

## MORTGAGE PORTFOLIO ANALYZER: CASE STUDY

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## The ECB 2022 Climate Stress Test: Location Matters for Dutch Mortgages

The European Central Bank (ECB) released six climate risk stress test scenarios in January 2022. The exercise combines different types of risk, horizons, and affected economic drivers. We present a case study for Dutch residential mortgages based on these scenarios. A key challenge associated with the ECB's bottom-up stress test exercise is the expansion of the regional assumptions proposed by the physical and transition risk scenarios.

These assumptions are insightful, but still not sufficiently granular. The impact of acute physical risk must be incorporated at the location level to accurately reflect a property's true exposure. We use location-driven climate risk scores to better predict climate-adjusted PDs, LGDs, and expected losses during a flood event.

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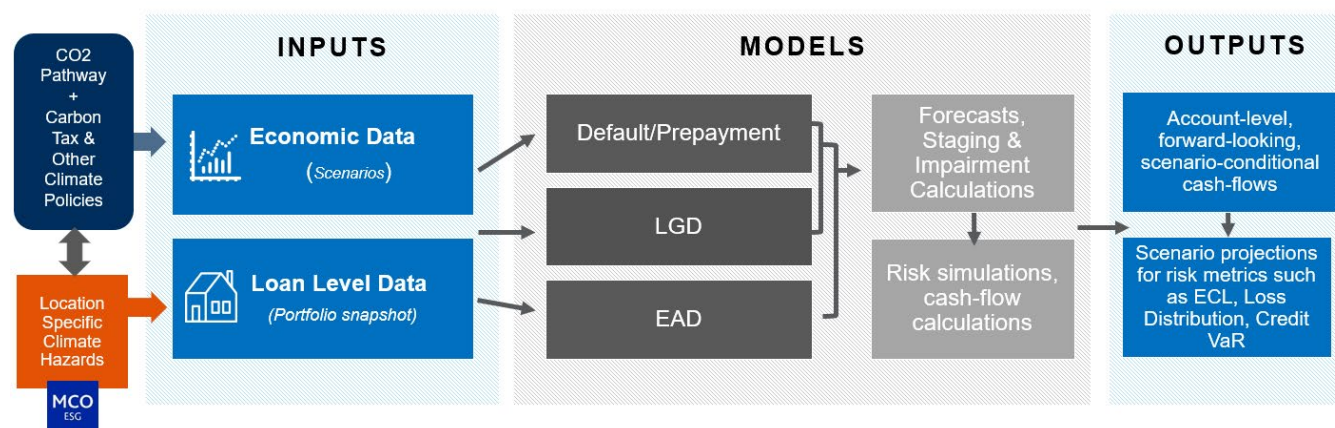
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## 1. Climate Risk Impact on Dutch Mortgages

There is increased demand to enhance credit risk models by incorporating climate-related change impacts. Transition risks are often captured through macroeconomic scenarios at the regional and sectoral levels. However, acute physical risk exposures vary widely by region, even differing significantly by neighbourhood. For many financial institutions, access to address-specific exposure is not readily available. This component is vital for accurately reflecting the impact climate risk may have on residential mortgages.

Based on the ECB's climate risk stress test exercise, we analyse the impacts that both transition risk and physical risk have on a representative sample of Dutch mortgages. We enhance ECB's regional assumptions by incorporating property-specific flood risk scores to determine the exposure each property faces. This approach enables us to discriminate by property location and better reflect the main contributors to increased credit risk due to climate-related events. To quantify the impact of the ECB's climate risk scenarios, we utilize Moody's Analytics Mortgage Portfolio Analyzer for the Dutch market, an off-the-shelf tool that predicts account-level credit risk metrics (PD/prepayment, LGD, exposure, and credit losses) conditional on macroeconomic scenarios. Figure 1 describes the Dutch Mortgage Portfolio Analyzer (Dutch MPA), where the set of credit risk models has been enhanced by adding climate change scenarios and location-specific information regarding climate hazards.

Figure 1 Climate-adjusted mortgage credit risk model



### 1.1 ECB's climate scenarios for the Netherlands

The ECB climate risk stress test exercise utilizes a bottom-up approach, which takes into account both transition risk and physical risk. The ECB provides a baseline scenario and six climate change scenarios, based on Phase II of the Network for Greening the Financial System (NGFS) models, described in Table 1.

Table 1 ECB's 2022 Climate Risk Scenarios

RISK TYPE	SCENARIO	DESCRIPTION	HORIZON
Short-term transition risk	Short-term disorderly	Sharp increase in carbon emissions in 2022	2022, 2023, 2024
	Disorderly	Climate policies are introduced in 2030. The delayed action results in strong measures to achieve targets	
Long-term transition risk	Orderly	Climate policies are introduced gradually, impact costs are minimized	2030, 2040, 2050
	Hot House World	No new climate policies are introduced. The scenario captures long-term physical risk, which translates into extreme costs	
Physical risk	Flood	Floods hit Europe on January 1, 2022	2022
	Drought	Heatwaves hit Europe on January 1, 2022	

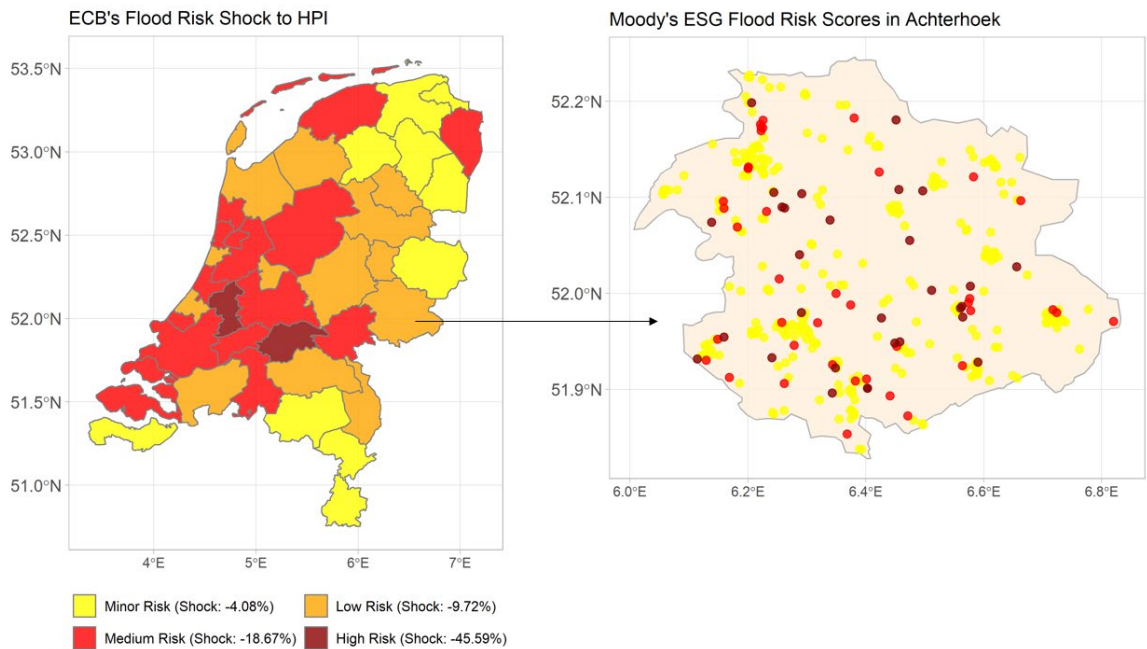
### 1.2 Accounting for location-specific flooding risk

The ECB provides NUTS3 House Price Index (HPI) impact shocks for the Flood risk scenario by segmenting the level of risk into four categories: Minor, Low, Medium, and High risks. These shocks represent annual growth rates by the end of 2022, depicted in Figure 2 (left panel). However, we obtain improved accuracy if the impact of climate hazards considers location characteristics of

the property, given that two properties located in the same NUTS3 region might face different levels of exposure to flooding risk. For instance, we expect a property located near a source of water (e.g., a river) to be at higher risk of being impacted by the flood event.

Moody's ESG provides facility-level climate risk scores for six climate hazards: heat stress, floods, hurricanes and typhoons, sea-level rise, water stress, and wildfires. The map on the right in Figure 2 presents a sample of flood risk scores<sup>1</sup> for the Achterhoek region, where each dot represents the location of the property with flooding risk ranging from Low (yellow dots) to Red Flag (dark red dots). Even though the region has been classified as Low Risk, some material hotspots are observed. For this reason, we base our approach on building a distribution of HPI trajectories at the property level using the ECB's assumption as the anchor point, but discriminating by location-specific exposures to flooding risk.

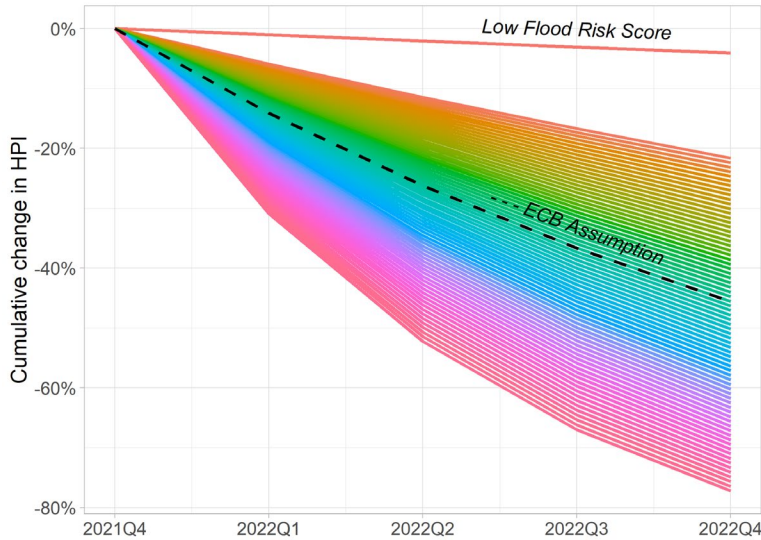
**Figure 2** ECB's HPI impact shock at NUTS3 level – Flood Scenario



We employ Moody's address-specific ESG flooding hazard scores to adjust the HPI path for each property. Figure 3 presents our location-specific or score-specific HPI trajectory for the ECB's High Risk flood segment. The dashed black line represents the target HPI provided by the ECB while the coloured lines are score-specific trajectories. To obtain these trajectories, we first assumed the path provided by the ECB is the average value for the segment. We then build a distribution around this path using Moody's ESG flood risk scores distribution. The average HPI shock for the segment is the target provided by the ECB, yet some mortgage accounts will be more impacted than others based on the exact location of the property. Moreover, accounts with low flood risk scores are not at risk of experiencing a flood event. However, to be on the conservative side, we assume these properties still experience the minor flood risk impact of 4.08%, defined by the ECB.

<sup>1</sup> The flood risk score measures the severity and frequency of historical floods, the frequency of future heavy rainfall events, and the intensity of prolonged periods of heavy rainfall. The flood risk scores range from 0 to 100.

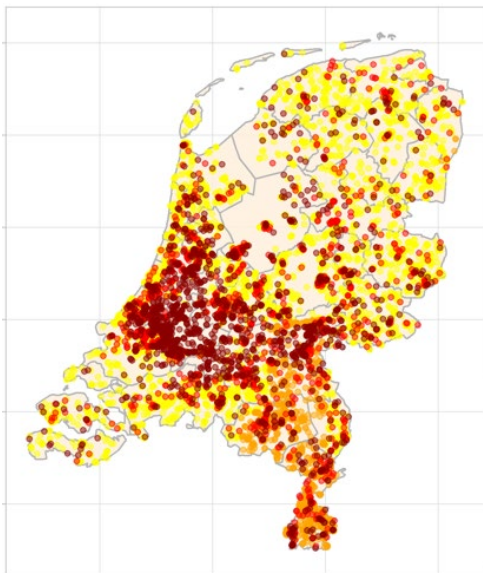
Figure 3 Score-based property-level HPI projections for the High Risk ECB segment



### 1.3 Climate risk impact on Dutch mortgages

We base our analyses on a representative sample of 10,000 Dutch mortgages originated between early 1990 and 2021. Approximately 22.5% of the loans are backed by the National Mortgage Guarantee. This scheme, known as NHG (Nationale Hypotheek Garantie), protects borrowers in the case of missed payments. In terms of geographic distribution, 40.4% of the portfolio is located in what ECB denominated the Medium Risk area (refer to Figure 2), followed by the Low (33%) and Minor Risk (24%) areas. Only 3% of the accounts are located in the High Risk area. Figure 4 presents flooding risk scores for our sample of Dutch mortgages.

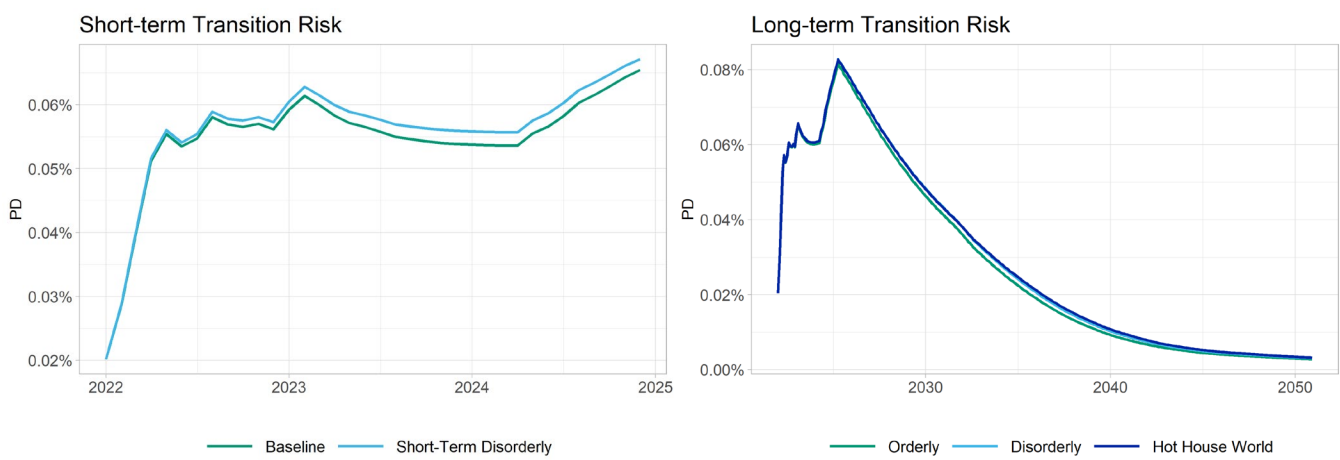
Figure 4 Moody's ESG climate hazard scores for a portfolio of Dutch mortgages



We input ECB's climate risk scenarios together with our property-specific HPI trajectories into the Dutch MPA. For each mortgage in the portfolio, MPA's loan-level models predict monthly default and prepayment probabilities over the pre-specified time horizon as a function of loan-specific characteristics and the economic scenarios. Similar forecasts are calculated for LGD and exposures. Figure 5 presents the PD projections under the transition risk scenarios. The slower increase in HPI under the Short-term Disorderly scenario together with higher unemployment rate translate into an increase in PDs relative to the baseline. The

relative spread between these two scenarios remains fairly constant from 2023. On the other hand, the Hot House World scenario is the most severe long-term transition scenario, reflected in the PD trajectory, while the Orderly scenario presents the lowest PD projections. Overall, the impact on PD for the three scenarios starts to converge beginning 2040.

Figure 5 Climate-adjusted PD – Short-term (left) and long-term (right) transition risks



The assumptions for the Drought scenario do not impose a material impact on PDs when compared to the baseline. This is not the case for the Flood risk scenario, where we observe higher PDs by the end of 2022 (see Figure 6, left panel). Furthermore, given our distinction of location-specific flooding risk, it is possible to compute PD forecasts by property location (or flood score). On the right panel in Figure 6, we show how the PDs behave for ECB’s High Risk area when accounting for location-specific characteristics. Each line represents the average PD trajectory for a location or flood score. We observe that properties with low Flood risk scores (i.e. properties not significantly exposed to flooding risk such as those with a Flood score  $\leq 27$ ) face significantly lower PDs compared to properties in riskier locations (e.g. properties with a Flood score of 90 or above).

Figure 6 Climate-adjusted PDs – Physical risk (left) and High flood risk segment by property location (right)

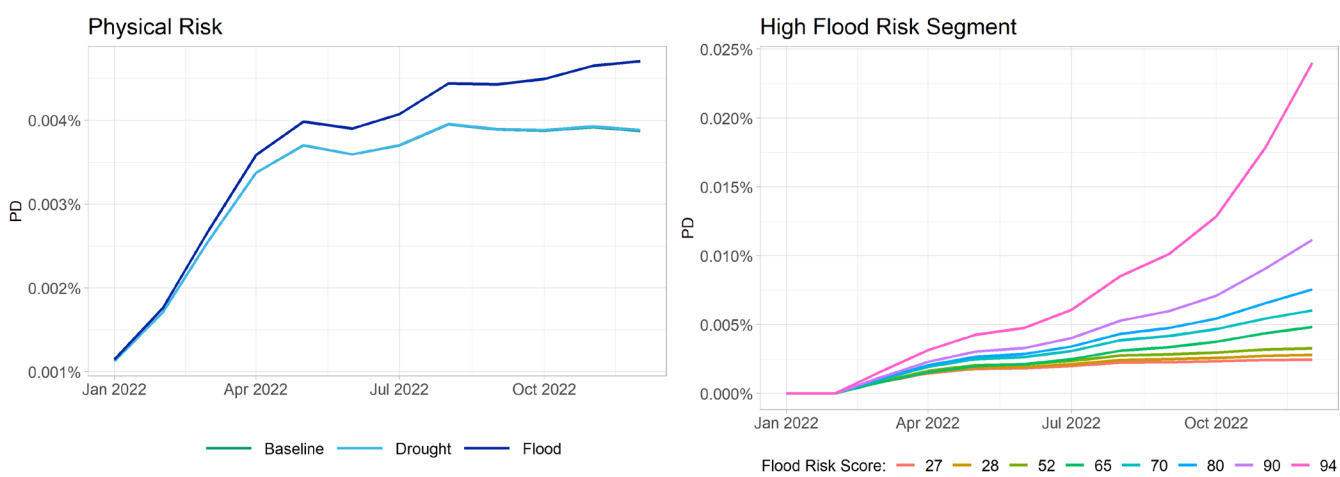
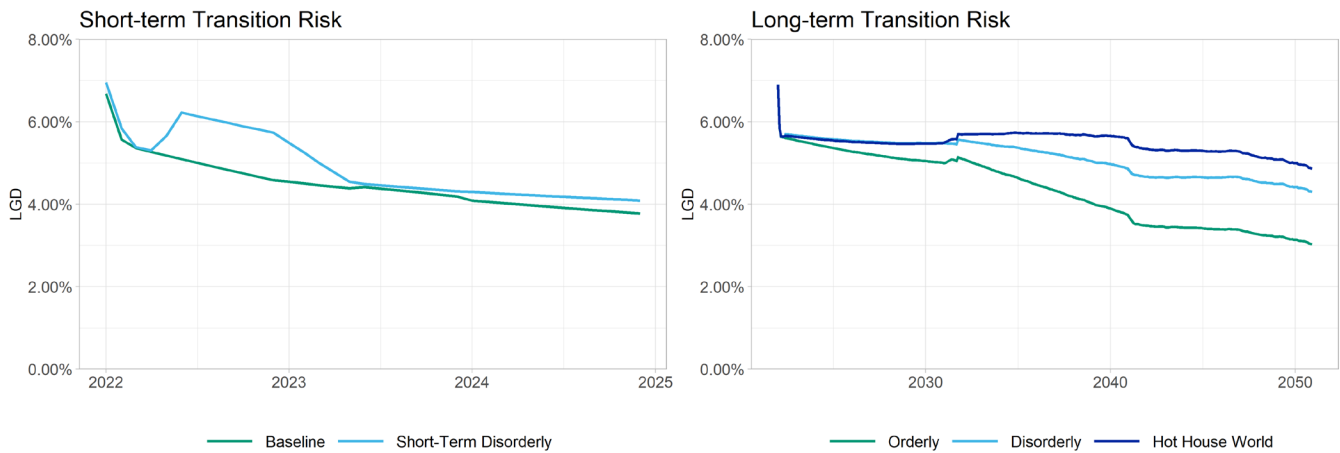


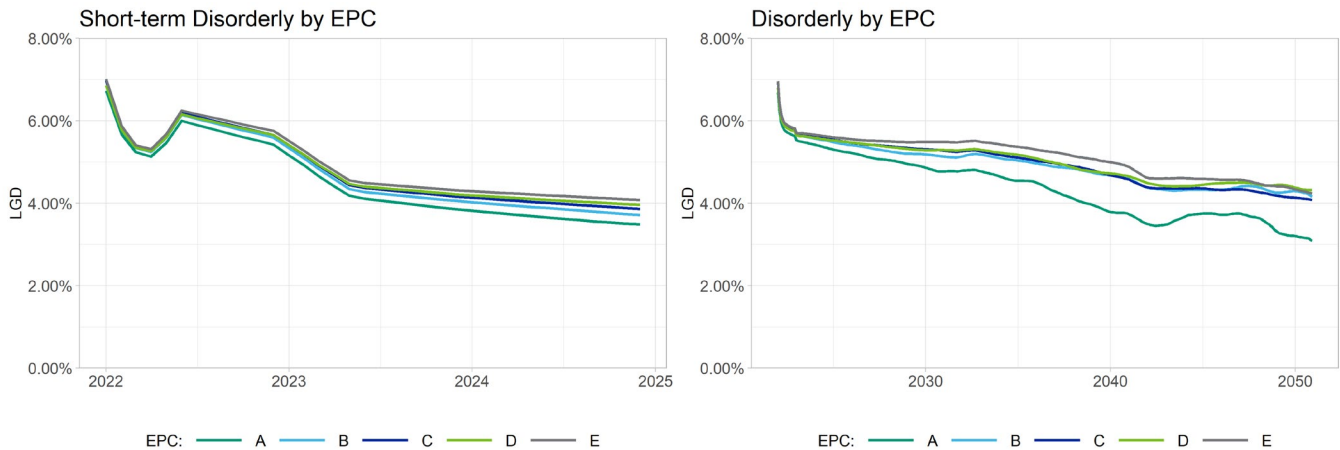
Figure 7 shows the impact of the transition risk scenarios on LGDs. The assumptions behind the Short-term Disorderly scenario materialise in 2022, as the maximum spread between the climate scenario and the baseline is observed in December 2022 (left panel of Figure 7). In terms of long-term transition risk scenarios, the Hot House World scenario presents the largest impact in terms of LGD levels, while the Orderly scenario shows the lowest. By 2050, the relative spread between these two scenarios is around 50%.

Figure 7 Climate-adjusted LGD – Short-term (left) and long-term (right) transition risks



The ECB also provides HPI trajectories by Energy Performance Certificate (EPC). Our portfolio sample does not include information related to EPC. However, we make assumptions about the EPC distribution, based on available information for the Netherlands. Figure 8 depicts the average LGD by EPC for the Short-term Disorderly and the Long-term Disorderly scenarios. As expected, more efficient properties (EPCs A, B, and C) face lower LGD levels than the least efficient properties, the difference amplifies for the most efficient segment (EPC A) in the long term.

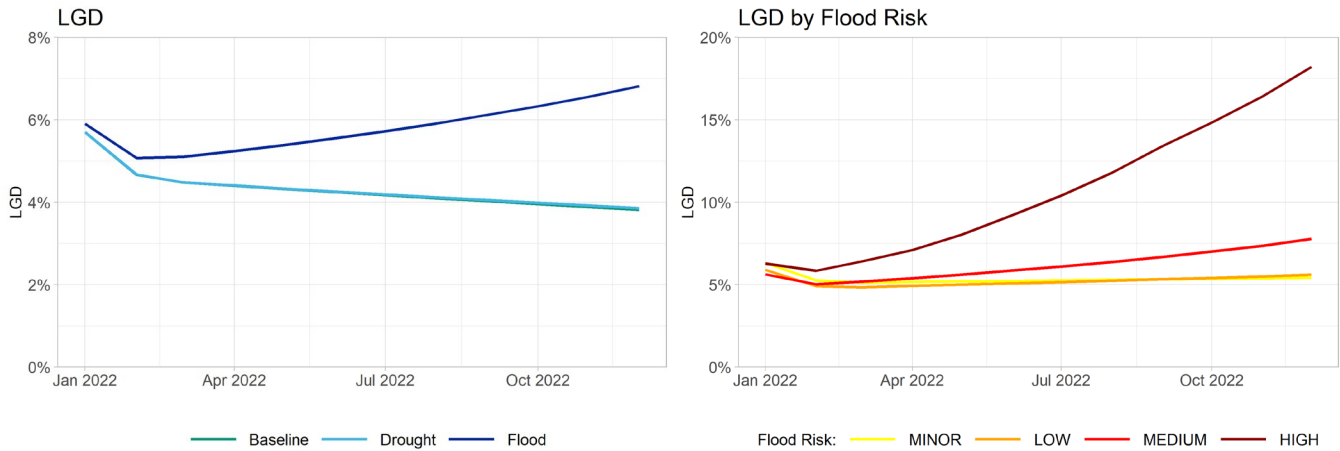
Figure 8 Climate-adjusted LGD – Short-term disorderly (left) and long-term disorderly (right) scenarios by EPC



Given the low impact of the Drought scenario on HPI, the LGD under this scenario does not significantly differ from baseline. However, we observe a significant impact driven by the Flood scenario, where LGD is on average 7% by the end of 2022 vs. 4% in baseline (see Figure 9). Further analysis of the Flood scenario shows that the LGD impact varies by risk category. For instance, the average LGD for the High Risk segment goes up to 18% by the end of 2022. For the minor and low segments, the average LGD is similar and relatively stable at around 5%.

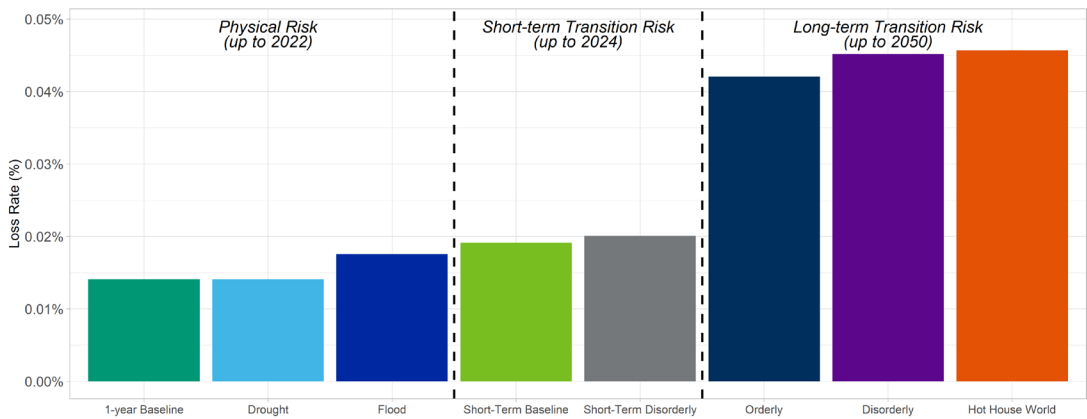


Figure 9 Climate-adjusted LGD – Physical risks (left) and flood risk by category (right)



Finally, Figure 10 compares expected losses from January 2022 to December 2022 for the Physical risk scenarios, to 2024 for the Short-term Transition Risk scenarios, and 2050 for the Long-term Transition Risk scenarios. The Drought scenario has an immaterial impact on our mortgage portfolio compared to the baseline, while the Flood scenario results in losses 24% higher, though total losses remain relatively small in absolute terms. In terms of the long-term transition risk scenarios, the Orderly scenario presents the lowest impact (0.042% expected loss rate), while the Disorderly and Hot House World scenarios result in similar levels of loss rates (0.045% and 0.046%, respectively).

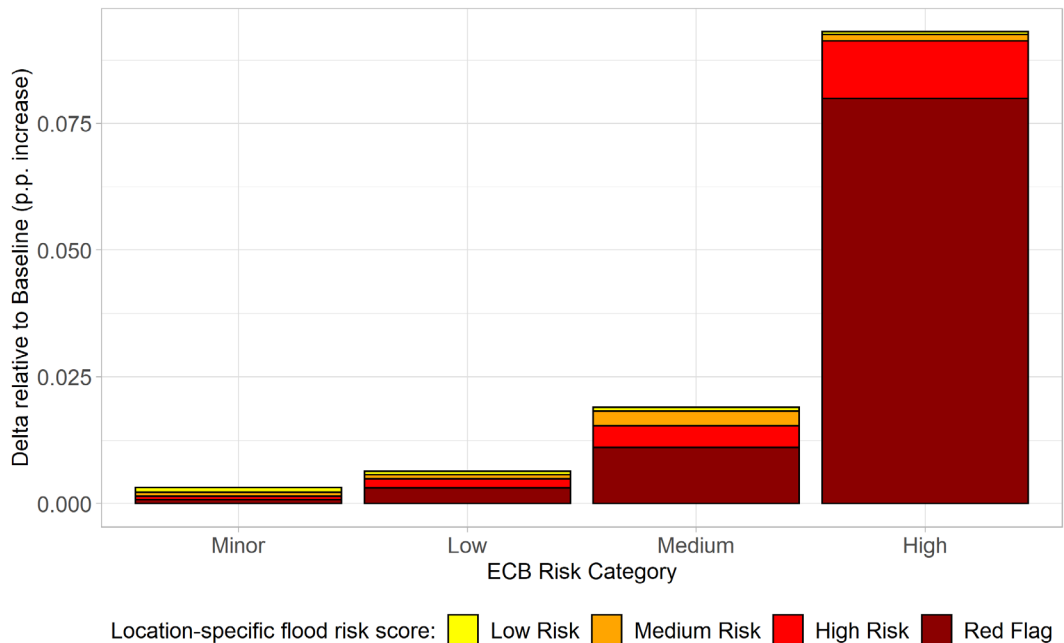
Figure 10 Expected loss by scenario



The impact of climate adjustment on losses can vary significantly based on the location of the property when accounting for a flood event. Figure 11 presents the calculated loss difference (relative to the baseline, in p.p.) for the Flood risk scenario. ECB's shock to HPI is significantly higher for the High Risk regions and this is reflected in the chart below. However, the specific location of the mortgage provides insight into whom contributes the most to the increased risk. For instance, properties in ECB's High Risk area with low flood risk scores present a negligible increase in credit risk compared to those properties located in Red Flag areas.



Figure 11 Increase in expected losses relative to base – Flood scenario



## 2. Conclusion

The ECB released a scenario-based framework for climate stress testing across Europe in early 2022. In addition to baseline projections, the ECB provides two short-term physical risk and two transition risk scenarios, plus three long-term NGFS II transition risk scenarios. We calculate the effect of the climate scenarios on the Dutch mortgages using Moody's Mortgage Portfolio Analyzer and Moody's location-specific ESG scores. While the impact of the transition risk is gradual and spread over a long time horizon, the impact of the acute flood event representing physical risk is immediate and large for properties with higher levels of flood risk exposure.

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