

Integrating flood risk in real estate management strategies

Real Estate Management in owner-occupied corporate and public contexts

“How can real estate owner-occupiers integrate flood risk management into their real estate strategies?”



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Colophon

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Abstract

Due to climate change, there is an increasing severity of extreme weather events and a rising sea level. This combination will lead to more flood-prone areas and areas at higher risk of flooding, which makes real estate located in these areas more vulnerable to flooding. Especially in the Netherlands, where a majority of the land lies below sea level, the risk of flooding is increasing. Real estate assets of organisations, often located in economically attractive but flood-prone regions, are increasingly exposed to physical damage, business disruptions, reputational risks, and a potential decline in property value. Flood risks are becoming an urgent concern in real estate management (REM) in the owner-occupier context. However, owner-occupiers of organisations have dual responsibilities: the asset as a workplace and operational continuity to retain business performance. While real estate owners, who also occupy the assets, continue to prioritise financial performance and operational efficiency, flood risks are not yet represented in REM strategies. This research explores how flood risks can be integrated into real estate strategies to support portfolio management on strategic, tactical and operational levels. The study answers the following main question: *“How can real estate owner-occupiers integrate flood risk management into their real estate strategies?”*

To answer the research question, this research follows a multimethod approach, qualitative and exploratory. This study combines desk research, empirical research, and a synthesis. The desk research, a literature study, focuses on exploring different concepts and their interrelationships. Concepts covered include (corporate) real estate management, risk management, flood risks, flood risk assessment, asset management, and business operational management. Its purpose is to identify flood risks in the real estate sector and examine their impact on real estate management, both strategically and operationally, at the asset and operational level. The empirical research includes exploratory interviews, three case studies, in-depth interviews, and a cross-case analysis. The purpose is to gain empirical insight into how flood risk is managed in REM and create practical knowledge to integrate flood risks into real estate management strategies. In the synthesis, the knowledge gathered in the desk research and the empirical research is combined.

This research aims to gain knowledge about the impact of flooding on real estate, integrating flood risks in REM, and to explore how owner-occupiers of real estate can start integrating flood risks into REM strategies. The practical deliverable following the academic insights delivered in this thesis is a theoretically informed roadmap that can be used to guide the integration of flood risk into real estate management strategies for owner-occupiers of corporate and public organisations.

Keywords: (corporate) real estate management, risk management, flood risk, portfolio management, business operations, flood resilience.

Preface

In 2019, I began my studies at the TU Delft. From an early age, I have been fascinated by the built environment. During my Bachelor's in Architecture, I gradually discovered that design was not my true passion within the field. Instead, I became intrigued by value creation, the process of developing buildings, and how the built environment aligns with the diverse values and needs of stakeholders. The Master's track *Management in the Built Environment* perfectly matched these interests. This programme provided me with valuable insights into how processes unfold within the built environment. Beyond its theoretical content, I believe the master's programme has also equipped me with practical knowledge that will be highly relevant in professional practice.

When it came to selecting a graduation topic, I quickly realised that I wanted to focus on flood risk in relation to the built environment. I have always been fascinated by how the Netherlands has historically managed flood risks, and how these risks appear to be increasing due to climate change. However, I found it interesting to understand how flood risks translate into the management of the built environment.

This research contributes to understanding how flood risks can be integrated into real estate management strategies. By focusing on flood risk and its integration into real estate management for public and corporate organisations that use their real estate portfolio to achieve their business objectives, this study explores a topic that has long captured my interest.

I received help from various people while conducting this research. I would like to thank these people. I would like to express my sincere gratitude to my supervisors, Ellen van Bueren and Alexandra den Heijer, for your guidance and support throughout this research. Your suggestions and critical questions have been invaluable in shaping this study. I also deeply appreciate your personal engagement, regularly checking in on how I was doing meant a great deal to me.

My thanks also go to Cazimir Boon, who helped me transform my research idea into a practical and feasible study. Your advice and the practical tools you provided were essential. By leveraging your network and introducing me to CBRE, you enabled me to carry out the empirical part of this research. You were always open to brainstorming and willing to help whenever I had questions. Thank you for that.

Finally, I would like to thank my friends and family. You have always been there for me, both in relation to this graduation project and during personal circumstances that required significant attention over the past year. Your support has been invaluable.

Many thanks.

Sincerely,

Willemijn Fanoy
Delft, January 2026

Executive summary

Due to climate change, sea levels are rising, precipitation patterns are changing, and the severity of extreme weather events is increasing, leading to an expansion of flood-prone areas and elevated risk levels (Botzen et al., 2010; IPCC, 2023). In the Netherlands, where a large proportion of land lies below sea level, the risk of flooding is particularly significant (Henkens et al., 2024). Real estate assets owned and occupied by organisations, which are often situated in economically attractive but flood-prone regions such as the Randstad, face growing exposure to physical damage, operational disruptions, reputational risks, and potential declines in property value (Boland et al., 2022; Sun et al., 2022).

Flood risks are becoming an urgent concern in Real Estate Management (REM), especially for owner-occupiers who have dual responsibilities: safeguarding the asset as a workplace and ensuring operational continuity to maintain business performance (Weinhofer & Busch, 2013). While REM frameworks traditionally emphasise cost-efficiency and flexibility, flood risks are not yet systematically integrated into real estate management strategies (Bartelink et al., 2015; Huffman, 2002; Shah et al., 2014). Existing research and practices in real estate management tend to focus on economic optimisation and flexibility, often overlooking the physical risks of flood hazards. Moreover, most research addresses flood risk management in public infrastructure or residential housing, whereas corporate and public real estate, closely aligned with business operations, has not been studied in depth. This creates a research gap: risk management in REM is relatively well-developed, but there is insufficient focus on integrating flood risk into these strategies. This research addresses this gap by exploring how flood risk can be integrated into REM strategies to support portfolio management at strategic, tactical, and operational levels. The study answers the following main question:

“How can real estate owner-occupiers integrate flood risk management into their real estate strategies?”

To address this question, a qualitative, exploratory multi-method research design was applied. The study consists of three parts. First, the desk research provides a theoretical background on (corporate) real estate management, risk management, flood risk assessment, asset management, and business continuity. Existing frameworks, such as the CREM Four Quadrant Model and Winch’s risk management cycle, were analysed for their applicability to flood risks. In addition, tools are analysed that can be used to integrate flood risks into REM. Second, empirical research includes exploratory interviews and three case studies (TU Delft Campus, ING Headquarters, and the Rijksvastgoedbedrijf in The Hague Central) supported by in-depth interviews, in-case analyses, and a cross-case analysis. Finally, the synthesis combines theoretical and empirical insights into a theoretically informed roadmap that serves as a structured guide for owner-occupiers of corporate or public organisations to initiate and shape their approach toward resilience, rather than prescribing rigid steps.

Findings of desk research

Real Estate Management (REM) is defined as aligning real estate assets with business operations. The CREM Four Quadrant Model by Krumm (1999) and Den Heijer (2021) is used to structure the analysis. The quadrants consist of four dimensions: Organisational, Functional, Financial, and Physical. Flood risks affect all dimensions of real estate management and influence the alignment between portfolio, assets, and business operations across strategic, tactical, and operational levels.

Risk management theory provides a structured process for addressing these risks: Identify, Assess, Respond, and Control (Winch, 2010). Identification begins with recognising the different types of flooding: fluvial, lacustrine, coastal, and pluvial (Environmental Health Atlas, z.d.). Once identified, risks should be assessed using structured methods such as the Location-Oriented Approach, which uses location-specific data, building characteristics, and local flood protection systems (Wu et al., 2024), and the Framework for Climate Adaptive Buildings (Dutch Green Building Council, 2022). Responses occur at both asset and operational levels. At the asset level, flooding accelerates depreciation and increases maintenance costs (Bartelink et al., 2015; Weinhofer & Busch, 2013). Physical measures can mitigate

these impacts (Rotterdam, n.d.). At the operational level, flooding introduces health and safety, flexibility, occupancy, and technical risks (Bartelink et al., 2015; Endendijk et al., 2024). Indirect impacts include business disruption, productivity loss, and reputational damage (Bartelink et al., 2015; Weinhofer & Busch, 2013). Business Continuity Plans are essential to maintain critical processes during and after disruptive events (Cerullo & Cerullo, 2004; Yang et al., 2020).

Finally, decision-making on flood risk measures requires balancing resilience with financial feasibility. Multi-Criteria Decision Analysis (MCD) supports complex evaluations (Arkesteijn & Binnekamp, 2013), while Cost-Benefit Analysis (CBA) weighs implementation costs against expected benefits in risk reduction (Jonkman et al., 2004; Špačková & Straub, 2015). Various studies using CBA show that taking proactive flood measures is more cost-effective in the long-term than reactive responses dealing with the direct and indirect consequences of flooding. (Abe & Adriaens, 2025; Molinari et al., 2021; OECD, 2016)

Findings of empirical research

The empirical research, based on case studies and exploratory interviews, shows that current Real Estate Management (REM) strategies address flood risk in a fragmented and inconsistent manner. Public organisations such as TU Delft and RVB have started assessing flood risks as part of broader climate resilience goals, mainly driven by regulatory requirements and sustainability ambitions. However, these efforts lack operational translation and a comprehensive strategy across all organisational levels. Corporate organisations, such as ING, demonstrate stronger operational preparedness through Business Continuity Plans, yet flood risks are rarely assessed and embedded in real estate management strategies, and physical mitigation measures remain minimal. Actions tend to be reactive at the operational level.

Interviewees emphasised the need for structured frameworks, clear responsibilities, and practical tools to move from awareness to action. Without such integration, organisations remain vulnerable to operational disruptions and physical impact on assets of floodings.

Conclusion & recommendations

This research concludes that integrating flood risk management into real estate strategies requires a shift from reactive measures to proactive resilience. Floodings pose both physical risks to assets and operational risks that threaten business continuity, making structured integration essential for owner-occupiers. Current practices are fragmented, and while awareness is growing, there is no consistent approach to embed flood risk into portfolio planning, asset management, and operational processes. To address this gap, this thesis proposes a theoretically informed roadmap presented in Figure 0-1. The roadmap translates research insights into practical actions using Winch's risk management cycle as a basis. Identification focuses on acknowledging flood risks and creating awareness around them. Assessment is getting a clear understanding of the effects of flood risks on portfolio and asset scale, and the effect on primary functions and operations. In the Response phase, measures are taken to mitigate or not mitigate flood risks. Finally, Control embeds continuous improvement through monitoring and feedback loops.

The theoretically informed roadmap provides a structured guide for integrating flood risk management. A detailed description, including a user guide of the roadmap, is provided in Appendix X.

To implement the proposed roadmap in an organisation, some recommendations are highlighted:

- Use the roadmap as a guide for the integration of flood risks in REM.
- Assign organisation-specific roles and responsibilities based on the proposed domains.
- Update the roadmap regularly to treat flood risk management as a dynamic process.

Roadmap to integrate flood risks into real estate management

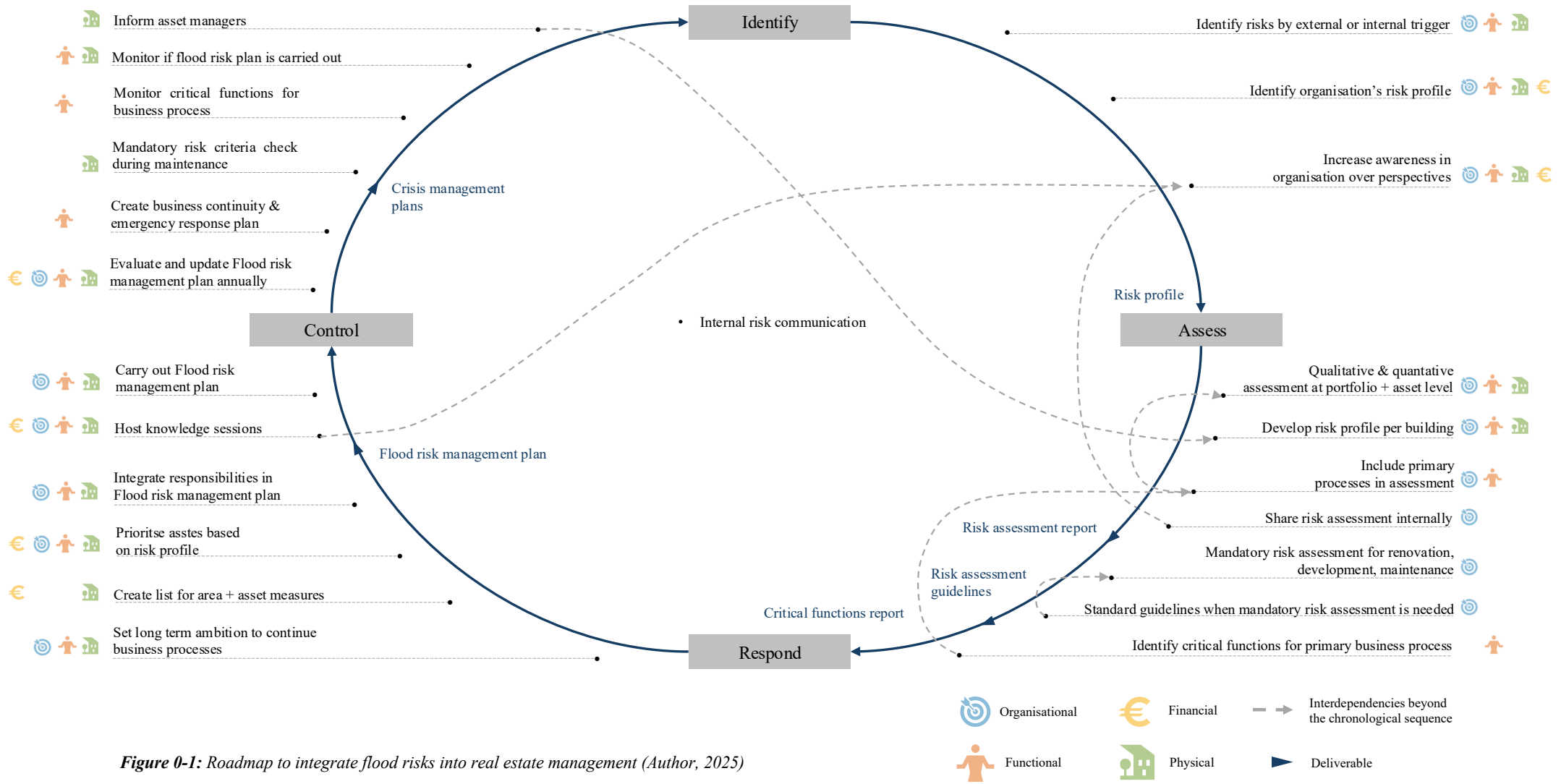


Figure 0-1: Roadmap to integrate flood risks into real estate management (Author, 2025)

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Part I

Relevance

1. Introduction

1.1 Context

The summer of 2021 was partly dominated by the floods in Limburg. Parts of the Netherlands, Belgium, and Germany were hit by flooding due to heavy rainfall. Rivers overflowed, causing considerable flooding. The inhabitants of Limburg were very surprised by the high water. The damage from these floods was enormous, estimated at 433 million euros. Now, more than 4 years later, not all damages have been solved, nor have all people been helped. The Netherlands has woken up, and we wonder more and more how this could happen, why buildings were built in such flood-prone areas, and whether this will happen again. (Slager, 2023)

One of the reasons why the Netherlands will experience more flooding is due to climate change. Climate change is an increasingly urgent problem around the world. It causes changing precipitation patterns (IPCC, 2023), an increase in the frequency and severity of extreme weather events (Botzen et al., 2010), and rising temperatures (IPCC, 2023). Because much of the Netherlands is below sea level, the Netherlands is expected to experience increasing flood risk due to climate change in the coming years (Henkens et al., 2024).

For centuries, the Netherlands has been known for its water knowledge and its excellent flood defences to protect the low-lying Netherlands from higher water. Yet, despite the increased risks of flooding, construction of real estate is taking place in flood-prone zones. These areas represent 59% of the Netherlands, as shown in Figure 1-1.



Figure 1-1: Flood-prone zones in the Netherlands (Haasnoot et al., 2020)

Not only do governments and individuals face the consequences of climate risks, but this growing exposure to flooding poses major challenges in the business sector. Buildings, such as offices, distribution centres, and production facilities, are often located in profitable but vulnerable areas (Boland et al., 2022). In the context of this research, real estate includes corporate and public real estate. This real estate is not only about property value but also about enabling core business processes and ensuring business continuity (Weinhofer & Busch, 2013). Therefore, this increasing flood risk impacts both assets and business operations of organisations.

Real estate is owned by owners and used by occupiers; however, an owner can also use their buildings. This is called owner-occupiers. This group is particularly interesting when researching flood risks on real estate portfolios. Owners have an interest in the value of the asset and long-term interests in the property. An occupier-only does not deal with long-term asset value but uses the asset primarily for business purposes. Owner-occupiers have a dual interest, considering the asset and the business operations of organisations.

By proactively integrating physical risks, such as flood risk, into real estate management strategies, owner-occupiers can better align their real estate with risk management frameworks, safeguard asset value, and ensure business operations (Huffman, 2002; Sun et al., 2022). This can be achieved by creating a roadmap to guide owner-occupiers of real estate to integrate flood risks into their REM strategies.

1.2 Problem statement

Climate change poses a rising risk to the built environment. Due to the combination of a rising sea level and an increasing severity of extreme weather, more areas will become flood-prone, and/or areas will be at higher risk, which makes real estate located in these areas more vulnerable to flooding. (Leefomgeving, 2024). Especially in the Netherlands, where a majority of the land lies below sea level. (Planbureau voor de Leefomgeving, z.d.) Simultaneously, organisations are locating themselves in areas that are economically attractive and easily accessible (Boland et al., 2022). These areas are often located in the Randstad. The Randstad has the highest risk of flooding, see Figure 1-1. When assets are located in these flood-prone areas, they face risks of flooding that can impact business activity, reputational risks, and property value (Sun et al., 2022).

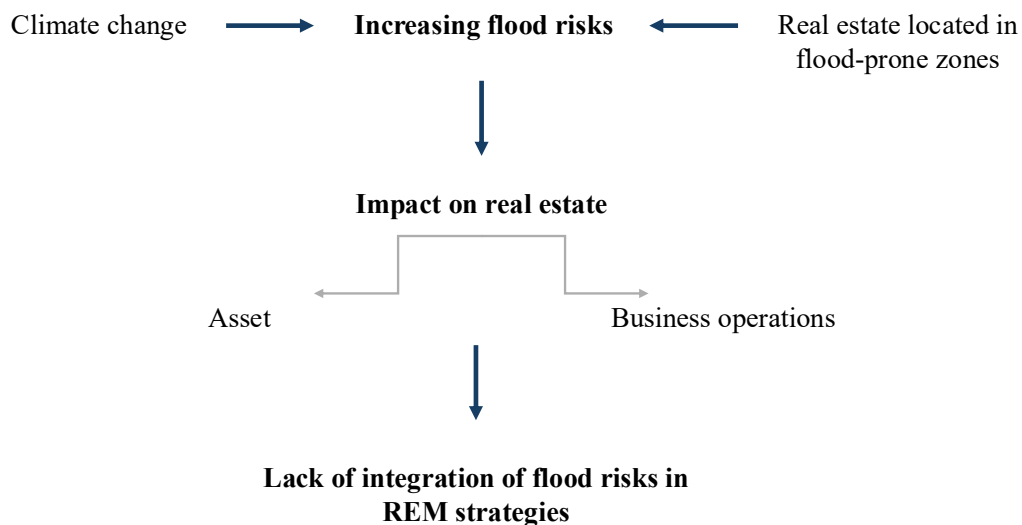


Figure 1-2: Problem statement (Author, 2025)

In this research, real estate is focused on corporate and public real estate. Unlike residential real estate, this type of real estate is typically managed to align with strategic business goals of an organisation, such as long-term value, risk mitigation and continuity of operations (Arkesteijn, 2019). Organisations face dual responsibilities: the asset itself and ensuring business operations continue. However, current Real Estate Management (REM) practices often prioritise cost-efficiency and flexibility over climate resilience (Arkesteijn et al., 2016; Bartelink et al., 2015; Msezane & McBride, 2002), rather than looking at long-term physical risks which are associated with climate change.

Given the increasing likelihood, frequency, and potential impact of flood events, it is becoming crucial for real estate to adopt a proactive attitude toward flood risks. This is particularly important for real estate owner-occupiers because it is not only about the asset itself but also about ensuring operational continuity. However, strategic integration of flood risks into real estate management strategies is still uncommon. To assist these real estate owner-occupiers in integrating flood risk management into their REM strategies for assets situated in flood zones, this research guides owner-occupiers to make their REM strategies more resilient to flood risks. The described problem statement of this research is shown in Figure 1-2.

1.3 Research gap

Although the effects of climate change, especially the increasing risk of flooding, have been recognised in academic literature, less is known about how flood risk management may be effectively integrated into a real estate management strategy of real estate owners-occupiers. This is partly because most studies focus on public infrastructure or residential housing, while corporate and public real estate have received comparatively little attention. Besides this, the increased risk of flooding due to climate change is a relatively new urgency in the Netherlands (Filatova & Krefeld-Schwalb, 2025).

Existing real estate management (REM) frameworks are generally well-equipped to address traditional risk categories, such as financial, operational, and market risks. However, the systematic integration of physical climate risks, including flood risk, remains limited (Bartelink et al., 2015; Huffman, 2002; Shah et al., 2014). As a result, REM research and practice tend to prioritise economic optimisation and flexibility, often overlooking the physical risks of flood events.

This creates a research gap: risk management in REM is relatively well-developed, but there is insufficient focus on integrating flood risk into these strategies. Addressing this gap would enable real estate owners-occupiers to more effectively anticipate and mitigate flood-related threats, safeguarding both asset and business operations. This study aims to close this research gap by exploring how flood risk can be effectively and proactively addressed, aligned with REM strategies.

1.4 Research goal

This research aims to investigate how flood risks can be integrated into real estate management strategies. This is done by applying scientific knowledge to various concepts in the literature: (corporate) real estate management, flood risks, and general risk management. By adding empirical research to this, knowledge is translated and expanded into practice. The practical deliverable following the academic insights delivered in this thesis is a theoretically informed roadmap that can be used to guide the integration of flood risk into real estate management strategies for owner-occupiers. Rather than prescribing concrete steps, this roadmap serves as a structured guide for owner-occupiers to initiate and shape their approach toward flood risk resilience.

1.5 Research questions

This section introduces the main question and the sub-questions. This thesis looks at the following main question:

“How can real estate owner-occupiers integrate flood risk management into their real estate strategies?”

To answer this question, it is required to subdivide the question into several sub-questions. The following sub-questions will be answered:

SQ1: *What are the key flood risks in the built environment, and how do they impact real estate portfolios, assets, and business operations in flood zones?*

SQ2: *How can flood risks be integrated into REM strategies?*

SQ3: *How are REM strategies currently addressing or neglecting flood risk management?*

SQ4: *What tools do real estate owner-occupiers need to effectively integrate flood risk into their strategies?*

1.6 Societal relevance

The safety, economic stability, and spatial planning of societies are seriously threatened by the increasing risk of flooding, especially in low-lying countries like the Netherlands. Nearly 65% of the Dutch population and a large proportion of the economic infrastructure are located in flood-prone zones (Planbureau voor de Leefomgeving, z.d.). As a significant element of economic activity and urban development, corporate and public real estate is essential to maintaining employment and business operation continuity. Organisations that fail to take flood risks into account in their real estate management risk not only physical damage to their real estate but also societal vulnerability.

This research helps owner-occupiers of real estate portfolios to make real estate management strategies more flood-resilient by guiding organisations to integrate flood risk into their real estate management. This will provide organisations with increased protection against flood risks, which will have a positive impact on the economy, employment, and business operation continuity.

1.7 Scientific relevance

The improvement of real estate portfolios, with a focus on cost-effectiveness, flexibility, and alignment with real estate strategy, has been a topic of numerous studies in the academic field of real estate management. However, there is still a lack of academic literature about the integration of flood risk into REM. Although REM has a strong history of general risk management (Huffman, 2002), little is known about how environmental risks can be systematically integrated into strategic real estate management, specifically, flood risks (Carlin et al., 2023).

In addition, this study takes a step towards understanding the relationship between different disciplines that influence each other: flood risks belong to urban development management, water management and spatial planning. Real estate strategies belong to real estate management. Much research has already been conducted on both topics in these disciplines, but the interrelationships between them have not yet been scientifically investigated in the context of the Netherlands. This study links these disciplines and looks at how they can be integrated by focusing on flood risks. It offers a conceptual and empirical foundation for future studies on resilience in the real estate domain.

1.8 Context of the research question

To understand the main question and its underlying sub-questions, it is important to explain the context of the research question and define some principles.

Real estate management

In this thesis, real estate refers to properties owned and occupied by organisations to support their core activities. This definition encompasses both corporate and public organisations, ensuring that the research includes a wide range of owner-occupiers while maintaining a focus on how real estate contributes to organisational performance and long-term strategic objectives. The common characteristic of these organisations is that their real estate is not held for investment purposes but is directly used to enable their mission.

- Corporate real estate: owned by private companies for business operations.
- Public real estate: owned by government institutions for public services.

Besides the described similarities, the thesis also acknowledges the differences between them. A key distinction lies in the public objectives associated with public real estate. Public real estate often serves as a role model and contributes to societal goals, whereas corporate real estate does not carry such responsibilities. While the overarching concept is used throughout the thesis, these differences are explicitly addressed in the empirical research.

Real estate management is the discipline concerned with the performance of the built environment, assessed through cost-effectiveness, functional, spatial, and technical quality, and sustainability. The performance is evaluated based on the needs of different users, applications, and stakeholders. (TU Delft, n.d.-a) Real estate management is examined through the lens of how owner-occupier organisations manage their real estate to support continuity, resilience, and strategic alignment. This includes corporate and public real estate.

The concept of real estate management overlaps significantly with corporate real estate management (CREM). CREM is described as the strategic management of the real estate portfolio of an organisation, aligning it with the core business and operational demands. (Arkesteijn et al., 2016) Its aim is not only to maximise financial returns, but also to enhance business value and contribute to overall performance (Krumm et al., 2000). Although CREM is traditionally applied to private-sector companies, its principles, such as strategic alignment, value creation, and integration of real estate into business strategy, are highly relevant to public organisations with business operations as well. Therefore, CREM literature is used as the theoretical foundation for this thesis, with its concepts adapted to fit a broader organisational context.

Owner-occupiers of real estate

Owner-occupiers of real estate are defined as organisations that both own and occupy their properties. Unlike tenants, who primarily derive from short-term operational benefits and can relocate at the end of the lease, real estate owners are focused on achieving long-term functional and economic value. In the context of this research, owner-occupiers have an interest in all facets of long-term real estate: economic value, operational value and a long-term vision. (Kadefors & Bröchner, 2004)

Flood risk management

Floods are defined as land that is temporarily covered by water outside its normal boundaries. The probability and the occurrence of potential damage by the flood events are called the flood hazard. The relationship between vulnerability to flooding and flood hazard results in flood risk. (Schanze et al., 2006)

Flood risk management refers to actions and decisions taken to analyse, assess, and decrease flood hazards. (Schanze et al., 2006). In this research, flood risk management is related to real estate. Therefore, flood risk management is the process of identifying, assessing, and reducing the consequences and likelihood of flooding of real estate assets. To improve resilience, protect business operation continuity, and align real estate management with risk frameworks, it consists of both policy-based and physical measures (Pittard, 2023; Sun et al., 2022).

Flood zones

The Netherlands is situated in a delta, which means that large parts lie below sea level. In the Netherlands, floods originate from rivers, lakes, the sea or rain. Climate change increases vulnerability through an increase in extreme weather events and rising sea levels. As a result, various regions in the Netherlands face growing exposure to flood risks. The Dutch government has mapped the flooding zones, shown in Figure 1-4 and Figure 1-3. (Leefomgeving, 2024)

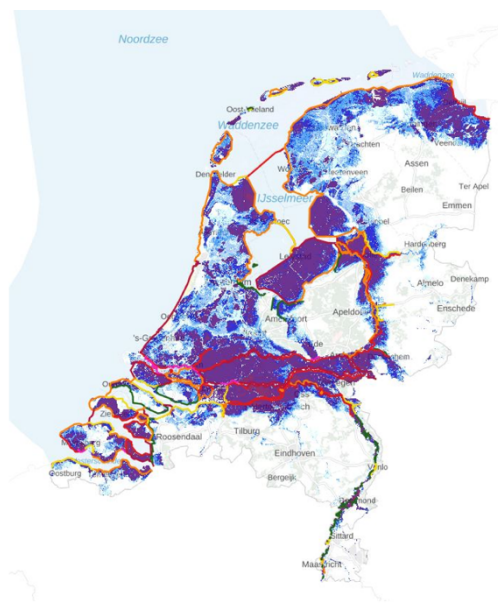


Figure 1-4: Flood map of the Netherlands (Leefomgeving, 2024)

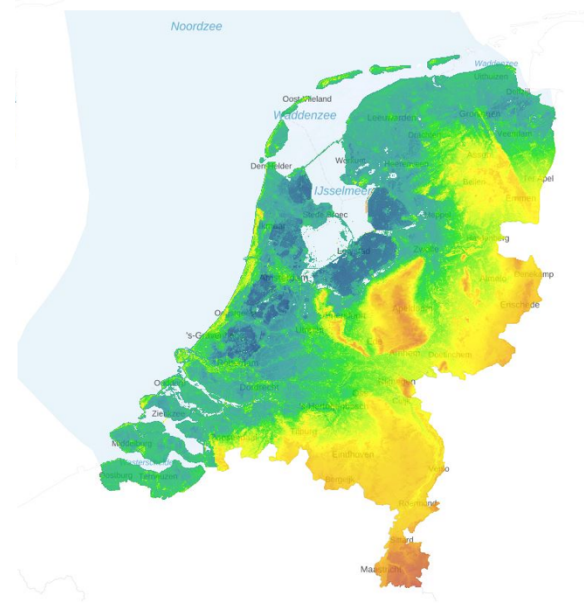
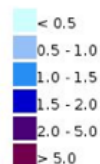


Figure 1-3: Chance of coastal, fluvial, or lacustrine floodings (Leefomgeving, 2024)

The darker the colour blue in the map, the greater the likelihood of flooding.

Business process in the context of real estate

Business operations refer to the core activities through which organisations deliver their products, services, or societal value. These activities form the foundation of an organisation's existence and are directly linked to its strategic objectives, whether profit-driven or public-serving in nature.

A business process can be defined as a structured set of activities within an organisation that collectively produce a desired outcome (Aguilar-Savén, 2004). In the context of real estate, these processes are supported by the physical environment in which they take place. Real estate functions as a strategic resource that supports the continuity, efficiency, and quality of these processes, rather than only providing physical accommodation. As Pycraft (2000) noted, the creation and delivery of products and services is central to organisational purpose. Therefore, the management of real estate must be aligned with these business processes to ensure that the physical infrastructure contributes to operational performance and resilience. This connection is particularly relevant for owner-occupier organisations, where the real estate is directly tied to business performance and the physical asset.

Part II

Desk research

2. Literature study

This chapter presents the concepts to understand the relationship between flood risk and real estate management strategies. It zooms in on (corporate) real estate management, risk management, flood risks, flood risk assessment, asset management, and business operational management. The literature study is in the context of the Netherlands.

2.1 Corporate real estate management

As indicated earlier in section 1.8, corporate real estate forms the theoretical basis of this study. The literature studied primarily originates from the Management in the Built Environment master's program at Delft University of Technology, specifically the Real Estate Management course. This foundation was complemented by relevant sources from other universities and scientific platforms. Searches focused on specific topics, considering the relevance of each source, citation frequency, and publication quality.

2.1.1 Concept of corporate real estate

Real estate management can be separated into two types: public and corporate real estate management. (Arkesteijn et al., 2016). Although corporate real estate management was originally developed for corporate organisations, its core principles are highly applicable to a broader range of owner-occupier organisations. These include public organisations, which also manage real estate to support their core missions, whether delivering public services or conducting education and research. Therefore, while this thesis adopts the broader concept of real estate management (REM) to encompass corporate and public owner-occupiers, it draws on CREM literature as its primary theoretical foundation.

CREM is the alignment between business and real estate, connecting the operational and the strategic levels. It refers to the management of real estate that is owned and used by organisations to support their primary business activities and as value for the business and its performance (Krumm et al., 2000). The corporate accommodation needs to serve the organisational performance by generating income and adding value to business objectives (Arkesteijn & Binnekamp, 2013). The goal of CREM is to “maximise the corporate real estate’s contribution to the corporate bottom line and the long-term health of the corporation” (Huffman, 2002)

In the mid-1990s, the TU Delft came up with a four-quadrant model to describe the position of CREM. Figure 2-1 shows this model, also called the Delft CREM model. The foundation of this model was laid in three lectures by Hans De Jonge in the 1990s, and Peter Krumm, a PhD student, was the first author of the publication of the four-quadrant model. (Vande Putte & Jylhä, 2023) This model is widely used as the basis of understanding corporate real estate management.

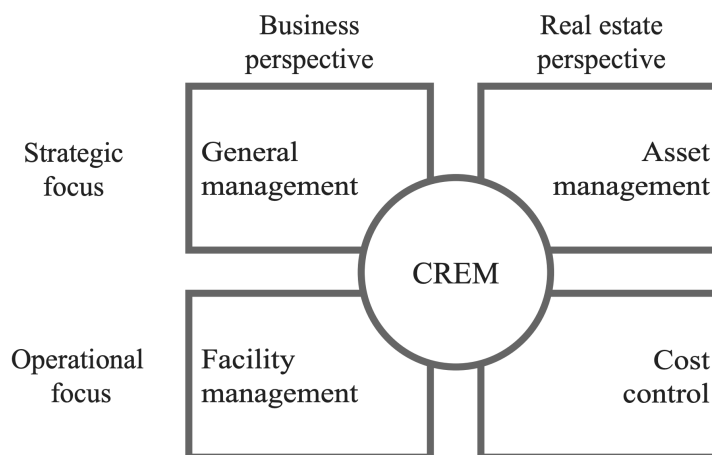


Figure 2-1: Four Quadrant Model of CREM (Krumm, 1999)

Figure 2-1 shows that CREM consists of multiple facets. There is a focus on business and on real estate, and strategic versus operational. These facets have interfaces from which quadrants emerge. (Arkesteijn et al., 2016). For this research, the business perspective in the Four Quadrant Model of CREM represents the business process perspective, because the business perspective of owner-occupiers of real estate is the business process. Quadrants are interrelated, and they influence each other, creating fields of tension. The rest of this literature study discusses how flood risks influence these different facets of REM and their interference. The CREM model is used in the context of REM. It is important to highlight that the four different quadrants cannot be viewed separately due to the relationships between them.

2.1.2 Perspectives in REM

The Real Estate Management (REM) process involves multiple perspectives, each with distinct goals and responsibilities. Krumm’s quadrant model, Figure 2-1, positions these perspectives along two axes: strategic versus operational focus, and business versus real estate orientation. Each perspective brings specific goals and conditions, often resulting in conflicting interests. The challenge lies in balancing these perspectives to enable coherent organisational decision-making, represented at the model’s centre. (Den Heijer, 2021)

Each quadrant reflects a perspective contributing to REM strategy: organisational, functional, physical, and financial (Figure 2-2). The organisational perspective, combining strategic and business focus, is linked to general management. It shapes long-term visions, strategic plans, and business continuity, ensuring real estate decisions align with organisational objectives. (Den Heijer, 2021)

On the real estate side, the financial perspective provides a strategic reality check through feasibility studies, investment assessments, and financial sustainability. In the original Quadrant model of CREM, Figure 2-1, cost control is positioned in the bottom-right quadrant, which combines a real estate perspective with an operational focus. However, the financial perspective goes beyond cost control and includes long-term strategic considerations. Therefore, this thesis adopts the positioning of the financial perspective as presented by Den Heijer (2021), reflecting its strategic relevance.

The functional perspective, combining operational and business focus, is often associated with facility management. It ensures daily continuity of business processes by translating strategic goals into operational realities through services, space management, and user needs. (Den Heijer, 2021)

On the real estate side, the physical perspective reflects an operational focus on the asset or portfolio itself. The physical perspective brings a range of environmental issues to the table. (Den Heijer, 2021)

Although each perspective has distinct interests, overlaps are common. Perspectives often cannot be placed strictly within a single quadrant but rather lie between them. Interests may coincide, and collaboration is frequently required for parties to reach decisions, even when their interests do not fully align.

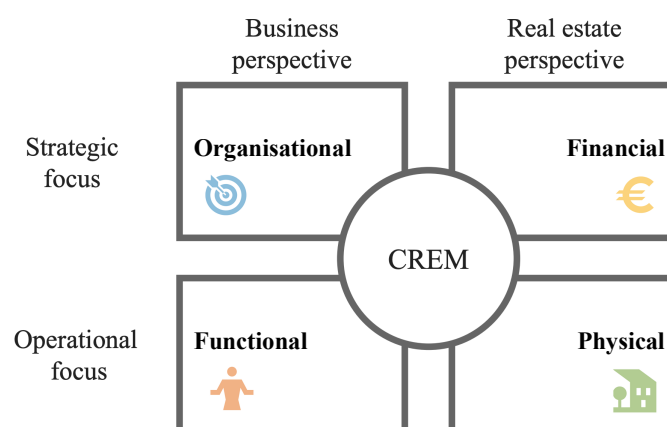


Figure 2-2: Perspectives in Quadrant Model CREM (Author, based on Krumm (1999) and Den Heijer (2021))

2.1.3 Strategy levels in REM

Real estate management operates across three interconnected levels: strategic, tactical, and operational. The pyramid in Figure 2-3 illustrates this hierarchy, where strategic decisions at the top set frameworks and long-term goals for the entire portfolio. These are translated at the tactical level into building-specific plans, such as maintenance, upgrades, or climate risk measures. Finally, the operational level implements these plans through day-to-day management, including facility services, technical maintenance, and safety measures. The pyramid also reflects scale differences: strategic decisions involve fewer actors than the operational level. (Janssen, 2008; Van Driel, 2010)

The levels described above correspond to those in the Quadrant Model of Krumm (1999) and Den Heijer (2021). In this model, the strategic and operational levels are positioned along the vertical axis. However, the tactical level, situated between strategy and operations, is not explicitly represented in the quadrant model.

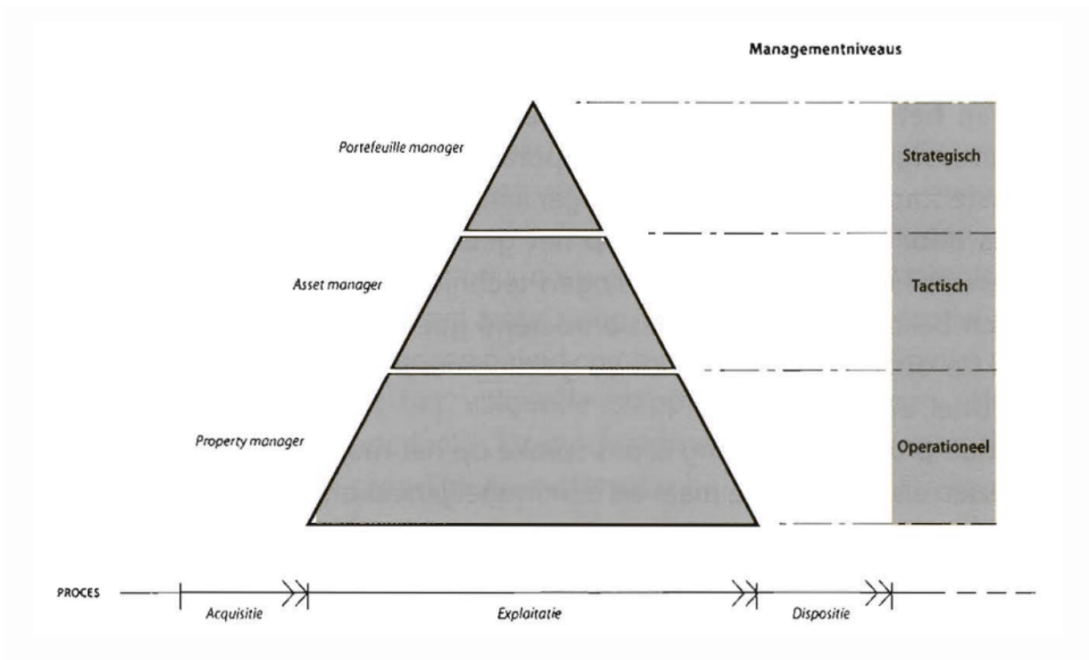


Figure 2-3: Strategy levels in real estate management (Janssen, 2008)

2.1.4 Decision-making

Decision-making occurs throughout the real estate management process, from portfolio to asset, from organisational to operational level. Portfolio decisions aim to optimise the use of assets and align them with organisational goals (Arkesteijn & Binnekamp, 2013). At the asset level, decisions concern the use, flexibility, functionality and maintenance of specific buildings. Decisions at the operational level concern facility management and workplace strategies to support the business processes. It is critical to align the company's organisational needs with the physical environment of different levels. Combining all these interests to make a decision is a complex task. The interests, objectives and visions of different perspectives must be compared and contrasted. (Den Heijer, 2021)

REM combines strategic decision-making with operational management to ensure real estate contributes effectively to organisational objectives (Arkesteijn et al., 2016). To support this, Arkesteijn and Binnekamp (2013) propose Multiple Criteria Decision Analysis (MCDA), which systematically rates criteria into an overall performance score (Dodgson et al., 2009). This MCDA model illustrates how advanced analytical methods can bring transparency to real estate decision-making (Arkesteijn & Binnekamp, 2013; Dodgson et al., 2009). MCDA helps identify portfolio interventions aligned with organisational goals through six steps: (Arkesteijn et al., 2016)

1. Specify decision variables
2. Define preference for each decision variable
3. Assign weights
4. Set design constraints
5. Generate design alternatives
6. Yield an overall preference scale

2.1.5 Financial evaluation

The financial management of flood-related real estate exposures requires careful assessment of the relative costs and benefits of different approaches. Investments in risk reduction can reduce the future cost of reconstruction and recovery. (OECD, 2016) In risk management, Cost-Benefit Analysis (CBA) is widely recognised as a fundamental tool for rational decision-making. It provides a systematic framework to weigh the costs of implementing risk mitigation measures against the expected benefits in terms of risk reduction. This evaluation typically occurs both before and during the selection of mitigation strategies, ensuring that resources are allocated efficiently and proportionally to the level of risk addressed. (Špačková & Straub, 2015)

The basic principle of CBA is that a project is considered economically viable when its benefits exceed its costs (Jonkhoff, 2009). In risk management, there is a point where the reduction of risk losses can become too costly or not feasible (Linnerooth-Bayer & Hochrainer-Stigler, 2015). In the context of flood risk management, costs generally include investment expenses, as well as maintenance and operational costs. Benefits, on the other hand, include the reduction of direct and indirect damage costs. Direct costs refer to physical damage, such as repairs to buildings and interiors, while indirect costs include business interruption within and beyond the affected area, as further explained in 2.7.1. Additionally, broader societal benefits, such as improved economic resilience and public safety, are often considered part of the benefit side of the equation. (Jonkhoff, 2009) Various studies using CBA show that taking proactive flood measures is more cost-effective in the long term than reactive responses dealing with the direct and indirect consequences of flooding. (Abe & Adriaens, 2025; Molinari et al., 2021; OECD, 2016)

Despite its widespread use, CBA has notable limitations. One major challenge lies in the monetisation of non-financial impacts, such as business continuity or social well-being, which are difficult to express in purely economic terms. Furthermore, predicting cost savings from mitigation measures involves significant uncertainty, particularly for low-probability, high-impact events like severe flooding. (Jonkhoff, 2009; Molinari et al., 2021) Nevertheless, a cost-benefit analysis remains an essential component of risk management because it provides decision-makers with structured, transparent, and rational information to guide strategic choices (Špačková & Straub, 2015).

2.2 Risk management in real estate

Managing risk in real estate is becoming increasingly important in today's culture. This is because external factors, such as climate change, are becoming increasingly risky (IPCC, 2023). To ensure that these risks are properly managed, it is important to understand them and know how to deal with them. This section describes how general risks and uncertainties in the context of real estate are addressed.

Risk management was covered in the Design and Construction Management course of the master's programme in Management in the Built Environment at Delft University of Technology. The content of this course was used as a basis for describing risk management. Relevant scientific articles were found that describe and explain risk management in the built environment. These sources were found by searching for specific concepts on scientific websites and further searching in the source lists.

2.2.1 Managing risks and uncertainties

Risks occur in every project. To deal with risks, it is important to manage them. Risk management is fundamental to making decisions for a portfolio as a real estate owner-occupier (Farragher & California, 2008; Nourse & Roulac, 1993). Climate change is a form of risk. There is information available, but there remains a lot of uncertainty. No fixed predictions can yet be made about the future consequences of climate change, so uncertainties and risks must be taken into account.

$$1) \quad Risk = Probability\ of\ event \times magnitude\ of\ loss/gain \quad (Raftery, 1993)$$

The Cambridge University dictionary defines risks as follows: 'the possibility of something bad happening' (Cambridge University, 2025). In literature, this definition is split down. According to Raftery (1993) risk consists of two components, shown in Equation 1. The *probability* of a risk is similar to the *possibility* mentioned in the definition of the Cambridge University (2025) and the *magnitude of loss/gain* is similar to *something bad*. However, uncertainty is used to describe the situation where it is not possible to assign a probability to an occurrence or an event. Risk is often an implication of something being uncertain (Merna & Al-Thani, 2008).

Winch (2010) defines risks as the probability of an event and its consequences. Again, this complies with the definition of Raftery (1993). To manage risks, Winch proposes a risk management process, shown in Figure 2-4. The risks need to be identified and clarified to know what is going on. Then, the risks need to be assessed so they are well-understood. After the assessment, respond to the risks and decide what to do about them. Control the risks during the whole project. This model is a circular model to emphasise that risk management is a learning process over time. (Gehner, 2008; Merna & Al-Thani, 2008; Winch, 2010)

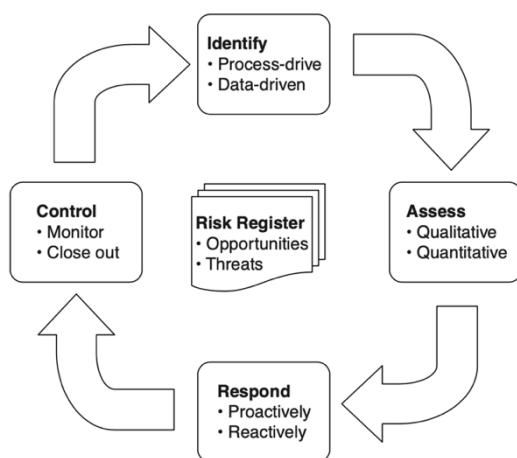


Figure 2-4: Risk management process (Winch, 2010)

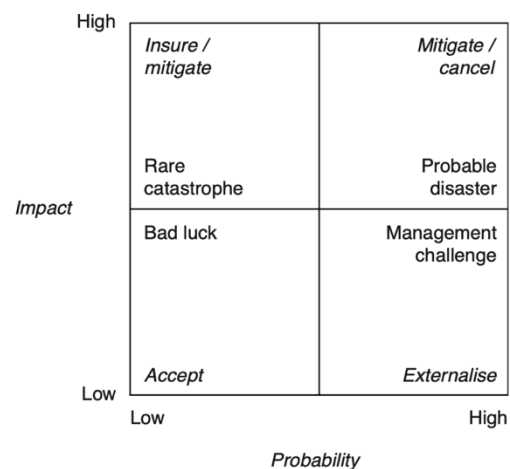


Figure 2-5: Probability/impact matrix (Winch, 2010)

To assess the risks Winch (2010) mentioned, the probability/impact matrix is proposed, shown in Figure 2-5. Climate risk on its own has a high probability and high impact, so it falls into the probable disaster category. Flood risks are less probable but have a high impact, so they fall into the category of rare catastrophes. These risks must then be responded to. Climate change is mitigated/cancelled as a response. This means that the project's mission or scope must be adjusted to deal with the risk. Flood risk is a rare catastrophe and therefore, according to Winch, should be responded to by insuring or hedging the risk where possible. If the risk has been responded to, the risk should continue to be monitored.

2.2.2 Risk disaster cycle

A risk disaster cycle is a systematic way of managing the risk of a hazard. The aim is to successfully minimise the effects of the hazard through prevention, preparedness, response and recovery. (UNDRR, n.d.) These measures are also shown in Figure 2-6. The difference with the risk assessment process of Winch, shown in Figure 2-4, is that action is taken not only based on the risk but also based on the disaster. The framework can be used for any disaster and can therefore also be used specifically for climate hazards or specifically for flood risks.

In the pre-disaster period, prevention and mitigation adaptations must be implemented. These are structural and nonstructural solutions designed to reduce the hazard's negative impact. This includes recognising potentially harmful human activities and physical processes. (Bosher et al., 2021) Following preventive and mitigation, preparedness is critical in the pre-disaster phase. Preparedness refers to the abilities and expertise that organisations, governments, individuals, and communities need to successfully prevent, respond to, and recover from a disaster (UNDRR, 2020).

The post-disaster phases consist of response, rehabilitation, and recovery. Responses are actions directly after or during the disaster to reduce the impact of the disaster. (UNDRR, 2020) Recovery and rehabilitation are actions to restore and improve the pre-disaster conditions (Bosher et al., 2021).

From a holistic DRM perspective, the problem with a disaster cycle is that the ‘disaster’ remains central in the cycle. Effective disaster management could ideally prevent the event from happening and reduce its impact by addressing root causes and physical effects. (Bosher et al., 2021) For example, good prevention and mitigation together with better preparedness could lead to less impact of the disaster and therefore easier response and rehabilitation and recovery process.



Figure 2-6: Disaster Management Cycle (UNDRR, n.d.)

2.3 General risk management in REM

Real estate management is increasingly integrated with risk management strategies to align real estate decisions with corporate objectives and risk preferences. Studies by Huffman (2002), Bartelink et al. (2015), and Shah et al. (2014) have been selected to analyse general risk management in CREM. These are studies that link CREM to risk management, all emphasising the importance of systematic risk assessment as an integral part of strategic CREM, although developed in a corporate context, are highly relevant to real estate management in owner-occupier organisations more broadly.

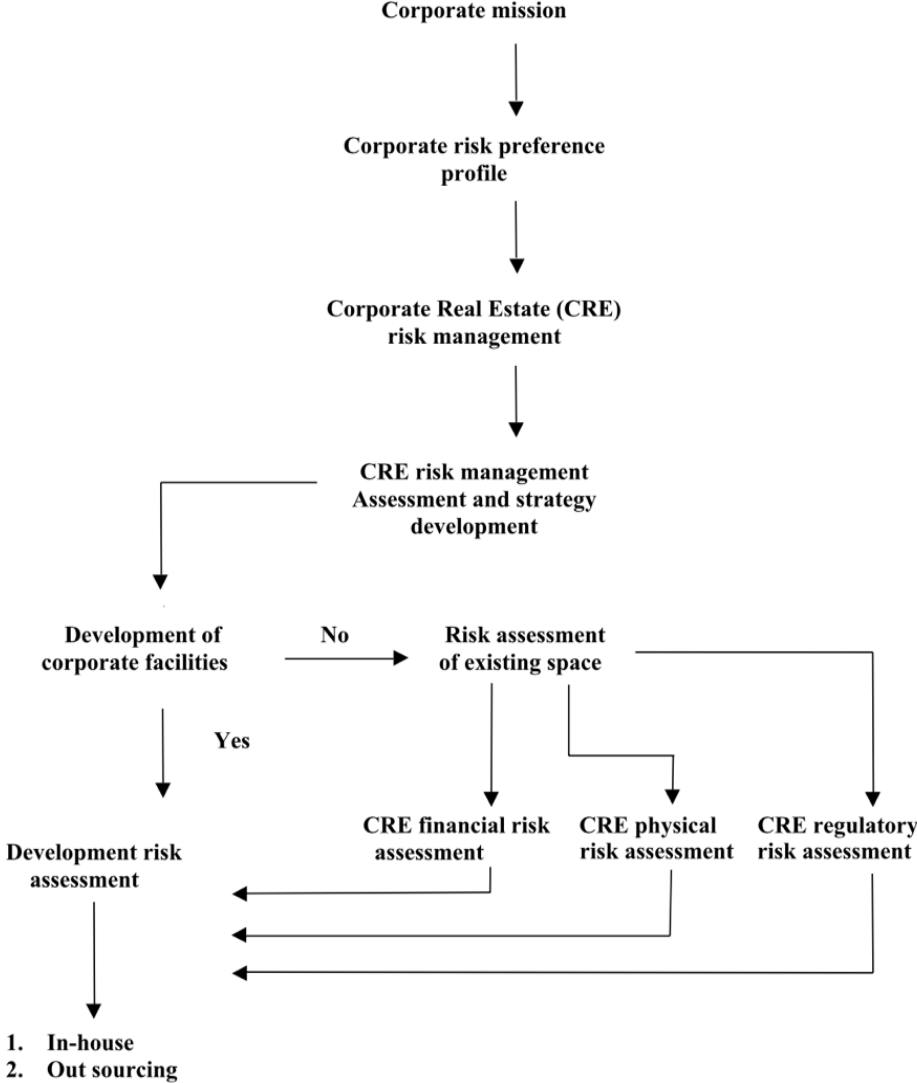


Figure 2-7: Corporate real estate risk assessment (Huffman, 2002)

Huffman (2002) provides a risk assessment framework for CRE, which is shown in Figure 2-7. In his research on corporate risk management and assessment, Huffman (2002) argues that the starting point for managing real estate risks is identifying the organisation’s overall risk profile. This helps to make sure that real estate strategies stay within the boundaries of corporate risk tolerance by following the standard risk-return trade-off, which is explained in 2.1.5. Huffman (2002) categorises the real estate risks into four categories: development risks, financial real estate risks, physical risks, and regulatory risks.

Flood risks are physical risks. Part of the physical risks are site and location risks, which include a lack of suitable access and exit, poor building placement, and a lack of necessary utilities and infrastructure. Flood risks can significantly affect these risks. Therefore, poor location choices will increase distribution and shipping costs to the corporation and will affect employees' satisfaction, hiring and turnover. (Huffman, 2002)

Bartelink et al. (2015) explain in their study the importance of risk management in corporate real estate management. Risk management contributes to the core business process and enables a corporate organisation to execute its strategies and achieve its objectives. Bartelink et al. (2015) expand on the research of Huffman (2002). 43 risks are identified across six categories. In addition to the categories identified by Huffman, which include development risks, financial real estate risks, physical risks and regulatory risks, two additional categories have been added: appearance risks and operational and business risks. (Bartelink et al., 2015)

To mitigate the risks, organisations use risk management strategies. According to Bartelink et al. (2015), Huffman (2002), and Shah et al. (2014) the most often used strategies are diversification (spreading assets or work/production places across types or locations to reduce overall exposure), insurance (particularly for physical and regulatory risks), avoidance (avoiding high-risk decisions), hedging (maintaining flexible options like lease renewals or purchase right), and due diligence (careful investigation before investment). The relation between the different types of risks and their strategy is shown in Figure 2-8. Flood risks are closest to the category of location risk and environmental risk. These risks, therefore, fit the strategies of due diversification and due diligence.

<i>Category</i>	<i>Types</i>	<i>Risk management strategies</i>
Development	Design risk	Avoidance
	Construction risk	Due diligence
	Financing risk	Hedging
	Property management risk	Insurance
	Reversion risk	
Financial	Leasing risk	Avoidance
	Default risk	Diversification
	Property management risk	Insurance
	Liquidity risk	Hedging
	Reversion risk	
Physical	Design risk	Due diligence
	Location risk	Diversification
Regulatory	Environmental risk	Due diligence
	Land regulation risk	
Other	Foreign currency risk	Hedging

Figure 2-8: Corporate real estate risks and strategies (Huffman, 2002)

When taken as a whole, these insights highlight how risk management is an essential and proactive part of CREM rather than a reactive process. Existing frameworks effectively account for traditional risks, but environmental risks, like flooding, are only now beginning to be recognised. The following part will discuss the need for flood risks to be more integrated into the real estate management strategies.

2.4 Understanding flood risks in the context of the built environment

In this section, the flood risks in the context of the built environment in the Netherlands are explored. This forms the basic knowledge for identifying flood risks, according to the risk management process of Winch (2010). The section first focuses on different types and causes of flood risks, and secondly, their trends related to climate change.

The literature studied for the types of flood risks is scientific and has been selected for its informative content on the relevant type of flooding. The information used to describe the trends due to climate change is practical and up to date, based on the Dutch context.

2.4.1 Types and causes of flood risk

Flood risk in the Netherlands stems from the country's unique geography next to the North Sea. A large portion of the Netherlands lies below sea level or in low-lying deltas. Large rivers such as the Rhine and the Meuse flow through the Netherlands into the North Sea. This makes the country vulnerable to large-scale water-related hazards, especially fluvial (river), lacustrine (lake), and coastal (sea) flooding. (Environmental Health Atlas, z.d.) In addition, the increase in more extreme precipitation will also increase the risk of flooding from rainfall, pluvial floods (IPCC, 2023; Rosenzweig et al., 2018). These four types of flooding form the core focus of this study because they pose the most significant threat to real estate assets situated in flood-prone areas in the Netherlands (Environmental Health Atlas, z.d.).

Fluvial flooding

Fluvial flooding, also called river floods, occurs when a river overtops its banks and overflows neighbouring areas (Merz et al., 2021). This is particularly critical in the Netherlands because of its position at the mouth of several major European rivers, such as the Rhine, Meuse and Ijssel (Bouwer & Vellinga, 2007). According to Merz et al. (2021), fluvial floods have an impact on society and the environment. These components are shown in Figure 2-9.

The first component of pluvial flood risk, hazard, is influenced by atmospheric processes (Wang et al., 2022). In the Netherlands, these processes can be rainfall and high temperatures. Flood exposure depends on economic activity in flood-prone areas (Wang et al., 2022). This factor is thus influenced in the activity of an area; the type of real estate is of importance here. The flood vulnerability is influenced by flood protection, crisis management and the characteristics of the people (Merz et al., 2021).

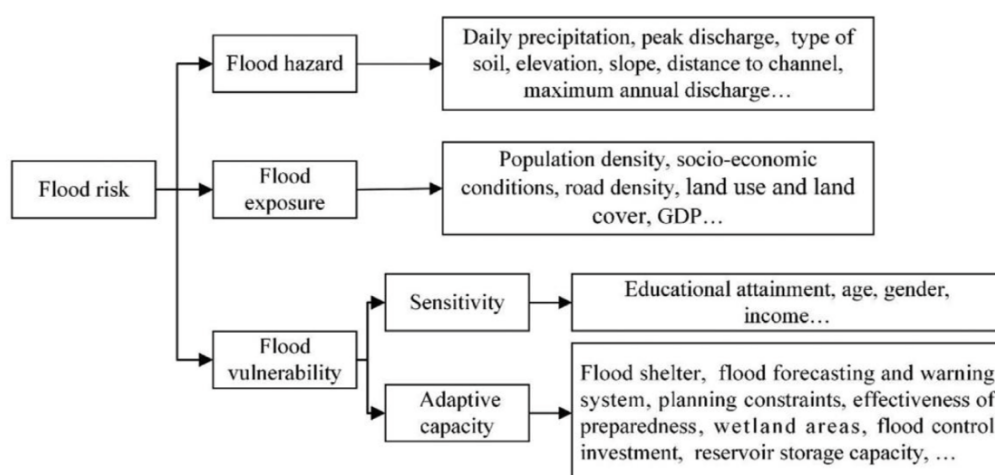


Figure 2-9: Pluvial flood risk (Wang et al., 2022)

Lacustrine flooding

Lacustrine flood, also called lake flooding, happens when the lake's outlet is unable to let out floodwaters quickly enough to keep the lake's pool level at its typical height (Maine Emergency Management Agency, z.d.). Lakes have an important function of storing water. If the lake is full, then the lake will overflow and can no longer complete this water-storing function, which also affects the rest of the water system. Rivers that drain into lakes can no longer discharge their water into the lakes and will also flood. (Jorriema, 2023)

Coastal flooding

Coastal flooding is a flood from the sea. A combination of tides, waves, and storm surges drives flooding of coastal areas. In the Netherlands, the natural sea defence is sandy dunes. Humans made 'hard' barriers as sea defences, such as the Oosterscheldekering. (Van Ormondt et al., 2012) However, with the rising sea level and more frequent extreme weather events due to climate change, the probability of coastal flooding is getting higher (Environmental Health Atlas, z.d.).

Pluvial flooding

Pluvial flooding is a different type of flooding from the flood types mentioned above. This is a form that is not related to the Dutch flood defences. Pluvial flooding is due to heavy rainfall or surface water. The floods occur when rainfall exceeds the capacity of the drainage system or the groundwater level (Rosenzweig et al., 2018). The water will flood the ground. One of the consequences of climate change is more intense precipitation patterns (IPCC, 2023). This has an increasing effect on pluvial floods. With more precipitation coming at the same time, there is a greater chance that the soil will saturate and drainage systems will not be able to carry the water away, causing pluvial flooding (IPCC, 2023; Kundzewicz & Pińskwar, 2022; Rosenzweig et al., 2018).

Pluvial flooding is mainly a problem in areas where there is urbanisation. As a result, there is less space available for water to sink into the ground. Thus, to reduce this type of flooding, space is needed to let the water sink into the ground, and good sewers are needed to drain the excess water (Rosenzweig et al., 2018).

2.4.2 Trends due to climate change

The IPCC (2021) reports indicate that global warming leads to increasing temperatures, sea level rise, and shifting precipitation patterns. According to scenarios of the KNMI (2023) the coastline can even rise to 1,2 meters by 2100. The combination of increased river flows and rising sea levels will significantly raise the likelihood of flooding in coastal areas. (IPCC, 2021; Merz et al., 2021)

To identify the risks of climate change in the Netherlands, the KNMI (2023) developed four climate scenarios, shown in Figure 2-10. Rising temperatures cause increased ice melt, which is transported through the Netherlands by rivers such as the Rhine and Meuse. Additionally, wetter winters, more extreme summer rainfall events, and significant sea level rise all contribute to a heightened flood risk. In the Rhine and Meuse region, peak river discharges are expected to increase by 10-20% by 2050 (Deltares, 2023). Therefore, even in low CO₂-emission scenarios, significant flood risks remain due to the less intense but still significant factors such as higher temperatures, wetter winters, heavy rains in summer and higher sea levels. (Environmental Health Atlas, z.d.; Merz et al., 2021)

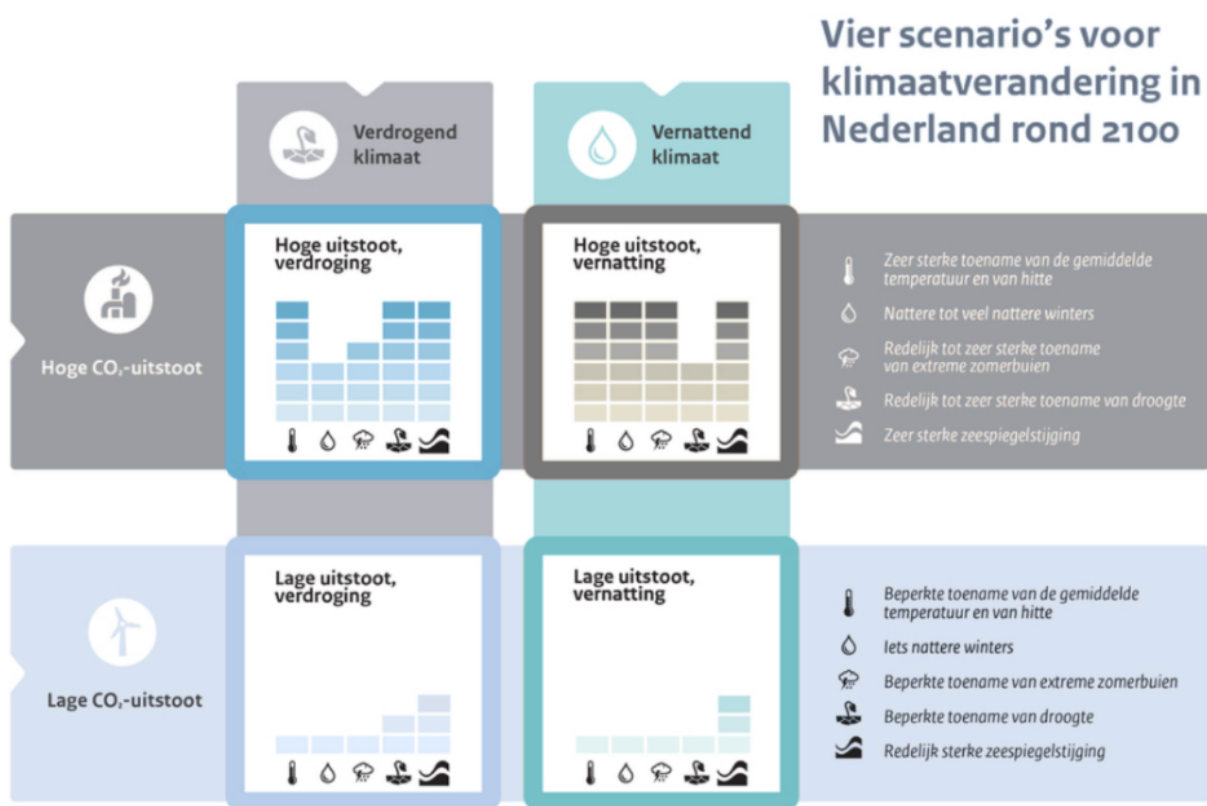


Figure 2-10: Climate scenarios (KNMI, 2023)

2.5 Flood risk assessment in REM

After identifying the flood risks, part of risk management involves assessing the risk (Winch, 2010). This section describes tools that can be used to assess flood risks. This thesis does not apply risk assessment but provides tools for this flood risk assessment.

First, tools are discussed that have been scientifically researched, specifically for flood risks. The scientific literature has been selected by studying current, internal articles that specifically address flood risk assessment. Next, tools used in Dutch practice were discussed. With basic knowledge gained from practice, the subject was explored in greater depth by studying these practical tools.

2.5.1 Flood risk assessment methods

Climate change increases flood risks, affecting real estate values and creating physical and operational threats (Kalogiannidis et al., 2024; Wu et al., 2024). In response, researchers have developed risk assessment tools that real estate owner-occupiers can use to manage and understand these flood risks in their real estate management.

Wu et al. (2024) propose a flood risk assessment tool for handling flood risks in real estate. The expression and relations of these risks are demonstrated in Equation 2 (IPCC, 2023; Wu et al., 2024). R is the expected loss of the asset value; H is the annual probability of the hazard; V represents the vulnerability; E is the exposure of the asset.

$$2) \quad R = H \times V \times E$$

In their research, Wu et al. (2024) propose two assessment methods for flood risks on real estate: the Local-Oriented Approach (LOA) and the Global-Oriented Approach (GOA). LOA uses detailed location-specific data, building characteristics, transaction records, and local flood protection systems, making it more accurate where such data is available. GOA relies on broader proxies, such as GDP per capita or housing price indices, and is applied when local data is limited. For the Netherlands, LOA is most suitable due to the comprehensive local datasets.

LOA consists of three components:

- Hazard: Determined using the Flood Protection Standard Method, which incorporates precipitation data, climate models, and Dutch flood maps (e.g., Overstroomik.nl, Rijkswaterstaat) showing water depths, flood types, and recurrence periods.
- Vulnerability: Estimated through the Housing Price Index Method of Adjustment (HPIMOD), which measures how property values respond to past climate events, using CBS price indexes and Kadaster data.
- Exposure: Includes asset replacement value, operational performance, and portfolio contribution, based on Kadaster records and internal company ratings.

By integrating these components, the LOA provides a location- and market-specific framework for estimating expected asset loss. This calculation is essential for risk management and portfolio planning in real estate management (Bartelink et al., 2015; Huffman, 2002; Shah et al., 2014) and to assess risks in portfolio management (Farragher & California, 2008; Nourse & Roulac, 1993).

2.5.2 EU-Taxonomy

Since 2020, the EU-Taxonomy has served as a uniform classification method for determining which economic activities are considered environmentally sustainable. Its major goal is to guide capital flows towards activities that meet the climate and environmental goals of the EU, which include both climate mitigation and adaptation.

An activity is considered sustainable according to the EU Taxonomy if it: (European Commission, n.d.)

1. Contributes to one of the six objectives (see Figure 2-11)
2. Does not harm any objective significantly
3. Complies with minimum social safeguards
4. Meets the criteria of the technical screening defined per sector

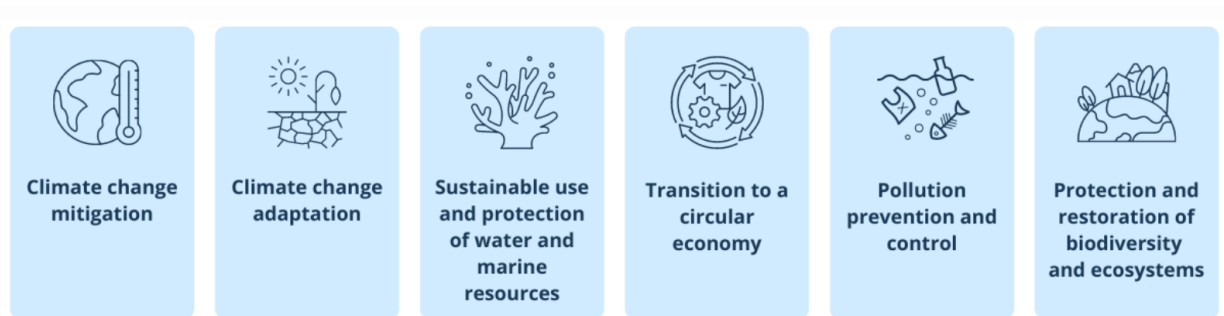


Figure 2-11: Environmental objectives EU-Taxonomy (Envoria, n.d.)

Within the EU Taxonomy framework, companies are required to assess climate-related risks, particularly for activities that fall under the climate adaptation objective. A key component of this risk assessment is the identification of flood risks. Companies must evaluate their exposure to flooding and subsequently describe adaptation measures that mitigate the impact of such risks on their economic activities. (European Commission, n.d.)

2.5.3 BREEAM

BREEAM is an international standard and certification method for measuring the sustainability of buildings. The Dutch version is BREEAM-NL, which has been adapted to Dutch legislation and regulations. The method evaluated the environmental performance of buildings across multiple categories: energy, water, material, health and wellbeing, pollution, and land-use. The BREEAM consists of multiple certification programs: (Dutch Green Building Council, n.d.; Envoria, n.d.)

- New construction and renovation
- In-use
- Demolition
- Area development

One of the key components of BREEAM is the assessment of climate adaptation; this assessment contains points for the BREEAM certification. In this assessment, the evaluation of flood risks is included. Buildings are assessed on their exposure to flooding, their vulnerability, and the adaptation measures taken to mitigate the flood risks.

2.5.4 Framework for Climate Adaptive Buildings (FCAB)

A widely used method for climate risk assessment, including flood risk, is the Framework for Climate Adaptive Building (FCAB) developed by the Dutch Green Building Council (DGBC). Risks are assessed at the building level across four themes defined with the Delta Program for Spatial Adaptation (DPRA): heat, drought, waterlogging, and flooding. Each risk is evaluated through two scores: an environmental score (exposure to climate effects) and a building score (vulnerability based on building characteristics). These scores are combined to produce the final climate score, as shown in Figure 2-12. (Dutch Green Building Council, 2022)

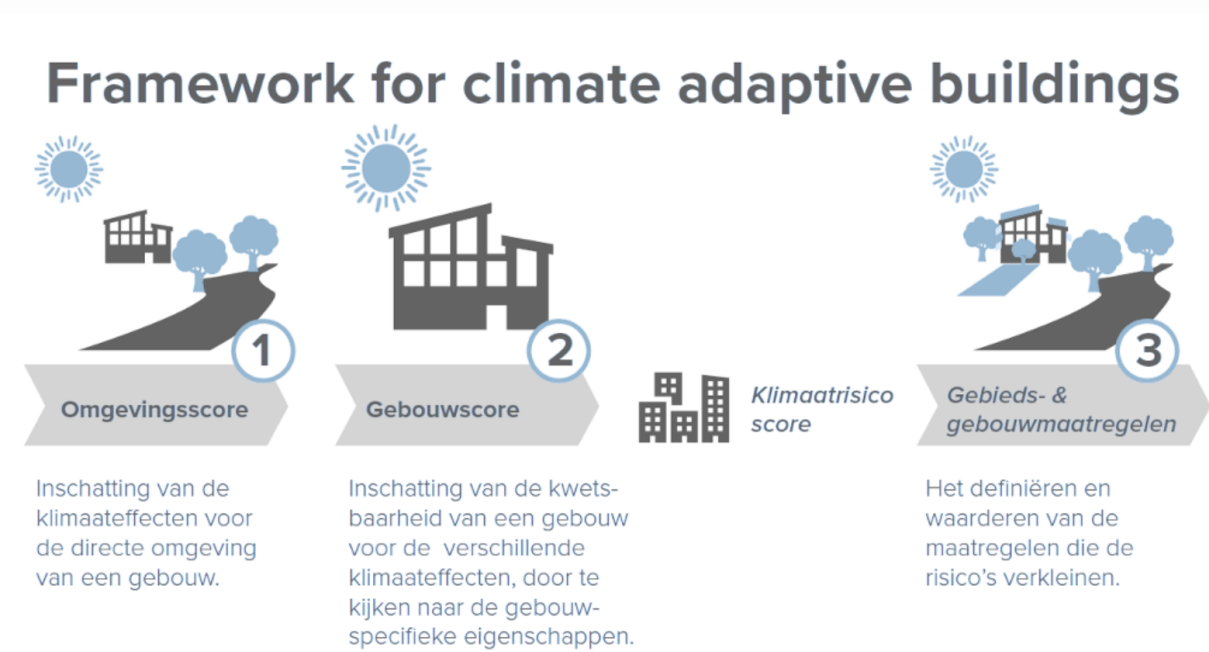


Figure 2-12: Framework for Climate Adaptive Buildings (Dutch Green Building Council, 2022)

In this study, floodings include fluvial, lacustrine, coastal, and pluvial floodings. When conducting a climate risk assessment using the FCAB framework, a distinction is made between pluvial flooding and fluvial, lacustrine, and coastal flooding.

Pluvial floods

To assess the pluvial flood risk, the environmental score and the building score are estimated. The environmental score indicates the extent to which a building is exposed to flooding after extreme rainfall. This is estimated using maps that calculate the extent of flooding. The building score provides an indication of flooding based on building characteristics. Building characteristics determine the vulnerability of a building. Building characteristics that focus on dry-proofing prevent water from entering the building. Buildings that focus on wet-proofing allow water to enter the building, but these measures limit the damage. (Sweco, 2025)

The environmental score is expressed on a scale from very high to very low. A building score is expressed on a scale from 0 to 100. Combining these scores produces a climate risk score. This can be seen in Figure 2-13. (Sweco, 2025)

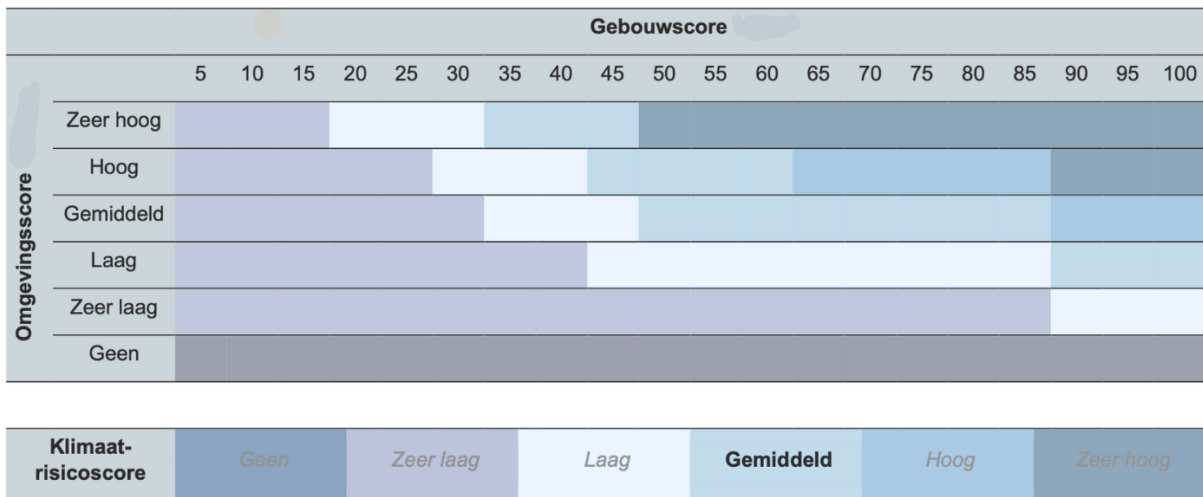


Figure 2-13: Risk matrix for classifying climate risk of flooding (Sweco, 2025)

Fluvial, lacustrine, or coastal floods

For fluvial, lacustrine, and coastal flooding, FCAB applies a step-by-step process, see Figure 2-14. First, the environmental score is determined by determining the location-specific flood probability using maps. Next, a building score is determined based on building characteristics. The building score provides insight into the vulnerability of buildings to flooding. These building characteristics are also divided into dry-proof and wet-proof characteristics. (Sweco, 2025)

By combining the environmental score and the building score in the manner shown in Figure 2-14, the climate risk score can be determined.

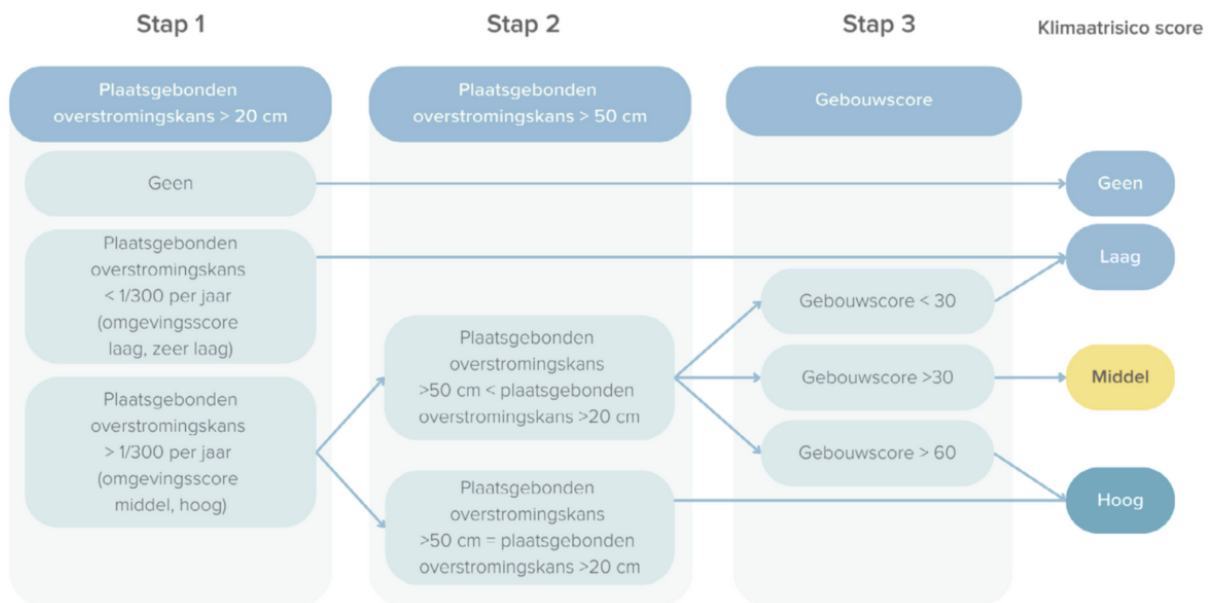


Figure 2-14: Flood risk assessment for environmental score (Sweco, 2025)

2.6 Flood risks as asset management risks in REM

After the risks have been identified and assessed, as described in sections 2.4 and 2.5, the risks are responded to (Winch, 2010). This section discusses how flood risks can be responded to and implemented in asset management. Few scientific studies or articles have been written on this subject. Knowledge on this topic has been obtained from the port of Rotterdam, which has extensive experience with flooding because of its geographic location.

Asset management is part of real estate management, as explained in section 2.1. Asset management focuses on the strategic and real estate perspective of individual assets within an organisation through, among other things, renovation, maintenance, risk management and anticipating market developments, including flooding. Haynes and Nunnington (2010) define asset management as the need to link the core business of an organisation to its buildings. The aim is to match the organisation's business objectives and goals with the asset.

Flooding is a direct and physical consequence that can lead to damage, increased maintenance and depreciation of a building (Bartelink et al., 2015; Weinhofer & Busch, 2013). Physical water safety measures can be implemented to manage the direct consequences of flooding on assets. The Port of Rotterdam has listed these possible measures, see Table 2-1 (Rotterdam, n.d.).

These measures are intended to protect physical assets. Indirect consequences that are not linked to physical assets are not included in these measures. Some of these measures must be taken during the development of the assets. Other measures can be taken retrospectively with minor adjustments. Some of the measures described in the table can be applied in crises and do not require any adjustments to the asset.

Part II - Desk research




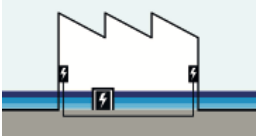

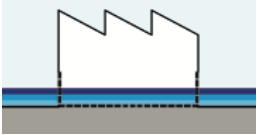
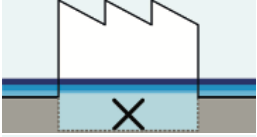
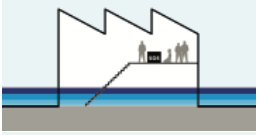
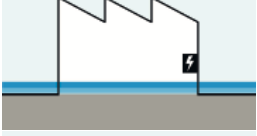
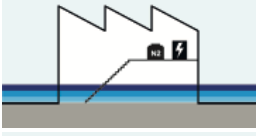

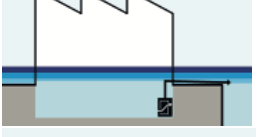

Measure	Description	Beforehand	Afterwards	
1. Waterproofing buildings and assets	Building with waterproof materials limit water from entering the buildings during a flood.	x		
2. Sealing off openings	Sealing openings off with flood panels, flood doors or stop logs reduces the probability of water entering the building.		x	
3. Raising thresholds	Raising the threshold in building with a waterproof plinth will prevent inundation of minor floodings.	x	x	
4. Flood-resilient assets and facilities	Make facilities, utilities, and assets water-resistant. Products or assets must be able to cope with water pressure.	x	x	
5. Company emergency plan	Describe the actions that need to be taken in an emergency plan.		x	
6. Water-resistant building materials	Water-resistant material limit or prevent damage of the flood. Water-resistant floors, walls and constructions are necessary.	x		
7. Avoid basements	Basements are vulnerable to flooding, even during relatively shallow floods.	x		
8. Emergency shelters for personnel	Safe shelters for personnel in a easily accessible and non-floodable area. Vertical evacuation for emergencies is important.	x		
9. Positioning assets and utilities at higher locations	Placing vulnerable, vital, or capital-intensive products on higher positions.	x	x	
10. Emergency system for critical functions	Certain on-site are critical for a company's business processes. This prevents the shutdown of critical systems and business processes.	x	x	
11. Emergency flood barriers	Emergency flood barriers are temporary barriers that can be installed if there is a flood threat. This could be sandbags or innovative mobile barriers.		x	
12. Install pumps	Installings pumps at strategic locations on site, you can pump out water. Pumping the water allows you to start recovery operations sooner.	x	x	
13. Flood damage insurance	Some insurers provide specific policies for flood damage.	x	x	

Table 2-1: Flood risk asset measures, adjusted from Rotterdam (n.d.)

2.7 Flood risks as business operational risks in REM

As described in section 2.6, flood risks can be responded to in asset management because flooding has an impact on the asset itself (Rotterdam, n.d.). Flooding also has an impact on business operations and can be responded to in operational management (A. den Heijer, personal communication, 22 May 2025). This section describes the business operational risks and how they can be responded to. The basis for this knowledge is due to personal communication. From there, specific scientific studies were sought that describe the business operational impact of flooding on real estate. The literature studied was selected based on relevant topics, recent studies, and their relation to corporate or public real estate.

Real estate is not only a physical asset, but also a facility which supports an organisation’s primary processes. It is considered the fifth resource alongside human resources, capital, technology, and information. (Den Heijer et al., 2021) According to Den Heijer, the building itself has a target value of 15% of a company's total value, with the majority of value found in business operations (personal communication, May 22, 2025). To ensure business operations, operational continuity is a key concern in real estate management.

2.7.1 Economic and operational impact of flooding

Climate change-related events, such as flooding, pose a direct threat to business operations (Wu et al., 2024). Wu et al. (2024) note that most economic losses stem from operational disruptions, repair costs, insurance claims, and collateral devaluation. Jonkhoff (2009) distinguishes three types of consequences of flooding:

- 1 Direct damage: damage to objects, capital goods and moving objects because of contact with water.
- 2 Production loss: direct damage due to economic loss where production or supply chains were interrupted.
- 3 Indirect damage due to production loss: damage due to other companies involved in the supply and demand, plus the damage to supply and demand that is interrupted because of damage to the infrastructure.

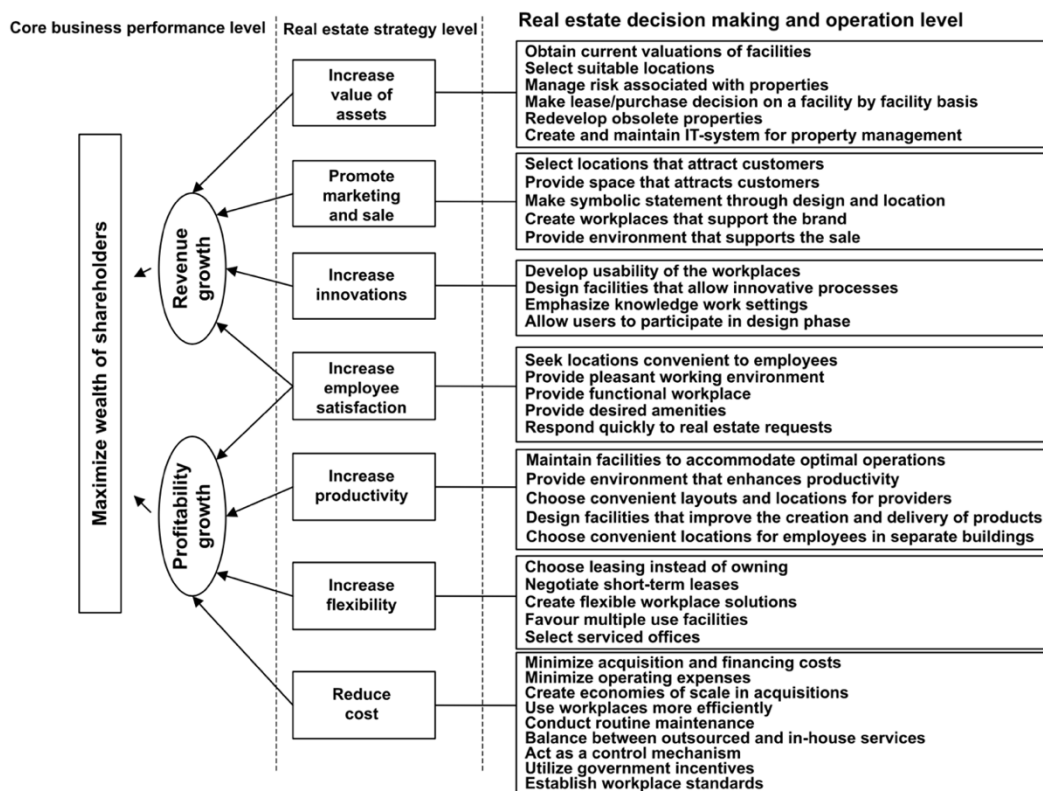


Figure 2-15: Decisions and operations impact business performance (Weinhofer & Busch, 2013)

These disruptions directly impact business operation continuity and performance. Weinhofer and Busch (2013) show that real estate decisions and business operations impact organisational performance, as shown in Figure 2-15. Flooding can lead to physical damage that not only affects the value of the asset but can also disrupt facilities, workplaces, accessibility, and supply chains. These factors will affect marketing and sales, employee satisfaction, innovations, and productivity. The revenue and profitability will be affected, and so will the performance of the organisation. (Weinhofer & Busch, 2013)

Losses in business continuity

In their research, Fatica et al. (2024) investigate the dynamic impact of flooding on European manufacturing firms. Flood damage has a significant and long-term negative impact on the firm's performance. A typical flood depreciated a firm's assets by 2% in a year. (Fatica et al., 2024) Each day a business is closed due to flooding, it incurs an average cost of 0,5% of annual revenue. These costs do not only include repair costs, but also include reduced network access, inability to collaborate, and delayed decision-making. (Endendijk et al., 2024)

2.7.2 Operational and business risks from flooding

Bartelink et al. (2015) describe operational and business risks as one of the six general risk categories in real estate management, mentioned in section 2.3. These categories include the following risks: maintenance risk, facility management risk, malfunctioning installation risk, real estate flexibility risk, occupancy risk, relocation risk, health and safety risk, office layout risk, and expansion risk.

Flooding increases exposure to these risks. For instance, water damage due to flooding raises maintenance needs. Buildings located in vulnerable zones face greater health and safety risks. Flexibility risk becomes relevant when buildings cannot easily be adapted or relocated in response to changing flood patterns. In addition, malfunctioning installation risks will increase as electrical systems fail due to flooding. Technical failures can cause breakdowns in heating, cooling, ventilation, electricity, ICT, and elevators. These systems are often located on the ground floor or in the basement, making them highly vulnerable to water damage. (Bartelink et al., 2015)

Access difficulty

Endendijk et al. (2024) emphasise the relevance of asset accessibility. Organisations may experience access difficulties in the first few weeks following a flooding incident. When the asset is difficult to reach for suppliers, customers, or staff, the revenues may be reduced, even if the company is operationally ready. Figure 2-16 shows an overview of the days that the firm was difficult to access after a flood event. (Endendijk et al., 2024)

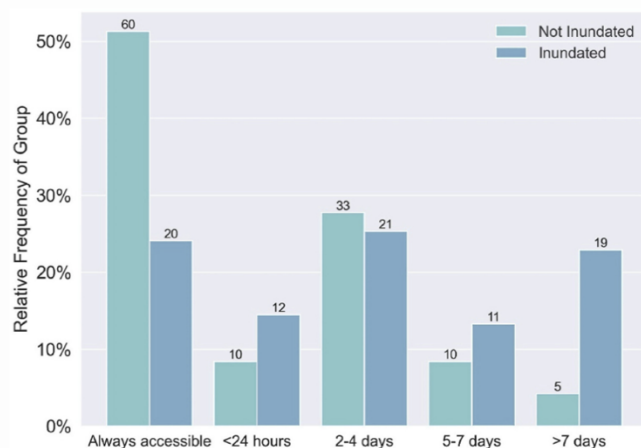


Figure 2-16: Days firms were difficult to reach (Endendijk et al., 2024)

2.7.3 Business operation continuity and disaster preparedness

To address operational and business risks from flooding, organisations operating in flood-prone areas must integrate flood risks into their risk management strategy. Organisations that have better preparedness strategies limit their operational disruptions, protect their employees, protect their assets, and recover faster from climate-related disasters. (Kalogiannidis et al., 2024) To ensure business operation continuity, an organisation can enable remote working, back-up data, have alternate workspaces, work with different types of parties in different locations, and make sure assets are protected from climate disasters (Kalogiannidis et al., 2024; Weinhofer & Busch, 2013).

Business continuity plan

To manage the risks mentioned above, implementing a Business Continuity Management System is essential to maintain operational continuity during disruptive events, such as flooding. A Business Continuity Management System (BCMS) ensures resilience during disruptions. It includes a Business Impact Analysis (BIA) and Risk Assessment (RA) to create a tailored Business Continuity Plan (BCP) (Cerullo & Cerullo, 2004; Rezaei Soufi et al., 2019).

A BCP aims to limit risk exposure, facilitate a fast return to ‘business as usual’, and reduce the duration of the disruption. The concept of BCP accelerating the return to business operations within the maximum tolerable time is shown in Figure 2-17. The BCP is a tailored plan based on specific operational vulnerabilities and dependencies (Yang et al., 2020).

Cerullo and Cerullo (2004) and Yang et al. (2020) describe the business continuity planning process as addressing three interrelated objectives:

- Identifying key risks to business continuity.
- Create a strategy to mitigate and decrease risks.
- Train employees and test the plan.

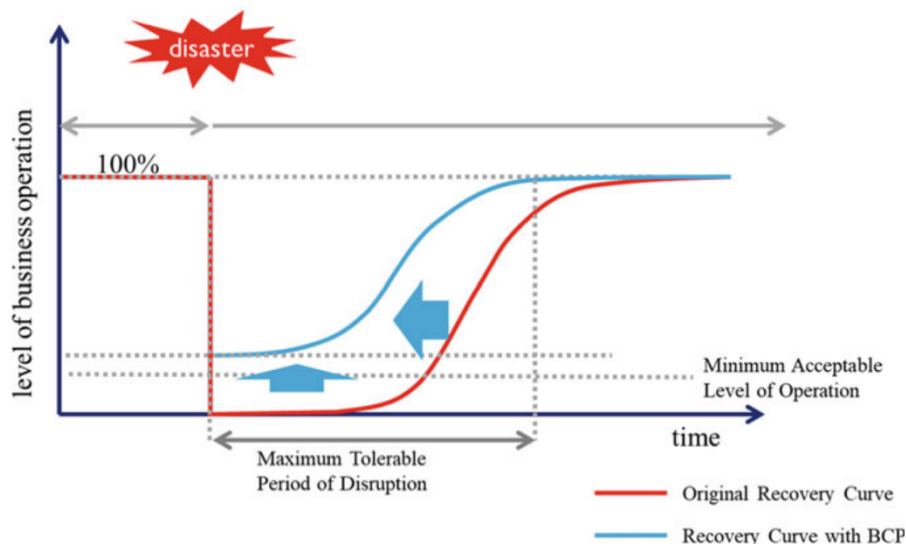


Figure 2-17: Business operation recovery process; with and without BCP (Yang et al., 2020)

1. Conduct Business Impact Analysis (BIA): (Cerullo & Cerullo, 2004)
 - Identify critical business functions.
 - Assess risks based on probability and impact.
 - Suggest measures to avoid, reduce, or absorb risks.
2. Create Disaster Contingency Recovery Plan (DCRP): (Cerullo & Cerullo, 2004)
 - Define roles and responsibilities.
 - Establish notification procedures and alternate work locations.
 - Outline crisis continuity operations.
3. Test and Train the Plan: (Cerullo & Cerullo, 2004)
 - Apply test methodology and revise as needed.
 - Train employees to ensure clarity of tasks and reduce panic during crises.

Ultimately, a carefully developed BCP gives businesses an organised strategy to manage flood-related interruptions, protecting not just physical assets but also employee well-being, business operations, and organisational resilience.

2.8 Conclusion desk research

The section outlines the conclusion of the desk research by presenting how flood risk impacts real estate portfolios, assets, and business operations in flood risk areas. The relationships explained below are presented in a theoretical framework, which can be seen in Figure 2-18.

Climate change is driving rising sea levels, shifting precipitation patterns, and more frequent extreme weather events, leading to an expansion of flood-prone areas and elevated risk levels (Henkens et al., 2024; IPCC, 2023). In the Netherlands, floods can take the following forms: fluvial, lacustrine, coastal, and pluvial (Environmental Health Atlas, z.d.).

To manage these risks effectively, organisations must adopt a structured approach to risk management. General risk management theory emphasises a structured process of risk identification, assessment, response, and control (Winch, 2010). In the context of disasters such as flooding, the disaster risk management framework provides specific guidance for managing these risks (UNDRR, n.d.).

Real Estate Management (REM) is defined as the alignment of real estate assets with business operations through decision-making at multiple levels (Arkesteijn et al., 2016). In this thesis, REM is used as a broad concept that includes corporate and public owner-occupier organisations. Although the literature originates from corporate real estate management (CREM), its principles are highly applicable to owner-occupiers. Therefore, the CREM framework, and in particular the Four Quadrant Model developed by Krumm (1999) and modified by Den Heijer (2021), is used to structure the analysis. Flood risks influence all levels and quadrants of the Four Quadrant Model of CREM. Their impact extends to the alignment between portfolio, assets, and business operations. Representing the three strategy levels in REM: strategic, tactical, and operational (Janssen, 2008; Van Driel, 2010).

According to the risk management framework of Winch (2010), flood risks must first be identified and assessed. A proposed assessment method for flood risks is the Location-Oriented Approach, relying on location-specific data, building characteristics, property transaction records, and local flood protection systems (Wu et al., 2024). In addition, a commonly used method for assessing flood risks is the Framework for Climate Adaptive Buildings (Dutch Green Building Council, 2022).

Following identification and assessment, organisations can respond to risks at both asset and operational levels. At the asset level, direct damage accelerates asset depreciation and increases maintenance costs (Bartelink et al., 2015; Weinhofer & Busch, 2013). Proactive physical measures can mitigate these risks (Rotterdam, n.d.). At the operational level, flooding can create multiple business operational risks: health and safety risks, flexibility risks, occupancy risks, and technical risks (Bartelink et al., 2015; Endendijk et al., 2024). Indirect impacts disrupt business operations, reduce productivity, and harm reputation (Bartelink et al., 2015; Weinhofer & Busch, 2013). To maintain resilience, organisations should integrate flood risks into operational management through Business Continuity Plans, ensuring critical processes can continue during and after disruptive events (Cerullo & Cerullo, 2004; Yang et al., 2020).

Ultimately, these assessments inform decisions that balance long-term asset value, operational continuity, and resilience. Multiple Criteria Decision Analysis (MCDA) offers a structured approach for such complex decision-making. (Arkesteijn & Binnekamp, 2013) When deciding, it is necessary to also consider the financial implications. A Cost-Benefit Analysis (CBA) weighs the costs of implementing risk measures against the expected benefits in terms of risk reduction (Jonkman et al., 2004; Špačková & Straub, 2015). Investments in risk reduction can reduce the future cost of reconstruction and recovery. (OECD, 2016) Numerous cost-benefit analyses demonstrate that proactive flood mitigation measures are more cost-effective over the long term than reactive responses to both direct and indirect flood damages (Abe & Adriaens, 2025; Molinari et al., 2021; OECD, 2016). However, cost-benefit analysis faces significant limitations, particularly in monetising non-financial impacts and due to uncertainty in estimating benefits for flood events (Jonkhoff, 2009).

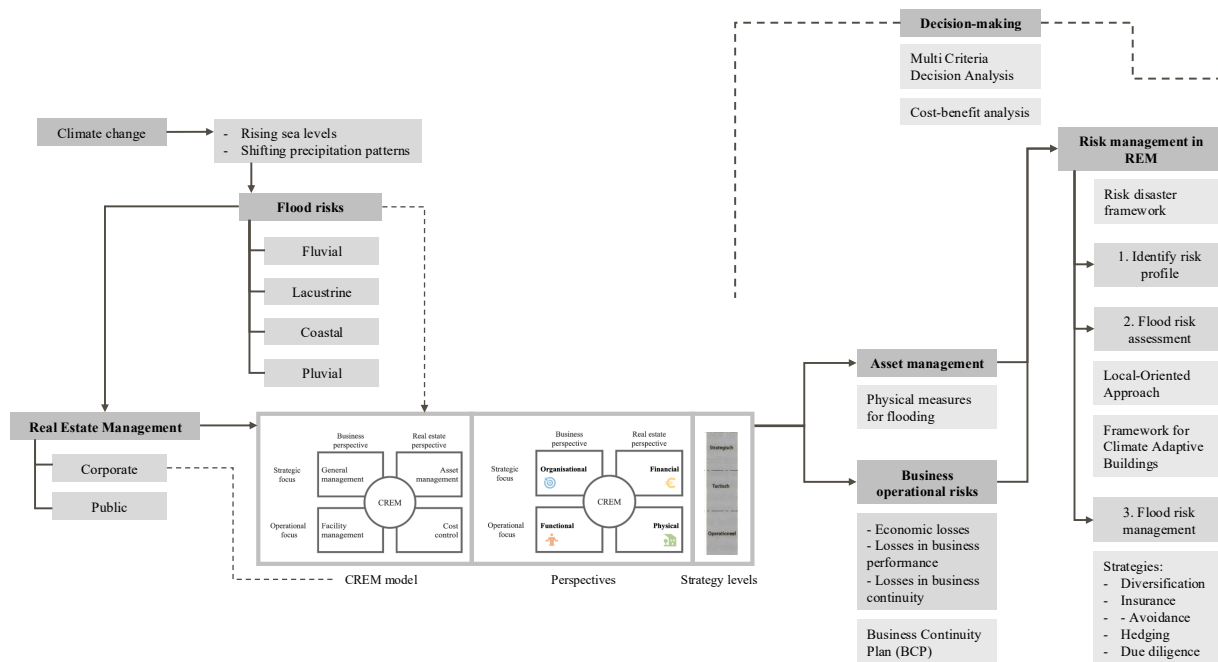


Figure 2-18: Theoretical framework (Author, 2025)

2.8.1 Conceptual framework

Based on the theoretical framework highlighted in the Literature study, a conceptual framework is drawn up. This framework shows the relation between the concepts covered in the literature. In Figure 2-19, it can be seen that climate change is increasing flood risk. These flood risks have an impact on the REM process. Flood risks have physical effects on the asset itself, but they also have an impact on business operations. To minimise these risks and their associated effects, flood risk management must be integrated into a REM strategy. This research explores how flood risks can be integrated into real estate management strategies for owner-occupiers of organisational real estate.

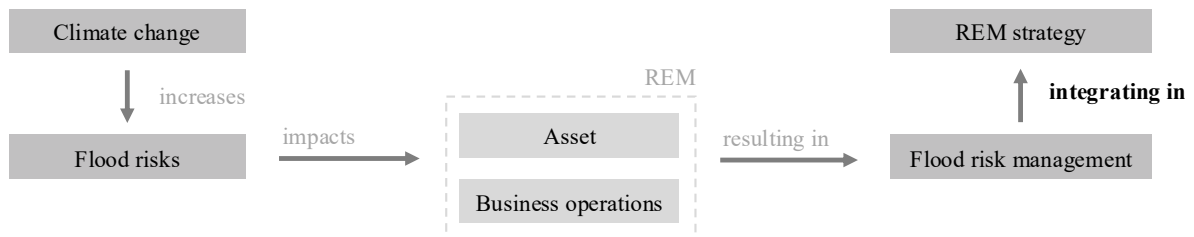


Figure 2-19: Conceptual framework (Author, 2025)

Part III

Research design

3. Methodology

The research aims to guide real estate owner-occupiers to start integrating flood risk management into their real estate management strategies. This chapter outlines the research approach and data collection methods to explore how flood risks can be integrated into REM strategies. This is done through a multi-method qualitative research design. This approach integrated multiple qualitative methods, as described in this chapter.

3.1 Research design

This research follows a multimethod approach, qualitative and exploratory. In the multimethod approach, different types of research methods are used: desk research and empirical research (Blaikie & Priest, 2019).

The different methods used to answer the main research question and sub-questions are a literature study, case studies (including case descriptions, in-depth interviews and in-case analyses), cross-case analysis, creating a theoretically informed roadmap and eventually validation of the roadmap. The simplified research approach is presented in Figure 3-1.

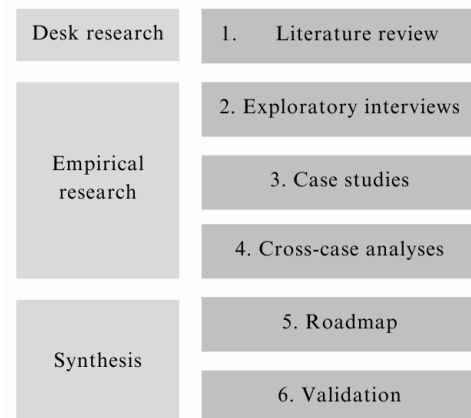


Figure 3-1: Research approach (Author, 2025)

3.2 Research methods

The methodology framework of the research is presented in Figure 3-2. It can be seen that different methods were used for different components with different deliverables.

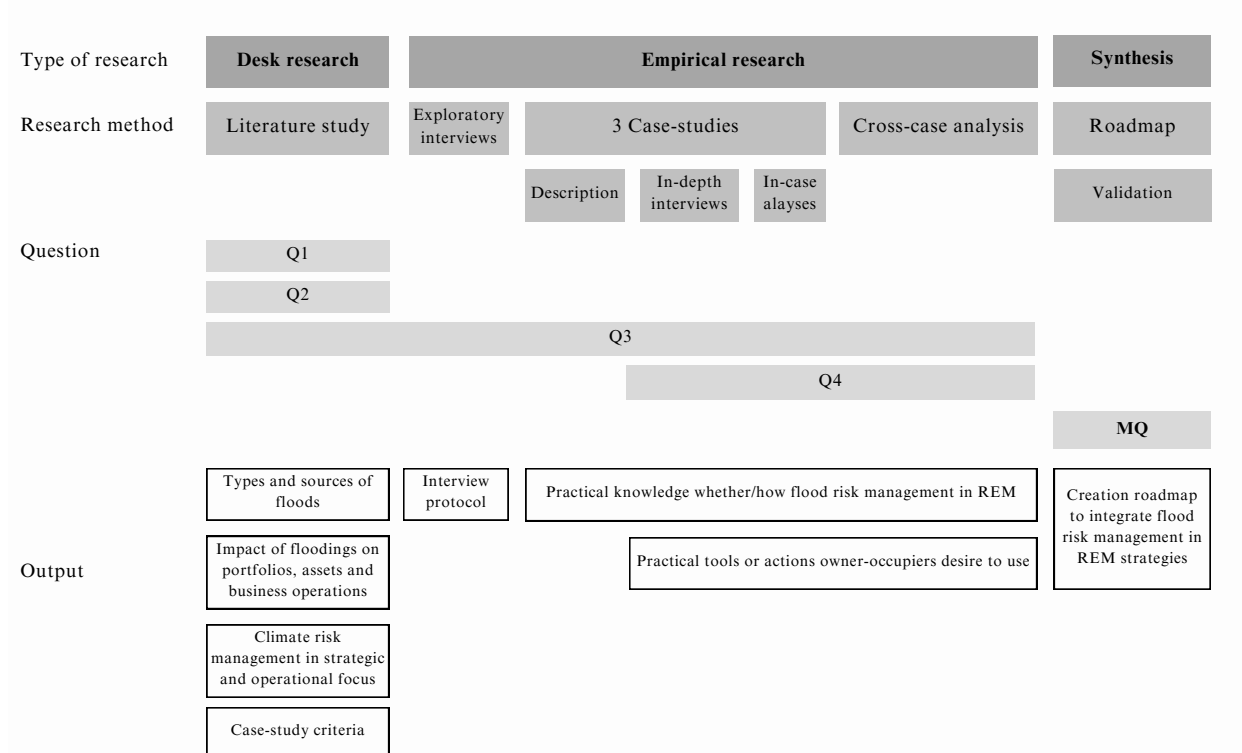


Figure 3-2: Research methodology framework (Author, 2025)

Desk research

The first component of this study is the desk research. This desk research consists of a literature study. The purpose of this desk research is to identify flood risks in the Netherlands and explore their impact on real estate management with a focus on the asset and business operational perspective. To achieve this goal, it is essential to build background knowledge to understand types and sources of flood risk in the context of the built environment, (corporate) real estate management as a concept, risk assessments in REM, and the impact of flood risks on different levels: strategic, tactical, and operational.

After framing the theoretical background, the desk research answers the first two sub-questions:

1. *What are the key flood risks in the built environment, and how do they impact real estate portfolios, assets, and business operations in flood zones?*
2. *How can flood risks be integrated into REM strategies?*

The selection criteria of the case studies are derived from the desk research. In addition, the knowledge gathered is used to formulate interview themes and questions used in the empirical research.

Empirical research

The empirical research consists of exploratory interviews, case studies and a cross-case analysis. This way of deepening knowledge from broad to specific is shown in Figure 3-3.

Exploratory interviews

The exploratory interviews provide a foundation for an empirical study to gain a better knowledge of flood risks in the built environment. These interviews are open-ended, allowing the interviewee to express their knowledge and thoughts. The outline for the exploratory is based on the literature study.

The literature study revealed three themes, which serve as the foundation for the interview outline:

- Flood risk assessment & flood risk management (Strategic level)
- Asset management & physical measures (Tactical level)
- Business operational continuity (Operational level)

The interviewees are first placed in the quadrants of the CREM-model: organisational, physical, functional and financial. 2.1.2 explains more about what these dimensions entail. The placement is done to gain a deeper understanding of their perspectives and motives. The transcripts of the exploratory interviews are analysed based on the themes and quotes. Gathered insights are used to set up the in-depth interview outline. An overview of the interviewees is drawn up below in Table 3-1. The selection of the exploratory interviews is further elaborated in 4.1.

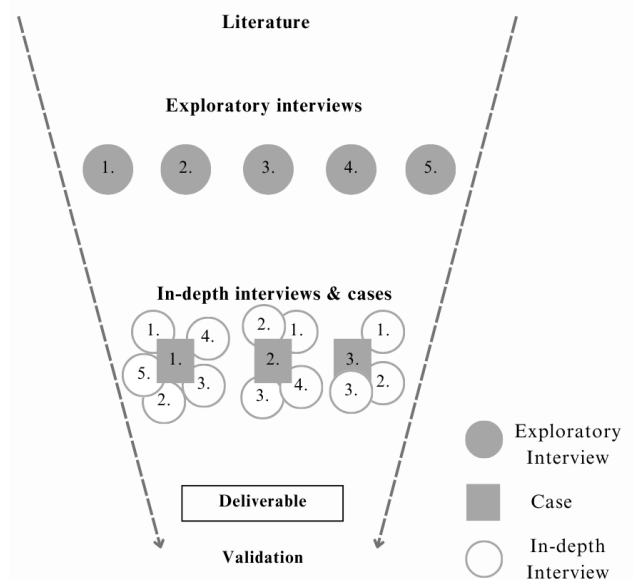


Figure 3-3: Knowledge deepening (Author, 2025)

Interviewee	Company	Function	Date interview
E1	CBRE	Building consultancy	17-09-2025
E2	CBRE	ESG	18-09-2025
E3	NSI	Technical Asset management	22-09-2025
E4	CBRE	DEBT	25-09-2025
E5	Patrizia	ESG	03-10-2025

Table 3-1: List of exploratory interviews (Author, 2025)

Case studies

The second part of the empirical component of this research is case studies. The case studies include case descriptions, in-depth interviews and in-case analysis.

According to Coombs (2022) case studies are used as a research methodology to gain an extensive understanding of an ongoing subject or event in a restricted system. Flood risk management in REM is not a generic process but is highly dependent on the type of organisation, the characteristics of its real estate portfolios, and the strategic priorities of the business. By examining cases as bounded systems, it becomes possible to analyse the interplay between asset management, operational continuity, and strategic decision-making. Therefore, case studies allow the research to capture the complexity of flood risks and organisations.

Cases were selected based on practical and theoretical criteria derived from desk research and CREM principles. The case study selection criteria are defined in Table 3-2. The first selection criterion is the location. As the study is focused on flood risks in the Netherlands, it is important to select Dutch cases that have locations which face risks of flooding. The second selection criterion is that the case needs to be owned and occupied by the organisation, to include both asset and operational perspectives. Third, business alignment was required, meaning the assets support the organisation's core business operations, reflecting REM's emphasis on aligning real estate with organisational needs. Fourth, each case had to include a portfolio of at least three assets to enable portfolio-level decision-making and ensure comparability. A minimum of three assets ensures that portfolios are selected that accommodate different functions in their buildings. Fifth, the case had to reflect the four quadrants of CREM theory: organisational, physical, functional, and financial, and should include interviewees who represent these domains. The sixth selection criterion is that the project needs to be finished, and in use to include the asset management and business operations. Finally, the case needs to have enough data to be researched.

1. **Location:** situated in area with relevance of flood management and /or flood hazard
2. **Real estate owner-occupier:** the case needs to be owned and used by the organisation
3. **Business alignment:** the case involves assets that support business operations
4. **Portfolio:** the case needs to include a minimum of 3 assets
5. **Reflect CREM theory:** reflect different quadrants in CREM theory
6. **Completion:** in-function project
7. **Data availability:** the case needs to have enough and correct data to be analysed

Table 3-2: Case study selection criteria (Author, 2025)

With the use of these selection criteria, 3 cases are selected, listed in Table 3-3.

Project name	Location	Organisation
TU Delft Campus	Delft	Technical University of Delft
ING Headquarters	South-East Amsterdam	ING
RVB The Hague Central	The Hague Central	Rijksvastgoedbedrijf

Table 3-3: List of case studies (Author, 2025)

In-depth interviews

In-depth interviews are conducted in these cases. This is done because the data relevant to this study cannot be obtained from public data sources but requires deeper knowledge in the organisation. In-depth interviews are conducted with experts in the field of managing and owning real estate in flood-prone areas. The interview will contain general questions that are not case-specific. The general questions are formulated in such a way that the interviewee answers the questions based on their case experiences, so the answers are case-specific. Before the interview, it will be explained that the answers relate to the specific case in combination with the company. The interviews will be conducted in a semi-structured

manner to keep the overview and gain new insights. The outline of the in-depth interviews is created based on the knowledge gained from the desk research and exploratory interviews.

Each interview will take up to 1 hour and will be conducted preferably at the location of the company of the interviewee or online. This makes sure that the participants are comfortable in their own environment. Before the interviews, the interviewee will be asked if it is allowed to record the interview. Besides this, the interviewees need to sign the informed consent in advance. This ensures that participants understand the research goal, confidentiality, and their rights. The interviewees are listed below in Table 3-4.

In line with case selection criterion 5, which requires that each case reflect the different quadrants of the CREM framework, this principle also guided the selection of interviewees. Interviewees were chosen to represent these quadrants: organisational, physical, functional, and financial, within each case. This approach ensures a comprehensive understanding of the organisation, incorporates multiple perspectives, and enables analysis of the interrelationships between these perspectives.

Interviewee	Company	Function	Date interview
I1	TU Delft	Sustainability campus real estate management	30-09-2025
I2		Strategic portfolio management & ecology	
I3	TU Delft	Public space management	01-10-2025
I4	TU Delft	Development and projectmanager	03-10-2025
I5	TU Delft	Facility and operational manager	14-10-2025
I6	ING	Manager corporate real estate & Facility services	07-10-2025
I7	ING	Real estate transactionmanagement	10-10-2025
I8	ING	Facility management & Local Real estate management	21-10-2025
I9		Facility services management	
I10	RVB	Portfoliomanagement	08-10-2025
I11	RVB	Strategy and implementation policy	15-10-2025
I12	RVB	Sustainability advisor real estate	23-10-2025

Table 3-4: List of In-depth interviewees (Author, 2025)

In-case analysis

After describing the case and conducting the interviews, case analyses are carried out. This analysis combines the case context with the interview data to better understand the situation, the decisions that were made, and the outcomes. Because the interviewees have different perspectives within the organisation, the first step is to identify their positions. This helps to understand their motivations and interests. Each interviewee is placed in one of the four quadrants of the CREM framework: organisational, physical, functional, or financial. This makes it easier to see how their perspective influences their view on flood risk management.

To compare the interviews in a structured way, important quotes from the coding process, explained in section 4.3.1, are collected in a table, shown in the Appendices. These quotes are grouped by theme, based on the codes. This allows for a comparison of how different perspectives talk about the same topics. Based on this comparison and supported by quotes, the current situation and possible actions for flood risk management were identified by the interpretation of the researcher based on the interview data.

Finally, a summary table is created that shows the current situation and what actions are needed regarding the different interviewees, but case-specific. This table will be used later in the cross-case analysis.

The exploratory interviews, case studies, including the description, in-depth interviews and the in-case analyses, will answer the sub-questions below:

3. *How do existing REM strategies currently address or neglect flood risk management?*
4. *What tools do real estate owner-occupiers need to effectively integrate flood risk into their strategies?*

Cross-case analysis

In this part, the results of the case studies are compared. This is done by comparing the current situations and the potential actions that were identified in each case. The comparison helps to find patterns and differences between the cases. These findings form the basis for the main conclusions of the research.

Synthesis

Developing the roadmap

All findings of the literature study, case studies and cross-case analysis are combined into a theoretically informed roadmap. This roadmap can be used to guide organisational and tactical levels in owner-occupier organisations to integrate flood risk management into their real estate strategies. The deliverable is derived from sub-question 4 and depends on what the owner-occupiers of real estate need. The deliverable aims to give guidance in structured and practical actions or tools to integrate flood risks into REM strategies, rather than prescribing a concrete step-by-step plan.

Expert validation

During the expert validation, discussions were held with experts who had previously been interviewed for the case studies. The selection of the experts is elaborated in 6.4. The purpose of this validation was to assess whether the roadmap is logical, feasible, and recognisable in practice. The feedback provided by the experts was used to make a final round of refinements to the roadmap. Ultimately, the roadmap, together with the user guide, addresses the main research question:

Research question: *“How can real estate owner-occupiers integrate flood risk management into their real estate strategies?”*

3.3 Data collection and analyses

Desk research

Relevant data is retrieved by searching reliable sources. To search for these reliable sources, articles are searched through Scopus and Google Scholar. To get to the right sources on these websites, search terms are used. In Google Scholar, the following keywords are used: flood risk management, real estate management, corporate real estate management, portfolio management, flood zones, and flood resilience.

In Scopus, the following keywords are used: (flood risk management OR climate adaptation OR climate risk management) AND (real estate management OR portfolio management) AND flood zones AND risk management.

In addition to the scientific literature, company reports, and government documents are used for research. In this process, the reliability of the companies publishing the reports and documents is considered.

Exploratory interviews

The exploratory interviews were conducted with professionals familiar with flood risks but not connected to the selected cases. These individuals work within the real estate sector and were approached through contacts provided by the graduation company, which acted only as a facilitator for initial introductions. To safeguard the independence of this research, all interviews were conducted and analysed by the researcher without any involvement from the company in the content or interpretation of responses. Before the exploratory interview, the interviewees signed an informed consent form giving permission for the interview to be recorded, transcribed and for their answers to be used anonymously in the research. The transcripts of the exploratory interviews were compared by comparing quotes relating to various predetermined themes. In addition, other motives of the interviewees were also examined, independently of the themes. These interviews were not coded.

Case-studies

Case studies are selected based on predetermined criteria, described in Table 3-2. An important criterion for the case study is that sufficient and reliable information must be available to properly analyse the case. To achieve this, the study uses case studies conducted by the graduation company or the TU Delft. This way, there is a lot of reliable data and knowledge available.

In-depth interviews

Interviews are conducted with experts who were involved in the selected cases. Contact with the interviewee is established through an intermediary from the TU Delft or the graduation company, who can introduce the research to the interviewee. To safeguard the independence of this research, all interviews were conducted and analysed by the researcher without any involvement from the graduation company or the TU Delft in the content or interpretation of responses. The interviews will be recorded and transcribed (with informed consent). The researcher owns all the data collected from interview notes, recordings, transcripts, and codes. The researcher oversees processing, disseminating, and storing the data.

In-case analyses

To use the data from the in-depth interviews for the case studies, the data must be analysed appropriately. The transcribed data will be coded in Atlas.ti to compare correct relationships and overlapping concepts. Codes that are used in Atlas.ti are visible in Appendix V.

This study used both inductive and deductive coding to systematically analyse the qualitative interview data (Rivas, 2012). Deductive codes were constructed from the theoretical framework and the exploratory interviews, allowing for a structured study of essential concepts. Inductive coding allowed the emergence of unexpected themes directly from the data, ensuring that participants' views and experiences were not overshadowed by predefined categories. This dual coding method allowed the exploration of both theoretically informed and context-specific findings. The qualitative data collected from the interviews and the case studies are analysed using content analysis to identify patterns and themes.

Cross-case analyses

No new data is cited in the cross-case analysis. Data from the case studies is combined.

Synthesis

No new data is used to develop the theoretically informed roadmap for owner-occupiers of real estate to guide the integration of flood risk management into their REM strategies. Data from the desk research and the empirical research are combined.

3.4 Research output

The research output of this thesis emerged after the synthesis. The deliverable is a theoretically informed roadmap that can be used to guide the integration of flood risk into real estate management strategies for owner-occupiers. Rather than prescribing concrete steps, this roadmap serves as a structured guide for owner-occupiers to initiate and shape their approach toward resilience.

3.5 Ethical consideration

The well-being of research participation is important. To make sure the well-being of all participants is achieved, four ethical considerations in the qualitative study are followed: (Arifin, 2018)

1. Informed consent
2. Voluntary participation
3. Anonymity
4. Avoiding exaggeration of objectives

Before participating in this research, all participants are obliged to fill in the informed consent form. Each type of data collection used in this study is voluntary. By filling in the informed consent prior to participation, participants have the choice to stay anonymous. Strict compliance is maintained with privacy protection protocols, especially while handling potentially sensitive information. It is crucial to protect participants' privacy and confidentiality at every stage of the study. It is guaranteed that the research's goals won't be overstated. When expressing the study aims, integrity and transparency are maintained, preventing any misinterpretation of the goals. More information regarding the ethical considerations can be seen in Appendix I.

Part IV

Empirical research

4. Empirical research

This chapter presents the empirical research of the exploratory interviews, the findings of the case study, including case descriptions, in-depth interviews, in-case analyses, and finally the cross-case analysis.

4.1 Exploratory interviews

Exploratory interviews were conducted with experts on flood risk in real estate, listed in Table 4-1. The experts were selected from within the circles of the graduation company. When selecting the interviewees, a variety of perspectives were chosen based on the theory of Krumm (1999) and (Den Heijer, 2021), explained in paragraph 2.1.2. These insights formed the foundation for the case studies, focusing on three concepts derived from the desk research: the flood risk management process, asset management & physical measures, and business operational continuity.

Interviewee	Company	Function	Date interview
E1	CBRE	Building consultancy	17-09-2025
E2	CBRE	ESG	18-09-2025
E3	NSI	Technical Asset management	22-09-2025
E4	CBRE	DEBT	25-09-2025
E5	Patrizia	ESG	03-10-2025

Table 4-1: List of exploratory interviews (Author, 2025)

The experts interviewed work for organisations that play key roles in real estate investment or management. These organisations represent different perspectives within the real estate sector, from advisory and asset management to institutional investment. CBRE is a global real estate services firm, providing advisory, property management, and investment solutions to corporate clients and investors (CBRE, n.d.). NSI is a Dutch-listed real estate company focused on office investments and workspace solutions, aiming to create long-term value through active portfolio management (NSI, n.d.). Patrizia is an international asset manager specialised in real estate investments for institutional clients, with a strong emphasis on sustainable and risk-aware strategies (Patrizia, n.d.).

Figure 4-1 maps experts to the CREM model perspectives, clarifying their roles (Den Heijer, 2021). ESG functions differ by quadrant: CBRE's ESG role is advisory (organisational level), Patrizia's ESG role focuses on real estate, while building consultancy and technical asset management fall within the physical quadrant. DEBT operates in the financial domain.

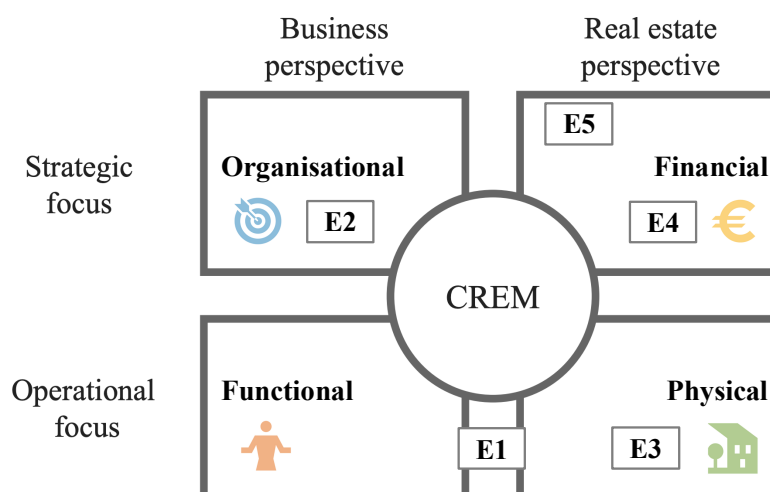


Figure 4-1: Perspectives in Quadrant Model CREM (Author, based on Krumm (1999) and Den Heijer (2021))

Flood risk management process | Strategic level

Flood risk identification

All experts agree that awareness of flood risks remains limited, though pluvial floods are recognised. They agree that the flood risk management process begins with identifying potential threats. Experts 2 and 5 are most familiar with this process. Expert 2 refers to the DGBC Framework for Climate Adaptive Buildings, previously discussed in section 2.5.4. Expert 5 adds that flood risks are identified during the acquisition of real estate investments.

“You need to map out the risks first. That’s where it starts. There are different maps you can use... a combination of those maps determines whether there’s a flood risk.” – E2

Experts 1 and 3 mention that flood risk identification is often carried out by external consultants, such as Expert 2. Experts 1 and 4 indicate that identifying flood risks is beneficial for sustainability purposes; they also note that it is not mandatory. Expert 1 points out that for new developments, flood risk mapping is required as part of the permitting process. Expert 5 explains that it is requested of them by the financial institutions that are customers of Patrizia. The EU taxonomy applies a regulation in this context. The motivation for experts to identify these risks is that they must, or simply to earn sustainability points for certification.

“We did it for the entire portfolio... We thought we were subject to CSRD, so that created a need for EU taxonomy... But we weren’t, so it faded away. Still, you can earn a BREEAM point if you’ve mapped the risk. That’s the honest answer.” – E3

Flood risk assessment

The depth and approach to flood risk assessment are significantly different among the experts. At the organisational level, Expert 2 applies a structured DGBC methodology. Expert 5 uses tools based on this framework. In contrast, at the physical level, Experts 1 and 3 assess risks based on potential damage and the vulnerability of installations. From the financial perspective, Expert 4 reveals that no risk assessment is conducted at all. These differences highlight how each perspective views flood risk in relation to real estate, shaped by their respective responsibilities and priorities.

“The outcome is a risk level: high, low, or medium. That’s based on the method from the Dutch Green Building Council, called the Framework for Climate Adaptive Buildings.” – E2

Flood risk management

According to the experts, strategic flood risk management is rarely practised. Action is typically triggered only by external pressure, such as certification requirements, regulatory changes, or impactful events that raise awareness. Experts 3 and 5 acted due to regulatory requirements. Experts 1 and 2 note that proactive integration is exceptional, only in organisations with critical functions.

“But that is why we actually do it, because we are obliged to provide information and report on it.” – E5

Expert 2 explains that flood risks are managed across multiple levels. The process begins with non-physical measures, followed by area-level interventions, and finally, building-specific actions. These levels do not represent a hierarchy of importance but rather a sequence in which flood risk is addressed. Each level offers a different lens through which mitigation strategies can be applied.

“You start with non-physical measures... Then you look at the area level, for example, with the municipality to see what’s possible... Then you look specifically at the building.” – E2

Asset management & physical measures | Tactical level

All experts mention physical measures for flood risk mitigation, but perspectives often conflict and lack awareness of cross-disciplinary constraints. For example, Expert 2 suggests relocating installations to higher floors, while Expert 1 insists they remain on the ground floor for supplier access. This highlights the need for a unified structure for measures. Although the DGBC framework offers guidance for assessment, it is incomplete and inconsistently applied for responding. Expert 5 notes their role ends with risk identification: implementation lies elsewhere.

“Yes, they do have a kind of step-by-step plan for what should be included. But the actual content and how you fill it in, that, well, you kind of have to figure that out yourself.” – E2

“If you inform them, but removing the risk is... If the investor is informed about it but does not want to invest to avoid risk, then that's it. Then it actually stops.” – E5

The measures vary widely in scale and impact. While some measures overlap, the decision-making process behind them is based on prior identification, assessment, and strategic planning. Expert 3 notes that risks are often accepted rather than mitigated, unless they involve critical installations or processes.

“If the damage is limited, you might accept that risk. If the damage is more severe, then you could take mitigating measures.” – E3

Several experts (E1, E2, E4 and E5) touch on the topic of insurance. It becomes clear that insurability is often relied upon without a full understanding of what is actually covered. Expert 1 suggests that insuring the physical asset can be a valid measure, while Expert 2 points out that some properties cannot be insured against flood risks at all. Expert 4 adds that there is a fundamental difference between water damage and flooding, between pluvial floods and fluvial, lacustrine or coastal floods. The type of flooding referred to in insurance policies used to secure financing is often unclear, leaving financiers unaware of the true scope of coverage.

“There's a gap between what insurers cover and what financiers think is covered.” – E4

Business operational continuity | operational level

Experts agree that estimating flood impact on operations is difficult due to a lack of experience, though consequences could be severe for critical processes. Experts 3 and 5 highlight that user type is ignored in assessments, despite its importance. ESG teams, which often conduct these assessments, also fail to include business continuity as a factor. The experts suggest that physical measures can help safeguard operations, allowing business activities to resume more quickly after a flood.

“The type of user isn't considered... which is actually quite strange.” – E3

“I don't think specifically about the type of real estate it is... I think that should be the case.” – E5

4.2 Conclusion of exploratory interviews

To conclude the exploratory interview findings, the experts shared their knowledge of flood risks on real estate from different perspectives. The insights gained form a base in shaping a more targeted and effective in-depth protocol.

One of the findings is the differences in knowledge and responsibilities across the perspectives. Each expert operates within a distinct quadrant of the CREM model: organisational, physical, functional, or financial, and their approach to flood risk is heavily influenced by their domain. The organisational domain focuses on structured frameworks to identify and assess the risks. In contrast, the physical domain relies more on practical knowledge, experiences, and physical constraints. The financial domain views flood risks primarily through the lens of insurability and financing conditions. This fragmentation leads to contradictions and blind spots. These conflicting views highlight the lack of cross-perspective awareness and underscore the need for a shared vocabulary and integrated framework. The in-depth interview protocol should therefore include questions that ask how professionals perceive the boundaries of their perspective, and whether they are aware of how their decisions affect other domains.

Across all interviews, there is a consensus that strategic flood risk management is rare. Most organisations act only when there is external, through regulations, certifications (e.g., BREEAM, CSRD), or after experiencing a disruptive event. Even when frameworks exist, such as the DGBC model, their use is inconsistent and often limited to sustainability reporting rather than proactive risk mitigation. This shows that the in-depth interview protocol should include questions about what actually motivates organisations to act. What triggers their decisions, and how do they decide whether their current approach is good enough?

One of the most overlooked parts of flood risk is how it affects business operations. The experts know that flooding can seriously interrupt important business activities, but none of the current tools or frameworks take into account who is using the building or what kind of business process is inside. Physical measures are discussed, but there is no link to business continuity. That's why the in-depth interview protocol should include questions about how organisations think about operational risks. Do they consider different types of users? And how do they connect physical measures to keeping their business going during or after a flood?

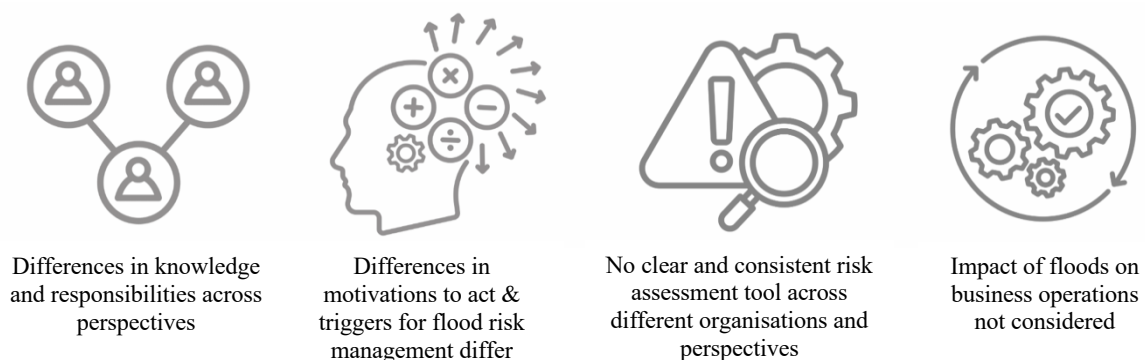


Figure 4-2: Main findings of exploratory interviews to be included in in-depth interview protocol (Author, 2025)

4.3 Case study | TU Delft Campus

Factsheet

- Location: Delft
- Size: 160 hectares
- Buildings: 60
- Phase: in-use
- Ownership: TU Delft
- Type: public real estate
- Program:
 - Academic
 - Office
 - Related business
 - Residential (student housing)
 - Retail & leisure

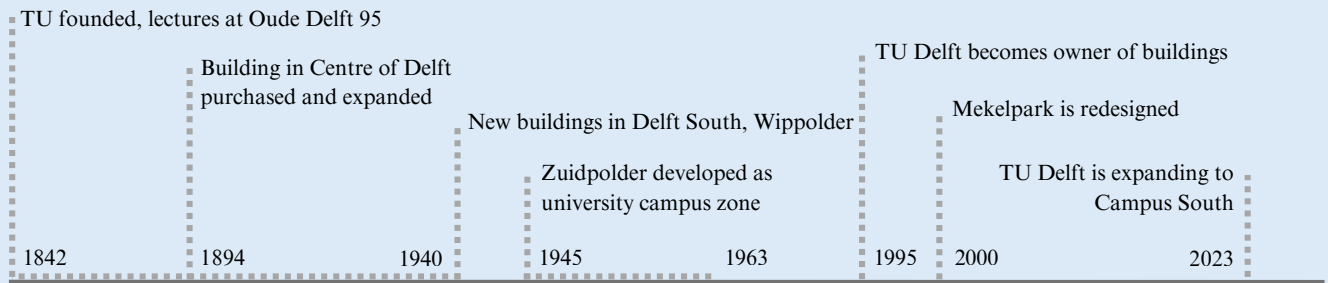


Figure 4-3: TU Delft case study area in Delft (Author, 2025)



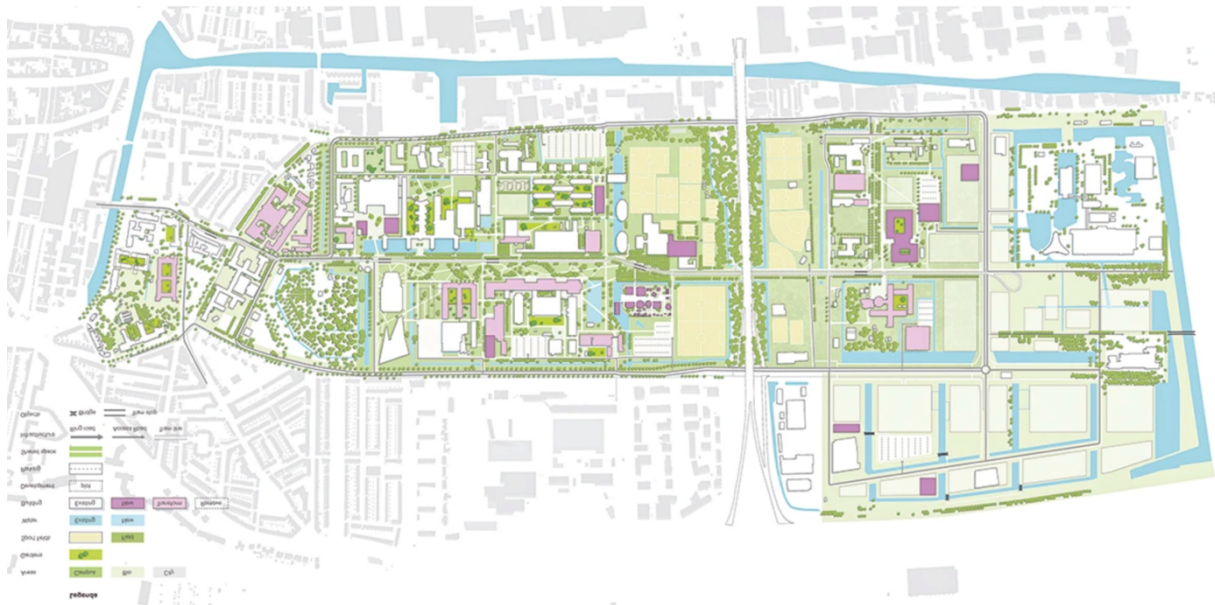


Figure 4-4: TU Delft campus overview (Karres Brands, n.d.-a)

Context

Delft University of Technology (TU Delft) is the largest technical university in the Netherlands, located in the southern part of Delft. The campus accommodates approximately 27,000 students and 7,600 staff. Founded 182 years ago in civil engineering, TU Delft now offers a broad spectrum of engineering sciences across eight faculties and 40 departments. (Technische Universiteit Delft, 2025)

As a public, non-profit institution, TU Delft operates as a complex organisation that manages people, resources, and time in a business manner. The varied programme makes the business vision complex. Its institutional strategy, impact for a sustainable society, guides its core missions: academic education, scientific research, societal knowledge transfer, and social responsibility. The main tasks of the university are to provide academic education, conduct scientific research, transfer knowledge to society and promote social responsibility. (Technische Universiteit Delft, 2023)

The TU Delft campus, shown in Figure 4-4, has eight faculties that facilitate education and research, including lecture halls, laboratories, studios, and offices. It also hosts specialised research facilities such as the Reactor Institute Delft, QuTech, and the Electrical Sustainable Power Lab, which support advanced research in energy, quantum technology, and materials science (TU Delft, n.d.-b). Community buildings like Aula, Echo, and Pulse support events, interdisciplinary teaching, and informal interaction. Climate-adaptive zones such as The Green Village and the Geothermal Heat Source contribute to TU Delft's sustainability ambitions.

The COVID-19 pandemic demonstrated that many educational services can be hosted online. However, research activities are inherently place-based, as they rely on specialised equipment, controlled environments, and collaborative physical spaces. Some of these research activities are considered critical infrastructure, particularly in fields such as energy, quantum technology, and materials science. These activities are place-based, meaning their function and impact are directly tied to their physical asset. (TU Delft, n.d.-b)

Vision regarding sustainability

The long-term development of the campus is guided by the *Campus Vision 2040*, which aims to create an inclusive, sustainable, and future-proof environment. (Technische Universiteit Delft, 2023). Key ambitions include:

- Carbon neutral - 2030
- Circular - 2030
- Climate-adaptive - 2030
- Contributing to quality of life
- Exposing its excellence and sustainable character on campus

These goals are detailed in the *Sustainable TU Delft* action plan and the *Climate Action Programme 2021–2030* (TU Delft, n.d.-b; Van den Dobbelsteen & Van Gameren, 2022). The Campus Real Estate & Facility Management (CREFM) department plays a central role in translating long-term ambitions into practical campus interventions through maintenance, construction, strategic portfolio management, and facility services (TU Delft, n.d.).

Flood risks

TU Delft is located in the Delfland water board region, the most urbanised region in the Netherlands. The campus lies within the Zuidpolder of Delfgauw and Wippolder systems, where water levels are actively managed. This system is shown in Figure 4-5. Two pumping stations west of the campus make it a discharge zone for the Zuidpolder (Van den Dobbelsteen & Van Gameren, 2022).

The southern part of the campus is lower in elevation and more vulnerable to flooding, as shown in . External water sources are used during dry periods, while innovations such as underground water storage are being explored for long-term resilience. The campus is also susceptible to pluvial flooding due to extreme rainfall, with certain zones exceeding safe water depth thresholds, shown in Figure 4-6.

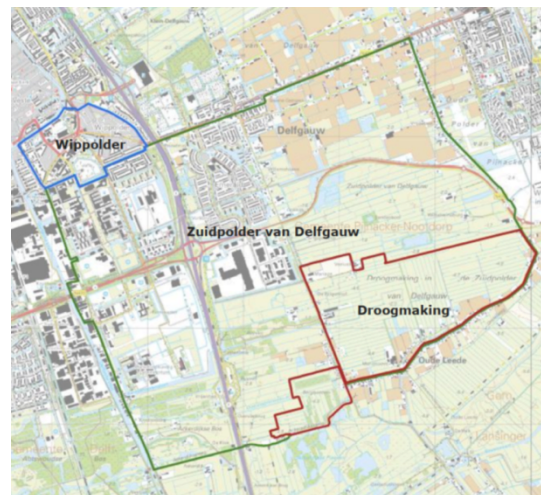


Figure 4-5: Polders connected to the campus (Van den Dobbelsteen & Van Gameren, 2022)

TU Delft acknowledges its responsibility in addressing flood risk management. Although the current infrastructure is not fully equipped for these challenges, the university prioritises the development of a sustainable water system in collaboration with the Delft Water Board. Integrating flood resilience into real estate strategy is essential to ensure future buildings can withstand climate impacts and avoid costly retrofits or replacements in the future. (Van den Dobbelsteen & Van Gameren, 2022)

Recent flood event

In August 2022, TU Delft experienced an extreme rainfall event, with 192 mm/hour recorded. This led to flooding in 21 buildings, including the faculties of Civil Engineering and Geosciences, Architecture, Applied Sciences, and the Dreamhall. According to the KNMI, the amount of rain that fell in 30 minutes was equivalent to a typical month's worth. Several emergency teams, including security staff, building managers, cleaners and the Integral Safety departments, worked overnight to ensure the campus could reopen safely the TU Delft next morning (De Bruijn, 2022). This event highlights the urgency of implementing flood risk in real estate strategies.



Figure 4-6: TUD Campus water challenge (Van den Dobbelsteen & Van Gameren, 2022)



Figure 4-8: TUD Campus. Water depth rainfall 70 mm/ 2 hours (Stichting Climate Adaptation Services, n.d.)



Figure 4-7: TUD Campus. Water depth rainfall 140 mm/ 2 hours (Stichting Climate Adaptation Services, n.d.)

4.3.1 In-depth interviews

The in-depth interviews were conducted with several professionals working at TU Delft, listed in Table 4-2. To analyse the interview data within this in-case analysis, the interviewees were first positioned within the CREM model. The interviews were then coded, as described in the section 3.3. Key quotes from the coded interviews were grouped by theme to allow for comparison. The tables containing these quotes can be found in Appendix VI. Based on this thematic analysis, conclusions were drawn and are discussed below. The in-case analysis ends with a conclusion table that outlines the current situation and possible actions related to flood risk management.

Interviewee	Company	Function	Date interview
I1	TU Delft	Sustainability Campus Real Estate Management	30-09-2025
I2		Strategic portfolio management & ecology	
I3	TU Delft	Public Space Management	01-10-2025
I4	TU Delft	Development and projectmanager	03-10-2025
I5	TU Delft	Facility and operational manager	14-10-2025

Table 4-2: In-depth interviews TU Delft Campus (Author, 2025)

Positioning in the CREM model

The interviewees hold different perspectives within the organisation, each with its own interests and motivations. To ensure a balanced analysis, their positions were mapped within the CREM model. This is shown in Figure 4-9.

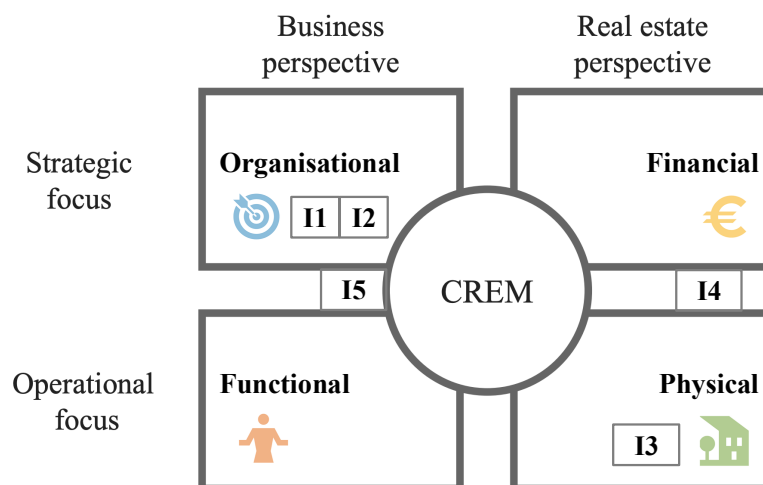


Figure 4-9: TU Delft perspectives in Quadrant Model CREM (Author, based on Krumm (1999) and Den Heijer (2021))

Note: I1 and I2 are positioned in organisational quadrant but have a physical perspective as well.

Analysis per level

Strategic level

There is growing awareness at TU Delft of climate change, climate adaptation, and related flood risks. All interviewees acknowledged the relevance of flood risks. Pluvial flooding is more frequently recognised than fluvial, lacustrine, and coastal floods due to dike breaches or rising sea and river levels. This awareness is mainly driven by municipal and water board policies, as well as recent campus flooding. External stakeholders, such as the municipality, often trigger internal identification by mapping risks and reporting them to TU Delft. However, awareness is not yet widespread. Perspectives that regularly deal with flood risks are more aware, while others noted that awareness is mostly concentrated at the front end of the organisation. Even those in the organisational domain confirm this. To improve awareness, TU Delft should improve internal communication. One interviewee suggested sharing risk analyses within the organisation.

“But that doesn’t mean that right now, that there is broad awareness across the whole organisation” – I1

Flood risk assessment is done using both quantitative and qualitative tools. External agencies perform quantitative assessments with hydraulic calculations, which are then used internally to identify areas on campus that are vulnerable to flooding during heavy rainfall, and the qualitative assessment. Interviewee 5 noted that this assessment is applied to buildings, faculties, and the campus as a whole, resulting in one risk file.

“We do that based on a risk analysis in which we actually have leading scenarios of a flood or water nuisance, ... but these are continuously applied across the primary processes to see what the risks are. And this is done at the faculty and building level, and eventually at the campus level, it is compiled into a risk file.” – I5

TU Delft updates its campus strategy every four years, incorporating flood risk identification and assessment. This includes meeting municipal requirements for new construction to obtain permits and providing guidelines for renovation and outdoor spaces. These are not strict rules, allowing designers flexibility, which can lead to inconsistent application. A handbook with concrete actions could address this gap. Although such a handbook exists, it is not widely used.

“These are design principles, so they are not mandatory requirements. We want to give the designer the freedom to decide how to implement this.” – I1

“So it is said that we have to do it, but it doesn’t prescribe concretely what we should.” – I5

“No, no, I’m sure the principles are not applied equally well everywhere. That doesn’t exist.” – I5

The strategy lacks a mandatory risk analysis for renovation, maintenance, or outdoor projects. Making this a required first step, followed by actions from the handbook, could improve implementation.

Flood risks are one of many factors influencing TU Delft’s real estate strategy. Final decisions are made by the Executive Board, advised by perspectives familiar with flood risks. Awareness, identification, and assessment occur behind the scenes and are presented as recommendations. Once a decision is made, flood risks are no longer discussed at the board level. Smaller decisions are made by asset managers with internal stakeholders, based on the following priorities:

1. Human safety
2. Animal safety
3. The environment
4. The asset

Flood risks can affect human safety and should be prioritised, but this is not always the case due to limited awareness.

“It’s already taken care of, so it doesn’t really interest the board anymore.” – I4

Tactical level

At the tactical level, flood risk management focuses on asset management and the physical consequences of flooding. Staff are aware of the impact, especially due to past incidents like flooding in the basements of the Faculties of Industrial Design Engineering and Applied Physics. Organisational perspectives pointed out that awareness of flood consequences is strongest among asset managers, as they are the ones who know what goes wrong and what the effects are. However, assessments of potential impact vary. Those focused on outdoor spaces see little risk due to existing mitigation, while those focused on assets and operations see high risk. Communication between these perspectives is essential, as indoor and outdoor spaces are interconnected.

“I think that awareness is mainly with our asset managers, they just know... if something goes wrong, what the consequences are.” – I1

“And that’s why communication with building owners, like the building manager, is important. A basement must be waterproof. And you shouldn’t store things in the crawl space.” – I3

Physical measures to reduce flood risks are mostly implemented at the area level. Interviewees explained that features such as retention zones, drainage systems, and green infrastructure are used to manage water. These area-level interventions help reduce pressure on individual buildings. This principle was also mentioned in the exploratory interviews, where Expert 2 stated that flood risks are with non-physical measures, followed by area-level interventions, and finally building-specific actions.

“We actually do a lot in the outdoor space when it comes to these measures.” – I1

Building-specific measures are less common due to financial constraints. Many buildings from the 1960s and 1970s require significant maintenance, and issues often persist. Adjustments are usually postponed until renovations. As a result, defects that increase flood risk often remain.

“These buildings are from the 60s and 70s, so they all need attention. With shrinking budgets, you have to make tough choices... There’s a building now, you know, you can’t just fix it today or tomorrow, so it drags on, and that’s often fine.” – I2

As mentioned, strategic real estate decisions are made by the Executive Board. Internally, stakeholders continuously assess risks and translate them into concrete measures, often using multi-criteria analyses at the asset level.

Operational level

At the operational level, perspectives differ on how flooding might affect TU Delft’s business processes. Interviewee 3, who focused on outdoor space, believes the impact is small due to existing area-level mitigation. In contrast, others in operational and organisational perspectives see significant risks, including repair costs, fire hazards, or structural collapse. The most serious impact, however, could be disruption of research or data loss, leading to major setbacks and financial consequences.

“Yes, yes, then it’s dramatic. No, it’s really dramatic, especially with long-term research. The damage is in the loss of data and continuity.” – I4

While most interviewees recognise the potential impact, they differ on how building functions and business operations are linked to flood risks. The organisational domain stated they do not consider primary functions for business continuity and thus don’t assess what must continue during a flood. In contrast, I5 does consider this, mapping risks against primary functions. The issue, according to one interviewee, is the lack of a requirement to conduct risk analyses per building, resulting in inconsistent protection of business processes.

“I don’t think we’ve thought that far to map out what the impact would be on business operations.” – I1

“For the buildings I’m responsible for, I eventually just set a framework to determine this, because otherwise it becomes arbitrary every time. So we just said, these are the criteria to define what is critical equipment or critical infrastructure.” – I5

At the moment, there is no business continuity plan in place to ensure that essential operations can continue during an emergency. Interviewees agreed that this is an area where progress is needed. There are emergency response plans for specific buildings, such as placing pumps and hybrid working. To improve operational resilience, TU Delft should develop a business continuity plan that identifies critical processes and outlines how they can be maintained during a flood. This plan should be supported by building-level emergency measures and flexible working arrangements.

“Taking a position as an organisation on what must continue if this happens? We haven’t done that” – I2

Responsibility for business continuity and safety is unclear. Perspectives are not well defined, and people often refer to others who may not be aware of their responsibilities. Five or six departments work on different aspects of safety, but no single department oversees them all. This fragmentation complicates the management of complex risks like flooding. Interviewees stressed the need for clearer responsibilities and better collaboration.

“But I think the Executive Board says CREFM, they’ve got it under control. I don’t want to interfere too much.” – I2

“I think it’s partly outside our department, not to say it’s not our responsibility, but it’s with HSE (Health, Safety and Environment).” – I2

“I think it should be a collaborative effort, because we are, of course, responsible for the physical side of the campus. But HSE also has to ensure the safe passage of business operations.” – I2

4.3.2 Conclusion of in-case analysis

Within TU Delft, the organisation is already working on flood risk management for the campus. The current situation has been mapped out using an in-case analysis. The analysis identifies areas where the current situation can be improved with concrete actions. Below, in Table 4-3, the current situation is described for each level, along with potential actions to improve flood risk management for TU Delft. The current situations described were mentioned by the interviewees and merged based on the researcher's interpretation. The barriers and potential actions are linked to this as the researcher's interpretation, using the interview data and literature study as input.

Current situation	Barrier	Potential action
Strategic level		
Flood risks are recognised, especially pluvial floods	Awareness especially at strategic level and involved perspectives	Improve awareness by sharing risk analyses and internal communication about the risks
Flood risks are identified by municipality		
Qualitative assessment by external stakeholders		
Quantitative assessment internally		
Assessment is placed over primary processes		
Strategy lacks consistent risk analyses component per building	Risk analyses are not mandatory	Implement mandatory risk analyses for construction, renovation and area
Strategy provides guidelines for flood risks	Strategy doesn't clearly highlight what measures could be taken	Apply handbook for flood risk mitigation measures
Strategy decisions are made by the board	The board is advised by internal stakeholders. The awareness of flood risk at board level is limited	Improve awareness by sharing flood risk analyses
Tactical level		
Physical risks of flooding are recognised		
The level of physical risks due to flooding is not recognised in the same way across the entire organisation	Building perspectives see the physical risk as greater than area perspectives	Improve awareness by sharing risk analyses and internal communication about the risks
Asset managers are responsible and aware of physical consequences		Internal communication
Area level mitigation measures are most common		
Building- and area-specific measures are rarely coordinated with each other	No clear guidelines on what needs to be addressed at area level and at building level	The mitigation measures must be implemented in cooperation between the area and the building
Building level mitigation measures are postponed until renovation	It is expensive to take individual measures at building level.	Establish mandatory criteria that existing buildings must meet in relation to flood risks. If this is not the case, measures must be taken
Operational level		
Operational risks are recognised, but the level of operational risks is seen differently across the organisation	Outdoor-focused perspectives see low operational risk due to mitigation measures; others see high risk including data loss and research disruption	Improve awareness by increasing internal communication
No consistent approach to flood risk assessment primary functions for business operations	Different perspectives indicate that assessment for primary operational management positions is approached in different ways	Identify primary processes as part of the risk analyses
Emergency response plan	There is an emergency response plan but no business continuity plan	Create business continuity plan
Responsibility of operational continuity and safety is not clear		Improve internal communication and clarify responsibilities

Table 4-3: Conclusion TU Delft in-case analyses (Author, 2025)

4.4 Case study | ING headquarters



Factsheet

- Location: Bijlmerdreef, Southeast Amsterdam
- Size: 3 hectares
- Ownership:
 - Linden, Maple, Treasury Centre: ING
 - Cedar: LCN capital partners
 - Acanthus: Credit Suisse Asset Management
- Buildings: 5
- Phase:
 - Linden: in development
 - Maple, Cedar, Acanthus, Treasury Centre: in use
- Type: corporate real estate
- Program: office

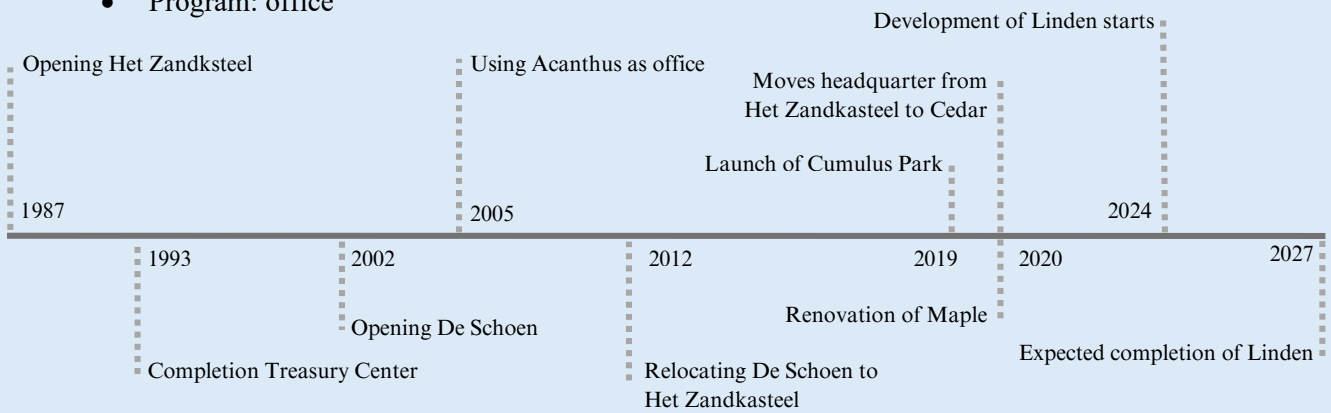


Figure 4-10: ING case study area in Southeast Amsterdam (Author, 2025)



Context

ING is the largest bank in the Netherlands, holding 41% of the market share as of 2023 (Banken.nl, 2024). Its headquarters are located in Southeast Amsterdam, previously housed in the iconic “Het Zandkasteel building on Bijlmerdreef.

As the banking sector evolved, ING shifted from a traditional office model to a modern campus that fosters creativity, co-creation, and informal collaboration. (Karres Brands, n.d.-b). This transformation led to the development of ING’s headquarters within the broader Cumulus Park innovation district, a collaborative initiative involving ING, the Municipality of Amsterdam, Amsterdam University of Applied Sciences (HvA), and ROC Amsterdam. The district aims to create an ecosystem where students, researchers, and businesses address societal challenges together (DZP, 2025).

ING Group N.V. is a publicly listed multinational bank operating in over 40 countries, with more than 60.000 employees. Its Southeast Amsterdam campus serves as a strategic hub, combining global operations with a strong focus on sustainability and innovation. The headquarters consists of several buildings named after trees: Cedar, Maple, Linden, Acanthus, and the Treasury Centre, located within walking distance of each other, see Figure 4-11.

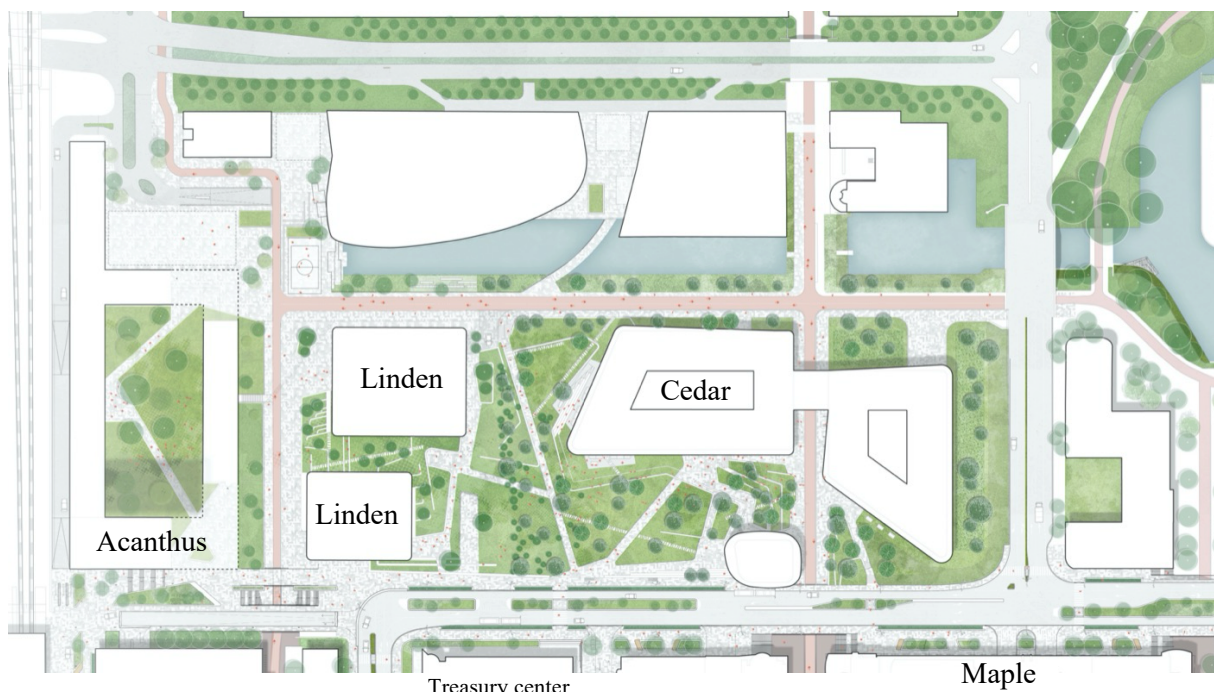


Figure 4-11: ING headquarters (Karres Brands, n.d.-b)

Maple, Cedar, and Acanthus house core business departments, with Cedar functioning as the symbolic and operational heart. The Treasury Centre hosts the Dealing Room, a critical and risk-sensitive function. Once Linden is completed, the Dealing Room will relocate there, and Acanthus will be sold.

ING owns most of its offices in Southeast Amsterdam. Although Cedar is not legally owned by ING, it was developed under a build-to-suit arrangement, giving ING substantial influence over its design and layout. ING holds a long-term lease and shares responsibility for sustainability with the property owner, aligning with its corporate strategy and enhancing long-term building value.

Vision regarding sustainability

ING's real estate sustainability strategy is built on four pillars: (CBRE, 2023)

1. Net zero buildings
2. Sustainable procurement
3. Green tech/operations
4. Conscious working

A key ambition is to achieve Net Zero buildings by 2035. To meet this goal, ING defined six performance criteria: (CBRE, 2023)

- 1 Consumes a maximum total amount of energy of 70 kWh/sqm/yr
- 2 Emits a maximum total of carbon emissions of 3 kg CO₂/sqm/yr
- 3 Consumes exclusively renewable energy with Guarantees of origin
- 4 Has an Energy Performance Certificate (EPC) with rating A
- 5 Has a BREEAM In-use 'very good' certificate
- 6 Is constructed, renovated, or owned in line with the EU taxonomy

All ING-managed buildings must meet sustainability guidelines aligned with local and international standards (ING Global Corporate Real Estate, 2023). Existing and renovated buildings require BREEAM 'Very Good'; new constructions must meet BREEAM 'Outstanding'. (CBRE, 2023)

Real estate investments are assessed against the EU Taxonomy, including the "Do No Significant Harm" (DNSH) criteria. Each project must include a climate risk assessment and a climate adaptation plan addressing material risks over a five-year horizon. (CBRE, 2023)

Flood risks

The ING Headquarters in Southeast Amsterdam faces a low probability of fluvial, lacustrine, or coastal flooding, estimated between 1 in 3.000 and 1 in 30.000 years, shown in Figure 4-12. However, pluvial flooding due to heavy rainfall occurs more frequently. Figure 4-13 shows a return period of once every 10 years, with water depths of 10-15 cm. Under extreme conditions (e.g., 70 mm in 2 hours), depths can reach 15-20 cm (Figure 4-15), and up to 30 cm with 140 mm in 2 hours (Figure 4-14).

Flood management

In 2024, ING conducted a Climate Hazard Assessment across its real estate portfolio using the Dutch Green Building Council's Framework for Climate Adaptive Buildings (FCAB). The assessment considered pluvial, fluvial, lacustrine, and coastal flooding. Of the 37 buildings assessed, 28 showed potential risk of pluvial flooding; none were significantly at risk from sea-level rise or dike failure. (CBRE, 2024) These findings apply directly to the ING Headquarters, confirming pluvial flooding as the primary climate hazard.



Figure 4-12: Location-specific flood risk 50 cm (Stichting Climate Adaptation Services, n.d.)

- Extreem kleine kans: <math>< 1/30.000</math> 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



Figure 4-13: Flood depth once every 10 years (Stichting Climate Adaptation Services, n.d.)

- 5 - 10 cm
- 10 - 15 cm
- 15 - 20 cm
- 20 - 30 cm
- > 30 cm



Figure 4-15: Water depth rainfall 70 mm/ 2 hours (Stichting Climate Adaptation Services, n.d.)



Figure 4-14: Water depth rainfall 140 mm/2 hours (Stichting Climate Adaptation Services, n.d.)

4.4.1 In-depth interviews

The interviewees consulted for the ING case study are employees involved in real estate management within the organisation. To analyse the interview data effectively, the interviewees are categorised according to the CREM model. Their responses are then compared per theme, shown in Appendix IIX. The in-case analysis concludes with a thematic overview of ING's current situation, followed by concrete actions linked to each theme. The interviewees are listed in Table 4-4.

Interviewee	Company	Function	Date interview
I6	ING	Corporate real estate management & Facility services	07-10-2025
I7	ING	Real estate transactionmanagement	10-10-2025
I8	ING	Facility management & Local Real estate management	21-10-2025
I9		Facility services management	

Table 4-4: In-depth interviewees ING (Author, 2025)

Positioning in the CREM model

The interviewees hold various positions within ING. To provide an overview of their roles, they are presented in Figure 4-16. During the selection process, attention was paid to include a range of perspectives, ensuring that different viewpoints within the organisation were represented.

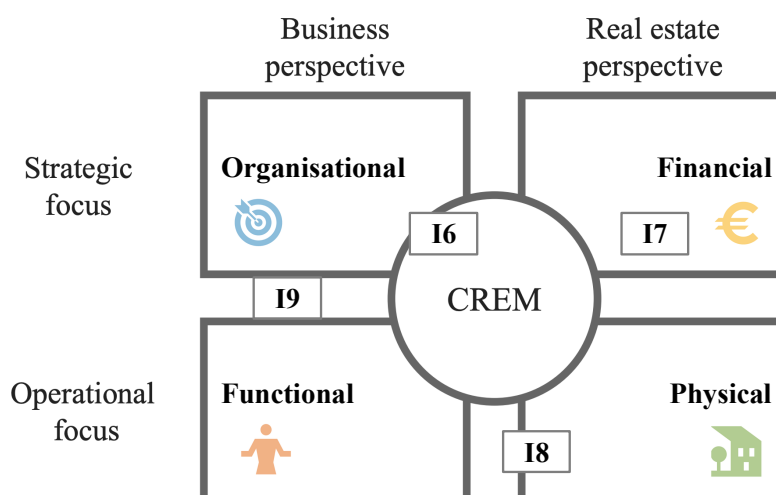


Figure 4-16: ING perspectives in Quadrant Model CREM (Author, based on Krumm (1999) and Den Heijer (2021))

Analysis per level

Strategic level

All interviewees within ING indicated that the organisation has limited awareness of flood risks. Fluvial, lacustrine, and coastal floods are generally not recognised as relevant threats, with responsibility attributed to the Dutch water management system. Pluvial floods are acknowledged to a greater extent, although broad awareness of this risk could still be improved. The perceived urgency of pluvial flooding is currently low, although it is gradually gaining attention. Interviewees 6 and 8 mentioned that participating in the interview itself triggered them to consider this risk more seriously. Another factor that could increase awareness is the occurrence of an actual flood event, which would raise the perceived urgency. However, by that point, it may already be too late to take preventive action. Therefore, it is important to begin raising awareness across ING proactively, before such events occur.

“But we’ve never had any major, serious incidents, and that’s usually what triggers awareness. And yes, then it’s often too late, right?” – I6

“And we’re insufficiently aware that it’s a real problem. No one currently realises that things could really go wrong with these kinds of issues.” – I7

Although some interviewees stated that flood risks are identified and assessed, others claimed this is not happening at all. This discrepancy may be explained by the fact that the physical domain within ING does engage with these risks. For example, flood risk assessments have been conducted for each building using the BREEAM method, which is explained in section 2.5.3. Interviewees from other domains did not mention this assessment and indicated that flood risks are not being evaluated.

“And for that we use BREEAM... So we’ve done analyses per building.” – I8

Currently, flood risks are not integrated into ING’s real estate management strategy. This is partly due to the low level of awareness and urgency, and partly because there is no clear method for incorporating flood risks into strategic decision-making. Additionally, external stakeholders such as municipalities do not provide a strong incentive to include flood risks. Interviewees acknowledged that ideally, flood risks should be considered from the very beginning of the location selection process. Some time ago, flood risks were included in the real estate strategy under the theme of ‘nature’, and assessments were carried out using the BREEAM method. However, no follow-up actions were taken based on the results. A clear working method, such as a checklist, for identifying and addressing flood risks would provide guidance. This checklist could then become part of the strategy. Interviewee 7 mentioned that such a checklist exists in his/her mind, but it has not yet been formalised or implemented.

“I have to admit that list is mainly in my head, because I’ve been doing this for 30 years.” – I7

Interviewees also noted that ING’s headquarters in the Southeast of Amsterdam is highly location-bound. As a result, they felt that flood risks do not need to be considered in the strategy. However, to incorporate flood risks into the strategy for existing, location-bound sites, these situations should also be included in the checklist.

“The ideal scenario is to include it in your strategy when relocating... But what about existing locations? And that’s what we’re dealing with” – I6

Currently, decisions are not based on flood risk. This is likely related to the above-mentioned lack of awareness and the absence of clear integration into the strategy. In real estate management decision-making, many other factors play a role; flood risk is not one of them.

Tactical level

At the building level, there is a certain degree of awareness regarding flood risks. When explicitly asked during the interviews, respondents were able to imagine the potential consequences. On a small scale, incidents involving water damage have occurred, which have contributed to physical awareness. However, knowledge of these incidents tends to remain within the physical domain. Interviewees with a real estate perspective acknowledged the physical damage that flooding can cause. One interviewee from the business perspective quickly pointed out that physical damage could lead to operational disruption, although ING is well prepared to handle such situations.

“In their building, 100 or 1000 of my colleagues work who know everything about mortgages and insurance, but not about the consequences of a flood, right? So I wouldn’t dare to claim that.” – I7

To limit physical damage, few, if any, mitigating measures are currently being implemented. All interviewees confirmed that no flood-specific measures are being taken. Although flood risks have been assessed for all buildings through BREEAM certification, there is no clear translation of these assessments into concrete actions. The step from identifying risks to responding to them through mitigation is missing.

“We’re not taking measures to reduce the likelihood of flooding, right? ... No, I don’t think we’re taking many measures to prevent flooding. At least not at the moment.” – I9

When asked what types of measures could be taken, responses varied. Interviewees with a strategic focus stated that it depends on the critical functions within a building. Those with an operational focus argued that this is less relevant, as ING is well equipped to handle disruptions to critical functions, for example, through backup generators.

Operational level

The interviewees are aware of the potential impact that flooding could have on ING’s operations. As mentioned earlier, a few physical mitigation measures are currently in place. Nevertheless, the interviewees indicated that the operational consequences of a flood would likely be limited. ING is well prepared to maintain its critical services, which are essential to the organisation. In particular, the dealing room must remain operational at all times. To safeguard these critical processes, emergency generators are available to take over the power supply, and all data is accessible via the cloud. While these measures do not reduce the physical impact of a flood, they do help to minimise the operational disruption.

“I think in general ING is quite good at thinking in terms of ‘what if’, because our services must always remain up and running.” – I7

“So we can, ING keeps its head above water, so to speak. Even if buildings are inaccessible, like in the case of a flood.” – I9

ING demonstrates strong adaptive capacity. Each department has a business continuity plan that outlines how to respond in the event of a disruption. In the case of a flood, most employees would be expected to work from home. However, some critical functions, such as the dealing room, are location-dependent. These functions follow a separate continuity plan and are typically supported by the aforementioned emergency generators. If these fail, operations can be relocated to a pre-designated backup site. Still, in the event of a flood, employees may be unable to leave the buildings. ING has previously experienced situations where staff could not return home. In such cases, improvised plans are developed by a crisis team to ensure both operational continuity and employee safety.

“The impact might be that we have to relocate, right? That we end up in an emergency scenario. A relocation to another site but those are always suboptimal. For, well, more office-based functions. It’s just a matter of getting out.” – I6

“And, we do have a backup for the dealing room, right?” – I9

4.4.2 Conclusion in-case analysis

At ING, flood risks have not yet been fully integrated into the real estate strategy. While there is a certain level of awareness, and actions are taken to safeguard business continuity, these efforts are mostly focused on emergency response. This could be improved by proactively addressing flood risks through flood risk management as part of the real estate strategy. Table 4-5 outlines the current situation of flood risk management at ING. The current situations described were mentioned by the interviewees and merged based on the researcher's interpretation. The barriers and potential actions are linked to this as the researcher's interpretation, using the interview data and literature study as input.

Current situation	Barrier	Potential action
Strategic level		
Limited awareness of flood risks	Low urgency and fragmented awareness across domains	Improve awareness by sharing risk analyses
Flood risks are assessed in the physical domain using BREEAM	Lack of cross-domain assessment	Improve internal communication and embed assessments in strategy
BREEAM assessments are included under the theme 'nature'		
Actions regarding flood risks, based on BREEAM outcome, are not integrated into real estate strategy	No clear method or incentive to include flood risks	Develop plan after assessment and integrate into strategy
ING's HQ is location-bound and not considered at risk	Existing locations are excluded from strategic flood considerations	Include existing location in checklist for strategy
Decisions are not based on flood risks	Lack of awareness and urgency	Integrate flood risks in strategy
Tactical level		
Some awareness exists at building level, triggered by past minor incidents	Knowledge remains within the physical domain	Internal communication
Flood risks assessed via BREEAM	No translation from assessment to action	Develop protocol or checklist and implement in strategy
No flood-specific mitigation measures are currently applied		
Well prepared to handle disruptions to critical functions		
Operational level		
ING is aware of the impact of the potential operational impact of flooding		
Well prepared to maintain critical business services during disruption		
Business continuity plan per department		
Crisis teams improvise when unexpected situation arise	Ad-hoc responses may lead to inconsistent or delayed decision-making	Define situation where employees cannot leave the building and integrate this into a protocol
No physical mitigation measures are in place to reduce flood impact	Focus is on operational continuity rather than physical protection	Implement physical mitigation measures to tactical level

Table 4-5: Conclusion ING in-case analyses (Author, 2025)

4.5 Case study | RVB

Factsheet

- Location: The Hague Central
- Size: 14 hectares
- Ownership: RVB
- Buildings: 9
- Phase: in-use
- Type: public real estate
- Program: Office, public functions

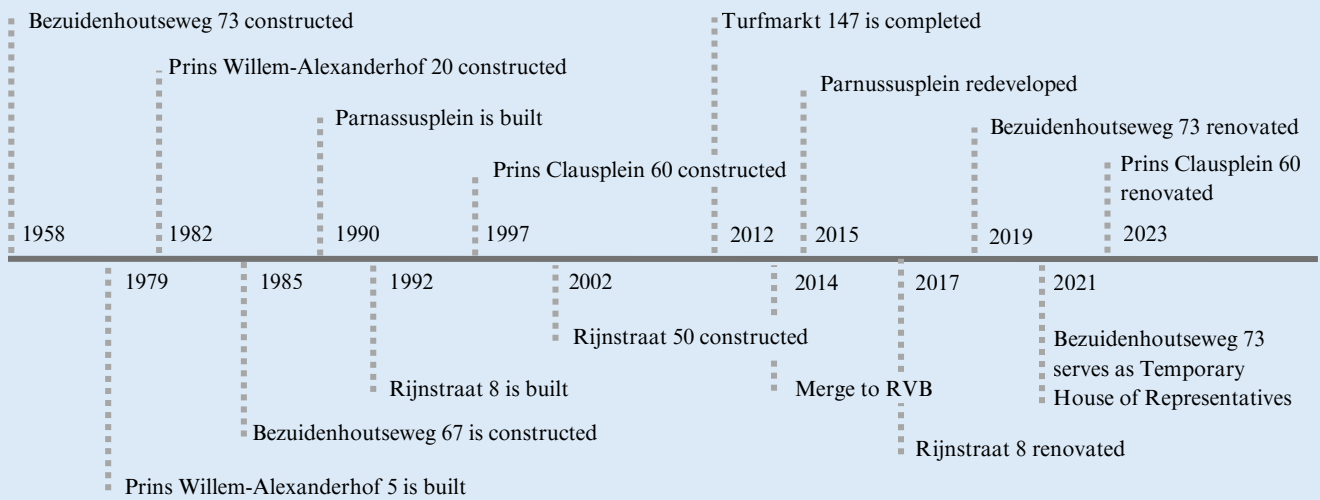


Figure 4-17: RVB case study area in The Hague (Author, 2025)



Context

The Rijksvastgoedbedrijf (RVB), or Central Government Real Estate Agency, manages the Dutch national government's real estate portfolio. Operating under the Ministry of Housing and Spatial Planning, RVB oversees nearly 900 km² of land, 11 million m² of building space, and employs 2.900 staff (Rijksvastgoedbedrijf, n.d.).

Established in 2014 through the merger of four government property services, RVB's strategy focuses on sustainable development, reducing office space, and increasing collaboration with private partners (Rijksvastgoedbedrijf, n.d.).

Its headquarters in The Hague reflect the city's role as the administrative capital. The selected buildings for this case study are located in the city centre, near The Hague Central Station, shown in Figure 4-17, forming part of the "The Hague Central" real estate cluster. The Municipality of The Hague and RVB aim to enhance this district into a vibrant urban area integrating living, working, shopping, and green public spaces (Rijksvastgoedbedrijf, 2019).

The buildings included in this case study are owned and operated by RVB and serve as the following essential governmental functions:

Adress	Building name	Function
Turfmarkt 147	JuBi	Ministry of the Interior and Kingdom Relations and the Ministry of Justice and Security
Parnassusplein	De Resident	Ministry of Health, Welfare and Sport and Ministry of Social Affairs and Employment
Rijnstraat 8	VROM	Ministry of Foreign Affairs, Ministry of Infrastructure and Water Management, Immigration and Naturalisation Service, Central Reception Center for Asylum Seekers, and Repatriation & Departure Service
Rijnstraat 50	Hoftoren	Ministry of Education, Culture and Science
Prins Willem-Alexanderhof 5		National Library
Prins Willem-Alexanderhof 20		National Archives
Bezuidenhoutseweg 67	Apenrots	Temporary House of Representatives
Bezuidenhoutseweg 73		Ministry of Economic Affairs, Ministry of Agriculture, Food security, and Nature, and the Ministry of Climate Policy and Green Growth
Prins Clausplein 60		Palace of Justice

Table 4-6: Building data for RVB properties in The Hague Central (Author, 2025)

Several buildings, such as the ministries, the Temporary House of Representatives, and the Palace of Justice, are critical and must remain operational. Others, like the National Library, can close temporarily, while the National Archives are highly vulnerable due to physical data storage.

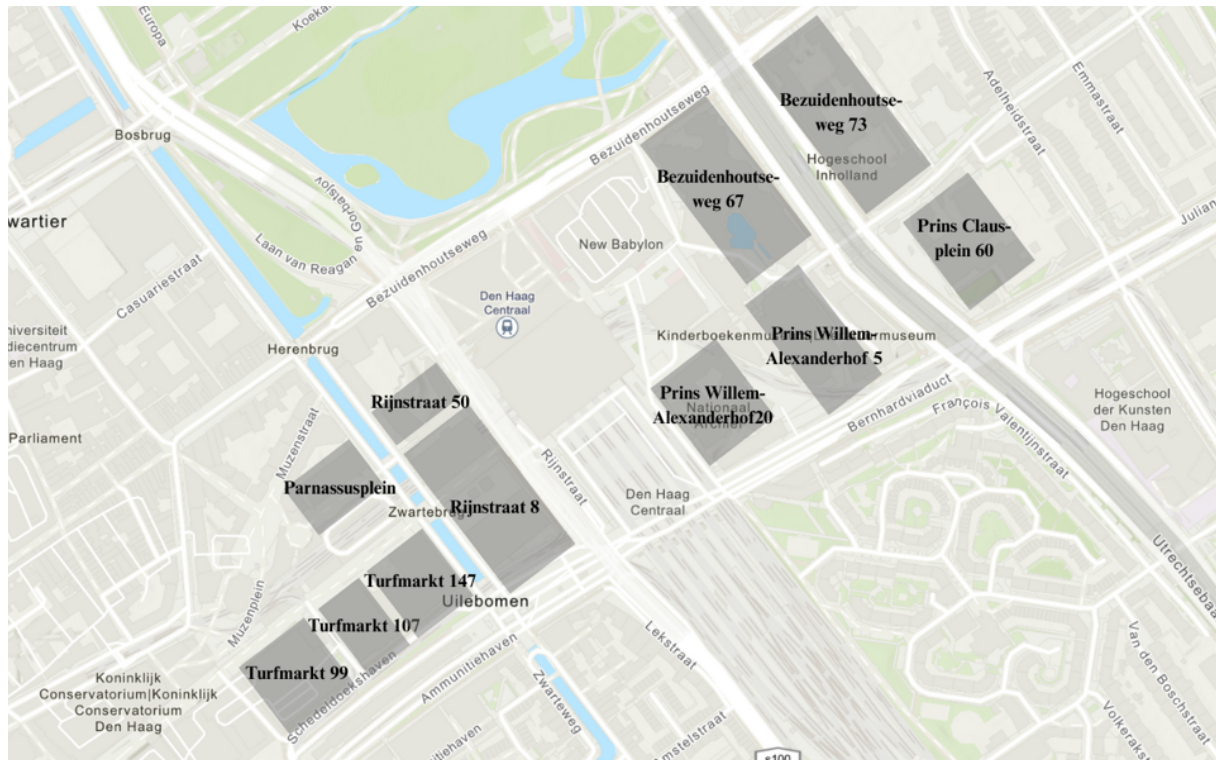


Figure 4-18: Buildings of RVB in The Hague Central (Author, 2025)

Vision regarding sustainability

The Municipality of The Hague has developed a spatial vision for the area around The Hague Central Station to create a high-quality, healthy, and attractive environment by 2040. Given RVB's extensive presence in this district, the vision is highly relevant. It is based on four principles:

- Activating the area
- Densifying and strengthening urban functions
- Connecting people and places
- Greening and making the area more sustainable

Sustainability measures include green spaces, water retention, and underground heating systems to support the energy transition. Buildings will be made climate-adaptive and future-proof (Gemeente Den Haag, 2023). In collaboration with the Municipality and the Province of South Holland, RVB launched the EnergieRijk Den Haag programme to improve the sustainability of key government buildings (Haskoning, n.d.; Rijksoverheid, n.d.).

To achieve a future-proof portfolio, RVB created the Strategic Roadmap for Sustainable Government Real Estate, which integrates four climate themes. Each type of intervention: maintenance, renovation, demolition, new construction, acquisition, sale, or leasing, requires a tailored approach. The four climate themes are:

1. Circular & biobased construction
2. Nature-inclusive design
3. Energy-efficient and renewable systems
4. Climate adaptation

Climate adaptation involves implementing measures that respond to changing climate conditions, ensuring that properties are protected against flooding, heat, and drought. According to the roadmap, such measures may include area-based water retention strategies and rooftop water buffering systems. (Rijksvastgoedbedrijf, 2023)

Flood risks

As shown in Figure 4-20 the specific location flood probability of a flood of 50 cm is less than one time in 30.000 years; this chance is extremely small. Figure 4-19 shows an estimation of this flood change in 2050; the change is still minimal. These figures represent fluvial, lacustrine, and coastal floodings. Pluvial floodings are shown in Figure 4-21 and Figure 4-22. Extreme rainfall of 70 mm/2 hours causes water depths of 10-15 cm. Rainfalls of 140 mm/2 hours cause water depths of 20-30 cm.



Figure 4-20: Location-specific flood risk 50 cm (Stichting Climate Adaptation Services, n.d.)



Figure 4-19: Location-specific flood risk 50 cm in 2050 (Stichting Climate Adaptation Services, n.d.)

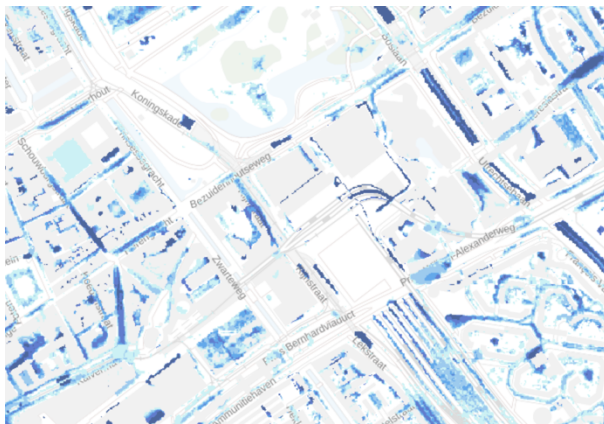
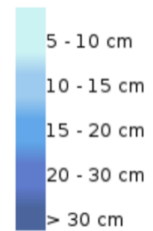


Figure 4-21: Water depth rainfall 70 mm/ 2 hours (Stichting Climate Adaptation Services, n.d.)

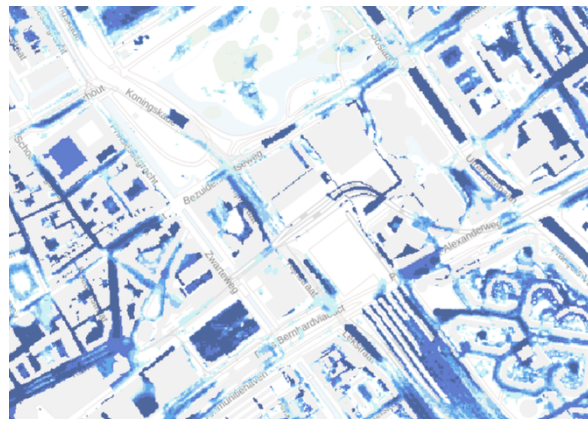


Figure 4-22: Water depth rainfall 140 mm/ 2 hours (Stichting Climate Adaptation Services, n.d.)

4.5.1 In-depth interviews

Various experts within the RVB were interviewed. All interviewees work on or have experience with the buildings involved in this case, located in The Hague Central. The interviews were processed and analysed in the same way as previously done for TU Delft Campus and ING Headquarters. The interviewees were first placed in the CREM perspective model, after which the interviews were coded and analysed per level. The study ends with a conclusion. The interviewees' positions can be seen in Table 4-7.

Interviewee	Company	Function	Date interview
I10	RVB	Portfoliomanagement	08-10-2025
I11	RVB	Strategy and implementation policy	15-10-2025
I12	RVB	Sustainability advisor real estate	23-10-2025

Table 4-7: In-depth interviews RVB (Author, 2025)

Positioning in the CREM model

Figure 4-23 shows how the interviewees fit into the CREM perspective model. When selecting the interviewees, interviewees from different perspectives were considered.

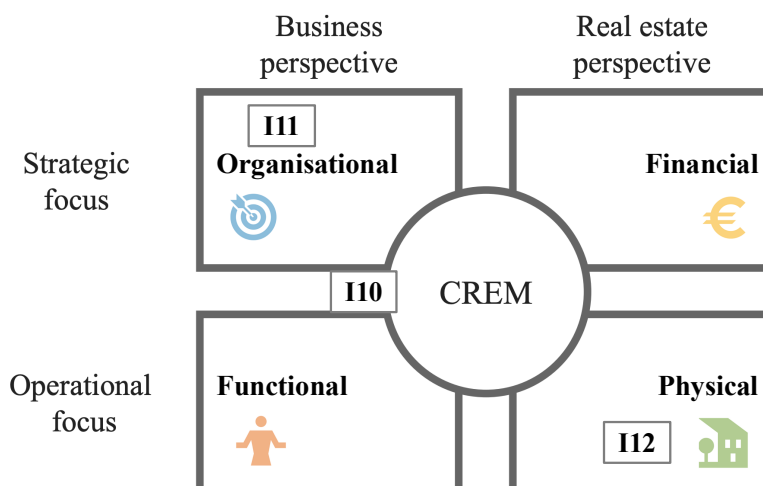


Figure 4-23: RVB perspectives in Quadrant Model CREM (Author, based on Krumm (1999) and Den Heijer (2021))

Analysis per level

Strategic level

Flood risk awareness at RVB has grown in recent years, which is a positive development, but it is still limited. The organisational domain highlights that although awareness exists, the sense of urgency is weak. Awareness is spread across the organisation and often depends on whether someone has dealt with climate issues before. Strategic managers at portfolio levels generally know that flood risks exist but are uncertain about what actions to take. As one interviewee explained, awareness alone does not lead to solutions; the next step is missing. This missing step refers to the strategy higher up in the organisation where awareness is triggered as a wake-up call, but the wake-up call is not enough.

“Yes, I do miss it a bit because now it's just the wake-up call, but then I don't have any tools at my disposal. Yes, per building, right? But not for your portfolio.” - I10

“Yes, or at least, we are aware that we need to gain that awareness, so.” - I12

To improve understanding, RVB asked an external advisor to map which buildings are in flood-prone areas and create a risk profile for projects. Sharing this risk profile would also help to generate more awareness internally of flood risks. There is also a tool for new construction projects that checks how flood risks can be considered and what measures can be taken for new construction. Ideally, the function of the building should also be part of the assessment, this is work in progress. From the physical perspective, climate risk scans are done for big projects and transactions, but not for regular maintenance. A problem is that flood risk data is often only used at the start of a project instead of being available all the time. This makes it hard to plan measures or change renovation schedules. For example, buildings are usually renovated every 25 years, but if climate risks are high, especially for vital functions, renovation or implementing measures might need to happen sooner.

“We have also developed a kind of tool. If I am going to build a building somewhere, how can I take this into account? And what measures can I take?” – I10

“You should not start a project without identifying the risks.” – I11

Flood risks are considered in the strategy of the RVB. They are part of a broader theme called ‘resilience’, and this highlights resilience against climate threats. Biodiversity, which includes climate adaptation, is the least developed theme in the strategy. But as mentioned before, the awareness of flood risks, climate adaptation, and sustainability is increasing over the years, therefore, this theme is going to develop more. Responsibilities are spread across many departments, and there is no single team that coordinates flood risk management. Strategic goals for sustainability and climate adaptation are written in a roadmap. These goals should be translated into requirements in the portfolio plan, which then goes to asset managers and finally to implementation. Interviewees highlighted that the transition from goals to requirements is difficult because there are no tools to help make this translation.

“The Strategy Department is leading the way in this regard, devising all kinds of strategic goals that we, as the RVB, want to move towards. Some of those goals also concern sustainability and therefore climate adaptation.” – I10

Flood risks are considered when choosing new locations, but existing buildings are harder to deal with. Many RVB buildings are located in The Hague because of its role as the administrative capital, so moving them is not an option. For existing buildings and renovations, requirements are written in the roadmap.

“Flood risks are not sufficiently taken into account in property decisions. It plays almost no role in location choices. But when we undertake a new construction project, it is taken into account, because then it simply has to meet all kinds of requirements to ensure that it is resistant to those flood risks.” – I11

Tactical level

All interviewees acknowledge that floods can cause physical damage to RVB buildings, particularly through the disruption of vital functions due to water damage. The extent of this damage depends largely on the function housed within the building. The interviewee in the organisational portfolio perspective notes that the visibility of this risk and its potential impact is currently limited. An interviewee at the strategic level suggests that awareness could be improved by organising knowledge sessions and actively engaging people with the topic.

“But I don’t think so, not sufficiently aware, no. Yes, by providing more insight. In general, yes, also through knowledge sessions and conversations, and by involving people in the topic.” – I11

Currently, the physical risks to RVB buildings are being mapped, so the condition of the real estate in relation to flood risks is known. From this point, the organisation can explore how to make the portfolio climate-adaptive. This opens the door to identifying appropriate solutions and mitigation measures. One interviewee mentioned dividing the portfolio into smaller segments, as not all buildings face the same risks. This segmentation allows for targeted measures at the building level. At the physical level, a

climate adaptation team is working on making existing buildings, those not necessarily due for renovation, resilient to climate risks such as flooding. Interestingly, this team is not mentioned by interviewees from the organisational perspective. When discussing physical measures, they refer to the roadmap but have limited insight into practical implementation. The physical domain confirms that flood risk mitigation measures are being incorporated into new construction and renovation projects. However, for the maintenance of existing buildings, the approach remains unclear.

“I mean, also from a strategic point of view and at the building level, there are all kinds of possibilities. But yes, that’s in the roadmap, not to refer to it too easily. But I don’t know exactly.” – I11

“I only know what measures are taken in new construction and renovation. I don’t know how that works for maintenance.” – I12

All interviewees refer to the roadmap as the internal system guiding climate adaptation for buildings. However, they also indicate that integration is lacking, and the roadmap does not yet provide sufficient guidance at every level. A proposed solution is to apply the roadmap across different levels and visualise the integration between them. This would help clarify responsibilities in the organisation.

“So that at all those different levels, ... So that’s a kind of risk loop of influence someone has, and that everyone is aware of their connection to the topic of climate adaptation.” – I12

Operational level

The RVB hosts several vital functions in The Hague Central. All interviewees are aware that a flood could have a significant impact on the business processes of these critical functions. These functions must remain operational at all times. However, this awareness has not yet translated into additional mitigating or operational measures. That said, the RVB has started to include the function of buildings in its flood risk assessments, which is considered an important first step. This development is particularly relevant because buildings are typically only renovated once every 25 years. Until recently, flood risks were only considered during such renovation moments. However, if a building is located in an area with high climate risks and houses a vital function, flood risk management may need to be addressed earlier. This shift is partly driven by the *national climate adaptation strategy*, which sets the ambition that by 2050, business processes must be able to continue even during extreme weather events.

“Is the function of a building included in the risk assessment?” - WF

‘Yes, we are, we haven’t done that before, but that research is now ongoing with the advice agency.’ – I11

“But there are many processes at the Rijksvastgoedbedrijf that are indeed critical and whose primary tasks must always remain executable.” – I12

At the operational level, there are still a few continuity plans in place, such as Business Continuity Plans or Emergency Response Plans, that apply across the entire organisation. These plans do exist for the most vital functions, but not yet more broadly.

“I’ve never received any communication in case of flooding, make sure you’ve taken these actions.” – I10

To develop such plans effectively, it is essential to involve asset managers. Currently, the extent to which flood or other climate risks are considered in asset management depends on the individual asset manager assigned to a project. This inconsistency could be addressed by clearly defining responsibilities and improving internal communication about risks. Information about existing risks and mitigation measures must be communicated from higher levels within the organisation. This would enable asset managers to understand which risks have already been addressed and which still require attention in their daily operations.

“I don’t think an asset manager knows exactly. I don’t know to what extent it ends up on the desk of an asset manager, where they know: ah, okay, the scenario they’ve created for us is that all these risks have been eliminated, and these risks need to be covered by an evacuation plan.” – I12

4.5.2 Conclusion in-case analysis

The RVB in The Hague Central is already working on integrating flood risks into real estate management. Flood risks are part of the real estate strategy, and various tools are being provided to integrate flood risk. The conclusion can be seen in Table 4-8. The current situations described were mentioned by the interviewees and merged based on the researcher's interpretation. The barriers and potential actions are linked to this as the researcher's interpretation, using the interview data and literature study as input.

Current situation	Barrier	Potential action
Strategic level		
Awareness of flood risks increased over the years	Awareness is still limited to who have dealt with these risks before + urgency not strongly felt	Increase awareness by sharing risks analyses and internal communication
External advisors assess risks in risk profile for the whole portfolio (ongoing)		
Flood risk data from assessment used at start of project	Data not available for in-use projects. This makes it hard to plan measures	Share risk assessment from external advisor for in-use projects
Tool available for how flood risks can be considered for new construction		
Flood risk scans are derived for major projects and transactions	Unclear when a flood scan should be performed	Create clear guidelines on when a flood scan should be performed
Flood risks are integrated in the real estate strategy under broader themes	This theme is the least developed, but this is growing	Increase awareness of flood risks by sharing risks analyses and internal communication
Strategic goals for climate adaptation are documented in a roadmap		
Strategy of flood risks isn't translated into tools at portfolio level	Tools are available at building level but not at portfolio level	Integrate portfolio tools
Tactical level		
There is awareness of the physical damage caused by flood risks, particularly in relation to vital functions	Awareness is not enough yet	Share risk analyses, host knowledge sessions, internal communication about flood risks
The physical condition of fixed assets is mapped out	Not yet translated into mitigation measures	Dividing the portfolio into small parts in order to offer targeted mitigation measures
The roadmap provides basis but does not yet offer guidance for different levels	Levels and responsibilities are not integrated	Integrate levels and responsibilities into the roadmap
Climate adaptation club investigates integration of flood risks into asset management		
Building measures are being taken for new construction and renovation	Measures not taken during maintenance	Implement findings of research on integration of flood risks into asset management
Operational level		
There is awareness of the impact of flood risks in business processes of critical functions		
Investigation of functions in assessment ongoing, no measures taken		Implement outcome of functions in assessment into mitigation measures
Ambition of 2050 to continue business processes during extreme weather events		
Continuity plans underdeveloped	Continuity plans only for most vital functions	Create business continuity plans and emergency response plans for all assets
Consideration of flood risks in asset management depends on the individual asset manager.	Inconsistent practices due to unclear roles and lack of guidance	Define responsibilities + set standard mitigation measures
Limited internal communication about existing risks and mitigation measures	Information gaps between strategic and operational levels	Improve communication to ensure asset managers are informed about risks

Table 4-8: Conclusion RVB in-case analysis (Author, 2025)

5. Cross-case analysis

In the cross-case analysis, the various cases are compared. The purpose is to find the similarities and differences between the three cases. Current situations and potential actions from each in-case analysis are aligned per level, then combined into cross-case actions. The current situations were mentioned by the interviewees and merged based on the researcher's interpretation. The potential actions per case and the cross-case actions are linked to this as the researcher's interpretation, using the interview data and literature study as input. This cross-case analysis is shown in Figure 5-1.

	Current situation			Potential action per case			Cross case action
	TU Delft	ING	RVB	TU Delft	ING	RVB	
Strategic							
Awareness	Flood risks (pluvial) are recognised	Limited awareness of flood risks	Flood risks (pluvial) are recognised, awareness limited	Improve awareness by internal communication by sharing risk analyses			Improve awareness by internal risk communication and by sharing risk analyses
Identification	Identification due to municipality	Identification due to BREEM	Internal identification				Identify risks through external trigger or internal awareness
Assessment	Qualitative / quantitative, internal / external assessment	Assessed in physical domain because of BREEM	Ongoing external assessment over portfolio		Improve internal communication + assessment in strategy	Share risk analyses from external advisor for in-use projects	Embed qualitative and quantitative assessment in strategy + internal communication over perspectives
	Primary processes included in assessment		Primary processes included in assessment (ongoing)				Include primary processes in assessment
Strategy	Strategy lacks of consistent risk analyses per building	No existing location assessment in strategy	Tool available for new construction	Implement mandatory risk analyses	Include existing locations in strategy		Integrate mandatory risk analyses for renovation, development, and maintenance
			Risk scans carried out but unclear when scan should be applied			Create guidelines on when a flood scan should be applied	Create guidelines on when a flood scan should be applied
	Strategy provides guidelines for flood risks	Outcome assessment not integrated in strategy	Flood risks included in strategy	Offer specific implementation measures	Develop plan after assessment and integrate into strategy		Develop plan after assessment and integrate into strategy with specific measures
		Flood goals in roadmap, not translated in portfolio tools			Integrate tools into roadmap for portfolio level	Integrate tools for flood implementation at portfolio level	
Tactical							
Awareness	Physical awareness over entire organisation	Physical awareness at physical perspective	Physical awareness, particularly in critical functions	Improve by internal communication by sharing risk analyses	Internal communication	Share risk analyses + host knowledge sessions	Improve awareness by internal risk communication, host knowledge sessions and by sharing risk analyses
Building & are level	Building and area perspectives see physical risks differently			Improve by internal communication by sharing risk analyses			Improve internal communication by sharing risk analyses between perspectives
Mitigation measures	Building- and area measures are rarely coordinated	No mitigation measures after assessment	Physical condition of assets mapped out, not translated in mitigation measures	Improve internal communication, define responsibilities and set clear measures	Develop protocol or checklist and implement in strategy	Divide portfolio into small parts	Develop a standard checklist to integrate assessment to building and area mitigation measures that can be implemented for parts of the portfolio
			Roadmap provides basis but no guidance for different levels			Integrate levels and responsibilities into roadmap	Integrate levels and responsibilities into flood risk management plan
Asset management			Ongoing investigation on integration in asset management				
Critical functions		Well prepared for disruption of critical functions					Integrate physical measures to mitigate disruption of critical functions + prepare critical functions for disruption
Building lifecycle	Mitigation measures postponed until renovation		Mitigation measures taken for construction and renovation, not maintenance	Mandatory criteria during maintenance		Implement mitigation measures into asset management / maintenance	Integrate mandatory flood risk mitigation criteria during maintenance
Operational							
Awareness	Operational risks are recognised, degree differences between perspectives	Operational risks recognised and impact is clear	Operational risks recognised and impact is clear	Improve awareness by increasing internal communication			Improve awareness by internal risk communication
Critical functions	No consistent approach to assess critical operational functions	Well prepared to maintain critical operational functions	Investigation of functions in assessment ongoing, no measures taken	Identify primary processes + critical functions as part of risk analyses		Implement outcome of functions in assessment into mitigation measures	Identify primary processes for critical business services as part of risk analyses and implement to mitigation measures
Emergency response	Emergency response plan, no BCP	BCP worked out, crisis teams improvise	Continuity plans underdeveloped	Create BCP	Integrate flood emergency in protocol	Create BCP and emergency response plans in all assets	Create business continuity plans and emergency plans in all individual assets
Responsibilities	Responsibilities of operational continuity and safety is not clear		Implementation in asset management depends on individual asset manager	Improve internal communication and clarity of responsibilities		Define responsibilities + set standard mitigation measures	Improve internal communication, define roles and responsibilities, and set standard mitigation measures for asset management
			Limited communication about existing risks & mitigation measures			Improve communication + ensure asset managers are informed	Improve internal communication + ensure asset managers are informed
Mitigation measures		No physical mitigation measures to reduce operational impact			Implement physical mitigation measures to tactical level		Focus on mitigation on the tactical level instead of response at the operational level
Ambition			Ambition in 2050 to continue business processes during extreme weather				Set long-term ambition to continue business processes under extreme weather events

Figure 5-1: Cross-case analysis (Author, 2025)

- Similarities
- Semi-similarities
- Differences

A key distinction is that TU Delft Campus and RVB in The Hague Central are public real estate, while ING in Amsterdam Southeast is corporate real estate. Although all properties support the organisation's business activities, public and corporate objectives differ.

TU Delft and RVB show more potential actions because they are further along in integrating flood risk management into their real estate strategies. Their advanced position reveals more challenges. ING, by contrast, is still in the early stages, resulting in fewer actions.

Strategic level

Flood risks are acknowledged by the organisations. To make awareness more widespread across the organisation, internal communication about these risks needs to be improved. Not everyone in the organisation needs to be equally aware of flood risks, but the perspectives associated with them must be aligned. An important step in this process is sharing the risk analyses, explained later, within the organisation to increase awareness. Risks are identified through internal or external triggers such as regulations or events, and assessments are conducted internally and/or externally. These assessments should cover the entire portfolio, including projects without planned renovation, and incorporate primary processes, currently not standard practice.

After the assessment, the findings must be incorporated into the real estate strategy. Public organisations have begun this, but corporate strategies lag. Both sectors highlight that there is no consistent risk analysis for each building. Such analyses are not always performed, and it is unclear when they should be carried out. Therefore, mandatory risk analyses for new construction, renovation, and maintenance, supported by clear criteria, are recommended. Finally, organisations must develop a plan to integrate the assessment outcome into the strategy with specific measures.

Tactical level

Awareness of physical impacts is generally high, especially for critical functions, but varies across perspectives. Sharing analyses and hosting knowledge sessions can strengthen this. TU Delft focuses on area-level measures, RVB on building-level measures, while ING relies on operational measures. Because risks can be addressed at different levels, it is important to ensure internal communication across these levels.

Organisations expressed a need for clear checklists of measures that can be implemented at both the area and building levels and highlight responsibilities of internal stakeholders. When implementing measures, it is essential to include the critical functions identified during the risk assessment.

New construction and renovation projects provide a clear starting point for implementing flood risk management. However, many buildings within the portfolios are not scheduled for renovation or construction in the near term. Flood risks should also be addressed in these projects, particularly when critical functions are present. A structural approach could involve a standard checklist during periodic maintenance inspections. This checklist would be tailored to each building based on its risk assessment, enabling smaller-scale flood measures that are not dependent on major renovations or new construction.

Operational level

Operational resilience is crucial. All organisations recognise potential impacts on critical processes, but preparedness differs. ING has advanced protocols; TU Delft and RVB need to integrate critical processes into assessments and plans. Emergency Response Plans (ERP) and Business Continuity Plans (BCP) should be developed for specific buildings or functions. To promote continuity in business processes, organisations can set long-term ambitions aimed at maintaining operations during flooding.

Internal communication is vital for implementing these plans and clarifying responsibilities. Communication about risks and measures should occur across all levels: strategic, tactical, and operational, to ensure awareness of risks, mitigation actions, and remaining vulnerabilities.

Part V

Synthesis

6. Roadmap

The goal of this chapter is to create a theoretically informed roadmap that can be used to guide the integration of flood risk into real estate management strategies for owner-occupiers. The roadmap serves as a structured guide rather than providing a step-by-step plan. The roadmap is implementable by multiple organisations and therefore not organisation specific. It functions as a guide and must be adapted by each organisation to make it implementable specifically for that organisation.

6.1 Shaping the roadmap

A roadmap is a visual representation of the strategy that can be applied to realise a solution. It outlines the steps and milestones that need to be achieved, along with the requirements for doing so. A roadmap is intended to create clarity and provide guidance to those involved in implementing the solution. (Erasmus University, n.d.) As indicated in section 1.3, the research gap, there is insufficient focus on integrating flood risks into real estate management strategies. In this research, the roadmap maps out the steps and milestones that can be taken to integrate flood risks. The main question is how flood risks can be integrated, and the roadmap provides a visual representation of this, showing the path to integration.

The roadmap is based on the risk management framework by Winch (2010), which provides a cyclical structure consisting of four phases: Identify, Assess, Respond, and Control. Actions are arranged chronologically within this cycle, but organisations can enter at any point depending on their current stage. Once all actions are completed, the cycle restarts, reflecting the continuous nature of risk management.

Rather than organising actions strictly by management levels (strategic, tactical, operational), the roadmap assigns perspectives to each action, based on the CREM model based on Krumm (1999) and Den Heijer (2021). This approach acknowledges that actions often span multiple levels and clarifies responsibilities across perspectives in the organisation. Assigning specific roles to actions is organisation-specific and therefore not integrated into the roadmap.

The development process of the roadmap followed these steps:

- Step 1 | Define actions & processes from desk research*
- Step 2 | Define actions & processes from empirical research*
- Step 3 | Find similarities and comparisons*
- Step 4 | Integrate actions & processes in structure*
- Step 5 | Assign perspectives to actions*

6.2 Audience

The primary audience for this roadmap is owner-occupiers of real estate. The roadmap supports integration of flood risk management across perspectives in an organisation: strategic, functional, physical, and financial. While financial perspectives were less prominent in the empirical research, literature emphasises that it is important to take the financial aspect into account during risk management. The roadmap can be used in three ways:

- **Understand:** Visualise relationships, the sequence of actions, responsibilities, and dependencies related to flood risk.
- **Integrate:** Embed flood risk considerations into real estate management processes.
- **Motivate:** Create organisational awareness and commitment to proactive flood risk management.

6.3 The roadmap

The theoretically informed roadmap is presented as a circular process, starting logically at Identify, but applicable from any phase. Risk management is iterative: once all actions are completed, the cycle restarts to reflect changing conditions and emerging risks. The roadmap is shown below in Figure 6-1 and the user guide to implement the roadmap can be seen in Appendix X.

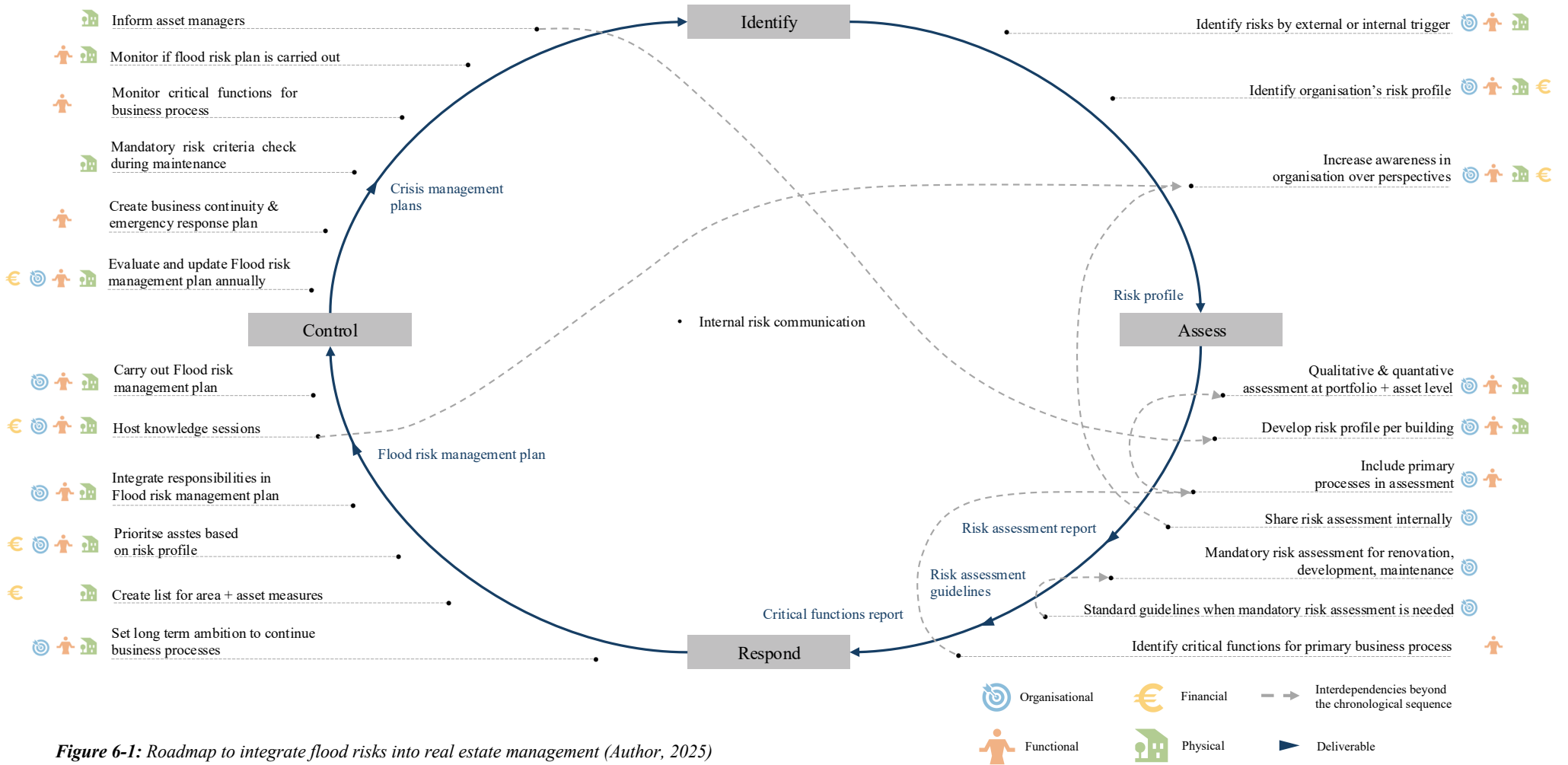


Figure 6-1: Roadmap to integrate flood risks into real estate management (Author, 2025)

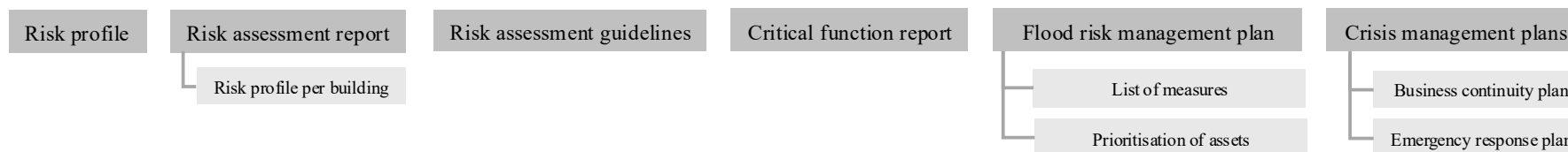


Figure 6-2: Deliverables of roadmap (Author, 2025)

Deliverable	Sub-deliverable	Description
Risk profile	Organisation's risk profile	Description of boundaries of corporate risk tolerance by risk-return trade-off. The profile determines risk appetite and tolerance. It links risks to corporate objectives and financial boundaries, ensuring flood risk management aligns with broader business goals.
	Risk assessment report at portfolio + asset level	Report includes qualitative & quantitative assessment of flood risks done by external or internal stakeholders. Provides insights into which locations and assets are most vulnerable to flooding.
Risk assessment guidelines	Risk profile per building	The profile per building includes a detailed profile for each building that captures exposure, vulnerability, and critical functions.
	Risk assessment for renovation, development, maintenance	A mandatory assessment of flood risk prior to renovation, new development, or maintenance activities to ensure risk mitigation measures are integrated.
Critical functions report	Guidelines for risk assessments	A set of instructions outlining when and how flood risk assessment should be conducted.
		Report that highlights all critical functions to continue primary business process.
Flood risk management plan	List of asset + area measures	An inventory of physical measures for building and area.
	Prioritisation of assets based on risk profile	A ranking of risks and assets based on their risk profile. The ranking focusses on the most critical and vulnerable assets first.
Crisis management plans	Business continuity Plan	Ensures essential operations continue during and after disruptions.
	Emergency response Plan	Provides immediate actions and recovery steps for emergencies.

Table 6-1: Deliverables of roadmap (Author, 2025)

The process line includes the four phases from Winch (2010) risk management framework. Along this line, key deliverables are positioned, each consolidating multiple actions, see Figure 6-1. The process line also represents a timeline, indicating the recommended sequence for implementing actions. Each action is linked to relevant perspectives, based on the CREM model by Krumm (1999) and Den Heijer (2021). This ensures clarity across organisational, functional, financial, and physical perspectives, of which perspectives are involved in the action. Internal risk communication applies throughout the entire cycle rather than a single phase.

The actions are placed in a sequence so that they follow each other logically. Some actions require input from actions that occur later in the circle. In this case, a grey dotted line is used to indicate that input is required from an action later in the process.

Identify

Integrating flood risk into real estate strategy begins with identification. This phase establishes the foundation for flood risk management. Identification can be triggered by:

- External triggers: regulatory changes, extreme weather events, updated flood maps, or insurance requirements.
- Internal triggers: asset condition, renovation or development plans, operational changes, or previous flood incidents.

Understanding the trigger provides context for the scope and urgency of the rest of the flood risk management cycle.

A critical step in this phase is defining the organisation's risk profile, which determines risk appetite and tolerance. This profile links risks to corporate objectives and financial boundaries, ensuring flood risk management aligns with broader business goals. It also strengthens stakeholder engagement by demonstrating why flood risk deserves attention. Strategic and financial perspectives are essential for this action, but involvement of functional and physical in this step will ensure that all perspectives are considered in the profile.

Finally, awareness must be created across all perspectives of the organisation. Many employees are unaware of the physical and operational consequences of flood risks. Low awareness often leads to reactive measures after an incident, which can be too late. Proactive awareness increases support, accelerates implementation, and enables preventive action, creating organisational support for the rest of the cycle. Actions later in the cycle could also increase awareness and are connected with a dotted grey line.

Assess

After identifying flood risks, the next step is to assess these risks at both the portfolio and asset levels. The most effective approach combines quantitative and qualitative assessments. Quantitative assessment is often carried out externally. Quantitative climate data is used as a basis for this.

Quantitative data sources:

- Klimateffectenatlas
- Overstromingsrisicokaart
- Atlas Leefomgeving

Once the data has been collected, tools are used to quantitatively assess the risks. In order to carry out a comprehensive assessment, the risks can also be assessed qualitatively. This means observing conditions in the field to understand how heavy rainfall affects the portfolio or the asset. Such observations provide insight into vulnerabilities that are not always captured in a quantitative assessment.

Assessment tools:

- Framework for climate-adaptive Buildings from the Dutch Green Building Council
- Local-oriented approach

Primary processes located within the assets should be considered. Information about functions and critical processes of a building is highly relevant in a risk assessment. It is important that the strategic, physical and functional perspectives are involved in this stage. Specifically, the asset managers. These people have operational knowledge of the buildings that is relevant to the assessment. The assessments at the building level, including function and critical processes, lead to a risk profile per building. The total assessment of the portfolio and the risk profiles per building results in a Risk assessment report where the current situation is assessed. Sharing this Risk assessment report internally has a direct positive effect on organisational awareness, ensuring stakeholders across perspectives are informed.

To maintain consistency and prevent flood risk assessment from becoming a one-off exercise, mandatory risk assessments must be conducted during renovation, development, and maintenance. Flood risks evolve, so guidelines should define when reassessments are required, for example, for projects above a certain investment threshold or during annual maintenance checks.

Finally, organisations should identify critical functions for business continuity. A Critical functions report enables targeted responses to protect essential processes. This report serves as information which should be included in the assessment, as shown by the dotted arrow.

Respond

After the risk assessment is completed, the organisation must take action to respond to the identified vulnerabilities. This phase is crucial because an assessment alone does not reduce risk; it needs to be translated into concrete measures and embedded in organisational processes. In this phase, the financial perspective weighs up the costs of responding to flood risks against accepting the risks.

The first step in this phase is to set a long-term ambition for managing flood risks within the real estate strategy. By defining ambitions, the organisation secures continuity and commitment. These ambitions can be formulated at different levels: for entire areas or portfolios, for individual buildings, or for critical business processes.

The main deliverable of the Respond phase is the Flood risk management plan. This plan translates the outcomes of the risk assessment into practical actions for tactical and operational levels into practical steps for integrating flood risks. It acts as a guide for integrating flood risk considerations into everyday processes, such as maintenance, but also processes such as renovation and development. It should also clearly define responsibilities across perspectives in the organisation, so that organisational, functional, and physical perspectives understand their roles and accountability.

An essential element of the Flood risk management plan is a comprehensive list of measures for both assets and areas. These measures can range from physical interventions, such as flood barriers and drainage improvements, to organisational actions like emergency protocols. To make this list actionable, measures should be categorised by area level and asset level, and further divided into interventions for new construction, renovation, and existing buildings. In addition, the Flood risk management plan must prioritise assets based on their pre-established risk profile. The buildings that host critical business processes should receive priority to ensure efficient allocation of resources and maximum impact on reducing risk.

To ensure the successful implementation of the Flood risk management plan, organisations should assign responsibilities of internal and external stakeholders to the Flood risk management plan. In order to communicate the content of the plan, clarify roles and responsibilities, and increase awareness across all perspectives, knowledge sessions should be hosted. Eventually, the Flood risk management plan must be carried out by.

Control

The final step in the cycle is to control and monitor the Flood risk management plan, ensuring measures remain effective and adapt to changing conditions. Risks evolve due to climate change, asset deterioration, and operational changes, so management cannot be static. Continuous evaluation and refinement of the Identify-phase enable ongoing improvement.

A key action in this phase is the annual evaluation and update of the Flood risk management plan developed during the Respond phase. By reviewing the plan regularly, organisations can incorporate new data, lessons learned, and changes in risk exposure. This prevents outdated measures and ensures that the strategy remains aligned with organisational objectives.

Another critical component of the Control phase is the development and maintenance of a Business Continuity Plan (BCP) and an Emergency Response Plan (ERP). These plans provide structured guidance for maintaining essential operations during and after a flood event.

- BCP: safeguards personnel and vital processes, ensuring core functions continue during disruptions.
- ERP: provides clear procedures for immediate response and structured recovery after a crisis.

To ensure that existing buildings remain compliant with flood risk guidelines, mandatory checks during maintenance are necessary. Unlike new builds and renovations, they lack defined intervention points, making regular inspections critical to prevent deterioration and postponed measures. These checks follow criteria established in the Assess phase.

Monitoring critical functions is another essential aspect of control. These functions must remain operational during a flood event, and regular checks confirm whether they can continue under adverse conditions. This monitoring supports business continuity and identifies areas requiring additional safeguards. Besides this, monitoring whether the mitigation measures of the Flood risk management plan are carried out is important in the Control phase.

Finally, effective control depends on informing and engaging asset managers, who are responsible for buildings during their operational phase. Asset managers must have full visibility of previous steps in the cycle: identification, assessment, and response. They need to understand the risks associated with their assets, the measures already implemented, remaining vulnerabilities, and the details of BCPs and ERPs.

Internal communication

Internal communication, situated in the middle of the cycle, ensures all stakeholders, including asset managers, remain engaged throughout the process. This creates support for flood risk management. As indicated by the dimensions icons, not every perspective needs to be involved in every action, but keeping each other informed, involving each other and sharing information ensures integration of the different perspectives and thus a smoother flood risk management cycle.

6.4 Expert validation

The roadmap was tested and validated by experts. The roadmap was presented to one expert per case. The purpose of this validation was to determine whether the roadmap is logical, feasible, and recognisable in practice. The experts' input was used to make a final round of improvements to the roadmap. The improvements that emerged from the expert validation are highlighted with an arrow. These improvements have already been incorporated in the roadmap.

Expert selection

The selection of experts was based on the criteria shown in Table 6-2. Experts were chosen from the group of previously interviewed participants who were part of the case studies. For each case, one expert was selected who had the highest level of involvement in the overall REM process by aligning real estate to business objectives and had the most comprehensive knowledge of different dimensions. This assessment was based on the interviews. The validation was conducted through individual meetings. Before the meetings, participants received the roadmap and the user guide to review in preparation. The protocol for the expert validation is provided in Appendix V. All meetings were recorded, and the resulting data were used to further refine the roadmap.

1. Part of case study

2. **Involvement in REM:** Expert must have knowledge of the REM process by aligning real estate with business processes across multiple domains.

Table 6-2: Selection criteria for expert validation (Author, 2025)

Findings of the expert validation

Structure and clarity

Experts indicated that the circular model provides a clear visual structure for risk management. The cyclical form is recognised from other risk management frameworks, and it is clear that the cycle must be repeated continuously. They understood the processes represented in the circle: the risk management process with chronological actions, internal connections beyond the chronological sequence shown by dotted lines, deliverables, and dimensions involved in each action. However, they noted that the circle contains a large amount of information, which may cause some processes to be overlooked. The accompanying guide is therefore essential for interpretation.

To strengthen the message of the roadmap, experts suggested adding a simplified version of the circle. This simplified model could be used to engage non-experts in the process, creating awareness and understanding of flood risks and the cycle's functioning without relying on technical terminology. Such a visual would help increase organisational buy-in by making the concept accessible to a broader audience.

- ➔ Add a simplified management circle with clear end goals for each phase.

Experts also commented that the dotted lines in the roadmap are unclear. There needs to be a consistent logic behind these connections, explaining why they exist and what relationships they represent between actions. This structure should be evident from the model itself, not only from the guide. While the lines do indicate that the roadmap is not a linear step-by-step plan, their meaning must be more explicit to show interdependencies clearly.

- ➔ Ensure clear structure and consistency in the use of internal relations.

Proposed actions

Initially, the roadmap stated that internal communication should occur throughout the process, and asset managers would be informed at the end to ensure they understood which risks had been mitigated and which remained. While this remains important, experts emphasised that asset managers should be involved from the very beginning. They hold critical knowledge about risks and operational processes within their assets, making their early engagement essential for effective flood risk management.

- ➔ Integrate asset managers early in the process.

In the original roadmap, there was no action to monitor whether the Flood risk management plan had been implemented. Experts highlighted that this is a crucial step to include in the Control phase. Internal stakeholders should be checked for compliance with their responsibilities to ensure measures are carried out.

- ➔ Add a monitoring step in the Control phase to verify implementation of mitigation measures.

The action ‘Develop handbook to integrate assessment outcome to tactical and operational level’ was originally presented as a separate action within the Flood risk management plan in the Respond phase. After reviewing the roadmap and expert feedback, it became clear that this is not an independent task but rather a deliverable that combines several actions already included in the roadmap. The handbook functions as an implementation tool, bringing together outputs from different steps. Instead of treating it as a standalone action, the handbook corresponds with the deliverable ‘Flood risk management plan’. Its purpose is to translate the outcomes of the risk assessment into practical guidance for tactical and operational processes.

- ➔ The handbook is a deliverable that corresponds with a Flood risk management plan.

Proposed dimensions, roles, and responsibilities

The dimensions involved in each action are currently indicated by icons. While this is clear for the strategic/tactical level for which the roadmap was designed, it is less understandable for operational staff. Experts highlighted the need for clearer responsibilities and role definitions. However, because organisational structures differ, assigning specific roles within the roadmap is not feasible. Instead, organisations should translate the roadmap’s actions and suggested dimensions into concrete roles and responsibilities internally.

- ➔ Recommend organisations to use the roadmap as a basis for defining roles and responsibilities aligned with the suggested dimensions.

Implement ability

Feedback from the experts indicated that the roadmap is implementable at the strategic and tactical levels, but the operational perspective is still lacking. The scope of this research was not to develop an operational tool but a strategic one. Nevertheless, experts emphasised that successful strategic implementation requires operational involvement. This can be achieved by engaging operational staff from the start of the cycle, creating buy-in and improving integration. When operational teams contribute to the flood risk assessment, their practical knowledge adds significant value, and they feel more involved in the process. In addition, as described above, it is important that an organisation assigns clear responsibilities to the actions so that the plan can be implemented at the operational level.

- ➔ Integrate operational input during the assessment phase.

ING indicated that the roadmap is applicable for integrating flood risks into its real estate portfolio strategy. The roadmap feels familiar because similar actions are already performed for other risk management processes. ING and TU Delft both reported being in the Identify phase, specifically focused on creating awareness. For TU Delft, the roadmap could also support the strategic component of risk management. While the terminology is new, the steps and logic of the process are clear. The Rijksvastgoedbedrijf (RVB) is further along, currently mapping flood risks across its portfolio in the Assess phase. All experts agreed that the roadmap is primarily implementable at higher organisational levels and requires an organisation-specific translation for full integration.

Part VI

Discussion, conclusion & reflection

7. Discussion

In this discussion, the results are interpreted, and the limitations are highlighted. The discussion will provide a better understanding of concepts highlighted in the desk research and their relation to the empirical research and reality.

7.1 Interpretation of the findings

Real estate management

This research builds on the concept of real estate management (REM), which is widely studied in theory. A central principle in REM is the alignment of real estate with business objectives (Arkesteijn & Binnekamp, 2013). This study focuses on both corporate and public owner-occupiers of real estate who use their properties to support organisational goals. While corporate real estate primarily serves business objectives and is financed by the company itself (Huffman, 2002), public real estate carries a societal role, must accommodate public interests, and is funded by the state (Den Heijer, 2021).

Based on the literature, the expectation was that corporate organisations would be more advanced in integrating flood risk into their real estate strategies, given their financial resources and business-driven approach. However, the empirical findings reveal the opposite: public organisations are further along in implementing flood risk management. Several factors may explain this difference. First, public organisations have an example-setting function and are expected to lead on emerging trends such as climate adaptation. Second, public organisations face stricter sustainability mandates and climate adaptation policies, whereas corporates encounter fewer legal requirements. Third, public organisations often collaborate with municipalities and water boards, gaining access to technical expertise that corporates may lack internally.

Another factor that may play a role is the organisation's risk-bearing profile. Choosing whether to accept or mitigate a risk involves an important financial decision. Mitigation requires a spread-out investment but is likely to be financially cheaper in the long term. This is because the actual occurrence of a risk can be very costly. Corporate organisations may be more inclined to accept the risk, as they can bear the financial consequences if it occurs. They have the financial resources to resolve the issue afterwards. Public organisations, on the other hand, may not be able to afford the consequences if the risk occurs and will therefore be more likely to mitigate it in advance. In that case, the financial burden is more evenly distributed.

Flood risk management

Flood risk is frequently framed under the broader umbrella of sustainability and climate adaptation. In all three cases, it appears as one item among many environmental risks. This linkage can be advantageous: embedding flood risk within ESG agendas, sustainability or climate adaptation goals, and certification schemes (e.g., BREEAM, DGBC frameworks) may accelerate awareness and action. (Dutch Green Building Council, 2022; Envoria, n.d.; European Commission, n.d.; Sweco, 2025) However, the danger lies in subsuming flood risk under generic sustainability goals, reducing it to a 'tick-the-box' exercise for compliance rather than a substantive resilience strategy. Desk research highlights that flood risks can also be reframed as a safety issue, rather than only a sustainability concern, which could elevate their urgency within organisations (Bartelink et al., 2015). Safety is often perceived as non-negotiable. Positioning flood risk under safety would help ensure that measures are implemented proactively, not just for certification purposes.

The literature identifies several types of flooding relevant to the Netherlands: pluvial flooding and flooding caused by dike breaches were most mentioned (Environmental Health Atlas, z.d.; IPCC, 2023; KNMI, 2023; Merz et al., 2021). Surprisingly, the empirical cases only considered pluvial flooding as a

relevant risk. Responsibility for dike-related flooding was largely deferred to Dutch water authorities. While these authorities play a critical role in national water management, the findings indicate that organisations rarely view them as stakeholders in their own risk management processes. This represents a missed opportunity. Collaboration between organisations and water boards could strengthen both parties' resilience strategies. Moreover, the risk management cycle of Winch (2010) used in this study for pluvial floods (Identify, Assess, Respond, Control) can also be applied to floods related to dike breaches. Organisations may not control dike integrity, but they can still prepare for consequences through continuity planning and adaptive measures. Therefore, implementing Responses to these risks identified and assessed by the Dutch water authorities could be beneficial for both parties.

Perspectives and responsibilities

The literature offers two dominant ways of structuring real estate management:

- Four perspectives: organisational, functional, financial, and physical. (Den Heijer, 2021)
- Three levels: strategic, tactical, and operational (Janssen, 2008; Van Driel, 2010)

The expectation from theory is that flood risk would influence all perspectives and levels. However, these frameworks are not fully interchangeable. The organisational perspective aligns closely with the strategic level, but functional and physical aspects cut across both tactical and operational levels. Financial responsibility is embedded in every level rather than existing as a separate layer, which explains why the level model of Janssen (2008) does not explicitly isolate finance. This interconnectedness is acknowledged in the model of Den Heijer (2021), which places a CREM circle at the centre to emphasise integration across all quadrants.

Assigning responsibilities based on these perspectives is complex. The empirical findings show that roles and accountability are highly organisation-specific, making it difficult to prescribe universal responsibilities to actions. Interviewees expressed a clear need for tools that allow flood risk integration from their own perspective. While the literature suggests such tools, developing them fell outside the scope of this research. Instead, the theoretically informed roadmap delivered here acts as a guide, enabling organisations to adapt actions to their structure.

Importantly, responsibilities cannot be confined to a single perspective or level. Flood risk management requires continuous dialogue between roles to maintain awareness and share knowledge. Communicating responsibilities internally is therefore essential for clarity and accountability. An overarching coordinating role, treating flood risk as an ongoing process rather than isolated tasks, could strengthen integration by connecting strategic objectives with operational execution and preventing gaps where responsibility is assumed but not carried out.

Financial implications of flood risk management

Although financial aspects were not the primary focus of this study, they strongly influence whether measures are implemented. As described in 2.1.5, the literature emphasises that the financial aspect is important to consider in decision-making about flood risk mitigation measures. However, it is difficult to estimate the financial value of proactive mitigation measures. (Jonkhoff, 2009; Molinari et al., 2021; Špačková & Straub, 2015) Empirical findings indicate that organisations rarely calculate the potential financial impact of flooding or incorporate it into investment criteria. None of the interviewees mentioned financial factors as a driver or barrier for flood risk management. Instead, actions tend to be reactive, taken after a flood event or when required for certification. This reactive approach contrasts with the literature, which indicates that the proactive implementation of flood risk measures is more financially advantageous in the long term than reacting to the direct and indirect consequences of flooding, such as high potential costs related to asset damage, operational downtime, and reputational harm.

Interviews suggest that many organisations believe existing physical and operational measures already reduce financial risk, which lowers the perceived urgency for additional investment. However, this

perception may underestimate systemic exposure, especially under changing climate conditions and increasing rainfall intensity. To move beyond ad hoc decisions, flood risk needs to be framed in financial terms. This means developing scenario analyses and business cases that show the cost of inaction versus the cost of preventive measures. For example:

- Direct costs: repair of damaged assets, replacement of equipment, and clean-up. (Jonkhoff, 2009)
- Indirect costs: operational downtime, loss of productivity, and reputational impact. (Jonkhoff, 2009)
- Insurance implications: higher premiums or exclusions for high-risk sites.

By quantifying these elements in a multi-criteria analysis, organisations can compare flood risk mitigation with other investment priorities.

Literature distinguishes between asset-related costs and operational costs. While asset-related costs are generally well documented in the literature, operational costs receive far less attention, despite their significant role in decision-making. Because both types of costs strongly influence financial risk, understanding their magnitude is essential. Providing concrete figures, such as the proportion of indirect costs compared to direct costs can improve awareness among public and corporate organisations. This approach helps demonstrate the urgency of addressing operational vulnerabilities and ensures that flood risk is recognised not only as a physical threat but as an operational financial issue.

Business continuity

This research focuses on real estate management because of its direct link to business continuity. Literature shows that continuity is a key element of risk management and should be considered during both the assessment and response phases (Endendijk et al., 2024; Fatica et al., 2024; Weinhofer & Busch, 2013). The empirical findings confirm that organisations see business continuity as important in their real estate strategies. However, the connection between continuity planning and flood risk is often weak. Continuity is usually addressed as a general topic, not tailored to specific risks. This is a gap. Flooding can make buildings inaccessible and damage critical systems, scenarios that can seriously disrupt operations. For example, if a headquarters cannot be reached and vital functions fail due to water damage, the impact on continuity is severe. The effect of flooding also depends on the type of asset and its function, which means continuity planning should be specific to each building and risk. Integrating flood risk into continuity planning would raise its priority and lead to targeted measures.

The relation between area and asset

This research primarily focused on flood risk management at the building level, as this is where most real estate strategies and actions are currently concentrated. However, the findings indicate that significant opportunities for risk mitigation exist at the area level, which has received far less attention. Area-level measures, such as improving drainage systems, creating retention zones, or elevating access routes, can substantially reduce the vulnerability of assets, yet these strategies are rarely integrated into real estate management.

The empirical evidence shows a clear distinction between corporate and public organisations in this regard. Corporate organisations, such as ING, do not engage in area-level measures at all. Their flood risk management is mostly operational preparedness or building measures. A plausible explanation is that the surrounding land does not belong to their property portfolio, limiting their ability to implement interventions beyond the building footprint. The public organisation, the Rijksvastgoedbedrijf (RVB), takes very few measures at the area level and does not perceive flood risks as an immediate concern at this scale. In contrast, TU Delft actively manages flood risks through area-level interventions. This difference can be attributed to property ownership structures: TU Delft owns and manages not only its buildings but also the surrounding grounds, enabling it to implement measures such as landscaping adjustments and water retention features.

Additionally, interventions at the area scale can create shared benefits for multiple organisations. It may be more financially attractive to take measures on a larger area scale, for which collaboration with neighbours and local authorities is essential. If neighbouring properties have robust flood risk management measures in place at the area level, this can provide indirect protection to adjacent sites, and the reverse is also true. A joint regional approach can also be beneficial in terms of business continuity. For example, certain primary functions can be jointly protected or taken over from each other, temporary work or shelter locations can be shared, or alarm systems can be implemented on a larger scale. This interdependency highlights the need for collective action and coordinated planning among organisations, municipalities, and water authorities to achieve effective flood resilience beyond individual assets.

7.2 Limitations on research design

This research provides many insights, but it also has limitations that should be considered. These limitations on the research design are explained below.

Desk research

Initially, the research aimed to concentrate on corporate owner-occupiers; however, this scope was broadened to include both public and corporate organisations with business objectives. This shift was based on the assumption that corporate real estate could serve as an overarching concept due to its alignment with organisational goals. Consequently, much of the literature study emphasised corporate real estate, leaving public real estate somewhat underrepresented. Although differences between corporate and public real estate were addressed in the empirical research, they were less prominent in the theoretical foundation.

Empirical research

The empirical component consisted of three case studies. Initially, the intention was to collect detailed organisational data from these cases and verify it through interviews. However, publicly available information on flood risk management within these organisations proved scarce. As a result, the case descriptions primarily provided contextual background, while nearly all insights on flood risk practices were derived from interviews. This limitation meant that interview data could not be triangulated with internal organisational documents, reducing the depth of verification.

A total of twelve interviews were conducted and analysed using a coding process. While coding enhances structure, qualitative analysis remains interpretative and subject to researcher bias. The interpretation of quotes may have been influenced by the researcher's expectations, potentially overlooking nuances or misinterpreting statements. Efforts were made to mitigate this risk through systematic coding and validation, yet subjectivity cannot be fully eliminated. Another potential source of bias lies with the interviewees. Since the interviews explicitly addressed flood risk, participants may have felt pressured to present their organisation in a positive light, leading to socially desirable responses. In addition, as mentioned earlier in the conclusions of the in-case analyses and the cross-case analysis, the current situations were taken from the interviews but interpreted and combined by the researcher to outline a current situation. The potential actions and cross-case actions are derived from these current situations and are based on the researcher's interpretation. This can lead to researcher bias.

Synthesis

The synthesis compared the current state of flood risk management with potential actions across the cases, enabling the identification of similarities and differences. Because the interviews were semi-structured, responses varied widely and required broad interpretation to ensure comparability. Expert validation added an important layer of reliability by verifying whether these interpretations aligned with practical realities. This step strengthened the connection between theory and practice and helped confirm the robustness of the proposed framework.

7.3 Limitations on research findings

In addition to limitations in the research design, which may influence the findings, the study also revealed limitations in the research findings.

The relation between findings and the roadmap

The purpose of this research, particularly in relation to Sub-Question 4 (SQ4), was to identify what owner-occupiers need to effectively integrate flood risk into their real estate strategies. However, the empirical findings did not provide a clear and uniform picture. Interviewees expressed a need for various types of guidance, which appeared to be strongly dependent on the organisational perspective they represented. These needs often involved specific tools applicable only within their own domain. To accommodate these preferences while maintaining focus on the main research question, how flood risk can be integrated into a strategy, the decision was made to develop a theoretically informed roadmap outlining key principles rather than creating highly specialised tools or step-by-step plans. The roadmap offers references to existing instruments but does not include the development of bespoke tools requested by some participants.

Awareness of pluvial flooding was consistently high among participants, whereas other types of flooding were perceived as negligible. Desk research, however, highlighted the significant relevance of other flood risks (IPCC, 2021; KNMI, 2023). This mismatch between theoretical insights and empirical findings made it challenging to develop a roadmap that comprehensively addresses all flood risks, as empirical knowledge on these other risks was limited.

Limited attention to insurability

It is noteworthy that none of the cases explicitly addressed insurability. As flood risk increases, insurance premiums rise, and at a certain tipping point, insurance becomes prohibitively expensive, forcing organisations to adopt mitigation measures or alternative strategies. The absence of this topic in the interviews may be explained by the lack of representation from financial domains.

Portfolio VS. Business level

The research focused on three case studies representing three portfolios. Interviewees who managed larger real estate portfolios than just the case study portfolio often answered questions from the perspective of their entire portfolio rather than the specific case being studied in the research. As a result, the case studies reflected business-level practices rather than location-specific strategies for the cases. For TU Delft, which operates a single campus, this alignment occurred naturally. However, for ING and RVB, responses frequently referred to the entire portfolio, creating inconsistencies and making comparisons between cases more complex.

Scale ambiguity

Although this study primarily examined portfolio-level strategies, some discussions extended to smaller-scale considerations, such as critical functions within individual assets. The research did not explicitly define the scale at which resilience measures should be applied. For example, measures implemented at the building level, such as elevating ground floors, may protect the structure but still leave occupants vulnerable if external access routes are flooded. Switching between scales aimed to provide a comprehensive view of flood risk management, but may also have introduced ambiguity. It remains difficult to determine the precise level at which resilience is most effectively achieved.

8. Conclusion

This study aimed to investigate how owner-occupiers of real estate, which supports business processes, can mitigate flood risks in their real estate strategy. This chapter summarises the answers to the sub-questions and then answers the main question. After this, recommendations are elaborated for further research and for practice.

8.1 Sub-questions

SQ1: *What are the key flood risks in the built environment, and how do they impact real estate portfolios, assets, and business operations in flood zones?*

The built environment faces four primary types of flood risk: pluvial, fluvial, coastal, and lacustrine flooding (Environmental Health Atlas, z.d.). Among these, pluvial flooding, caused by extreme rainfall, is perceived as the most relevant by organisations because it is considered both likely and partially controllable through local measures. In contrast, fluvial and coastal flooding are often underestimated and regarded as the responsibility of Dutch water management systems, creating a sense of security.

Flooding impacts real estate on multiple levels. Direct damage accelerates asset depreciation and increases maintenance costs, while indirect impacts disrupt business operations, reduce productivity, and harm reputation (Bartelink et al., 2015; Weinhofer & Busch, 2013). Operational continuity is particularly vulnerable: floods can restrict access to facilities, interrupt critical processes, and lower output. Research indicates that each day of closure costs approximately 0.5% of annual revenue, and asset depreciation after a flood averages 2% per year (Fatica et al., 2024).

Ultimately, flood risks affect both the physical portfolio and organisational performance, making them a strategic concern for real estate management. According to Krumm et al. (2000) and Den Heijer (2021), these risks influence all quadrants and perspectives of the Four Quadrant Model of Corporate Real Estate Management, impacting alignment between portfolio, assets, and business operations.

SQ2: *How can flood risks be integrated into REM strategies?*

Real estate management operates across three organisational levels: strategic, tactical, and operational (Janssen, 2008; Van Driel, 2010). At all these levels, flood risk can be integrated into REM strategies.

A theoretical foundation for integrating flood risk across these levels is provided by the risk management framework of Winch (2010), which consists of four phases: Identify, Assess, Respond, and Control (Winch, 2010). In the Identify phase, flood risks are recognised. In the Assessment phase, risks are quantified based on probability, vulnerability, and exposure using standard tools such as the Local-Oriented approach (Wu et al., 2024) and the Framework for Climate Adaptive Buildings (Dutch Green Building Council, 2022). The Respond phase focuses on developing mitigation strategies. This can be done at the tactical level, including physical asset measures (Rotterdam, n.d.), or at the operational level, including business operation measures such as developing a Business Continuity Plan to ensure critical processes can continue during and after disruptive events (Cerullo & Cerullo, 2004; Yang et al., 2020). The Control-phase ensures continuous improvement through monitoring and feedback loops. Aligning REM strategies with this cycle enables organisations to move from reactive measures to proactive resilience.

Implementing measures across these levels requires informed decision-making. Multi-Criteria Decision Analysis offers a structured approach for evaluating options (Arkesteijn & Binnekamp, 2013). Financial considerations form an integral part of this process, determining whether flood risk measures are economically viable. A cost-benefit analysis weighs implementation costs against anticipated benefits in terms of risk reduction (Jonkman et al., 2004; Špačková & Straub, 2015).

SQ3: *How are REM strategies currently addressing or neglecting flood risk management?*

Current Real Estate Management (REM) strategies demonstrate fragmented and inconsistent approaches to flood risk management across organisational levels. While awareness of climate-related risks is growing, integration into REM remains limited and often reactive rather than proactive.

Public organisations, such as TU Delft and RVB, have taken initial steps by assessing flood risks under the umbrella of greater climate resilience. These efforts are primarily driven by regulatory requirements for new construction and renovation, as well as sustainability objectives. However, these ambitions lack operational translation. There is no comprehensive strategy ensuring that flood risk considerations are integrated at all organisational levels, resulting in gaps in implementation. Corporate organisations, on the other hand, such as ING, are often strong in operational preparedness through business continuity planning. Nevertheless, flood risk is rarely embedded in their real estate strategy, and physical mitigation measures are minimal. Actions tend to occur reactively at the operational level, rather than being guided by strategic planning.

This gap between awareness and action suggests that flood risk management is not yet a core element of REM strategies. Organisations recognise flood risks, but lack an integrated approach to translate the recognition into an assessment and respond to the flood risks. Without structural integration, organisations remain vulnerable to physical damage, operational disruptions and financial losses during extreme events.

SQ4: *What tools do real estate owner-occupiers need to effectively integrate flood risk into their strategies?*

Real estate owner-occupiers require a combination of tools that address flood risk across strategic, tactical, and operational levels. The tools they desire depend on their perspective.

From the desk research, risk assessment frameworks such as the Local-Oriented Approach (LOA) and the Framework for Climate Adaptive Building (FCAB) emerged as essential tools. These frameworks provide structured methods for evaluating hazard, vulnerability, and exposure, enabling quantitative assessments. Besides this, operational resilience requires Business Continuity Plans (BCPs) and Emergency Response Plans (ERPs), which offer structured guidance for maintaining critical operations during and after a flood event. These plans define roles, responsibilities, and recovery protocols, reducing disruption and accelerating return to normal operations.

Empirical findings highlight additional needs: risk assessments for new and existing assets, standard guidelines when risk assessment is needed, mandatory checks, and a clear Flood risk management plan including a list of flood risk measures for area and asset level, prioritisation of assets based on the risk profile, and clear responsibilities.

Together, these tools enable a shift from reactive responses to proactive resilience, ensuring that flood risk becomes an integral part of real estate management.

8.2 Main research question

“How can real estate owner-occupiers integrate flood risk management into their real estate strategies?”

This research concludes that integrating flood risk management into real estate strategies requires a fundamental shift from reactive responses to proactive resilience. Flooding is not only a physical threat to assets but also an operational and financial risk that can disrupt core business. For owner-occupiers, who depend on their properties for both asset value and operational continuity, this dual exposure requires a structured and proactive approach to flood risks embedded in Real Estate Management (REM) strategies.

The literature study and the empirical research reveal that current practices remain fragmented. While awareness of flood risk is growing, integration into portfolio planning, asset management, and operational processes is limited. The literature provides tools and frameworks for risk identification and assessment, yet empirical evidence shows these are not consistently applied, and organisations lack a clear strategy to operationalise them.

To address this gap, this thesis proposes a theoretically informed roadmap to guide owner-occupiers in integrating flood risk management into REM strategies. The roadmap, presented in Figure 8-1, operationalises this shift through the risk management cycle of Winch (2010): Identify, Assess, Respond, and Control. Each phase translates research insights into practical actions. Identification focuses on acknowledging flood risks and creating awareness around them. Assessment is getting a clear understanding of the effects of flood risks on portfolio and asset scale, and the effect on primary functions and operations. In the Response phase, measures are taken to mitigate or not mitigate flood risks. Finally, Control embeds continuous improvement through monitoring and feedback loops.

Importantly, integrating flood risk management is not about implementing isolated actions. It is about creating organisational awareness and providing a structured approach where actions are executed in a logical sequence and embedded across multiple domains. This ensures that strategic, tactical, and operational levels work together to build resilience throughout the entire organisation. The full description of the roadmap and the user guide is provided in Appendix X.

Roadmap to integrate flood risks into real estate management

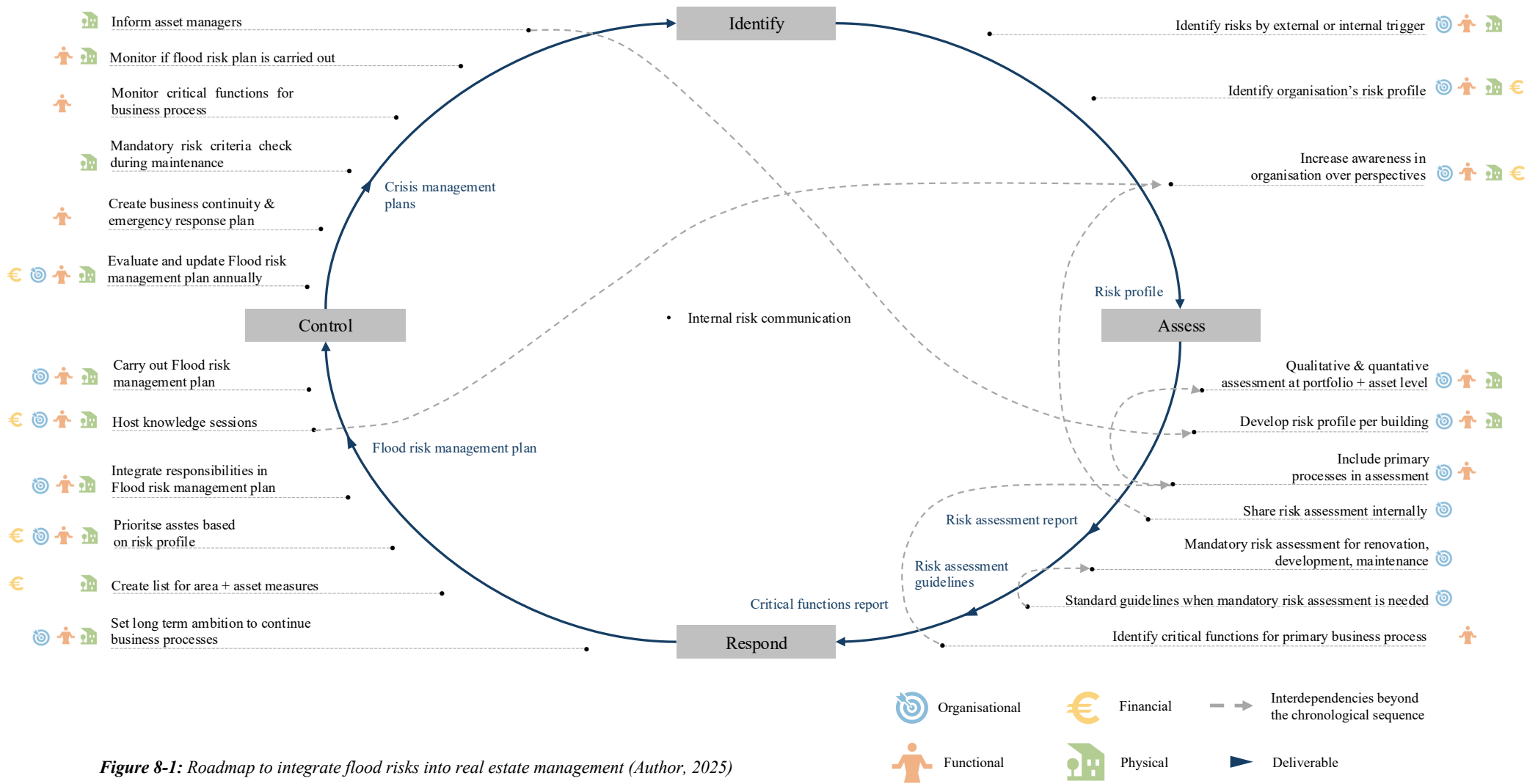


Figure 8-1: Roadmap to integrate flood risks into real estate management (Author, 2025)

8.3 Recommendations

Based on the results, conclusions, and validation of this research, several recommendations are proposed. These are divided into recommendations for practice and recommendations for further research.

8.3.1 For practice

Updating the roadmap

As highlighted throughout this study, risks evolve, particularly climate-related risks such as flooding, which are dynamic and influenced by external factors like climate change. This variability affects how flood risks should be integrated into real estate strategies. Therefore, the roadmap should not be considered a fixed solution but rather a living tool that is periodically reviewed and adapted. Updates should incorporate new developments, emerging risks, and lessons learned from past events. Therefore, not only must the roadmap be implemented in a cyclic process, but it must also be reviewed regularly.

As previously indicated, the theoretically informed roadmap can be used to guide the integration of flood risk into real estate management strategies for owner-occupiers at strategic and tactical levels. The further implementation of specific roles and responsibilities is important, but organisation specific. It is therefore recommended that the roadmap be adapted to each organisation's own roles and responsibilities.

Create cross-functional flood resilience teams

Fragmentation between perspectives often occurs, creating blind spots and slowing implementation. While internal communication, assigning responsibilities in an organisation, and risk-sharing can mitigate this issue, a more structural solution is to establish dedicated resilience teams. These teams should include representatives from portfolio management, facility management, asset management, finance, operations, and other departments. By coordinating actions and sharing knowledge, they ensure that decisions consider both physical and operational impacts. A cross-functional approach fosters integration, reduces duplication, and accelerates implementation.

Embed flood risk awareness in training and onboarding

Flood risks can pose significant threats to employee safety and organisational continuity. Although physical and operational measures reduce these risks, they do not eliminate them. This research revealed that awareness of flood risks is unevenly distributed across organisations. To address this, companies should develop training modules focused on climate risks, flood risks in particular, and resilience. These modules should be integrated into onboarding for new employees and refreshed periodically for existing employees. Training should cover technical aspects as well as organisational implications, such as business continuity and reputational risk, and safety concerns. Building a culture of resilience ensures that awareness does not depend on individual experience but becomes an organisational standard.

Strengthening municipality organisations collaboration

Municipalities play a key role in climate adaptation and work closely with Dutch water authorities. Stronger partnerships can enable coordinated measures, data sharing, and large-scale solutions that benefit both organisations and regional resilience goals.

8.3.2 For further research

Quantitative validation of findings

This research is qualitative in nature and was conducted using a limited number of case studies and interviews. To achieve more robust and generalisable results, future studies should either expand the number of cases and interviews or apply quantitative methods to validate the findings. A quantitative approach could include surveys across a broader sample of organisations or statistical modelling to test relationships identified in this study.

Explore the financial implications of flood risk integration

This study placed limited emphasis on financial aspects, as the focus was primarily on other organisational, functional, and physical perspectives. The empirical research did not include interviews with financial stakeholders, even though these perspectives are highly relevant to flood risk management. Financial considerations influence how much risk an organisation can absorb and determine the economic consequences of flooding. Future research should examine the relationship between flood risks, financial consideration for mitigation measures, financial capacity, financial factors, and real estate management. This includes analysing insurance premiums, investment decisions, and differences in financial motivations between public and corporate organisations. Research could also investigate the tipping point at which insurance becomes unaffordable, triggering a shift to physical mitigation measures. Such insights would help build robust business cases for resilience investments and support the integration of flood risk into financial strategies.

Interdependencies between climate risks

Flooding is not the only climate-related hazard that needs to be integrated into real estate strategies. Other risks, such as drought and heat stress, also affect the built environment and often interact with flood risks. Mitigation measures rarely address a single hazard; they frequently influence multiple risks simultaneously. Therefore, flood risk can be considered within a broader climate risk framework to avoid tunnel vision and prevent conflicting or redundant measures. Integrated climate risk management offers a solution by aligning strategies across hazards. To ensure complete and effective resilience strategies, future research should focus on creating frameworks that address several climate hazards at the same time or show relations to other climate risks.

Difference in corporate and public real estate

This research included both corporate and public real estate portfolios, revealing notable differences in their motivations and approaches to flood risk management. Corporate organisations often prioritise financial performance and operational efficiency, whereas public organisations tend to emphasise societal responsibility and long-term sustainability. Research should examine how these differences shape flood risk strategies and whether tailored frameworks are needed for each sector.

9. Reflection

Topic

This graduation project has been both challenging and rewarding, professionally and personally. From the beginning, I knew I wanted to work on a topic that is relevant to today's society. I was struck by the paradox that, despite the growing flood risk in the Netherlands, this issue receives little attention in the real estate sector. Everyone acknowledges the risk, yet few act on it. This raised fundamental questions: 'Why is this happening? What are the barriers to action? And how can we overcome this?' These questions shaped my decision to focus on the impact of flood risk on real estate.

However, scoping the topic further proved difficult. It needed to align with my first supervisor's expertise, my second supervisor's input, and the expectations of my graduation company. This balancing act made the initial phase feel uncertain, compounded by personal health challenges that limited my ability to work consistently. Preparing the P2 presentation was a turning point; it helped me sharpen the research focus and lay a solid foundation for the graduation project.

Looking back, I am glad I chose this topic. It is not only academically relevant but also resonates with professionals in practice. I noticed that people around me found the subject engaging because it addresses a tangible and urgent societal issue. This reinforced my motivation and confirmed the importance of the research.

Process

After defining the topic, I began the literature study, which turned out to be the most challenging part of the research. At that stage, the study lacked a clear outline, making it difficult to identify concrete and useful sources. As a result, the research was partly shaped by the literature I found rather than the other way around. The P2 milestone marked a shift. With a clearer structure and theoretical foundation, the research became clear. The literature and the research design shaped each other. This iterative process taught me that research is rarely linear. New insights often require revisiting earlier steps, and flexibility is essential. The next step was conducting the empirical part at CBRE, which made the project feel like 'my own research'. Case selection, however, proved more complex than expected. Finding cases that met the criteria I defined in the literature was challenging for CBRE, and after losing time, I decided to adjust the criteria slightly to keep the research feasible. I changed the scope of the research from only corporate real estate to public and corporate, as a constraint that real estate serves business objectives. This decision was difficult but necessary to maintain progress.

Once cases were selected, I moved on to interviews in late September, the most enjoyable part of the process. Talking to professionals validated the problem I had been working on for months and provided new insights that enriched the research. These conversations also highlighted the non-linear nature of research: new knowledge often meant revisiting literature to refine concepts and strengthen arguments. Initially, stepping back felt like wasted time, but these iterations were essential for shaping the study.

The final stage, synthesising empirical data into a coherent analysis and deliverable, was demanding. Interviews generated extensive input, making it difficult to structure and compare findings across cases. To overcome this, I developed a stepwise analysis approach, piloted it on one case, and then applied it to the others. This method allowed me to maintain consistency and produce a clear synthesis that supported the final deliverable. Creating the final deliverable was not that easy either. At the start of my research, I had a clear idea that I wanted to develop a practical tool that was scientifically founded. Once I got to the point of developing the deliverable, I realised that bringing together all the knowledge from the literature and empirical research and combining it into a deliverable that could be implemented by all organisations was not easy. The knowledge gained is extensive, but translating it into practice makes it broad. I also didn't want the practical side to take precedence, which was quite difficult because the empirical research was very practice-oriented. Next time, I would start mapping out the deliverable earlier so that I would have more time and influence on the result.

Method

The chosen qualitative approach suited both the research objectives and my personal preferences. I enjoy working with qualitative data because it allows room for creativity and interpretation. From the beginning, I was determined to produce a deliverable that could be applied in practice, and a qualitative case study approach was the best fit for this goal. However, qualitative research also brings uncertainties. There is rarely a clear right or wrong, which makes it challenging to judge whether interpretations are accurate. As this was also a learning process, I reminded myself that uncertainty is part of research, as long as I justify my decisions and remain transparent about my reasoning. The method combined several components: literature study, case studies, and semi-structured interviews, woven together to fit the research objectives. Applying a well-established research design as a reference could have provided additional structure and confidence. For example, reviewing similar studies that developed practical frameworks might have served as inspiration or guidance.

Theory

Several theoretical models informed this research about real estate management, including the quadrant CREM model of Krumm (1999), the perspectives CREM model of Den Heijer (2021), and the Strategy levels in real estate management model (Janssen, 2008; Van Driel, 2010). The perspectives model developed is derived from the original quadrant-based CREM model. A key difference between the two is the position and focus of the financial dimension. In the model of Krumm (1999), *cost control* is placed within the real-estate perspective with an operational focus. In contrast, Den Heijer (2021) positions the financial perspective within the real-estate domain but assigns it a more strategic focus.

In the Strategy levels model, the financial perspective is not included as a separate level. This reflects the notion that financial considerations should be embedded across all levels of management rather than treated as a standalone domain. These differences illustrate how theoretical models evolve.

Based on this research, it can be argued that it is challenging for these theories to operate strictly within quadrants, perspectives, or levels. Overlaps and ambiguities do not occur only within the financial domain, but can be identified across all domains, making rigid categorisation difficult. It is therefore important to select one or two models as a conceptual foundation rather than attempting to use multiple frameworks simultaneously.

For this study, two models were chosen as the primary analytical basis: the perspectives model of Den Heijer (2021) and the Strategy levels model. The following theoretical models are used for risk management: the Risk-management process model of Winch (2010), and the Disaster cycle model (UNDRR, n.d.). These models differ in their scope and applicability. The Risk management process model is designed for all types of risks, whereas the Disaster cycle is only applied when an actual disaster occurs. Winch's model can be interpreted as covering the *preparedness* and *prevention and mitigation* phases of the Disaster cycle. However, the moment of the disaster itself is not incorporated in Winch's model. As a result, the subsequent phases of the Disaster cycle: Disaster, Response, Rehabilitation, and Recovery are also absent from Winch's model.

To create a fully comprehensive framework, both models would need to be integrated. In the deliverable developed for this research, Winch's model serves as the foundation, but elements from the Disaster cycle have been incorporated into the roadmap, such as the inclusion of Emergency Response Plans.

Personal process

The graduation process was a journey with highs and lows. It was enriching, brought me closer to the professional field, and allowed me to meet inspiring people. At the same time, it was an uncertain and, at times, an individual experience. Personal health challenges made me feel like I was constantly catching up, and the individual nature of graduation made it difficult to compare progress with fellow students, perhaps for the better.

Nevertheless, I always felt supported by mentors and peers who provided valuable feedback and encouragement. This experience taught me resilience, adaptability, and the importance of clear communication. Professionally, I learned how to translate complex theoretical concepts into practical frameworks and how to manage ambiguity in research. Personally, I discovered the value of persistence, the ability to step back and rethink when necessary, and the courage to ask for help. Looking back, I am proud of the outcome and grateful to those who supported me: my supervisors, colleagues, friends, and family, throughout this process.

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11. Appendices

Appendix I

Data management plan

Plan Overview

A Data Management Plan created using DMPonline

Title: Integrating flood risk in real estate management strategies.

Creator: Willemijn Fanoy

Data Manager: Willemijn Fanoy

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2025)

Project abstract:

Due to climate change, there is an increasing severity of extreme weather events and a rising sea level. This combination will lead to more flood-prone areas and areas at higher risk of flooding, which makes real estate located in these areas more vulnerable to flooding. Especially in the Netherlands, where a majority of the land lies below sea level, the risk of flooding is increasing. Real estate assets of organisations, often located in economically attractive but flood-prone regions, are increasingly exposed to physical damage, business disruptions, reputational risks, and a potential decline in property value. Flood risks are becoming an urgent concern in real estate management (REM) in the owner-occupier context. However, owner-occupiers of organisations have dual responsibilities: the asset as a workplace and operational continuity to retain business performance. While real estate owners, who also occupy the assets, continue to prioritise financial performance and operational efficiency, flood risks are not yet represented in REM strategies. This research explores how flood risks can be integrated into real estate strategies to support portfolio management on strategic, tactical and operational levels. The study answers the following main question: *“How can real estate owner-occupiers integrate flood risk management into their real estate strategies?”*

To answer the research question, this research follows a multimethod approach, qualitative and exploratory. This study combines desk research, empirical research, and a synthesis. The desk research, a literature study, focuses on exploring different concepts and their interrelationships. Concepts covered include (corporate) real estate management, risk management, flood risks, flood risk assessment, asset management, and business operational management. Its purpose is to identify flood risks in the real estate sector and examine their impact on real estate management, both strategically and operationally, at the asset and operational level. The empirical research includes exploratory interviews, three case studies, in-depth interviews, and a cross-case analysis. The purpose is to gain empirical insight into how flood risk is managed in REM and create practical knowledge to integrate flood risks into real estate management strategies. In the synthesis, the knowledge gathered in the desk research and the empirical research is combined.

This research aims to gain knowledge about the impact of flooding on real estate, integrating flood risks in REM, and to explore how owner-occupiers of real estate can start integrating flood risks into REM strategies. The practical deliverable following the academic insights delivered in this thesis is a theoretically informed roadmap that can be used to guide the integration of flood risk into real estate management strategies for owner-occupiers of corporate and public organisations.

Integrating flood risk in real estate management strategies.

0. Administrative 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.

Janine Strandberg, Data Steward at the Faculty of Architecture and the Built Environment has reviewed this DMP on 17-07-2025.

Ellen van Bueren, the responsible supervisor, has reviewed this DMP on 23-09-2025

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

Yes, leading the collaboration – please provide details of the type of collaboration and the involved parties below

In this project, TU Delft is leading the research design and developing the research hardware. CBRE is sharing knowledge and commercial data on the performance of current tools and the proprietary schematics described in the table in question 3.

1. 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? <i>For re-used data/code: what are the sources and terms of use?</i>	Purpose of processing	Storage location	Who will have access to the data/code?
Contact information (Name, company name, function, phone number, email address)	.txt, .xlsx, .PDF files	Network of the graduation company CBRE, in-person, Outlook email. This data contains PII data.	Communication, interview planning and other administrative purposes	TU Delft OneDrive, Outlook webmail.	The researcher (Willemijn Fanoy) + 1st supervisor (Ellen van Bueren) + 2nd supervisor (Alexandra den Heijer)
Signed consent forms	.PDF, docx. files, papers.	Filling in the form before the start of the interviews. This data contains PII data.	Ethics	TU Delft OneDrive. Locker storage at home.	See above
Audio-recordings of interviews	.MP3 files	Audio recordings via phone or via Teams recording. This data contains PII data.	Collecting interview data, answering RQ3 & 4. The audio-recordings will be transcribed. (read below)	TU Delft OneDrive	See above
Transcribed interviews	.PDF files, docx. files	The audio recordings will be transcribed via Teams directly or Word. This data contains PII data.	Collecting interview data, analysing data, answering RQ3 & 4. The transcribed interviews will be coded (read below)	Atlas.ti project map, TU Delft OneDrive	See above
Coded data	Atlas.ti file, PDF files.	Via transcribed interviews. This data contains PIRD data. AI functions in Atlas.ti will be turned off.	Collecting interview data, analysing data, answering RQ3 & 4. Coded data will be analysed using Atlas.ti.	Atlas.ti project map, TU Delft OneDrive	See above + conclusions of the coded data will be uploaded at the TU Delft

			conclusions about whether/how flood risks are integrated in REM will be drawn.		repository in the thesis itself. The coded data itself will not be uploaded.
Interview quotes	.docx files	Interview quotes from the audio. This data contains PIRD data.	Interview quotes will be used in the thesis-text to explain the conclusions from the coded data.	Atlas.ti project map, TU Delft OneDrive	Interview quotes will be uploaded at the TU Delft repository. The interviews themselves will not be uploaded; see explanation above.
Case data	.PDF, .xlsx, .docx	Online available data, data from a graduation company, and data provided by the TU Delft.	Input for case-study analyses, answering RQ3 & 4.	TU Delft OneDrive	See above + conclusions from the case-study will be uploaded at the TU Delft repository. The case data itself will not be uploaded.
Expert panel recordings	.MP3 files	Audio recordings via phone or via Teams recording. This data contains PII data.	Collecting expert panel data, answering RQ3, 4 & MQ	TU Delft OneDrive	See above + conclusions of the expert panel will be uploaded at the TU Delft repository. The recordings itself will not be uploaded.

II. Storage and backup during the research process

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

- < 250 GB

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

- Another storage system – please explain below, including provided security measures
- TU Delft OneDrive

The data will be stored at the TU Delft OneDrive, which is accessible via the researcher's account and will not be shared with others.

PII data will be stored at Outlook webmail in the form of emails with interviewees.

Audio-recordings will be destroyed when they are transcribed.

PII and PIRD data will be stored in the Atlas.ti project map. AI functions will be turned off. This data will be destroyed after the research.

Paper-informed consent forms will be stored in a locked storage at home.

Data will not be stored at CBRE's storage. Only the data used for the research, non-personal, anonymised (PIRD), and coded data is accessible for CBRE. This is the same data published at the TU Delft's repository.

III. Data/code documentation

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

- Data – Methodology of data collection

The dataset will not be shared in a data repository, but the methodology of data collection will be explained in the MSc thesis, which is made publicly available in the TU Delft Repository.

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 applied for ethical approval from the Human Research Ethics Committee, this is approved.

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 personal data collected through the interviews may involve name, company name and function. This PII data will be anonymised into PIRD data. The PII data is not presented in the thesis manuscript. This PIRD data is used in the thesis manuscript.

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.)

- 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 audios, transcripts, and recordings of the interviews and expert panel (PII data) will remain the property of the author of this thesis, Willemijn Fanoy. It is not allowed to reuse the data. The anonymised data (PIRD) is published on the TU Delft repository.

The audio recordings will be destroyed after transcribing.

The informed consent forms assure that this interview/expert panel data will only be assessed by the author, Willemijn Fanoy, or the supervisors (Ellen van Bueren and Alexandra den Heijer) if this is necessary. The informed consent will not be part of the thesis and therefore will not be published on the TU Delft repository.

The intellectual property rights are framed by a graduation agreement between Delft University of Technology, me, and CBRE.

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

- Audio recordings
- Other types of personal data or other data from human participants – please provide details below
- Proof of consent (such as signed consent materials which contain name and signature)
- Telephone number, email addresses and/or other addresses as contact details for administrative purposes
- Names as contact details for administrative purposes
- Company name
- Function/job title

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

The participants of the interviews are involved in real estate management in flood-prone areas 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

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

All participants of the interview or the expert panel will be asked to sign the informed consent in advance of the interview or the expert panel. The informed consent will be emailed to the participants in advance so they can carefully read the information. Before the start of the interview or the expert panel, they will be asked to sign the informed consent.

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 consents will be stored at the TU Delft OneDrive. Hard copies of the informed consent are stored in a locked storage at home, scanned, and destroyed. The digital scans of the informed consents will be stored at the TU Delft OneDrive.

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.

- None of the above apply

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

- Other – please explain below
- Anonymised or aggregated data will be shared with others

Anonymised data is used in the manuscript of this thesis. At the end of the research, personal data will be destroyed.

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

- 10 years, in accordance with the TU Delft Research Data Framework Policy
- Other – please state the duration and explain the rationale below

The personal data will be destroyed at the end of the research project. The anonymised data is stored at the TU Delft OneDrive until the researcher, Willemijn Fanoy, graduates.

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.

All participants will be asked for their consent for data to be shared anonymously in the body of the MSc thesis, which is made publicly accessible in the TU Delft Repository. The personal data will not be made public. Participants who do not consent to their data being included publicly in the thesis will not be included in the research project.

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’.

- All other non-personal data/code produced in the project
- Coded data from the interviews + expert panel
- Anonymised quotes from the interviews + expert panel
- Open accessible case data

This data will be made publicly available via the TU Delft repository.

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

Select all that apply and provide additional details below.

- All anonymised or aggregated data, and/or all other non-personal data/code will be uploaded to 4TU.ResearchData with public access

30. How much of your data/code will be shared in a research data repository?

- < 100 GB

31. When will the data/code be shared?

- At the end of the research project

32. Under what licence(s) will the data/code be released?

- CC BY-NC-SA

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: Prof.dr. E.M. van Bueren

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.

35. Which faculty do you belong to?

- Faculty of Architecture and the Built Environment (ABE)

Appendix II

Informed consent

Toestemmingsformulier

U wordt uitgenodigd om deel te nemen aan een Master-onderzoek genaamd *Integrating flood risk in real estate management strategies*. Dit onderzoek wordt uitgevoerd door Willemijn Fanoy, student van de TU Delft, in samenwerking met de mastertrack Management in the Built Environment en CBRE / Turner & Townsend.

Het doel van dit onderzoek is om te onderzoeken hoe corporate en publieke organisaties overstromingsrisico's structureel op kunnen nemen in hun vastgoedstrategie. Dit is relevant gezien de toenemende impact van klimaatverandering en de kwetsbaarheid van veel Nederlandse locaties voor overstromingen. Het interview zal ongeveer 45 minuten in beslag nemen. De data zal gebruikt worden voor academische doeleinden.

U wordt gevraagd om mondeling in gesprek te gaan over de volgende thema's: overstromingsrisico management proces, asset management & fysieke maatregelen en de continuïteit van bedrijfsvoering. Uw antwoorden in dit onderzoek blijven, voor zover mogelijk, vertrouwelijk. Gegevens worden geanonimiseerd en er zal geen persoonlijk identificeerbare informatie openbaar worden gemaakt. De gegevens zullen beveiligd worden opgeslagen op versleutelde apparaten en zijn alleen toegankelijk voor de onderzoeker.

Uw deelname aan dit onderzoek is volledig vrijwillig, en u kunt zich elk moment terugtrekken zonder reden op te geven. U bent vrij om vragen niet te beantwoorden. Als u besluit zich terug te trekken, worden uw gegevens verwijderd, mits deze identificeerbaar zijn en binnen de termijn van gegevensverwerking vallen. Als u vragen of opmerkingen heeft over dit onderzoek kunt u contact opnemen met de uitvoerende onderzoeker: Willemijn Fanoy, via Of met de verantwoordelijke onderzoeker: Ellen van Bueren, via

GELIEVE DE JUISTE VAKJES AAN TE VINKEN	Ja	Nee
A: ALGEMENE TOESTEMMING – ONDERZOEKSDOELEN, DEELNEMERSTAKEN EN DEELNAME		
1. Ik heb de informatie over het onderzoek gedateerd [/ /] gelezen en begrepen, of deze is aan mij voorgelezen. Ik heb de mogelijkheid gehad om vragen te stellen over het onderzoek en mijn vragen zijn naar tevredenheid beantwoord.	<input type="checkbox"/>	<input type="checkbox"/>
2. Ik doe vrijwillig mee aan dit onderzoek, en ik begrijp dat ik kan weigeren vragen te beantwoorden en mij op elk moment kan terugtrekken uit de studie, zonder een reden op te hoeven geven.	<input type="checkbox"/>	<input type="checkbox"/>
3. Ik begrijp dat mijn deelname aan het onderzoek betekent dat ik deelneem aan een semigestructureerd interview dat wordt opgenomen, getranscribeerd en geanonimiseerd.	<input type="checkbox"/>	<input type="checkbox"/>
4. Ik begrijp dat ik geen financiële vergoeding ontvang voor deelname aan dit onderzoek.	<input type="checkbox"/>	<input type="checkbox"/>
5. Ik begrijp dat dit onderzoek zal eindigen in februari 2026 en dat hierna dit formulier wordt vernietigd of verwijderd.	<input type="checkbox"/>	<input type="checkbox"/>
B: POTENTIELE RISICO'S VAN DEELNAME (INCLUSIEF GEGEVENSBESCHERMING)		
6. Ik begrijp dat mijn deelname de volgende risico's met zich meebrengt: <ul style="list-style-type: none"> • Gevoelige informatie kan ondanks anonimiteit herleidbaar zijn. • De informatie die gedeeld wordt mogelijk informatie bevat over interne processen, beleid of strategieën. Ik begrijp dat deze risico's worden geminimaliseerd door anonimiteit en vertrouwelijkheid te waarborgen.	<input type="checkbox"/>	<input type="checkbox"/>
7. Ik begrijp dat mijn deelname betekent dat er persoonlijke identificeerbare informatie en onderzoeksdata worden verzameld, met het risico dat ik hieruit geïdentificeerd kan worden.	<input type="checkbox"/>	<input type="checkbox"/>
8. Ik begrijp dat gevoelige gegevens zullen worden geanonimiseerd en verwerkt in overeenstemming met de AVG-wetgeving.	<input type="checkbox"/>	<input type="checkbox"/>
9. Ik begrijp dat de volgende stappen worden ondernomen om het risico van een databreuk te minimaliseren, en dat mijn identiteit op de volgende manieren wordt beschermd in het geval van een databreuk veilige gegevensopslag, beperkte toegang tot ruwe gegevens, en volledige anonimiseren vóór publicatie.	<input type="checkbox"/>	<input type="checkbox"/>
10. Ik begrijp dat de persoonlijke informatie die over mij verzameld wordt en mij kan identificeren, zoals: naam, niet gedeeld worden buiten het studieteam.	<input type="checkbox"/>	<input type="checkbox"/>
11. Ik begrijp dat de persoonlijke data die over mij verzameld wordt, vernietigd wordt binnen 1 jaar na de publicatie van het onderzoek.	<input type="checkbox"/>	<input type="checkbox"/>
C: PUBLICATIE, VERSPREIDING EN TOEPASSING VAN HET ONDERZOEK		
12. Ik begrijp dat na het onderzoek de geanonimiseerde informatie gebruikt zal worden voor academische publicaties, presentaties en rapporten die verband houden met het onderzoek.	<input type="checkbox"/>	<input type="checkbox"/>
13. Ik geef toestemming dat mijn antwoorden, meningen of input anoniem mogen worden geciteerd in onderzoeksresultaten.	<input type="checkbox"/>	<input type="checkbox"/>
D: (LANGDURIGE) OPSLAG, TOEGANG EN HERGEBRUIK VAN GEGEVENS		
14. Ik geef toestemming dat de geanonimiseerde gegevens die ik verstrek, worden geplubliceerd in de repository van de TU Delft voor toekomstig onderzoek en educatieve doeleinden.	<input type="checkbox"/>	<input type="checkbox"/>
15. Ik begrijp dat de toegang tot deze repository open is.	<input type="checkbox"/>	<input type="checkbox"/>

Handtekeningen

Naam deelnemer

Handtekening

Datum

Ik, **de onderzoeker**, verklaar dat ik de informatie en het instemmingsformulier correct aan de potentiële deelnemer heb voorgelezen en, naar het beste van mijn vermogen, heb verzekerd dat de deelnemer begrijpt waar hij/zij vrijwillig mee instemt.

Naam onderzoeker

Handtekening

Datum

Contactgegevens van de onderzoeker voor verdere informatie:
Willemijn Fanoy

Appendix III

Exploratory interview protocol

Exploratory interview protocol (Dutch)

Afstudeerder (student): **Willemijn Fanoy**

Begeleiding vanuit:

Technische Universiteit Delft: Prof.dr. E.M. (Ellen) van Bueren
& Prof.dr. A.C. (Alexandra) den Heijer

CBRE: C. (Cazimir) Boon

Agenda	Categorie	Vraag
Introductie (10 min)	Kennismaking	<ul style="list-style-type: none">• Doel onderzoek: <i>Inzichtelijk krijgen hoe eigenaar-gebruikers overstromingsrisico's kunnen integreren in een real estate management strategie.</i>• Structuur van onderzoek: 3 thema's, ongestructureerd• Informed consent + toestemming opname
Onderzoek (30 min)	Thema 1: Overstromingsrisico management proces	
	Thema 2: Asset management & fysieke maatregelen	
	Thema 3: Continuïteit van bedrijfsvoering	
Afsluiting (5 min)	Afronding	<ul style="list-style-type: none">• Ruimte voor vragen of suggesties

Appendix IV

In-depth interview protocol

In-depth interview protocol (Dutch)

Afstudeerder (student): **Willemijn Fanoy**

Begeleiding vanuit:

Technische Universiteit Delft: Prof.dr. E.M. (Ellen) van Bueren
& Prof.dr. A.C. (Alexandra) den Heijer

CBRE: C. (Cazimir) Boon

Agenda	
Introductie (5 min)	<ul style="list-style-type: none">• Bedanken• Doel onderzoek: <i>Inzichtelijk krijgen hoe eigenaar-gebruikers overstromingsrisico's kunnen integreren in een real estate management strategie.</i>• Structuur van onderzoek: 3 thema's• Informed consent + toestemming opname• Duur: +/- 60 min
	<ul style="list-style-type: none">• Kunt u iets over uzelf vertellen? Wat is uw functie?
Thema 1: Flood risk management process strategisch niveau	
	+/- 15 min
Doel: Inzicht krijgen in strategische bewustwording, beoordeling en besluitvorming rond overstromingsrisico's.	
<ul style="list-style-type: none">• Is uw organisatie zich bewust van overstromingsrisico's?• <i>Waarom wel/niet?</i>	
<i>Identificatie</i> <ul style="list-style-type: none">• Hoe worden deze risico's (klimatrisico's) in kaart gebracht?• Zou dit ook gedaan kunnen worden voor overstromingsrisico's?• Gebeurt dit structureel of ad hoc?	
<i>Assessment</i> <ul style="list-style-type: none">• Worden er tools of methoden gebruikt voor risicobeoordeling?• Hoe worden overstromingsrisico's afgewogen tegenover andere risico's?	
<i>Management</i> <ul style="list-style-type: none">• Worden deze overstromingsrisico's meegenomen in vastgoedstrategie of vastgoedbeslissingen?• Welke stakeholders zijn betrokken bij deze strategische afwegingen?	

Thema 2: Asset management & fysieke maatregelen asset niveau	+/- 15 min
Doel: Begrijpen hoe fysieke risico's worden ingeschat en welke maatregelen worden genomen op gebouwniveau.	
<ul style="list-style-type: none"> • Is uw organisatie zich bewust van de fysieke gevolgen van een overstroming op gebouwen? • Waarom niet? • Worden er richtlijnen of standaarden gevolgd om de gevolgen van overstromingsrisico's (klimaatarisico's) te beperken of in te schatten (bouwbesluit of eigen beleid)? • Hoe groot acht u de impact van een overstroming op primaire functies in het gebouw? • Welke maatregelen zijn genomen om schade te beperken? • Welke maatregelen zouden genomen kunnen worden om de schade te beperken? • Wat is hiervoor nodig qua middelen, kennis of samenwerking? 	
Thema 3: Business operational continuity operationeel niveau	+/- 15 min
Doel: Inzicht krijgen in de impact van overstroming op bedrijfsvoering en continuïteit.	
<ul style="list-style-type: none"> • Is uw organisatie zich bewust van de impact van overstromingsrisico's op bedrijfsvoering? • Wat zou de impact kunnen zijn op primaire processen? • Is uw organisatie zich bewust van de kosten die hierbij komen kijken? • Beschikt uw organisatie over een plan om primaire processen te laten doorgaan bij een overstroming? • Noodplan of business continuity plan? • Hoe zorgt uw organisatie voor veiligheid van medewerkers en voortzetting van werk indien een overstroming? • Welke lessen zijn geleerd uit eerdere crises (zoals COVID-19, extreme weersomstandigheden: zoals hitte of storm)? • Zijn deze lessen vertaald naar beleid of protocollen? 	
Afsluiting	
<ul style="list-style-type: none"> • Heeft u suggesties, opmerkingen of aanmerkingen? • Bedanken 	

Appendix V

Expert validation protocol

Expert validation protocol (Dutch)

Afstudeerder (student): **Willemijn Fanoy**

Begeleiding vanuit:

Technische Universiteit Delft: Prof.dr. E.M. (Ellen) van Bueren
& Prof.dr. A.C. (Alexandra) den Heijer

CBRE: C. (Cazimir) Boon

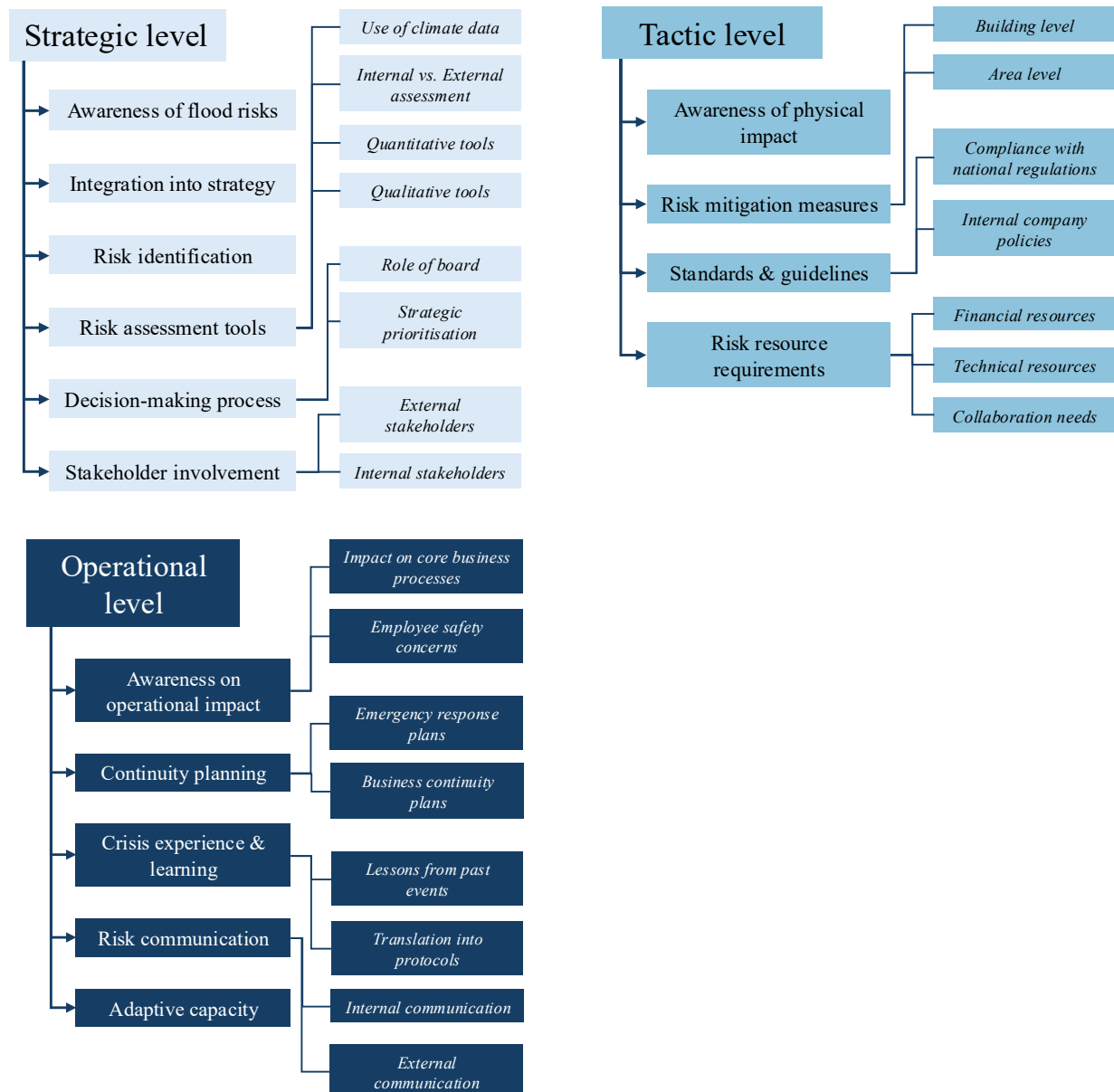
Agenda	
Introductie (5 min)	<ul style="list-style-type: none">• Bedanken• Doel onderzoek: <i>Inzichtelijk krijgen hoe eigenaar-gebruikers overstromingsrisico's kunnen integreren in een real estate management strategie.</i>• Doel van validatie: <i>Erachter te komen of deze roadmap logisch, uitvoerbaar, en herkenbaar is en waar eventuele verbetering zitten.</i>• Informed consent + toestemming opname• Duur: +/- 30 min
Validatie roadmap	+/- 25 min
<ul style="list-style-type: none">• Doorlopen roadmap + guide• Is de structuur van de roadmap logisch en herkenbaar?• Zijn de deliverables per fase duidelijk en uitvoerbaar?• Mist er belangrijke informatie of acties?• Zou u deze roadmap in uw organisatie kunnen implementeren?• Waar zit uw organisatie nu in de roadmap?	

Appendix VI

Codebook

The literature study presented three levels: strategic, tactical, and operational level. The exploratory interviews were based on these themes and they form the basis of the in-depth interviews, which resulted in a coding structure. The themes link codes. Codes are used to analyse the in-depth interview.

Deductive codes



Inductive codes

- Responsibilities
- Lack of integration

Appendix VII

Quotes TU Delft | strategic

Interviewee	Quote	Code
I1	Dus vanuit die hoek zijn we vanuit programma duurzaamheid bezig om de campus aan te passen aan klimaatverandering en dus ook om de campus voor te bereiden op heviger piekbuien en overlast van hemelwater.	Awareness of flood risks (identification)
I1	Maar dat betekent dus niet dat het op dit moment al. Dat er wat brede bewustwording over is bij de hele organisatie.	Awareness of flood risks (identification)
I2	Daar zijn we mee bezig. Ja, dat gaat tijd kosten.	Awareness of flood risks (identification), resource requirement: collaboration needs
I3	Oh, van die bui? Nee, je bent zeer bewust. Alleen de dijkdoorbraken niet.	Awareness of flood risks (identification)
I4	Dus eigenlijk op strategisch niveau aan de voorkant. Is het niet helemaal of niet meegenomen en die bewustwording die begint wel te komen.	Awareness of flood risks (identification)
I4	En daar is, zeg maar waterretentie wel een issue. Maar ook van eigenlijk meer ingegeven vanuit de eisen vanuit de gemeente dan dat strategisch. Bedacht is van de voorkant.	Awareness of flood risks (identification)
I5	Ja, ja, dat zijn we zeker helaas ook door ervaring, maar dat is zeker het punt van aandacht.	Awareness of flood risks (identification)
I1	De gemeente Delft die hebben ook een eigen klimaatadaptatie strategie, dus die hebben verschillende stresstesten gedaan aan de hand van modellen aan de hand van bepaalde van piekbuien hebben ze gekeken waar, wat zijn nou plekken binnen de gemeente Delft, ook op de campus waar eventueel overlast kan ontstaan als gevolg van piekbuien dus 70 mm in een uur.	Risk assessment tool: qualitative tools, use of climate data. Standards & guidelines: Compliance with national regulations
I3	Door de hydraulische berekeningen. Nou wij maken hydraulische berekeningen of laten we maken dan hè? Door een adviesbureau als Haskoning.	Risk assessment tool: internal vs. External, Quantitative tools
I1	Tegelijkertijd proberen we ook zoveel mogelijk gewoon te kijken wat er gebeurt als het een keertje wel heel hard regent. Waar loopt het water naartoe?	Risk assessment tools: Qualitative tools
I5	We doen dat vanuit een risicoanalyse dat we eigenlijk maatgevende scenario's hebben en overstroming of wateroverlast zijn, ... maar die worden continu over de primaire processen heen gelegd om te kijken, wat zijn dan de risico's? En dat wordt eigenlijk op faculteits- en gebouw niveau gedaan en uiteindelijk op campus niveau wordt dat tot een tot 1 risicodossier gevormd.	Risk assessment tools
I5	Een Tripod Beta analyse.	Risk assessment tools: Qualitative tools
I2	Het zit nog een beetje op strategisch tactisch, hè? Want we hebben het beleid gemaakt en nou zijn we dat aan het implementeren.	Integration into strategy
I4	Dus op strategisch niveau wordt niet gezegd: Nou, We willen een kans op overstroming van daar wordt niet over nagedacht.	Integration into strategy
I3	Dus daar hoort bij dat je één keer in de 4 jaar een beleidsplan/ beheerplan maakt waar je de boel weer laat doorlichten.	Integration into strategy
I1	Dat zijn ontwerpprincipes, dus het zijn geen maatregelvoorschriften, dus we willen wel de aan de ontwerper de vrijheid laten dus de manier waarop dit oplost.	Integration into strategy, Standards & Guidelines: Internal policies
I1	De gemeente heeft een vastgesteld beleid. En daarmee verplicht heeft gesteld bij de aanvraag van een omgevingsvergunning.	Integration into strategy
I5	Nee, nee, ik weet zeker dat de principes niet overal even goed worden toegepast. Dat is er niet.	Awareness of flood risks (identification), Integration into strategy
I5	Ja, er zit een soort afwegingskader in een zet is dat beleidsmatig. Waarin we zeggen, hè? De veiligheid van de mens en dan die er dan milieu en dan assets, hè? Met de in die volgorde zit dat in nou overstroming kan toch iets met veiligheid van mensen of dieren doen?	Integration into strategy, Strategic prioritisation of risks

I2	Nou ja de truc voor ons al altijd om de organisatie hier zo goed mogelijk te adviseren	Decision-making process: Role of board
I3	Het is al geregeld, dus dan heeft het bestuurlijk ook niet zoveel interesse.	Decision-making process: Role of board, Strategic prioritisation of risks
I4	Dat moet opgelost worden, dus dat is meer een technische invulling. En dan is hij op bestuurlijk niveau komt hij niet meer op het A4'tje voor.	Decision-making process: Role of board
I3	Wij natuurlijk... En de rijksdienst van CRE die die die keurt goed. En gemeente, waterschap.	Stakeholder involvement
I2	maar ook assetmanagers... Maar ook een gebruiker.	Stakeholder involvement

Quotes TU Delft | Tactic

Interviewee	Quote	Code
I1	Ik denk dat bewustzijn, wel met name bij onze beheerders zit, zeg maar die weten gewoon als ik het een keertje ergens mis ga wat er nou wat gevolgen daarvan zijn.	Awareness of physical impact
I1	We hebben het wel eens meegemaakt dat er dat de boel is overstroomd tijdens een hevige regenbui, ... dan krijg je gewoon schade en gedoe.	Awareness of physical impact
I3	Ja.... We hebben geen ondergrondse gebouwen, dat is alleen een kelder. Heb je vaak nou? Dat is, daar staan dus geen cruciale installaties.... als je er last van hebt, dan stroomt het via een raam of een lekje in de muur naar de kelder van het gebouw.	Awareness of physical impact
I5	Dat zit nog wel bij een selectief groepje. Ja, dat klopt. Ja ja.	Awareness of physical impact
I2	Als het moet ergens een ingreep doen. Maar het liefst als we een gebouw gaan renoveren, pakken we dat allemaal in één keer om financiën beter te besteden.... Dus zo ga je niet afzonderlijk ergens een drempel verhogen of dat gebeurt eigenlijk bijna niet.	Risk mitigation measures: building level
I5	Ja dus boven het maaiveld serverruimtes op een verhoging zetten, hè? Dus als er dan een lekkage is dat die dan gewoon x centimeter hoger staat. Kijken naar leidingen dat die dan niet over kritische apparatuur heen lopen.	Risk mitigation measures: building level
I5	En een detectiesysteem dat is wat we ook veel in de gebouwen hebben, gewoon echt waterdetectie dus als hè, ook als dat is dan wel de laatste maatregel die je neemt.	Risk mitigation measures: building level
I5	Dus met elkaar maken we die analyse en ook de kansanafweging van. Hoe kan dit gebeuren? In gebouw en op een gegeven moment ook specifieker, hè?	Risk mitigation measures: area level, Awareness of physical impact, Decision-making: Strategic prioritisation of risks
I1	We doen heel veel eigenlijk in de buitenruimte als het gaat om ja, deze maatregelen.	Risk mitigation measures: area level
I2	Het zijn panden uit de jaren 60, 70, dus die hebben allemaal aandacht nodig. Met krimpende budget momenteel moet je heel veel moeilijke keuzes maken.... Het speelt nu ook wel een gebouw dat weet je, je kan het ook niet gewoon vandaag of morgen oplossen en dat het dan doorsukkelt en dat is vaak prima.	Risk mitigation measures: area level
I3	En eerste wat we hebben gedaan voor 20 miljoen aanleggen van leidingen en wadi's de afgelopen jaren, want de kelder van IO liep onder met hevige buien. Dus in Zuid zorg je dat je deze buien in één keer kunt opvangen in de sloten, maar bij bestaande bouw kan dat helemaal niet.	Risk mitigation measures: area level
I3	En daarmee is de communicatie met gebouweigenaren, dus meneer van het gebouw weer belangrijk. Een kelder moet waterdicht zijn. En de kruipruimte moet je geen spullen in opslaan.	Risk mitigation measures: building level, Risk communication Internal communication strategies
I5	Dus ja op gebiedsniveau wordt er zeker wel rekening mee gehouden.	Risk mitigation measures: area level
I3	En zo gauw als je nieuwbouwt, zo zou je het ben je verplicht, anders krijg je niet eens een vergunning, maar voor bestaande wijken geldt dat niet. Is dat geen verplichting, maar die hebben we wel gewoon onszelf opgelegd.	Standards & Guidelines: national regulations, Internal company policies
I5	Er is de TU Delft werkt met een handboek. Daar staan heel veel richtlijnen in en daar staan dus ook een aantal richtlijnen in dat deze kritische assets mogen niet meer onder het maaiveld. Sterker nog, die moeten verhoogd staan, dus er staan allerlei criteria en die bij nieuwbouw of verbouw nu eigenlijk de richtlijn geven om daar rekening mee te houden.	Risk mitigation measures: building level, Standards & Guidelines: internal communication strategies

Quotes TU Delft | operational

Interviewee	Quote	Code
I2	Omdat we weten dat we een aantal kwetsbare functies hebben waar je voor wil zijn dat daar iets mee gebeurt, toch?	Awareness of operational impact: Impact on core business processes
I2	Ja onderzoek dat lange tijd stilvalt en dat dingen dusdanig stuk zijn dat we ze moeten repareren of laten repareren. Onderwijs tijdelijk niet door kan gaan. En in het ergste geval ook nog brand of instorting.	Awareness of operational impact: Impact on core business processes, Employee safety
I1	Ik denk dat we nog niet zover hebben doorgedacht dat we in kaart hebben gebracht wat voor impact het heeft op de bedrijfsvoering.	Awareness of operational impact: Impact on core business processes
I2	Ja, dus ik denk dat het ook deels mee te maken heeft dat het wat versnipperd zit. En een standpunt innemen als organisatie over wat moet er dan minimaal doorgang in vinden als dit aan de hand is? Dat hebben we eigenlijk ook niet.	Awareness of operational impact: Impact on core business processes, Continuity planning: Business continuity plans
I3	Nee nee er wordt geen rekening gehouden met bedrijfsvoering.	Awareness of operational impact: Impact on core business processes
I5	Ja, ja dus dat krijgt wel zijn aandacht en heeft ook wel geleid tot paragraaf in handboeken, hè?	Awareness of operational impact: Impact on core business processes
I5	Voor de panden waar ik voor verantwoordelijk ben, heb ik op een gegeven moment ook gewoon een kader vastgesteld om te bepalen, want anders wordt het elke keer zo'n willekeur. Maar we hebben gewoon gezegd, ja, dit zijn kaders om te zeggen, wat is kritische apparatuur of kritische infrastructuur?	Awareness of operational impact: Impact on core business processes
I4	Het risico is eerder dat je een verstoring krijgt van je primaire proces. En niet dat die installatie. En dan dat gaat dan niet meer. Ja, dat wordt verstoord.	Awareness of operational impact: Impact on core business processes
I4	Ja dan dramatisch. Nee, dat dat is echt dramatisch, zeker bij langdurig onderzoek. De schade zit in verlies van data continuïteit.	Awareness of operational impact: Impact on core business processes
I1	WF: Is er iets van een plan om deze primaire processen wel door te laten gaan bij een overstroming? I1: Zover, is het beleid nog niet. Nee.	Continuity planning: Business continuity plans
I2	WF: Hoe zorgt de organisatie voor veiligheid van werknemers en voortzetting van werk tijdens overstromingen? I2: Ja, ik denk dat we op dat niveau nog moeten bouwen.	Continuity planning: Emergency response plans, Integration into strategy
I3	Dan komen we ook de nooddiensten in actie.... Dus die weten welke pompjes aan moeten om de boel zoveel mogelijk droog te houden.	Continuity planning: Emergency response plans, Risk mitigation measures: Building level
I2	We zijn heel erg druk met hybride werking.	Adaptive capacity: Remote working or relocation strategies, Crisis experience & learning: Lessons from past events
I2	Maar zelf denk ik dat het CVB zegt het CREFM, die hebben dat wel in de smiezen. Ik wil me daar niet teveel mee bemoeien. Denk ik hoor.	Responsibilities
I2	Ik denk dat hij ook deels buiten onze dienst niet om daarmee te zeggen dat we er niet van zijn, Maar dat hij bij HSE (Health Safety and Environment) zit.	Responsibilities
I2	Ik denk dat het samenwerken moet zijn, want wij zijn natuurlijk van de fysieke kant van de campus. Maar HSE moeten ook gewoon zorgen voor. Nou ja de veilige doorgang van de bedrijfsvoering.	Risk communication: internal communication strategies, Responsibilities
I5	En dat zijn 5/6 afdelingen verspreid tussen allerlei diensten op de campus dus en één daarvan heet integrale veiligheid. Maar die is niet voor de volledige integrale veiligheid verantwoordelijk dat de naam wel zou zeggen.	Awareness of operational impact: Employee safety, Lack of integration

Appendix IIX

Quotes ING | strategic

Interviewee	Quote	Code
I6	Nou het wordt het kortste antwoord ooit: Nee. Nee klinkt heel bruto, maar dan vond ik jouw onderzoeksvraag ook wel interessant, want nou wel of niet, Maar dat heeft op geen enkele manier tot op heden ooit gespeeld.	Awareness of flood risks
I6	Maar we hebben nooit hele grote, ernstige incidenten gehad, want dat is vaak wel de aanleiding om die bewustwording natuurlijk op te piepen. En ja, dan is vaak te laat, hè?	Awareness of flood risks, crisis experience & learning: Lessons from past events
I6	Je hebt me echt wel getriggerd.	Awareness of flood risks
I7	Ik kan wel even op mezelf spreken en dan denk ik in algemeenheid dat hij een ware dus beter kan... We realiseren ons deze dingen pas sinds een paar jaar. Daarvoor is het nooit een issue geweest en nu begint het wel te komen.	Awareness of flood risks
I7	Het belangrijkste is al gedaan, dat het bij mij getriggerd is.	Awareness of flood risks
I7	En waar we ons onvoldoende aware zijn dat het echt probleem is. Niemand realiseert zich op dit moment nog dat het echt fout kan gaan met dit soort zaken.	Awareness of flood risks
I8	Ik denk dat het toch wel afgelopen jaren ook wel opgekomen is, hè?	Awareness of flood risks
I9	Ik denk dat de urgentie dan niet groot genoeg is.	Awareness of flood risks
I6	Zonnestudies eno en zoninstraling en warmte berekeningen. Daar wordt ook naar gekeken, maar naar de extremen dan weer niet, hè?	Risk assessment tools: use of climate data, Risk identification
I6	Dus vandaar dat je hè je nu bewust en dan moet je gaan onderzoeken van hoe groot is een risico en welke incidenten kunnen zich voordoen?	Risk identification
I7	Het is niet dat we niks doen. Kijk, we denken erover na. Het wordt besproken ... Maar ik moet eerlijk zijn, dat ik niet durf te zeggen: het wordt gedaan. We bekijken het vanuit alle kanten, maar als je nou het vraagt aan mij, laat het protocol zien waarin het precies staat dan, dan wordt het akelig stil.	Risk assessment tools: qualitative tools
I8	En daarvoor maken we gebruik van BREEAM.... Dus daarop hebben we analyses per pand.	Risk assessment tools: Use of climate data, Standards & Guidelines: Internal company standards
I8	Nou dus in ieder geval die waardering nemen we dan mee, dus dit is voor ons eigenlijk een nieuwe methodiek die we nu hanteren. En daar gaan we de komende jaren gewoon mee verder bouwen, dus nu is het nog gewoon ja, gewoon constateren per asset, hè? Hoe we scoren als het ware?	Risk assessment tools
I6	Dus die zie je wel meegewogen worden, maar overstromingsrisico en geen idee, echt gewoon nooit naar gekeken. Dus wat dat betreft is het wel interessant, want dat zou je ook zeker wel mee kunnen nemen.	Integration into strategy
I6	Het ideaalbeeld zou zijn in je strategie als je gaat herhuisvesten meenemen en dan de goede positie kiezen waar je minder risico loopt. Maar wat nou voor bestaande locaties? En daar hebben wij natuurlijk mee te maken.	Integration into strategy
I7	Dan moet ik ook eerlijk zeggen dat rijtje zit met name in mijn hoofd, omdat ik dit al 30 jaar doe.	Integration into strategy
I9	We hebben in ons programma. ... hadden we 'Nature' ook centraal staan en toen hadden we ook als één van de target punten dat we alle locaties zouden onderzoeken ten aanzien van overstromingsgevaar.	Integration into strategy, Risk assessment
I8	We doen er nu nog niks mee in dat we zeggen van we gaan panden nu verlaten of andere keuze maken. Maar ik kan me heel goed voorstellen dat we het in de toekomst gaan gebruiken.	Integration into strategy
I9	Ik denk dat heel goed zou zijn als je met dat soort handvatten zou komen. Dat zou denk ik wel het keuzeproces nog beter maken, ja.	Integration into strategy
I9	Nee, nee wordt nu nog helemaal niet meegenomen. Als belangrijk risico kijken veel meer naar. Ja, wat zijn de risico's? Veiligheid?... Maar nee, de overstroming wordt niet echt als een risico tot nu hoog risico geschat?	Decision-making process: Strategic prioritisation of risks

Quotes ING | Tactic

Interviewee	Quote	Code
I6	Van onbewust onbekwaam, misschien nu naar bewust onbekwaam wel even kijken van ja jongens. Stel nou dat inderdaad de kelder en de eerste verdieping onderloopt, hè? Welke elektrische installaties worden er geraakt? En dan hebben we wel noodzaam aggregaten, maar als de boel is uitgevallen beneden, dan gebeurt er ook niks. Of gaat het dan goed?	Awareness of physical impact
I7	In hun gebouw werken 100 of 1000 van mijn collega's die helemaal afweten van hypotheek en verzekering, maar niet van de gevolgen van een overstroming, hè, dus dan, dat zou ik niet durven te beweren.	Awareness of physical impact
I8	Jazeker, we hebben natuurlijk wel ervaring, ook wel in Amsterdam. In andere panden hoor dat ook wel eens een keer wateroverlast hebben gehad, hè? Dat is vervelend natuurlijk, maar het komt heel beperkt voor.	Awareness of physical impact, Crisis experience & learning: lessons from past events
I6	Nou en afhankelijk van die risico's en naar welke mitigerende maatregelen kunnen we dan nemen?	Risk mitigation measures
I7	Dat is onze technische man die veel bij de nieuwbouw betrokken is of daar ook echt naar gekeken wordt dat kritische installaties. Op een verhoging, hè? Of op een locatie worden gesitueerd waar ze er minder last van hebben en dus niet in de kelder.	Risk mitigation measures: building level
I7	Dus ja, als ik me niet vergis, is de grootste verkeerde voorbeeld daarvan. Wel een plan dat als er een enorme overstroming kwam dan hadden ze daar wel een heel netwerk liggen, om dat water zo snel mogelijk weg te pompen en dat waar en dat dat hele systeem, maar die zaten in de kelder en werkten dus niet meer.	Risk mitigation measures: building level, Crisis experience & learning: lessons from past events
I8	We kijken zelf ook wel naar een waterretentie wat je kunt doen om meer water op te vangen, hè? Dus we gaan kijken van wat kan je doen?	Risk mitigation measures: Area level
I9	We zijn niet bezig om maatregelen te treffen, zodat overstromingen minder kansen slagen hebben, toch?	Risk mitigation measures: building level
I9	Nee, ik denk niet dat we veel maatregelen treffen op het gebied van overstromingen. In ieder geval op dit moment om het te voorkomen. Nee.	Risk mitigation measures: Area level

Quotes ING | Operational

Interviewee	Quote	Code
I6	Ik denk meer aan een overstroming waarin echt serieus het probleem in het gebouw zijn, ontstaan ze op de begane grond. Eerste verdieping, misschien zelfs. Ja dan gaan er toch, denk ik een aantal stroomvoorzieningen gewoon zeggen, klaar ermee. En dan gaat het uit en dan kan je wel noodstroom hebben, maar en dan, als je dan gaat uitwijken naar een andere locatie	Adaptive capacity: Remote working or relocation strategies, Awareness of operational impact: impact on core business processes, Awareness of physical impact. Continuity planning: emergency response plans
I6	Ja, daar heb ik natuurlijk eigenlijk ook al gezegd, in principe niet, hè? En daarom triggert mij deze vraag wel voor met name het gebouw wat we nu hier achter ons aan het bouwen zijn, Linden. Omdat daar dus wel een kritiek proces in terecht komt en je inderdaad zou moeten aanvragen. Stel nou, we hebben zo een regenval en de kelder en de begane grond komt onder water te staan. Het gebouw kan je eigenlijk niet meer fatsoenlijk in. Wat dan? En nogmaals voor een gewoon kantoorgebouw gaan we gewoon tegen iedereen zeggen. Jij werkt thuis... maar voor dat proces...	Awareness of operational impact: Impact on core business processes
I7	Ik denk dat wij ons iets meer focussen dan op het gevolg van die overstroming, namelijk bijvoorbeeld de stroom valt uit. En, ik denk dat ING toch behoorlijk goed weet, want dat brengt onze dienstverlening in gevaar.	Awareness of operational impact: Impact on core business processes, awareness of physical impact
I7	Ja, ik denk toch beperkt op bedrijfsproces.	Awareness of operational impact: Impact on core business processes
I7	Ik denk in algemeenheid dat ING behoorlijk goed kijkt naar what if, want onze dienstverlening moet altijd overeind blijven	Awareness of operational impact: Impact on core business processes
I9	Dus we kunnen ING, houdt het hoofd boven water, zeg maar. Ondanks dat panden niet bereikbaar zijn, dus als er een overstroming is.	Awareness of operations: Impact on core business processes, Crisis experience & learning: Lessons from past events
I6	En nog over de dealing room. Nou het is wel, nog steeds heel erg cruciaal zijn en eigenlijk nog meer gedigitaliseerd dan vroeger. Dus ja, als daar wat mee gebeurd door middel van een overstroming. En, we hebben allerlei noodvoorzieningen zoals noodaggregaten en ik weet het allemaal niet.	Awareness of operational impact: Impact on core business processes
I9	Dan heeft ING altijd de uitweg om allemaal thuis te gaan werken.	Adaptive capacity: Remote working or relocation strategies
I9	En, we hebben een uitwijk voor de dealing room, toch?	Adaptive capacity: Remote working or relocation strategies
I6	Helemaal, we praten over schade en processen, maar de ergste wat je kan gebeuren is natuurlijk dat er mensen bij omkomen die en dat die ook nog cruciaal zijn in je bedrijfsproces.	Awareness of flood risks: employee safety concern
I6	Gaat de impact zijn dat we mogelijk moeten gaan uitwijken naar andere, hè? Dat we in een noodscenario terechtkomen. Een uitwijking naar een andere locatie, maar die zijn altijd suboptimaal. Voor de ja meer kantoorfuncties is gewoon een huis, is gewoon wegwezen.	Adaptive capacity: flexibility in operations, Adaptive capacity: Remote working or relocation strategies, Awareness of operational impact: Impact on core business processes
I9	En sommige activiteiten daar hebben we dan een uitwijk voor, dus we hebben voor alle panden in ieder geval en voor alle belangrijke business die dus niet zomaar naar huis kan. Hebben we die plannen liggen? Ja.	Continuity planning: Business continuity plans
I8	Business continuity plan per locatie.	Continuity planning: Business continuity plans

Appendix IX

Quotes RVB | Strategic

Interviewee	Quote	Code
I10	Maar dus vraag een ja dat die bewustwording is er en we snappen dat er wat mee moeten en dat je dus je vastgoed daarop moet, ja, op moet laten anticiperen.	Awareness of flood risks
I10	Maar omdat het bij ons nog niet zover is, schuiven we het nog voor de time being voor ons uit. En dat zie je natuurlijk heel vaak dat je wel ergens al bewust van wordt. Maar dat het reageren eigenlijk pas gebeurt als we net op het randje zitten van dat het te laat is of net al te laat.	Awareness of flood risks, Integration into strategy
I11	Ik denk dat we dat veel mensen zich daar wel bewust van zijn, maar dat de urgentie nog niet voldoende gevoeld wordt.	Awareness of flood risks
I11	We hebben wel best wel wat adviseurs ook rondlopen dus gewoon technische experts op het gebied van klimaatadaptatie of water. Die weten dit natuurlijk. Er zijn mensen die projecten hebben gedaan waar sprake was van overstroming. Nou, die weten het ook, maar als je er nog niet zoveel mee te maken hebt gehad dan is het nog wel een ver van je bed show.	Awareness of flood risks
I11	Dat is één van de manieren om die bewustwording te vergroten, want ten eerste ga je daarmee echt over in dialoog? Zo'n risicodialoog dat helpt heel erg. Wat ook helpt is dat we daar daarmee de opgave in kleinere stukjes opknippen namelijk niet je hele portefeuille heeft last van overstromingsrisico's, maar hè?	Awareness of flood risks
I12	Ja of tenminste, het is de bewust van dat we dat die bewustwording moeten krijgen, dus.	Awareness of flood risks
I12	We zijn nu bezig met in kaart brengen wat er allemaal. Welke van onze panden allemaal in overstromingsgebied liggen en op sommige portefeuilles dat wel heel duidelijk, aangezien het dan een hele portefeuille zijn met hele belangrijke primaire taken.	Risk identification, Risk assessment
I11	Ik heb een onderzoek weggezet bij een adviesbureau om eigenlijk veel beter de, want we hebben wel de klimaatrisico's in beeld, hè? Maar we gaan ze nu dan ook echt koppelen aan de functie die er op die plek zit.	Awareness of flood risks, Risk assessment tools: internal vs. External, Awareness of operational impact: Impact on core business processes
I10	We hebben ook een soort tool ontwikkeld. Als ik dan ergens een gebouw ga bouwen, hoe kan ik daar dan rekening mee houden? En wat voor maatregelen kan ik dan nemen?	Risk assessment tools: Quantitative tools
I11	Ja met de klimaateffectenatlassen. Dat is eigenlijk hetzelfde framework wat de Dutch Green Building Council ook gebruikt, dus dat is gewoon sectorbreed. Zo wordt het in kaart gebracht.	Risk assessment tools: Use of climate data
I12	En van andere portefeuilles is dat nog niet goed in kaart gebracht en er lopen nu onderzoeken om het portefeuille breed. Gewoon alle portefeuilles in kaart te brengen, en dat doen ze dan middels de openbare kaarten en de klimaateffectenatlas. Dat is de Dutch Green Building Council framework for climate adaptive building wordt aangehouden.	Risk assessment tools: Quantitative tools, Risk assessment tools: Use of climate data
I12	Bij transacties en projecten dus als ik een project ga doen, dan voer ik zelf een klimaatrisico's scan uit. Kan het dat die op kunnen treden? WF: Wat maakt het dat het bij bepaalde dingen wel wordt gedaan bij anderen niet? I12: Ja goeie vraag dat weet ik eigenlijk niet	Risk assessment tools: Quantitative tools
I11	Je moet niet als een project start die risico's in beeld hebben. Dit moeten we gewoon op de plank hebben liggen, waardoor je dus veel beter beeld hebt van welke plekken echt veel risico lopen, waardoor je wellicht je projecten programmering ook zou moeten aanpassen dus.	Integration into strategy, Risk assessment tools
I11	Trek de strategie eens bij klimaatadaptatie of bij thema's die niet zoveel bekend die niet zo bekend zijn nog en die niet zoveel aandacht krijgen, is de strategie. Hoe kun je een goed meeliften op thema's die wel belangrijk gevonden worden?	Integration into strategy, Awareness of flood risks
I10	De afdeling Strategie, zijn ze daar de trekker van en bedenken allerlei strategische doelen waar we als Rijksvastgoedbedrijf naartoe willen bewegen en deels van die doelen, gaan ook over duurzaamheid en dus ook over klimaatadaptatie. En zij zijn dus gestart met ook beleid rondom klimaatadaptatie.	Integration into strategy
I10	Joh ja jullie hebben de bewustwording gecreëerd. Hartstikke goed, maar hoe kun je nu een stap verder gaan?	Awareness of flood risks, Lack of integration, Integration into strategy

I10	Ja, ik mis het wel een beetje omdat het nu alleen de wake up call is, maar ik vervolgens geen tools in handen heb. Ja wel, per gebouw hè? Maar niet voor je portefeuille.	Awareness of flood risks, Lack of integration, Risk mitigation measures
I11	Overstromingsrisico's worden onvoldoende meegenomen in vastgoedbeslissingen. Bij locatiekeuzes speelt het bijna geen rol. Maar bij als wij nieuwbouw project dan zitten, dan zit het er wel goed in, want dan moet het gewoon aan allerlei eisen voldoen zodat het bestand is tegen die overstromingsrisico's.	Integration into strategy, Integration into strategy
I12	Ik weet niet of dat wordt meegenomen in locatiekeuze. Ik weet wel dat als dat wel wordt meegenomen, dan wordt dat meegenomen als een scala aan.	Decision-making process: Strategic prioritisation of risks, Integration into strategy

Quotes RVB | Tactic

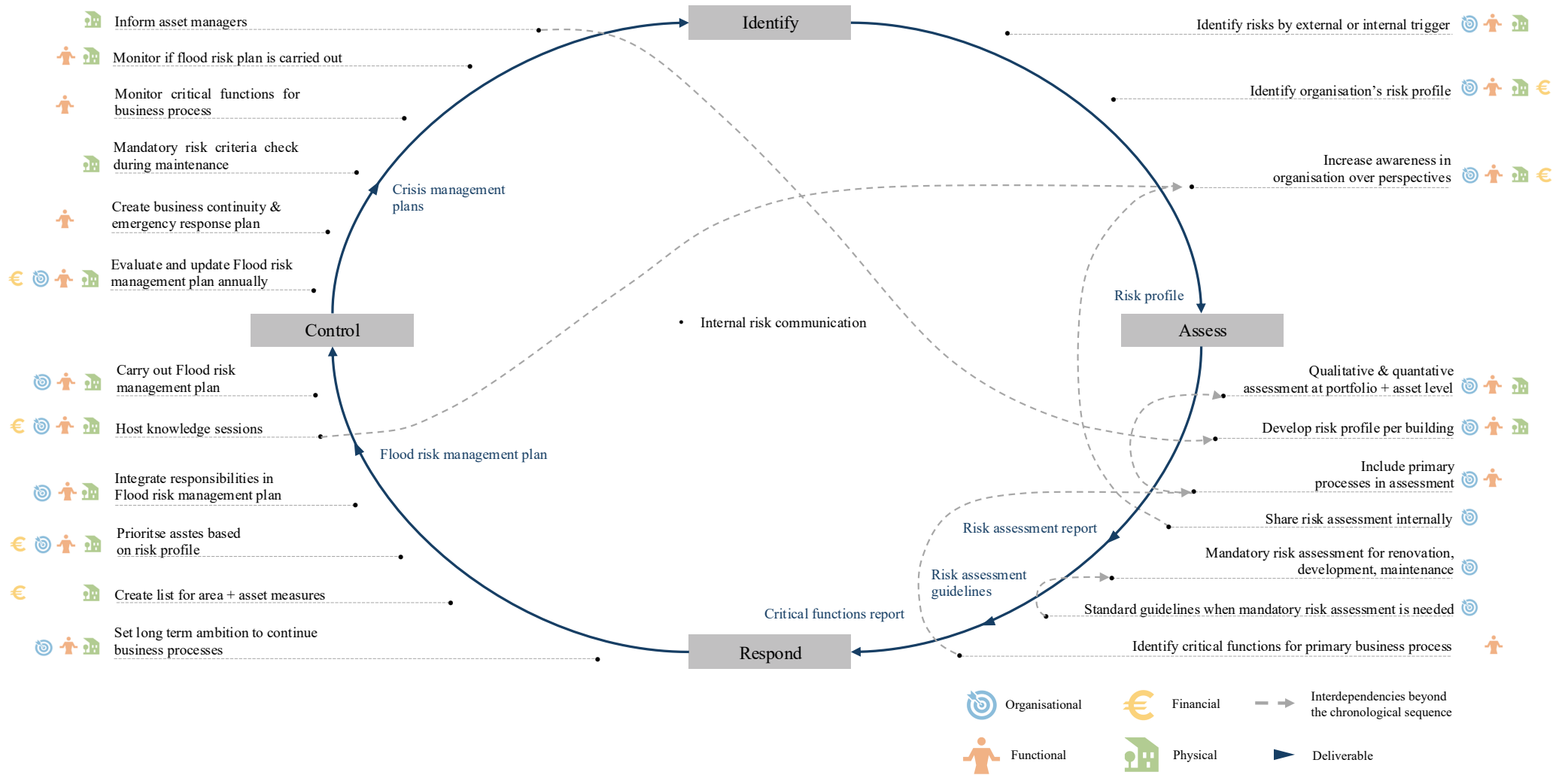
Interviewee	Quote	Code
I10	Dus ja, we zijn ervan bewust en we hebben een soort inspiratieboek van joh. Wat denk je hieraan?	Awareness of physical impact, Risk mitigation measures, Standards & Guidelines: Internaal company standards
I10	Dus dat is allemaal niet zo'n probleem, dus veel meer probleem als bepaalde vitale functies uitvallen.... Omdat dat onder water is gelopen. Daar heb ik eerlijk gezegd niet zoveel zicht op. Of dat echt hoe groot die kans is dat dat zou gaan gebeuren?	Awareness of operational impact: impact on core business processes, Awareness of physical impact
I11	Maar ik denk het niet voldoende bewust, nee. Ja door er meer inzicht in te geven. Überhaupt ja, daar met ook met kennissessies en gesprekken en mensen daarin meenemen in dat thema.	Awareness of physical impact, Risk communication: Internal communication strategies
I12	Ja heel groot, maar dat ligt er dus heel erg aan. Welke functie het huisvest kijk we hebben.	Awareness of physical impact, Awareness of operational impact
I12	De situatie goed in kunnen schatten en weet waar je staat. Weet hoe je vastgoed er aan toe is en hij zegt, ja, we zijn nu echt heel erg in die stand en vanaf daar gaan we kijken naar hoe we het geheel klimaatadaptief kunnen krijgen en welke processen we daarvan moeten inrichten.	Awareness of physical impact
I10	Doordat er nu aandacht voor is sinds een jaar of 3/4 is het niet meer onderbelicht, dus hou er rekening mee. Maar ik denk dat we er meer rekening mee houden door dan vervolgens naar de oplossingen te kijken, hè?	Lack of integration, Risk mitigation measures
I10	Maar ik zie dus niet een soort klimaatmaatregel om dat gebouw, hè, dat die dealingroom die ik zie ik. In de praktijk zie ik geen maatregelen.	Risk mitigation measures
I10	Maar dat zijn dingen die ik hoor binnen de organisatie, maar ik heb er niet precies zicht op. Wat voor concrete maatregelen nemen dan? Dat weet ik niet goed genoeg.	Risk mitigation measures
I11	De opgave in kleinere stukjes opknippen namelijk niet je hele portefeuille heeft last van overstromingsrisico's, maar hè? Bij gebouw XY en Z moet je echt even opletten. Ik denk dat dat heel erg gaat helpen.	Risk mitigation measures
I11	Ik bedoel ook vanuit strategisch oogpunt en op gebouw niveau is er ook van alles mogelijk, Maar dat ja dat staat dan in de routekaart niet om daar flauw naar te verwijzen.	Risk mitigation measures, standards & Guidelines: Internal company standards
I12	Bij vastgoedbeheer zijn ze echt een klimaatadaptatie club aan het oprichten, hè? Dat is echt een soort van expertgroep en die zijn ook heel hard bezig met het beleid schrijven van hoe gaan we zorgen dat het vastgoed wat niet in zo'n grootschalige renovatie onder handen genomen gaat worden in de komende 50 jaar, dat toch dan in de periodieke instandhoudingsprocessen stapsgewijs klimaatadaptief worden gemaakt? Ja, ja, maar dat ei is nog niet helemaal gelegd.	Risk mitigation measures: Building level
I12	Ja ja en dan wij schrijven alles altijd functioneel uit, dus ik mag het doel opschrijven. En of dat dan uiteindelijk met een groen dak wordt gedaan of met een wadi of met een, dat is dan aan de ontwerpende partij.	Risk mitigation measures
I12	Ik weet alleen wat voor maatregelen er worden genomen bij nieuwbouw en renovatie. Ik weet niet hoe dat bij instandhouding gebeurt.	Risk mitigation measures
I10	Dus het zal wel standaard opgenomen in zijn in een checklist, maar ik ken die checklist niet	Standards & Guidelines: Internal company standards
I11	Dus die routekaart die is verplicht gesteld, dus die eisen daarover. Die staan dus in die routekaart dus daarmee.	Standards & Guidelines: Internal company standards
I12	Nee wat we intern gebruiken is de routekaart.	Standards & Guidelines: Internal company standards
I12	Dat je dus op al die verschillende levels, dus dat een iemand bij transacties en projecten denkt: Hoe kunnen we het zo ontwerpen en iemand anders bij het management van gebouwen weet wat hij moet doen als er iets gebeurt, dus dat is weer een soort van risicoloop van invloed die iemand heeft en dat iedereen bewust is van zijn aanraking met het onderwerp klimaatadaptatie.	Lack of integration
I12	Ik denk dat niet bij elke plek in het RVB duidelijk is de Circle of influence is op gebied van klimaatadaptatie, dat sommige mensen met portefeuille strategie zoiets hebben van, oh ja, maar dat betekent dat er een evacuatieplan moet zijn, dat is niet onze verantwoordelijkheid. Terwijl eigenlijk iedereen op een bepaalde manier kan meedenken over de impact minimaliseren als er klimaatrisico's optreden.	Lack of integration, responsibilities

Quotes RVB | Operational

Interviewee	Quote	Code
I10	Ik denk dat ons bewustzijn. Ik denk dat ze heel goed snappen dat de vitale functies kunnen uitvallen. Maar ik zie er in de praktijk niet veel van terechtkomen, dus ik zie niet dat wij dus hele concrete maatregelen nemen rondom die vitale gebouwen om nu klimaat adaptieve maatregelen te nemen.	Awareness of operational impact: Impact on core business processes
I11	Ongeveer één keer in de 25 jaar hè komt een gebouw langs om grootschalig te renoveren. Maar als het bijvoorbeeld op een plek is waar heel veel klimaatrisico's zijn, dan moet je misschien niet over 25 jaar dat gebouw oppakken, maar misschien nu al als daar een vitale functie in zit.	Awareness of operational impact: Impact on core business processes
I11	Ja dat er zitten zoveel functies tussen die kosten, want het kost altijd overeind moeten blijven. Ja, daar is de impact echt huge.	Awareness of operational impact: Impact on core business processes
I11	WF: Wordt de functie van een gebouw meegenomen in de risicobeoordeling? I11: Ja dus dat zijn we, dus dat hebben we nog niet eerder gedaan, maar daar loopt dus nu dat onderzoek met adviesbureau.	Awareness of operational impact: Impact on core business processes
I11	Voor 2050 vertaald dat zich helemaal aangesloten op de nationale adaptatiestrategie dat bedrijfsprocessen altijd moeten kunnen blijven doorgaan. Ook tijdens weersextreme. Dat is de ambitie voor 2050.	Awareness of operational impact: Impact on core business processes, Integration into strategy
I12	Maar daar zijn bij het rijksvast heel veel processen die wel kritiek zijn en waarvan de primaire taak altijd uitvoerbaar moet blijven.	Awareness of operational impact: Impact on core business processes
I12	Het is het ook zo dat portefeuille van dit onderzoek wat nu wordt gedaan. Daar worden de risico's geschaald aan de hand van de functie. Dus we kijken niet alleen naar de klimaat effecten die optreden, maar ook als dit effect optreedt.	Awareness of operational impact: Impact on core business processes
I10	Ik heb nog nooit iets van communicatie gehad van joh bij overstroming. Doe dan dit of dit of zorg dat je deze acties hebt gedaan.	Continuity planning: Emergency response plans
I11	We hebben nog niet echt plannen om primaire processen te laten doorgaan. Nee dus wel calamiteitenplannen bijvoorbeeld. En voor sommige echt vitale functies bestaat dat overigens wel. Maar voor de kantoren niet.	Continuity planning: Emergency response plans, Business continuity plans
I12	Nee, maar ik denk wel dat als je iedereen vraagt die bezig is met het onderhoud klimaatadaptief maken, laten willen zeggen. Nee, maar dat is wel de holy grail waar we naartoe werken.	Continuity plans: Business continuity plans
I11	Nog te veel afhankelijk vind ik zelf van wie er op zo'n project zit, welke asset manager het doet.	Risk communication: Internal communication strategies
I12	Ik denk niet dat een assetmanager precies weet. Ik weet niet tot in hoeverre dat in een soort van op het bureau van een asset manager komt waarin die dus weet ah, oké, het scenario wat zij voor ons hebben gemaakt is dat al deze risico's weggenomen zijn en dat deze risico's ondervangen moeten worden door een evacuatieplan.	Risk communication: Internal strategies, Continuity planning: Emergency response plans

Appendix X

Roadmap to integrate flood risks into real estate management



User guide

What is it?

Flood risks are becoming an urgent concern for real estate owner-occupiers. Climate change, rising sea levels, and more frequent extreme weather events increase the likelihood of flooding, especially in low-lying areas. Many organisations still approach flood risk reactively, only after an incident occurs. This roadmap provides a structured, proactive approach to embedding flood resilience into real estate management.

The roadmap is based on a cyclical risk management framework with four phases: **Identify**, **Assess**, **Respond**, and **Control**. It translates scientific and empirical research insights into practical actions, tools, and deliverables.

How to use?

The roadmap can be used in the following ways:

1. **Start anywhere:** The cycle begins logically at Identify, but you can enter at any phase depending on your current stage.
2. **Follow the phases:** Use the map cyclically to implement the actions step by step.
3. **Dotted arrows:** These show interdependencies beyond chronological sequence.
4. **Check deliverables:** Each phase includes key outputs that help monitor progress.
5. **Continuous cycle:** Once all actions are completed, it restarts to reflect changing conditions and emerging risks.

Goal?

The theoretically informed roadmap can be used to guide the integration of flood risk into real estate management strategies for owner-occupiers. It serves several goals:

- **Understand** flood risk and its impact on assets and operations.
- **Integrate** flood risk into real estate management strategies.
- **Motivate** organisational awareness and commitment to proactive risk management.

For whom?

The roadmap is designed for owner-occupiers of real estate in organisations, especially for **strategic** or **tactical** use. It addresses multiple perspectives:



Strategic



Physical

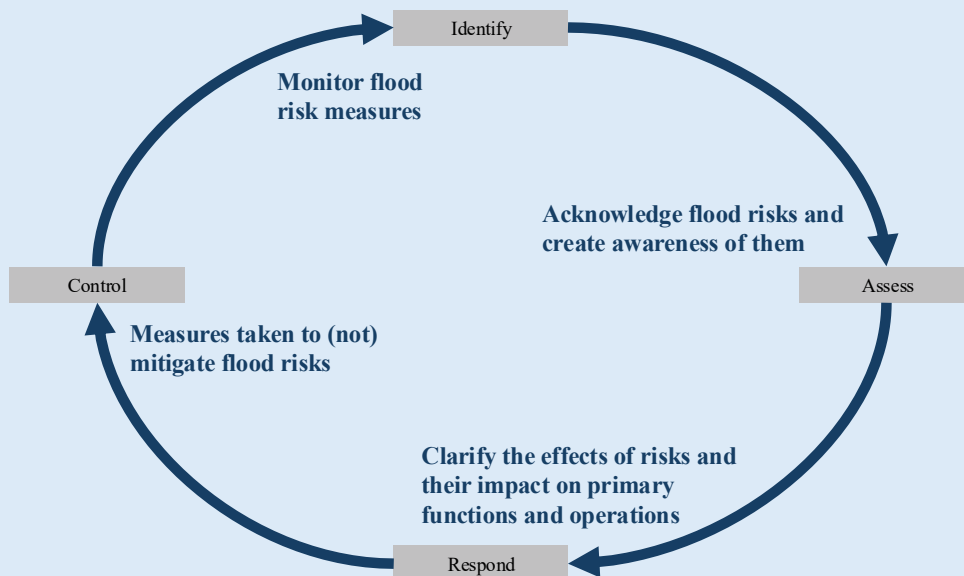


Functional

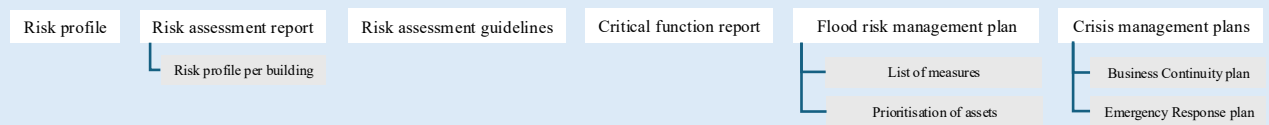


Financial

Final status per phase



Deliverables?



Deliverable	Sub-deliverable	Description
Risk profile	Organisation's risk profile	Description of boundaries of risk tolerance by risk-return trade-off. The profile determines risk appetite and tolerance. It links risks to objectives and financial boundaries, ensuring flood risk management aligns with broader business goals.
Risk assessment report	Risk assessment report at portfolio + asset level	Report includes qualitative & quantitative assessment of flood risks done by external or internal stakeholders. Provides insights into which locations and assets are most vulnerable to flooding.
	Risk profile per building	The profile per building includes a detailed profile for each building that captures exposure, vulnerability, and critical functions.
Risk assessment guidelines	Risk assessment for renovation, development, maintenance	A mandatory assessment of flood risk prior to renovation, new development, or maintenance activities to ensure risk reduction measures are integrated.
	Guidelines for risk assessments	A set of instructions outlining when and how flood risk analyses should be conducted.
Critical functions report		Report that highlights all critical functions to continue primary business process.
Flood risk management plan	List of asset + area measures	An inventory of physical and organisational measures for building and site. These lists are examples.
	Prioritisation of assets risks based on risk profile	A ranking of risks and assets based on their risk profile. The ranking focusses on the most critical and vulnerable assets first.
Crisis management plans	Business Continuity Plan	Ensures essential operations continue during and after disruptions.
	Emergency Response Plan	Provides immediate actions and recovery steps for emergencies.

The four phases?

1. Identify

Flood risk management starts with awareness. Identification can be triggered by:

- **External factors:** new regulations, updated flood maps, insurance requirements, or recent flood events.
- **Internal factors:** renovation plans, asset condition, operational changes, or previous incidents.

Understanding the trigger provides context for the scope and urgency of the rest of the flood risk management cycle.

Key actions:

- **Define your risk profile:** Determine risk appetite and tolerance. Link flood risk to corporate objectives and financial boundaries.
- **Create awareness:** Inform stakeholders across all perspectives. Awareness builds support for proactive actions.

Deliverable:

Organisation's risk profile: A structured overview of risk tolerance and potential impacts of the organisation.

2. Assess

Once risks are identified, assess them at both the portfolio and asset levels. Combine quantitative and qualitative approaches:

- **Quantitative:** Use climate data and tools such as Klimaateffectenatlas, Overstromingsrisicokaart, and Atlas Leefomgeving.
- **Qualitative:** Observe conditions on-site to capture vulnerabilities not visible in data.

Assessment at the portfolio and asset level results in a risk assessment report. At the asset level, a risk profile is created where the primary functions of the assets should be included. The primary functions follow from the Critical function report, where critical functions for primary business processes are identified. Operational knowledge of asset managers is important to take into account during the development of the risk profile per building.

By sharing this risk assessment of the portfolio and asset level internally, awareness over perspectives is increased and ensures stakeholders across perspectives are informed.

To ensure consistency, make flood assessment mandatory during renovation, development, and maintenance. Establish guidelines for when reassessments are required.

Deliverables:

- **Risk assessment report** (portfolio + asset level)
- **Risk assessment guidelines**
- **Critical functions report**

3. Respond

Assessment alone does not reduce risks; action does. This phase translates findings into measures to respond to the risks.

Key actions:

- **Set long-term ambition:** Define goals for managing flood risk at the portfolio, building, and business process levels.
- **Develop a Flood risk management plan.** This plan includes the following components:
 - A **list of measures** for assets and areas drawn up based on the assessment phase. The measures should be categorised by area and asset level, and divided into new reconstruction, renovation, and existing building
 - Define **responsibilities** into the list of measures. These responsibilities and roles are organisation-specific.
 - **Prioritisations** of assets based on their risk profile, focusing on critical business processes.
- **Organise knowledge** sessions to communicate the Flood risk management plan. This action increases awareness in the organisation over perspectives.
- **Carry out the Flood risk management plan** according to the predefined responsibilities.

Deliverables:

- **Flood risk management plan**
- **List of measures**
- **Prioritisation of assets**

4. Control

Flood risk management is not static. Risks evolve due to climate change and operational changes, or other events. Continuous monitoring ensures effectiveness.

Key actions:

- **Update the Flood risk management plan annually** to include new data and lessons learned.
- **Develop and maintain Business Continuity Plan and Emergency Response Plan.**
 - BCP: Protect personnel and maintain essential operations during disruptions.
 - ERP: Provide immediate response steps and recovery procedures.
- **Perform mandatory checks** during maintenance to keep existing buildings compliant with flood risk guidelines.
- **Monitor critical functions** regularly to ensure resilience and monitor if the Flood risk management plan is carried out.

Deliverables:

- **Updated Flood risk management plan**
- **Business Continuity Plan and Emergency Response Plan**

→ Continue to 'Identify'

Recommendations:

- Make the roadmap organisation-specific by filling in the proposed dimensions with specific roles and responsibilities.
- Make internal communication standard so that all stakeholders are aware of all phases in the roadmap and are integrated into the necessary phase.

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