Analysis

Floods and financial stability: Exploring the role of sea level rise

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Executive Summary

This analysis explores the links between sea level rise, flood risk, and financial stability. Flood risk is relevant in the Dutch context from both a physical and a financial perspective. One fourth of the country lies below sea level and about half of its land surface is at risk of river or coastal flooding (see, e.g., Van Ginkel et al. 2025). Many households and companies reside in such at-risk areas. Any flood event would damage properties and affect livelihoods. As insurance coverage is often not available, such events could also impact financial institutions who have granted loans to those households and companies.

At present, the financial stability implications of a flood event seem manageable. The Netherlands has traditionally invested heavily in flood defense systems. Thus, the likelihood of a flood event is low, while the expected damages in case of a breach are expected to remain contained. In a recent scenario-based study, Caloia, van Ginkel, and Jansen (2023) report that, in the event of a flood, property damages would mostly lead to capital depletions for Dutch banks of less than half a percentage point. This would be a small impact for lenders, even in the current situation where Dutch insurance policies typically do not cover property damages for major flood events.

However, climate change can exacerbate future climate-related physical risks. Climate change implies more frequent and more severe extreme weather events. This could lead to larger financial risks, especially in case of a delayed transition to carbon neutral. It is important to understand the long-term implications of climate change for financial stability in a timely manner. Along these lines, the International Monetary Fund (2024) has recommended to "*conduct physical risk analysis using forward-looking medium and long-term flood scenarios accounting for the impact of climate change*" in the Dutch context.

Sea level rise could amplify the financial stability implications of flood events. This study illustrates this amplification for one transmission channel, namely how flood-related property damages lead to higher credit risk on loans secured by property. Due to sea level rise, the potential depletion of financial institutions' capital would increase. Compared to baseline estimates of 30 – 50 basis points (Caloia et al., 2023), sea level rise could increase capital depletions significantly. Based on exploratory calculations for stress scenarios, average capital depletions are estimated to be five to ten basis points higher by 2050 and fifteen to twenty-five basis points higher by 2100. While this would still considered manageable, tail risks would increase as well. Damage-related capital depletions can already reach up to 280 basis points in the most severe scenarios. In such extreme scenarios, additional macroeconomic adversity would, almost certainly, put further pressure on capital positions.

Addressing insurance protection gaps and/or investing in adaptation measures can dampen the financial stability impact of flood events. Adaptation can take different forms. Strengthening flood protection will play the most important role moving forward, in minimizing the likelihood of a flood event as well as the expected damages. Adaptation also relates to discussions on where and how to build. Beside adaptation, addressing insurance protection gaps can help dampen the financial stability implication of flood events (DNB, 2022). Prudent lending decisions and sound risk management are also ways of increasing the resilience of financial institutions and adapting to a potential increase in the severity of physical climate shocks.

Future work is welcomed to understand the implications of sea level rise, and the mitigating effects of adaptation in more detail. In terms of methodology, this analysis relies on a rough mapping of climate pathways onto inundation depths. Future work could improve this mapping, thus ensuring more precise estimates. In this context, the IMF (2024) also recommended to "*strengthen data sharing and collaboration with floods, climate and environment experts in the Netherlands*" For now, the findings do suggest it is important to understand the transmission from physical risks to financial stability in a timely and forward-looking fashion.

1. Motivation

The risk of a flood event has always been of high relevance for the Netherlands. One fourth of the country lies below sea level and about half of its land surface is, in principle, at risk of flooding (Van Ginkel et al., 2025). Given this, the Netherlands has historically attached great importance to flood defenses and developed a comprehensive flood protection system. In the next few decades, further strengthening of Dutch flood defense systems will be taking place.[1]

In the absence of insurance coverage, Dutch lenders have an exposure to flood events via loans for which at-risk properties serve as collateral. About forty percent of the total assets of Dutch banks consist of loans secured by residential or commercial immovable property (DNB, 2021). A large share of these properties is located in areas at risk from floods, as mortgage lending is an inherently domestic business and most people reside in the western part of the country, where most economic activity is concentrated. Also, Dutch lenders can grant loans with, from an international perspective, relatively high Loan-to-Value (LTV) ratios, while their portfolio is characterized by a high share of non-amortizing loans (Interest-Only) mainly originated between the late 1990s and early 2000s. The combination of large domestic real estate exposures, high LTV ratios and high shares of interest-only mortgages can potentially exacerbate the vulnerability of lenders to flood events.

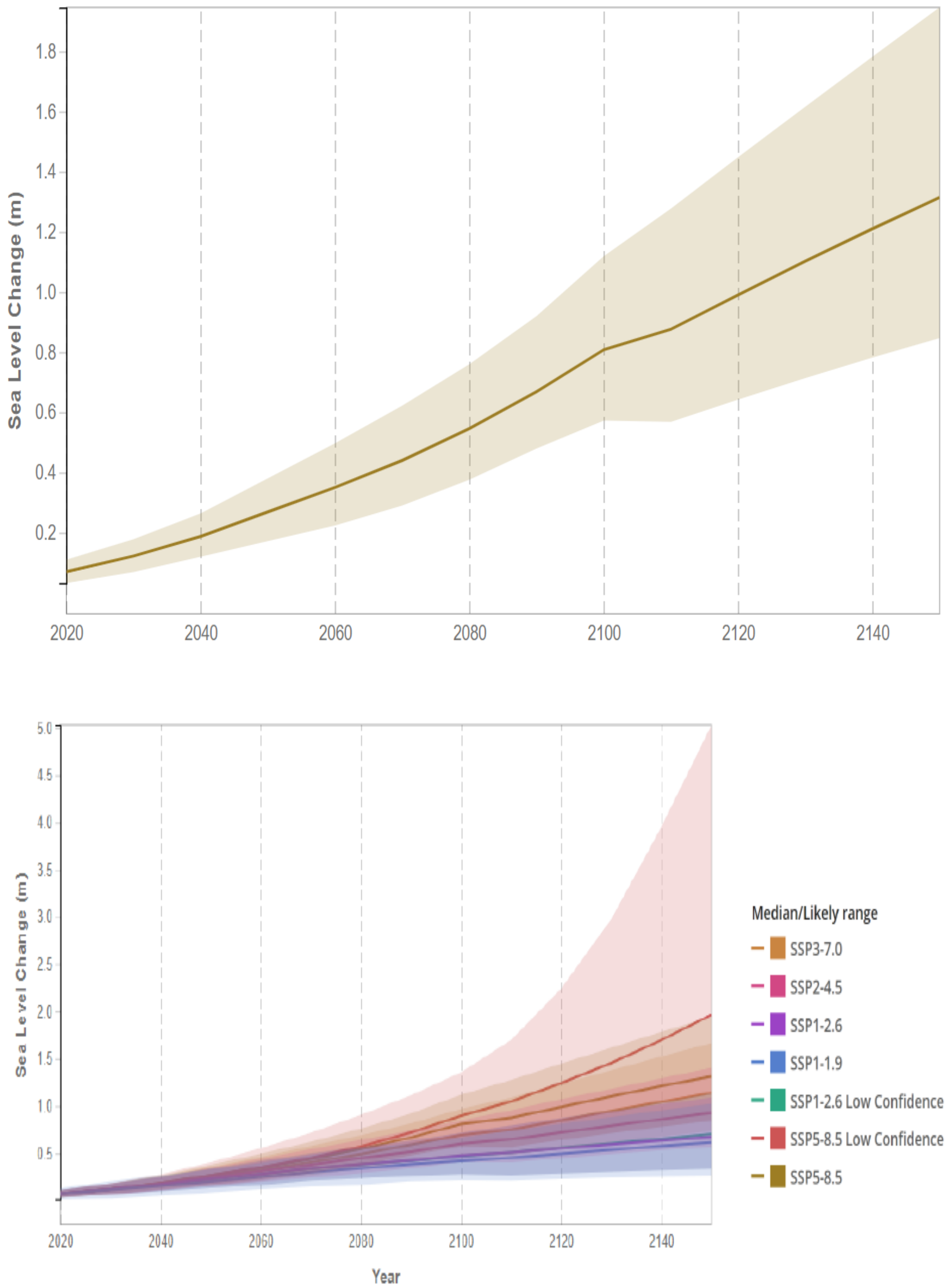
From the perspective of current climate conditions, the financial stability implications of a flood event are manageable. Given the structural investments in flood defense systems, the likelihood of a major flood event in the Netherlands is low, while the expected damages are expected to remain contained. In a scenario-based study of financial stability implications, Caloia, van Ginkel, and Jansen (2023) report that flood-related property damages would mostly lead to CET1 capital depletions for banks of less than half a percentage point.

However, sea level rise due to global warming may amplify financial stability impacts, thus making it important to analyze its role in a timely fashion. Current estimates suggest that sea level rise may reach up to 5 meters by 2150. Under such scenarios, the implications of flood events are likely to be significantly more severe. Figure 1 shows projections for sea level rise relevant to the Netherlands. These are combinations of Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs)[2]. There could be thirty-five combinations of RCPs and SSPs, some of which are very unlikely. For each RCP-SSP combination, a country-specific pathway for sea level rise is available, which for the Netherlands ranges from 0.4 to 5 meters by 2150. The bottom panel of Figure 1 shows possible pathways for sea level rise over the next century. The top panel zooms in on the SSP 5-8.5 scenario, which is one of

[1] The aim is to have strengthened primary flood defense systems by 2050. For more information about the work under this High-Water Protect Program (in Dutch: *Hoogwaterbeschermingsprogramma*), see also http://www.hwbp.nl.
[2] RCPs are pathways for greenhouse gas emissions and atmospheric concentrations, which come with various levels of global warming and thus different climate extremes. SSPs capture the challenges associated with adaptation and mitigation. In this context, climate conditions refer to the various scenarios of climate and societal development represented by RCPs and SSPs.

the most used in the scenario-based literature (O'Neill et al. 2020). It is also the scenario used in a recent analysis for the Netherlands by the IMF (2024).

Figure 1. *Sea level rise between 2020 and 2150, as estimated under the SSP5-8.5 pathway (top panel) and other pathways (bottom panel)*



Note: Per scenario, the solid lines denote the point estimate of sea level rise. The shaded areas denote the associated confidence intervals. The projections are obtained from NASA (2021). The top panel zooms in on the SSP 5-8.5 scenario.

This report proposes an exploratory analysis on how sea level rise affects the estimates of credit risk triggered by flood events. The approach taken here should be seen as a first step, essentially relying on a first mapping of how sea level rise pathways onto present-day average estimates for local inundation depths. Other than that, this DNB Analysis strongly leans on the framework developed in Caloia et al (2023) but does provide new elements, including discussions on possible risk-mitigation strategies and the possible implications of climate adaptation.

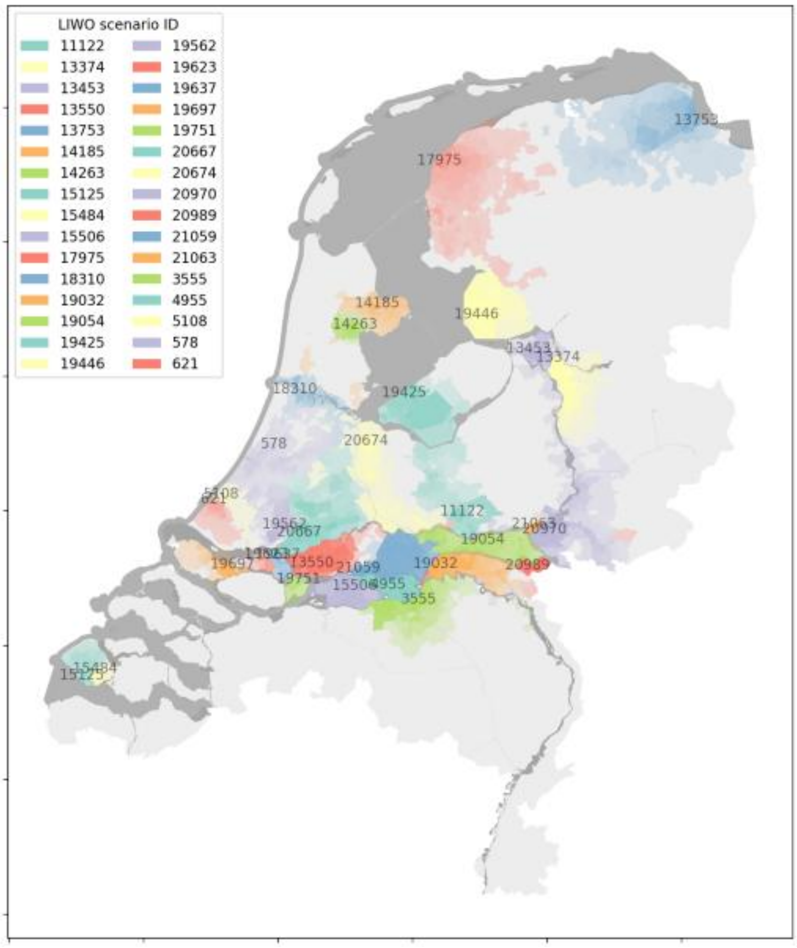
Future work is welcomed to understand the implications of sea level rise on the one hand and various adaptation measures on the other hand in more detail. At present, there are still substantial knowledge and data gaps with regards to how sea-level rise could impact water stress levels during flood events as well as the size of the areas at risk of the impacted areas. Further work, cooperation and data-sharing between experts remains crucial, for example on the development of forward-looking maps and scenarios with timely information on the evolution of the return periods, inundation depth, and the size of the impacted areas. Such information would help assess the potential effects of sea level rise better, while it could also provide further insights into the effects of various forms of adaptation.

2. Methodology

2.1 Flood scenarios

This analysis uses 32 single breach flood events with expected damages of over EUR 500 million. These represent severe but plausible scenarios based on current flood risk levels, as available in the LIWO, a public database containing flood risk maps with information on flood return periods and water depth levels[3]. Figure 2 shows the single breach scenarios. This analysis focuses on floods in protected areas resulting from breaches of the primary defense system. An important point is that insurance policies do not typically cover damages in case of a failure of a primary defense against the water. This means that this type of financial risk mitigation is not available. Importantly, these scenarios reflect current risks, as they are generated based on the current state of climate conditions and climate mitigation, in terms of hydraulic loads and the strength of the flood defense system.

Figure 2. *Single breach flood scenarios*



Note: Each number and color in the map refers to a specific flood scenario sourced from the LIWO information system. All scenarios refer to floods due to a single breach of primary flood defense systems. Source: Caloia, van Ginkel, Jansen (2023).

[3] See also https://basisinformatie-overstromingen.nl/#/maps. URL last accessed on 16 May 2025.

For multiple breach scenarios, we rely on a set of six *worst conceivable floods* developed by flood experts. These EDO (in Dutch: *Ergst Denkbare Overstroming*) scenarios were constructed to guide the flood management taskforce in the work on water crisis management.[4] They represent outcomes that experts considered (at that time) extreme but still somewhat realistic. These scenarios resulted from the combination of multiple breaches and severe weather conditions, such as wind speed and direction. As such, they can naturally be interpreted as extreme tail risk scenarios with regards to flood risk.

2.2 Integrating future climate conditions – a first step

This analysis considers future climate conditions at two points in time, namely 2050 and 2100. The first date is exactly thirty years apart from the reference date of the analysis by Caloia, van Ginkel and Jansen (2023) and represents the main key target date for the 2015 Paris Agreements. The second date represents a long-term horizon for current climate projections. Admittedly, projections of future climate conditions are surrounded by large degrees of uncertainty. Naturally, this degree of uncertainty implies that the results of this exploratory analysis should be interpreted with caution. Still, the findings do provide a first indication on the likely range of outcomes with regards to the impact of future climate conditions. Future work can then further refine the estimates and perform additional sensitivity analyses.

This analysis looks at the degree of sea level rise as suggested by the RCP-SSP pathways. Out of the existing RCP-SSP combinations, this analysis focuses on SSP 5-8.5 and the associated projection for sea level rise. SSP 5-8.5 is a high-emissions scenario frequently referred to as "business as usual". It considers that there are no concerted efforts to cut greenhouse gas emissions. For each horizon (2050 and 2100), this analysis uses the point estimate of sea level rise as well as the confidence bands around this value. Thus, the analysis accounts for a range of sea level rises associated to a climate change scenario which is deemed as relatively likely by climate change experts. Moreover, this analysis accounts for the uncertainty around sea level rise due to the energy transition by investigating the interactions between physical and climate risks.

2.3 Key assumptions

First, this analysis assumes that *ex ante* insurance solutions for flood risk will remain unavailable in the Dutch context. Following that assumption, property damages are assumed to weigh fully on lenders' capital positions. There has been a discussion on a public/private approach, whereby insurers would offer coverage for a first part of the damages, while the government would commit to compensating for an additional part (see also DNB, 2022). At present, such an approach is not in place.[5] Recently, a joint ECB/EIOPA (2024) report proposed an EU approach to natural catastrophe risk management. One pillar

[4] See also Ten Brinke et al (2010) for a description of the EDO scenario set and Caloia et al (2023) for a visualization of the EDO scenarios.

[5] At present, the government could cover part of the damages *ex post* using the Wts (*Wet tegemoetkoming schade bij rampen*). For a recent evaluation of the Wts, see also Engelhard et al (2024).

would be an EU public-private reinsurance scheme; the other pillar would be an EU fund for public disaster financing.

Furthermore, a key technical assumption is the mapping of sea level rise on flood hydraulic loads. One meter of sea level rise does not necessarily translate into an additional meter of inundation depth. At present, there are not many approximations available for the Dutch context. This analysis relies on work by Shaffrey (2023), which studies flood inundations if one of the Dutch dikes in one defense ring were to breach and connects this to sea-level rise. Shaffrey (2023) compares four different breach locations in the Netherlands. It finds that the mapping from sea level rise to inundation depth is indeed not 1-for-1. This analysis uses the calibration for the municipality of Katwijk, as it seems fairly conservative across the four calibrations. It indicates how sea level rise of 5 meters would imply an increased inundation depth of a little under 2 meters. In future work, it would certainly be desirable that further calibrations are explored.

Third, the scope of the analysis is restricted to loans for which properties serve as collateral. Lenders' real estate exposures mainly consist of household mortgages, commercial real estate loans and loans secured by commercial immovable property. The scope of the analysis is limited to banks' exposures on these assets as i) one of the main consequences of floods is the damages to properties, ii) real estate represents the largest asset holdings in the Dutch banking sector, iii) more detailed information is available on these assets. Still, it should be noted that floods may have important implications for other financial institutions (e.g. insurers and pension funds)[6] as well as other assets (e.g. corporate loans through disruptions in supply and value chains and damages to machinery and equipment).

In addition, this analysis assumes a static balance sheet. To compare the results of the sensitivity analysis to the results of the Caloia, van Ginkel and Jansen (2023) study, the same set of bank exposures are tested. In other words, the analysis assumes the size and riskiness of the exposures remain constant. Of course, future exposures may differ from current ones for a variety of reasons. For example, new bank regulations may shift the risk-appetite of banks, or banks may anticipate the impact of climate change and phase-out some of the risk pockets in their current exposures. Still, the assumption is useful to draw a comparison that only reflects changes in the risks faced by financial institutions rather than changes in their balance sheet size or risk-profile.

Fifth, the analysis uses currently-available damage curves. The calculation of damages for each individual property follows the SSM (*Schade Slachtoffer Module*) methodology. This is the standard method for calculating flood damages in the Netherlands (Slager and Wagenaar, 2017) and does so based on damage functions mapping inundation depths to property damages (per m^2). There is, however, a recent

[6] Insurers and pension funds are out of scope for this analysis, partly as no detailed information is readily available. However, DNB (2021) discussed how flood risk could also be a relevant factor for these institutions due to large national and international exposures to real estate. More generally, these institutions could also be affected by climate shocks via other types of exposures (FSB, 2025).

discussion on whether these damage curves should be updated in light of actual damages observed after the 2021 floods in Limburg (Endendijk et al., 2023; De Moel et al., 2025).

Sixth, the analysis abstracts from second-round effects on banks through the macroeconomy. Table A in the Appendix summarizes the findings of the academic literature regarding the short-term effects of flood on GDP growth. This shows that existing research on the macroeconomic effects of floods is not conclusive, as these are found to have ambiguous effects on GDP growth. This is because, for example, floods caused by heavy rainfalls may cause damages in one location but may spur agriculture productivity elsewhere. Similarly, damages caused by floods hamper productivity but, at the same time, often spur public spending and investments in reconstruction which positively contribute to GDP. Also, the local nature of the floods we consider is not likely to induce broader effects on GDP growth and the macroeconomy. However, in a multiple-breach events, such second-round effects would most likely be much more relevant.

Lastly, the analysis focuses on isolated adverse events. The calculations provide an indication of capital depletion in the wake of one flood event at the time. However, dynamic considerations related to capital and risk management could play a role, in the context of a slow but progressive sea level rise, leading to a higher frequency and severity of events. On the one hand, if floods happen more often, lenders would be asked to re-capitalize more often to maintain a certain management buffer. On the other hand, a pattern of extreme weather events could also create more urgency to adapt.

3. Estimates for financial stability impacts

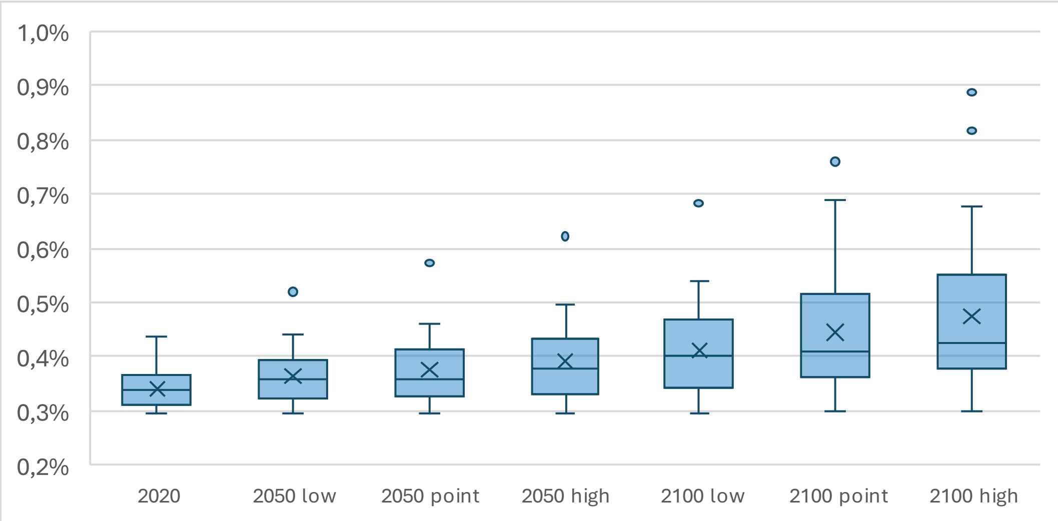
Flood-related property damages impact financial stability via higher credit risk on real estate loans. Property damages caused by a flood lower the collateral value of the property. This increases the loan-to-value (LTV) ratio and in turn the loss-given-default (LGD), i.e. the amount of credit losses the bank would incur in the event of a default on the loan secured by the property. Also, LTVs are positively correlated with a probability of default (PD), as loans with high LTV ratios are usually more likely to default. Lastly, damages would lead to higher regulatory risk-weights (RW), i.e. the regulatory parameters that determine how much capital banks need to put aside, given the size and riskiness of their exposures. This is because risk-weights positively depend on the LGD and PD, in line with the Basel framework.

The financial stability implications are illustrated using bank capital depletions. In the absence of insurance coverage, the focus is on implications for lenders (see also Caloia et al., 2023). The capital adequacy of banks is usually assessed by looking at the CET1 ratio, the ratio between the highest quality regulatory capital (CET1) and the total risk-weighted assets (RWA) in bank balance sheets. In the scenario analysis, we focus on the depletion of capital, i.e. the decline of the CET1 ratio after a shock. Higher credit risk leads to a depletion of banks' CET1 ratios due to both higher credit losses and an increase in capital requirements. The estimated bank CET1 capital depletion, i.e. the difference between the projected and the starting point CET1 ratio, informs on the resilience of banks to severe but plausible events. In turn, the increase in the capital depletion due to sea level rise gives an indication of the financial stability implications of future climate physical risk.

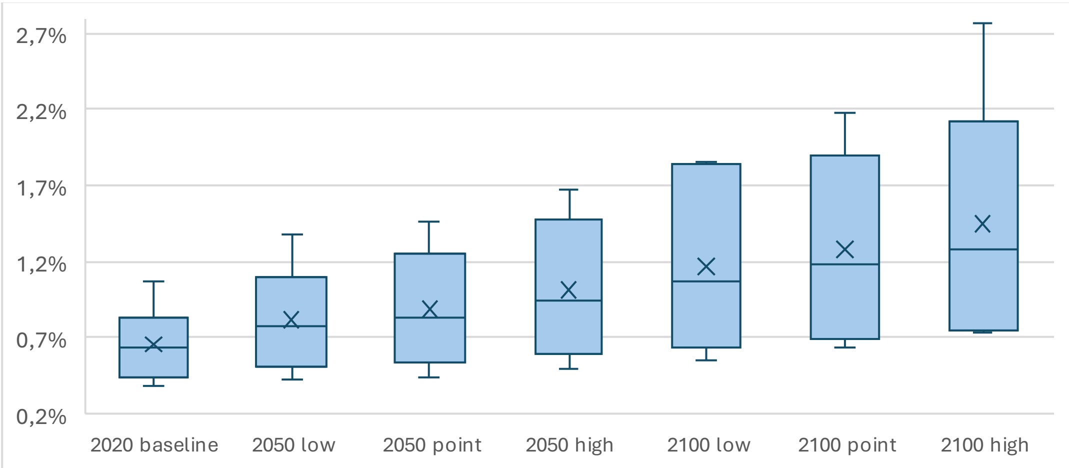
The findings suggest that sea level rise (in the absence of adaptation) will amplify the financial stability implications of flood events. As sea level rise increases, the average capital depletion will be larger. Also, the range for the estimated depletion will also widen. Figure 3 summarizes the results. The figure shows the estimated capital depletion at different horizons (2020, 2050 and 2100) and for various paths for sea level rise (low, point and high estimate of SSP 5-8.5). Panel A focuses on single breach flood events; Panel B focuses on multiple breach events.

Figure 3. Capital depletion under various scenarios for sea level rise (w/o adaptation)

Panel A: single breach events



Panel B: multiple breach events



Note: the figure shows the distribution of the capital depletion by horizon (2020, 2050, 2100) and Sea Level Rise scenario (baseline, low, point, high estimate) for the set of single-breach (top panel) and multiple-breach (bottom panel) flood scenarios. The blue bars denote the 25th and 75th percentile. The whiskers denote the 10th and 90th percentile. The horizontal line and the cross denote the median and mean. The dots denote higher-end estimates (> 95th percentile).

For single breach events, the average projected effects remain limited. For instance, the distribution of current capital depletions (2020) associated to the single breach scenarios (top -panel) ranges from 29 to 45 basis points, with an average of 35 basis points. Instead the distribution of future capital depletions (2050 and 2100) associated to the same scenarios and the point estimate of sea level rise of SSP 5 8.5 range from 30 to 58 and from 30 to 76 basis points, respectively, with an average of 38 and 45 basis points.

For multiple breach events, however, the impact of sea level rise is nonlinear and more severe. The bottom panel of Figure 3 shows again the capital depletions as a function of sea level rise, now for the set of multiple breach events. These are considered the most severe floods, as both water levels and the size of the inundated areas are usually higher than for the single breach scenarios. The figure shows that the capital depletions associated to the multiple breach scenarios are more sensitive to sea level rise than for the single breach scenarios, as the average depletion (baseline / point estimate) goes from 66 basis point in 2020 to 90 basis points in 2050 and 130 basis points in 2100. The nonlinearity is also evident from the range (max – min) which increases from 70 basis points in 2020 to about 100 basis points in 2050 and to 150 basis points in 2100.

Furthermore, given the uncertainty around future sea level rise, there are important tail risks to be considered. The estimates about future sea level rise are surrounded by high uncertainty, and this uncertainty also increases proportionally with the forecast horizon. This is why this report not only quantifies the impact associated to the main projection of sea level rise (point estimate) but also the one associated to the higher and lower confidence band of the estimate (high and low estimate). If the most conservative and least likely scenario for sea level rise materializes (high estimate) the range of capital depletion would increase to about 120 basis points in 2050 and to 200 basis points in 2100.

4. The role of adaptation

While sea level rise in itself increases impacts, adaptation measures will have a dampening effect on financial stability impacts. The NGFS (2024) has outlined how adaptation is important as a form of risk management for the financial system specifically and society more broadly. The IMF (2024) further outlines that in the national context the reinforcements of the safety standards leads to lower return periods, representing the acceptable failure probability of the flood defense system. In other words, flood events with certain return periods would lead to fewer dyke breaches, if protection systems are further reinforced. According to the analysis, this has a dampening effect on financial stability in the longer term, as lower defense failure probability more than compensate the higher damages and losses due to worse climate conditions (sea level rise). DNB has been active in facilitating a dialogue on adaptation in recent years (box 1).

Box 1: A dialogue on climate adaptation

Through its role as founder and chair of the Dutch Sustainable Finance Platform, DNB is actively facilitating a dialogue on sustainable finance in the Netherlands between the financial sector, supervisory authorities and government ministries.

As part of the platform, a Working Group on Climate Adaptation has been active since 2022. This working group, consisting of financial sector and government representatives, examines how physical climate risks and climate adaptation affect the economy and the financial sector. It also looks at how the financial sector can contribute to climate adaptation.

A 2023 report analyzed both the impact of climate change on the financial system ('outside in') and the contribution the sector can make to climate adaptation ('inside out'). The report provided recommendations for achieving climate resilience for the financial system, government and business, and shared good practices regarding actions that financial institutions can take to stimulate adaptation.

Since 2024, the Working Group is focusing on five theme clusters: Communications, Housing, Business, Data, and Investments.

Adaptation can take different forms. Strengthening flood protection will play the most important role in minimizing the likelihoods of a flood events as well as the potential damages. Adaptation could also take the form of decisions related to the built environment, i.e., where and how to build. Prudent lending decisions are also a way of adapting to potential impacts of physical climate shocks. This section discusses some of these approaches, mainly from a qualitative perspective. Regarding lending decisions, some initial calculations are also described.

Strengthening flood protection will play a key role in minimizing financial stability impacts (box 1). As this report presents a scenario-based analysis, it is important to highlight that the estimates in figure 3 shows a conditional impact, indicating how much capital would be lost in case a flood event occurs. This differs from the expected impact, which depends on both the probability and damage associated to the scenario. Given the current efforts planned under the *Hoogwaterbeschermingsprogramma*, it is, in fact, to be expected that potential impacts between now and 2050 may decline The ambition of the Delta Programme is, by 2050 at the latest, to lower the probability of mortality as a result of flooding to once every 100,000 years, for everyone located in areas protected by flood defenses.

Other measures would also help adapting to and mitigating future flood risks. Part of the adaptation strategy relates to where and how to build. In the face of sea level rise, it is key to consider whether or not to build in flood zones. Second, crisis management helps mitigating the impact of floods by preparing, as much as possible, for potential disasters. Examples include drawing up evacuation plans and creating shelter locations that can be used in case of adverse climate events, but also damage-limiting strategies such as dry- or wet-proofing. Lastly, increasing the public's awareness[7] also helps to adapt to the risk connected to high water. All these elements are already an integral part of the Delta Programme, which sets the current and future ambitions with regards to flood risk management.

Moving forward, it is also important to consider insurance protection gaps. Climate-related damages worldwide have increased in recent years. A large fraction of these damages in the EU (75%) is currently uninsured or uninsurable (see also DNB, 2025). This is also the case in the national context, in case of damages due to floods in protected areas resulting from breaches of the primary defense system. If damage is not insurable, climate-related disasters can affect financial stability, for example through an increase in credit risks (FSB, 2025). A recent ECB-EIOPA joint publication (2024) suggests that the insurance protection gap is expected to widen further due to the increasing risk posed by climate change.

Lastly, incorporation into financial risk management represents a further way to increase resilience to climate physical shocks. Box 2 investigates how financial institutions can mitigate the vulnerability to flood risk of their loans portfolio. Financial institutions could apply more prudent lending standards at loan origination, especially for loans secured by properties located in flood zones and, more generally, in the expectation of higher flood-related risks in the future. Potentially, this could also be complemented by risk transfer to the capital markets (ECB, 2023) to reduce stock other than flow vulnerabilities. The findings presented in box 2 reveal that a maximum LTV of 90% would halve the maximum capital depletions associated to either single or multiple breach events. The average capital depletion in 2050 for the whole set of single and multiple breach scenarios would be reduced from about 45 to 15 basis points.

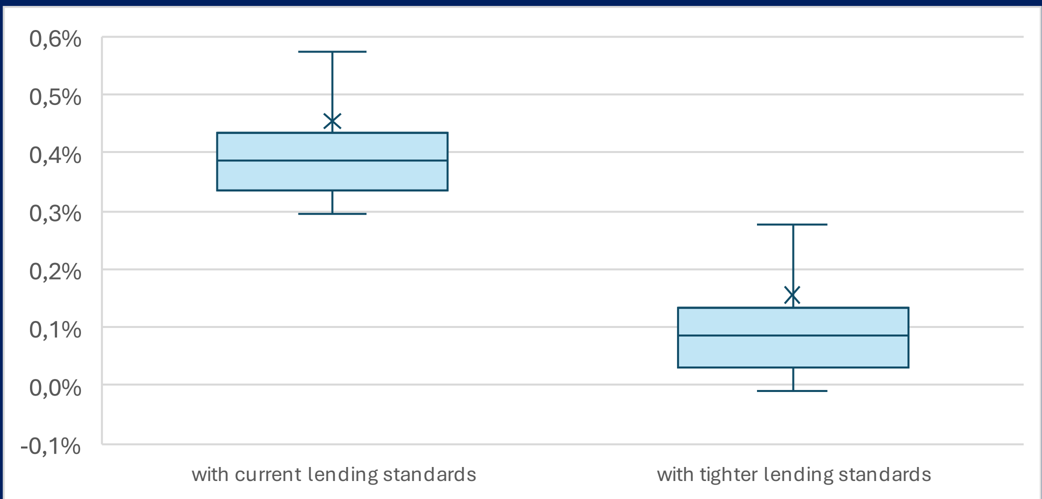
[7] For instance, the *overstroomik* website allows everyone to check the flood risk in their neighborhood and access resources to help increase preparedness to flood events. The Klimaatadaptatie website allows everyone to calculate a Water Label that helps understanding and comparing the rainwater retention capacity of houses.

Box 2: Risk mitigation via more prudent lending standards

This box explores how changes in lending standards could build resilience to climate physical shocks. The exercise is a simple one. It assumes that a maximum loan-to-value (LTV) ratio on new real estate loans is used in order to increase the resilience of the portfolio to sea level rise. All real estate exposures in flood risky areas maturing before 2050 are replaced with new business exposures of equivalent amounts, but subject to a maximum 90% LTV limit. After applying this constraint, the capital depletion in the various scenarios is recomputed.

Figure 4 shows the result of this exercise. The box plot on the left indicates capital depletions with sea level rise and current lending standards. Estimated depletions range from 0.3 to 0.6 p.p. Tightening lending standards would decrease this impact by approximately 0.3 p.p.. As the right box plot shows, the estimated capital depletions now range from 0.0 to 0.3 p.p. The mechanism is as follows. Lower LTVs translate into lower credit risk by reducing the loss-given-default, i.e. losses the lenders would incur in case of a default on the loan. In this way, lenders increase the chance that collateral values remain above the associated exposure amounts in the event of a flood event causing damages to the property used as collateral.

Figure 4. Effect of tighter lending standards (SSP 5-8.5, point estimate of SLR in 2050)



Note: This figure shows the distribution of the capital depletion with current and with tighter lending standards. Results include all flood scenarios (single- and multiple-breach) with sea level rise (point estimate in 2050). The blue bars denote the 25th and 75th percentile. The whiskers denote the 10th and 90th percentile. The horizontal line and the cross denote the median and mean. The distribution under tighter lending standards is obtained by applying a cap of 90% to the starting point LTVs observed in the data, before testing the scenarios.

5. Implications and next steps

Taking a forward-looking perspective on climate change, this analysis illustrates how sea level rise induced by climate change could amplify the financial stability impact of flood events. This analysis studies 38 flood scenarios and considers how flood events may impact credit risk of loans for which real estate serves as collateral. From today's perspective, the capital depletion associated with such flood events has been estimated to be manageable (Caloia et al., 2023). Once one starts accounting for sea level rise, capital depletions increase, sometimes considerably. By 2050 and 2100, the average depletion increase to 90 and 130 basis points, respectively. Downside risks for lenders could increase too, as capital depletions could reach up to 150 basis points in 2050 and up to 275 basis points by 2100 if the most severe path of sea level rise materializes.

These amplifying effects of sea level rise underscore the need to keep climate change into financial stability discussions. Various authorities are working on integrating climate change into financial stability analyses. For instance, the International Monetary Fund increasingly includes climate change into their FSAP analyses, the Financial Stability Board includes climate change into their monitoring of financial vulnerabilities (FSB, 2025), and the European Central Bank has carried out a thematic climate risk stress test among significant institutions. All these analyses suggest that climate change remains a key source of financial risk in the long run. As such, it is important to maintain climate-related risk and ways to adapt integrated in financial stability discussions

The financial stability implications of sea level rise depend on progress towards net zero and actions related to the insurance protection gap and climate adaptation, as well as lenders' risk management and lending practices. The analysis in this report is exploratory and focuses on one transmission channel and one out of a range of available IPCC scenarios. This scenario (SSP 5-8.5) is one in which there are no concerted actions. As such, this Analysis is exploring tail risks, in line with the aim of understanding financial stability impacts. A timely and orderly transition to net zero could mean that sea level rise would be less likely to affect financial stability. A key role is also played by climate adaptation. For instance, flood defenses have been continuously reinforced and this reinforcement will continue in the coming decades. This can contribute to reducing the frequency of such events (e.g. likelihood of a dyke breach) and lowering expected impacts. Also, closing the insurance protection gap would increase the insurance and insurability of flood-related damages and prevent them to affect financial stability. Lastly, integrating climate considerations in lending decisions and risk-management practices by financial institutions will be an important factor for the financial system's resilience in the face of climate change.

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Appendix

Table A: Summary of the literature

This table reports selected conservative estimates of the short-term effect of floods on GDP growth.

	Estimate (%)	Reference	Channel
Article			
Cavallo et al. (2013)	2.50%	Fig. 3	Disaster intensity, area size, etc.
Cunado et al. (2014)	0.14%	Tab. 6	Agriculture
Felbermayr et al. (2014)	5.00%	Fig. 3	Capital depreciation
Fomby et al. (2014)	0.00%	Tab. 4	Agriculture
Hallegatte et al. (2021)	0.50%	Fig. 16	Consumption, investments
Loayza et al. (2012)	0.00%	Tab. 6	Agriculture
Raddatz (2007)	2.00%	Fig. 2	External vs internal shocks
Raddatz (2009)	0.00%	Fig. 8	Food & Agriculture
Von Peter et al. (2012)	0.17%	Tab. 3	Uninsured losses

Note: The table reviews the literature on the macroeconomic effects of natural disasters. It indicates the estimate of the impact of floods on GDP suggested in each paper, with a reference to the specific figure or table where this information is sourced.