

UNDERSTANDING RISKY REAL ESTATE INVESTMENTS

Exploring risk perception of structural
damage in Amsterdam's real estate
investment decisions

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Summary

Climate change is becoming a significant consideration for long-term investors, influencing strategies for redevelopment projects. The associated challenges, including climate adaptation are estimated to require substantial attention and financial investment. The issue of land subsidence which gets exacerbated by anthropological activities is currently receiving minimal attention despite its significant effects.

Amsterdam stands out as one of the most vulnerable regions to the repercussions of land subsidence due to its location in a peat soil region and the use of wooden pile foundations for building construction. This increases the potential damage to buildings and investment portfolios. As the 17th Century Canal Ring Area of Amsterdam is recognised as a UNESCO World Heritage Site it is imperative to preserve this urban landscape for both cultural and economic purposes.

Moreover, the absence of insurance coverage for subsidence damage in the Netherlands, coupled with the lack of climate risk assessment in real estate valuation creates a gap in stakeholder transparency and risk inclusion. Shifting all potential financial liabilities onto homeowners who invest in real estate within the affected areas as the final link in this chain of consequences.

So far, little research has been done to explore in which ways investors' decision-making is influenced by these risks as a large part of the real estate market is privatised. This study uses in-depth qualitative research to explore in which ways land subsidence influences the decision-making process and strategies used by both private and public investors, while also discussing the issue with other planning professionals and community based stakeholders. This is done to increase transparency and mitigate the socio-economic and environmental risks of land subsidence in Amsterdam. It contributes to addressing the structural damage crisis induced by subsidence and fills a research gap in understanding governance strategies for physical climate risks in real estate. This study holds relevance for policymakers, developers, and homeowners, providing insights for informed decision-making and fostering resilience in Amsterdam's real estate market.

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1. Introduction

Understanding how stakeholders perceive and respond to risk is crucial for informed real estate investment decisions. This study explores the influence of risk perception regarding land subsidence and structural damage on the decision-making processes of investors, developers, politicians and homeowners. This thesis emphasizes the need to integrate climate risk assessments into real estate valuations, providing insights to enhance resilience in the housing market.

§1.1 Background information

Climate change and its effects are emerging as one of the foremost forces and risks that (long-term) investors must proactively consider into their strategies when investing in redevelopment projects¹ (Clayton, Devaney, Sayce, & Van de Wetering, 2021). All climate change related challenges (climate adaptation, energy transition, reaching sustainable agriculture, and the enhancement of biodiversity will demand attention, space, and financial investments, driving costs up to around EUR 900 billion until 2050 (Hekman & Booister, 2021). Climate change manifests itself primarily in the form of (1) more frequent, prolonged, and extreme rainfall, (2) more frequent and longer periods of drought and heat, and (3) rising sea levels (Kok & Angelova, 2020; AFM, 2023).

One issue the Netherlands has long been addressing, is the issue of sea level rise. This can be seen in the pathways developed to fortify the country against the threats posed by water (Haasnoot, Diermanse, Kwadijk, de Winter, & Winter, 2019). Many governments base these future scenarios solely on these consequences but forget that this challenge is intensified by the even more pressing issue of land subsidence — while the sea is rising by three to ten millimetres a year, land levels can fall by up to ten centimetres a year —which currently is receiving minimal attention (Deltares, n.d.; Hekman & Booister, 2021).

Land subsidence mainly affects peat and clay soil regions and is exacerbated by anthropogenic activities such as salt mining and gas extraction, the expansion of built-up areas and infrastructural networks, the drainage of peatlands and areas reclaimed from the sea, and the active lowering of groundwater levels to keep the Netherlands economically thriving and liveable (TNO, n.d.; Willemsen, Kok, & Kuik, 2020; Stouthamer, et al., 2020; Clayton, Devaney, Sayce, & Van de Wetering, 2021; RLI, 2024). Additionally, it leads to permanent reduction in aquifer-system capacity, the formation of earth fissures and damage to infrastructure such as buildings, roads, and can even cause mental health issues for homeowners (TNO, n.d.;

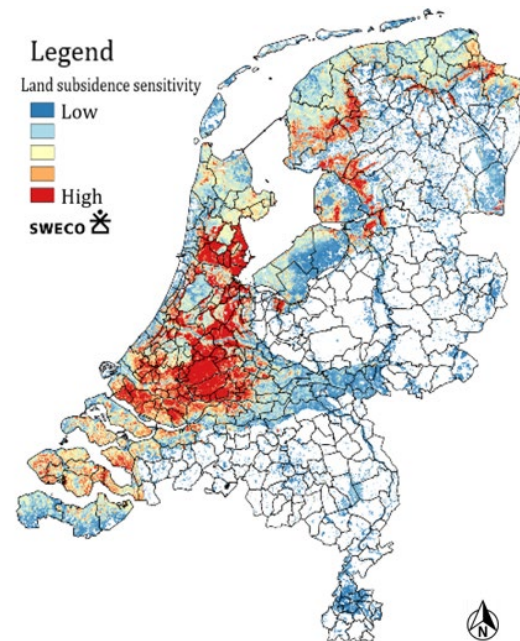


Figure 1: Land subsidence sensitivity in the Netherlands. Source: (Sweco, 2024). Translated by author.

¹ The term “redevelopment project” refers to the process of revitalising or renovating an existing property with the aim of enhancing its economic value (historic preservation, aesthetics, sustainable value, and functionality). This process can be initiated by (private) real estate developers, municipalities, or independent homeowners.

Willemsen, Kok, & Kuik, 2020; Herrera-García, et al., 2021; RLI, 2024).

In the Netherlands, land subsidence is predominantly observed in the northern and western land basins. The western coastal region is of particular interest as it encompasses the Randstad, which serves as the economic and residential hub of the country (see figure 1) (Sweco, 2024).

In February of 2024, the Advisory Council for the Living Environment and Infrastructure (RLI), in Dutch known as the “Raad voor leefomgeving en infrastructuur”, released an advisory report for the government on addressing the national “funderingsproblematiek” (structural damage crisis) stemming from land subsidence. This crisis originates from multiple sources: first, the mean costs associated with subsidence damage have the potential to reach up to EUR 120 thousand per building, leading to a total estimated cost ranging between EUR 17 billion and EUR 54 billion until 2050 (AFM, 2023; RLI, 2024).

Second, in the Netherlands, these expenses fall within the responsibility of property owners due to the absence of insurance coverage for structural damage, unlike other types of climate-related risks (Vanhuysse, Piseddu, & Moberg, 2023; AFM, 2023; RLI, 2024). Despite numerous studies conducted both nationally and internationally demonstrating the negative impact of land subsidence on real estate prices (Koster & van Ommeren, 2015; Yoo & Perrings, 2017; Willemsen, Kok, & Kuik, 2020). In addition to these challenges, it is important to recognise that the housing market in the Netherlands is under significant pressure. This strain often pushes climate change-related risks and issues into the background, despite their contribution to further exacerbating the housing market’s difficulties.

This situation has the potential to result in detrimental financial consequences for property owners, the real estate market and the broader economy if left unaddressed (TNO, n.d.; Willemsen, Kok, & Kuik, 2020; Hekman & Booister, 2021; Clayton, Devaney, Sayce, & Van de Wetering, 2021; AFM, 2023; RLI, 2024). Making it paramount for the Netherlands, as a highly populated governed delta, to start addressing land subsidence risks within the Randstad.

§1.2 Research problem

Land subsidence presents a significant concern for the Netherlands, as approximately 25% of the country is situated below sea level (Herrera-García, et al., 2021). This issue assumes even greater significance considering that land subsidence predominantly impacts low-lying coastal plains, particularly densely populated areas, such as the Randstad (see Figure 1) (Willemsen, Kok, & Kuik, 2020; Herrera-García, et al., 2021). Furthermore, the government has intentions to construct an additional one million homes in areas already urbanised as part of redevelopment projects (Hekman & Booister, 2021). The buildings prone to subsidence damage are the ones built before 1970 when shallow or wooden pile foundations were still commonly used in construction (TNO, n.d.; Deltares, n.d.; AFM, 2023; RLI, 2024).

This implies that the region’s most susceptible to subsidence damage coincide with the locations chosen by the government for upcoming redevelopment projects aimed at alleviating the housing market, such as in Amsterdam. Unlike other visible climate risks, land subsidence remains untreated because of its invisibility, this threatens the stability and sustainability of the real estate market and even the broader economy (TNO, n.d.; Willemsen, Kok, & Kuik, 2020; Hekman & Booister, 2021; AFM, 2023; RLI, 2024). With estimates ranging from 425,000 to a million buildings potentially experiencing structural damage, the significance of the crisis is emphasised (Kok & Angelova, 2020; RLI, 2024).

The issue of land subsidence and its impact on buildings has long been drawing attention from the scientific community and independent research centres (Klaassen, 2015; Willemsen, Kok, & Kuik, 2020; Sweco, 2024; RLI, 2024). Despite the wide range of affected parties – such as government entities, insurance companies, real estate developers, and homeowners – a lack of transparency allows responsibilities for addressing the issue to become dispersed among stakeholders. This situation arises from the absence of clear incentives for any single party to assume accountability (Termeer, et al., 2011; Kok & Angelova, 2020; Clayton, Devaney, Sayce, & Van de Wetering, 2021; Kok, van der Putten, & Kraus, 2021; RLI, 2024)

Limited available information complicates the accurate assessment of real estate values. Despite the current rise in property values, the possibility of a decline remains a concern for homeowners. A significant decrease in prices could lead to a situation where the value of a house falls below the outstanding mortgage debt (DNB, 2023). Regardless, developers, municipalities, and private homeowners are still engaging with redevelopment projects in Amsterdam, without further assessing the possible consequences of land subsidence. Therefore, this study will address the issue of opacity in order to better understand how risk perception influences real estate investment decisions in Amsterdam.

§1.3 Research objective and questions

The aim of this study is to investigate the factors considered by stakeholders when investing in redevelopment projects in areas prone to structural damage from land subsidence. Specifically, the study seeks to explore how the decisions of real estate developers, municipal authorities, and independent homeowners are influenced by their perception of the risks associated with land subsidence in redevelopment projects. Initially, this study conducts a review of academic literature to determine which information is available and which topics have been studied within the theme of land subsidence, real estate valuation and the subsequent decision-making process.

This study strives to improve transparency by examining the perception and assessment of land subsidence risks in the decision-making process for redevelopment projects in Amsterdam. By enhancing transparency, the study intends to raise risk awareness among all stakeholders, thereby contributing to the strengthening of the resilience, stability and sustainability of the real estate market in Amsterdam, while simultaneously mitigating investment risks. In doing so, it aims to minimise the adverse effects for independent homeowners who would otherwise have to deal with the financial consequences (AFM, 2023; RLI, 2024).

This research will employ an iterative process to analyse information and employ a qualitative method approach to collect primary data. Real estate developers, property owners, government officials, urban planners, environmental experts and community representatives will be engaged through qualitative methods to delve into their motivations and decision-making processes when investing in high-risk real estate areas in Amsterdam. In order to maintain feasibility, the scope of this research will be limited to the areas within the city of Amsterdam that have a high-risk for pile decay, a condition leading to structural instability in the foundations of buildings. This coincides with parts of the city that play an important role in maintaining Amsterdam's urban landscape. Based on the research problem and the aim of this study, the following research question has been formulated to guide this study:

How does the perception of structural foundation risks influence real estate investment decisions in Amsterdam?

To help answer this main research question a set of explanatory sub-questions have been derived, based on the literature review:

1. How do predisposing factors impact stakeholders' risk perception of structural foundation risks?
2. How do stakeholders take structural foundation risks into consideration in their decision-making process?
3. How do stakeholders weigh the potential risks and benefits associated with investing in areas with a high risk for land subsidence?
4. What adjustments, if any, do stakeholders make to their investment strategies in response to land subsidence in Amsterdam?

§1.4 Research relevance

Research relevance can be observed from two perspectives: societal and scientific relevance. The first addresses the question of how this study contributes to the solution of practical issues. The latter addresses how this study fills up a research gap and contributes to academic knowledge.

§1.4.1 Societal relevance

It is evident that land subsidence has a significant impact on society, on individual, regional and even national levels (TNO, n.d.; Kok, van der Putten, & Kraus, 2021; Herrera-García, et al., 2021). Particularly in regions prone to subsidence, such as the Netherlands, where anthropogenic activities often exacerbate the phenomenon, land subsidence poses a considerable threat to the stability and sustainability of urban areas, as it poses a threat to existing infrastructure, public utilities, and community resilience (Koster & van Ommeren, 2015; Kok & Angelova, 2020; Herrera-García, et al., 2021; Hekman & Booister, 2021). Estimates indicate that the total costs associated with subsidence could range between EUR 17 billion and EUR 54 billion until 2050 (Kok & Angelova, 2020; AFM, 2023). Adding to the complexity, when combined with other climate change-related challenges, unaddressed subsidence issues will undoubtedly exacerbate societal burdens.

Despite the Netherlands' global reputation in the field of water management, the ongoing subsidence, in some areas reaching up to ten centimetres per year, presents a difficult challenge, neglecting it may further strain the economy (Deltares, n.d.; Hekman & Booister, 2021). Furthermore, the societal challenge of a constrained housing market exacerbates the situation. The recent surge in interest rates for housing has rendered construction costlier, leading to a decrease in the initiation of new projects. Moreover, the soaring prices of construction materials and the nitrogen regulations further complicate the construction of new residences (DNB, 2023). Socio-economic effects of subsidence are the limiting of housing options, the rise of real estate values, and constraining efforts to address the underlying issues (Koster & van Ommeren, 2015; Willemsen, Kok, & Kuik, 2020; Stouthamer, et al., 2020; Merten & Verhoeven, 2022; Vanhuyse, Piseddu, & Moberg, 2023).

This study is also relevant for society on a smaller scale, as understanding the potential risks associated with subsidence, individuals can take proactive measures to mitigate these risks, such as conducting thorough property assessments, investing in resilient infrastructure, or opting for properties built on stable foundations (Willemsen, Kok, & Kuik, 2020; AFM, 2023). The foundation crisis not only entails financial ramifications but also substantial emotional consequences. Having a safe and affordable home is, after all, one of the most fundamental human needs. However, due to damaged foundations and structural damage, this basic necessity is compromised, burdening homeowners with stress and additional worries (RLI, 2024).

By examining how the perception of subsidence risks influences decision-making in redevelopment projects, this study helps to identify strategies to enhance the resilience of urban infrastructure and mitigate the potential impacts of subsidence on communities (Koster & van Ommeren, 2015). In summary, a study on land subsidence risk perception and its impact on redevelopment projects is crucial for addressing the multifaceted challenges posed by subsidence in Amsterdam.

§1.4.2 Scientific relevance

Climate change, its associated risks, and impacts constitute one of the most extensively researched topics in contemporary science (Moon & Blackman, 2014). Research in the field of climate risks and real estate typically revolves around valuation of those either transition or physical climate risks. Transition risks have been studied extensively, while literature on physical risks is comparatively scarce (Jansen, 2019; Schulten, Bertolotti, Hayes, & Madaan, 2019; Vanhuyse, Piseddu, & Moberg, 2023; RLI, 2024).

Existing literature on physical climate risks within the domain of real estate predominantly focuses on their impact on property values and does not further engage the decision-making process behind it (Clayton, Devaney, Sayce, & Van de Wetering, 2021; AFM, 2023; Vanhuyse, Piseddu, & Moberg, 2023). The RLI report, released in February 2024, provides a comprehensive analysis of the structural damage crisis induced by land subsidence in the Netherlands. It identifies four primary issues: (1) a lack of information about the current state of structural foundations, (2) insufficient collaboration between property owners, (3) focus on judicial procedures and (4) a lack of transparency in the real estate market (RLI, 2024). To contribute to scientific literature and fill a research gap this study aims to enhance transparency within the real estate market by building upon the market response research conducted by Clayton, Devaney, Sayce & van de Wetering (2021). The goal is to determine which factors steer the decision-making process of stakeholders and their governance. Dabara, Anthony, Gbenga, & Adeyanju (2014) state that real estate development decisions involve taking risk and is often characterised by great complexities and inherent uncertainties. For independent homebuyers some of these influencing actors have been conceptualised and operationalised (Hassan, Ahmad, & Hashim, 2021).

However, an actual analysis framework that depicts the influence of land subsidence risks on the decision-making process of whether to invest in redevelopment projects is missing. Kok, van der Putten & Kraus (2021) specifically mention the knowledge gap on the socio-economic and governance aspects of the structural damage crisis.

By investigating stakeholders' perceptions and responses to subsidence risks in redevelopment projects, insights can be gained into the governance and environmental dynamics driving land subsidence processes and the factors contributing to its perpetuation in relation to broader societal issues surrounding housing shortages, historic urban landscape preservation, and climate adaptation.

§1.5 Thesis outline

This paragraph will briefly outline the structure of this thesis, to provide a foothold for its readers. Chapter 2 will consist of the literature review, offering the context and identify information on the key topics of the thesis. Chapter 3 discusses the relevant theoretical concepts that have been used to create the conceptual model and guide this thesis. In chapter 4, the methodological approach is explained in full, including research methods and case-study area. Chapter 5 will address the

results and their analysis, followed by chapter 6 and 7 which will discuss the conclusion and discussion respectfully.

2. Literature review

Within the scientific community, the significance of theory in shaping the central argument cannot be overstated. Theory serves as the foundation upon which originality, coherence and critical analysis are built, playing an essential role in guiding research. As highlighted by Adams & Buetow (2014), theory permeates every stage of the research process. Establishing the broader context and delineating which knowledge is available is thus essential. Aiming to provide a foundation for understanding the research landscape, concepts and theories that will become the silver lining of this thesis. By examining existing literature and different layers of theory available, this chapter will assess the topic of discussion from multiple angles, therefore providing a deeper insight into the information available and offering support for the grand theory discussed in the following chapter (Jesson & Lacey, 2006; Adams & Buetow, 2014; Bryman, 2016).

Climate change is one of the most extensively researched subjects in contemporary science (Bowyer, Bender, Rechid, & Schaller, 2014; Moon & Blackman, 2014), with a notable focus on climate change risks and their implications (Vanhuysse, Piseddu, & Moberg, 2023).

This literature review aims to improve the climate change adaptation and mitigation strategies to enhance climate resilience. The focus of this chapter will be on the concepts of climate adaptation, climate risks, risk perceptions, decision-making, risk management and the current situation of land subsidence risks in Amsterdam. It will then focus on establishing the context within which these phenomena play out.

§2.1 Climate adaptation

Climate adaptation refers to the process of adjusting to the changing climate conditions in order to minimise the negative impacts and maximise opportunities. It can be considered as a continuous process involving understanding, awareness, planning, implementation and ultimately monitoring and evaluating the choices made (Bowyer, Bender, Rechid, & Schaller, 2014). As climate adaptation focuses on a societal problem, it will demand participation from the private sector, which includes organisations and individuals that can be governed to collectively solve the issue (IPCC, 2014; Keskitalo, Juhola, Baron, Fyhn, & Klein, 2016).

Climate adaptation has mostly been carried out by governmental bodies as the delineation of responsibilities among stakeholders remains ambiguous (Termeer, et al., 2011). This underscores the significance of engaging multiple sectors in climate adaptation initiatives, highlighting the growing necessity for effective governance (Termeer, et al., 2011; Mees, Driessen, & Runhaar, 2012).

Climate adaptation faces a myriad of challenges. Firstly, it struggles with social complexity, uncertainty and spatial diversity (Termeer, et al., 2011; Mees, Driessen, & Runhaar, 2012; Knieling & Filho, 2013). Secondly, it contends with competing societal issues that are often perceived as more urgent and deserving of attention (van Buuren, Driessen, Teisman, & van Rijswijk, 2014). Moreover, the implementation of climate adaptation alone is insufficient, it needs complementary actions to achieve optimal results (Knieling & Filho, 2013). Lastly, technical and physical constraints, along with societal and cultural resistance, pose significant barriers for developers, municipalities and organisations seeking to engage in climate adaptation efforts (Bowyer, Bender, Rechid, & Schaller, 2014).

To further elaborate on the risks posed by climate change and their perception, the following paragraph will focus on theories about risks, their perception and strategies to manage them as these are the primary drivers of adaptation measures (Bowyer, Bender, Rechid, & Schaller, 2014).

§2.2 Climate risks and their perception

Risk is an ambiguous term open to multiple interpretations, making it difficult to grasp. Not only is it ambiguous, it also can vary by specific application and situational context (French & French, 1997; IRGC, 2017). In general, risk has a mostly negative connotation and describes the possibility of unfavourable future developments and includes the probability that an individual encounters danger (Sjöberg, 1998; Wiegmann, 2012). Unfavourable outcomes become threats, while favourable outcomes are labelled as opportunities or chances (Sjöberg, 1998; Bowyer, Bender, Rechid, & Schaller, 2014). Business activities may yield profits or other beneficial effects, yet they also entail exposure to potential negative consequences (Wiegmann, 2012). A definition of risk limited to the anticipation of negative developments is insufficient in contemporary risk conceptualisation (Duncan, 2002, as in Wiegmann, 2012). Vaughan (1996, p. 8) provides an encompassing definition, including both the possibility for a positive or negative outcome: *“Risk is a condition in which there is a possibility of an adverse deviation from a desired outcome that is expected or hoped for.”*

Similarly, the Australian/New Zealand Standard for Risk Management defines risk as *“(...) the possibility of something happening that impacts on your objectives. It is the chance to either make a gain or a loss. It is measured in terms of likelihood and consequence.”* (AS/NZ, 2004, as in Wiegmann, 2012). According to this standard, risk is determined by both the likelihood and the consequences of an event. The higher the likelihood and/or consequences, the higher the risk. A similar definition is later on given by the International Standards Organisation (ISO): *“Effect of uncertainty on objectives.”* (ISO, 2009, as in Bowyer, Bender, Rechid, & Schaller, 2014). Uncertainty solely pertains to the probabilities of outcomes, whereas risk encompasses both the probabilities and the quantified losses or gains associated with those outcomes (Wiegmann, 2012). French & French (1997) agree and state that a situation in which the “risk of an undesired consequence” is different from the “risk of taking a decision”. The exact distinction between these two concepts will be explained further along in this chapter.

Real estate development, being a unique field, inherently involves significant risks. Therefore, Wiegmann (2012) adopts an alternative approach by incorporating risk appetite and time horizon into their definition of risk. Risk appetite is the degree of uncertainty a business, in this case real estate developers, are willing to accept to reach their goal. It is the point of balance between risk and reward at which a decision-maker feels comfortable to reach stakeholder satisfaction. All risks are defined over a certain period of time, this is the time horizon, and has a significant impact on what is perceived as a risk (IRGC, 2017; Schulten, Bertolotti, Hayes, & Madaan, 2019). Other dimensions that shape a risk are the degree of novelty, the scope, the range, the type of hazard and the presence of a time delay.

The following definition of risk given by Wiegmann (2012) will be used, as it incorporates the components of uncertainty, normative real estate objectives, the difference between negative and positive outcomes and the acknowledgement of a time horizon: *“Risk is the uncertainty expressed through the significance and likelihood of events and their outcomes that could have a material effect on the goals of a real estate development organisation over a stated time horizon.”*

§2.1.1 Climate risks

The recognition of anthropogenic climate change as an established reality is now widespread, posing significant threats to society as a whole (Bowyer, Bender, Rechid, & Schaller, 2014). According to the Inter-Governmental Panel on Climate Change (IPCC) global greenhouse emissions trapped in the atmosphere are unequivocally impacting the climate system (Clayton, Devaney, Sayce, & Van de Wetering, 2021; IPCC, 2023). The effects of this impact are becoming apparent, prompting societies to adapt in order to strengthen their resilience against climate risks (Schulten, Bertolotti, Hayes, & Madaan, 2019; Seo, Oh, & Kim, 2021).

The source of a climate risk can be one of three types: natural phenomenon, human activity or a combination of the two (IRGC, 2017). Outcomes become risks either because the occurrence influences humans or because certain human activity was unintended or poorly managed. Climate risks as defined by Schulten, Bertolotti, Hayes & Madaan (2019), encompass the potential financial repercussions society faces due to climate-related events or changes. These risks can be classified into three main categories: physical risks, transition risks and liability risks (see Figure 2) (Jansen, 2019; Merten & Verhoeven, 2022).



Figure 2: Categories of climate risks. Source: (APRA, 2021).

Transition risks encompass the challenges arising from societal adjustments aimed at achieving a climate-neutral economy, primarily driven by policy instruments and technological advancements. Liability risks entail the financial implications resulting from stakeholder litigation. Despite considerable attention from both governmental and private sectors toward these developments, few measures have been effectively implemented thus far (Jansen, 2019; Schulten, Bertolotti, Hayes, & Madaan, 2019; Haasnoot, Diermanse, Kwadijk, de Winter, & Winter, 2019; Hekman & Booister, 2021; IPCC, 2023). Liability risks have diverted focus from practical measures, leading to unnecessary costs. Studies focused on the risks for asset investments often combine liability risks with transition risks (Schulten, Bertolotti, Hayes, & Madaan, 2019; Jansen, 2019).

Physical and transition risks are interrelated and expected to move in opposite directions (Merten & Verhoeven, 2022). As the economy transitions to sustainability, transition risks are projected to increase, while anticipated physical risks decrease. Despite the potential value of physical climate risks assessments, little attention is given to it in the financial sector (Schulten, Bertolotti, Hayes, & Madaan, 2019; Attoh, de Bruin, Goosen, van Veldhoven, & Ludwig, 2022). Postponement of effective climate policy implies higher carbon emissions in the future, thereby increasing the physical climate risks and the financial costs (Schulten, Bertolotti, Hayes, & Madaan, 2019; Merten & Verhoeven, 2022). The Autoriteit Financiële Markten (AFM) has publicly recognised this as of last year and has urged market actors to incorporate these risks into their real estate valuation or in the mortgage system (AFM, 2023).

Physical risks can be subdivided into chronic (e.g.: sea level rise and global warming) and acute risks (e.g.: tornados, flooding and wild fires) (Vanhuysse, Piseddu, & Moberg, 2023). Extreme weather conditions such as heavy rainfall and prolonged periods of drought and heat will become

more frequent due to rising temperatures, directly influencing our living environment, individual citizens and subsequently the Dutch real estate market (Haasnoot, Diermanse, Kwadijk, de Winter, & Winter, 2019; Attouh, de Bruin, Goosen, van Veldhoven, & Ludwig, 2022).

§2.1.2 Risk perception

Risk perception is influenced by various factors across multiple dimensions. Stobbelaar, van der Knaap & Spijker (2021) delineate these factors based on the European Smoking Prevention Framework (ESPF) developed by de Vries et al. (2003). They categorise them into ‘predisposing factors’ and ‘information factors’. The former encompasses biological, behavioural, psychological, socio-cultural and physical environmental factors, see Figure 3.

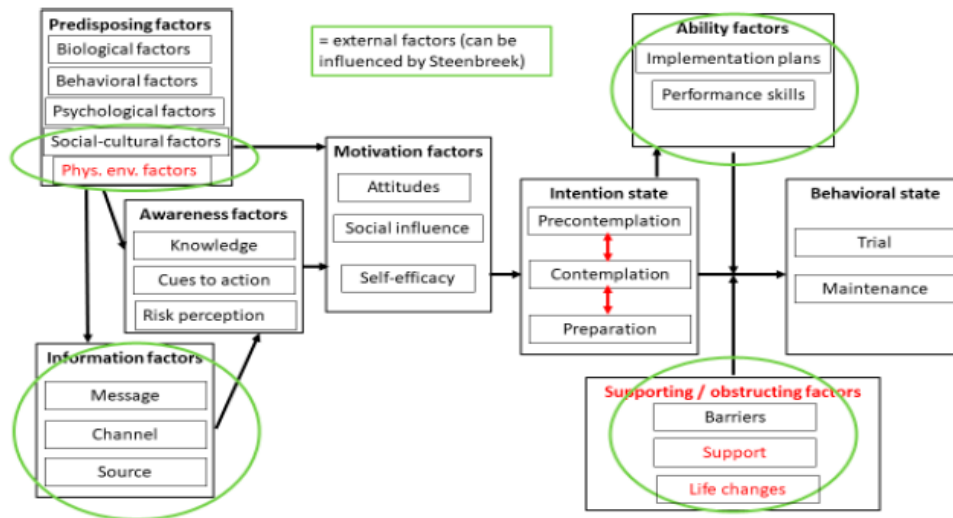


Figure 3: Garden greening behavioural model as adapted from the ESPF by de Vries et al. (2003). Source: (Stobbelaar, van der Knaap, & Spijker, 2021).

The physical environment, though seemingly static, remains dynamic and subject to changes (Stobbelaar, van der Knaap, & Spijker, 2021). Additionally, they state that the message, channel and source through which an individual receives information influences how one perceives risks. This theory closely corresponds with results from Lorencová, Loučková, & Vačkářů (2019). It is safe to say that the predisposing factors exert mutual influence on each other, creating a unique state of awareness and risk perception that differs per individual (de Vries, et al., 2003; Stobbelaar, van der Knaap, & Spijker, 2021).

According to Taylor et al. (2014, in Lorencová, Loučková, & Vačkářů, 2019) two significant concepts shape the degree of apprehension regarding climate change threats: optimism bias (acknowledgement of the risk but unawareness of personal vulnerability) and psychological distance (viewing climate change impacts as affecting distant regions, occurring in the future or impacting other social groups). These concepts influence individual’s willingness to partake in adaptation measures, as the threat may not be perceived as urgent.

Similarly, Haasnoot, Diermanse, Kwadijk, de Winter, & Winter (2019) suggest that risk perceptions are influenced by path dependency. It is impossible for an individual to imagine the Netherlands flooding as Dutch water technology is so advanced and the Dutch spatial strategy strongly promotes technological advancements to keep the country from flooding. Consequently, drastic changes in the urban landscape that deviate from this ‘ideology’ are generally not anticipated nor accepted.

A similar opinion is presented by Kahneman (2013, as in IRGC, 2017), who identifies several cognitive biases affecting how individuals perceive risks: availability (events that are more salient in a person's thoughts are rated as more probable), choice avoidance (resistance to changing habits), anchoring effect (failure to incorporate new information), personal experience and avoidance of cognitive dissonance (disregarding information which challenges a set belief system). Also, interpretations of the threat, personal experience with shock events and their availability, personal priorities and environmental value systems have also been identified to shape risk perception (Oppenheimer, et al., 2014).

According to Brulle, Carmichael, & Jenkins (2012), the primary factors influencing public risk perception and concern regarding climate change includes experiences with extreme weather events, understanding scientific information, media discourses, efforts of advocacy groups, cues from the political elite and economic and political factors. They concluded that the political and economic factors together with media coverage had the biggest impact, while the personal experiences with extreme weather events and scientific information were the least relevant.

Contrasting conclusions were achieved by Spence, Poortinga, Butler, & Pidgeon (2011), who concluded that experience with extreme weather conditions (in their case flooding) increases concern about climate change and influences individuals to undertake mitigation measures. Lorencová, Loučková, & Vačkářů (2019) reach a similar conclusion in their research, where extreme weather events play an important role. On top of that, they also find a strong link between gender, sociodemographic factors and climate risk perception.

§2.2 Climate risks in the real estate market

Climate risks are perceived differently all around the world, leading to interesting scenarios based on geographic location.

The Netherlands as a coastal region and delta is extra susceptible to “double jeopardy” of simultaneous climate-related and financial risks, mostly in the real estate market (Chen & Chu, 2022; Eren, Merten, & Verhoeven, 2022). All of these effects are exacerbated in urban areas, due to the extensive grey infrastructure and buildings. This makes the urbanised economic heart of the country, the Randstad, especially vulnerable (den Exter, Lenhart, & Kern, 2014). Externalities such as climate change do not integrate into the financial market system seamlessly, possibly fostering a decoupling between market prices and the true social costs (Nordhaus, 2019; Chen & Chu, 2022). Other studies have expressed that physical climate risks are not sufficiently reflected in the market pricing of real estate (Jansen, 2019; Clayton, Devaney, Sayce, & Van de Wetering, 2021; Eren, Merten, & Verhoeven, 2022; RLI, 2024). This is hampered by a lack of historical data, consistent methodologies, standardised metrics, and trustworthy information regarding physical climate risks (Eren, Merten, & Verhoeven, 2022). Clayton, Devaney, Sayce & van de Wetering (2021) found that property prices tend to decline after climate events, especially in regions that were previously less exposed to climate change, this can lead to a long-lasting decline.

However, several microeconomic studies have found evidence that physical climate risks are priced in certain markets (Koster & van Ommeren, 2015; Yoo & Perrings, 2017; Willemsen, Kok, & Kuik, 2020). Still, the evidence is often mixed or insufficiently comprehensive to conclude that physical risks are broadly and consistently priced across real estate markets (Eren, Merten, & Verhoeven, 2022). An increase in irregular weather patterns causing prolonged dry periods together with anthropogenic activities to lower groundwater levels, are exacerbating the physical climate risks the

Randstad is facing (TNO, n.d.; Jansen, 2019). This causes land subsidence, making structural foundation damage one of the most significant costs homeowners in the Randstad are facing.

Research conducted indicates that when structural damage is reported, the asking price of real estate is, on average, 12% lower than the estimated value predicted by the model lacking information about the foundation's condition (AFM, 2023). The mean price of structural repairs is EUR 54 thousand and with a mean housing price of EUR 416 thousand as per September 2023, the repairs make up 13% of the mean housing price (AFM, 2023). There are no benefits for the property seller to have research carried out on the state of the structural foundation of the property if the chance at structural is high.

§2.3 Decision-making

Decision-making is inherently shaped by both predisposing and internal factors, as individuals are inclined to perceive specific situations as risky based on a variety of influences. The depth of their understanding regarding the nature of these risks significantly affects how such risks are managed and the decisions made in response to them.

Decisions play a fundamental role in shaping human lives and determining outcomes. Consequently, it is unsurprising that decision-making has been extensively researched across various academic disciplines (Hansson, 2005). However, decision theory specifically examines non-routine decisions, emphasising scenarios where multiple options are available, and the selection process is non-random. These choices typically pertain to purposeful activities (Hansson, 2005).

A definition that aligns with this concept of decision-making is: "... the study of models of judgments involved in and leading to deliberate, and usually rational, choice." (French & French, 1997, p. 226). Hansson (2005) provides several theories of dividing decisions into stages. A first theory of is provided by John Dewey. Problem-solving consists of five consecutive stages: (1) identification of a perceived challenge, (2) characterising the nature and parameters of said challenge, (3) suggestion of possible solutions, (4) evaluation of suggestion and (5) iterative observation and experimentation to ascertain the suitability and validity of the suggestion leading to acceptance or rejection of the suggestion (Dewey, 1978, in Hansson, 2005). Brim et al. (1962, p. 9, in Hansson, 2005) proposes an identical subdivision.

Decision theory intersects various disciplines, integrating the philosophy of ethics and the mathematics of decisions, while an economic perspective emphasizes the ideal rational choice. These fields concentrate on how decisions ought to be made, whereas the disciplines of psychology and political science examine how decisions are made. This distinction introduces the difference between normative and descriptive decision models (Hansson, 2005). Descriptive models show the current situation, while normative decision models aim to guide the decision-making process. However, these models often fail to capture the entire thought process that influences the final decision (French & French, 1997). Especially, in cases of collective decision-making – when a decision is made by more than one person – the thought processes of several individuals is difficult to visualise (Hansson, 2005).

In many cases, theories of individual decision-making can be applied to collective decision-making scenarios, operating under the assumption that the group functions as a singular entity. Likewise, many corporate decision-making theories conceptualise the corporation as a singular entity (Hansson, 2005). The sequence provided by Simon (1960, in Hansson, 2005), who offers a modified

version of Dewey's sequence which was especially designed for corporate use, is an example of this misconception. This sequence consists of three phases and does not seem to be altered for group application: (1) identifying occasions for making a decision; (2) exploring possible courses of action; and (3) choosing among the available options (Hansson, 2005).

Contrastingly, social decision theories are theories that model situations in which decisions are taken by two or more persons, who may have conflicting views on how and which goal is to be achieved. Most studies concern the voting, bargaining and other methods to create rational collective choices out of individual preferences (Hansson, 2005). These individual preferences are in turn based on internal and predisposing factors as mentioned throughout this chapter and are essential to incorporate into a social decision theory model (Clement, 2010; Lorencová, Loučková, & Vačkářů, 2019; Stouthamer, et al., 2020; Stobbelaar, van der Knaap, & Spijker, 2021)

Additionally, both individual and social decision theory suggest a specific order for the stages due to the sequential nature of their models. However, Witte (1972, in Hansson, 2005) criticises the concept of consecutive stages, arguing that his empirical evidence indicates these stages are frequently conducted simultaneously. He adds: "We believe that human beings cannot gather information without in some way simultaneously developing alternatives. They cannot avoid evaluating these alternatives immediately, and in doing this they are forced to a decision..." (Witte, 1972, p.180, in Hansson, 2005). Giving indication for decision theories to be designed in parallel and iteratively.

Understanding the complexities of decision-making and its theories is essential as many corporate management models involve the use of these concepts. To ensure resilience and sustainability in an ever-changing environment, optimising these models for corporate businesses to function properly. The following paragraph will discuss scientific discourse on risk management strategies.

§2.4 Risk management

For this study a single definition of risk has been determined. However, generally speaking there is no single approach for the management of risk. As real estate development is inherently risky it is important to distinguish between the "risk of an undesired consequence" and "risk of taking a decision" and how these concepts are the backbone of risk management (French & French, 1997; Wiegelmann, 2012). The risk of an undesired consequence focuses on the potential negative outcomes from specific actions or conditions, while the risk of a decision focuses on the negative outcomes of the decision itself. Risk management, specifically climate risk management focuses on both concepts but is often not incorporated as a detailed strategy (Wiegelmann, 2012). Using these concepts, leads this study to use the following definition for risk management: "Risk management is a structured and disciplined approach that aligns strategy, processes, people, technology, and knowledge with the purpose of evaluating and managing the uncertainties a real estate development organisation faces as it creates value." (Wiegelmann, 2012).

Even though this study will focus on the role of individuals within decision-making it must be acknowledged that certain variables influence the capacity of an enterprise to perform and implement risk management strategies. This paragraph will therefore discuss both the variables to be considered and the several risk management strategies that have been researched in existing literature.

Corporations have several predisposing factors that influence risk management strategies. Before any risk management strategy can be initiated, these factors need to be identified and considered. Like previously mentioned, a few of these factors that influence how a company performs risk management are external. These factors influence the functioning and abilities of the company from the

outside. As stated by Clement (2010), decision-making processes all occur within a certain political-economic and institutional context. This refers to the broader environment in which political, economic, and institutional systems operate, including their interplay. This encompasses the overall climate affecting all governance, economic policies, market conditions and institutional frameworks.

The second factor identified as an external influence is path dependency as identified by Haasnoot, Diermanse, Kwadijk, de Winter, & Winter (2019). Decisions and practices of the past influence the present and future decisions within several contexts. It emphasizes that once a particular path is taken, it becomes increasingly difficult to change course due to the entrenched systems, beliefs and practices that have developed over time (Haasnoot, Diermanse, Kwadijk, de Winter, & Winter, 2019). In a cultural context, path dependency refers to the societal norms, values and beliefs that are rooted in historical traditions. In a historical context, the emphasis lies on on experiences that occurred in the past, such as wars, colonisation, or economic crises that influence societal structures and collective memory. The last context in which path dependency can occur which is relevant for this paper is the institutional context. Established rules, policies and organisational structures create a framework that shapes future decisions and actions that can be made (Greener, 2002; Clement, 2010).

Another similar factor that partially overlaps with the previous two factors mentioned is policy instruments, and laws and regulations (Agrawala, et al., 2011). They are a product of the political-economic and institutional context, which in its own turn is dependent on path dependency (Clement, 2010). Policy instruments are measures designed to influence the behaviour of individuals. Each policy is established on either repressing or stimulating behaviour and is crucial and can boost the effectiveness and legitimacy of government policies (van der Doelen, 1991; Mees, et al., 2014). They can come either as juridical, economic or communicative instruments (van der Doelen, 1991). This once again emphasizes the relation between the strategies that can be implemented and how they are accepted and implemented by the context.

Another set of factors to consider includes the company structure and its capacity for action (Agrawala, et al., 2011; Wiegelmann, 2012). The underlying philosophy of the company and the influence of its board of directors, each of which uniquely impacts the organisation, play a significant role in shaping how the company is managed. These elements affect the organisational structure, human resource standards, and ethical values of the company (Wiegelmann, 2012). A company's capacity is, in part a consequence of its structure, alongside other factors. Technical capacity, financial resources, company size and the existing policy instruments, laws, and regulations collectively determine the extent of the company's ability to achieve specific goals.

A company's capacity is a result of the company structure, among other factors. The technical capacity, financial capacity, the size of the company, and the current policy instruments and laws and regulations all influence how much a company can do to reach a certain goal (Clement, 2010; Agrawala, et al., 2011). Another means to reach the goal of profit is risk appetite. An organisation's risk appetite is inherently unique, shaped by its strategic objectives and the dynamic conditions within its industry and markets. In the context of real estate development decision-making, an unfavourable outcome is typically identified when, a decision fails to achieve the desired result (IRGC, 2017). As external factors always play role, risk appetite will be added to the group of factors belonging to company structure, as the final decision of risks to be taken is in hands off the people leading said company.

Wiegelmann (2012) discusses multiple theories and frameworks that describe risk management processes. A first one is an eight-component procedure: internal environment, objective setting, event identification, risk assessment, risk response, control activities, information and

communication and monitoring. Each of these components touches on concepts and variables discussed in other studies performed (Agrawala, et al., 2011; IRGC, 2017; Attoh, de Bruin, Goosen, van Veldhoven, & Ludwig, 2022).

Before initiating such a process, specific corporate objectives must be identified. However, many companies do not view risk management as a continuous and dynamic process, leading to a failure in aligning management practices with the organisation's risk appetite (Wiegelmann, 2012). According to Agrawala, et al. (2011) most companies focus only on the direct impacts of climate change, specifically extreme weather events, while only fewer companies consider the indirect risks and broader implications. A company's capabilities and priorities influence the kind of risk assessment that occurs, which could partly cause a gap between its assessment and implementation. This could mean that certain companies feel like they are addressing climate change risks adequately, even though reality is different.

§2.5 Land subsidence and structural damage in Amsterdam

Van den Born et al. (2016) delineate the different processes that lead to subsidence and settlement of peat soil in the Netherlands. Land subsidence causes various issues depending on the location and the type of structures and subsoil management that is enforced.

The three processes that cause land subsidence are: consolidation, shrinkage, and oxidation. Consolidation occurs when the groundwater level in peat soil is lowered, reducing the upward pressure, and increasing the compression of the subsurface. Shrinkage occurs when dehydration causes the solid soil particles to be pressed together (TNO, n.d.). Oxidation occurs within the soil above the groundwater level as incoming oxygen decomposes organic material. Collectively these lead to soil subsidence. Settlement is the compression of soil due to external loading.

This study will focus on the land subsidence in issues in Amsterdam, therefore this contextualisation will mostly discuss land subsidence issues in urban areas and structural damage costs instigated by the deterioration of wooden piles that serve as foundations for buildings.

In urbanised areas, peat soil subsidence primarily arises from soil settlement, typically induced by loading on the soft ground. The extent of settlement heavily depends on local conditions and the physical loading. On average, settlement amounts to a few millimetres per year (van den Born, et al., 2016). Insufficient consideration of soil settlement in the past has led structural damage to many buildings and infrastructure. Consequently, in historical city centres, there are limited solutions for counteracting subsidence. Addressing house and infrastructure subsidence is both technically intricate and expensive (van den Born, et al., 2016; Kok, van der Putten, & Kraus, 2021; RLI, 2024). From the Middle Ages, three different types of wooden foundations were common: (1) 'on ground', using horizontal timber constructions, (2) 'on adhesive' using short timber constructions driven into the ground and, (3) 'on point' using piles long enough to reach the solid sand layer beneath the peat (van den Born, et al., 2016). Given the age of these foundations, identifying the specific type of foundation beneath each building and their qualitative state poses a challenge (Kok & Angelova, 2020; RLI, 2024).

Buildings constructed prior to 1975 using the 'on point' method are susceptible to four distinct threats leading to structural damage (Deltares, n.d.; Kok & Angelova, 2020). Firstly, piles that do not reach the solid sand layer beneath the peat are susceptible to sinking into the soft peat, rendering them incapable of supporting the structure (Klaassen, 2015). Secondly, piles may experience increased loading due to soil settlement adhering to them, causing them to sink further into the ground, a phenomenon termed *negative friction*, problematic in cases of uneven subsidence

(Klaassen, 2015; Kok, van der Putten, & Kraus, 2021). The third threat involves bacterial decay of wood underwater. Certain wood species may completely lose their load-bearing capacity within fifty years across the entire length of the pile. Lastly, *pile decay*, resulting from fungal growth, occurs due to fluctuating groundwater levels, sometimes exposing the wooden piles to air, causing them to rot (Klaassen, 2015; van den Born, et al., 2016; Kok, van der Putten, & Kraus, 2021). In urban areas, a balance needs to be found between dry streets and basements, and water coverage of the wooden piles. On a local scale, factors such as temporary dewatering for construction projects, maintenance of waterways, adjustments in surface water levels and the type and quality of sewage systems, can impact the groundwater level, making its management a complex issue (Klaassen, 2015; van den Born, et al., 2016; Kok & Angelova, 2020; Kok, van der Putten, & Kraus, 2021).

These risks of damage to buildings and foundations typically occur mainly in the most settlement-sensitive areas. These areas are depicted in red in Figure 1. Not only does subsidence damage affect these buildings on a local scale. It can also lead to the deterioration of entire neighbourhoods. Owners often refrain from investing in their properties while awaiting foundation repairs. Consequently, the value of real estate in the entire neighbourhood may decline. Especially in already socio-economic vulnerable neighbourhoods, subsidence damage issues could ultimately impact the well-being of all residents (RLI, 2024).

3. Theoretical framework

This theoretical framework aims to provide a comprehensive lens through which to examine the complexities of risk perception and decision-making processes within redevelopment projects in the inner city of Amsterdam. This framework aspires to lead to a conceptual model that offers valuable insights for policymakers and practitioners to catalyse and improve land subsidence adaptation measures. This will be done by using insights gained during the literature review, decision theory and the IRGC framework created by the “International Risk Governance Center” (IRGC). The concepts discussed will be adopted to fit both the scope of this thesis and the perspective of the real estate market.

§3.1 Risk perception and its external influences on decision making.

Firstly, the theories and concept that make up the independent variable, risk perception, and the context within which these relations occur will be clarified in this paragraph.

The garden greening model adopted by Stobbelaar, van der Knaap, & Spijker (2021) describes the many steps that occur prior to actual behavioural change. Beginning with external factors that influence an individual’s awareness and motivational state, the model progresses towards the intention state. At this point, the individual deliberates on whether to engage in a particular behaviour. Clement (2010) argues that the political, historical and economic context in which certain choices are made all influence the actors that make certain choices. Several other theories affirm this assumption, a first is the garden greening model mentioned above, specifically used when tracking behavioural changes. Another model is the planning systems as Institutional Technology by Rivolin (2012), this model emphasizes how political, economic and discursive dynamics influence planning cooperation meant to decide the collective action for the use of space. Similarly, the Policy Arrangement Approach by Arts, Leroy, & van Tatenhove (2006), acknowledges how interactions between actors putting policy into practice on the one hand, and processes of social and political change on the other hand, influence the final result. The overlap between these models highlights the significant role of the institutional and political context in which decisions are made. This context is crucial to this study, as it frames the environment in which the studied relationships occur. It is also assumed that predisposing factors and risk perception, in a way similar to how they influence behaviour, influence decisions (which in turn determine behavioural outcomes). French & French (1997) define the act of decision making as the judgements involved in leading to a deliberate and usually rational choice. The theory that studies this rational choice making is also known as decision-theory, but rarely captures the whole thought process which influences certain choices. Within decision theory several schools of thought exist, of which a pair has been chosen to explain the separate steps occurring within organisational decision making. Besides individual decision theory, collective decision theory also exists. It is meant to model situations in which decisions are taken by two or more persons, who may have conflicting interests or different opinions on how to reach certain goals (Hansson, 2005). Collective decision theory often concerns itself with voting, bargaining and other methods for combining individual preferences into collective decisions (Hansson, 2005, p. 80). One also needs to acknowledge that the stages of decision making, whether it be an individual or organisational choice, may occur simultaneously and the steps of making a choice may also occur iteratively, as mentioned by Witte in Hansson (Hansson, 2005, p. 11). This emphasizes the importance of including individual choices when looking at organisational decision-

making and why this study merges the theories of individual risk perception, contextual influence, individual and collective decision-making to create the conceptual model.

In conclusion, risk perception plays a crucial role in shaping decision-making processes, particularly in complex environments where various stakeholders assess potential risks and benefits. Understanding how risks are perceived can reveal underlying biases that guide their choices. To further explore how these perceptions and the context translate into decisions, it is essential to examine decision-making and the several steps in a thought process that lead to the making of said decision. The following paragraph will discuss the International Risk Governance Center Framework which integrates different factors that make up the decision process.

§3.2 Decision-making with the International Risk Governance Center Framework

The IRGC framework (see Figure 4) is a comprehensive approach designed to help identify, analyse, and manage risks in a structured and inclusive manner. It consists of several interconnected elements that each serve a specific purpose in the risk governance process, starting with understanding of the risks and leading to a decision (IRGC, 2017). The framework addresses challenges of managing complex and uncertain risks through several principles: system thinking, structure, inclusive stakeholder engagement, transparency and communication, evidence-based decision-making, and adaptability.

The framework advocates for a multidisciplinary and multi-stakeholder approach to risk governance. It considers diverse perspectives and expertise which help in understanding the interconnected nature of risks and their potential impact on society. Additionally, it provides structure for identifying, analysing, and managing risks. This systemic approach helps in breaking down complex risks into manageable components. By emphasising stakeholder engagement, the framework includes a wide range of voices and interests that need to be considered in the risk governance process. This inclusivity helps in addressing diverse concerns, norms and values, and perceptions, leading to a more informed and possibly more successful risk management. Moreover, it stimulates transparency, which helps build trust among stakeholders and by encouraging decision-makers to base their actions on scientific evidence and societal values and interests (IRGC, 2017). Another strength of the framework is its recognition of the dynamic nature of risks and their evolving complexities. It still allows for adjustments in management style while ensuring resilience when facing uncertainty. The framework exists out of four parts, with the overarching concepts and context depicted in the centre of the model.

The first element is pre-assessment. This initial stage involves defining the boundaries of the risk under consideration. It aims to clarify the scope of the risk and establish a common understanding among stakeholders. The second element is

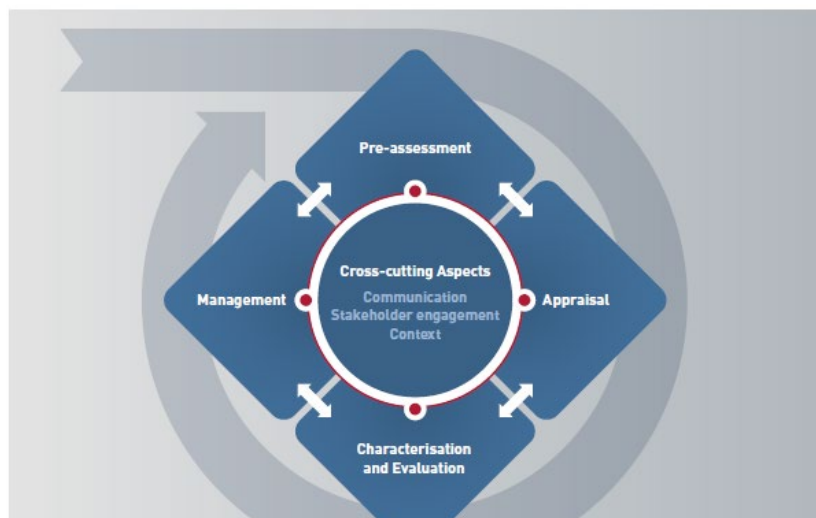


Figure 4: Visual representation of the IRGC Risk Governance Framework. Source: (IRGC, 2017).

appraisal. In this phase risk and concern assessment occur. This entails the evaluation of the technical and perceived causes and consequences of the risk. Exposure and vulnerability are assessed. Scientific evidence, experts opinions and stakeholder perspectives are gathered to determine the different visions on risk perception and social concerns (IRGC, 2017). The third step is characterisation and evaluation, which involves passing judgment on the seriousness of the risk based on the information gathered in the previous phase. It includes determining the need for risk management actions and evaluating potential strategies to address the risk. The fourth step is management, which revolves around decision-making and implementation. This stage focuses on deciding and implementing available and suitable risk management options. This can vary from involving appropriate risk mitigation measures to monitoring the effectiveness of interventions.

In the centre of the framework the so-called cross-cutting aspects communication, stakeholder engagement and context are represented. Effective communication is essential throughout risk governance to ensure transparency, trust and facilitate stakeholder engagement. Several stakeholders need to be involved to create a diverse pool of norms, values and concerns, to address the risk in the most informed way possible. The entire risk management process occurs within a broader social, political, economic, cultural and even institutional context. Understanding this is crucial for specific risk governance strategies (Clement, 2010; IRGC, 2017).

§3.3 Conceptual model

Based on the concepts discussed in chapter 2 and 3 the conceptual model in Figure 5 has been established. This model depicts the assumed relations between the variables that play a role in the decision-making process.

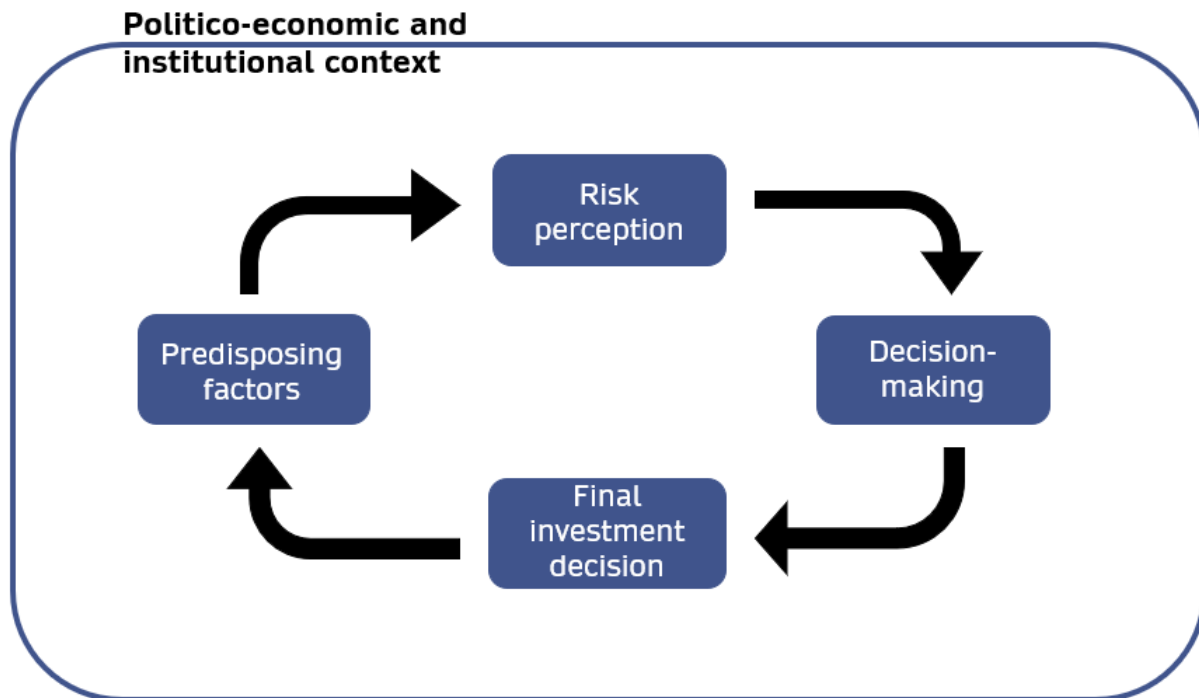


Figure 5: Conceptual model depicting the assumed relations. Source: Made by author.

This study is based on the assumption that the independent variable (risk perception) influences the dependent variable (decision making). This relation is influenced by the predisposing factors, while simultaneously also influencing them.

The assumed relations will be tested against primary data to further explore and determine how and to which extent these variables interact with each other. Creating a simplified version of reality gives the opportunity to further dissect each variable to a measurable indicator. This operationalisation will be described in detail in the following chapter.

4. Methodology

This chapter will present the justification of the underlying philosophical approaches and further methods that were used in this research. This includes the research paradigm, research philosophy, research strategy, time horizon, research tactics, the operationalisation of the theoretical framework, methods of data collection and data analysis. These selected perspectives and techniques will be explained using a revised version of the Saunders ‘research onion’ (see Figure 6) metaphor provided by Haydam & Steenkamp (2020), as the different ‘layers’ of research design are often confused with one another (van Thiel, 2014). Hereafter, the limitations of this research will be presented by discussing its validity and reliability.

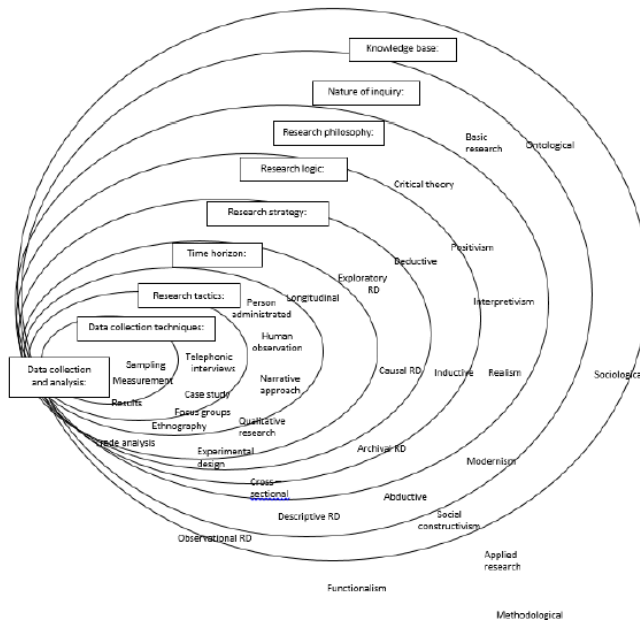


Figure 6: The revised ‘research onion’ adopted from Saunders (Haydam & Steenkamp, 2020).

§4.1 Research paradigm, philosophy, and strategy

The outermost layer of the research onion, depicts the knowledge base, also known as the research paradigm. A researcher’s understanding and associated decisions in relation ontology, epistemology and theoretical perspective provide the context and boundaries of research (Saunders & Tosey, 2012, p. 58; Moon & Blackman, 2014). What exists in the world on which knowledge can be acquired on and what reality is can be regarded as ones ontological views. For this research a relativist ontology has been adopted. Relativist ontology holds that there is no such thing as one true reality; reality is relative according to each individual who experiences it at a given time and place (Moon & Blackman, 2014, p. 1170). Relativist research typically centres on the individual, emphasising human decision-making, behaviour, emotions, and experiences (Brown, 2003; Kolkman, Veen & Geurts, 2007, as cited in Moon & Blackman, 2014). This makes relativism the better choice for this study as risk perception and decision-making are the two concepts that will be analysed and are highly personal.

The epistemology adopted in this research is primarily subjectivist, with some constructionist influences. Epistemology concerns the researcher’s beliefs about what things can be seen as

knowledge, and subsequently how it is acquired (Moon & Blackman, 2014). Subjectivism entails that knowledge is dependent on how people perceive and understand reality. Interests, purposes, values, and experiences of individuals all shape reality, making it a pluralistic concept, given meaning in one's mind (Moon & Blackman, 2014). A constructionist approach states that knowledge is constructed as one engages with the world, emphasizing the role of social constructs (Moon & Blackman, 2014). How an individual engages with the world around them is based on cultural, historical, and social perspectives, meaning is derived from interaction with one's surroundings (Crotty, 1998; Creswell, 2009, as cited in Moon & Blackman, 2014). This research adopts the notion that the constructionist and the subjectivist approach co-exist. Risk perception is an individual experience but is also shaped by the experiences one has with their surroundings (Haasnoot, Diermanse, Kwadijk, de Winter, & Winter, 2019; Lorencová, Loučková, & Vačkářů, 2019). The same goes for decision-making processes, as an individual will always be influenced and steered by their environment to make certain choices (IRGC, 2017). A lot of risk perception research uses subjectivist epistemology as people tend to perceive risk on the basis of very personal experiences (Burgman, 2005, as cited in Moon & Blackman, 2014). Examining the perceptions of land subsidence risks on the basis of emotions, values, trust, and worldviews, provides important insights into the factors that contribute to individual behaviour, while also acknowledging that interaction with one's surroundings shape the meaning given to risk perception (Fishbein & Ajzen, 1975; Slovic, 2000, as cited in Moon & Blackman, 2014).

As per the next layer of the onion, the nature of inquiry for this research is applied empirical research. Risk perception, also within the context of climate change and its associated risks, is a concept that has been researched a lot (Moon & Blackman, 2014). This study aims to provide relevant information to improve the position of independent homeowners within the real estate market.

The research methodology employed in this study adheres to a framework that encompasses both post-modernist and emancipatory research philosophy. Firstly, post-modernist philosophy challenges traditional notions of objective truth and emphasizes the importance of multiple perspectives and interpretations. In the context of land subsidence risk perception and decision-making, adopting a post-modernist approach gives space to acknowledge the complexity and subjectivity inherent to how individuals perceive and respond to risks. Rather than assuming a singular, objective reality, this philosophy encourages an exploration of diverse viewpoints, which is essential when conducting research on risk perception (Moon & Blackman, 2014; Haasnoot, Diermanse, Kwadijk, de Winter, & Winter, 2019).

Secondly, an emancipatory research philosophy seeks to empower marginalized voices and challenge existing power structures. In the context of land subsidence, certain communities or individuals may be disproportionately affected by the risks, yet their perspectives and concerns may be overlooked or marginalized in decision-making processes. Adopting an emancipatory approach gives space for this research to focus on the voices of the independent homeowners while simultaneously creating transparency within the spheres with more power (Moon & Blackman, 2014; Koster & van Ommeren, 2015; RLI, 2024).

The research logic employed in this study follows a deductive research approach as it is based on a framework found during the secondary data collection (Bryman, 2016). The conceptual model functions as a guiding framework, facilitating the investigation into whether the observed processes align with the proposed theoretical constructs as the nature of this research is exploratory.

§4.2 Case description

The case area chosen for this study is part of the historical city centre of Amsterdam. The area is the UNESCO World Heritage Site known as the “Seventeenth-century Canal Ring Area of Amsterdam inside of the Singelgracht” and a part of the inner city centre of Amsterdam. This chapter will explain why this area was selected and describes its characteristics. The geography of the city of Amsterdam and the case area are briefly introduced and described as well as the current state of the housing market and the role each stakeholder plays in upholding the status quo.

§ 4.2.1. Geography

Amsterdam is the capital of the Netherlands and is its most populous municipality with 931,298 inhabitants in 2024 (CBS, 2024). Located in the Western part of the country, see figure 7, the city is subjected to natural land subsidence. Additionally, the weight of the buildings and infrastructure in the city in combination with the regulation of the groundwater level, make the risk of structural damage quite high (Kok & Angelova, 2020; Herrera-García, et al., 2021). Therefore it was expected that relevant information could be gained by researching stakeholders and their relations in an urban area that has these characteristics. The fact that the area is a UNESCO World Heritage Site highlights its historical and cultural value and the importance of preserving its original state.



Figure 7: Map of the Netherlands with Amsterdam indicated on the map. Source: Vecteezy (2024).

The case area makes up the majority of the historic city centre of Amsterdam and was constructed to serve as a new ‘port city’ at the end of the 16th century. The development includes a network of four canals to the west and south of the historic old town and the medieval port, which encircled the old town and was accompanied by the city’s fortified boundary, the Singelgracht, see figure 8. The long-term program involved extending the city by draining the swampland, utilising a system of canals in concentric arcs, and filling the intermediate spaces. These spaces facilitated the development of urban infrastructure characterised by gabled houses and monuments. This urban extension was the largest and most homogeneous of its time, serving as a model of large-scale town planning that was referenced globally until the 19th century (UNESCO, 2024).



Figure 8: The UNESCO World Heritage Site “Amsterdam Canal District”. Source: (UNESCO, 2024)

According to Deltares (Deltares, n.d.), buildings constructed prior to 1975, whether on wooden pile foundations or ‘steel’ foundations, are vulnerable: wooden piles can suffer damage if exposed to air for extended periods, while ‘steel’ foundations can be compromised by the uneven settling of soft clay soils. The canal district of Amsterdam is built on wooden piles, for that reason that will be the only category of buildings looked at during this thesis.

§4.3.1 Data collection

In this study, data has been collected in several ways. First, research started with secondary data collection. This refers to the literature review, the theoretical framework and documents retrieved for document and discourse analysis. Document and discourse analysis are part of a qualitative research approach as language and rhetoric used in speech and text influence the perception of the information that is being communicated (Karppinen & Moe, 2012).

Afterwards, data was collected through means of interviewing stakeholders. Conducting interviews as a primary means of data collection allows the capture of rich narratives and perspectives of participants (Bryman, 2016). These individual social conceptions and their interpretations is facilitated through interactive engagement between the researcher and research participants. This process involves employing conventional explanatory techniques alongside dialectal interchange to compare and contrast different experienced realities.

Secondary data collection

First, a literature review was performed as a first step to uncover which information was already available on the topic and how both scientific literature as well as grey literature report on the topic. For the scientific literature the search engines Google Scholar and the Radboud University's online library have been used. The search prompt and the keywords all revolved around climate change, climate risk, real estate, decision-making, drought, land subsidence and similar. Any other literature was derived through the snowballing technique. The same data collection method was applied for the theoretical framework. The grey literature was derived from the search engine Google, found within mainstream media and through recommendation of peers working at RYSE. The grey literature consists mostly of media reports or articles written by experts in the field and thus inherently assumed reliable for the purpose of this study.

Secondly, a document and discourse analysis were performed to gain a more qualitative understanding of the different structures of risk perception and the context it is shaped by. The document analysed in this study is the uncorrected stenogram of a political debate called "Funderingschade aan woningen". According to Gee (2011), judgements of relevance decide what ultimately is deemed relevant to the arguments of the analysis and what even makes it into the documents that have been analysed as a step even prior to analysis. These are based on theories of how language, the user and the context interact. In that sense, a transcript of itself, whether it be narrow or broad, is also part of the analysis (Gee, 2011, p. 117).

Primary data collection

The second method of data collection involved conducting interviews. Given the research's predominantly subjectivist epistemology and exploratory nature, interviews provide a flexible approach, allowing for the interviewees' perspectives and opinions to offer rich, detailed and sometimes unexpected responses (Bryman, 2016). A semi-structured interview approach was adopted, using an interview guide to ensure that all key topics were addressed. However, interviewees were given enough flexibility to explore additional topics or ask questions not included in the guide. This allows them to emphasise how they frame certain phenomena, providing deeper insights into the thought process of real estate investment decisions that face structural damage due to foundation issues. The interview guide can be found in Appendix I.

The respondents were chosen for the interviews to acquire a better understanding of the developments around structural damage in recent and coming years. For this reason, market-oriented, governmental and science-oriented actors were interviewed. This was done with the aim to acquire a

more in-depth understanding of the relations and standings of the public and the private sector that are active in spatial development within the planning system. The interviewees were chosen on either their experience or knowledge on the topic of structural damage, real estate investments, civil engineering or planning systems. They were recruited through either online searches or mutual contacts. Table 1 provides an overview of the respondents interviewed for this study.

#	Respondent	Profession
1.	Research agency I	Senior Hydrologist at Fugro
	Research agency II	Expert advisor Urban Water and Soil Management at Deltares
2.		
3.	Strategic advisory board	Advisor at the Council for the Living Environment and
4.	Housing corporation I	Head of real estate at Parteon
	Research agency II	Technical Advisor at Deltares and Associate Professor at TU Delft
5.		
6.	Scientific community	Professor of urban planning and area development at Radboud University

Table 1: Overview of respondents.

§4.3.2 Data analysis

In this study, the literature review, document analysis and interviews are the primary sources of data. First, the conducted interviews have been recorded - where needed additional notes were made - and transcribed in order to process the data. As the interviews were held in Dutch, the transcriptions are in Dutch as well. Once transcribed, the data was analysed using the dimensions, variables, and indicators identified in the operationalisation (Table 2). The qualitative analysis tool ATLAS.TI was employed for coding, with the code list staying the same as the operationalisation.

The document “Funderingsschade aan woningen” was also analysed using ATLAS.TI. A similar technique to the interviews was used on this document. Additionally, a discourse analysis was added to the coding. This approach allowed new themes and perspectives to emerge organically (Karppinen & Moe, 2012). This step was essential, as it revealed how governmental actors within the political arena perceive and address the issue. This adds another layer of information to the analysis increasing its external validity (Bryman, 2016, p. 384)

§4.3.3 Operationalisation

In order to break down the experiences and perspectives of respondents and analyse the data retrieved from the interviews, it is imperative to explain the concept of land subsidence risk perception and its influence on the decision-making process. This operationalisation, Table 2, has been based on a synthesis of dimensions and variables explained in the literature review and further specified in the theoretical framework. These findings, pertaining to the factors influencing risk perception and the functioning of decision-making, serve as the foundational premise of this research.

The column of indicators allows for the variables to be recognized and categorised during data analysis and to identify potential patterns and highlight certain themes.

Concept	Dimension	Variable	Indicator	
Risk perception Influence on Investment decision- making process	<i>Risk perception</i>	Risk awareness	Mentions acknowledgement of risks or mitigation measures	
		Availability	Mentions specific events	
		Choice avoidance	Refusal of behavioural change	
		Optimism bias	Downplaying personal vulnerability	
		Anchoring effect	Inability to remember new information	
		Cognitive dissonance	Refusal of new information contradictory to beliefs	
		Knowledge	Familiarity with causes, consequences and specific cases	
		<i>Decision-making</i>	Risk Identification	Mentions specific hazards, contributing factors or warning signs
			Concern assessment	Expression of anxiety or worry, fear, potential consequences, impact on stakeholders or probability assessment
			Seriousness Judgement	Use of direct language, relative risk evaluation, prioritisation, impact, assessment or mentions irreversibility
Option assessment	Mentions explicit comparisons, ranking, CBA, trade-offs, preferences, time constraints, short/long term comparisons or references data			
	Implementation	Mentions practicality, logistical challenges, time estimates, role definition, stakeholder engagement or communication		

Predisposing factors

Physical environment	Mentions exposure to and from infrastructure, impact on landscape, groundwater issues, natural vs. human induced subsidence or post-war neighbourhoods
Socio-economic conditions	Mentions health concerns, low income neighbourhoods, social cohesion, cultural significance or personal impact
Path dependency	Mentions historical context, resource allocation, stakeholder roles, community memory, cultural attitudes or feedback loops
Media discourse	Mentions public awareness, information sources, representation, framing or community engagement
Political-economic conditions	Mentions post war neighbourhoods, economic drivers, power dynamics or external political or economic conditions
Capacity for action	Mentions financial power, company size, inside knowledge or current laws and regulations
Company structure	Mentions organisational hierarchy, ethical values, CSR or risk appetite
Institutional context	Mentions institutional roles, policy frameworks, institutional history, coordination or responsibilities

Table 2: Operationalisation of the influence of risk perception on the investment decision-making process based on a collection of scientific literature. Source: (Hansson, 2005; Clement, 2010; Agrawala, et al., 2011; Brulle, Carmichael, & Jenkins, 2012; IRGC, 2017; Haasnoot, Diermanse, Kwadijk, de Winter, & Winter, 2019; Lorencová, Loučková, & Vačkářů, 2019; Stobbelaar, van der Knaap, & Spijker, 2021). Table made by Author.

§4.4 Validity and reliability

Validity and reliability are essential pillars of research integrity, ensuring the credibility and trustworthiness of findings (van Thiel, 2014, p. 48; Bryman, 2016). Even though they are closely interconnected, these concepts pertain to various aspects of research. Bryman (2016) addresses many forms of testing measurement validity and reliability, however due to the scope of this research, this study will focus only on external and internal validity and reliability. This section will discuss how these concepts have been considered in this study.

§4.4.1 Validity

Measurement validity refers to the accuracy and appropriateness of conclusions drawn from data, ensuring that the study measures what it intends to measure (Bryman, 2016, p. 158). It ensures that the results of a study are credible, accurate and applicable to the real world. Without validity, research outcomes may lack relevance or misrepresent reality.

The correspondence between a researchers' observations and the theoretical ideas and conclusions they develop is referred to as internal validity (Bryman, 2016, p. 41). The validity of this study rests upon its comprehensive examination of the influence of land subsidence risk awareness on the decision-making processes of stakeholders involved in redevelopment projects within Amsterdam. By employing an approach that integrates both theoretical frameworks and empirical data, this study aims to provide a nuanced understanding of how the respondents perceive, assess, and respond to the risks associated with land subsidence. For this study to achieve a high internal validity it is imperative that the conclusions drawn from the results are clearly derived from the collected data. Due to its in-depth operationalisation and subsequent data analysis, it can be stated that internal validity for this study is high (van Thiel, 2014).

The degree to which findings can be generalised across social settings is known as external validity (Bryman, 2016, p. 384). It describes to which extent the results of this study can be applied to other populations or contexts beyond the specific conditions under which the study was conducted (van Thiel, 2014, p. 49). As this study relies heavily on context and individual experiences, generalisation across different populations is difficult, making its external validity low (Bryman, 2016, pp. 41-22). Generalisation is difficult because the results are limited to the context in question (Flyvbjerg, 2006). To ensure external validity as best as possible, a wide range of stakeholders can be interviewed to gather many different individual experiences. However, this proved difficult, keeping the external validity for this study on the low end. Comparing the results of similar studies could give further insight into this study's external validity.

§4.4.1 Reliability

How consistent and reproducible a study is, is addressed by its reliability. It ensures that the study's findings can be replicated and trusted. The accuracy and consistency with which the variables are measured determine the study's reliability (van Thiel, 2014, p. 48; Bryman, 2016). The operationalisation of the variables helps to increase consistency, ensuring the results will be systematic and representational rather than coincidental. The results of the interviews will then provide evidence for a causal relationship (Marugg, 2022). Repeatability is a second concept referred to by consistency. Under identical conditions, the same measurements will lead to comparable results, proving its accuracy. However, in social sciences this might be difficult to achieve as the researchers' interpretation influences the method by which information is extracted from the data (van Thiel, 2014, p. 48). Clear transparency on each step taken during the research and a section on (possible) implications, may also increase this study's reliability as it offers information on how possible future research could rely on and use this study.

5. Results

In this chapter, the results from the interviews and the document review are described. This chapter aims to explore the significance of the results, examining how they contribute to the current body of knowledge existing in scientific literature, while also addressing any unexpected outcomes. The results are analysed and structured per dimension as categorised in the operationalisation (Table 2). It is imperative to acknowledge that even though these variables have been categorised, it is possible for them to exist within multiple dimensions simultaneously.

Additionally, the conceptual model has been used to structure this chapter. Any inductively obtained indicators that were not included in the initial literature review and operationalisation are presented in this chapter, as they will serve to update the conceptual model in the final chapter.

Any interpretations and citations from the interviews discussed in this chapter have been translated from Dutch to English by the author with extra attention to not change the intended meaning of the quote.

§5.1 Results on predisposing factors

As noted by French & French (1997), the risk of an undesired consequence differs from the risk of making a decision. This instantly became clear in several interviews when the introduction was made on the case study area. Several respondents explained why Amsterdam was both an interesting case to study, and possibly overstudied due to the uniqueness of the case. Nonetheless, relevant results were drawn from the interviews.

Respondents I and II gave remarkably similar information on the case area. Both respondents mention how the city of Amsterdam has been dealing with the structural damage issue for a long time, referring to its path dependency. Not only has the city been controlling the water levels since it came into existence. Humans living in the Netherlands have been regulating water levels since the Middle Ages. The fact that the waterboards were the first democratically elected governmental bodies in The Netherlands emphasizes the importance of regulating those water levels for all citizens.

Respondent I talked about how Amsterdam, from a policy and climate adaptation standpoint, demonstrates a high level of organisation, supported by stringent and leading laws and regulations. Compared to other cities, Amsterdam is significantly more proactive in addressing foundation-related issues. The city is characterised by a large number of pile foundations, and the favourable price per square meter often leads to an interesting phenomenon: during foundation repairs, homeowners frequently opt to add a basement beneath their properties. This not only increases the property's value, but also enables homeowners to cover the costs of the foundation repairs almost immediately. Additionally, most residents in the case study have a high socio-economic status and are not financially restrained due to the high value of their properties. This presents a unique scenario, as similar solutions are unfeasible in cities with lower property values.

Respondent II corroborates these findings, emphasizing that the high property values in Amsterdam allow homeowners to leverage the surplus value of their properties to secure additional funds for foundation repairs. According to the respondent, the most severe foundation-related problems are typically found outside the historic city centres, in neighbourhoods with lower socio-economic status. These areas are often characterised by homes with no historical value, hastily constructed in the post-war period, which consequently perform poorly in terms of liveability, energy efficiency and other sustainability factors.

On top of that, there are very few foundation restoration companies, resulting in limited capacity to address these issues. Despite the fact that sufficient knowledge now exists to effectively manage structural damage, as noted by Respondents I and VI, the industry' capacity for action remains constrained. It also explains why only stakeholders with sufficient financial funds are capable of commissioning restoration, as a lower service provision leads to higher costs.

Due to a complex bureaucratic web, allocating funds to the right place is complicated. The interview with Respondent I revealed that certain stakeholders within the market sphere definitely have the knowledge and willingness to address the issue. However, these individuals are still tied to how funds are spent – once money is allocated to a specific budget, it cannot simply be reallocated to something else. The same goes for municipalities. Respondents I and VI mention how several issues need to be dealt with simultaneously, reducing the capacity for action a stakeholder has. Especially smaller municipalities are easily overwhelmed with the tasks they face in the light of climate risks.

Another indicator of a stakeholder's capacity for action is financial power. Heavily influenced by the institutional and politico-economic context it exists in, money plays a large role. A large portion of the Governmental Debate revolved around and whether the government should offer monetary compensation to homeowners struggling, and if so, in which shape and to what extent. The mere fact that this is an option increases the likelihood that discussions on this topic could continue for a long time, while the problems worsen in the meantime. Respondents I and VI highlight this as one of the simplest steps in the process, emphasizing that everything nowadays is expensive and cannot be avoided. The sooner, the better.

A stakeholder's decision-making process is also influenced by the internal structure of the organisation. Both government and market actors must navigate structural foundation issues, guided by a complex interplay of ethical values, organisational hierarchy, and corporate social responsibility (CSR). Each interview discusses how those factors shape priorities and accountability mechanisms within and between organisations. A lack of ethical values and accountability causes the low transparency in communication. Additionally, decisions on how to approach foundation issues may be delayed through multiple levels of management which can create bottlenecks. Each layer of individuals needs to feel the urgency of the issue before it gets addressed. Rigid hierarchy, like in The Netherlands, can hinder effective communication between departments and sectors due to an individualised approach. This individualism lets companies to want to secure their own stability, regardless of the negative consequences for other actors. The market functions freely and the institutional and political context allows for this to happen.

Both physical surroundings, pre-existing institutional, political and socio-economic conditions influence an individual's risk perception (Lorencová, Loučková, & Vačkářů, 2019; Stobbelaar, van der Knaap, & Spijker, 2021). Media discourse and framing perspectives also have an impact on risk perception in similar ways as to how physical surroundings and exposure to certain factors (nature in the case of Stobbelaar, van der Knaap & Spijker), in this case structural damage to infrastructure.

In the case of Amsterdam, stakeholders possibly getting involved in redevelopment projects in the city, probably are very aware of the issue. However, real estate investments are very low risk due to the high value of real estate in Amsterdam's inner city.

Another interesting finding within this theme is how Dutch water technology influences risk perception. All over the world and throughout the country the Dutch showcase their mastery over water, e.g.: polder systems, land reclamation, locks and storm surge barriers. Many people might have the perception that the government will protect them or solve the issues surrounding water management (Haasnoot, Diermanse, Kwadijk, de Winter, & Winter, 2019). This form of optimism

bias created by path dependency decreases risk perception and might be the most difficult to change. Respondent VI remarks it be a factor as to why land subsidence, and other climate related risks, have not yet been incorporated into the housing price.

In short, the way government actors, market actors and homeowners or tenants experience structural damage risks – if they experience them at all – varies depending on the combination of external factors. In the case of the inner city of Amsterdam, a combination of knowledge and a high socioeconomic status seem to give the stakeholders complete control over the situation and taking away a lot of the uncertainty around structural foundations. The benefits weigh more heavily than the consequences, completely diminishing the perceived risks.

§5.2 Results on risk perception

As results showed in the previous section, these structural foundation risks for the inner city of Amsterdam, due to the uniqueness of the case, do not outweigh their benefits. A combination of favourable housing prices, takes away all uncertainty, leaving no risk to be perceived (Wiegelmann, 2012).

Consistent with the findings of Stobbelaar, van der Knaap & Spijker (2021), it was found that information and knowledge significantly shape risk perception. Interviews with respondents indicate a high awareness of the risk and its importance, suggesting that access to information leads to a higher perception of risk, as all respondents are experts on the topic or have experience in dealing foundation issues. However, as Eren, Merten, and Verhoeven (2022) argue that the lack of standardized methodologies and reliable information complicates the process of incorporating these risks into housing prices, further hindering the adoption of comprehensive risk mitigation strategies in the real estate sector. Although this issue has national implications, respondents assert that a comprehensive understanding of how to restore structural foundations already exists and that the necessary expertise to address the problem is already available.

Besides knowledge and access to information, media discourse and framing also influences risk perception. It shapes public awareness, attitudes and eventually behaviour (Stobbelaar, van der Knaap, & Spijker, 2021). Over the years media has covered multiple instances wherein the municipality had to deal with subsided homes publicly. Reporting on the issue in a clear, positive, and understandable way might have even mitigated fear and encouraged proactive measures. This reduces the uncertainty factor of risk, giving stakeholders the idea of control.

The results found that risk perception plays an interesting role on decision-making in real estate investments in Amsterdam. While business activities are inherently risky, this does not necessarily mean that land subsidence risks are adequately accounted for (Merten & Verhoeven, 2022; RLI, 2024). Leaving the party that acknowledges these risks as the less profitable, as ignoring them currently has no negative material consequences.

As previously mentioned, path dependency has played a big role to create the current situation. The capacity for action and politico-economic conditions wherein stakeholders can function is greatly shaped by culturally ingrained acts. Behaviour is difficult to change and requires many factors to actually set thought into action. What Stobbelaar, van der Knaap & Spijker (2021) describe in their model, Respondent II describes as a “*follow the money*” strategy. Even if risk awareness might be the present, it is perceived as not taunting. This leaves the stakeholders to continue taking the ‘risk,’ preferring a quick reward, often monetary, over the possible negative consequences in the face of uncertainty.

It can also be stated that the perceived severity of land subsidence is diminished by the lack of governmental and market-driven measures that would make stakeholders more aware of the consequences (AFM, 2023). This phenomenon also affects homeowners, who may not recognize the risk or choose to ignore it, leading them to believe they are not exposed to any danger. For the stakeholders that are aware of the risks another factor comes into play: personal experience. In Chapter 2 it was decided that this variable would not be included in this study due to the varying results on its relevance in previous studies (Spence, Poortinga, Butler, & Pidgeon, 2011; Brulle, Carmichael, & Jenkins, 2012). However, data analysis revealed that this topic was frequently mentioned, leading to its inclusion under the code 'socio-economic conditions'. This choice was made as data analysis revealed that personal experience often was related to socio-economic status of a stakeholder. Interview III shows an example of this relation, in this case the respondent is talking about tenants from the housing corporation they work for. They mention how tenants become more anxious especially when a renovation project approaches and how they become more alert of their home. They try to manage it or relocate them to another home. However, other tenants feel differently:

"The funny thing is, on the other hand, many tenants feel that the situation is not that bad. It is true that people from the Zaanstreek are more aware of these issues, but they are much more reluctant to leave their homes. They prefer to stay in their homes... Occasionally, we even need the help of the municipality to get these people out of their homes, so we can carry out the necessary repairs."

Having a personal experience with structural damage might not be an issue for the tenants as they themselves will not have to carry the financial costs of repairing the foundation of their home. Relieving them from most of the negative consequences that homeowners might experience during such a situation. Which could play a role in the experienced optimism bias.

Furthermore, public scepticism about climate risks reduces the perceived risk for some individuals, who may not understand the underlying mechanisms or cannot envision structural damage resulting from such events (Lorencová, Loučková, & Vačkářů, 2019). This is especially the case with land subsidence as it is a phenomenon that slowly grows, call it a "creeping crisis", as Respondent V calls it. In combination with the previously mentioned choice avoidance, this might lead to the cognitive dissonance that many stakeholders and even respondents have shown.

The anchoring effect was the least relevant variable in this study. Only being coded four times in the governmental debate, this variable was only signalled in instances where information was seemingly twisted to confuse the conversation and remain ambiguous about perspectives and opinions, not necessarily because there was an anchoring effect. This confirms that political circumstances play a significant role in shaping how this issue is managed. A detailed discussion of this influence, possible options and implementations will be provided in the following section.

§5.3 Results on decision-making

The results of this study reveal significant insights into how the perception of structural damage risks shapes decision-making processes among stakeholders. The findings suggest that risk perception is not merely a reflection of objective conditions. Amsterdam has a long history with dealing with structural damage issues, which makes their policies and regulations for the issue detailed as mentioned by Respondent I. Data analysis shows how differing risk perceptions influence the different steps in the decision-making process. The first step of the decision-making process included in this study is risk identification. In this stage all involved relevant actors are identified in hopes to capture the various perspectives on the risk (IRGC, 2017). All perspectives are combined to frame a

complete picture of the risk. The two main contributing factors have been identified as lack of information and transparency. Both factors influence the decision-making process. This became apparent in the interviews and debate in several ways.

First of all, many choices are evaded or postponed simply because people feel they are not informed enough (RLI, 2024). If one does not understand the scope of the problem or does not know what its causes and consequences are, the urgency to act is low. Respondent V states that some housing corporation employees or policy staff members working for municipalities have no idea about structural damage issues. This can cause bottlenecks already at the start of the decision-making leading to misinformed decisions. A similar issue caused by lack of knowledge or information, is the absence of an obligation to include any information on the state of the foundation when selling property. During the parliamentary debate, Mr. Madlener from the PVV asserted that property buyers have a duty to investigate the condition of the home before purchase. According to him, this obligation is not always adequately met. This framework places the burden of responsibility on the buyer, even before the property has been officially acquired. A moderating factors in this relationship is the state of the housing market. Respondents I, II, IV and V advocate for mandatory inspections of a property's structural foundation. However, in an extremely overheated housing market, buyers are often reluctant to request such inspections as a condition of purchase, fearing it may cause them to lose out on the property. This situation places immense strain on homebuyers, who are already under pressure, and the current level of understanding demonstrated by policy-makers raises doubts about whether any effective decisions will be made to address the issue. Any indication of risk identification has been coded fourteen times in the Governmental Debate. An overarching theme for these fragments is the acknowledgement of the risks, consequences, and rising concern regarding the situation. However, this concern mainly pertains to areas that are not highly urbanised, as the regulation of the surface water level in, for example Amsterdam, has partly caused the issues in other areas.

Another identified risk in the interviews is how it is difficult for municipalities to deal with several issues at once. The government in The Netherlands is decentralising, leaving smaller governmental bodies to create policies, and effectively tackle issues on a lower scale. There are many risks that municipalities must consider both within this issue as all societal challenges combined. Numerous other processes may be occurring that increase the risk and damage to foundations. Renovations at one location can lead to problems elsewhere, as evidenced by the subsidence issues surrounding the Noor-Zuid Lijn in Amsterdam. Additionally, municipalities have to deal with many other issues that societies face, leaving truly little capacity to deal with the issues.

The range of identified risks that have caused and will continue to exacerbate foundation issues is significant. It is challenging to acknowledge the government has amplified the consequences through local policies, as a logical step would also be to take responsibility for those choices. The political debate clearly reveals disagreement between the speakers regarding the extent to which responsibility should be assumed. This is another factor that contributes to maintaining these issues. Dr. Bekerman from the SP states that it is ethically not fair to keep saying "we should all take responsibility" and to then continue exacerbating the issue.

This leads to the next step in the decision-making process: concern assessment. As previously discussed, this theme emerged across all interviews, in varying levels. Respondent III exhibited the lowest level of concern, with only one fragment coded under this theme. This is understandable,

given that this respondent is already actively engaged in efforts to mitigate this issue and perceives the risk of structural damage as being low for his situation.

One might think that a higher concern acknowledgement would also lead to a more cautious approach in decision-making. However, this is not the case. The results of this thesis indicate that while concern assessment regarding the risk of structural damage is notably high among real estate investors, this heightened awareness does not translate into observable changes in behaviour regarding the inclusion of these risks in housing prices, especially in Amsterdam. Respondents consistently express significant worry, recognising its implications for long-term property value, safety and societal health. However, this concern does not lead to a corresponding adjustment in pricing strategies or negotiation tactics. This disconnect suggests that market dynamics and competitive pressures in the real estate sector inhibit meaningful behavioural change. Respondent II confirms this with the following statement:

“It often happens that buyers are rejected when they request such an [structural foundation] inspection. This should carry more weight than having to decide within fifty seconds whether to buy the house or not because otherwise someone else will take it.”

Despite knowledge about the topic, risk awareness and justified concern for structural damage risks, buyers face significant obstacles when attempting to act on their concerns. This suggests that while concern may be present, the market environment and transactional urgency overshadow the ability to address these issues effectively.

Furthermore, data analysis shows that the code concern assessment most often co-occurred with the code socio-economic conditions. The concern or worries expressed regarded the health of homeowners having to deal with the consequences of dealing with structural damage. All respondents and the governmental debate acknowledge that having to deal with the consequences is an awful experience, leading to stress and hopelessness in homeowners. In this case, it is important to consider that none of the respondent nor none of the speakers in the governmental debate have personally experienced the negative effects of structural damage. Excerpts from the transcript reveal concerns regarding these problems, with phrases such as:

“I have also seen people who can shake hands with their neighbours through the cracks in their homes and the emotional toll it takes. These people are financially ruined for the rest of their lives. They are under enormous stress, and it’s truly terrible.” – Respondent I

This specific case is awful and leaves a deep impression on all parties involved, raising their risk perception and probably the following parts of their decision-making process. Unfortunately, many of these insights are gained when the damage is already done.

Concern assessment is closely tied to how seriously the problem is perceived. This is evident in governmental debates, where each speaker begins by invoking an anecdote or an appeal to the imagination, emphasizing the distress caused by deteriorating structural foundations. While this highlights the complexity of the issue – touching on causes, consequences, responsibilities, and urgency – there is a noticeable lack of unified direction. Much of the language used is evasive, as Dr. Beckerman from the SP noted when she pointed out that various organisations, governments, and companies are debating among themselves, all while ignoring the people directly affected, whose homes are already sinking. This behaviour can be seen across all involved stakeholders and is difficult to change as most stakeholders have been avoiding responsibility till now.

Despite this complexity, stakeholders are not excused from the responsibility of finding combined approaches to address the issue. Data analysis reveals that stakeholders are at different stages in their understanding and response to structural damage risks, leading to varied perspectives and solutions. These differences result in a broad range of options for stakeholders to choose from.

The code *option assessment* emerged frequently in interviews I and VI, where respondents demonstrated extensive knowledge of either structural foundation research or the dynamics between government and market actors, as well as how to navigate and influence these systems effectively. A first option all respondents agree with is that doing nothing, is not an option. Not all possible options have to be looked into or assessed before starting with the few ones you already know are possible to start with. As time passes, the best possible combination within Amsterdam's path dependency will surface. A first relevant finding resulted from interview I and II, both respondents mention lobbying as a way to increase awareness, individual availability and knowledge on the topic. The role of Respondent I is often for a client. Time and the specific goals they are allowed to work towards are guided by the client's demand. Option assessment often involves evaluating trade-offs between immediate financial gains and long-term stability, which can complicate the process. However, they still try to incorporate as many options as possible for the client to choose from. Meaning that the role Respondent I has in their day to day job does not allow them to make the final decisions on which path is chosen. The same goes for some other respondents, except Respondent III. They are already in the execution phase of the decisions that were made to mitigate the issue. The other respondents are often placed in consultancy or advisory roles, separating them from the final decision-making process. This highlights a gap in unified decision-making processes, leaving the less knowledgeable make the decisions.

A second relevant finding, was the type of options and possible solutions offered by the respondents. Most respondents focused their options on lobbying, equal financial responsibility distribution or on the other hand let market forces solve the issue or subsidies. It is clear to everyone the government must be more active and provide more guidance. A few possible options mentioned by the respondents are as followed:

- Regulations to make foundation research mandatory;
- Municipal assistance for homeowners;
- Online information distribution in the form of maps;
- Regulations to make transparency within the selling and purchase process a priority, and
- Improvement of communication between governmental bodies

Only one respondent, Respondent VI, seemed to have a creative out-of-the-box thinking. This was the only respondent that is not an expert on the specific topic of land subsidence or structural damage and does not have a technical background. The approach and perspective they showed to understand the issue in a more systemic way offered them the opportunity to find solutions in different parts of the institutional and political context. These options are the use of benefit tax, compensation for planning damage or the use of the leasehold system. The benefit tax, is a levy imposed by municipalities on property owners who benefit from public works or improvements that increase the value of their property. The compensation for planning damage is a regulation which functions in the exact opposite manner as the benefit tax. Property owners are compensated for their financial loss. The use of the lease hold system to tackle larger project areas at once has been previously discussed. These three options are based on already existing legislation. However, they are also focused on finding a party to take full responsibility, which can also become a judicial struggle and remains a liability risk. Tweaking on parts of the regulations might show a way forward in either further adapting already existing regulations or showing which parts are essential to

incorporate in new policies. This also underscores the importance of a balanced team with interdisciplinary backgrounds and intersectional thinking at their disposal.

Several municipalities have already implemented the use of a local portal that provides information and assistance to property owners regarding foundation problems. Structures like these help spread information and increase awareness on the dangers of land subsidence. Even though Amsterdam municipality has extensive exemplary policy and regulations on the topic, incorporation of these possible damages is not yet implemented. The findings underscore the complexity of the decision-making process, revealing a gap between risk perception and practical implementation in real estate investment decisions.

The possible options that can be implemented depend on the institutional context and the path dependency created by past decisions. Simultaneous realisation of several option can often be forgotten in the big bureaucratic system The Netherlands has. The results show that implementation is delayed as the integration of structural damage into real estate valuations leads to reduced profitability, making it a less favourable choice for investors as economic gain is their main goal.

6. Discussion

This chapter will answer each sub-question by integrating the key themes and findings from the research and. Furthermore, it will establish connections between the empirical results, the literature review and insights drawn from other relevant studies to create a coherent picture. Lastly, this chapter will discuss the recommendations for future research. This final part will draw upon insights from relevant literature for each sub-question, highlighting potential ways for other researchers to contribute to this line of work.

§6.1 The impact of predisposing factors on the perception of land subsidence risk

This section will address how predisposing factors influence stakeholder's risk perception by answering the following question: *How do predisposing factors impact stakeholders' risk perception of land subsidence risks?* The question will be answered for market actors, private homeowners and government actors.

Predisposing factors significantly shape stakeholders' risk perception of land subsidence risks. Several studies revolving around the formation of risk perception state the context wherein said perception is formed as a large influence (Clement, 2010; Rivolin, 2012; Stobbelaar, van der Knaap, & Spijker, 2021). Both Clement (2010) and Rivolin (2012), argue the influence of the political and institutional context on the actors. On top of that the ESPF model confirms it, by acknowledging that socio-economic conditions and physical environmental factors influence risk perception. This study shows similar results. Factors such as physical environment, politico-economic context, institutional context, path dependency and capacity for action significantly influence risk perception. This group of factors inhibits the severity of the risks perceived. The Netherlands has unique geological characteristics, making it prone to land subsidence and its consequences. A first step in acknowledging subsidence risks, how they are exacerbated by human activity and the possible negative outcome for homeowners starts with acknowledging human induced climate change. Respondent II states that if homeowners or stakeholders deny this relation it already puts up another barrier for understanding the possible risks of not acknowledging subsidence risks. People may be aware that the ground is sinking but do not automatically connect it to structural damage, let alone understand the potential effects on their foundation and the associated risks that follow. Especially in The Netherlands, since land subsidence occurs regardless of human activity and has a very slow pacing nature. Experts noted that stakeholders operating in regions with visible signs of subsidence do tend to have a heightened perception of the risks.

As the interviews revealed, predisposing factors interact and influence one another, ultimately shaping the final outcome of how subsidence risks are assessed. Path dependency and optimism bias contribute to the belief held by certain stakeholders that the situation will resolve itself, and that negative outcomes are unlikely to materialise. Another factor that can be added to this group is media discourse. Media framing can greatly influence the information a person receives on a certain topic. The proximity of an individual to the incidents on which the media reports and how these issues are framed can influence if a person perceives the risk. Still, this is not always the case as became apparent in Interview III. The interplay of factors creates a complex landscape of risk varying risk perceptions which define stakeholders' strategies when making real estate investment decisions.

A similar combination of predisposing factors can still lead to varying degrees of land subsidence risk perception in individuals. Stobbelaar, van der Knaap, & Spijker (2021) find similar conclusions in their results. According to them, predisposing factors, especially social-cultural and physical environment factors are essential. This is because these two factors can be influenced separately by any type of external intervention. On top of these two, their study also concluded that information factors play a large role in creating risk perception. The message a certain source communicates through a certain channel also greatly influences who picks up the message and how it is interpreted. Lorencová, Loučková, & Vačkářů (2019) found similar patterns across other predisposing factors in their research. Their study highlights education and income as key sociodemographic influences, showing that individuals with higher education and income levels are generally more aware of climate change risks. They also saw that sex and age play a significant role in climate risk perception. Which is interesting to include as this study did not focus specifically on those factors.

§6.2 The role of land subsidence risks in decision-making processes

This section will address how land subsidence risks are taken into consideration during the decision-making process of real estate investments by answering the following question: *How do stakeholders take land subsidence risks into consideration in their decision-making process?*

In examining how stakeholders incorporate land subsidence risks into their decision-making processes it must be underscored how complex risk perception is. A higher risk perception is related to a more extensive decision-making process. More knowledge on the topic increases risk identification and the perceived severity of land subsidence risks. It also increases the options to be considered. However, in The Netherlands, the tight housing market often leads to the oversight of long-term risks in favour of perceived short-term security. The security of a home or economic gain from an investment. The purchase of property of which the state of the foundation is unknown or in bad shape is far from a stable choice. Still, it could be the only one currently available. These decisions are stimulated by the fact that the consequences of structural damage may not manifest until later in the future. The uncertainty surrounding when stakeholders will face financial costs causes these risks to be largely excluded from decision-making processes. Additionally, the range of options available in the real estate market, as well as the motivations for assuming such risks, vary across stakeholders. Market actors, such as developers often prioritise short-term economic profitability, which can lead to the underestimation or exclusion of subsidence risks from their calculations. Policies and laws also make it possible for these parties to purchase and sell properties without having to investigate the current state of the foundation. Only certain municipalities in The Netherlands have policy in place, and in the case of Amsterdam certain very specific rules apply. For these actors it is easy to avoid the risks of having to take financial responsibility, and even if they do, their financial power is often enough to pay the high costs.

Private homeowners on the other hand, may lack the overall knowledge to fully assess these risks, often relying on government regulations or market trends to guide their decisions. Personal experience and overall understanding of climate risks may also play a role. In many cases they overlook long-term structural risks in favour of securing a property in a highly competitive housing market.

The role of the government is crucial, as it sets the regulatory framework for building standards and land-use policies. The government gives direction to the framework of options of which market actors and private homeowners can choose from. However, the complexity of bureaucratic processes and political preferences can delay effective response to subsidence risks, leaving gaps in

protection. Banks and insurance companies also play a significant role. While banks may consider structural risks when approving mortgages, structural damage risks are not integrated into neither loan assessments or real estate valuations unless it is flagged during property evaluations. Most market actors leave the responsibility for these problems in the homeowners hands even though they themselves may be faced with the consequences. Leaving risk perception to play almost no role in real estate investment decision-making.

§6.3 The risks and benefits of investing in areas with a high risk of land subsidence

This section will discuss how market actors, private homeowners and the government weigh risks and benefits associated with investing in real estate in the inner city of Amsterdam. This will be done by answering the following question: *How do stakeholders weigh the potential risks and benefits associated with investing in areas with a high risk for subsidence?*

In the inner city of Amsterdam, stakeholders largely overlook the potential risks of land subsidence when making investment decisions. The combination of a strained housing market, a high level of knowledge about the subsoil due to a long history with the issue and experience with fixing it, create an environment where subsidence risks are not given significant weight. Market and government actors are generally aware of the issue but do not perceive it as a significant risk. Even for private homeowners who are unaware of potential foundation damage, the problem is mitigated by the high real estate values, which allows for easy recovery from a foundation restoration. Consequently, foundation risks are often deprioritised in decision-making processes. This behaviour reflects a broader trend in which perceived security and market pressure override risk considerations. Stakeholders often distinguish risks as acceptable, tolerable or intolerable, based on economic benefits and the institutional frameworks they occur within (IRGC, 2017). In Wiegelmann's study (2012), the level of risk stakeholders are willing to accept is referred to as *risk appetite*, or their willingness to take on uncertainty in exchange for potential returns. The high real estate prices in Amsterdam makes the decision-making process fairly easy as steps like risk identification, concern assessment and seriousness judgement don't play a role. Leaving only a few options to be assessed during the option assessment part of the process. Most of them having only benefits as outcomes.

§6.4 Adjustments in investments strategies as a response to land subsidence in Amsterdam

The next part discusses the actual changes stakeholders make to their investment strategies based on their risk perception of structural damage in Amsterdam. The following question will be answered: *What adjustments, if any, do stakeholders make to their investment strategies in response to land subsidence in Amsterdam?*

In response to land subsidence in Amsterdam, stakeholders generally make minimal adjustment to their investments strategies. Market actors, despite being aware of the risks, do not incorporate land subsidence into their decision-making processes due to the city's high real estate values and the perception that these risks are manageable.

For private homeowners. The strain of the housing market further diminishes concern about the subsidence risks, as short-term financial gains overshadow potential future issues. This is a consideration which can only be made when the concerned homeowners is aware of the potential risks that land subsidence carry. Otherwise, a need to adjust any investment strategy does not exist.

The only notable adjustment occurs when foundation repairs are needed, and in some cases, homeowners capitalise on this by adding basements to their properties, increasing their value and offsetting repair costs. However, the fundamental risk of subsidence is not a primary factor driving strategic changes in real estate investments. On top of that, Amsterdam municipality offers to pay for the foundation research. However, this is only done when a private homeowner applies for this through the foundation counter and meets certain requirements.

Furthermore, the government naturally controls permits for construction and enforces building codes, ensuring that developments take land subsidence risks into account. Amsterdam being a large municipality has both the financial capacity and the knowledge to address these issues. Still, the political arena plays a role in how these issues are addressed and framed. The issues surrounding structural foundations are becoming more relevant each day. Members of parliament advocate for stronger measures to mitigate the issue, but consensus on the approach is hard to find. Especially because the problems outside of high density urban areas are partially caused by water authorities trying to keep the water levels steady. Concerns about the economic impacts of stricter regulations sometimes limit more aggressive action.

For now, the benefits of steadily investing in real estate in Amsterdam easily outweigh the risks. This upholds the status quo surrounding insurances and approach to avoiding potential disaster for unknowing homeowners. Various levels of government are involved, the overarching challenge is aligning these efforts with the pressures of a competitive housing market and economic considerations.

§6.5 Conceptual framework revision

During the interviews important themes were identified which weren't included in the initial creation of the conceptual framework used in this study. The first point to acknowledge is that the conceptual framework used in this study is a simplified representation of reality. Not all existing relationships were included in the model, raising the question of how much the model may need to be revised. Predisposing factors, risk perception, and decision-making are broad, complex concepts, and this study did not account for all the factors that contribute to each concept from the outset. Still, the patterns identified in the interviews are interesting enough to make some small but and significant changes to the model. The new revised conceptual model can be seen in Figure 10.

The first modification to the conceptual model involves the role of predisposing factors. These factors not only influence risk perception but also interact with one another, which is crucial for accurately representing the relationship between predisposing factors and risk perception. The interplay among these factors is highly nuanced and varies significantly among individuals.

Consequently, it is necessary to acknowledge certain more relevant predisposing factors separately as their influence is more significant. Based on data analysis from the interviews it is determined that the following factors are to be mentioned separately: local policies, path dependency, media discourse, biological and psychological factors. Local policies have been separated from the predisposing factors as Amsterdam municipality uses a leasehold system which enables them to easier access and control certain lands if necessary. This local variation can have a significant impact on addressing the issue. Path dependency has been separated in a similar way that politico-economic and institutional context are separated. Path dependency refers to the idea that decisions are heavily influenced by past events. Once a particular course of action is chosen it can be difficult

to deviate from it. The context of this set path also occurred in the politico-economic and institutional context of that time. Making it a special predisposing factor to consider.

The role media discourse plays as a predisposing factor is also essential to recognise separately. Especially when creating a framework used to describe individual thought processes and their influences. Most people that have experience on this topic or any knowledge on land subsidence are people who in some kind of way have been exposed to the issue either through their work or from direct exposure. For many people their first contact with this topic will be through some kind of media source. The way in which this source represents themselves to society and how they frame the news they broadcast and through which medium heavily influences how people perceive that information.

Biological and psychological factors are also best separated from the other predisposing factors as they are tied to each individual and can create different types of perspectives depending on how heavily each of the other factors are taken into account by said individual.

In Figure 10 these factors are framed together, this is done to emphasise that these factors all influence each other.

The second modification pertains to the influence of risk perception on the decision-making process. Structural damage risks associated with land subsidence are not always recognised or perceived as genuine threats. This oversight neglects the impact of certain predisposing factors on risk perception and their subsequent effect on decision-making. Instead of visibly altering the conceptual model to incorporate this discrepancy can be added as a note to alert users of the model to incorporate it into their process.

The final alteration to the conceptual model is the inclusion of more relations between the variables. Simplifying a complex process such as decision-making that occurs within a planning system that is dependent on various contexts and individual perceptions. A few more essential relations

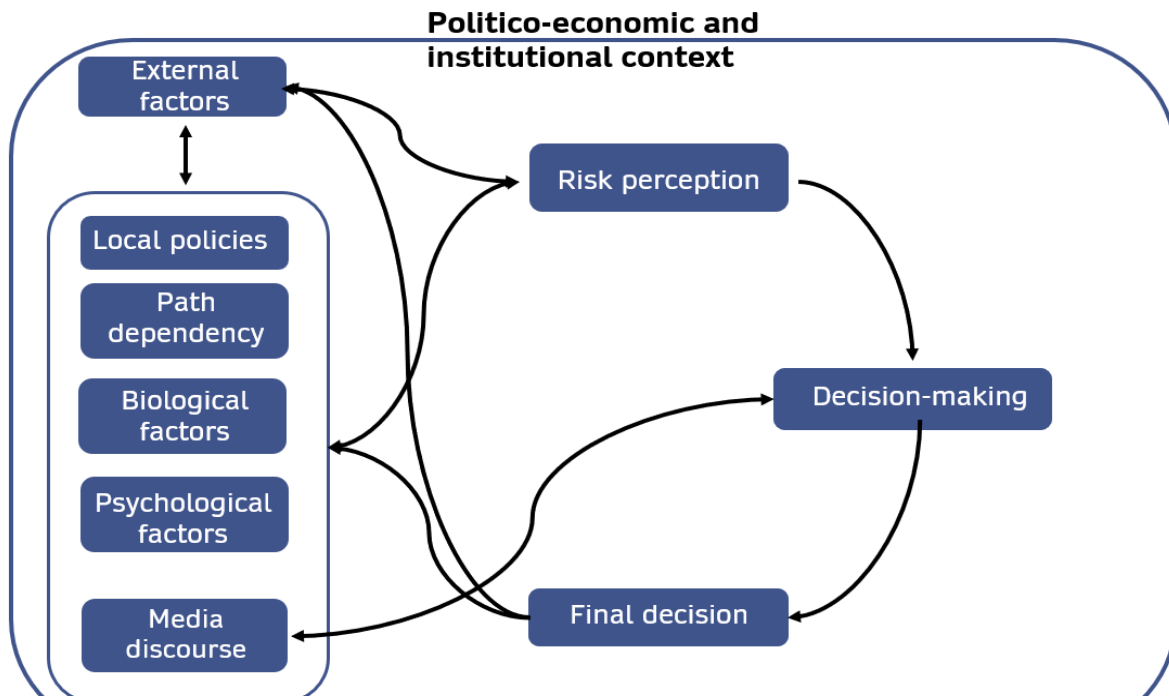


Figure 10: A revised version of the conceptual model. Adapted based on the results from this study.

vectors have been added to emphasize the relations that were identified as most important during this study.

Changing the conceptual model has several theoretical implications. Firstly, the introduction of more separate predisposing factors shifts the model's emphasis even more to consider the influence of external factors on risk perception. With its aim to align more with systems theory and show how individuals are interconnected with their surroundings.

Secondly, the inclusion of psychological biases within the model ties directly to behavioural finance theories. Investors are not entirely rational actors as assumed in many finance models, but are also influenced by individual biases. This addition would support a more nuanced understanding of investor behaviour under uncertainty.

These theoretical shifts suggest a more holistic, interdisciplinary understanding of decision-making in real estate, blending insights from behavioural economics, institutional theory, and systems thinking. This would allow for richer analyses of how investors navigate complex urban markets like Amsterdam. On top of that, framing these challenges with a structured framework can also serve as a valuable tool when dealing with similar large-scale issues in the future, ensuring a more resilient and prepared approach.

§6.6 Future research

Future research on land subsidence risk perception and its influence on decision-making should focus on the collaborative structures between the public and private sectors. These partnerships have the potential to significantly mitigate the challenges posed by subsidence. Investigating how municipalities, government agencies, and private stakeholders can work together to share knowledge, and resources will be crucial in understanding the effectiveness of existing strategies. For now, certain stakeholders do focus on spreading knowledge, by means of lobbying or These strategies should be further analysed. This could be especially interesting between different governmental bodies as some have more experience and capacity, which can be shared with the smaller municipalities that do not have areas of great historical value.

Furthermore, research could explore the role of public-private partnerships in facilitating infrastructure investments. By examining case studies of successful collaborations, researchers can identify best practices and recommend frameworks that enhance stakeholder engagement and promote proactive approaches to managing land subsidence. Another possible way to approach further research is to dive into the influence of several predisposing factors on individuals. Bringing research to the first step of the process, exploring a more objectivist approach. Ultimately, understanding these collaborative dynamics will provide valuable insights into fostering resilience in urban environments, particularly in areas susceptible that do not have the financial means to pay for all the repairs.

7. Conclusion

The final chapter of this thesis will reach a conclusion by way of answering the main research question: *“How does the perception of structural foundation risks influence real estate investment decisions in Amsterdam?”*. This chapter will also reflect on significance and limitations of the study. Finally, practical recommendations based on the findings of this thesis will also be offered.

§7.1 The main research question answered

In Amsterdam’s housing market, where high demand and rapid economic gains dominate, the influence of land subsidence risks on investment decisions is notably diminished. The dynamics of this market, particularly in the inner city, are driven by the cultural and historical value of properties, which significantly inflate prices. This situation creates an environment where short-term economic benefits often outweigh potential long-term risks, especially when it comes to land subsidence. Properties in Amsterdam’s inner city are rich in cultural significance, making them highly attractive to investors and buyers. This intrinsic value often drives up prices, even when there is a substantial risk of structural damage due to land subsidence. Investors appear willing to pay premium prices, putting private homeowners in situations where they do not have the privilege to think about long-term stability. Regardless, possibilities to immediately regain on investments of purchase or investments of restoration, lower the perceived risks. Additionally, it must be recognised that investment behaviour is often not fully rational. Investors and homebuyers alike are driven by the pursuit of profits, safety and path dependency to secure property. Many investors do not recognise the risks as properties are frequently bought and sold before any long-term effects materialise. Speculation is common, but difficult to quantify and dependent on a variety of combinations of the predisposing factors. This leaves the decision-making process behind these investments to remain vague.

The way in which government and market actors manage land subsidence risks is becoming more relevant in the risk perception of land subsidence risks. These risks are slowly being factored into real estate valuation. The municipality of Amsterdam has long been addressing the consequences of land subsidence, developing a framework of policies and regulations to minimize both the physical and transitional risks. However, the Dutch national government has been slower to respond, only recently recognizing the growing impact of land subsidence on a national scale. With climate change exacerbating the problem, the government is now investing more time, money, and

manpower into creating plans to address these issues. As political and institutional awareness of land subsidence risks grows, the decision-making context for investments is starting to shift. The AFM is a driving factor in this change. The presence of these physical risks increase the transitional risks and potential further damages to the economy and the housing market. Market actors, such as project developers, insurance companies and banks are becoming more cautious about properties in high-risk areas. Preparing themselves to incorporate such risks into their practices. Nevertheless, the persistent demand for housing especially in Amsterdam, continues to overshadow these concerns. Still, that doesn't take away that due to these developments, property sales in Amsterdam will also have to abide to the new regulations, when and if they get implemented.

Another factor that plays a role in the reduced risk perception of land subsidence risks in Amsterdam from a governmental perspective can be the leasehold system. Since land remains under municipal ownership, the government has a significant say in the conditions under which land is leased and developed. It is easier for them to perform large, scaled restoration projects, while market actors stay clear of responsibility. However, due to such a long-term investment higher fees or more stringent land lease conditions may become applicable. As for now the issue does not seem to be as urgent to address from a governmental perspective as the pressure to sustain the real estate market is more urgent.

The high cost of property in Amsterdam's inner city means that only individuals with significant financial resources can afford to purchase property. This creates a growing socio-economic gap, as wealthier homeowners are able to restore foundations and add features to further increase property values, leaving those with fewer resources at a disadvantage. In some cases legal structures such as homeowner associations can complicate restoration efforts. On the other hand, they can also provide strength as shared costs and lobbying efforts can pressure local governments. This can also help in reducing the perceived risk of unstable foundations by providing psychological relieve to homeowners.

Urban planners and public-private partnerships (PPPs) also play a role in lowering the risk perception of land subsidence risks in Amsterdam. Using expertise on project and process management can play a critical role in designing cities that are resilient. These PPPs can improve water management structures and can enforce stricter building codes, or other regulations that force other market actors and private homeowners to adhere to. This can also be a starting point for large-scale projects to stabilise entire neighbourhoods rather than addressing these issues on a property-by-property basis. This collective effort can bring long-term solutions to the city's growing subsidence challenge by increasing the pace and volume of these renovations.

With the report from the Rli and its recommendations, we are likely to see increasing efforts by the national government and market actors to gradually integrate land subsidence risks into real estate investment decisions. This will slowly alter how risk perception influences these decisions. Although people are concerned about the societal and economic consequences, the complexity of perspectives, political interests, and the focus on short term profit has delayed a focus on long-term solutions. Investors tend to prioritise immediate gains, and the cultural value of properties in Amsterdam's inner city often overshadows concerns about long-term structural risks. However, as climate risks become more pronounced and land subsidence issues more evident, government regulations and rising insurance premiums might begin to reshape the landscape of real estate valuations, influencing the way these risks are considered in investment decisions.

§7.2 Implications and limitations

This study provides valuable insights from expert and experienced respondents into how land subsidence risks are being perceived in Amsterdam within the context of a highly competitive real estate market. The findings suggest that due to the city's UNESCO World Heritage status and the high demand for property, economic impacts from structural damage are often offset by the value gains from renovations, such as adding extra floors. These results contribute to understanding how economic incentives and cultural factors shape investment behaviour in urban centres with historical significance. This demand is expected to persist as the national government pursues investments in brownfield redevelopment and transformation projects. As spatial developments will continue to be realised within the city, this study offers interesting insights that shine light on the decision-making process aiming to balance economic growth with a more sustainable planning and risk management included. The results give a broad overview of what experts think are steps that could be taken to reduce the consequences of careless investments, such as: lobbying for foundation research, incorporation of land subsidence risks into the mortgage or real estate valuation system or the increase of risk awareness due to governmental action.

This study has several notable limitations. First, while Amsterdam offers valuable insights into resilient and sustainable building practices, the selected case area may not be the most pressing or representative. Other cities and neighbourhoods face more severe challenges, including socio-economic disparities, path dependency and sustainability issues, which could offer more relevant data for assessing broader climate and structural risks.

Although efforts were made to engage various stakeholders, many were hesitant to participate, possibly due to a lack of knowledge or reluctance to address subsidence-related risks in their projects. This led to the exclusion of several government actors, market actors and societal actors of which their insights could have been valuable. This created a sample bias, limiting the internal and external validity of the findings and narrowing the scope of the conclusions. Moreover, in cases of qualitative research it is preferred to have a minimum number of participants to ensure its reliability. Due to the sensitivity of the topic it was difficult to find stakeholders willing to talk about their role. This also implies many stakeholders are delaying intrinsic participation to mitigate the issues.

Still, due to the qualitative nature of this study and the inclusion of the governmental debate, the insights gained from the interviews still provided relevant information to create a picture of how land subsidence and its risks are perceived in Amsterdam.

Another key limitation is the study's over-reliance on secondary data and expert opinions, which may not fully capture the lived experiences of residents in the case area. The exclusion of societal actors weakens the comprehensiveness of the study, particularly in understanding how different groups perceive and respond to risks. Furthermore, the geographical limitation of focusing solely on Amsterdam reduces the generalisability of the study, of course this trait is inherent to case study's and is an expected limitation.

The study also faced challenges in processing the vast amount of available data on the topic. In the digital era, the ability to access large volumes of information can surpass our capacity to critically handle and process it. This limited may have led to the omission of relevant documents, theories, concepts or insights, impacting the completeness of the study.

§7.3 Recommendations for stakeholders

To address the growing issue of land subsidence and its impact on infrastructure and real estate investment decisions in Amsterdam, several recommendations emerge from this study that apply to the various stakeholders involved in urban development and policy-making.

Based on the findings, it is crucial for local and national governments to play a more proactive role in mitigating subsidence risks by reforming institutional frameworks. The municipality of Amsterdam has an extensive set up and policy framework, still the issues persist due to a lack of incorporation of these risks into real estate valuation. The national government needs to implement further laws and regulations that compel market actors to incorporate climate risks into their property valuations or mortgage systems. This would create transparency and reduce market uncertainty, ultimately protecting both buyers and investors. Additionally, the government should explore creative uses of existing policy instruments, such as the leasehold system and the benefit cost tax, to reduce the financial vulnerability of private homeowners. Updating existing policies should be faster and more efficient than creating entirely new frameworks, especially in a turbulent political climate. If new policies were to be implemented, the government could start with regulations that require risk assessment prior to the sale of older homes. An example of this regulation can be found in the Zaanstreek, where housing corporations are not allowed to sell homes older than 1950 without have performed foundation research and transparently informing the buyer on the state of the foundation. Policies like this can easily be copied and adapted to use in other municipalities. Another instrument the government could use, are incentives. The use of subsidies makes it easier for people to start such a large project. In a similar way to how subsidies encouraged the adoption of solar panels, similar initiatives should be used to stimulate structural foundation research. Other incentives, like being more lenient with other non-safety related rules could also be offered to make it more appealing.

Collaboration between municipalities with greater experience in handling subsidence, such as Gouda, Rotterdam and the Zaanstreek, can further strengthen the institutional response. Money available should also be spent on a collaboration between the market and the government. Many market actors are willing to address the issue and with their expertise, they can built towards a strategic plan to solve this issue. Coordinated action is essential to minimize further damage and prevent long-term instability in Amsterdam's housing market. With the implementation of strategic policies and collective efforts, the city can begin to address the lack of incorporation of climate risks more effectively and gradually fix the issue while restoring confidence in the real estate market. Together, they can create urban areas that are resilient to both environmental and economic pressures.

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Appendix I – Topic list interviews (questions in Dutch)

(A) Introductie

Toestemming vragen voor het opnemen van het interview.

Introductie respondent: naam, leeftijd, interesses, eerdere professionele ervaring

Uitleg over functie binnen het bedrijf

(B) Bewustzijn klimaatverandering

De volgende vragen gaan over

- Hoe urgent is het probleem van 'klimaatverandering' in uw ogen?
- Welke factoren spelen hier denkt u een rol in? En voor Nederland specifiek?
- Bedrijfsbreed klimaatbeleid → in hoeverre is het bedrijf bezig met duurzame ontwikkeling (intern en extern)

(C) Landverzakking Risico perceptie

- Hoe kijkt u naar de problemen die door landverzakking veroorzaakt kunnen worden? Als het bekeken wordt op grotere schaal en langere termijn
- Hoe denkt u dat recente nieuwsberichten over landverzakking de manier waarop belanghebbenden naar de risico's kijken?
- Hoe denkt u dat de reputatie van een buurt een rol speelt in de risicoperceptie van de private en publieke sector?

- Wat is momenteel de status van de beschikbare data? Hoe proberen jullie deze aan te vullen?
- In hoeverre denkt u dat mensen worden beïnvloedt door hun leefomgeving bij het ervaren van deze risico's?
- Weet u van projecten waarin het bedrijf landverzakingsproblemen is tegengekomen? → kunt u nadere toelichting geven
- Hoe bewust wordt er in de praktijk tijdens projecten met dit soort risico's omgegaan door stakeholders?
- Kunt u recente ervaringen of gevallen beschrijven waarin bodemdaling risico's van invloed zijn geweest op besluitvormingsprocessen binnen vastgoedontwikkelingsprojecten in Amsterdam? Kunt u deze verder toelichten?
- Wat zouden mogelijke gevolgen zijn van het onderschatten van bodemdalingsrisico's in herontwikkelingsprojecten?

(D) Risico management

- Heeft het bedrijf een risicobeheerstrategie?
- Welke factoren gelooft u dat het meest bijdragen aan de vormgeving van de risicoperceptie van landverzakingsrisico's onder professionals in de projectontwikkeling?

- Welke risico's en voordelen worden meegenomen in het besluitvormingsproces?
- Hoe effectief denkt u dat al bestaande risicobeheersing en praktijken zijn? En welke informatiebronnen worden hierbij geraadpleegd?
- Op welk punt in het besluitvormingsproces worden deze risico's typisch overwogen?
- Hoe denkt u dat er grote stappen gemaakt kunnen worden om de negatieve effecten van landverzakking in te perken? Zowel binnen projectontwikkeling, maar ook voor de uiteindelijke huiseigenaren?

(E) Risico governance

- Hoe verloopt momenteel de communicatie tussen de private en de publieke sector m.b.t. bodemdalingsrisico's?
- Welke rol speelt governance bij het beheren en verminderen van bodemdaling risico's in herontwikkeling in Amsterdam volgens u?
- Welke uitdagingen voorziet u bij het effectief communiceren en vergroten van het bewustzijn, de perceptie en de besluitvorming m.b.t. bodemdalingsrisico's (financiële effecten) in herontwikkelingsprojecten in Amsterdam?
- Welke acties zullen er vanuit zowel de private als de publieke sector nodig zijn om de risico's te verlagen/beter in beeld te brengen?

(F) Conclusie

Einde van het interview

Ruimte voor vragen vanuit de respondent

Bedanken

Vraag of de respondent anoniem vermeld wil worden

Appendix II – Consent Form

INFORMATIE OVER HET ONDERZOEK NAAR DE INVLOED VAN RISICOPERCEPTIE VAN BODEMDA-
LING OP HERONTWIKKELINGSPROJECTEN.

Introductie

U bent uitgenodigd om deel te nemen aan een wetenschappelijk onderzoeksproject aan de Radboud Universiteit. Voordat u beslist of u wilt deelnemen aan het onderzoek, ontvangt u een korte uitleg over wat het onderzoek inhoudt. Lees deze informatie alstublieft zorgvuldig door.

Waar gaat het onderzoek over?

Dit onderzoek beoogt de transparantie op de vastgoedmarkt te vergroten door te identificeren hoe het besluitvormingsproces van belanghebbenden wordt beïnvloed door de risicoperceptie van landverzakking in herstructureringsprojecten in Amsterdam.

Wat wordt er van u verwacht?

In dit onderzoek wordt u geïnterviewd door Julia Hummel, hetzij op locatie of via Microsoft Teams. Als u akkoord gaat, wordt er een audio-opname gemaakt en worden er aantekeningen van dit interview gemaakt om de nauwkeurigheid van het onderzoek te waarborgen. De opname en aantekeningen zullen worden gebruikt als onderzoeksdata. Een interview zal ongeveer 45 minuten duren. In het interview stellen wij u vragen over uw persoonlijke profiel, professionele werkervaring, klimaatrisico's, risicobewustzijn en -perceptie, en risicomangement. Voorbeeld van vragen zijn: "Wat denkt u wat de gevolgen van landverzakking in Nederland/Amsterdam zouden kunnen zijn?" "Hoe effectief denkt u dat al bestaande risicobeheersing en praktijken zijn?"

Vrijwillige deelname

U beslist zelf of u aan dit onderzoek wilt deelnemen. Uw deelname is vrijwillig. U mag op elk moment de deelname stoppen. Ook hoeft u geen vragen te beantwoorden die u liever niet beantwoordt, en u kunt uw toestemming op elk moment tijdens het onderzoek intrekken. Het onderzoek zal dan per direct stop gezet worden. U bent niet verplicht aan te geven waarom u stopt. U kunt ook tot twee weken na deelname uw onderzoeksgegevens en persoonlijke gegevens laten verwijderen door een e-mail te sturen naar Julia Hummel. Deze zullen dan niet verder worden verwerkt of gebruikt worden in het onderzoek.

Wat gebeurt er met mijn gegevens?

De opnamen en notities zullen alleen verwerkt worden om in dit onderzoek gebruikt te worden, en verwijderd worden zodra de transcripten zijn voltooid. Op verzoek kunnen de gegevens gepseudonimiseerd of geanonimiseerd worden, zodat deze niet terug te traceren zijn naar u als persoon. Deze gegevens zullen dan ook gebruikt worden voor presentaties en eventuele wetenschappelijke artikelen.

Toestemmingsverklaring

Ik ben geïnformeerd over het doel van het onderzoek. Ik heb vragen kunnen stellen over het onderzoek. Ik neem vrijwillig deel aan het onderzoek. Ik begrijp dat ik op elk moment tijdens het onderzoek mag stoppen als ik dat wens. Ik begrijp waarvoor de gegevens zullen worden gebruikt. Ik stem ermee in deel te nemen aan het onderzoek zoals beschreven in dit document.

Contactgegevens onderzoeker

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