such as risk sharing, investment capacities and policy goals. Developers contribute by connecting stakeholders, maintaining progress, and ensuring project viability (Zeeuw, 2018).

	Municipal exploitation	*Building claim (bouwclaim)*	*Joint venture (super) light*	*Joint venture*	*Private exploitation*	*Concession*
Initiative	Municipality	Municipality or market	Municipality or market	Municipality or market	Municipality or market	Municipality
Land acquisition	Municipality	Market sells to municipality	Each for themselves	Each for themselves	Market	Municipality sells to market
Ground exploitation	Municipality	Municipality	Each for themselves	Jointly	Market	Market
Outline planning	Municipality	Municipality with input market	Jointly	Jointly	Market and municipality	Market
Planning elaboration	Market or municipality	Market	Each for themselves	Jointly	Market	Market

Table 7 Collaboration models (Zeeuw, 2018)

Realisation

After approval of the plans, the realisation phase begins. Responsibilities vary per project and per governance model:

- In municipal land policy, the municipality carries out the preparatory work, such as infrastructure and public space.
- In private sector-led developments, market parties arrange this themselves and the municipality only bears responsibility after delivery (Heurkens, 2012).

Exploitation

After completion, the project will be put into use. The municipality can remain involved through the management and maintenance of public space, while private parties operate the real estate. In some collaboration models, public and private parties remain involved in the exploitation and management of an area for a long time (Heurkens, 2012).

The research of Shearer et al. (2013) examined the stages at which developers consider climate adaptation. When combined with the five development stages identified by (Peek & Gehner, 2018), this highlights the importance of both the initiative and feasibility phase for integrating climate adaptation, as they are critical for decisions regarding location, programme, design, and the business case. At this stage, none of these factors are yet fixed, and flexibility for the real estate developer remains. It is important to note that in some cases, land has already been acquired by the time feasibility is assessed, whereas in others, feasibility studies precede land acquisition.

3.3.3 Financing real estate development.

A private market party, such as an investor or a developer, invests money to earn it back later with profit. During this process he takes market-, process-, and other risks. He prices these risks; the higher the risk, the higher the profit target he strives for.

Land exploitation and real estate exploitation

In order to understand the financial and economic mechanisms of area and real estate development, it is essential to grasp the relationship between land exploitation and real estate exploitation (Zeeuw, 2018). The financial feasibility of a project begins with each market player, or stakeholder, defining their desired outcomes from the development. An important aspect of this stakeholder collaboration is the recognition that each stakeholder operates on a different timeline. The landowner focuses on the moment of selling the land, the project developer concentrates (also) on the sale of the real estate, the investor considers a holding period of at least ten years, potential housing associations (as future users) focus on the lifespan of the dwellings, and the municipality and waterboards concentrate on the maintenance costs of public space that will fall under their permanent management (Zeeuw, 2018).

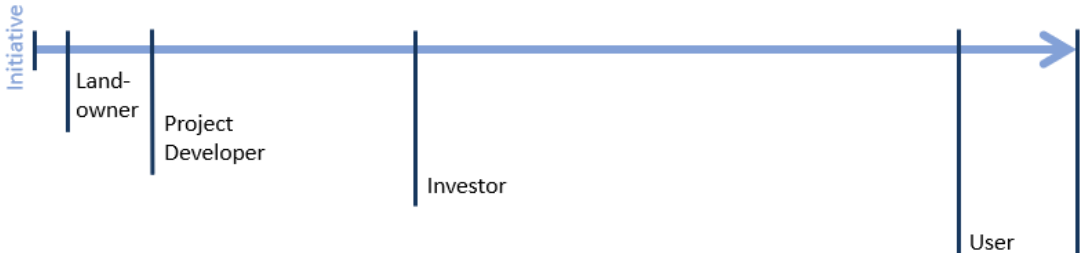

Figure 12 Stakeholder timeline sketch (own work, 2025)

The relationship between land exploitation and real estate development is essential. The real estate market functions as a stock market, meaning that new real estate is added to the existing stock at a given location. At some locations more growth in stock is desired, which leads to different price levels at different locations (Pelzer et al., 2023). The price level at each location plays a crucial role in the land exploitation process. At a popular location, the same project can be sold for a significantly higher price, allowing the developer to spend more on acquiring the land (Pelzer et al., 2023; Zeeuw, 2018). Although this study does not delve into land exploitation, it is important to note that at growth locations, the land development budget is higher, as higher returns on investment are expected.

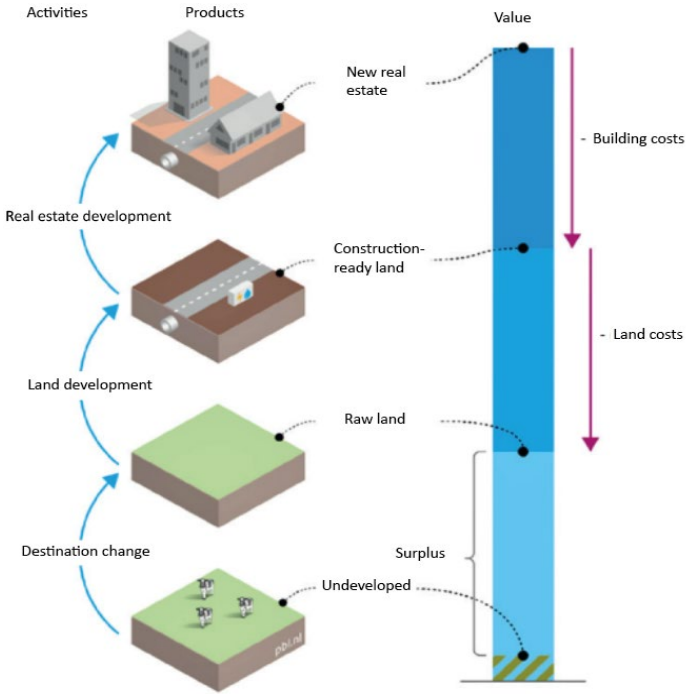

Figure 13 Phases of real estate development (Pelzer et al., 2023)

Real estate as an investment

In recent decades, the financing of real estate developments has shifted from largely public financing to a mix of public and private resources. What is interesting, is that worldwide starting in the 70s, commercial real estate development is increasingly seen as an investment. It is built with the investor in mind, rather than the end users (Aalbers, 2019). In the Netherlands, more recently focused research has shown that there was an increase in projects led by end-users and long-term investors. Large developers, in this case, had a decreasing foothold in real estate development (Buitelaar et al., 2017).

New financing models, such as revolving funds and area investment zones, are used to link public and private investments (Heurkens, 2012). Following the cashflow in real estate development leads to the scheme seen in Figure 14.

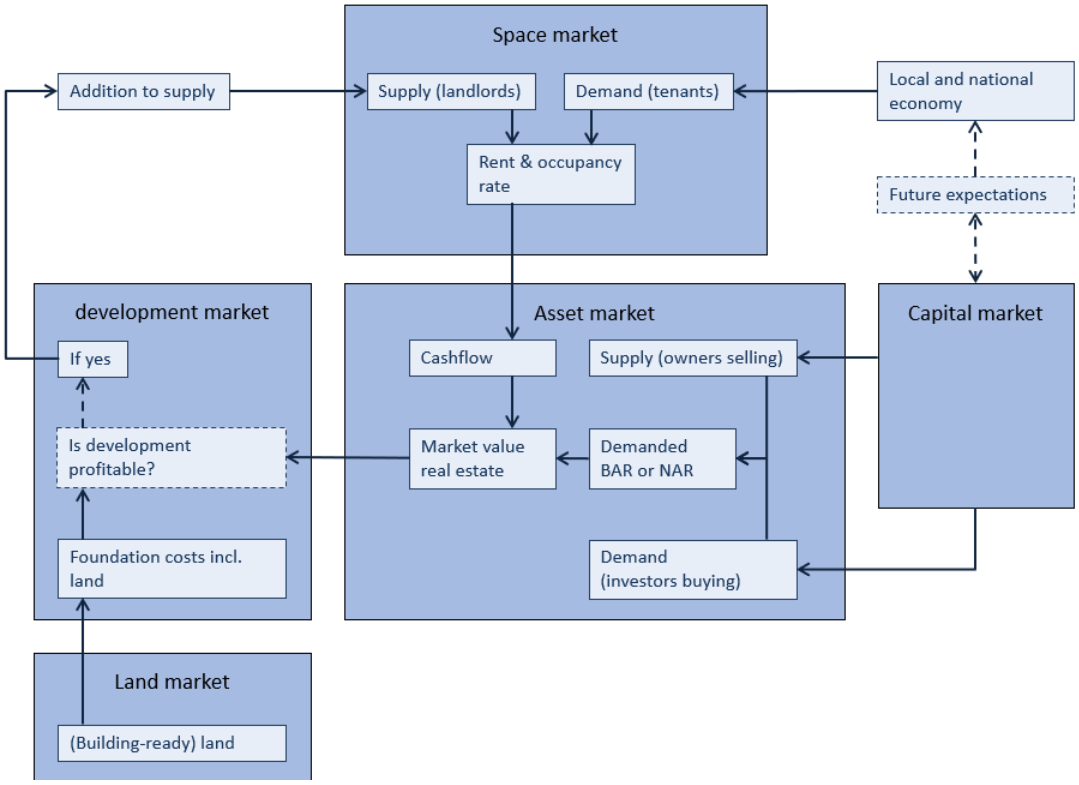

Figure 14 The real estate market as assembly of sub-markets (Peek & Gehner, 2018)

A real estate developer has to be aware of the bigger macro-economic field when a new real estate development is started. The potential and financial feasibility of a project is often connected to a demand in the space market. However, real estate development is directly affected by the bigger (international) capital market. This market is subject to booms and busts, which are created by asset rotation (Peek & Gehner, 2018). The asset rotation is driven by investors moving their investments to the market they see as most profitable. This would often be the market that has the most growth potential (Peek & Gehner, 2018). When investors have little trust in the stock market, they may turn to the real estate market – or more precisely, the asset market – as it is perceived to be a safer investment (Peek & Gehner, 2018). Real estate investment companies facilitate this by allocating capital to what they consider the most promising asset classes. Real estate developers can then approach these investment companies to obtain the equity required for their projects. Through contractual agreements with every party involved agreements are made on who bears the financial

risks and responsibilities (Peek & Gehner, 2018). These risks play a significant role in the cooperation between public and private parties:

- In some PPP structures, the private party bears the majority of the financial risk, while the municipality mainly facilitates.
- In other cases, the municipality remains partly financially involved, for example through guarantees or co-investments (Heurkens, 2012). The economic crisis of 2008 brought the risks of real estate development into sharper focus, which led to more cautious municipal policy and greater dependence on private investors (Heurkens, 2012).

3.3.4 Real estate development strategies

Each real estate development firm has their own development strategy. Research by Gehner and Peek (2008) has identified five different development strategies. The strategies differ in moments the following commitments are made: land purchase, conceptual design choice, application for building permit, closing majority of leasing contracts, and closing sales contract. This sequence has influence on budget control, revenues, and flexibility (Gehner & Peek, 2008). "A development strategy determines how value is created during the process and secondly how sensitive the development process is to the main risks in a project" (Gehner & Peek, 2008, p. 4). Table 8 explains the five different development strategies briefly.

Strategy	*Characteristics*
Supply driven strategy	Starts with acquiring land, often without a predetermined use. Developers aim to apply for zoning changes or building permits based on market demand.
Demand driven strategy	Initiated by securing a tenant or user before land acquisition. The development is tailored to meet the specific needs of the pre-committed user.
Concept driven strategy	Begins with a well-defined concept that seeks suitable land and tenants. Development focuses on bringing a unique idea to market.
Project driven strategy	Focuses on the implementation of an established concept. This strategy prioritises executing a predefined project plan based on market conditions.
Investment driven strategy	Driven by investor interest, this strategy seeks to develop real estate assets that fit the investor's criteria for returns and usage, potentially influencing design and financing.

Table 8 Development strategies (Gehner & Peek, 2008)

Land banking

In the Netherlands, approximately 80% of land is privately owned, including by real estate developers (Buitelaar, 2021). Through the right of self-realisation, these landowners have significant influence over development, as long as the intended use aligns with the zoning plan. As a result, many developers acquire strategic land positions in potential expansion areas at an early stage – often well before any formal public planning has taken place. This practice, known as land banking, is aimed at capturing a so-called 'surplus': the difference between the projected real estate value and the associated development costs (Pelzer et al., 2023). Land banking is not only practiced by private parties, public entities such as the Rijksvastgoedbedrijf, municipalities, and housing associations have also done this (Pelzer et al., 2023). Physical climate risks such as soil subsidence or flood damage are rarely factored into this calculation, since developers are not responsible for these long-term costs after project completion. As a result, municipalities face a dilemma: they are expected to implement Water and Soil Guiding ambitions, which discourage development in vulnerable areas, but are simultaneously pressured by public and private landowners to enable projects on land acquired for development (Pelzer et al., 2023).

3.3.5 Fitting climate risks in the development process

Research conducted in Australia (Shearer et al., 2013) has shown that the size of a developer, along with the spatial and temporal scale of their developments, were the most significant factors in determining whether the developer perceived climate change as a major risk. The same study found that larger developers had a greater adaptive capacity due to having more resources and engaging specialist consultants (Shearer et al., 2013).

Additionally, it was observed that smaller developers tend to have a short-term vision, whereas larger developers often operate on longer time scales (Shearer et al., 2013). Another key finding from the research was that small developers who rely on bank loans tend to be significantly more risk-averse than those who do not require bank financing. This means that, in many cases, these developers avoid innovation and prefer solid, predictable profits. In contrast, larger developers, who often have multiple ongoing projects and possibly own several land parcels, experience less time pressure to repay loans (Shearer et al., 2013).

Nonetheless, developers generally operate with a short-term perspective, which influences their approach to climate adaptation (Shearer et al., 2013). Therefore, when researching developers' willingness to adapt real estate to climate change, it is crucial to consider the following characteristics of the developer:

Characteristics	*Developers' impact on CA*
Financial capacity	More financial resources enable investment in climate resilience, energy efficiency, and sustainable materials.
Risk exposure	High-risk developers avoid uncertain investments like climate adaptation, while lower-risk developers integrate long-term resilience.
Project timelines	Short-term projects often ignore climate risks, whereas long-term projects require adaptation for sustainability.
Market position	Large, publicly listed firms prioritise ESG compliance and sustainability; smaller firms may focus only on profit-driven decisions.
Innovation & adaptability	Innovative firms adopt climate adaptation solutions, while traditional developers may resist change due to financial or market concerns.
Regulatory compliance	Developers who can navigate regulations efficiently integrate climate adaptation measures; those struggling with bureaucracy avoid costly adaptations.
Land ownership & banking	Land banking allows developers to plan for long-term sustainability, while smaller developers may take risks on vulnerable sites.
Lending practices	Banks prefer safe, traditional projects, discouraging developers from experimenting with sustainable designs.

Table 9 Developers' characteristics and the impact on CA (based on Shearer et al. (2013))

Shearer et al. (2013) mention that climate change was considered when selecting new development sites, which in this figure would fall under land development. When looking at design and construction, developers were hesitant, as implementing climate adaptation would mean extra costs for additional measures. If embedded in the concept plan from the very start these measures had a chance, however, if later introduced no contractor would be willing to decrease their return on investment (Shearer et al., 2013). The developers want to be competitive in the market. Doing extra measures led to a feeling of over-service in the development if other competitors are not doing the extra mile as well (Shearer et al., 2013). Which leads to the following concern: sales. Shearer et al. (2013) found that almost all developers and consultants considered that one of the major risks in the development process was marketing and selling the products of development. Simply put: if the

market is not concerned with climate risks, there is no market advantage to be gained. This would just be overspending. Another important market that has impact on climate adaptation is the financial market, according to Shearer et al. (2013). Developers indicated that obtaining development financing from banks is challenging, requiring significant personal investment. Due to extreme risk aversion, banks rarely support experimentation with sustainable innovations. Moreover, major banks typically finance short-term projects, with little consideration for climate change risks. Interest in adaptive development mainly came from equity providers and pension funds (Shearer et al., 2013). This, however, is likely to be different this day and age, at least in the Netherlands. As sustainable finance is increasing in the policies of Dutch banks.

3.3.6 Potential drivers and barriers for climate adaptation

Research in Sweden has shown that property developers are facing several challenges in implementing climate-oriented measures (Storbjörk et al., 2018). The research uses the distinctions of Albrechts (2010), which come from planning studies, to analyse the responses of property developers. The categories are: inactive, reactive, preactive and proactive (Storbjörk et al., 2018). With proactive and preactive responses developers anticipate for the future with certain strategies. Reactive responses mean reacting to threats or changes when they actually happen. This could mean aligning with new minimum requirements for building standards. Inactive responses of developers would mean that the developer avoids action (Storbjörk et al., 2018).

Storbjörk et al. (2018) conclude that most developers interviewed stated ambitious goals and a proactive role in climate change on paper. They presented themselves as sustainable and innovative. However, in the interviews and daily practice these intentions are often not met. Instead developers tended to lean more to reactive or even inactive responses, adhering to the minimal requirements (Storbjörk et al., 2018). Additionally, the interviews show that the developers have a reserved attitude towards taking risks to implement new innovative measures. The developers state that they are unsure whether the market for new climate friendly options is big enough to go further than the minimal required practices. Resulting in traditional development practices instead of innovative solutions. Lastly the research showed that the willingness to implement climate measures in a development project depends strongly on location. Developers are more willing to take on ambitious projects in bigger cities like Stockholm and Malmö, while in smaller cities there is more reluctance because of the demographics and market dynamics (Storbjörk et al., 2018).

Research conducted in the Netherlands looked into how climate adaptation could be mainstreamed in urban development projects. This would mean that climate adaptation would be a standard procedure in the urban redevelopment projects (Ten Brinke et al., 2022). The following drivers and barriers were mentioned for private parties to incorporate climate adaptation.

Drivers	*Barriers*
Qualitative (Non-Monetary) Benefits: Private developers recognise the value of adaptation in terms of creating a high-quality living environment and professional value, such as enhancing corporate reputation.	**Perceived Absence of Direct Monetary Benefits:** Developers and investors feel a lack of immediate financial returns from climate adaptation, discouraging them from integrating such measures.
Business Advantages: The potential to gain competitive advantages and develop knowledge and expertise as a result of climate adaptation.	**Risk-Averse Behaviour:** Fear of financial risks associated with climate adaptation may make developers hesitant.
Need for a Green Living Environment: The growing recognition that a green environment can contribute to property value and user well-being.	**Competition with Other Policy Goals:** Adaptation may compete with other policy priorities, potentially diluting the focus on climate adaptation.
Collaboration and Co-Creation: Acknowledgment that cooperation with municipalities and other stakeholders leads to better solutions and innovative approaches.	**Insufficient Understanding of Requirements**: A lack of clear guidelines and requirements from municipalities can lead to confusion among developers.
Consumer Awareness: Increasing demand from consumers for climate-smart and sustainable housing can encourage developers to mainstream adaptation.	**Small and Temporary Incentives:** Available subsidies and other incentives are often perceived as insufficient, limiting their effectiveness.
	Lack of Collaboration: Insufficient cooperation between developers and governments can hinder the integration of climate adaptation.
	Perception of Adaptation as a Public Responsibility: The belief that climate adaptation is primarily a government responsibility reduces motivation in the private sector to take independent action.

Table 10 Drivers and barriers for mainstreamed climate adaptation (based on Ten Brinke et al. (2022))

One thing that is interesting is that a lot of these drivers are not necessarily because of the necessity to adapt to the changing climate, but additional benefits that are often deemed more important than the actual adaptation part. The research stated that investors and developers seldom explicitly include adaptation measures into their development projects (Ten Brinke et al., 2022).

3.4 Key insights for empirical focus

The desk research has highlighted several critical insights that inform the empirical focus of this study. First, it has shown that physical climate risks – such as heat stress, drought, flooding, and subsidence – are increasingly relevant for real estate development in the Netherlands. Open data such as the Klimaateffectatlas and emerging disclosure standards like the EU Taxonomy and SFDR reflect a growing institutional and informational infrastructure aimed at supporting climate-resilient decision-making. However, despite the availability of data and increasing regulatory signals, the actual integration of physical climate risks into development decisions remains inconsistent and highly context-dependent. The SFDR aims to stimulate climate adaptation through transparency, but its impact on real estate development remains limited and uneven in practice.

Furthermore, literature reveals that developers operate within a complex network of market and policy actors. Their decisions are not made in isolation but are shaped by financing structures, planning frameworks, and the expectations of municipalities, investors, and banks. While some

studies point to developer characteristics such as scale and financial model as key variables, other sources indicate a growing role for public and private institutions in steering sustainability goals. Yet, climate adaptation still lacks the structural incentives and standardisation that would help mainstream climate risk mitigation in real estate.

This research aims to further explore these dynamics through empirical data gathered from real estate developers and financial actors. The following empirical section will provide deeper insights into how developers in the Netherlands are currently incorporating (or failing to incorporate) climate risks into their decision-making.

PART 4 | EMPIRICAL RESEARCH

4. EMPIRICAL RESEARCH

4.1 Introduction

As mentioned in the methodology, this study applies the framework developed by Kallio et al. (2016). Desk research informed the creation of a layered interview structure, with each layer building upon specific findings from the literature, progressively deepening the understanding of each topic. The layered structure was deliberately chosen, as it first allows for an exploration of the characteristics of the organisation, and subsequently analyses how these characteristics influence its actions and decision-making. Additionally, this approach clearly identifies the relevant factors, interests, and barriers, distinguishing which factors from the desk research are indeed influential, and which are not.

- *Layer 0: Organisational context and financing structure*
  This layer is essential for understanding the system in which the developer operates, as well as the extent to which other actors may influence the decisions made. It highlights the developer's dependencies on various stakeholders.

- *Layer 1: Investment criteria*
  This layer aims to clarify the typical criteria developers use when deciding whether to pursue a project. It also reveals whether and how climate risks are incorporated into this initial decision-making process.

- *Layer 2: Integration of physical climate risks*
  In this layer, maps of the Netherlands are presented, each illustrating a different physical climate risk. This approach ensures that the risks discussed are clearly defined and made tangible for the developer, particularly since their prior awareness or understanding of physical climate risks cannot be assumed. The risks presented align with those used by (BlueLabel, 2025), and are derived from the Klimaateffectatlas (n.d.).

- *Layer 3: Regulatory and market pressure*
  This layer builds upon the system outlined in Layer 0 and aims to explore why certain factors—such as the EU Taxonomy, SFDR, and tender requirements—do or do not influence the developer's decision-making process, and if developers notice pressure from other stakeholders to integrate the physical climate risks presented in layer 1.

- *Layer 4: View on disclosure measure: climate risk label*
  This layer is designed to observe how developers would respond if climate risks were to be formalised through a labelling system. (BlueLabel, 2025) – discussed in 3.2.3 Climate risk tools – is used for this purpose, consisting of two components: one part reflecting the environmental exposure score based on climate risks (omgevingsscore), and a second, hypothetical component representing the extent to which these risks are mitigated within the proposed development plan.

- *Layer 5: Behavioural barriers and decision logic*
  This final layer serves to define the key issues that have emerged during the interview so far and to explore why these have had an impact. Additionally, several concluding open-ended questions are posed to allow for the emergence of any remaining insights or perspectives.

This chapter presents the findings from qualitative interviews conducted with real estate developers. The data is thematically analysed to explore how physical climate risks are considered in development decision-making. All interviews were recorded with an audio device. Anonymous transcripts were made of these audio files, which were used for the analysis.

4.2 Overview of respondents and context

In order to obtain a broad and nuanced understanding of how climate risk information influence development decisions, a diverse range of real estate developers, investors, a bank, and a municipality were interviewed. This diversity was deliberately chosen, not only because the desk research suggests that climate risk disclosure is effective only when combined with financial incentives, market-driven pressure, or clear regulation, but also because developers differ significantly in how they finance their projects.

As mentioned in the methodology variety in the following prerequisites was sought.

1. Scale (regional vs. national reach)
2. Project type (housing, mixed-use, urban development)
3. Investment structure (equity-financed, investor-driven)

Additionally, a fourth factor was included stemming from the desk research.

4. Type of developer (see Table 6 Different types of developers (Heurkens, 2012)) – this includes construction-related developers (CD), who are affiliated with construction firms, and independent developers (ID), who operate autonomously.

This led to the following participants:

Developer ID	*Scale*	*Project type*	*Investment structure*
CD-1	National	Area (re)development, residential focus	Equity + banks + investors
CD-2	Regional	Small area (re)development, residential focus	Equity + banks
CD-3	National	Area (re)development, residential focus	Equity + banks
CD-4	National	Area (re)development, residential focus	Equity + banks
ID-1	International	Inner-city (re)development, mixed portfolio	Equity + banks
	National	Inner-city (re)development, residential focus	Investors + banks
ID-3	National	redevelopment, residential focus	Investors + banks
ID-4	National	Inner-city redevelopment, mixed portfolio	Investors + banks

Table 11 Participant list developers (own work, 2025)

First, the developers were interviewed. This revealed that each developer has distinct strategies, interests, partners, and motivations, all of which influence how they perceive and integrate climate risks into their development decisions. These insights informed the design of the subsequent interviews with investors and a bank, which aimed to provide a better understanding of the capital and building markets that shape developers' decision-making.

Lastly, an interview was conducted with the Land and Development department of a municipality to gain insight into the municipal guidelines that can be applied to real estate development. This was particularly relevant, as several stakeholders indicated that municipalities and regulatory frameworks play a role in enforcing the integration of climate risks in development processes.

Type of developer	*Characteristics*	*Code*	*# of interviewees*	*Interviewer*
Independent Developers	Small-scale firms focusing on niche markets like housing, offices, or retail. Successful ones may be acquired by larger construction firms.	ID	4	Interviews conducted by author
Developers Related to Construction Firms	These developers have a strong link to the construction sector and prioritise continuous cash flow to maintain operations.	CD	4	Interviews conducted by author
Investors	Primarily develop or acquire properties for institutional investment portfolios. Their focus is on long-term value growth and maintaining steady cash flow, often with end-user involvement.	I	2	Interviews conducted by author
Banks	Act as key financiers in real estate development, as nearly every project involves some form of bank financing.	B	1	Interviews conducted by author
Private Equity	Invest in real estate projects with the aim of maximising returns over a defined investment period, often involving strategic repositioning or redevelopment.	PE	1	Interviews conducted by fellow student (Carl Caliva, 2025)
Municipality	Provides spatial planning guidance and land policy; influences development through zoning, tenders, and infrastructure requirements.	M	1	Interview conducted by author

Table 12 List of interviewees (own work, 2025)

4.3 Thematic analysis developers

This section presents the findings from the thematic analysis of the developer interviews. Through in-depth conversations with professionals in real estate development, several key themes have emerged that illustrate how physical climate risks influence decisions made in real estate development. These themes are structured according to the layered interview design and are enriched by the practical experiences and perspectives shared by the participants. The key themes discussed in this section are:

1. Investment criteria
2. Integration of physical climate risks
3. Regulatory and market pressure
4. View on disclosure measure: climate risk label
5. Behavioural barriers and decision logic

Each theme is presented clearly, giving practical examples and context. Combined, these themes provide a thorough understanding of how developers currently approach climate risks in their decision-making, highlighting both motivations and challenges.

1. *Investment criteria*

Most of the developers interviewed are active in the Randstad and the big cities in Brabant. These areas are often seen as economically promising and familiar territory. Some parties explicitly state that they are also active or want to expand to the north and east of the Netherlands (such as Groningen, Arnhem, Ede or Zwolle), while others limit themselves more to areas along the A12 and A2, with Eindhoven often just being included.

A number of developers emphasise that their choice of projects is partially determined by their network or previously built-up land positions. This leads to them being geographically flexible, but ultimately often concentrating on well-known or strategically located regions. Two parties mention they work nationwide. Although there is a geographical spread, it is noticeable that hardly anyone uses climate risks as a primary filter for area selection. The presence of existing relationships, municipal willingness and development potential appear to be dominant.

The interviews show that the decision to start a project in almost all cases starts with a rational consideration of economic and strategic factors: market potential, scale, complexity, feasibility and timing. Developers all state that a project is only eligible if there is sufficient demand, it fits into the zoning plan, and the business case is profitable. This forms the foundation of feasibility investment decision-making.

In addition, the planning process of the municipality plays an important role. Projects are mainly started if there is a clear spatial vision and if it is realistic that there will be development space within a few years. Some respondents explicitly mention a period of five years in which the planning feasibility must be visible. Without that prospect, a project is generally not taken up.

At the same time, several developers indicate that in addition to this rational core, a certain intuitive component also plays a role. A project must “feel logical” or “feel good” – with the own experience, the risk profile and the reputation of the partners or location as the underlying frame of reference. One developer noted that climate risks are part of this “common sense” but rarely serve as a decisive criterion.

The influence of partnerships and reputation is also striking. Projects are started sooner if reliable long-term partners are involved, such as municipalities or investors. This creates trust and predictability in the development process, which is seen as helpful in relation to risk management. As a result, decision-making is not only guided by the hard figures, but also by the quality of the network and mutual expectations. Finally, some parties reflect on the lack of climate adaptation in this initial consideration.

“We have thought about where we want to do projects but had not yet included climate adaptation in that – we are going to do that now.” (CD-1).

This shows that awareness is increasing but is not yet standardly anchored in the start of the project cycle.

2. *Integration of physical climate risks*

Most developers indicate that they are aware of physical climate risks, such as flooding, rainwater issues, pile rot, heat stress, and – in some cases – soil subsidence. However, the interviews reveal that these risks rarely result in the rejection of a location, and not all developers are aware of climate risks specific to a site. Typically, climate risks are only considered after a location has already been selected and its spatial and economic potential has been determined.

There is a clear distinction between developers who approach risks through formal instruments and those who rely primarily on experience and intuition. For example, one larger developer uses a mandatory climate scan that analyses six risk themes. This scan is applied to 95% of their projects and determines whether further investigation by external experts is necessary.

Other developers indicate that they consider risks mainly in an implicit way – for instance, by avoiding areas that are "simply known to be risky," such as those near major rivers. These judgments are not based on formal risk assessments but rather on professional knowledge and the reputation of the location. One interviewee described this as their "gut feeling," while another referred to it as boerenverstand (common sense), which in practice often carries as much weight as a formal scan or map.

Changing temperatures are rarely mentioned as a decisive risk. Water-related issues (particularly heavy rainfall) and soil-related problems are more prominent in developers' perceptions. In some cases, risks such as foundation damage are explicitly said to prompt immediate action, as they are easy to identify and technically justifiable to partners. Both are classified as acute risks under the EU Taxonomy, meaning they can result in sudden damage to real estate – even if the underlying processes develop gradually. In general, the acute climate risks are acknowledged by nearly all developers, but they are not considered decisive factors in site selection. Rather, they are treated as manageable boundary conditions that can be addressed through technical measures or design adjustments.

Heat waves, extreme precipitation, and soil-related hazards such as subsidence are generally regarded as manageable, assuming that sufficient resources and spatial flexibility are available to mitigate the associated risks. Only in the case of flood risk – particularly in areas outside the dikes or in low-lying regions – do developers tend to be more cautious. One interviewee even explicitly distinguished between heat waves and water nuisance versus flood risk, stating that the former relate to liveability, while the latter concerns survival.

As a result, flood risk is experienced as more fundamental – partly due to reliance on external parties such as the government, water boards, and insurers. In these cases, developers sometimes explicitly choose to engage additional expertise or to assess an area more critically for development potential.

Overall, developers indicate that climate risks are rarely a reason to reject a location altogether. Instead, they are typically addressed during the design and realisation phases – especially in cases involving previously acquired land through land banking.

"For a developer it is an unnatural choice not to build; we always solve it technically and develop it." (CD-4)

Solutions vary from technical interventions to urban planning strategies, depending on the type of risk and the space within the project. Commonly mentioned measures are the application of green roofs, limitation of paving, retention crates, and water storage in public spaces. In some projects, water squares, raised ground levels, or explicit restrictions are also included in the sales

documentation, such as the provision that only part of the garden may be paved. One party even said that they install a green roof on storage areas as standard for ground-level homes.

In the case of flood risks, the situation becomes more complicated. One interviewee said to involve engineering firms such as Royal Haskoning or Sweco in the early project phase to analyse the technical feasibility. These processes require more time and coordination and are often described as 'difficult'. However, some parties consciously choose to develop these types of areas as well, as long as the risks can be made manageable.

In existing construction or redevelopment, foundations are mentioned as a point of attention. In locations such as Amsterdam, pile rot is anticipated based on historical knowledge, which can lead to modified constructions. At the same time, some developers indicate that they sometimes consciously avoid technical measures for climate adaptation – such as heavy constructions for roof water storage – because they lead to higher CO_2 emissions. This is precisely an aspect that banks, possibly under pressure from the EU Taxonomy, are already actively managing. This creates a tension: measures that reduce physical risks can conflict with the requirements for emission reduction that financiers seem to consider more important.

Although many solutions are technical in nature, several developers emphasise that cooperation with the municipality is crucial. Management burden, regulations, and willingness to tailor-made solutions often appear to be more decisive than technical feasibility. Climate-adaptive measures sometimes fail if the municipality does not want to bear the responsibility for maintenance.

In short, climate risks are almost never completely ignored but are primarily approached as solvable within the project framework. The approach is therefore pragmatic, technical and highly context dependent.

3. Regulatory and market pressure

The direct influence of regulations such as the SFDR (Sustainable Finance Disclosure Regulation), CSRD (Corporate Sustainability Reporting Directive) and the EU Taxonomy on the handling of physical climate risks is currently still limited, but a shift is clearly noticeable. Developers feel that the sustainability pressure from investors, banks and parent companies is slowly increasing. Several respondents indicated that they are "preparing" for what is to come, even though they are not yet formally obliged to do so. A few specifically mention they know that their customers are subject to the SFDR, and they adapt their plans on that. One of these developers is already working with an internal ESG barometer that is filled in per project, including certification criteria. Other developers see this emerging regulation as an opportunity to adapt their existing tools to future EU regulations.

What also emerged from the interviews is that the influence of banks and investors is not yet explicitly linked to physical climate risks when providing financing or green loans. Although several developers do experience pressure to become more sustainable, this pressure is usually focused on energy performance or CO_2 reduction – not on physical risks. Most developers mentioned examples in which climate adaptation is deprioritised in favour of mitigation, as buyers ultimately decide against adaptation measures when they negatively affect mitigation-related sustainability labels.

Another confirmed that even in so-called 'green financing', hardly any questions are asked about flood risks, foundations or other climate effects. At the same time, there is an awareness that this will change, especially due to insurability.

"A bank has never said: what are the climate risks here?" (CD-2; ID-2)

At the moment, the pressure from financial institutions is therefore still mainly focused on mitigation sustainability, while specific attention for physical risks is lagging behind. However, the expectation is that this will shift in the short term, under the influence of the CSRD, EU Taxonomy and changing requirements from investors and insurers.

Although not every developer is equally deeply involved in this matter, the general picture is that the sector is aware of the direction in which the regulations are moving – and that financial parties will probably exert the first concrete pressure in this. The CSRD and EU Taxonomy therefore currently function more as signallers than as hard steering mechanisms.

4. View on disclosure measure: climate risk label

Views on a possible climate risk label vary among the developers interviewed. While some see it as a valuable tool to create transparency, others are more reserved or sceptical – depending on how such a label would be introduced and by whom it is carried. Several developers indicate that a label can help in the discussion with municipalities, investors or financiers, especially when it provides insight into the climate resilience of a project in a neutral and reliable way. It is then seen as a kind of 'language' that helps parties to coordinate expectations with each other.

"It would not just be us saying "we have done this", but also a neutral label that removes the noise." (CD-4)

At the same time, clear attention points are being raised. Several respondents warn that it is difficult to fairly weigh different types of climate risks within one label, especially because the risk of heat stress or flooding have different ways of impacting the real estate. For all risks they state the importance of including factors like location, scale, project type and future adaptation options.

The acceptance and application of the label also plays a role. According to several respondents, a label that is only used "for form's sake", or that is non-binding, will have little impact. According to them, the legitimacy must come from serious parties that do something with the label, such as investors, financiers or insurers.

Finally, the conversations with investors show that unfamiliarity also plays a role. The concept of a 'climate risk label' is not known to everyone, but it does raise interest as soon as it is explained. These reactions underline that the sector is still searching for workable and credible methods to make climate risks transparent, and that the success of a label depends on the method of implementation and its institutional anchoring.

5. Behavioural barriers and decision logic

Across nearly all interviews, developers reflected on the broader system in which they operate. While awareness of climate risks is growing, many feel that the current governance framework – the way responsibilities and incentives are distributed – does not sufficiently encourage integration of physical climate risks in real estate development.

Developers recognise their own opportunistic nature but also point to dependencies that limit structural change. Municipalities and water boards are seen as key actors: sometimes as facilitators, sometimes as barriers to integrated climate adaptation. In some cases, municipalities cite high maintenance and management costs as a reason to increase financial contributions required from developers – an approach that is clearly not encouraging. However, in other locations, municipalities specifically request certain adaptation measures, effectively compelling developers to incorporate them into their projects. Water boards are increasingly vocal and assertive, actively intervening in

planning decisions. This is positively experienced mostly, as they bring necessary knowledge to the table.

Governmental bodies are described as both partners and obstacles. On the one hand, their spatial planning authority enables them to steer climate adaptation. On the other hand, political dynamics, administrative burdens, and the absence of a long-term national vision limit their capacity to adopt a consistent position. This tension was observed across various levels of government, from national to municipal.

"Ultimately, we simply need clarity from the government. Where are we going to build homes?" (CD-3)

In sum, the system is perceived as fragmented, and developers often feel that they are responding to rather than shaping structural dynamics.

Beyond governance, many developers point to financial mechanisms as the main bottleneck for integrating climate risks in development decisions. While most express a willingness to act, they stress that adaptive measures only become feasible when there is financial space – or external pressure.

Climate adaptation measures are sometimes included when it offers a competitive advantage in tenders or enhances marketability; in such cases, developers are happy to implement additional measures. Others link adaptation more directly to the risk–return logic of development – meaning that when the potential gains are high, developers are more willing to invest in extra climate risk mitigation efforts.

"Developers are natural opportunists. They take it with them, but only if they need it to sell." (ID-1)

Yet for many, financial margins remain tight. Even with intrinsic motivation, climate adaptation often falls away when it competes with other priorities like energy performance, CO_2 reduction, or affordability. These insights show that developers are not unwilling but face clear limitations in the current economic logic. This underscores the importance of including financial actors and incentives in the discussion – a topic that is explored further in the validation interviews with banks and investors.

4.4 Cross-analysis developers

To further explore the data retrieved, all data from layer 1 to layer 4 is cross analysed with layer 0: organisational context and finance structure. This led to the following findings:

Scale of the company influences systematic approach

Large national developers reported using more structured tools, such as climate scans and quick scans, during the initiative and feasibility phase. These developers also have dedicated employees focusing on sustainability, and increasingly, on climate adaptation. In more complex cases, external experts are involved to evaluate physical climate risks.

In contrast, smaller or regional developers primarily rely on intuition and local knowledge, meaning that climate risks are not formally integrated into their processes.

Overall, larger developers tend to use more structured and formal risk assessment tools than smaller developers. These larger companies often have employees specialised in sustainability. However, there also appears to be a correlation between the scale of the company and the scale of the projects they develop, which leads to the next characteristic.

Scale of the development projects determines climate risk integrations

Companies involved in large-scale area developments reported that climate adaptation is integrated into decision-making during the initiative and feasibility phase of new projects. The larger scale and availability of open spaces facilitate the incorporation of measures such as water retention and green infrastructure. In addition, the scale offers opportunities to account for soil conditions and to strategically position specific functions and buildings across the area.

In smaller-scale inner-city developments, climate risks generally do not influence decision-making during the initiative and feasibility phase. These projects often involve only a single plot. When municipalities require specific climate adaptation measures, they are implemented; however, building-level adaptation is perceived as more challenging and often seen as conflicting with mitigation strategies. Overall, the scale of the development largely determines the extent to which climate adaptation measures are integrated into the project.

Ownership of companies

The developers with a listed parent company had integrated more climate adaptation strategies into their processes. They indicated that striving for EU Taxonomy alignment serves as an internal incentive, or "stick behind the door." Greater pressure from the shareholders of the parent company, and regulatory frameworks such as the SFDR, appear to drive these developers to use formal processes, including internal climate scans. One interviewee also expressed the ambition to further adapt its internal climate scan to meet future CSRD reporting requirements, in order to prepare for the future.

Developers with corporate ownership but without stock listing experience greater flexibility in their approach to climate risks, as they are less dependent on external financing. This reduces their exposure to capital market actors and their SFDR-driven strategies. As a result, these developers tend to address climate risks on their own terms and do not necessarily aim for full alignment with the EU Taxonomy.

Independent developers act more opportunistically and pragmatically. With limited external accountability, they prioritise fast, market-driven decisions. If required for project sales, these developers are willing to adapt their projects to meet sustainability ambitions, often referencing SFDR criteria when relevant to investors.

Thus, a clear link emerges between the ownership structure – internal or external – and the degree to which developers formally integrate climate risk management and regulatory alignment. Listed developers embed climate risks more strongly and formally into their processes than private developers. Notably, for all, climate adaptation plays a much smaller role in practice than climate mitigation.

Financing structure of projects

While strongly connected to company ownership, the financing structure of projects also influences investment decision-making. A distinction can be made between developers who finance projects using external equity – such as (institutional) investors – and those who rely primarily on internal equity. Most developers also use bank loans to finance parts of the development, although one developer mentioned doing this only occasionally.

Developers collaborating with institutional investors are expected to meet certain SFDR requirements, depending on the investor's level of ambition. While the SFDR includes components related to physical climate risks and their mitigation, developers reported that most communication and guidance from investors focuses on climate mitigation (e.g. energy and carbon neutrality), rather than adaptation. As a result, climate adaptation ambitions are rarely passed on to the developer. This is a point for further exploration in the interviews with investors.

All developers mentioned seeking additional financing from banks. These institutions are also subject to the SFDR, which – depending on their interpretation – could lead them to demand climate adaptation measures in financed projects. However, developers did not report any such requirements to date. This observation will be explored further in the interview with a large Dutch bank.

While current financial pressure to address physical climate risks appears limited, follow-up interviews with investors and banks will help clarify whether this reflects a conscious strategy, and whether this may shift in the near future.

4.5 Synthesis of developer Insights

To conclude this part of the research, the findings are synthesised in a flowchart that illustrates key decision points and barriers in the integration of climate risks into developers' decision-making processes. The light blue elements represent moments where external actors exert influence, prompting developers to form a decision considering climate risks. In contrast, the darker blue elements indicate internal decision points formed by the knowledge of the developers themselves.

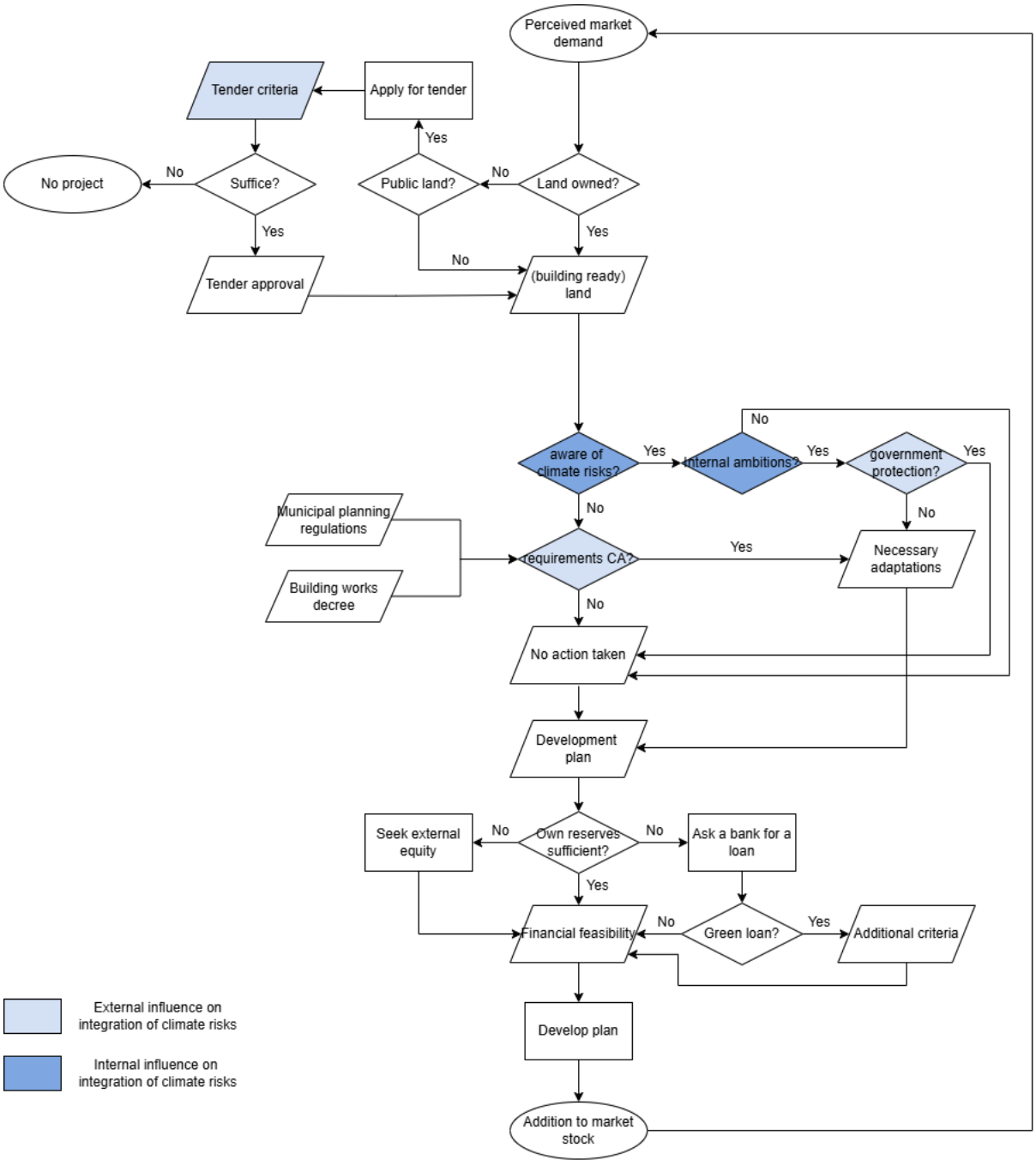

Figure 15 Developer decision flow on climate risk integration (own work, 2025)

4.6 Financial actors: investors and banks

Due to the significance of financial actors and the decisions made by developers in real estate development, contextual interviews are held with both institutional investors and banks. As their influence can indirectly steer developers' decisions.

4.6.1 Investors

Two investors have been interviewed. Investor 1 acquires a mixed-use portfolio, while Investor 2 focuses on office real estate.

Investor 1 mentioned that they are increasingly integrating climate risks into their investment decisions. Operating as a fund manager for pension funds and large insurers, they primarily purchase newly built real estate through forward funding agreements. Although they do not develop projects themselves, they require developers to meet strict sustainability and climate-related standards. Investor 2 mentioned something similar. While they also invest in existing real estate, each project in the portfolio has to meet strict standards.

Climate risk assessment

When considering a potential acquisition, both Investors 1 and 2 evaluate a range of factors beyond climate risks, including concentration risk within their existing portfolio (the risk of being too focused on one type of asset, location, or sector), local demographic and economic trends, accessibility, and overall location quality. Climate risks – such as exposure to flooding, heat stress, or soil subsidence – are assessed as part of this broader evaluation. While these environmental risks are becoming increasingly important, they are considered alongside financial and market criteria, which often remain decisive.

"We are required to assess how a given project scores on physical climate risks before we even enter into any binding commitments." – (I-2)

For each acquisition, both investors conduct a detailed climate scan at the address level, assessing risks such as heat stress, flooding, and soil subsidence. If risks are present, they evaluate whether adequate mitigation measures have been implemented by the developer. However, these assessments are generally carried out after the project is offered to them, rather than requiring upfront adaptations. Investor 1 emphasised that, due to the rigorous spatial planning regulations in the Netherlands, most significant physical climate risks are already accounted for. Their internal climate scan therefore acts as an additional safeguard. Investor 2 partially agrees, and adds that in terms of physical climate risks, sometimes additional measures are needed after acquiring the asset.

"We perform the climate scan ourselves. Developers usually have to address climate risks due to zoning or permitting, but we verify if the measures are sufficient." – (I-1)

Responsibility and scope of climate risks

Investor 1 also distinguished between the types of physical climate risks that are considered their responsibility and those that fall under the responsibility of public authorities. Investor 1 and 2 emphasised that they focus primarily on risks that directly affect the liveability and attractiveness of their real estate, such as local water nuisance issues, heat stress, and soil subsidence. These factors are seen as important for tenant satisfaction and long-term value retention. Both investors stressed the importance of heat stress mitigation, particularly looking at dwellings with vulnerable residents such as the elderly.

However, larger-scale risks, such as river flooding or dike breaches, are viewed as the responsibility of national authorities and water boards. Both Investor 1 and 2 stated that it is not realistic for private investors to individually address such systemic risks, and that a well-functioning public protection system is assumed. Therefore, their internal climate risk assessments mainly concentrate on the project-specific and local impacts, rather than national or regional infrastructure resilience.

"We have dike monitoring, we have polder pumping stations, and many measures we take nationally and with the water boards to keep the country dry." – (I-1)

Market expectations

Investor 1's requirements are driven by their investors' demands for ESG (Environmental, Social, and Governance) alignment, with specific reference to the EU Taxonomy and the Sustainable Finance Disclosure Regulation (SFDR). They note that they are strongly guided by these investor expectations, stating that standard building code requirements are no longer sufficient, and that additional sustainability labels are considered the norm.

Investor 2 adds that Dutch institutional investors tend to focus more on sustainability criteria, whereas international investors are more concerned with the project's location within the Netherlands and the specific physical climate risks involved. Flooding is frequently cited as a concern, but, according to Investor 2, it is relatively easy to explain as a mitigated risk due to government protection.

Mitigation versus adaptation

Investors demands create indirect pressure on developers to meet certain standards if they wish to sell projects to institutional investors. Nevertheless, the focus remains predominantly on climate mitigation measures (such as achieving energy performance labels), while climate adaptation receives far less emphasis. Climate mitigation is explicitly linked to labelling requirements that are well known to developers, whereas climate adaptation lacks such clear guidance. Investor 2 noted that this may also apply to climate adaptation in the future, as developers are increasingly aware of the requirements to make buildings suitable for institutional sale.

Climate risk label

When discussing the possibility of climate risk labels, Investor 1 was a bit hesitant. They emphasised that raising awareness about physical climate risks is important but questioned the effectiveness of simply assigning a risk label to existing areas. Investor 1 noted that, while some areas may appear "red" due to physical risks like heat stress or flood risk, good spatial planning, zoning, and public protection measures already mitigate many of these risks. The interviewee further pointed out that, unlike energy labels which directly stimulate sustainable construction, climate risk labels often highlight risks that developers and investors cannot easily influence. Therefore, while Investor 1 supports raising awareness, they remain cautious about the practical value of risk labels in their investment decisions. Investor 2 noted that climate risk labels would not affect their portfolio decisions, as all assets are already required to meet these standards. They note that in their portfolio, it is a minimum requirement.

4.6.2 Banks

Bank 1 is gradually beginning to integrate climate risks into their risk assessments, although this process is still in transition. They mention that compared to climate mitigation, climate adaptation is often more neglected. However, they mentioned, banks themselves are increasingly recognising these risks and taking action. As a bank is primarily focused on mitigating risks as much as possible. Primarily climate risks that have a direct financial impact on assets – such as flooding and soil subsidence – are gaining increasing attention.

"Because heat stress actually has relatively little impact on property value." – (B-1)

Climate risk assessment

Currently, Bank A conducts climate risk analysis at the portfolio level, primarily assessing exposure to these risks across their overall real estate financing portfolio. However, these assessments are not yet systematically conducted at the individual project level for each loan. The bank has expressed ambitions to move toward more project-specific assessments in the future, particularly with regard to flooding and foundation-related risks.

When looking ahead, Bank 1 noted that the risk of river flooding is expected to improve positively due to future government investments. Over the next 25 years, the risk of river-related flooding is anticipated to decrease. However, soil subsidence and foundation-related risks are becoming increasingly significant concerns. The interviewee emphasised, from a personal perspective, that these risks should ideally be managed at the building level.

Market expectations

According to the interviewee, their current focus lies in having more tailored conversations with individual clients. They observe that developers – particularly the larger ones – tend to show more awareness of physical climate risks than investors in existing real estate. This is likely because new developments are expected to remain in use for at least 50 years or more, which increases the relevance of long-term climate considerations.

For real estate development financing, Bank 1 requires that developments are almost fully permitted ("onherroepelijke vergunning") before significant financing is provided. Developers are therefore responsible for ensuring that their projects comply with local spatial planning requirements, including climate-related considerations. Climate risks are evaluated mainly through location-based analyses, for example by considering flood risk zones, but are not yet part of the standard loan assessment procedure.

Mitigation versus adaptation

Although Bank 1 acknowledges that climate adaptation is becoming increasingly important, their current focus remains primarily on climate mitigation, driven by existing regulatory frameworks such as the BENG requirements (Nearly Energy Neutral Buildings) and CO_2 emissions reporting obligations. Nevertheless, Bank 1 is actively developing internal models and methodologies to better assess physical climate risks at the project level, with particular attention to building-specific or area-specific adaptation measures that already address certain risks.

This shift is largely motivated by evolving European regulatory pressures, particularly the SFDR and the EU Taxonomy, which require financial institutions to disclose and mitigate climate risks more transparently. Bank 1 expects that within the next year; climate adaptation considerations will be more formally embedded into financing conditions. In time, projects that align better with adaptation

requirements may benefit from more favourable financing terms, such as lower interest rates or preferential lending conditions – a dynamic that currently only applies to climate mitigation efforts. This explains why developers have never been asked about climate adaptation when receiving a green loan from a bank.

Climate risk label

When looking at a possible mandatory climate risk label, Bank 1 recognises that climate risk labels are not a complete solution but sees added value in using them to reduce information asymmetry in the market. Addressing the black box of climate services (see 3.2.1 Data).

4.7 Governmental actor: municipality

Lastly, an interview was conducted for the viewing point of a municipality.

Municipal policy and organisation

The department of Land and Development (Grond en Ontwikkeling) is responsible for steering desired spatial developments from a governance perspective, while Space and Sustainability (Ruimte en Duurzaamheid) makes spatial plans, including density allocations and climate adaptation considerations. These departments work together to identify locations suitable for construction, where water management and other physical climate risks are incorporated into planning decisions.

Addressing climate risks

The municipality has policies in place for dealing with the four main physical climate risks: flooding, heat stress, drought, and subsidence. A central instrument is the stormwater ordinance, which mandates that new developments must retain at least a certain amount of rainwater on their own plots. This rule has led to frequent use of green roofs, which also support biodiversity and urban cooling. The interviewee mentions that while past planning focused primarily on water management, other risks like heat stress and drought are increasingly addressed in public space design. Additionally, the overheating risk in new residential buildings is regulated nationally through the TOjuli requirement in the Building Works Decree (Bbl).

Planning instruments and legal frameworks

The municipality has outlines two main development routes:

1. Transformation projects on privately owned land,
2. New construction on municipally issued leasehold land (erfpacht).

In the first case, the municipality cannot impose requirements beyond legal building codes and the environmental plan. In the second, tenders are used to allocate land, allowing the city to set programmatic, spatial, and sustainability-related selection criteria. These tenders typically assign 30% of the selection weight to sustainability, and although some climate-related measures (like water retention) are already legally required, other ambitions must be incentivised through the selection process.

“If a party already owns the land, we can’t impose any requirements beyond what’s legally mandatory—like the Building Works Decree or the stormwater ordinance.” – (M-1)

Public-private collaboration and developer types

In many cases, public space remains under municipal ownership and maintenance. However, some publicly accessible spaces lie on private land, raising questions about responsibility and design standards. If developers want the city to do the maintenance of such areas, they must comply with the municipalities design method to ensure manageability. Ambitious design proposals might be limited due to the city’s capacity to maintain them.

According to the interviewee, developers also have a growing understanding of the importance of future-proofing, especially when it comes to data centres or critical infrastructure.

Future expectations

The interviewee foresees that municipalities and national government will need to strengthen climate-related regulation. Although the Netherlands has long dealt with water risks, these risks are only expected to increase in impact and frequency, thus spatial policies are expected to evolve. They anticipate more prescriptive rules regarding climate adaptation – such as limits on paved surfaces or mandatory retention measures for existing buildings. Yet, such steps may require stronger societal support, possibly triggered by further climate-related disasters.

They also expect that adaptation requirements will increasingly become standardised in law or zoning practices, especially as climate risks intensify and the need for resilience grows. Governmental steering on location choices – such as discouraging development in low-lying polder areas – is likely to increase.

4.8 Key empirical findings

The empirical research shows that the integration of physical climate risks in real estate development is limited, reactive, and largely shaped by external actors. The following key insights emerged:

1. **Adaptation is rarely a starting point.**
   Developers only consider climate risks if required by municipalities (e.g. in tenders) or investors, and mainly later in the process. Risks like heat waves or water nuisance are seen as technically solvable, not as reasons to reject a location.

2. **Mitigation dominates over adaptation.**
   Sustainability efforts focus primarily on energy and CO_2 performance, driven by labelling and regulation. Adaptation often loses priority, even when developers are motivated.

3. **Internal ambition varies.**
   Large or listed developers apply structured tools like climate scans, often to align with future disclosure rules. Smaller developers rely more on intuition and respond flexibly to external demands.

4. **Financial pressure is emerging.**
   Investors and banks are increasingly paying attention to physical risks, but still focus mainly on mitigation. Climate adaptation is not yet systematically included in financing conditions.

5. **Municipal influence depends on planning tools.**
   Adaptation can be enforced through tenders on municipal land, but not on private land. Legal limitations reduce the scope for local governments to steer adaptation.

6. **Decision moments depend on external triggers.**
   The moments when climate risks are considered are mostly shaped by external actors. Developers act when requirements are binding, visible, or financially relevant—less so from intrinsic motivation.

These insights underpin the synthesis in the next chapter, which visualises key decision points and external influences in the integration of climate risks.

PART 5 | SYNTHESIS

5. SYNTHESIS

5.1 Introduction

To understand how climate risk information influences developers' decision-making in real estate development, this research integrates theoretical insights and empirical findings into a unified system overview (Figure 16). The figure visualises the interactions between different markets and actors in relation to climate adaptation (CA), highlighting where external or internal pressures may drive change. In this figure, a minus sign (-) indicates a negative influence on the integration of climate risk considerations, while a plus sign (+) represents a positive influence. As the analysis is situated within the Dutch context, the national government is included in the background as an overarching factor. It synthesises the fragmented dynamics identified in both the interviews and the literature into a cohesive structure, revealing not only points of inertia but also areas where targeted incentives or regulatory pressure could catalyse adaptation. A larger version of Figure 16 is provided in Appendix I.

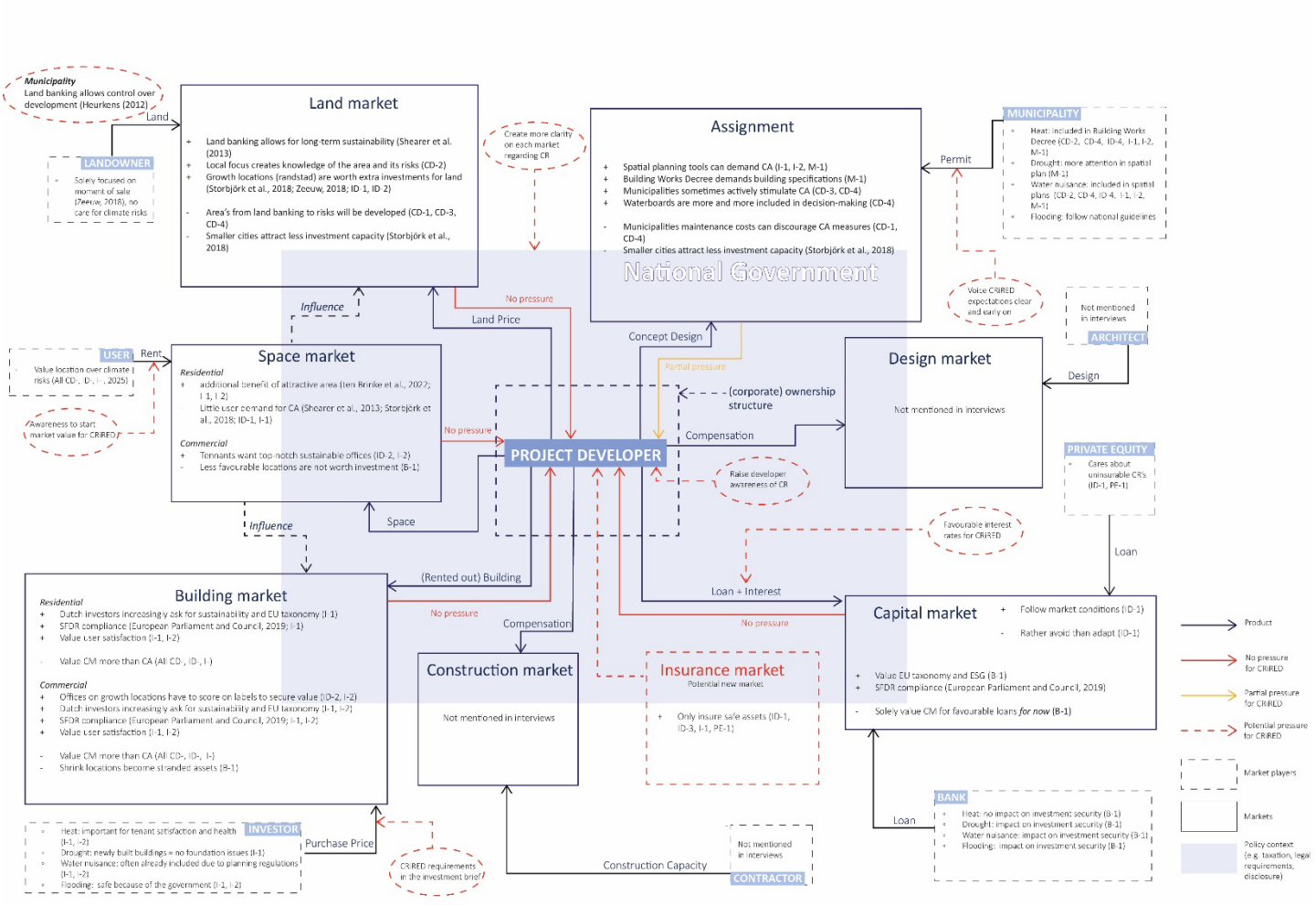

Figure 16 Systemic overview of markets and its actors influencing developers' climate risk integration (own work, 2025)

5.2 Climate adaptation pressure per market

Land market

Climate risks rarely influence site selection. Most developers do not structurally avoid risk-prone areas, unless prompted by public restrictions. Locations already acquired are still to be developed, if necessary, with technical measures. Particularly in inner-city developments, the high market value of available land is valued a more dominant factor. One developer mentioned screening out flood-prone areas in advance (ID-1), but overall, growth regions such as the Randstad or Brabantse Stedenrij are perceived as inherently safe – in part due to governmental flood-protection plans (ID-2; ID-3; ID-4;I-A; I-B). One developer expressed the importance of governmental bodies clearly stating where development is encouraged or restricted (CD-3).

A key opportunity is to attach climate adaptation requirements to public land sales, using ownership as leverage for climate-resilient development.

Capital market

Banks currently show limited concern for climate adaptation when financing real estate development (CD-2; ID-2). The interview with B-1 revealed that, while climate risks are not actively communicated to developers, internal risk assessments are conducted – particularly for risks that may affect asset value. These include flooding and foundation issues. In contrast, risks related to liveability, such as heat stress, are not considered financially material from a lender's perspective. B-1 indicated that in the near future, climate adaptation measures may be incentivised through favourable financing conditions on loans, which is now only the case for climate mitigation. Next to banks, private equity firms are also active in financing real estate development projects. As indicated by PE-1 and ID-3, insurability is becoming an increasingly critical factor. Projects may only receive funding if they can be adequately insured, introducing the insurance market as a new and influential player that developers must consider when making development decisions.

A promising opportunity lies in linking climate adaptation measures in development projects to favourable financing conditions.

Building market

The influence of the EU Taxonomy and CSRD is increasing within the investment sector. Institutional investors conduct internal climate risk assessments to ensure that newly acquired assets meet their long-term risk and compliance criteria (I-1; I-2). Both investors indicated that they experience pressure from their own stakeholders to comply with sustainability labels and the EU Taxonomy. Governmental flood protection is largely trusted, and as a result, flood-prone areas are generally not seen as a reason to reject an investment. Other risks – such as heat waves, water nuisance, and foundation problems – are often already mitigated through municipal requirements or technical construction standards (I-1; I-2). As a result, newly built assets typically meet investors' expectations for physical climate resilience. If not, the asset is unlikely to be acquired.

A key opportunity lies in communicating climate adaptation expectations earlier in the development process, to avoid late-stage mismatches between investor requirements and project design.

Assignment market

Tender documents and land sale agreements are often key instruments through which municipalities can influence project content, including climate adaptation. The empirical data shows significant variation between municipalities: while some have imposed requirements for measures such as water retention or public greenery in certain projects, there have also been cases where municipalities discouraged CA proposals put forward by developers (CD-1; CD-4).

The interview with Land and Development of a municipality further explained that municipal influence is generally limited. Although the municipality formally has instruments at its disposal – such as the integration of water retention requirement into the environmental plan – the interviewed official explained the limited scope for imposing additional demands on private developments beyond what is already codified in legal requirements.

According to the interviewee, climate adaptation can only be encouraged as part of the selection criteria in public tenders. Developers confirm that in tenders where CA is clearly demanded, they do adapt their strategies accordingly (CD-1; CD-3; CD-4).

A clear leverage point is the inclusion of standardised climate adaptation criteria in public tenders, and land sale contracts, ensuring that adaptation is addressed early in the development process.

Design and construction market.

Architects and contractors operate on a request basis, and none of the interviews identified these actors as independent drivers or barriers of climate adaptation. As noted by Shearer et al. (2013), adaptation measures are only likely to succeed when integrated from the concept phase onward – highlighting the role of the developer in initiating such requirements early in the process.

Space market (users)

The role of end users is frequently mentioned in interviews. Developers and investors indicate that users rarely inquire about climate adaptation measures, focusing instead on location and general comfort (ID-1, ID-2, ID-3, ID-4, I-1, I-2). In high-demand areas, adaptation is often overlooked, as buyers are primarily concerned with availability. However, increasing awareness of the impact of climate hazards on liveability may gradually shift user expectations.

A potential leverage point lies in enhancing public awareness, supported by insurance incentives and future regulatory requirements, to increase user-driven demand for climate-resilient development.

5.3 System-level conclusions

The current system exhibits multiple feedback gaps in integrating climate risk. While climate risk information is often available (e.g., in climate risk assessments, public climate data, and the EU taxonomy), it rarely translates into market demand, financial incentives, or public conditions that reach developers early enough in the process.

The initiative and feasibility phases are particularly crucial. These stages are characterised by time pressure, uncertainty, and fragmented responsibility. However, these phases are also the most promising for incorporating climate risks into development decisions. Each subsequent phase, starting with the commitment phase, will involve more stakeholders, thereby reducing the developer's autonomy over decisions. Currently, developers rarely act on adaptation independently; instead, they typically respond when pressed by investors, regulations, or specific assignments.

The most promising leverage points for integrating climate adaptation into real estate development are:

1. The Space Market: In the space market, evolving user expectations and compelling insurance incentives are crucial drivers. These factors can progressively establish climate adaptation as a commercial necessity, making resilient properties more desirable and insurable.
2. The Land Market: Within the land market, public landowners, such as municipalities, are pivotal. They can impose adaptation requirements when issuing land through sale or leasehold, thereby progressively embedding climate adaptation as a standard condition for development.
3. The Assignment Market: On the assignment market, national and regional governments are key influencers. They should clearly and early communicate their expectations on climate risk integration in the development process, using tools like spatial planning and regulations such as the Building Works Decree. This ensures climate considerations are front and centre from the outset.
4. The Capital Market: Within the capital market, financial institutions are crucial enablers. They can encourage adaptation by offering more favourable financing conditions for climate-resilient projects, thereby progressively establishing climate adaptation as an investment norm.
5. The Building Market: In the building market, investors play a significant role. They have the opportunity to embed climate risk requirements in investment briefs or express their expectations directly during project initiation, helping to make climate adaptation a core part of project planning and execution.

To ensure that climate adaptation becomes a standard part of investment decision-making – rather than a reactive, last-minute consideration – it must be embedded early in the investment logic and across all relevant markets in the built environment.

However, leveraging these markets effectively requires more than generic policy tools – it demands a clear understanding of how different actors perceive climate risks and what power they have to act. The next section explores this fragmentation in more detail by examining the diverging priorities and capacities among key stakeholders.

5.4 Divergent priorities and capacities of key actors

To better understand climate risk integration in real estate development, it is crucial to examine not only the developer's position, but also how other key actors perceive and can influence climate risks. While climate adaptation is increasingly recognised as necessary, different stakeholders assign varying levels of importance to specific risks and have different capacities to act upon them.

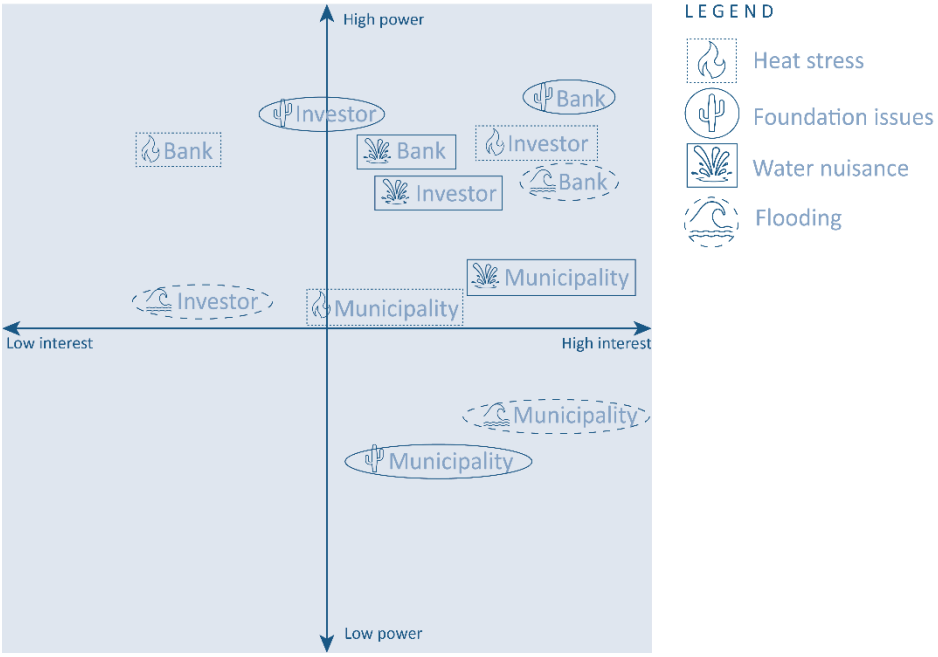

Figure 17 Power interest matrix of stakeholders

Figure 17 illustrates this divergence by mapping stakeholders across a power–interest matrix for four types of physical climate risks: heat stress, foundation issues, water nuisance, and flooding. Each stakeholder–risk combination is positioned based on their relative influence over adaptation decisions (power) and their concern or involvement with the risk (interest). This power can manifest either as financial leverage – for example through funding conditions set by banks and investors – or as regulatory demands imposed by public bodies. The mapping is based on the qualitative data gathered through the interviews and desk research.

The figure reveals several patterns:

- **Municipalities** often show high interest across all risks due to their public responsibilities, but their influence is uneven. They tend to have moderate influence on water nuisance and flooding via urban planning, but little control over foundation issues and heat stress within private developments.

- **Banks** exhibit high financial power in many cases, particularly in relation to foundation issues and flooding, as these risks directly affect property value and financial exposure. If desired, they could incentivise adaptation through favourable financing conditions for the risks they prioritise. However, the findings indicate that banks currently show limited interest in risks such as heat stress, as these are not yet reflected in asset valuation frameworks. Given their long-term involvement in projects, banks might focus more on chronic risks that are expected to worsen over time.

- **Institutional investors** vary in their positioning depending on their long-term involvement. Some express increasing concern about heat stress and water nuisance, particularly due to ESG commitments and the importance of tenant satisfaction. Flooding, by contrast, is often regarded as a government responsibility. It is also worth noting that investors tend to be more flexible than other stakeholders, as they can choose to divest from assets that are deemed unfavourable in terms of risk. Chronic risks can therefore be undervalued compared to acute risks.

Climate risk integration is not only a technical or financial challenge, but also a matter of governance alignment. The power–interest matrix reveals that stakeholders differ significantly in both their prioritisation of, and their capacity to act on, specific climate risks. These misalignments can delay or dilute adaptation efforts – particularly when no single actor holds both the motivation and the leverage to initiate change on all risks.

By visualising where interest and influence lie, the matrix helps clarify which actors are best positioned to take the lead on which risks – whether to unlock financing, secure public support, or coordinate project-level adaptation. Yet while many stakeholders influence individual aspects of development, it is ultimately the developer who must navigate this fragmented landscape and translate external expectations into concrete project decisions.

The following section therefore shifts perspective to the developer's trajectory, highlighting the critical phases in which climate adaptation can be integrated early – not only to align with future demands, but also to avoid costly retrofits or design revisions later in the process. Proactive integration enables developers to embed resilience from the outset, rather than responding reactively once decisions have already been made.

5.5 Developer's trajectory

The visualisation below synthesises the process a real estate developer follows from the initiative phase to a feasible, climate-resilient concept. While the broader market structure includes several distinct sectors – land, capital, construction, assignment, and use – Figure 18 adopts the developer's perspective to clarify when and how external actors influence decision-making. It highlights the gradual loss of autonomy as more stakeholders become involved, expectations take shape, and – most importantly – the motivations of each stakeholder regarding climate adaptation become more defined.

For this visualisation, a combination of demand driven and investment driven strategy is assumed (see Table 8 Development strategies (Gehner & Peek, 2008)), as interviews revealed that most projects were housing projects. These projects are often sold directly to future home-owners, or to institutional investors with large real estate portfolios. Although these investors typically acquire projects on a turn-key basis – when all major design and development decisions have already been made – there is currently little alignment on how climate risks should be addressed. Developers are often unaware of the specific expectations investors may have in this regard. This visualisation therefore suggests earlier contact between developers and investors, for example around the concept phase, to ensure that climate risks are being addressed in ways that align with investors' long-term requirements.

In the earliest stages of development, developers enjoy a relatively high degree of autonomy. This period offers the greatest flexibility to incorporate climate adaptation into location choices, initial spatial planning, and risk assessments, as nothing about the project is fixed yet. However, as the synthesis shows, climate risks rarely influence these early decisions – unless pre-existing public restrictions or tender conditions explicitly require it.

As the process progresses, the developer must engage with municipalities, neighbouring landowners, consultants, and increasingly also with financial and investment partners. Each of these actors brings their own perspective on climate risks – often focused on their specific mandates or interests (e.g. financial risk, spatial quality, ESG compliance, or user comfort). The developer's room to manoeuvre narrows as these expectations converge, and initial design decisions must align with external requirements in order to secure approval, financing, or market uptake.

In current practice, banks are usually only approached once the development concept is largely fixed. However, early-stage dialogue – also suggested by De Nederlandsche Bank (DNB) (2023b) – could help developers align their plans with emerging climate risk requirements from financial institutions. As climate risk is expected to become a more explicit part of financing criteria, integrating this feedback earlier on could strengthen the financial feasibility and resilience of the project. The interview with a bank confirmed their interest in engaging with clients earlier in the development process to discuss climate-related risks. While banks may not formally commit funding at this stage, developers could benefit from sharing early concepts to receive feedback on alignment with evolving financing criteria – especially as climate adaptation becomes a more explicit component of financial risk assessment.

The figure also identifies key leverage points where developers can actively shape the integration of climate adaptation before external pressure dictates the outcome. These include moments of land acquisition, early dialogue with municipalities, coordination with future investors, and the strategic use of pre-sales and marketing to ensure that adaptation measures are understood and valued. Developers who anticipate these moments – and tailor their stakeholder engagement to the relevant climate risks – can maintain greater control over their concept and reduce the risk of costly late-stage revisions. Ultimately, the developer's role is both exposed and pivotal. While many external

stakeholders bring their own fragmented and sometimes inconsistent expectations, it is often the developer who responds reactively – adjusting strategies only when adaptation becomes a condition for financing, permits, or sales. Yet developers also hold the key to earlier integration: by embedding climate resilience into the initial vision, initiating alignment with future investors and authorities, and using early sales strategies to communicate added value, they can shape more resilient outcomes. This figure does not prescribe a linear process, but offers a strategic lens to identify where climate adaptation can shift from external pressure to proactive value creation. Figure 18 will be included in Appendix II in a larger format.

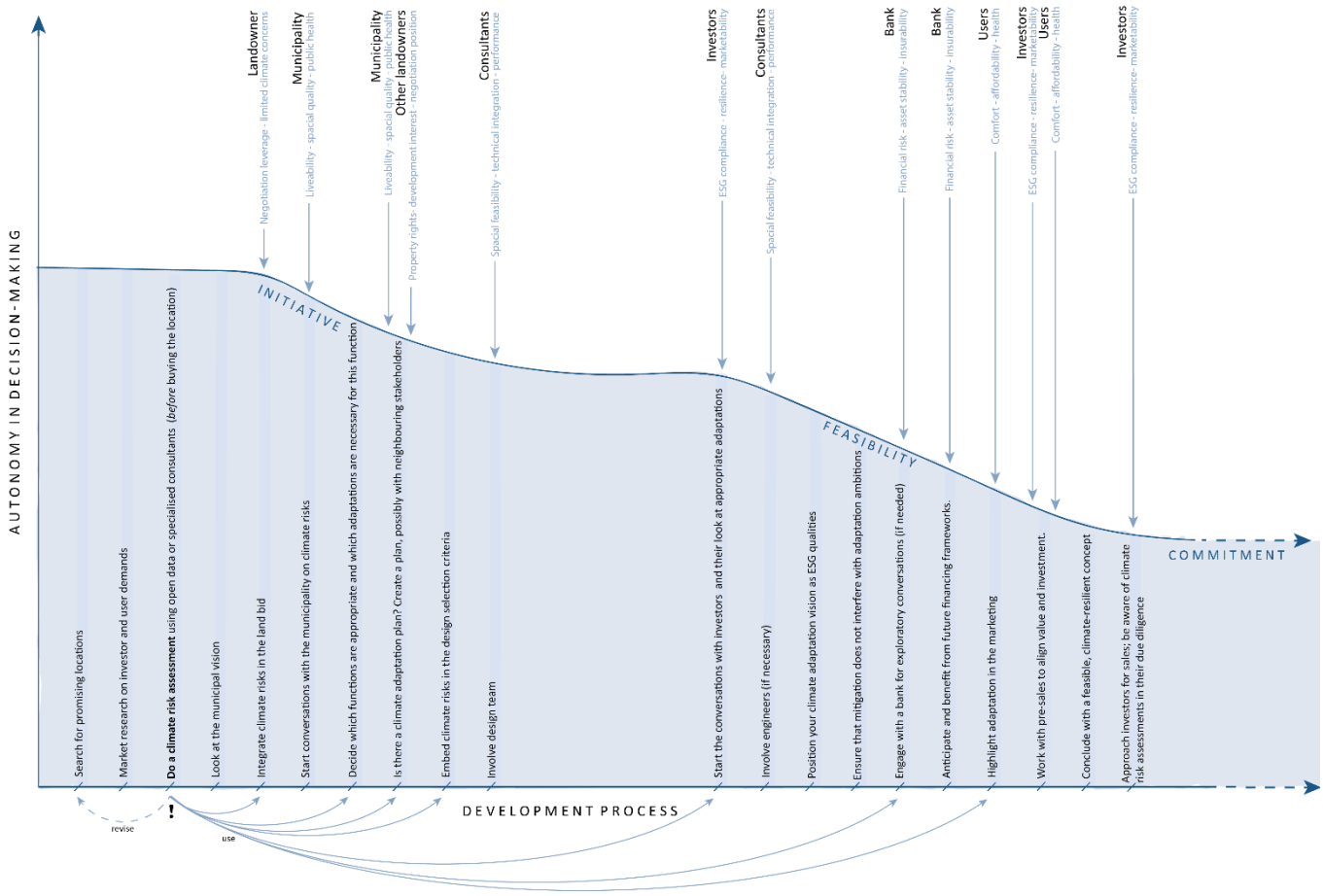

Figure 18 Action plan on integrating climate risks in real estate development - developers perspective (Own work, 2025)

PART 6 | DISCUSSION AND CONCLUSION

6. DISCUSSION AND CONCLUSION

6.1 Discussion

This section opens the discussion on the research findings. The findings of this research show several important alignments with the existing literature. At the same time, the research also reveals new insights and contradictions that nuance, or challenge previously held assumptions.

Used desk research

The desk research focused on two central themes: physical climate risks and real estate development. While academic interest in the impact of climate change on the real estate sector is growing, the majority of existing literature focuses on countries outside the Netherlands. On the policy side, a substantial body of information exists, particularly as the Dutch government seeks to balance the urgent need for housing expansion with increasing climate-related challenges.

Regarding real estate development specifically, a broad range of literature was available. However, some of the most detailed sources were more than a decade old. Given the highly dynamic nature of the real estate sector – especially in light of today's drastically different financial landscape compared to, for example, 2012 – this data might be a little outdated for current investment logic. As noted in the desk research, macroeconomic conditions significantly influence development behaviour.

Effect of the interview design

A key methodological decision—to present developers with visual maps of various climate risks—generated a wide range of reactions. Responses ranged from developers being largely unaware of such risks to those who had already established internal climate risk assessments. Interestingly enough, many developers appeared initially unaware of the extent to which climate adaptation had been embedded in their projects through external requirements, particularly from governmental bodies and legal obligations. In several cases, this led to a shift in narrative: developers who first claimed that climate risks were not considered began to recognise that adaptation measures (e.g. water storage) were in fact being implemented – albeit as a result of municipal demands rather than internal development decisions.

The systemic overview of real estate development, created as the synthesis, distinguishes between individual sub-markets within the broader real estate system. This serves to visualise where and how developers' decisions are influenced by other actors—and where such influence appears limited or absent. The scheme helps contextualise the various stakeholder perspectives within the larger development process. The overview is based on qualitative input from the twelve interviews conducted by the researcher. As such, it represents a personal interpretation of the data and is not statistically validated. Nonetheless, it offers a useful representation of generalised dynamics and interdependencies observed by the interviewees and provides a structured basis for further analysis and reflection.

Awareness and perception of climate risks

The literature confirms that awareness of physical climate risks is increasing among public and private stakeholders, driven in part by scientific data (van Gaalen, 2024), national tools like the Klimaateffectatlas, and EU regulatory pressure through the Taxonomy and CSRD (European Commission, 2020). The empirical findings partially reflect this trend: most interviewed developers were aware of climate risks, and those with internal ESG strategies had developed internal tools or consulted external consultants.

Unexpectedly, several developers expressed internal ambitions to integrate climate adaptation into their projects – an aspect that had not prominently surfaced in the desk research. Additionally, the influence of location proved to be a far more important factor than anticipated.

However, similar to what Shearer et al. (2013) found in the Australian context and Storbjörk et al. (2018) in the Swedish context, awareness does not always translate into action. Several Dutch developers acknowledged the relevance of climate risks but admitted they were not systematically integrated into project decision-making unless externally required. This supports Ten Brinke et al. (2022)'s conclusion that adaptation is often not mainstreamed due to a lack of direct incentives.

Role of developer characteristics and business models

Both the literature (Shearer et al., 2013; Peek & Gehner, 2018) and the interviews emphasise the importance of organisational characteristics in determining adaptive behaviour. Developers with a long-term investment horizon were more likely to assess climate risks proactively. Similarly, large developers with internal ESG departments or long-term project timelines integrated climate considerations more consistently than smaller, profit-driven developers. This confirms the theory from Shearer et al. (2013), which suggests that size, financial capacity, and business model significantly shape climate adaptation potential.

Regulatory signals and investor expectations

A notable addition to the literature arises from the specific regulatory context of the Netherlands, as part of the European Union. Under the Sustainable Finance Disclosure Regulation (SFDR), financial institutions are required to report on the sustainability of their investments – including the degree to which climate risks are mitigated. This regulatory pressure introduces a marketing and reputational dimension to adaptation: in order for developers to successfully sell their projects to investors, they must align with investor expectations.

The findings indicate clear distinctions between investor types. Private equity investors focus primarily on insurability as a threshold condition for investment, showing little interest in broader climate risk integration. Institutional investors, by contrast, face increasing pressure from their own stakeholders – such as pension funds – to address both sustainability goals and, particularly in international contexts, flood risks. A possible influence might be that different timelines are also included in the different type of investors, however, because the interview with the private equity investor was not held personally, this is merely a speculation. Both interviewed institutional investors confirmed that they assess physical climate risks before acquiring new projects. Interestingly, however, these assessments occur after project completion. This introduces a degree of inefficiency: logically, one might expect these considerations to be integrated earlier in the development process.

Nonetheless, the system appears resistant to change, and the current approach seems to be waiting for developers to catch up. One investor observed that developers are increasingly tailoring their projects to meet the expectations of institutional investors. This is particularly evident in the area of climate mitigation, where developers often align their strategies with established standards and

certifications. However, comparable benchmarks for climate adaptation are lacking. As a result, it becomes more difficult to communicate expectations to developers – and even more so to translate them into actionable solutions. This raises the question of whether climate adaptation will ever become structurally embedded in real estate development decisions, given that developers typically respond to clear, quantifiable guidelines rather than probabilistic risk data.

Blurred definitions and unrecognised adaptation

Another unexpected insight was the inconsistency in how developers define and recognise climate risks. When asked directly whether such risks influenced their decision-making, most developers initially responded negatively. However, as the interviews progressed and the climate risk maps were introduced, it often became clear that adaptation measures were, in fact, being implemented – though not as a result of deliberate internal strategy. Instead, these measures were typically imposed externally, through municipal requirements, the Building Decree, or spatial planning conditions.

This finding highlights a structural gap between project-level adaptation and strategic climate risk awareness. Developers may be fulfilling adaptation objectives without actively identifying or internalising them as such. Interestingly, this passive form of adaptation is currently perceived positively by institutional investors. Both interviewed investors noted that developers often already meet their expectations for climate adaptation – not due to direct coordination, but because of the regulatory conditions set by (local) authorities.

Diverging climate risk priorities among stakeholders

The interviews revealed clear differences in how stakeholders prioritise physical climate risks, shaped by their roles, responsibilities, and planning horizons. These differences help explain why adaptation is inconsistently addressed across the real estate development process.

- **Municipalities** focus on liveability and spatial quality. Their main concerns were historically localised flooding, although current attention towards heat and drought are also leading to requirements for green infrastructure, water storage, and shading in development plans. These measures are often seen by developers as design conditions rather than climate adaptation.
- **Banks** approach climate risks from a financial liability perspective. Their priorities include flooding and soil subsidence, as these directly imply financial risks in the portfolio. The interviewed bank is preparing to assess such risks on the asset level and link them to favourable loan conditions, but generalisation remains difficult.
- **Institutional investors** consider long-term risks like water nuisance and heat, especially those affecting asset value or tenant comfort. However, large-scale flood risks are seen as a public responsibility, not something they factor into acquisitions. Their adaptation expectations are often indirectly enforced through developer compliance with municipal and national requirements.
- **Developers** tend to focus on feasibility and marketability. Adaptation is mostly considered when it improves project appeal – through public space or ESG compliance – or when it is required by municipalities. Most developers do not see it as a strategic priority on its own.

These divergent priorities highlight the fragmented nature of adaptation. Each stakeholder engages with climate risks through their own lens, possibly limiting opportunities for coordinated, proactive responses across the development chain. Clear national guidance might enhance this, although not every interviewee would agree.

Timing of stakeholder involvement

The influence of external stakeholders on climate risk integration often arrives late in the development process, a point validated by the interviews. De Nederlandsche Bank (DNB) (2023b) suggests that involving financiers at an early stage is crucial. This early engagement can facilitate the establishment of appropriate financial instruments, for instance, for foundation repair or climate-resilient construction, thereby enabling more efficient financing and implementation.

A key implication of these findings, therefore, is that earlier dialogue between developers, institutional investors, and banks – ideally during the concept development phase – could significantly align expectations regarding climate risk management. Currently, investors tend to assess physical risks only after a project's completion, which introduces inefficiencies and misses opportunities for a more integrated approach to adaptation. Developers, meanwhile, often remain unaware of investor expectations in this regard.

As banks increasingly focus on climate adaptation for real estate development, they will undoubtedly develop new financing instruments. Discussing these possibilities early on could lead to more holistic climate risk integration within projects and enhance their financial feasibility.

Bridging these gaps earlier in the process may not only reduce the need for costly late-stage revisions and support smoother transactions, but, more importantly, it could also enable a more deliberate and effective integration of climate risks into development concepts – moving beyond mere compliance with regulatory requirements.

Black box of climate services

Which brings us to the next point, the black box of climate services. A striking divergence emerges when discussing the potential of a formalised climate risk label. Most developers expressed strong support for such a label, viewing it as a much-needed guideline to reduce the uncertainty and inconsistency currently caused by each private actor relying on their own consultants and assessment methods. The bank echoed this sentiment, emphasising the label's potential to reduce information asymmetry in the market. One investor, however, expressed a more cautious stance. While acknowledging the importance of making climate risk information available to the right stakeholders, they warned against the potential for public labels to incite unnecessary alarm – highlighting a tension between transparency and market stability.

Adaptation vs. mitigation

A recurring theme in both interviews and literature is the dominance of climate mitigation over adaptation. One likely explanation is that mitigation is much easier to quantify and standardise. A developer, investor, or bank can refer to an established energy label or performance criterion and build this into project financing and evaluation. Adaptation, on the other hand, resists such standardisation. Risks vary by location and type, and measures are often project-specific.

This imbalance may shift in the near future. As noted by the bank interviewed for this study, financial institutions are preparing to assess climate risks at the asset level instead of the portfolio level. In doing so, they intend to include climate adaptation as a criterion for favourable loan conditions – expected to become operational by the end of 2025. The growing interest of banks in asset-level climate risk assessments suggests that financial institutions will soon play a more active role in steering adaptation efforts.

As these criteria become more central to financing decisions, developers may benefit from approaching banks at an earlier stage for orienting conversations. This would allow them to pre-empt future financing barriers and incorporate feedback while adaptation strategies are still flexible.

However, as the bank itself acknowledged, generalising adaptation requirements remains difficult due to the inherently localised and qualitative nature of climate risks.

Although the precise impact of this shift is hard to predict, there is a significant chance it could trigger a broader shift in real estate development practice. As one interviewee summarised:

“Money will set a lot in motion.”

This sentiment underscores the broader finding that financial incentives and institutional alignment may ultimately prove more effective than awareness-raising alone in embedding adaptation into real estate decision-making.

6.2 Conclusion

To conclude this research, the sub-questions will first be addressed individually, after which the main research question will be answered.

6.2.1 Research questions

RQ1 – What physical climate risks are most relevant for real estate development in the Netherlands?

The most relevant physical climate risks in the Dutch real estate context are heat stress, water nuisance (localised rainfall), soil subsidence, and drought. While national flood risks are widely acknowledged, they are not perceived as urgent by developers or investors due to strong national protection systems. Stakeholders prioritise different risks: municipalities focus on liveability and urban heat or water retention, banks evaluate physical risk exposure (e.g. groundwater issues and flood potential), and investors are more concerned with long-term risks like water nuisance, drought or heat that affect asset value. This stakeholder-specific prioritisation reveals a fragmented understanding of climate risks across the development chain.

RQ2 – Which actors play a role in integrating climate risks in real estate development?

Four key actor groups were identified as influential in the integration of climate risks into real estate development: (1) real estate developers, who incorporate internal sustainability ambitions into their projects; (2) institutional investors, who apply ESG screening and set post-completion acquisition requirements; (3) banks, which increasingly influence projects through green loans and climate risk assessments; and (4) municipalities, which shape development through zoning plans, tenders, and spatial planning conditions. In addition, end users – or the space market – play a significant role, as their preferences, although currently still latent, may shift market logic in the future. Insurance companies were also recognised as a potentially influential group, as the insurability of assets may become a more decisive factor in project feasibility. Developers do not operate in isolation but are shaped by pressures from these various actors – particularly when requirements are clearly defined, enforceable, or financially consequential.

RQ3 – How do developers address physical climate risks in real estate development?

Developers generally do not proactively integrate physical climate risks into decisions made during development. Climate adaptation is rarely considered a core component of project feasibility unless it is externally mandated – by municipalities through zoning plans or tender requirements, by investors through ESG screenings post-completion, or in anticipation of future regulations. A notable finding is that many developers underestimate their own role in climate adaptation, often failing to recognise imposed measures – such as water retention or heat mitigation – as part of a broader adaptation strategy. In their perception, addressing climate change is more closely associated with location choices rather than with design or technical measures implemented during development.

Developers with internal ESG departments or those involved in large-scale area developments – particularly those affiliated with construction firms – tend to be more responsive to climate-related concerns. However, even in these cases, the primary focus remains on climate mitigation, such as achieving CO_2 neutrality, rather than on climate adaptation. This imbalance is largely driven by the structure of the business case: mitigation measures often yield clear financial returns through energy savings and are reinforced by well-established sustainability labels. In contrast, adaptation measures typically lack equivalent financial incentives and are not yet supported by standardised frameworks or institutionalised criteria. As a result, developers have limited motivation to systematically integrate physical climate risks into their development strategies.

RQ4 – What leverage points exist to enhance climate risk integration in real estate development?

The research identifies five promising leverage points for strengthening the integration of climate adaptation in real estate development:

1. The space market – where evolving user expectations and insurance incentives can gradually position adaptation as a commercial necessity.
2. The land market – where public landowners, such as municipalities, can impose adaptation requirements when issuing land through sale or leasehold.
3. The assignment market – where national and regional governments should clearly communicate their expectations on climate risk integration early in the development process, for example through spatial planning tools or regulations such as the Building Works Decree.
4. The capital market – where financial institutions could encourage adaptation by offering more favourable financing conditions for climate-resilient projects.
5. The building market – where investors have the opportunity to embed climate risk requirements in investment briefs or express their expectations directly during project initiation.

Crucially, embedding adaptation considerations earlier in the development process – rather than treating them as late-stage add-ons – is essential for achieving systemic improvement.

6.2.2 Main research question

This thesis explored the following main research question:

> *"To what extent do physical climate risks influence decision-making in real estate development?"*

The findings reveal that, although climate risk information is increasingly accessible, it does not yet structurally influence development decisions. From the outset – beginning with land development – developers often proceed with projects on land previously secured through land banking, including in areas prone to climate risks. This is largely due to the perceived absence of clear national guidelines indicating where it is or isn't safe to build. As a result, climate risk assessments are typically conducted by private actors without a standardised approach.

Nevertheless, growing public awareness has contributed to the incorporation of technical adaptation measures in some development plans. However, climate risks are rarely addressed proactively. Their integration is often a response to external obligations. Developers affiliated with construction firms tend to consider these risks more systematically, while independent developers generally respond reactively – in this case mostly forced by governmental demands. The scale of development also matters: large-scale area developments, including public space or multiple plots, offer greater flexibility for adaptation compared to inner-city infill projects, which often lack room for meaningful climate measures.

A key insight is the fragmented perception of climate risks among stakeholders. Municipalities focus on liveability and water retention, banks assess financial exposure and technical risks, and investors prioritise asset resilience. Developers, although central to decision-making, often adapt to these external agendas rather than shaping them. Their ability to act independently is correlated with financial dependency: the more dependent they are on external financing; the less autonomy they have to prioritise climate risks in the development process. However, this dependency can also

positively impact the integration of climate risks in the development process, as financial institutions are focussing more and more on climate adaptation.

Ultimately, this research suggests that awareness alone is insufficient to ensure meaningful climate risk integration. Systemic change will require a combination of financial incentives, regulatory clarity, and assignment-based obligations. Only through coordinated alignment across stakeholders – beginning early in the development chain – can climate adaptation shift from a reactive burden to a structural element of sustainable real estate development.

6.3 Limitations

Like any qualitative study, this research has certain limitations that must be acknowledged.

The findings are rooted in the Dutch context, which is shaped by strong public planning traditions, a well-regulated real estate market, and extensive flood protection infrastructure. These characteristics may limit the applicability of the conclusions to countries with different governance systems, legal frameworks, or climate-related challenges.

Even within the Netherlands, perspectives are not uniform. The interviewed investors were primarily active in the Randstad region, where trust in protective infrastructure influenced their relatively low concern about catastrophic flooding. This view may not apply to other regions where physical climate risks are more pronounced or perceived differently.

The study also draws on a relatively small sample. While the interviews yielded valuable, practice-based insights, the limited number of conversations with municipalities and financial institutions means that the range of perspectives from these groups remains constrained. Notably, the sample did not include a developer affiliated with a bank – an angle that might have offered useful insights, particularly in light of evolving financial regulations such as the SFDR.

Moreover, the voices of real estate users and the insurance sector are absent. Including these stakeholders could enrich understanding of issues such as risk transfer, maintenance responsibilities, and market expectations regarding resilience.

Lastly, the figures presented in the synthesis provide useful tools for interpreting stakeholder dynamics and their respective markets. However, as they are all qualitative and interpretative in nature – based on a limited set of interviews – their conclusions would benefit from further validation through case studies or quantitative analysis.

6.4 Recommendations

My personal recommendations are divided into two categories: research recommendations and practical recommendations. This distinction reflects both the academic contribution of this study and its practical relevance to ongoing climate and spatial planning efforts in the Netherlands.

6.4.1 Research recommendations

- **Quantitative validation of findings**: This research was qualitative in nature and based on a limited number of interviews. To strengthen the generalisability and robustness of the findings, future studies should explore opportunities for quantitative validation – e.g. through survey-based studies or multi-case comparisons across regions or developer types.
- **Researching the leverage points**: This research presents five leverage points in five different submarkets of real estate development. Each leverage point can be seen as an anchoring point for further research into these markets.
- **The emerging role of the insurance market**: While not directly investigated in this study, the insurance sector was repeatedly mentioned by interviewees as a potential driver of adaptation. Future research could examine how insurers assess and price physical climate risks, and whether this may create new benchmarks for climate-resilient development. This could represent an "eighth market" influencing real estate decisions—alongside the capital, space, land, building, design, construction and design markets.
- **Regional differentiation beyond the Randstad**: The developers and investors interviewed in this study were primarily active in or near the Randstad. It would be highly relevant to explore whether local developers in other regions – such as the north or south of the Netherlands – perceive and address climate risks differently. Such a comparison could reveal spatial inequalities in risk perception and adaptation strategies.
- **The influence of government protection narratives**: Several interviewees expressed a sense of safety rooted in the belief that the Dutch government would always protect critical urban areas like the Randstad from flooding. Future research could further explore how these narrative influences stakeholders' flood risk perception, and whether it leads to complacency in adaptation planning.
- **Development strategies and risk integration**: Finally, future research could examine the relationship between different development models (e.g., supply driven, demand driven, concept driven) and the integration of climate risks. The way a project is financed, held, and transferred might influence whether adaptation is considered.

6.4.2 Practical recommendations

In addition to academic contributions, this research offers several actionable insights for policymakers, financial institutions, and real estate practitioners. The following recommendations aim to strengthen the structural integration of physical climate risks into real estate development.

- **National Government:** Provide long-term, climate-informed spatial guidance. While local governments often apply clear spatial strategies, there is a growing need for the national government to take a stronger long-term role in guiding where climate-resilient development should occur. Developers seek clarity and predictability when making location and development decisions. Nationally coordinated spatial frameworks – grounded in climate risk data – can help prevent development in vulnerable areas and reduce future costs. A proactive national vision, aligned with climate adaptation goals, would offer developers the certainty they need while safeguarding long-term public interests.

- **Municipalities**: Embed adaptation requirements earlier and more explicitly in planning tools. Municipalities play a central role in guiding real estate development through zoning plans, tenders, and environmental requirements. To enhance the quality and intentionality of adaptation measures, municipalities should actively raise awareness about local climate risks early in the planning process. By engaging developers before design choices are fixed, there is more room for co-creative solutions, integrated thinking, and the incorporation of adaptation not just as a requirement, but as a design opportunity. Early and transparent communication can thus lead to both more effective and more innovative adaptation outcomes.

- **Banks**: Move from portfolio-level to asset-level risk assessments. Financial institutions are beginning to assess physical climate risks but currently do so primarily at the portfolio level. This limits the ability to distinguish between high- and low-risk projects. To incentivise developers to act earlier, banks should operationalise climate risk assessment tools at the building or project level, and link favourable loan conditions to projects that clearly mitigate relevant risks.

- **Institutional Investors**: Align acquisition criteria with adaptation goals. Institutional investors often assess climate risks during the acquisition phase, which typically takes place after project completion. This timing can result in costly redesigns or, in some cases, the withdrawal from deals altogether. To encourage earlier integration of adaptation measures, investors could communicate their climate resilience expectations during the design and development phases. By aligning acquisition criteria with adaptive design standards upfront, they can incentivise developers to embed resilience from the outset. In the long term, this practice may help shift market norms and establish adaptation as a core value criterion in investment strategies.

- **Developers**: As developers have been the main subject of this research, multiple recommendations have been formed.

    - Many developers – though certainly not all – currently lack structured methods to assess climate risks. Internal ESG teams could play a stronger role in developing or procuring tools that combine open-access risk data (such as the Klimaateffectatlas) with spatial and financial assessments. For smaller companies, external consultants may offer a practical alternative. Integrating climate risk evaluation into standard internal workflows can help shift adaptation from a reactive compliance issue to a proactive design criterion.

    - Be aware of the fact that stakeholders prioritise different climate risks. This divergence can be strategically used to engage the right stakeholder for the right type of risk. For instance, a bank may be more inclined to support flood-proofing measures due to concerns about asset value and financial exposure, whereas an investor might be more motivated to finance measures against heat stress due to ESG commitments and user satisfaction. While these findings are based on qualitative insights and not statistically validated, they do provide a valuable starting point for initiating targeted conversations with key stakeholders.

    - Including climate risks in the project vision from the outset not only improves budget predictability, but also creates the opportunity to embed risk mitigation directly into the spatial and technical design – rather than relying on costly technical fixes at a later stage. This strengthens both the long-term resilience and the feasibility of the development.

Once developers have gained insight into the risks associated with a specific location, they are also better positioned to initiate conversations with key external stakeholders – such as municipalities, investors, and banks. For developers, proactively initiating such conversations may offer a competitive advantage, especially as climate risk is expected to become a more explicit component of financing conditions, regulatory compliance, and asset valuation. Integrating investor and lender perspectives early in the process can help shift adaptation from an externally imposed requirement to a shared design ambition, thereby improving both marketability and strategic alignment.

Figure 17 Action plan on integrating climate risks in real estate development - developers perspective (Own work, 2025) outlines potential leverage points for developers to embed these conversations throughout the early stages of development.

PART 7 | REFLECTION

7. REFLECTION

This thesis journey began with an extensive – and at times frustrating – search for a suitable research topic. My personal interests were broad, but my lack of specific knowledge made it difficult to define a clear angle. In the process, I gathered roughly 100 pages of unused literature studies, reflecting the trial-and-error nature of the early stages. Eventually, I chose to focus on physical climate risks, more out of fascination than certainty. From that point onward, new challenges emerged.

The biggest obstacle was the absence of clear academic or practical reference points. Although the urgency of climate adaptation in the built environment is widely acknowledged in the Netherlands, there was a surprising lack of research into how such risks are actually addressed in real estate development practice. Ironically, many people I spoke to outside the field assumed the topic had already been thoroughly studied – often responding with remarks like, “Hasn’t that already been done?” While in reality, I found few concrete studies on how physical climate risks influence decision-making in Dutch development projects or how key stakeholders – such as developers, municipalities, and investors – engage with these risks. Additionally, all interviewees thought it to be a relevant and fairly “new” topic to get attention in real estate development.

This lack of clarity left the research without a solid starting position. I had no clear understanding of whether EU regulations influenced decisions, how municipalities incorporated climate risk, or whether developers even saw adaptation as part of their role. Moreover, I deliberately chose not to focus on just one specific climate risk. Since it has never been systematically studied which risk is perceived as most urgent, or by whom, this question in itself became a research point. As a result, the study maintained a broad and initially unfocused scope, covering all major physical climate risks and including a wide range of potentially relevant factors. Without a clearer understanding of how the market currently responds to climate risk information, it was impossible to define firm boundaries or test specific assumptions early on.

The uncertainty of what to expect also led to a different approach to the empirical research. Initially, a decision was made to include a fictitious case in the interviews to observe how developers would respond. However, after a test run, it became clear that the subject I wanted to explore might be too vague to address effectively in that format. Therefore, the initial fictitious case study was replaced by a more open and interactive method. This allowed developers to freely share their experiences and perspectives in a clearer and more meaningful way, while keeping the subject tangible due to applying it to their own development experiences.

The research only started to take shape once the interviews began. Engaging directly with stakeholders – especially developers – made the dynamics of real estate development much more tangible. Through these conversations, clear distinctions emerged between different types of developers and their responsiveness to climate risks. Patterns surfaced around company structure, project size, land strategies, and financing models – factors that shaped how and to what extent climate risks were considered.

As the interviews progressed, discussions moved from abstract logic to more concrete constraints – especially financial feasibility and location-based limitations. This realisation prompted a strategic expansion of the research. Municipalities were added to understand public-private dynamics in early-stage development. Several developers also suggested involving institutional investors, as long-term asset owners with a stronger incentive to consider future risks. To capture this dimension, I interviewed two institutional investors and included input from a fellow student’s interview with a private equity firm.

Lastly, because nearly all developers depend on loans, the role of banks was critical. Developers frequently mentioned green or preferential loans but noted that banks do not currently require climate risk assessments. To verify this and explore potential future shifts, I interviewed a representative from a major bank.

Altogether, these developments fundamentally reshaped the research. What began as a study about developers' decisions evolved into a broader exploration of how decisions are made throughout the real estate development process. While this widened scope posed clear challenges in terms of depth and structure, it proved necessary for understanding the complexity of physical climate risk integration and the interdependent roles of different stakeholders in shaping the future resilience of the built environment.

The final step of this thesis – translating the findings into a coherent set of practical recommendations – turned out to be the most challenging part. Unlike studies that evaluate a specific method or test a clear theory, this research focused on describing and interpreting a current practice. While this approach yielded rich insights into the status quo, it made it much harder to formulate actionable advice. There was no obvious benchmark or framework to build on. I knew from the start that I wanted this research to result in something practically useful – not just an analytical snapshot, but a strategic direction. But crafting such direction from a fragmented and exploratory study proved to be an ongoing puzzle. The challenge was not just to summarise what was said in the interviews, but to structure it in a way that could guide future development decisions across varying contexts. It took multiple iterations and reinterpretations of my own findings before the advice sections began to feel grounded, consistent, and relevant. In hindsight, this struggle also deepened the research: it forced me to look beyond surface-level observations, to connect stakeholder perspectives, regulatory shifts, and structural dynamics into an integrated narrative. Ultimately, while difficult, this process turned out to be the most rewarding part of the thesis. It enabled me to bridge the gap between academic exploration and professional relevance – something I had hoped to achieve.

Now, further research can hopefully build on the anchoring points this study provides, and it is my hope that practitioners will find value in the recommendations put forward – as a starting point for more climate-conscious decision-making in real estate development.

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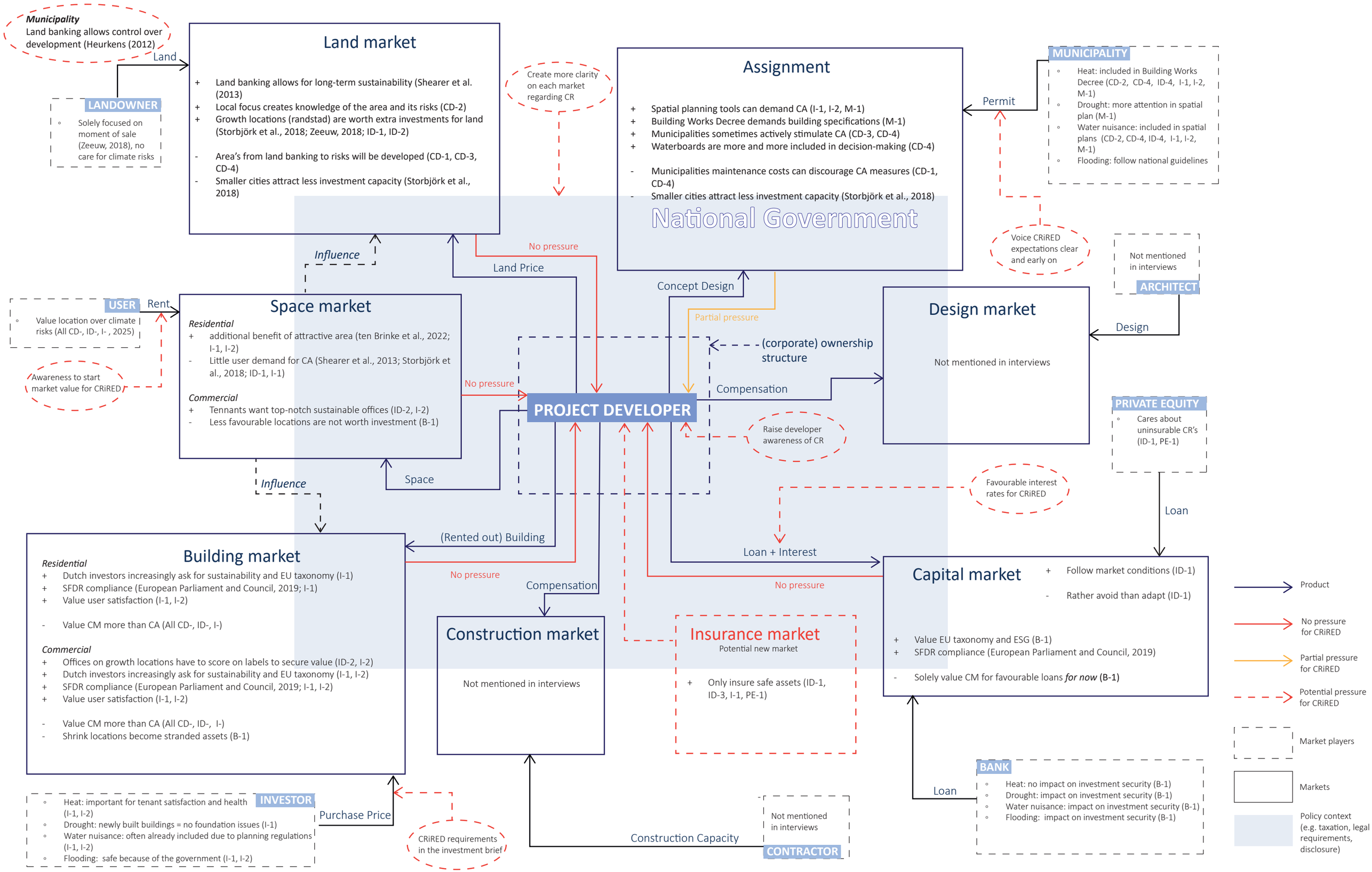
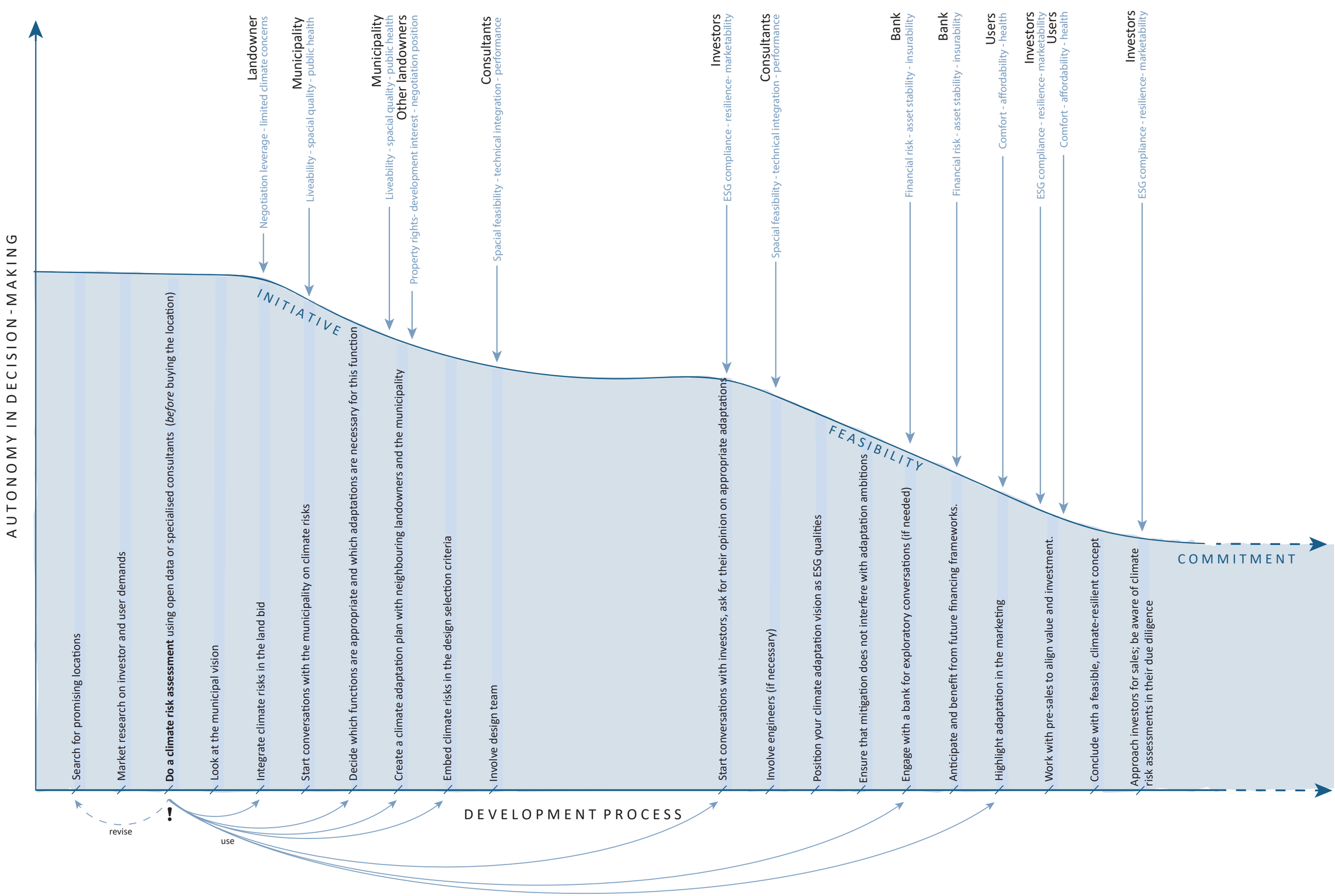
Appendix I: Systematic overview of markets and its actors influencing developers' climate risk integration



Appendix II: Action plan developers



Plan Overview

A Data Management Plan created using DMPonline

Title: Integrating physical climate risks in real estate development

Creator: Marieke Algie

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2025)

Project abstract:

This research consists of desk research and interactive interviews. The desk research will follow a literature study, which will be used to figure out what the key climate risks are in the Netherlands, how these risks are defined and disclosed, what the role is of a developer in real estate development, and what the influence of the EU taxonomy is on investments. The findings will be used as a foundation for the following phases of the research and to put the conclusions of the research in a scientific context. Interviews will be carried out to gain a better understanding of the way developers look at climate risks and adaptation and what factors have an influence on their decision-making. In order to do this, a layered interview guide is used, to which developers have to respond what factors impact their decisions. The interactive interviews will be conducted with 8 different developers, recruited either through an internship or through personal contacts.

ID: 167947

Start date: 28-09-2024

End date: 18-06-2025

Last modified: 17-06-2025

Integrating physical climate risks in real estate development

0. Adminstrative questions

1. Provide the name of the data management support staff consulted during the preparation of this plan and the date of consultation. Please also mention if you consulted any other support staff.

This research follows a standard template. The DMP has been shared with my thesis supervisor Michaël Peeters via DMPonline, and reviewed by them on 14-3-2025.
Janine Strandberg has reviewed this DMP on 7-3-2025, the feedback has been incorporated.

2. Is TU Delft the lead institution for this project?

- Yes, the only institution involved

I. Data/code description and collection or re-use

3. Provide a general description of the types of data/code you will be working with, including any re-used data/code.

Type of data/code	**File format(s)**	**How will data/code be collected/generated?** *For re-used data/code: what are the sources and terms of use?*	**Purpose of processing**	**Storage location**	**Who will have access to the data/code?**
Personally Identifiable Information (PII): participants' name, email, work address, company name, mobile numbe	.pdf files	Contact information for participants taking part in interviews, received [from participant sign-ups, professional network, etc.] Informed consent forms are signed digitally and contain participants' name + email.	For administrative purposes: obtaining informed consent and communicating with participants	SURF drive	the researcher
Anonymized data about the roles and influences of parties involved in redevelopment projects	.docx files	through spoken interviews, transcribed to .docx files	to determine the roles and influences of parties involved in development projects	SURF drive	the researcher

Audio-recordings of interviews with real estate developers	.mp3 files	Interviews are conducted during on-site visits to the company the developer work for. Audio-recordings are made on an external device, before being moved to SURF drive. Recordings are deleted after transcription.	Capturing the opinions on climate adaptation and climate risks from participants, experts in real estate development	SURF drive	the researcher
Anonymous transcriptions of interviews	.docx files	Anonymous transcriptions created manually based on audio-recordings. Participants are asked to review the transcriptions of their interview before the transcript is finalised	Privacy-preserving data on climate adaptation and climate risks from participants, experts in real estate development	SURF drive	the researcher
Anonymised data on opinion on climate risks and climate adaptation + age group, city, occupation	.docx files	Data obtained from coding anonymised transcriptions using Atlas software. TU Delft has a campus licence for employees	Privacy-preserving data on climate adaptation and climate risks from participants, experts in real estate development	SURF drive	the researcher
Report/thesis	.pdf files	Serves as record of the process as well as documentation	long-term documentation	SURF drive	the researcher
choice data	.pdf files	the decisions made during the interactive part of the interview	to determine what the decisions would be of the participant in possible scenarios	SURF drive	the researcher
choice reflection	.docx files	through spoken interviews, transcribed to .docx files	to further gain knowledge on why certain decisions were made	SURF drive	the researcher
Participant feedback	.docx files	through spoken interviews, transcribed to .docx files	to gain feedback on the interview	SURF drive	the researcher

II. Storage and backup during the research process

4. How much data/code storage will you require during the project lifetime?

- 250 GB – 5 TB

5. Where will the data/code be stored and backed-up during the project lifetime? (Select all that apply.)

- SURFdrive

III. Data/code documentation

6. What documentation will accompany data/code? (Select all that apply.)

- Data – README file or other documentation explaining how data are organised

IV. Legal and ethical requirements, code of conducts

7. Does your research involve human subjects or third-party datasets collected from human participants?

If you are working with a human subject(s), you will need to obtain the HREC approval for your research project.

- Yes – please provide details in the additional information box below

I have received HREC approval on March 14, with application number: 5334

8. Will you work with personal data? (This is information about an identified or identifiable natural person, either for research or project administration purposes.)

- Yes

The research data collected in the project will be anonymised, but processing of personal data is required for administrative reasons for conducting the research project.

9. Will you work with any other types of confidential or classified data or code as listed below? (Select all that apply and provide additional details below.)

If you are not sure which option to select, ask your Faculty Data Steward for advice.

- No, I will not work with any other types of confidential or classified data/code

10. How will ownership of the data and intellectual property rights to the data be managed?

For projects involving commercially-sensitive research or research involving third parties, seek advice of your Faculty Contract Manager when answering this question.

The personal data collected from the participants will be anonymized. The participants will get an ID name based on their profession and years of experience. For example, Developer_1(3) is the first participant to be a developer with 3 years of experience. The personal data will be deleted after the project, and the anonymous data will remain. The anonymized data will be shared with the participants.

11. Which personal data or data from human participants do you work with? (Select all that apply.)

- Free text fields (for instance, in questionnaires) in which participants could unintentionally share personal data
- Proof of consent (such as signed consent materials which contain name and signature)
- Audio recordings
- Names as contact details for administrative purposes
- Telephone number, email addresses and/or other addresses as contact details for administrative purposes
- Date of birth and/or age
- Gender

interviewee name, work address, company name, email address, and mobile phone number are processed for administrative reasons (to obtain informed consent and communicate with participants). Personal research data processed for interview participant includes:

audio-recordings (interview)

personal professional opinion on climate change and climate adaptation in the built environment (interview)

occupation: real estate developer, investor (interview)

experience: time in the work field (interview)

12. Please list the categories of data subjects and their geographical location.

Different stakeholders within the field of project development, with different ages, and years of experience. All practicing in the Netherlands.

13. Will you be receiving personal data from or transferring personal data to third parties (groups of individuals or organisations)?

- No

16. What are the legal grounds for personal data processing?

- Informed consent

The HREC informed consent guide and template will be used to create the informed consent forms for the interviewees.

17. Please describe the informed consent procedure you will follow below.

Interviews: The researcher will inform the potential participants about the goals and procedures of the research project. The researcher will also inform them about the personal data that are being processed and for what purpose. A digital copy of the information will be emailed to participants before the interview, and all participants will be asked for their consent for taking part in the study and for data processing by signing a digital informed consent form before the start of the interview.

18. Where will you store the physical/digital signed consent forms or other types of proof of consent (such as recording of verbal consent)?

Digital informed consent forms and contact information are stored in the SURFdrive.

19. Does the processing of the personal data result in a high risk to the data subjects? (Select all that apply.)

If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data in your research project.

If any category applies, please provide additional information in the box below. Likewise, if you collect other type of potentially sensitive data, or if you have any additional

comments, include these in the box below.

If one or more options listed below apply, your project might need a DPIA. Please get in touch with the Privacy team (privacy-tud@tudelft.nl) to get advice as to whether DPIA is necessary.

- None of the above apply

23. What will happen with the personal data used in the research after the end of the research project?

- Anonymised or aggregated data will be shared with others

Anonymised data suitable for sharing consists of anonymised coded datasets and anonymous interview data: these will be included in the MSc thesis. Complete anonymised interview transcripts will be removed after the research is done.

24. For how long will personal research data (including pseudonymised data) be stored?

- Personal data will be deleted at the end of the research project

25. How will your study participants be asked for their consent for data sharing?

- In the informed consent form: participants are informed that their personal data will be anonymised and that the anonymised dataset is shared publicly

V. Data sharing and long term preservation

27. Apart from personal data mentioned in question 23, will any other data be publicly shared?

Please provide a list of data/code you are going to share under 'Additional Information'.

- I do not work with any data other than personal data

29. How will you share research data/code, including those mentioned in question 23?

- I am a Bachelor’s/Master’s student at TU Delft and I will share the data/code in the body and/or appendices of my thesis/report in the Education Repository

31. When will the data/code be shared?

- As soon as corresponding results (papers, theses, reports) are published

VI. Data management responsibilities and resources

33. If you leave TU Delft (or are unavailable), who is going to be responsible for the data/code resulting from this project?

My supervisor Dr. Ir. M.U.J. (Michaël) Peeters MRe will be responsible for the data after I leave TU Delft.

34. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

4TU.ResearchData will be used as a resource to data management and will ensure that the data will be FAIR. I do not expect to exceed the free of charge available 1TB amount of data, and therefore there are no extra costs of long-term preservation.

Appendix IV: Informed consent form

Participant Information

You are being invited to participate in a research study titled "The Influence of the Availability and Disclosure of Climate Risk Information on Investment Decision-Making in Real Estate Development." This study is conducted by Marieke Algie from TU Delft in collaboration with Dev_ real estate (internship company).

The purpose of this research study is to understand how real estate developers assess and respond to climate risks and how data availability and disclosure about these risks influences their decision-making and strategic planning. This study will take approximately 40 minutes to complete.

The data collected will be used for academic research and potential publication in scientific journals.

During this study, you will be asked to participate in a semi-structured interview, where you will be presented with real estate development scenarios that vary in terms of climate risk information and financial implications. You will be asked about your risk perception, investment considerations, and potential strategic adjustments based on the provided information.

Confidentiality & Data Security
Your answers will remain confidential to the best of our ability. This survey is anonymous, meaning that no personally identifiable information (such as your name, IP address, or company name) will be collected. All data will be stored on a secure, encrypted server and used only for research purposes. If direct quotes are used in publications, they will be fully anonymized.

The data collected may be made available as Open Data in anonymized form to contribute to further academic research and policy development.

Voluntary Participation & Withdrawal
Your participation in this study is entirely voluntary, and you may withdraw at any time without providing a reason. You are free to omit any question you do not wish to answer. After the interview, you will receive a transcript of your responses. You will have the opportunity to review the transcript and request corrections or the removal of specific parts within 7 days. Once the data is fully anonymized and integrated into the analysis, further removal may no longer be possible.

Contact information
For any questions regarding this study, please contact:
Marieke Algie – Corresponding researcher (TU Delft) – m.e.a.algie@student.tudelft.nl

By proceeding to the interview, you acknowledge that you have read and understood this information and consent to participate in this study.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated [*DD/MM/YYYY*], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves:	☐	☐
• *Taking part in a semi-structured interview that will last approximately 60 minutes* • *Reviewing and responding to scenarios related to climate risks and real estate decision-making* • *The interview will be audio-recorded, transcribed into text, and anonymized* • *I will have the opportunity to review my transcript and request modifications or deletions within 7 days* • *The anonymized data from this interview will be used solely for academic research.*		
4. I understand that the study will end June 2025		
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
5. I understand that taking part in this study involves minimal risks. However, discussing climate risk decision-making could potentially create professional or financial sensitivities. These risks will be mitigated by:	☐	☐
• *Keeping my responses strictly confidential and anonymous.* • *Ensuring that no identifiable company names or project details are disclosed in the research.* • *Allowing me to review and request redactions to my transcript if necessary.*		
6. I understand that taking part in the study also involves collecting specific personally identifiable information (PII) and associated personally identifiable research data (PIRD) with the potential risk of my identity being revealed	☐	☐
• *My role and experience in real estate development (but not my name or company name).* • *My views on climate risk, climate risk transparency and investment decisions.*		
7. I understand that no sensitive personal data (such as political views or criminal records) will be collected.	☐	☐
8. I understand that steps will be taken to minimize the risk of a data breach, including:	☐	☐
• *Anonymized transcripts (no direct names or company identifiers).* • *Secure storage of data on SURFdrive* • *Limited access to the research team only.*		
9. I understand that my personal data (such as my name, email, or any identifiable information) will not be shared beyond the research team.	☐	☐
10. I understand that the original audio recordings will be permanently deleted once the transcripts are anonymized and verified.	☐	☐
11. I understand that Dev_real estate, the hosting organization of the research internship, will not have access to raw interview recordings. They will have access to anonymized interview transcripts to reflect on practical implications.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
11. I understand that after the research study the de-identified information I provide will be used for [*see points below*]	☐	☐

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
• *Academic publications (such as research papers and reports).* • *Presentations and policy recommendations on climate risk transparency in real estate.* • *Potential applications in teaching or professional training.*		
12. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
13. I give permission for the de-identified coded data obtained from interviews that I provide to be archived in TU Delft repository so it can be used for future research and learning.	☐	☐
14. I understand that access to this repository is open and that data will be stored in anonymized form.	☐	☐

Signatures

_____ _____ _____

Name of participant Signature Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____ _____ _____

Marieke Algie Signature Date

Study contact details for further information: Marieke Algie
M.E.A.Algie@student.tudelft.nl

APPENDIX V: interview Bank

1. General Financing Approach

- What is your role within the bank?
- Does your bank finance real estate development and real estate investments?

2. Climate Risks in Lending Decisions

- Are physical climate risks structurally taken into account when assessing loan applications? (e.g., flooding, water nuisance, foundation issues, heat stress)
- Does the bank use internal tools or external sources (e.g., Climate Impact Atlas) to assess risks?
- Are developers or investors required to submit climate risk analyses when applying for a loan?
- Are projects with high climate risks assessed differently (e.g., higher interest rates, lower loan-to-value ratios, rejection)?
- Is there a difference in how climate risks are assessed between financing development projects and investment projects?

3. Impact of EU Regulations (CSRD, EU Taxonomy)

- Is the bank influenced by the SFDR in real estate financing, particularly regarding physical climate risks?
- Do real estate projects need to meet certain sustainability or climate adaptation criteria to qualify for financing?
- Has the bank formulated internal ESG requirements that include climate adaptation criteria for financeable real estate projects?
- Are there specific “green loans” or “sustainability loans” available for real estate projects that integrate climate adaptation?

4. Future Expectations and Trends

- Does the bank expect climate risks to play a larger role in credit assessments in the coming years?
- Are changes already visible in financing conditions due to the increased attention to climate risks?
- Is there increased caution in financing projects in risk-prone locations (e.g., along rivers, in peatland areas, low-lying regions)?

5. Specific Cases (optional)

- Could you provide an example of a project that:
    - was rejected due to climate risks, or
    - required additional measures because of climate risks?

Appendix VI: Interview investors

1. General Approach to Real Estate Investment

- What is your company's role in real estate development?
- What is your personal role within the company?
- What are your criteria for acquiring new developments?
- In which locations are you active?
- Are these mainly greenfield or brownfield developments?
- At what stage of a project do you typically make acquisitions?

2. Impact of Climate Risks

- Are physical climate risks considered when deciding whether to acquire projects?
- At what stage are these physical climate risks taken into account?
- How do you assess climate risks?
- Can a climate risk prevent an investment from going through?
- What type of climate risk would that be?

3. To what extent does the SFDR influence your investment decisions regarding climate risks?

4. Expectations from Other Market Actors

- What do you expect from developers regarding physical climate risks?
- What do your clients expect from you regarding physical climate risks?

5. Potential Climate Risk Label

- Would you consider a standardized label for physical climate risks a good idea?

6. Do you expect climate risks to play a larger role in investment decisions in the future?

Appendix VII: Interview municipality

1. Municipal Policy and Organization

- Does the Municipality of Amsterdam have a policy for addressing physical climate risks such as heavy rainfall, drought, flooding, and heat?
- How are responsibilities divided within the municipality when it comes to spatial planning and incorporating climate adaptation?

2. Instruments and Regulations in Area Development

- Are climate adaptation requirements included in tenders or environmental permits?
- What does the development process look like for projects on municipal land versus private land?
- What can the municipality require from developers, and at what stages in the process?
- What are the main selection criteria in tenders, and how important is sustainability among them?
- Are there specific climate adaptation measures in the Dutch Building Decree, or are these mainly part of municipal policy?

3. Public Space and Management

- Is public space always owned and maintained by the municipality?
- Has it ever occurred that a developer proposed a public space that was too ambitious or impractical for municipal maintenance?

4. Developer Types and Adaptation Behaviour

- Do you observe differences between types of developers (large vs. small, long-term investors vs. 'hit-and-run' parties) in how they deal with climate risks?

5. Policy Outlook and Expectations

- Do you expect climate risks to play a larger role in future municipal spatial planning policy?
- Do you expect that climate adaptation will be more legally embedded in the future, for example through the Environment and Planning Act (Omgevingswet)?

Appendix VIII: Interview developers

0 General information

- How is your company involved in real estate development?
- How does your company finance its projects/investments? (e.g., loans, investors, own capital)
- Is your company publicly listed?
- In which geographic areas are you currently developing projects?

1 Investment criteria

- Which factors play the biggest role in your investment decisions? (e.g., location, return on investment, regulation, ESG criteria, climate risks, market trends?)
- Do you also participate in tenders?

2 Integration of physical climate risks (Physical climate risk maps, shown below)

- Does this information change how you view these locations?
- Have these risks been considered or accounted for?
- Which climate risks do you find important to consider in real estate development?
- Does your organization have fixed routines or processes to explicitly incorporate climate risks into investment decisions? If so, which ones?

3 Regulatory and market pressure:

- Does the CSRD influence how your company invests? For example, do you aim to be taxonomy-aligned due to financing advantages?
- Do you perceive disclosure initiatives such as the CSRD as market incentives (e.g., competitive advantage or better financing conditions through green loans)? Why (or why not)?
- Do you notice that your financiers feel pressure from the SFDR?
- Have you ever used green loans for a project?

4 Impact climate risk label

Imagine a mandatory climate risk label (A–E), similar to energy labels, that gives investors and banks insight into the climate risks of an area. One example is BlueLabel, which incorporates all such risks.

- What would you think of such a climate risk label for real estate development?

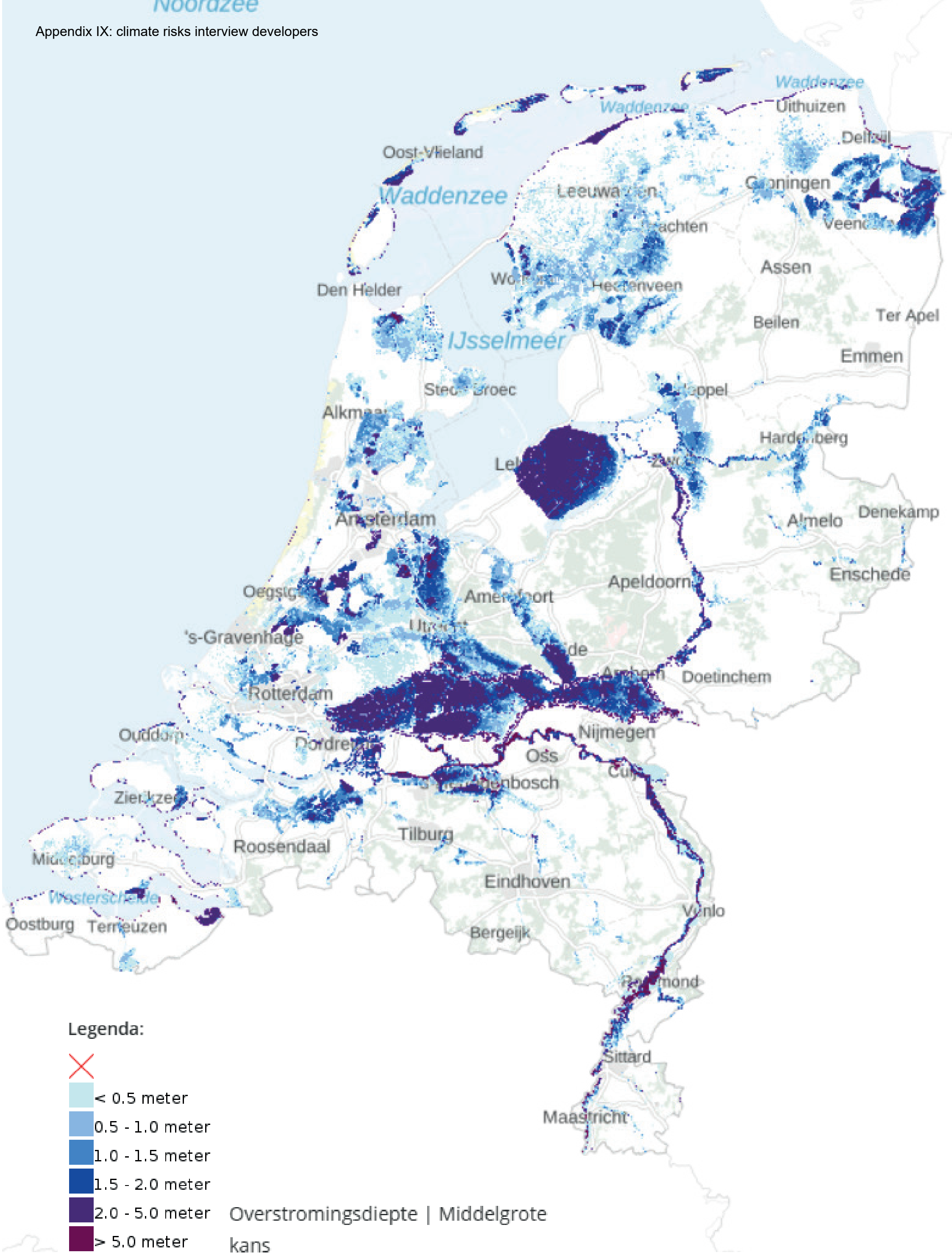
5 Behavioural barriers and decision logic

- How do you usually assess climate risks in your investments? Is it primarily based on intuition and experience, or through formal analyses?
- What role does the time perspective (short-term returns vs. long-term climate risks) play in your decisions?
- Have you ever actually rejected a project due to explicit climate risks? Why or why not?

General reflection:

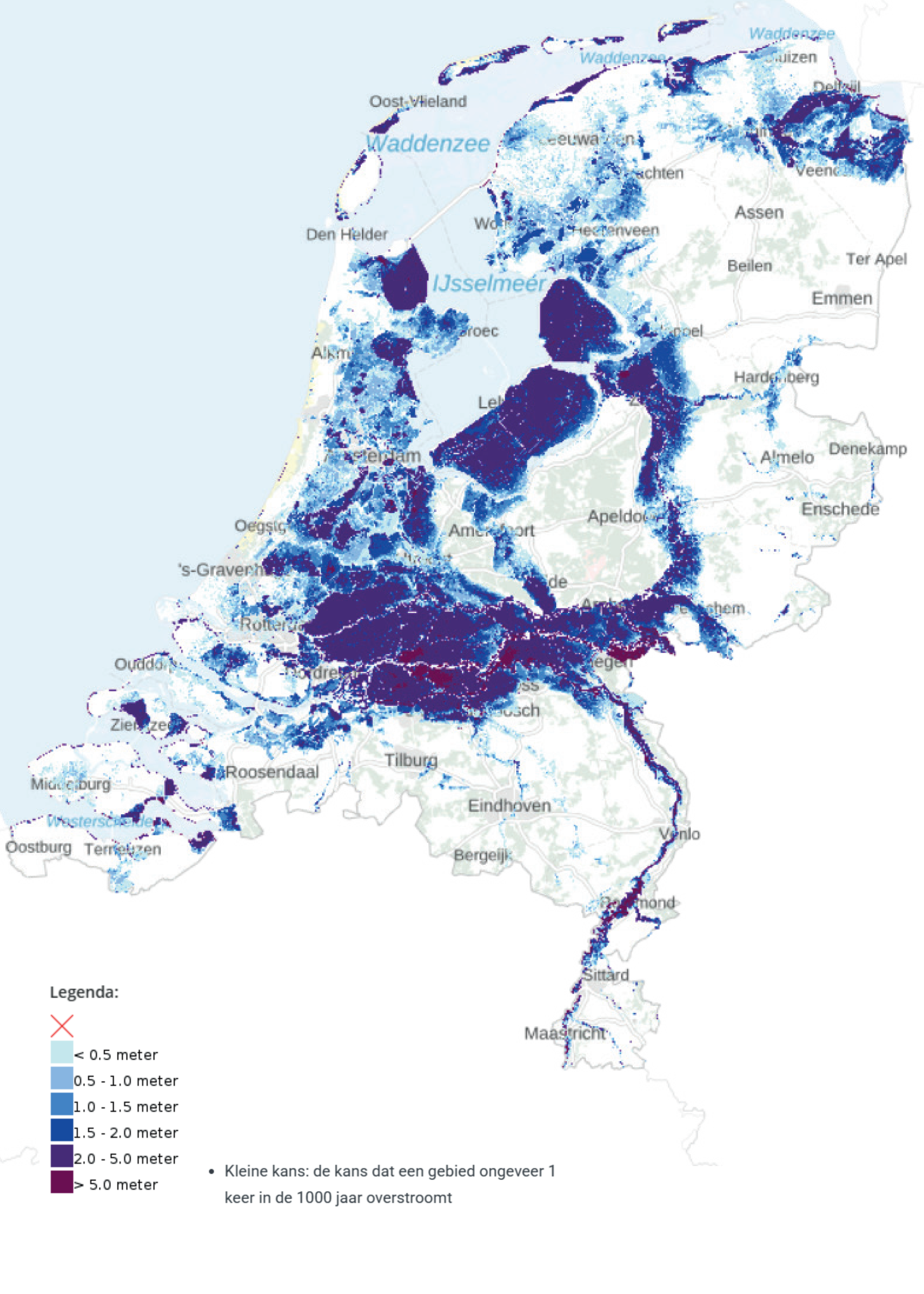
- Has this conversation changed your perspective on climate risks and climate adaptation? If so, what was the most important insight?
- Do you think increasing transparency about climate risks will influence your overall investment strategy in the future? Why (or why not)?

Appendix IX: climate risks interview developers

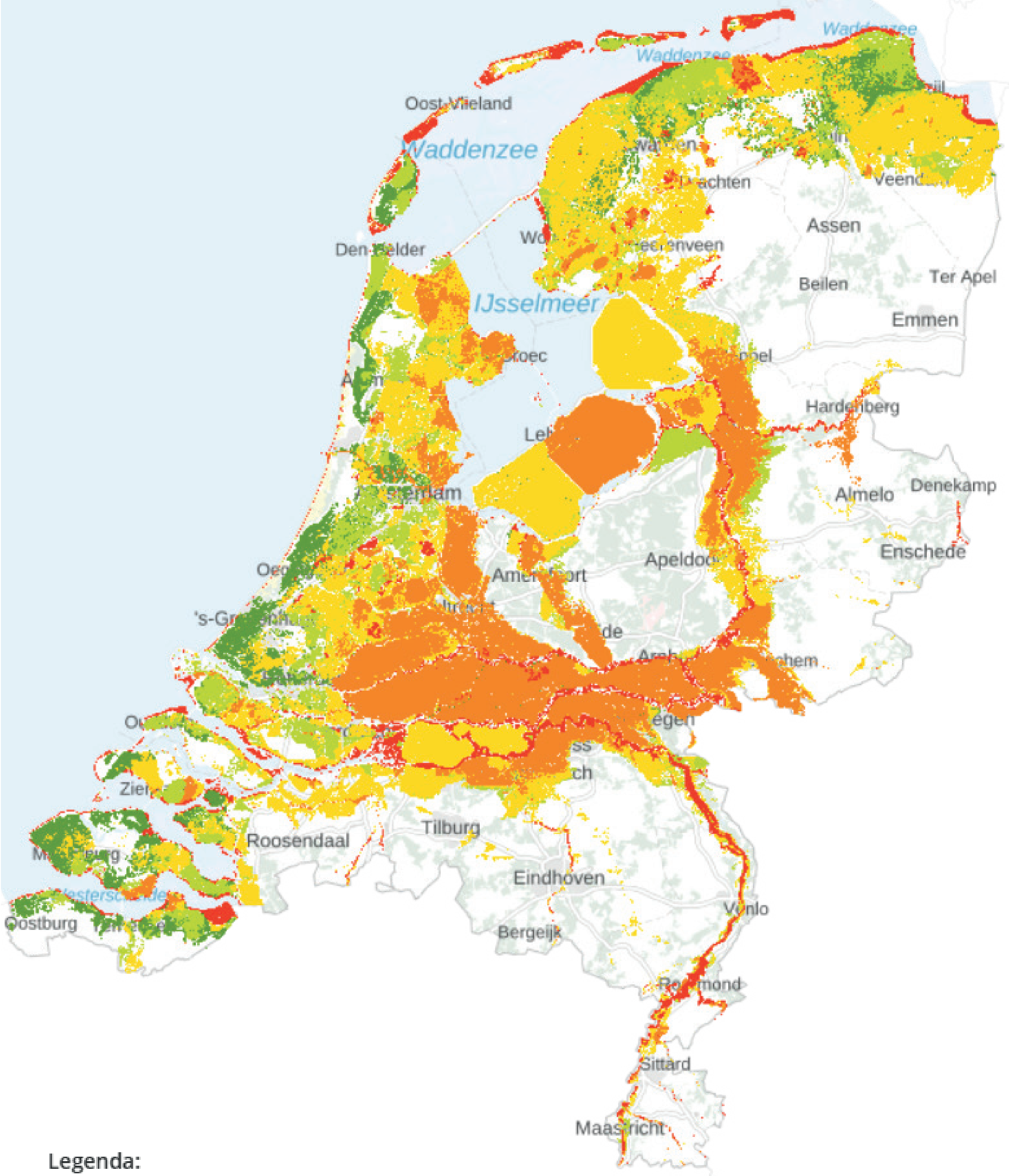


Overstromingsdiepte | Middelgrote kans

- Middelgrote kans: de kans dat een gebied ongeveer 1 keer in de 100 jaar overstroomt



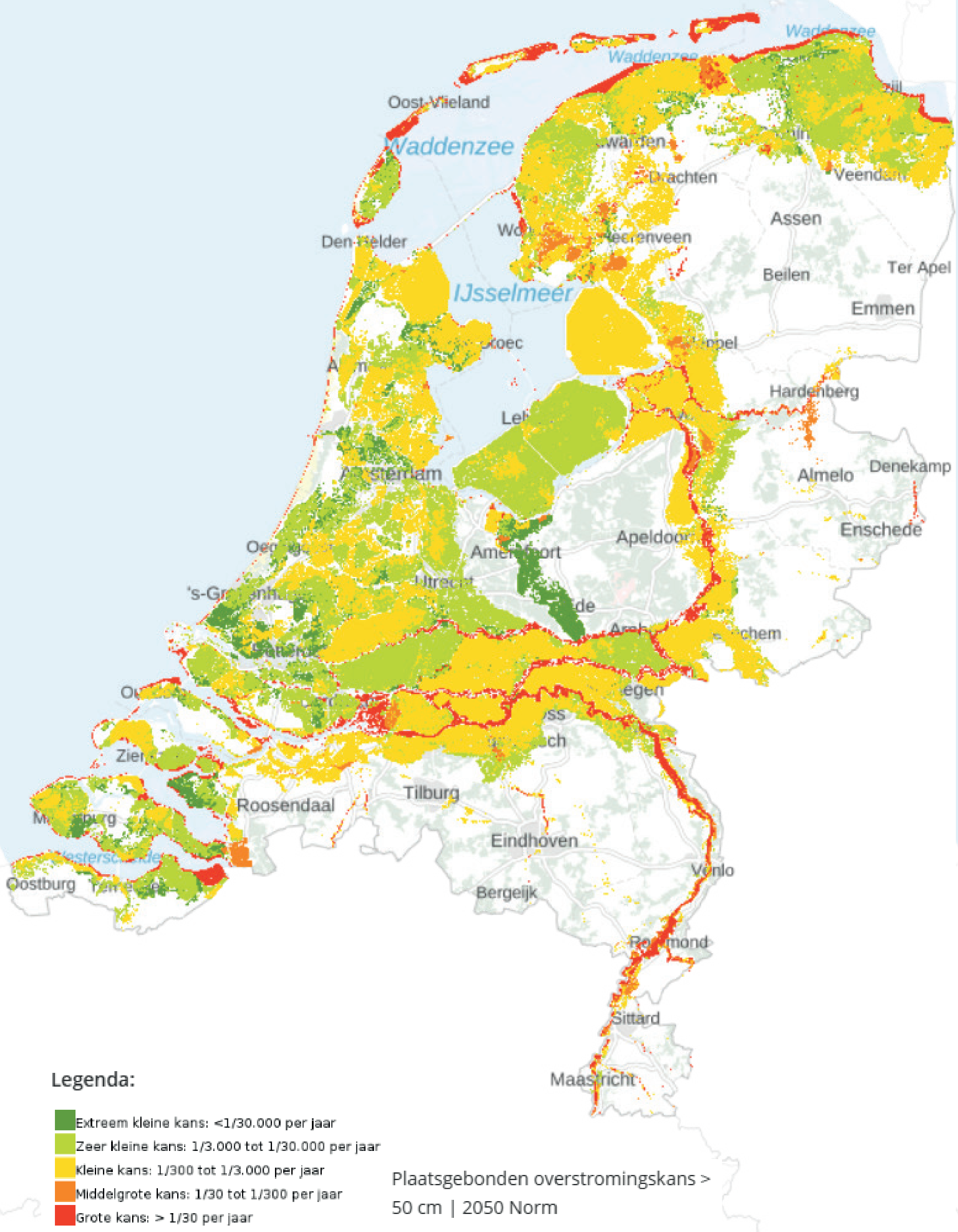
- Kleine kans: de kans dat een gebied ongeveer 1 keer in de 1000 jaar overstroomt

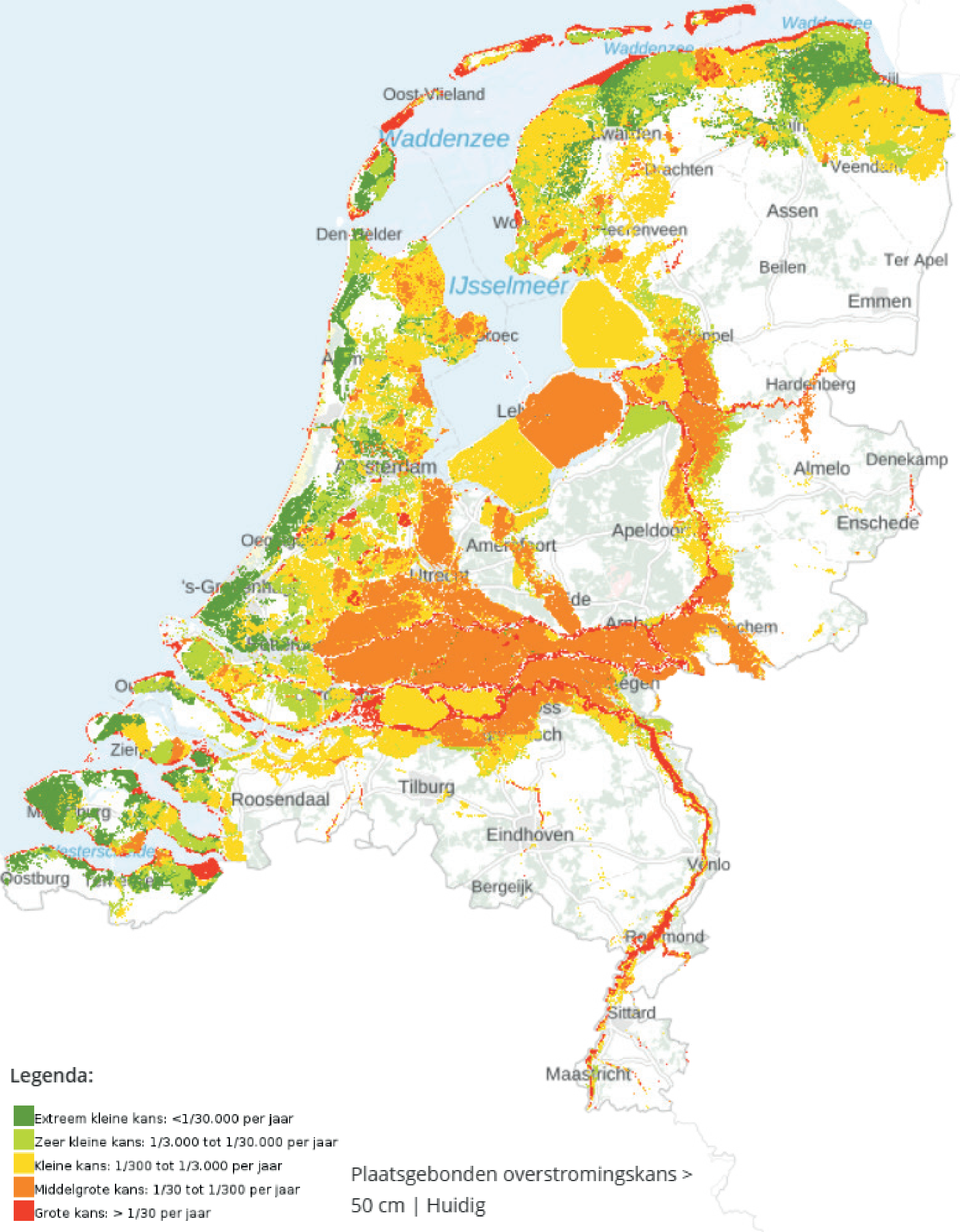


Legenda:

- Extreem kleine kans: <1/30.000 per jaar
- Zeer kleine kans: 1/3.000 tot 1/30.000 per jaar
- Kleine kans: 1/300 tot 1/3.000 per jaar
- Middelgrote kans: 1/30 tot 1/300 per jaar
- Grote kans: > 1/30 per jaar

Plaatsgebonden overstromingskans > 20 cm | Huidig


Waddenzee
Waddenzee
Oost-Vlieland
Waddenzee
Den Helder
IJsselmeer
Assen
Beilen
Ter Apel
Emmen
Hardenberg
Almelo
Denekamp
Enschede
Apeldoorn
Amersfoort
Utrecht
Tilburg
Roosendaal
Eindhoven
Venlo
Bergeijk
Sittard
Maastricht
Oostburg
Legenda:
Extreem kleine kans: <1/30.000 per jaar
Zeer kleine kans: 1/3.000 tot 1/30.000 per jaar
Kleine kans: 1/300 tot 1/3.000 per jaar
Middelgrote kans: 1/30 tot 1/300 per jaar
Grote kans: > 1/30 per jaar
Plaatsgebonden overstromingskans > 50 cm | 2050 Norm

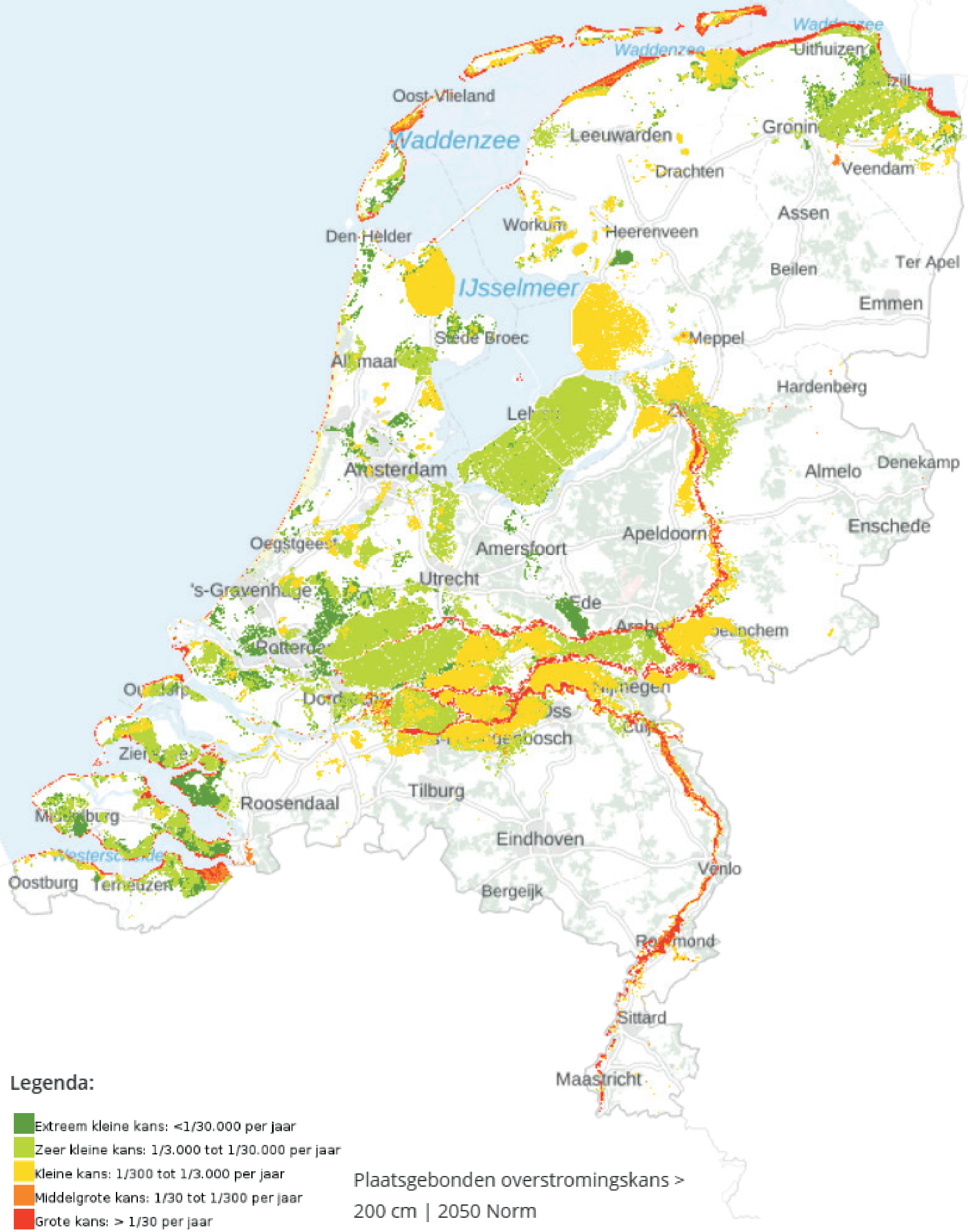

Waddenzee
Oost-Vlieland
Waddenzee
Den Helder
IJsselmeer
Assen
Beilen
Ter Apel
Emmen
Hardenberg
Almelo
Denekamp
Enschede
Apeldoorn
Amersfoort
Utrecht
Arnhem
Nijmegen
Tilburg
Roosendaal
Eindhoven
Venlo
Bergeijk
Sittard
Maastricht
Legenda:
Extreem kleine kans: <1/30.000 per jaar
Zeer kleine kans: 1/3.000 tot 1/30.000 per jaar
Kleine kans: 1/300 tot 1/3.000 per jaar
Middelgrote kans: 1/30 tot 1/300 per jaar
Grote kans: > 1/30 per jaar
Plaatsgebonden overstromingskans > 50 cm | Huidig

Waddenzee
Waddenzee
Uithuizen
Oost-Vlieland
Waddenzee
Leeuwarden
Gronin
Drachten
Veendam
Assen
Workum
Heerenveen
Den Helder
Beilen
Ter Apel
IJsselmeer
Emmen
Stede Broec
Meppel
Alkmaar
Hardenberg
Amsterdam
Almelo
Denekamp
Enschede
Apeldoorn
Amersfoort
Utrecht
's-Gravenhage
Ede
Tilburg
Roosendaal
Eindhoven
Venlo
Bergeijk
Sittard
Maastricht

Legenda:

- Extreem kleine kans: <1/30.000 per jaar
- Zeer kleine kans: 1/3.000 tot 1/30.000 per jaar
- Kleine kans: 1/300 tot 1/3.000 per jaar
- Middelgrote kans: 1/30 tot 1/300 per jaar
- Grote kans: > 1/30 per jaar

Plaatsgebonden overstromingskans > 200 cm | Huidig



Legenda:

- Extreem kleine kans: <1/30.000 per jaar
- Zeer kleine kans: 1/3.000 tot 1/30.000 per jaar
- Kleine kans: 1/300 tot 1/3.000 per jaar
- Middelgrote kans: 1/30 tot 1/300 per jaar
- Grote kans: > 1/30 per jaar

Plaatsgebonden overstromingskans > 200 cm | 2050 Norm

Legenda:

- Kleine kans door lage grondwaterstand
- Kleine toename kans
- Aanmerkelijke toename kans
- Grote toename kans
- Zeer grote toename kans

grondwateroverlast

- Hoge luchtvochtigheid in huis en schimmelvorming door natte kruipruimtes of optrekkend vocht in muren
- Doorslaand vocht in kelders
- Drassige tuinen en langdurig natte groenstroken in de wijk
- Schade aan stedelijk groen en omwaaien van bomen door verdrinking van wortels
- Schade aan panden als gevolg van wijziging in de opwaartse waterdruk onder de fundering
- Spoorvorming en ongelijkmatige verzakking van wegen en straatverharding

Waterdiepte hevige bui (140mm/2uur (kans 1:1000)

Legenda:

5 - 10 cm

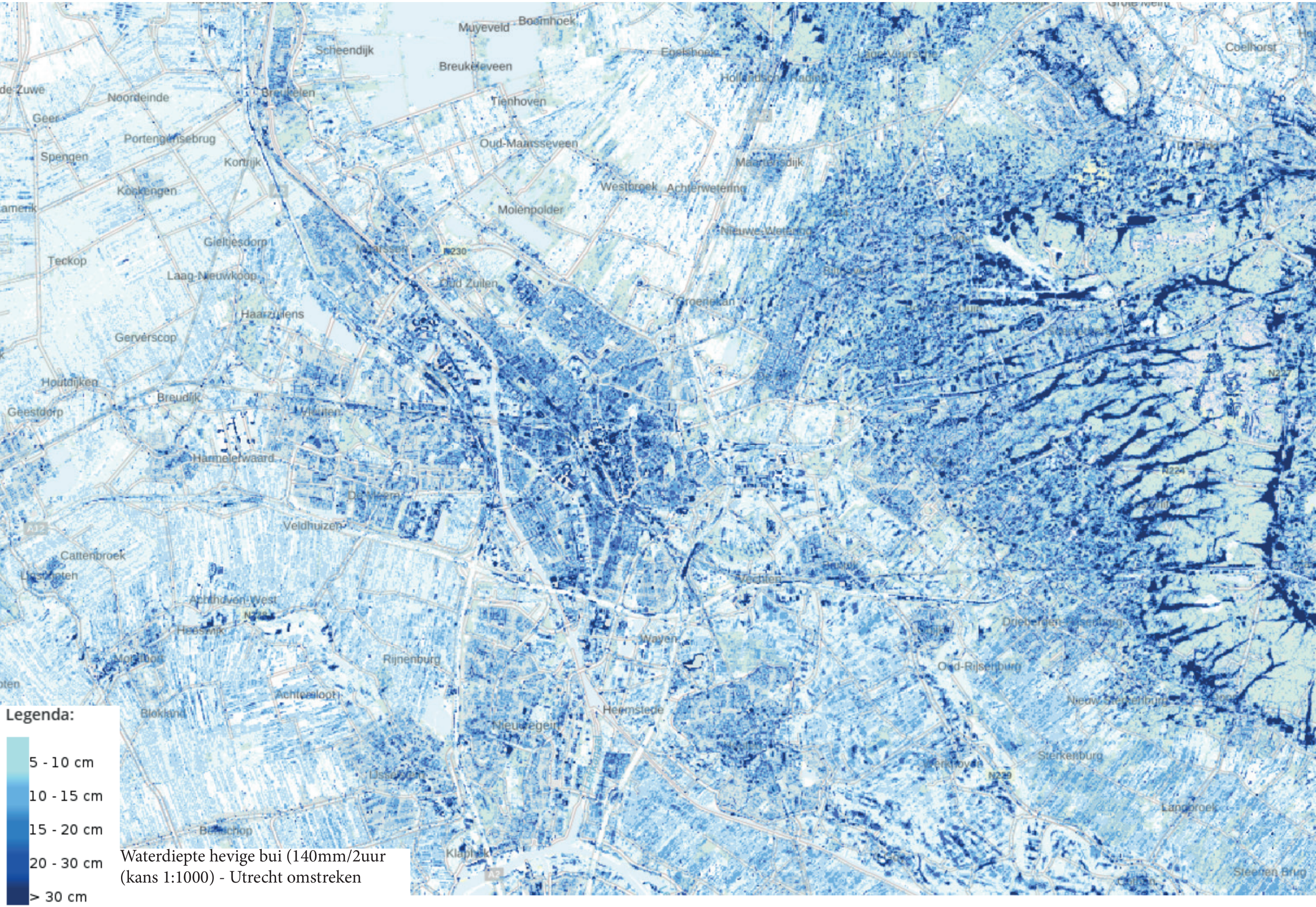
10 - 15 cm

15 - 20 cm

20 - 30 cm

> 30 cm

Waterdiepte hevige bui (70mm/2uur (kans 1: 100) - Utrecht omstreken



Waterdiepte hevige bui (140mm/2uur (kans 1:1000) - Utrecht omstreken

Legenda:

5 - 10 cm

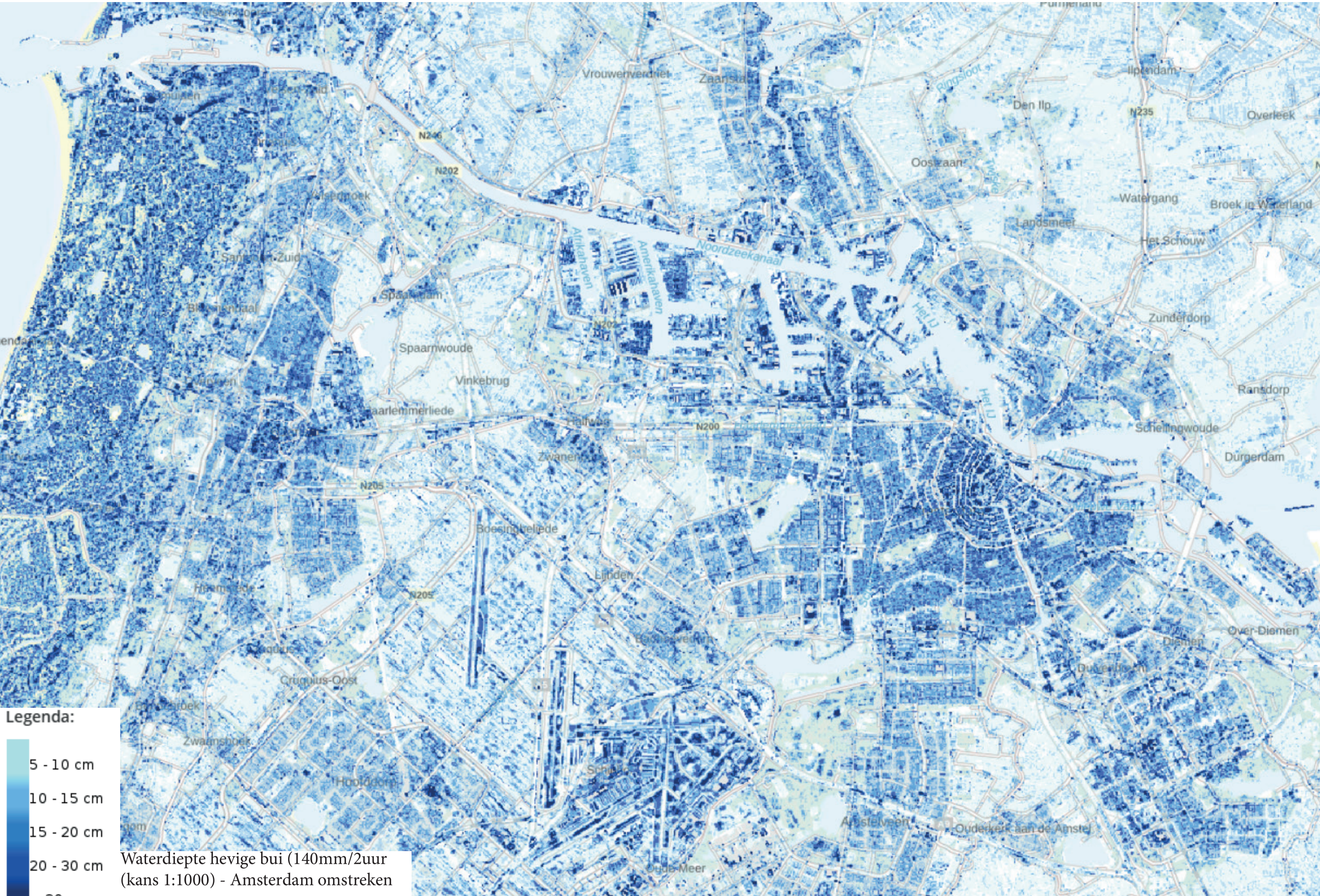
10 - 15 cm

15 - 20 cm

20 - 30 cm

> 30 cm

Waterdiepte hevige bui (70mm/2uur (kans 1:100) - Amsterdam omstreken



Waterdiepte hevige bui (140mm/2uur (kans 1:1000) - Amsterdam omstreken

Legenda:

5 - 10 cm

10 - 15 cm

15 - 20 cm

20 - 30 cm

> 30 cm

Waterdiepte hevige bui (70mm/2uur (kans 1:100) - Rotterdam omstreken

Legenda:

5 - 10 cm

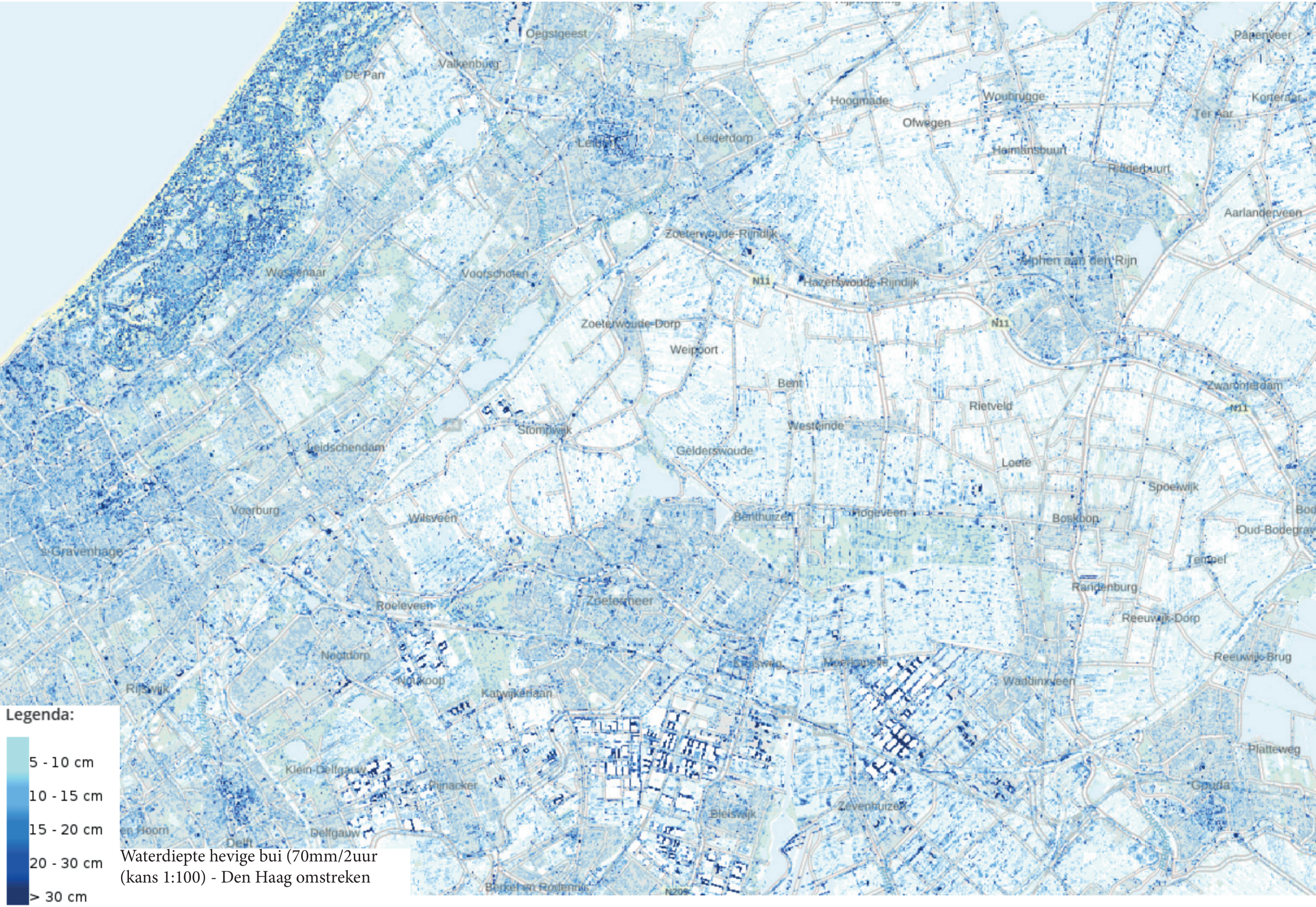
10 - 15 cm

15 - 20 cm

20 - 30 cm

> 30 cm

Waterdiepte hevige bui (140mm/2uur (kans 1:1000) - Rotterdam omstreken



Waterdiepte hevige bui (70mm/2uur (kans 1:100) - Den Haag omstreken

Legenda:

5 - 10 cm

10 - 15 cm

15 - 20 cm

20 - 30 cm

> 30 cm

Waterdiepte hevige bui (140mm/2uur (kans 1:1000) - Den Haag omstreken

Legenda:

5 - 10 cm

10 - 15 cm

15 - 20 cm

20 - 30 cm

> 30 cm

Waterdiepte hevige bui (70mm/2uur (kans 1:100) - Den Bosch omstreken

Legenda:

5 - 10 cm

10 - 15 cm

15 - 20 cm

20 - 30 cm

> 30 cm

Waterdiepte hevige bui (140mm/2uur (kans 1:1000) - Den Bosch omstreken

Legenda:

5 - 10 cm

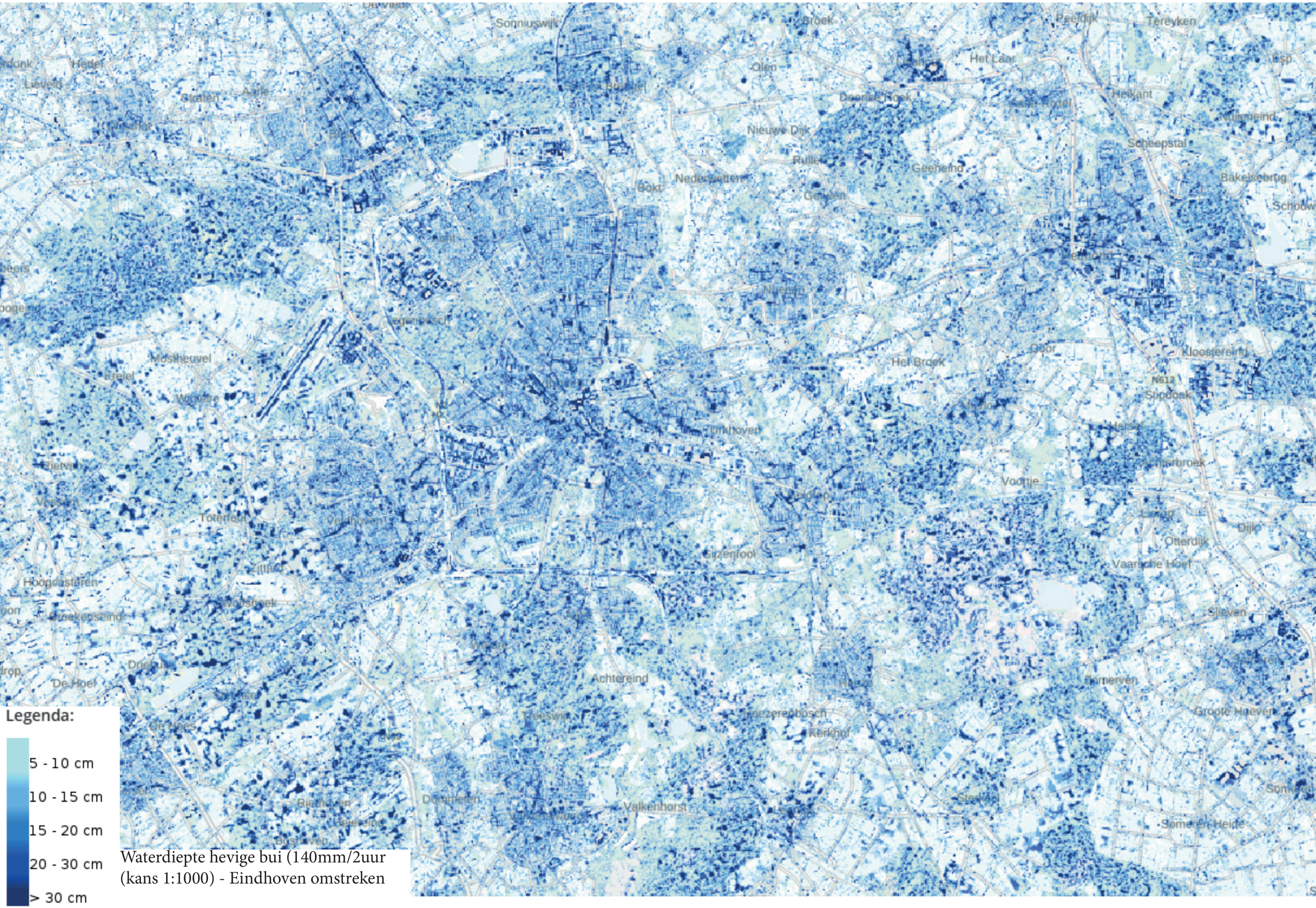
10 - 15 cm

15 - 20 cm

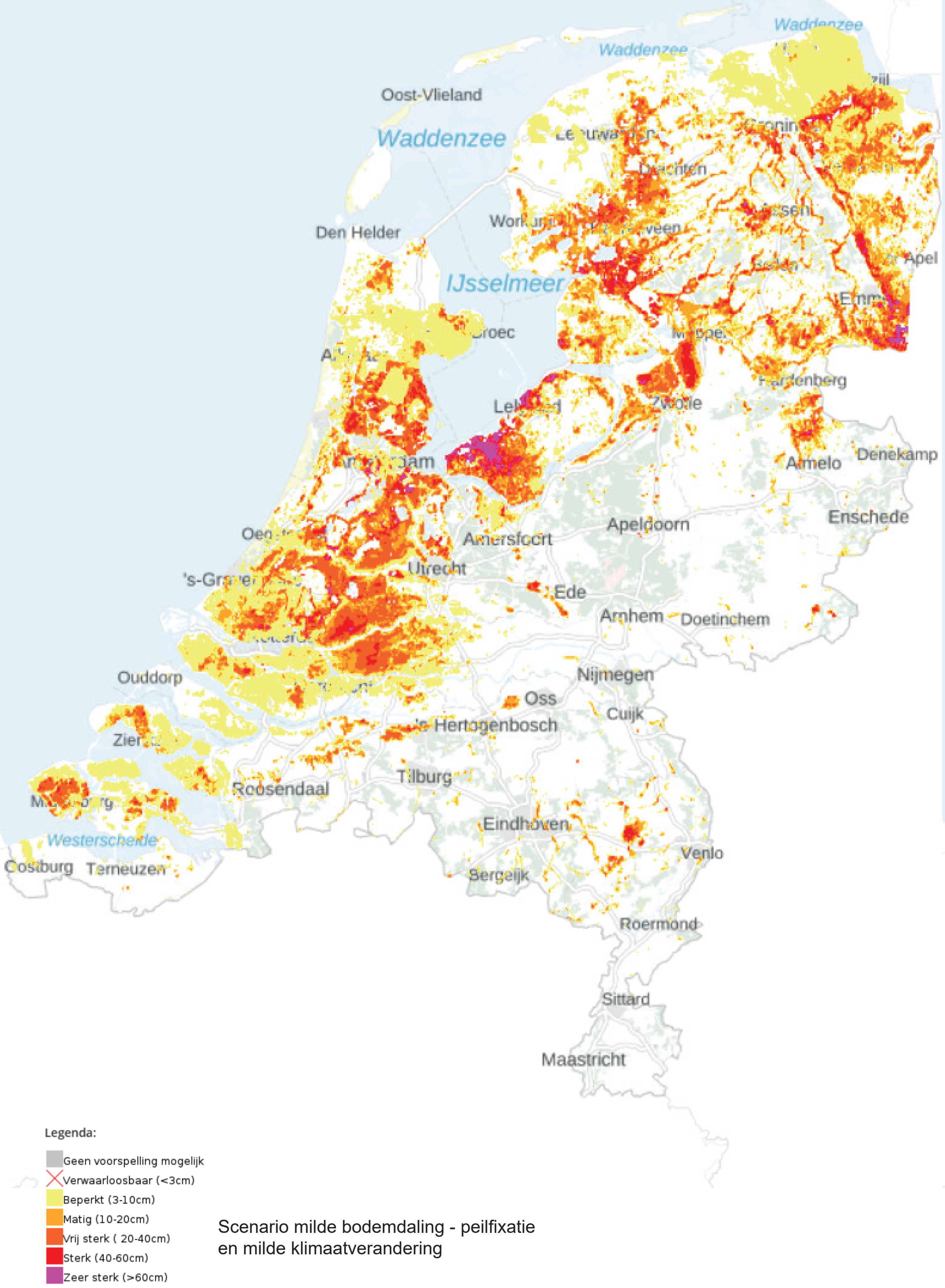
20 - 30 cm

> 30 cm

Waterdiepte hevige bui (70mm/2uur (kans 1:100) - Eindhoven omstreken



Waterdiepte hevige bui (140mm/2uur (kans 1:1000) - Eindhoven omstreken



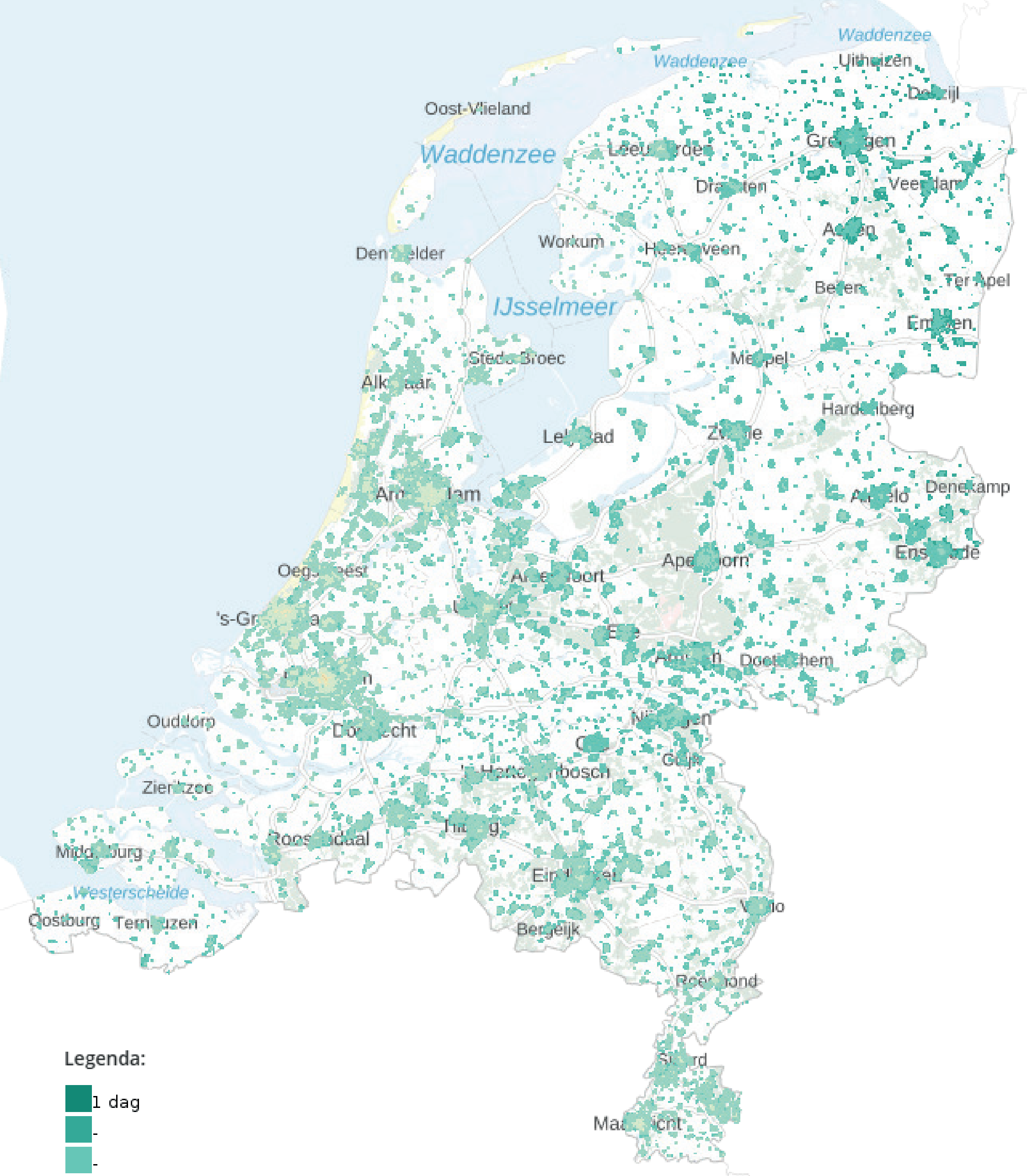
Scenario milde bodemdaling - peilfixatie
en milde klimaatverandering

Waddenzee
Waddenzee
Waddenzee
Oost-Vlieland
Den Helder
IJsselmeer
Groningen
Leeuwarden
Drachten
Assen
Emmen
Apel
Hoogeveen
Lelystad
Zwolle
Harderwijk
Amsterdam
Almelo
Denekamp
Enschede
Apeldoorn
Amersfoort
Utrecht
Ede
Arnhem
Doetinchem
Nijmegen
Oss
's Hertogenbosch
Cuijk
Ouddorp
Tilburg
Roosendaal
Eindhoven
Venlo
Roermond
Sittard
Maastricht
Westerschelde
Vlissingen
Terneuzen

Legenda:

- Geen voorspelling mogelijk
- Verwaarloosbaar (<3cm)
- Beperkt (3-10cm)
- Matig (10-20cm)
- Vrij sterk (20-40cm)
- Sterk (40-60cm)
- Zeer sterk (>60cm)

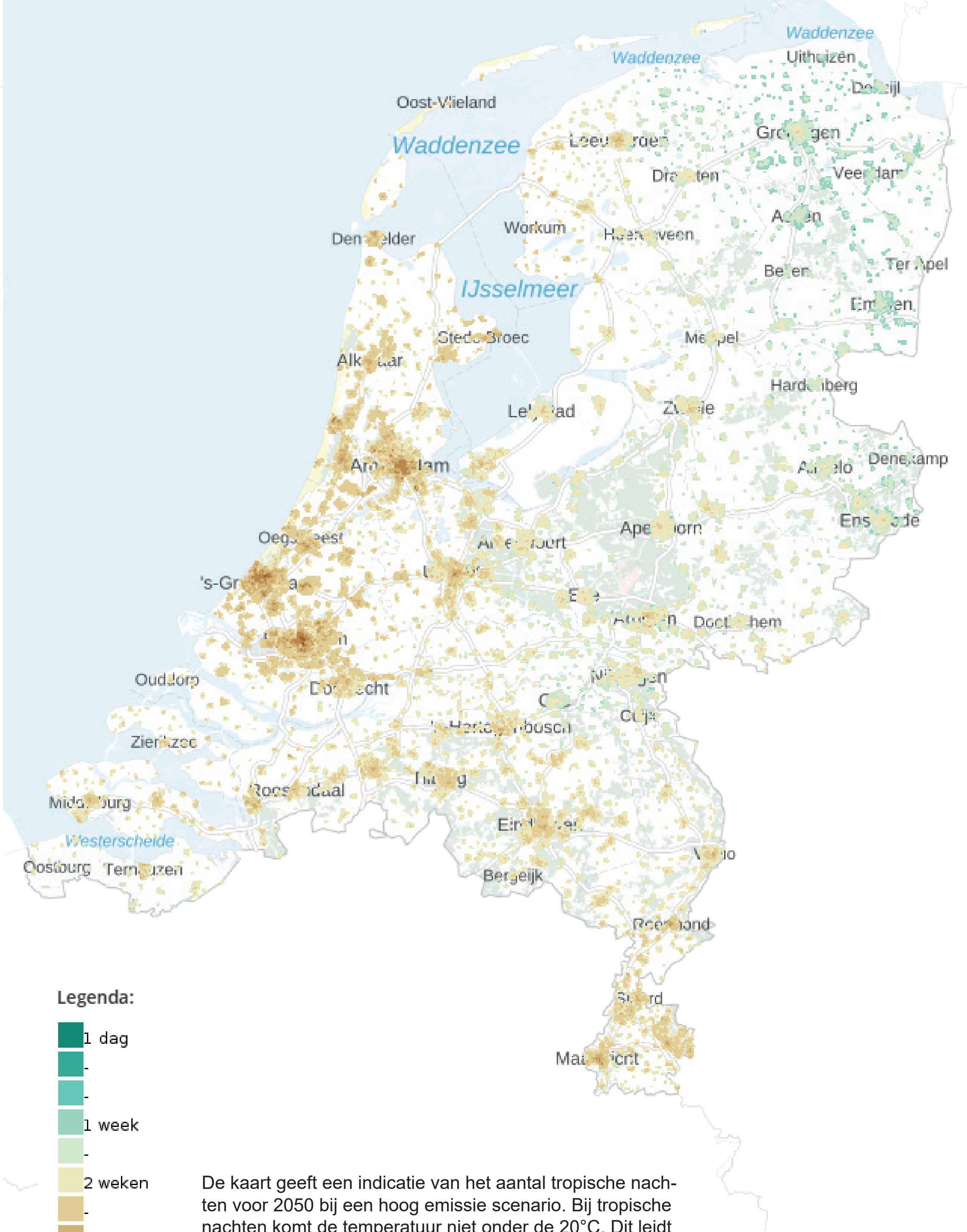
Scenario hevige bodemdaling - peilindexatie
en sterke klimaatverandering



Legenda:

- 1 dag
- -
- -
- 1 week
- -
- 2 weken
- -
- 3 weken
- -
- >1 maand

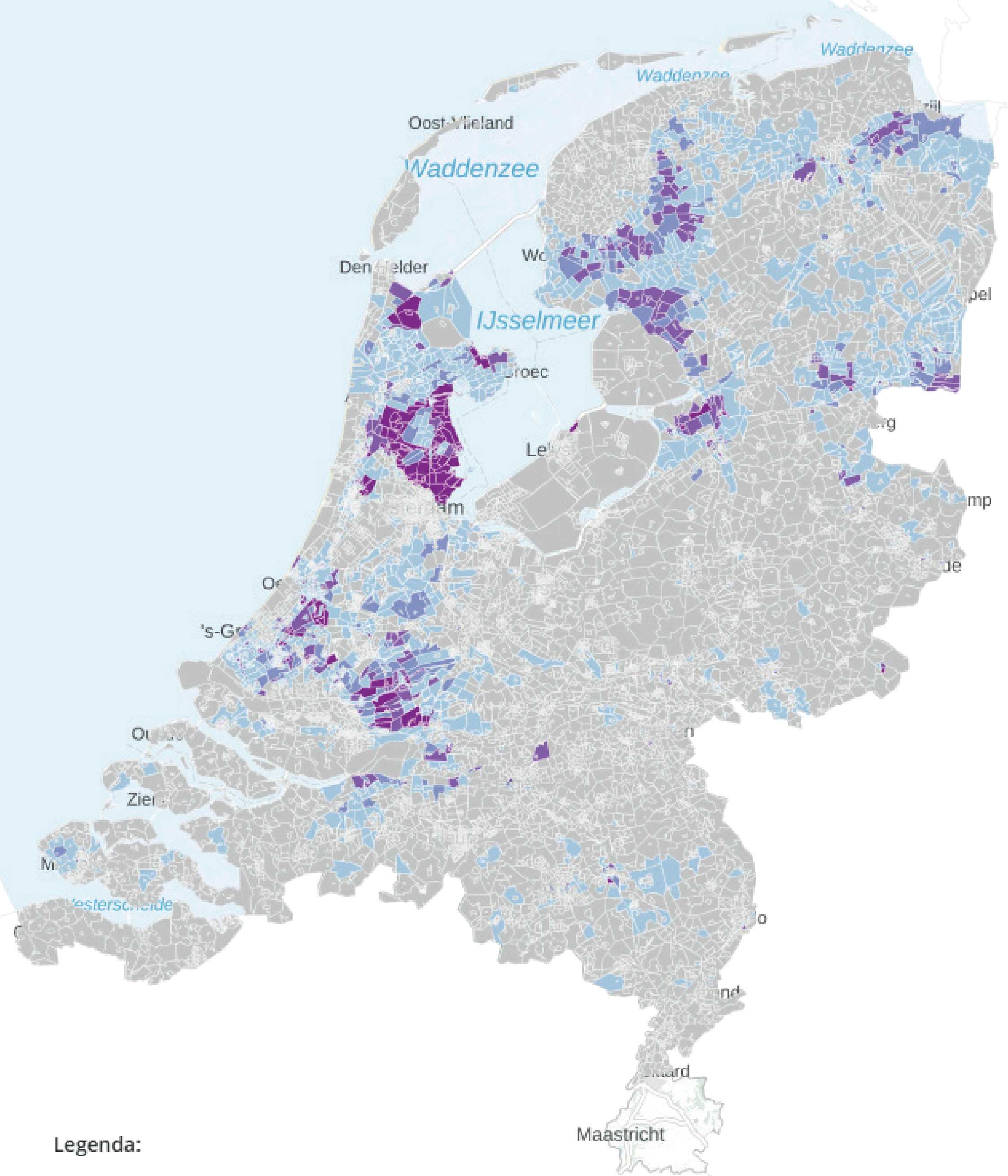
De kaart geeft een indicatie van het aantal tropische nachten voor het huidige klimaat (1981-2010) voor stedelijke gebieden. Bij tropische nachten komt de temperatuur niet onder de 20°C. Dit leidt tot risico's voor de gezondheid.



Legenda:

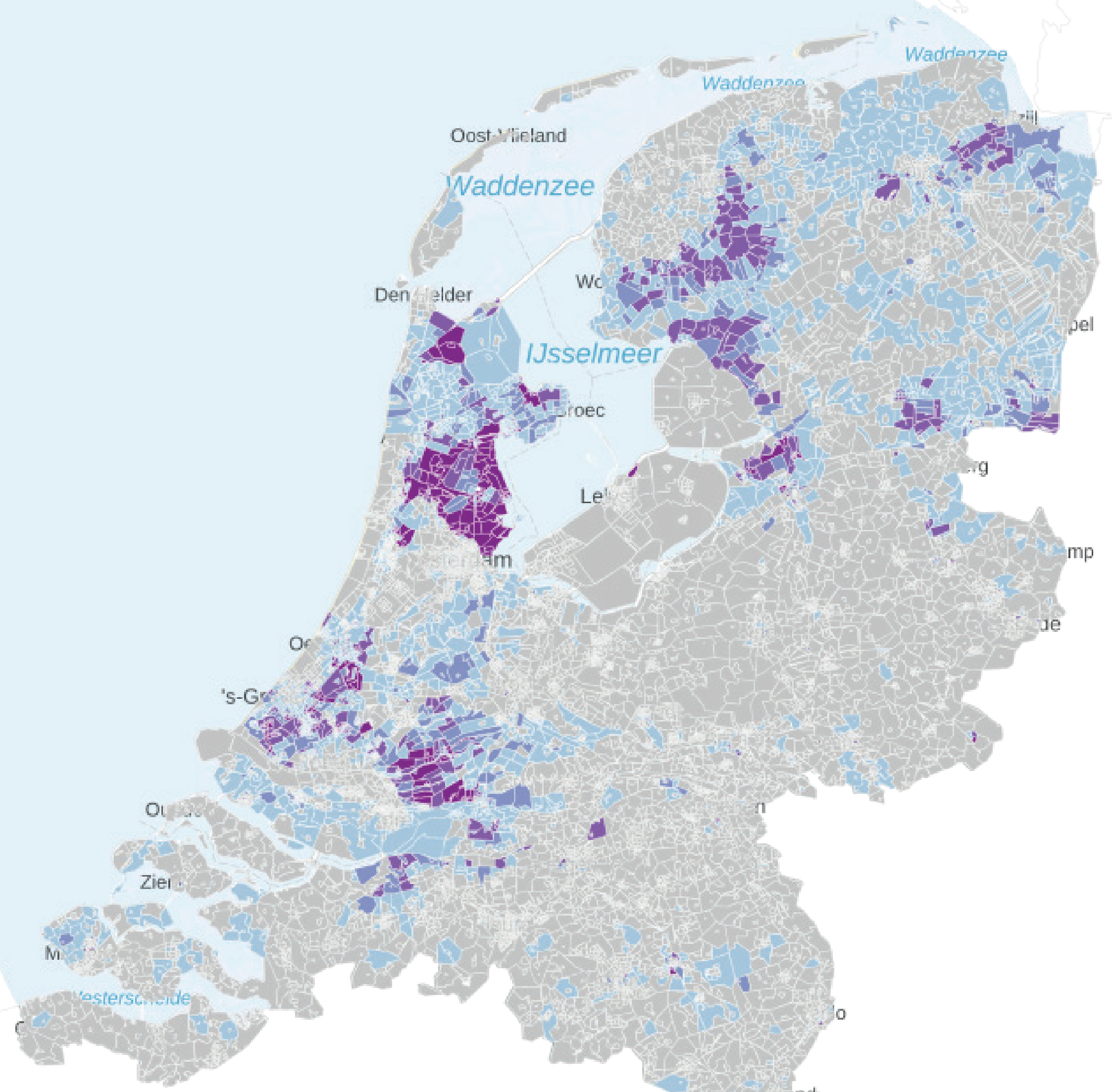
- 1 dag
- -
- -
- 1 week
- -
- 2 weken
- -
- 3 weken
- -
- >1 maand

De kaart geeft een indicatie van het aantal tropische nachten voor 2050 bij een hoog emissie scenario. Bij tropische nachten komt de temperatuur niet onder de 20°C. Dit leidt tot risico's voor de gezondheid.



Verschilzetting scenario 2050 laag

De panden die voor 1975 gebouwd zijn op een ondiepe fundering (‘op staal’) op ondergrond waar veen of klei in voorkomt zijn gevoelig voor verschilzetting. Dat betekent dat ze door bodemdaling of krimp-zwel gedrag van kleibodems kunnen scheefzakken.

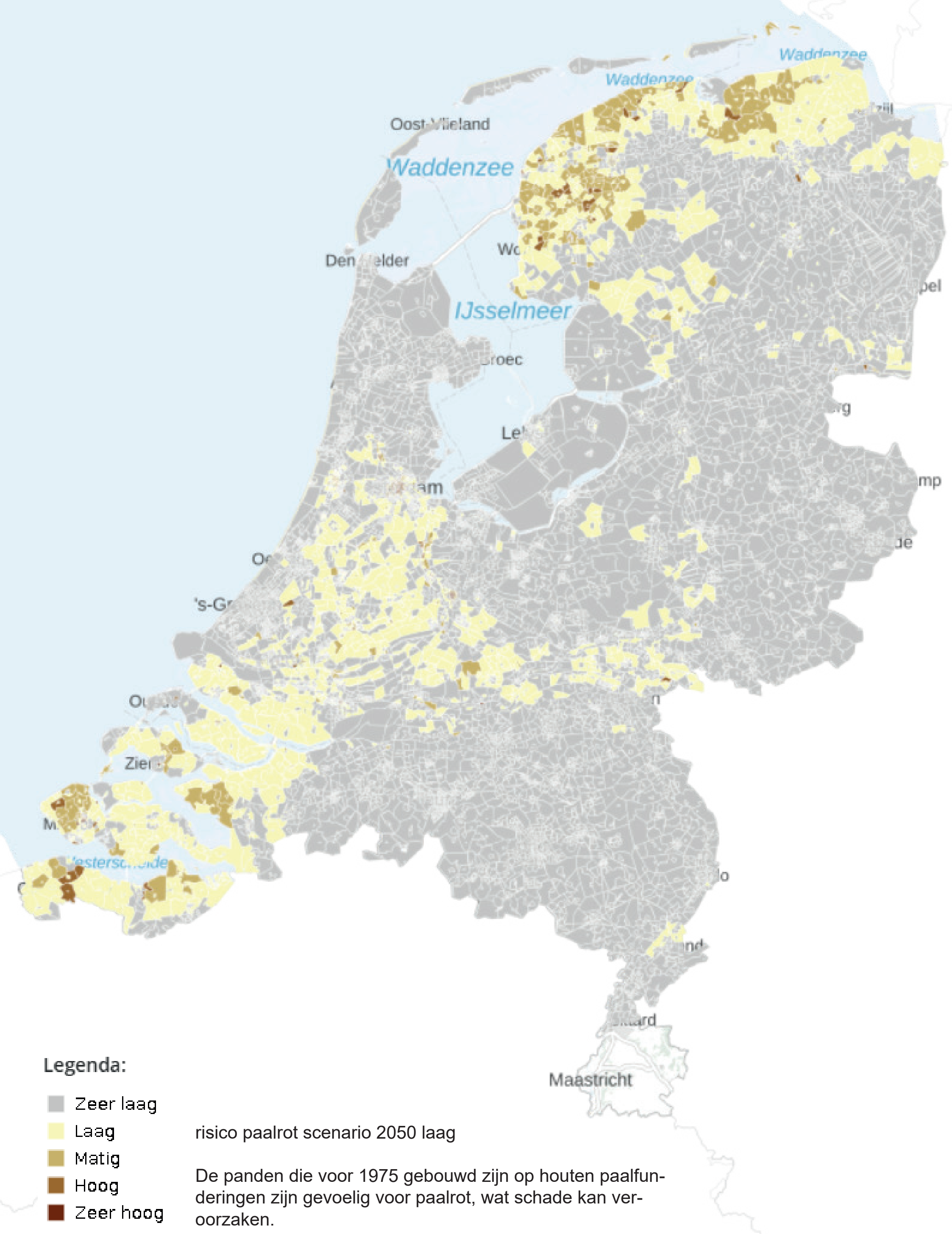


Legenda:

- Zeer laag
- Laag
- Matig
- Hoog
- Zeer hoog

Verschilzetting scenario 2050 hoog

De panden die voor 1975 gebouwd zijn op een ondiepe fundering (‘op staal’) op ondergrond waar veen of klei in voorkomt zijn gevoelig voor verschilzetting. Dat betekent dat ze door bodemdaling of krimp-zwel gedrag van kleibodems kunnen scheefzakken.

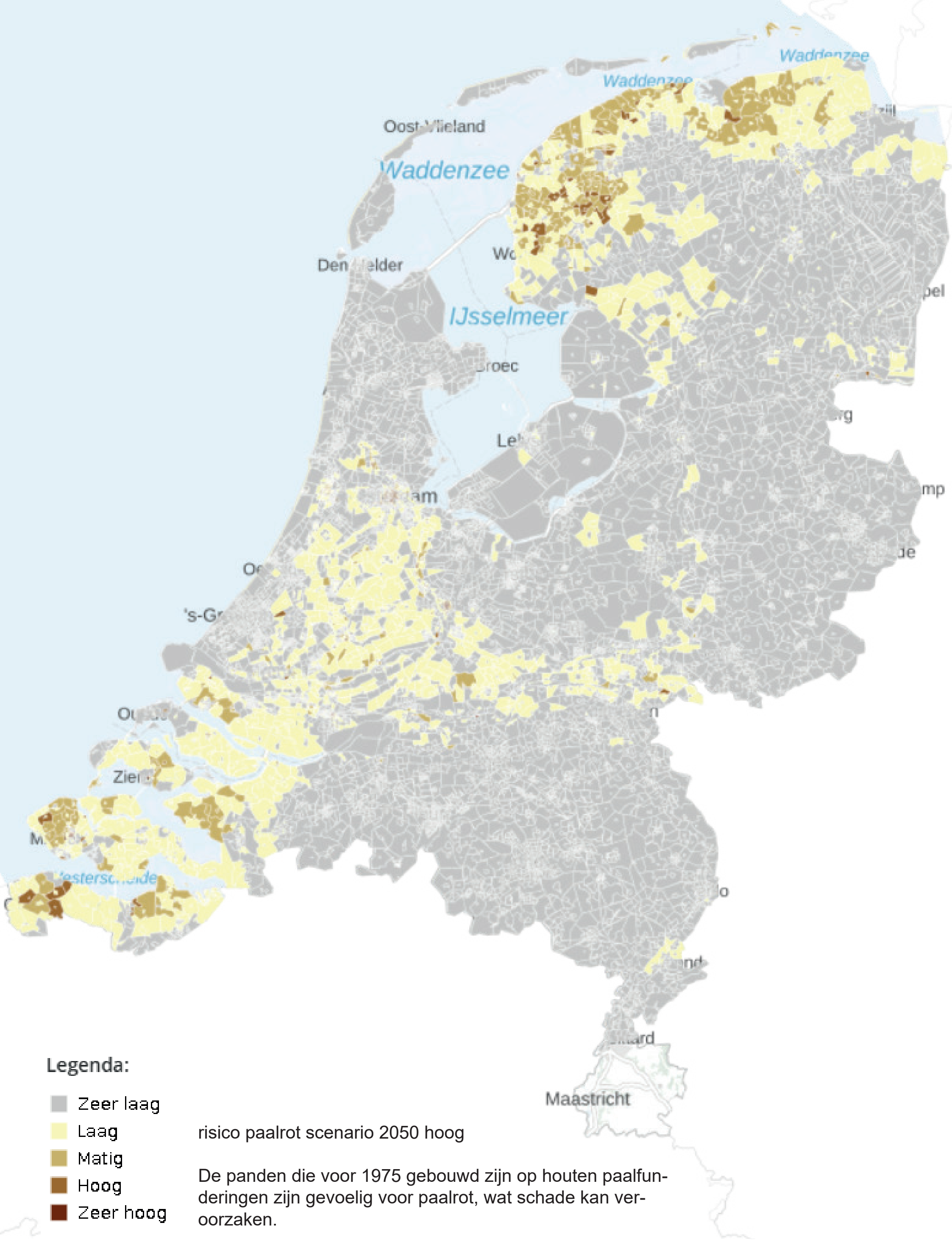


Legenda:

- Zeer laag
- Laag
- Matig
- Hoog
- Zeer hoog

risico paalrot scenario 2050 laag

De panden die voor 1975 gebouwd zijn op houten paalfunderingen zijn gevoelig voor paalrot, wat schade kan veroorzaken.



risico paalrot scenario 2050 hoog

De panden die voor 1975 gebouwd zijn op houten paalfunderingen zijn gevoelig voor paalrot, wat schade kan veroorzaken.

Legenda:

- Zeer laag
- Laag
- Matig
- Hoog
- Zeer hoog

Risico paalrot Amsterdam-Haarlem omstreken - scenario laag

Legenda:

- Zeer laag
- Laag
- Matig
- Hoog
- Zeer hoog

Risico paalrot Schiedam- Rotterdam omstreken - scenario laag

Legenda:

- Zeer laag
- Laag
- Matig
- Hoog
- Zeer hoog

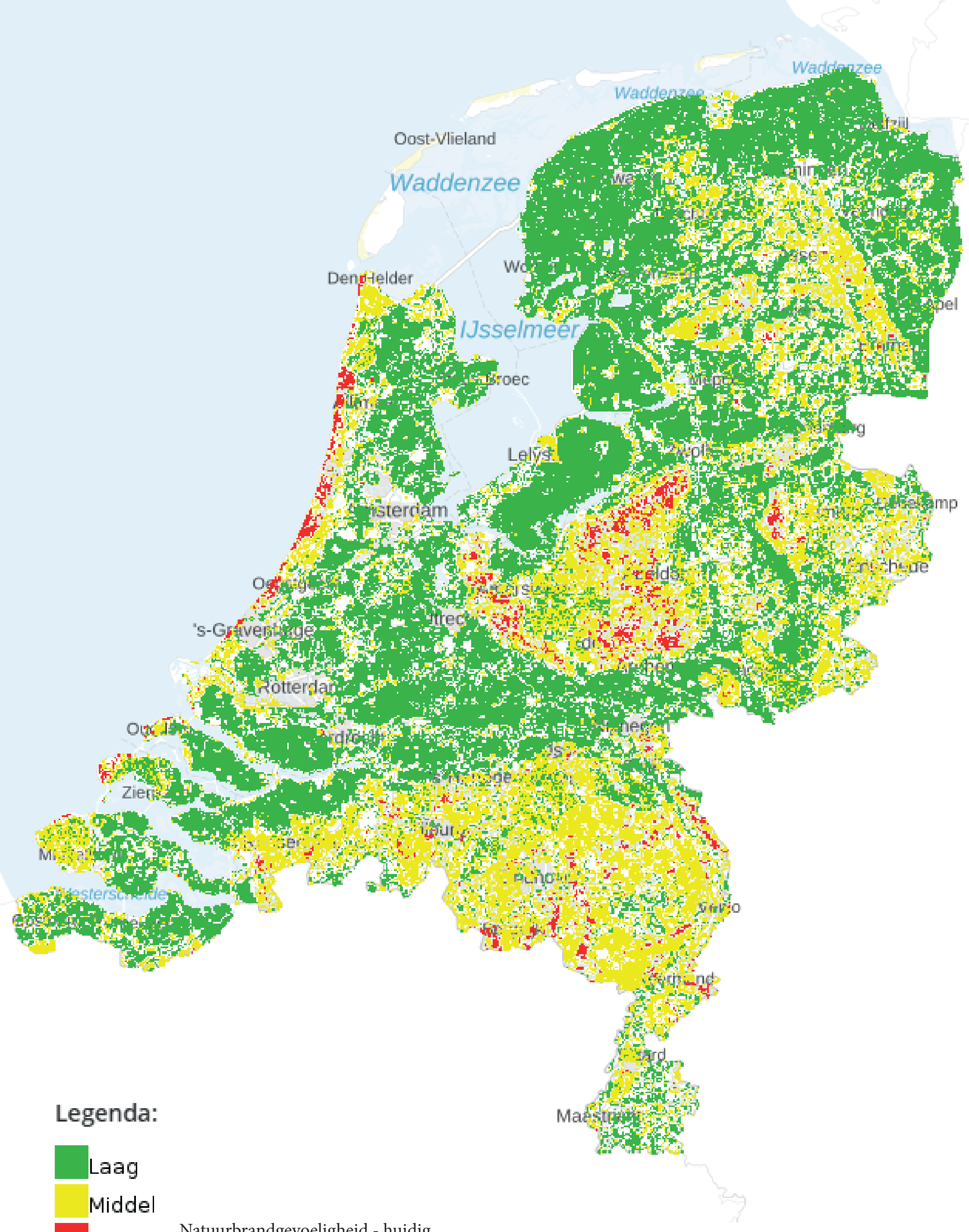
Risico paalrot Utrecht Breukelen omstreken - scenario laag


Waddenzee
Waddenzee
Uithuizen
Delfzijl
Oost-Vlieland
Waddenzee
Leeuwarden
Groningen
Drachten
Veendam
Assen
Workum
Heerenveen
Den Helder
Ter Apel
Beilen
IJsselmeer
Emmen
Stede Broec
Meppel
Alkmaar
Hardenberg
Lelystad
Zwolle
Amsterdam
Almelo
Denekamp
Enschede
Oegstgeest
Amersfoort
Apeldoorn
Utrecht
's-Gravenhage
Ede
Arnhem
Doetinchem
Rotterdam
Nijmegen
Ouddorp
Dordrecht
Oss
Cuijk
's-Hertogenbosch
Zierikzee
Tilburg
Roosendaal
Middelburg
Eindhoven
Westerschelde
Venlo
Oostburg
Terneuzen
Bergeijk
Roermond
Sittard
Maastricht

Waddenzee
Waddenzee
Oost-Vlieland
Waddenzee
Veendam
Assen
Heerenveen
Ter Apel
IJsselmeer
Emmen
Hardenberg
Aimelo
Denekamp
Enschede
Apeldoorn
Amersfoort
Ede
Oss
Cuijk
Tilburg
Roosendaal
Eindhoven
Venlo
Bergeijk
Roermond
Maastricht

Niet noemenswaardig
3 - 10 cm
10 - 25 cm
25 - 50 cm
50 - 100 cm
> 100 cm

Bodemdaling door ophoging



Natuurbrandgevoeligheid - huidig

Legenda:

Laag

Middel

Hoog

Natuurbrandgevoeligheid - 2050 Hoog