DMFCO

Asset Management

# Foundation Risk Dutch Mortgage Investments

Q3 2025

## Introduction

Investing in Dutch residential mortgages has proven to be a stable and reliable long-term investment for institutional investors. Nevertheless, investing in mortgages also entails certain risks. Traditionally, risk analyses have focused on 'classic' risks such as credit and prepayment risk. In recent years, investors have increasingly focused on ESG risks.

DMFCO aims to contribute to a deeper understanding of these risks within mortgages. In 2022, DMFCO published an initial paper on physical climate risks[1], addressing flooding risk. To offer a more comprehensive overview of physical climate risks in Dutch mortgage loans, this paper builds on that analysis by focusing on foundation risk by using our own model.

While this study focuses on Dutch residential mortgages, it is important to note that this specific risk is not unique to the Netherlands.

A wealth of literature and articles exists on the topic of foundation problems and their impact on homeowners. However, there is a notable lack of analysis regarding the implications for investors. This paper specifically addresses foundation risk and identifies the properties most vulnerable to it. It quantifies the risk in terms of probability, assesses the financial impact on homeowners, outlines mitigating factors, and estimates potential loss for investors.

It is important to note that foundation problems—and the associated future risk—are not a recent phenomenon; they have been recognised for approximately two decades. However, there has never been a structured approach to assessing the size of the problem and the possible solutions (Kok et al., 2021) (Rli, 2024)

This has led to widely varying estimates of the number of properties at risk and of the potential financial damage—most of which have not materialised (Kok et al., 2021).

## Foundation risk explained

Foundation risk refers to potential damage to a property's foundation, which can lead to serious structural integrity issues. In the Netherlands, every property has a foundation. There are two types of foundation: 1) deep foundations (piles), which are used on non-bearing soil such as peat and clay, and 2) shallow foundations, mostly used on more sandy substrates.

Although both foundation types carry specific risks, this paper—and the associated model—focuses on the risks linked to deep foundations, particularly timber piles. The cost for repair of timber piles is substantially higher compared to shallow foundations and the main reason for the focus on timber piles.

Such risks are strongly associated with fluctuations in groundwater levels. Among other factors, prolonged drought conditions can cause groundwater levels to drop, leading to uneven soil settlement and the drying of timber foundations.

The drying of timber foundations is particularly concerning because it exposes the wood to oxygen, fostering an environment for fungal growth. This fungal activity results in pile rot—a process that gradually but severely compromises the structural integrity of timber foundations, posing a serious threat to the stability of the entire structure.

This risk predominantly affects properties built before 1975. In contrast, modern properties are generally not vulnerable to pile rot, as their piles are made of concrete rather than timber.

[1] Other physical climate risks such as extreme weather or fire hazard are present in Dutch mortgage loans, but are generally covered by insurance policies.

## Literature on the topic

Foundation issues have increasingly attracted attention from regulators, local authorities, research institutions, and investors. Yet, about half of homeowners remain unaware of the type of foundation or materials used in their property (AFM, 2025). Many homeowners also mistakenly believe that foundation-related losses are covered by insurance.

Recent estimates indicate that 425,000 properties either have foundation problems or are expected to face them by 2035 (Rli, 2024). With restoration costs ranging between €54,000 and €100,000 per property (KCAF, 2019), it becomes clear why numerous institutions have expressed concern over this matter.

The literature on this topic has grown steadily. While the causes of issues like pile rot due to fungal growth are well understood, knowledge gaps remain about which properties are most at risk and how quickly deterioration occurs.

DMFCO built on this literature to map the problem and complemented it with expert interviews to fill knowledge gaps.

As previously noted, this paper and our model focus exclusively on pile rot, which occurs only when the pile is composed of organic material. Or in other words, timber piles. Other risks, such as bacterial infection and differential settlement (Kok et al., 2021), fall outside the model's scope.

Identifying a property's foundation type—especially in older buildings—is often difficult (Kok, 2021). Techniques have evolved over time and are often regionally consistent. Deltares provides likelihood estimates for timber foundations based on location, year of construction, and soil type, using expert input and literature.

Pile rot requires the presence of timber piles and is triggered by fluctuating groundwater levels. These vary naturally throughout the year, with surpluses in autumn/winter and deficits in spring/summer, and are influenced by active water management (Bani et al., 2024; Kok et al., 2021).

Other contributing factors include leaking sewers and temporary construction drainage, which are highly localised and common in dense urban areas. These dynamics make predicting groundwater levels in cities particularly difficult (Kok et al., 2021).

When groundwater levels drop below the top (or head) of the pole, oxygen can reach the timber, enabling fungal growth to begin (Kok et al., 2021). This process is known as pile rot. Over time, the timber deteriorates, and the pole loses its structural integrity, potentially resulting in damage to the property.

Repairing the damage caused by pile rot is a costly undertaking, with current estimates ranging between €1,750 and €2,000 per square metre of ground floor (Gemeente Rotterdam, 2025), and total costs averaging between €54,000 and €100,000 per property. This risk is not insurable and should, in theory, be reflected in the market value of the property (Bani et al., 2024).

However, in practice, uninsurable climate risks are not (fully) reflected in market values, and there are three main reasons for this (AFM, 2023): i) limited knowledge on the purchaser's side, ii) a lack of incentive to investigate the risk on the seller's side, and iii) limited availability of high-quality data.

Research has shown that foundation quality is mentioned in the property description on Funda in only 2.2% of cases (Hommes et al., 2023). However, when a poor foundation is explicitly disclosed, the sale price is 12% lower than predicted by the Automated Valuation Model, indicating that available foundation information is indeed reflected in the property's price.

## Relevance for investors

Foundation problems can lead to a decrease in property value and compromise the structural integrity of the property. Institutional investors play a significant role in the Dutch residential mortgage market. Although they do not own the underlying properties, these properties serve as collateral for borrowers' debts, making any depreciation a matter of concern.

As market values do not sufficiently account for this risk, an independent assessment of the potential risk and associated losses is necessary.

Beyond financial considerations, the impact on homeowners is significant. A safe and secure home is essential for individuals and families, but foundation problems can undermine this sense of security and, in some instances, compromise the property's structural integrity. A compassionate and understanding approach can make a substantial difference to affected homeowners

Investors can play a constructive role by helping fund repair costs, provided such support aligns with prudent investment principles.

## Technical description model

Determining foundation risk is challenging due to the numerous factors that contribute to this phenomenon and the limited availability of relevant data. The type of foundation is often unknown, previous repairs are undocumented, and the current condition is unclear. This lack of data necessitates estimating certain data points, which introduces a degree of uncertainty.

As a result, making accurate predictions at the individual property level is problematic. Accordingly, we have adopted a statistical credit risk modelling approach to estimate the expected loss within the DMFCO mortgage portfolio.

**Necessary conditions**

For pile rot to occur, the following conditions must be met: i) the soil on which the property is built must be either clay or peat and ii) timber piles must have been used.

We use soil maps to determine whether the property is built on clay or peat. We use estimations from Deltares (Kok, 2021) to determine the probability ($P_{Timber}$) that timber piles are used. In accordance with other credit risk models, the event of having timber piles is simulated by drawing from a uniform distribution $u \sim U(0,1)$. We assume that a property is built on timber piles if $u < P_{Timber}$.

**Cumulative drought**

Provided the necessary conditions are met, we focus on the cumulative drought affecting the pile heads. Groundwater levels fluctuate throughout the year, as illustrated by the maps in Figure 1. These maps depict the Average Lowest Groundwater level (ALG) and Average Highest Groundwater level (AHG) in relation to ground level.

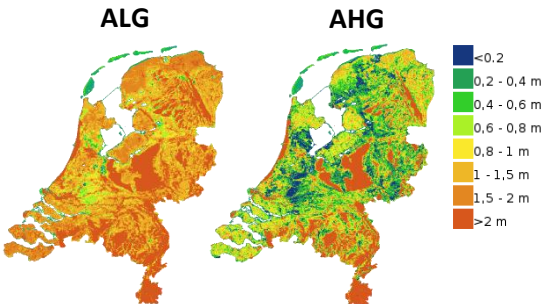


*Figure 1: Average groundwater levels.*
*Source: klimaateffectatlas.nl*

Using linear interpolation between ALG and AHG, the number of days the pile heads remain above water can be estimated. To determine the number of days the poles are above water, the simulation must begin from the year the property was constructed.

Klimaateffectatlas provides projections of groundwater levels for future years. Their simulation model accounts for climate change, as well as water and land usage. It is therefore considered the best estimate of expected conditions up to 2050. By contrast, historical data on groundwater levels is limited, particularly in highly urbanised areas. Consequently, average annual rates of decline have been used to derive a proxy for historical groundwater levels.

The calculation is further complicated by the fact that all groundwater level maps are measured relative to ground level, while the tops of foundation piles (pile heads) lie below that level. As detailed information on the depth of pile heads is generally unavailable, we estimate this depth based on the year of construction and the groundwater levels at that time. We assume that, at the time of construction, the pile heads were positioned beneath the groundwater level.

With the groundwater data and the pile head level estimated, the cumulative drought can be calculated. Figure 2 shows a schematic overview of the water level fluctuations and the cumulative drought calculation, where ALG represents the lowest and AHG the highest water level.

From interviews and meetings with experts, foundation researchers, and repair companies, we learned that fungal growth does not commence on the first day of drought; it requires a certain period of maturation before it can damage the timber. This factor has been incorporated into the calculation. In this example, the drought days in year t are calculated as follows:

$$(25\% \times 365.25) - 60 = \text{Drought days year t}$$

This means that on 25% of the days, the groundwater level falls below the pile head. If such drought conditions persist for more than 60 days, the period after which fungal growth typically begins, the pole will become affected.

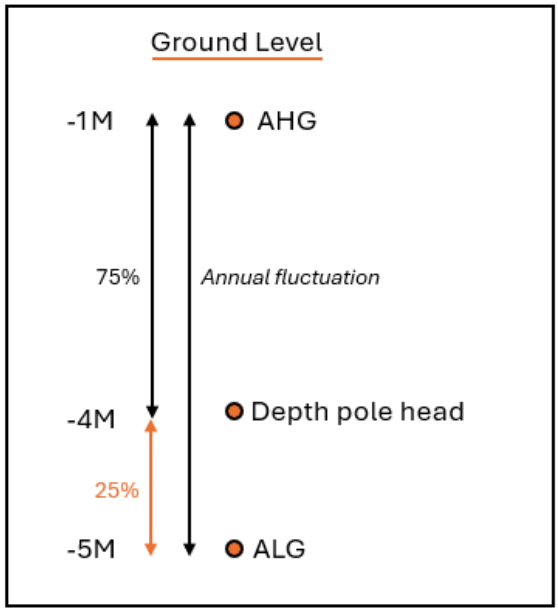


*Figure 2: Example groundwater fluctuation*

There appears to be a consensus in the literature that a cumulative drought lasting between ten to twenty years will deteriorate timber to the extent that it loses its structural integrity. However, this period partly depends on the type of soil and the rate at which oxygen can penetrate once water levels have receded. To account for this variability, an exponential damage function is employed, beginning in year 10 and reaching 100% by year 20.

This means that not all houses in the model simulation are immediately considered fully damaged after ten years of cumulative drought. Rather, the issues worsen over time. A simulation is used to determine the specific year in which the foundation requires repair.

The second element in the model concerns the expected financial damage, i.e. the repair costs, once a foundation has broken.

The cost to repair a damaged foundation, per square metre of ground floor, depends on several factors. Examples include the length of the piles, the type of deep foundation (which varies by region), and whether soil remediation is necessary—for instance, when the soil contains contaminated substances such as PFAS. As these factors cannot be accurately estimated or modelled, the average cost per square metre, as reported by the Municipality of Rotterdam, is used. This average has been validated through various expert interviews and amounts to €1,850 per square metre for ground floor repairs.

The number of square metres of ground floor is not typically known or readily available; therefore, an algorithm is utilised to calculate the ground-level area based on the exterior coordinates of the property. For multi-layer properties such as flats, there is additional complexity, as costs must be distributed across the number of dwellings and commercial units in the building.

The probability of foundation problems, in combination with the financial damage, constitutes the estimated cost that the homeowner will incur if the risk materialises—i.e. the gross cost.

## Mitigating factors for investors

From the perspective of an investor investing in mortgages, there are several mitigating factors.

The first—and most significant—mitigating factor is the loan-to-value (LTV) ratio. Mortgages are, at least in part, repaid over time, and the value of the collateral securing the mortgage tends to appreciate. Additionally,

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Both factors positively influence the available financing headroom for any necessary repairs. When the cost of foundation repairs can be financed by the borrower, there is no associated risk for the investor. It is assumed, consistent with the efficient market hypothesis, that the cost of repairs will be reflected in the property's increased value. As a result, the impact on mortgage loan investors is neutral, as the risk profile of the loan does not materially change.

The second mitigating factor concerns mortgages with NHG[2]. Investors' losses are limited to 10% of the total loss when a mortgage is subject to an NHG. Therefore, in cases with insufficient LTV headroom to finance foundation repair costs, the model assumes the property will be sold at a loss—with 10% of that loss not covered by the guarantee.

There is an additional mitigating factor which is not incorporated into the model. A specialised fund exists in the Netherlands to assist individuals in financing the cost of repairs where they would not otherwise be eligible. At the time of writing this whitepaper, the size and criteria of the fund were not clear; therefore, it has been excluded from the scope of the model.

## Model estimates over the portfolio

The following section illustrates how the model quantifies foundation risk across the DMFCO mortgage portfolio and outlines the expected impact over time

Figure 3 illustrates an example of the model in practice. Two green lines depict the declining trends in AHG and ALG over time. From 1985 onwards, the ALG falls below the pile head depth, indicating that the pile head begins to experience annual dry spells. In 1997, these dry spells first exceed 60 days. At this point, cumulative drought begins to develop.

As groundwater levels continue to decline, the pile heads are exposed to increasingly prolonged dry spells each year, resulting in a progressively worsening drought. It is estimated that the pile heads will experience 10 years of cumulative drought by 2035, signifying that the foundation becomes at risk from that year onwards.

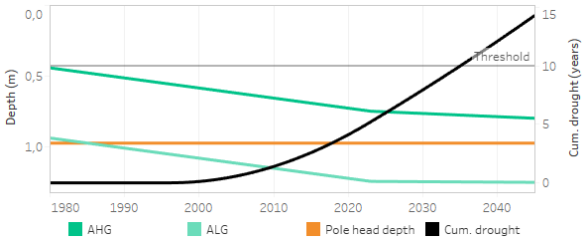


*Figure 3: Example of model outcome over time*

In the first ten years following 2035, a simulation estimates the specific year in which damage is likely to occur. After this ten-year period, it is assumed that the foundation will inevitably have sustained damage and will require repair.

### Impact on portfolio

The model is applied to all collaterals within the DMFCO portfolio. Approximately 47% of the associated properties are built on clay or peat, while the remaining properties are situated on sand or other soil types with a low chance of piles used as foundation.

Considering the probability of timber piles being present, an estimated 12% of the collaterals in the portfolio meet the conditions necessary for pile rot to develop.

Simulations of groundwater levels between the year of construction and the mortgage end date indicate that 1.1% of all collaterals will experience ten years of cumulative drought before the loan matures. This figure aligns with recent external research showing that, of the 425,000 residences expected to face foundation issues in the coming years,

[2] Dutch government-backed mortgage guarantee protecting homeowners from residual debt and investors from losses.

approximately 25% have timber piles and 75% have shallow foundations (Deltares, 2024).

The impact on investors is mitigated by several factors. Figure 4 illustrates the number of collaterals that sustain foundation damage over time, in comparison to the number of mortgages that result in losses as a consequence.

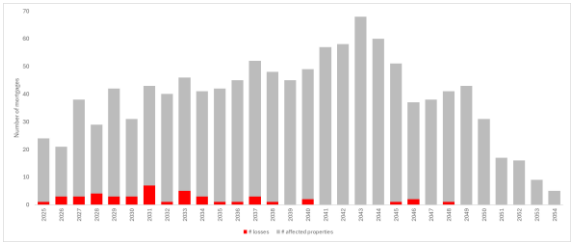

*Figure 4: Affected properties versus losses*

Foundation risk increases over time; however, the headroom also grows due to a decreasing LTV ratio.

Taking these factors into account, only 0.04% of all loans are expected to result in a loss. When a loss does occur, it averages approximately €46,000, leading to a total loss of €2.1 million across the entire loan portfolio of over €33 billion.

This equates to roughly 0.1 basis points over the full term of the mortgages.

## Conclusion

The risks and issues associated with foundations have been recognized for over 20 years, but more recently, the matter has attracted growing attention from a wide range of stakeholders. It is a complex issue, influenced by numerous factors and further complicated by a lack of available data.

As a result, many assumptions are required, introducing uncertainty into our model—particularly at the most detailed level. Nevertheless, inferences can still be drawn at the (sub)portfolio level for investors in mortgage investments.

Research has shown that awareness of the risks related to foundation problems remains limited among buyers. However, the impact of a compromised foundation on homeowners is significant. It entails not only substantial financial repair costs, but also considerable emotional strain and stress.

Mortgage investors are similarly impacted by foundation issues, as the property serves as collateral for the mortgage. Due to this indirect exposure, certain mitigating factors exist which help to limit the financial risk for investors. The expected loss for investors within the current portfolio is approximately 0.1 basis point over the full term of the mortgage, which does not justify explicit inclusion as a cost in the pricing (interest) of the mortgage.

## To end, some limitations of the model

The scope of the model is limited to pile rot. This decision was made deliberately, as pile rot is a major contributor to foundation issues and entails significant repair costs. However, other potential causes have been excluded from the current version of the model.

Due to data limitations, numerous estimations were required. These include assumptions about the foundation type (whether timber piles are used), groundwater levels and their seasonal fluctuations, pile head depth, and the erosion process caused by fungal activity. Despite careful efforts and due diligence in making these estimates, they inevitably introduce a degree of uncertainty, which, in this instance, cannot be quantified with precision.

# References


AFM. (2023). *Inprijzen klimaatrisico's op de woningmarkt.* Amsterdam.

AFM. (2025, 02 26). *Woningeigenaren vaak onbekend met zelf betalen van funderingsschade.* https://www.afm.nl/nl-nl/sector/actueel/2025/feb/pb-consumentenmonitor-hypotheekbezitters-q4-2024?utm_term=mailing&utm_medium=email

Bani, M., Barendregt, E., Blom, M., Burgers, S., Groot, C. d., Hordijk, R., Nobel, A., Phlippen, S., & Vendel, B. (2024). *Climate change and the Dutch housing market: Insights and policy guidance based on a comprehensive literature review.*

Deltares. (2024, Februari 29). *www.Deltares.nl*. https://www.deltares.nl/nieuws/funderingsschade-nederland-kaart-nationale-aanpak

Gemeente Rotterdam. (2025, May 7). *Duik in je Fundering*. https://www.rotterdam.nl/funderingsherstel

Hommes, S., Phlippen, S., van Reeken van Wee, J., Schreuder, C., & Ypma, F. (2023). Gemelde funderingsschade leidt tot forse prijskorting bij woningverkoop. *Economisch Statistische Berichten: ESB 08(4819)*, 136 - 139.

KCAF. (2019, 6 23). *De Nationale Funderingsramp (deel 2): Funderingsherstel vraagt een lange adem.* https://www.kcaf.nl/de-nationale-funderingsramp-deel-2/

Kok, S. (2021). *Technische toelichting risicokaarten funderingen.* Deltares.

Kok, S., Putten, S. V., & Kraus, J. (2021). *Naar een kennisagenda funderingsproblematiek.* Deltares,TNO.

Rli. (2024). *Goed gefundeerd.* Den Haag: Raad voor de leefomgeving en infrastructuur.

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