Climate scenario analysis

Enhancements for banks & financial institutions

Part 2: Scenario generation
May 2024

Bridging the gap – Building on scenario generation

In our first publication on this topic, we delved into the intricacies of scenario generation, emphasizing the necessity for sophisticated and adaptable climate scenarios, while also acknowledging the accompanying challenges. This article is the second in our three-part series on climate scenario analysis. For most banks, the main financial impact of climate change is through credit risk. In this article, we discuss the methodology used to model the impact of climate scenarios on the most parts of most banking books – mortgages and corporate loans – and the challenges involved.

Many central banks, including the Bank of England, the Federal Reserve, the HKMA and the ECB, have required participants to conduct stress tests or scenario analyses[1] regarding the impact of climate risk on their portfolios. Having derived climate scenarios and generating the corresponding macroeconomic pathways, as discussed in our previous article, the next major challenge banks face is to translate the climate-conditioned economic pathways into financial impacts on the institution itself.

Financial institutions have initially focused on climate-related credit risk impacts, although analysis is broadening out into other risk types, including operational risk, market risk and reputational risk, among others. From the lender's perspective, credit risk is still perceived to be the most material. It is therefore necessary to assess the financial impact of both physical and transition risk on the borrower, in order to estimate changes in the probability of default and the severity of associated losses.

Larger banks often look to leverage their existing stress testing infrastructure for use in climate scenario analysis. In some circumstances, the macroeconomic scenarios generated as part of the scenario building process can interface directly with current models. Typically, however, some model modification is needed to properly capture the full range of physical and transition risks that can operate through both microeconomic and macroeconomic channels.

Macroeconomic channels are the broad systemic risks that arise under a given scenario, the modelling of which is detailed in the previous thought leadership article. Microeconomic risks are asset-specific (such as the carbon taxes applied to a particular asset, or the exposure of an asset to specific physical risks such as flooding or extreme wind). Comprehensive climate risk modelling involves assessing both levels of impact.

[1] The terms stress testing and scenario analysis are sometimes used interchangeably, though stress testing sometimes refers to capital-relevant (and often shorter horizon) analyses.

Figure 1 – Schematic view of climate scenario analysis for credit risk. This approach is loosely based on KPMG's Climate IQ methodology

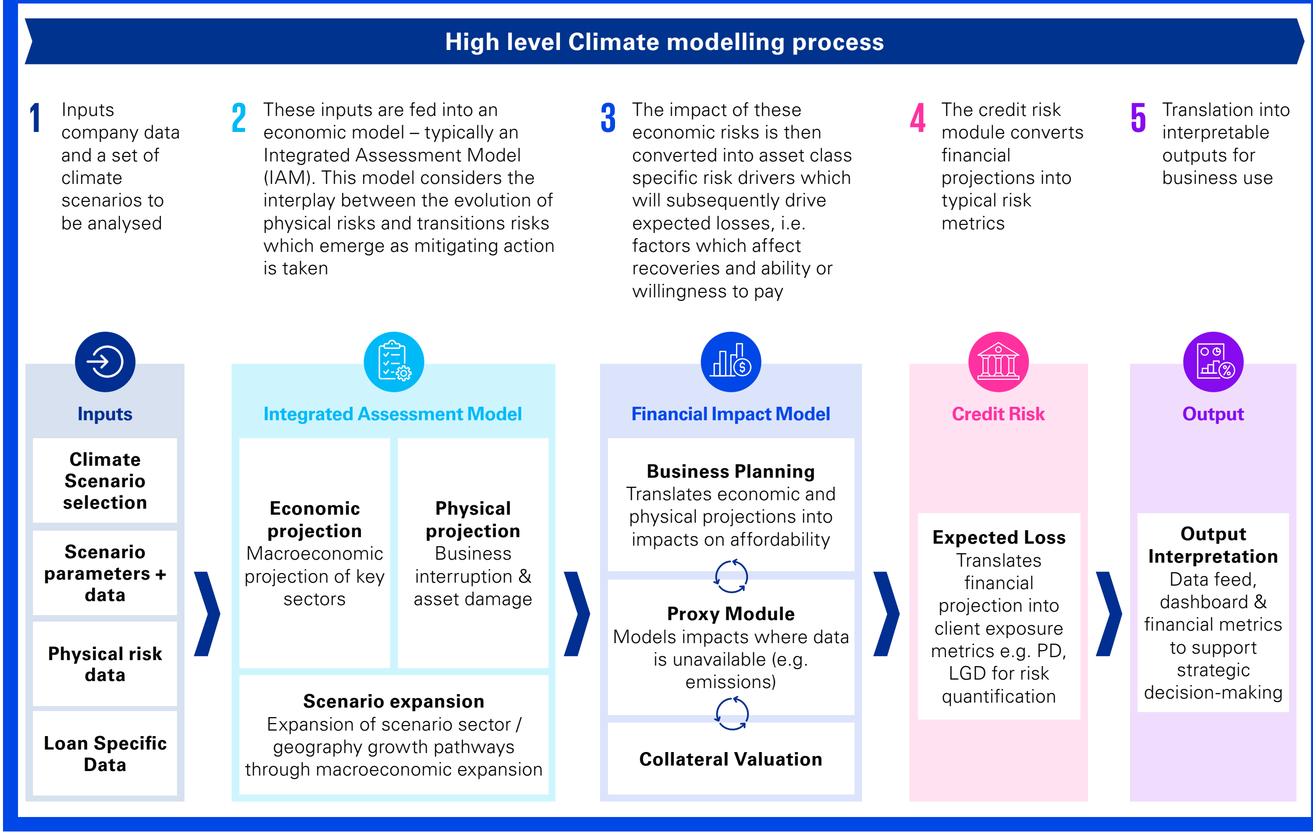


Table 1 outlines eight key focus areas that leading banks and other financial services providers expect climate risk scenario analysis models to address over the next couple of years. These are based on KPMG's review of the main gaps and recommendations identified in the UNEPFI report on the 2023 Climate Risk Landscape (March 2023), as well as our own insights and findings from the ECB 2022 thematic review on climate-related and environmental risks (November 2022) and PRA Dear CEO letter (October 2022).

Specific considerations

Climate scenario analysis methodology can vary greatly depending on the objectives. Considerations can include top-down versus bottom-up analysis, the severity of the scenarios, and assumptions around the behavior of the balance sheet.

Top-down vs bottom-up analysis

Quantifying the impact of climate risk is typically undertaken by a financial institution using either a 'top-down' or 'bottom-up' approach, or a combination of the two. In general, top-down modelling involves a set of assumptions that are defined centrally and applied consistently across the modelling space to derive a system-wide outcome, while bottom-up modelling involves the interaction between multiple stakeholders operating independently, the outputs of which can be aggregated to drive the evolution of the overall system.

This means that a top-down analysis tends to be more standardized and easier to compare across banks but may be less specific to individual banks' risk profiles. The standardized methodology of top-down analysis is of particular significance to regulators, as it provides consistency and facilitates their understanding of risk transmission pathways across institutions.

The key advantage of the top-down approach is its simplicity which reduces data requirements and ensures an intuitive, consistent narrative. However, this comes at the expense of the nuance of the more detailed bottom-up approach which more effectively captures interaction effects and sector-specific performance and requires more sophisticated modelling and assumptions. Bottom-up modelling on the other hand, involves representing different sector-geography combinations (or corporations) as individual agents acting to maximize performance, then aggregating these individual elements to derive overall national economic performances. Bottom-up exercises are often tailored to each bank's risk profile but may be less comparable across banks and more resource-intensive.

Analytical framework

Traditional scenario analysis frameworks transmit shocks to the bank's financials through macroeconomic scenario variables. They estimate standard risk measures such as expected credit losses, which are composed of EAD, PD and LGD. The scenario-conditioned financials can be used to assess impacts on common metrics such as capital or liquidity ratios. Some calculations incorporate additional climate-specific metrics, such as exposure-weighted financed emissions and income derived from emissions-intensive sectors, to better evaluate climate risks.
According to the BIS (The role of climate scenario analysis in strengthening the management and supervision of climate related financial risks) it is crucial that frameworks take into account long-term structural changes and avoid relying solely on historical data assumptions. Ensuring this will lead to more accurate and representative impact quantification. KPMG stays ahead of the curve by integrating state-of-the-art data analytics, such as computable general equilibrium models into their frameworks. This enhances the bank and/or regulator's ability to analyze and predict the impact of climate-related financial risks more effectively over the long term.

Static vs dynamic balance sheet assumptions

Balance sheet assumptions for climate scenario analysis can have a significant effect on impact quantification[2]. One of the most fundamental model choices is between a static and a dynamic balance sheet approach. Under the static approach, balance sheets are assumed to remain constant over the chosen time horizon. This helps evaluate current risk without considering mitigating actions. This becomes less useful for longer-term projections.

In contrast, the dynamic balance sheet assumption allows for changes based on economic and strategic factors. This prioritizes understanding a bank's response to risk, but it introduces more subjectivity into the analysis, and with it a large number of additional assumptions.

Climate scenarios vary in severity, ranging from modal pathways representing probable future climate conditions to extreme tail risk events. Historically, supervisory focus has been on modal scenarios, which assume gradual structural changes due to climate risks. Recently, however, attention has shifted to shorter-term scenarios that assess resilience to extreme events (NGFS).

When assessing the severity of risks, incorporating compound risks (where multiple risks interact) into impact quantification is becoming increasingly important. For example, a financial shock occurring at the same time as a natural disaster can have more severe impact than if each event occurred in isolation. To accurately reflect such tail risks, scenarios must include multiple shocks and consider their cumulative impact. Currently, most capital adequacy assessments don't include these severe scenarios to account for feedback effects and compounding risks. However, KPMG models are able to integrate compound risks into impact quantification, helping banks to assess the required capital to cover losses from tail events.

Severity of scenarios

The next section describes some of the modelling considerations for two asset classes which are typically considered to be among the most materially affected by climate-related risks (the BIS has a working paper on the effects of climate change-related risks on banks, mentioning these two asset classes are key into considering climate risk), as well as often comprising a significant proportion of a bank's lending portfolio on an exposure basis.

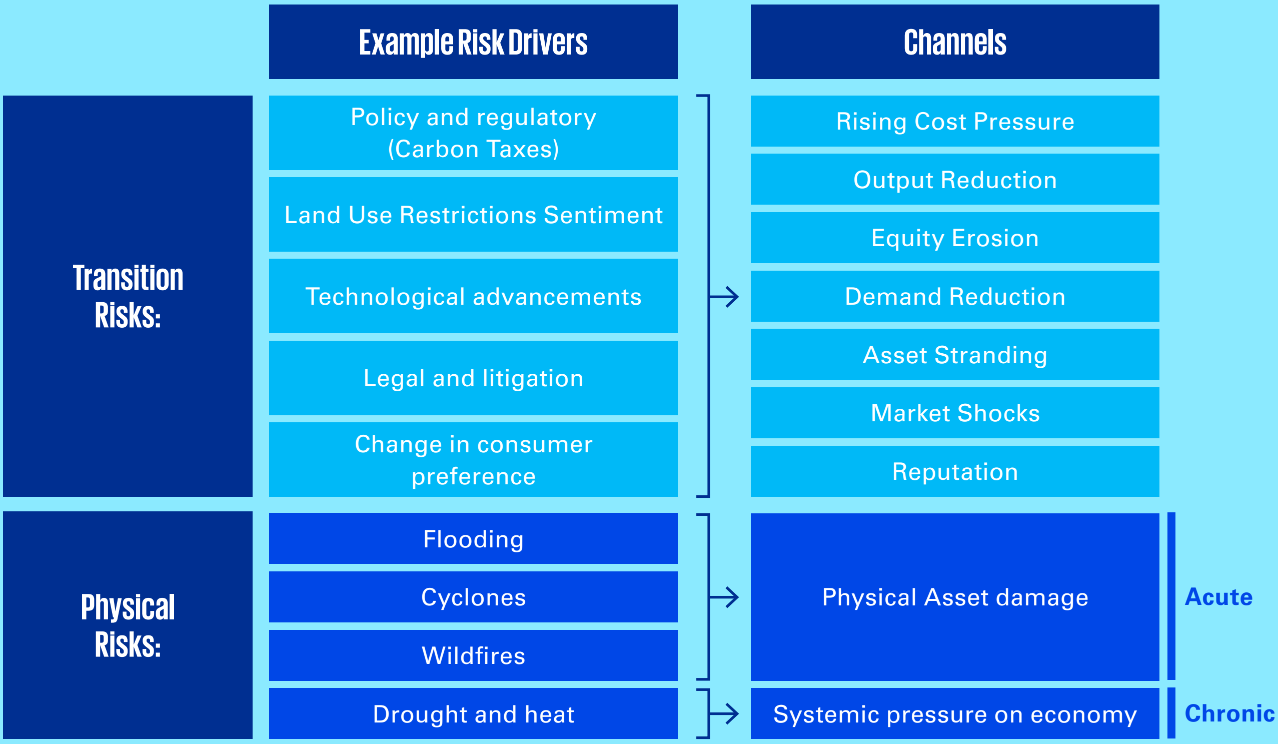


Figure 2 – Selection of Corporate Climate Risk Drivers and Channels. Important to note: All these processes ultimately lead to credit risk.

[2] Balance sheet assumptions in this context refer to the bank's own balance sheet, not that of investee of obligor corporates

From Risk Drivers to Impact Channels

Climate risk is typically broken down into physical and transition risk components for the calculation of financial impacts.

Physical risks: these are the direct consequences of climate-related events such as extreme weather events, rising temperatures, sea-level rise, and changes in precipitation patterns. Physical risks can manifest as damage to infrastructure, reduced agricultural productivity, and health impacts on human populations. Quantifying physical risks involves assessing the likelihood and magnitude of such events occurring and their potential impact on assets and operations.

Transition risks: these arise from the process of transitioning to a low-carbon economy in response to climate change mitigation efforts, policy changes, technological advancements, and shifts in market preferences.

When considering credit risk, the various risk drivers (macroeconomic risks, physical/transition risks) play a critical role in determining the probability of default (PD) and subsequent losses. Macro risks, such as economic downturns or industry-specific challenges, can directly impact the financial health of borrowers, affecting their ability to repay loans. Similarly, physical risks, such as natural disasters or climate-related events, can disrupt operations, leading to financial instability for businesses and individuals alike. When these risks materialize, borrowers may face increased financial strain, resulting in higher PDs—the probability of them defaulting on their obligations. Consequently, these elevated PDs contribute to higher expected credit losses for lenders and investors, underscoring the interconnectedness between macro risks, physical risks, and credit risk in the financial landscape.

	Possible Drivers	Explanation	Potentially affected portfolios	Consideration in stress testing
E	CO_2 -Price	Change (esp. increase) in CO_2 price (global or local) with impact on emissions-intensive industries – but also the energy price with all its implications.	**Sovereigns, banks, corporates sector-specific:** Materially due to the high corporate share in Europe, partly in emissions-intensive sectors, but also macroeconomically effective (energy prices, for example).	For many banks first consideration in stress tests, especially PD discounts for corporates; macroeconomic component also relevant (also banks, sovereigns).
E	Consumer Behavior	Change in consumer preferences toward "green" products, and related shift in sales in many industries.	**Corporates sector-specific:** Material due to high corporate exposure, partly in emissions-intensive sectors and sectors with transformation potential.	Useful as an additional stress component in transition scenarios (especially as an unexpected disruption), probably initially sector-specific and supported by experts.
E	Flood/ Heavy Rain	Increased acute (e.g., triggered by heavy rainfall) and/or chronic river or sea flooding events.	**Corporates partly sector-specific, banks & sovereigns with concentration:** According to ECB, most important risk driver in Northern Europe (incl. Germany).	Mostly consideration of acute effects on real estate
E	Drought/ Heat	Increased (acute or chronic) periods of heat and drought, especially in conjunction with water scarcity.	**Sovereigns, banks, corporates partly sector-specific:** According to the ECB, one of the most important risk drivers in Europe, in Southern Europe but also in Brandenburg, for example.	Modeling sensible via macro-econ. (banks/sovereigns), across-the-board sector discounts, and detailed analysis of business of business impairment (corporates).
S	Social Unrest	Increased social unrest, e.g. triggered by climate events (e.g. famines in connection with droughts, rising energy prices) or political measures.	**Sovereigns, corporates across sectors:** fundamentally material due to significant exposure and ELs in the global South (particularly vulnerable and low resilience).	Useful as an additional stress component in climate scenarios (physical, but also transitory), with estimation of macroeconomic effects on specific regions and countries.
G	Compliance Violations by Banks	Publicly disclosed legal or compliance violations by one or more major banks, including material reputational and financial damage.	**Banks:** Material due to high bank exposure, despite special features of the business model (mainly pass-through loans).	More useful as an event-driven "what-if analysis" for bank lending and pass-through business, as opposed to medium- or long-term scenario analysis.

Deep Dive: Corporate and Residential Mortgages

This next section describes some of the modelling considerations for two asset classes that are typically perceived as being among the most materially affected by climate change-related risks (the BIS has a working paper on the effects of climate change-related risks on banks, mentioning these two asset classes are key into considering climate risk), as well as often comprising a significant proportion of a bank's lending portfolio on an exposure basis.

Corporate Focus

In our experience certain banks have significant corporate lending exposures in sectors that are expected to be materially impacted by climate transition risks. These sectors include industries such as energy, water, transportation, mining, agriculture, and manufacturing.

This results in increased vulnerability to climate-related impacts in the lending portfolios. This corporate loan (and bond) asset class has been a key focus for lenders and investors regarding climate risk stress testing.

Corporate loan stress testing typically relies on projecting counterparty-specific financial statement data to derive stressed probabilities of default using scorecards or rating models, or by linking the default rate with a macroeconomic factor (often a combination of several macroeconomic variables that have been shown to drive risk).

The latter approach requires less data, is perhaps more robust, and has been used in stress testing since it was mandated by regulators after the 2008 financial crisis.

Residential Mortgages Focus

Residential mortgage portfolios are likely to be subject to both significant physical and transition risks, impacting the obligor's ability to service the debt. In net-zero transition scenarios, the likely policies required to achieve a reduction in emissions present their own set of impacts on borrowers.

Regulations on energy performance standards for properties may result in additional costs for property retrofitting places stresses on collateral value or borrower affordability. Broader macroeconomic effects through 'disorderly' transition scenarios can cause more general economic malaise, resulting in lower wages and higher unemployment. In terms of physical risks, the predominant threats vary by geography, and risks can be both chronic and acute. The prevalence of chronic risks such as land subsidence and coastal flooding is likely to increase under 'hot house world' physical risk style scenarios.

Correspondingly, extreme weather events such as flooding and wildfires and storms which cause sudden and unexpected damage to properties as likely to increase in both frequency and severity. In 2019/2020, the Australian wildfires destroyed over 3,000 residential properties, after a report by the IPCC concluded that it was 'virtually certain' that the rising frequency and intensity of wildfires was being driven by anthropogenic climate change. IPCC: Climate Change 2022: Impacts, Adaptation and Vulnerability - Australia. Meanwhile, 6-8 million people in Bangladesh are at risk of displacement by 2050. The World Bank: The Cost of Adapting to Extreme Weather Events in a Changing Climate.

Key Challenges

Corporate Loans

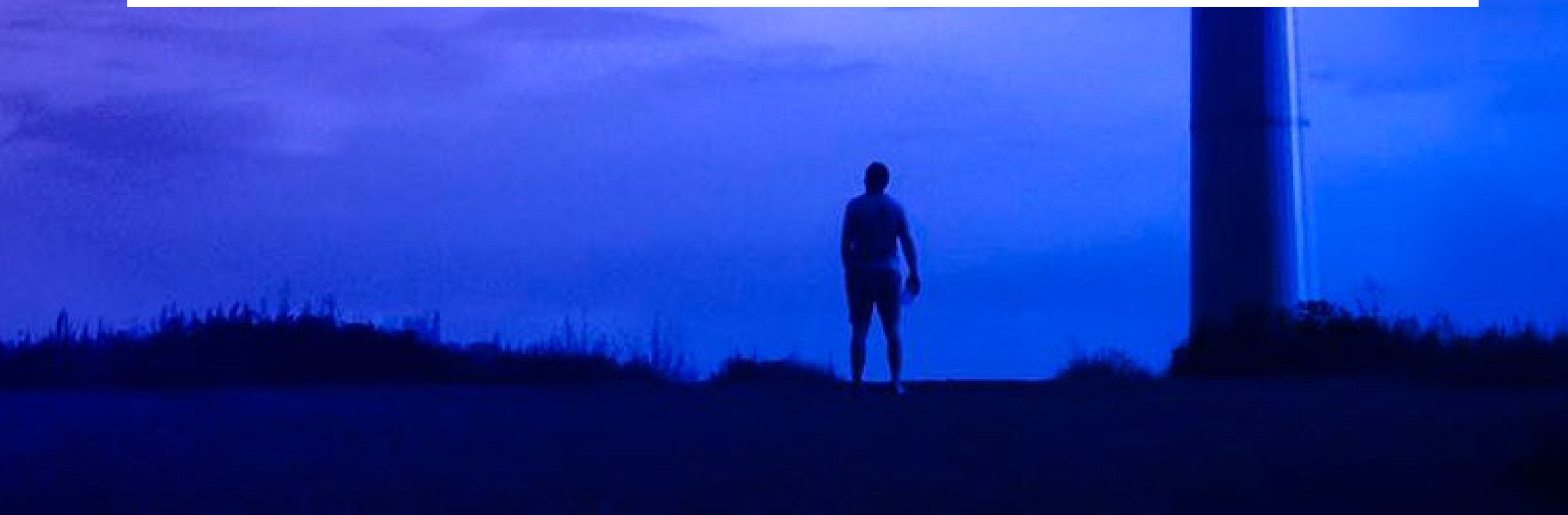
Time Horizons: one aspect that is particular to climate stress testing is the time horizon of the longer scenarios, which can extend 30 years or more into the future. In the corporate space, this presents challenges around modelling the nuances of the evolution of corporate financial statements. Such models are driven by rules around the evolution of income statement components, cash flows, dividends and the drawdown or repayment of debt, among other factors. Careful forecasting calibration is required to model plausible company behavior when the economic environment around them changes significantly. KPMG has developed models that plausibly handle this corporate balance sheet evolution, but it remains difficult to account for idiosyncratic corporate decision making.

Double Counting: most macroeconomic climate change scenario providers capture physical risk in their scenarios. However, it is not always clear whether this physical risk assessment is limited to systemic economy-wide impacts, or whether it also includes the granular microeconomic channels, such as blended HPI impacts that result from physical hazards on individual properties. For example, does a projected property price index directly include the impact of retrofitting regulations on a property-by-property basis, or is this an additional impact which needs to be layered on top of a broader systemic risk. KPMG's proprietary Integrated Assessment Model provides full control over the assumptions and inputs into the macroeconomic model, allowing for transparency

Residential Mortgages

Forward Looking Physical Risk: physical hazard events can be modelled as shocks to borrower's income, either directly through hits to borrower incomes, or through higher insurance premiums. However, as borrowers start to become aware of higher levels physical risk, these additional costs are likely to start being reflected in the value of a property. In addition, as physical hazards become more common, borrowers may start to build a more forward-looking view of how physical risks will increase in the future. As a result, contemporaneous consideration of physical risks may not be sufficient to capture the impact on collateral value.

Missing Data: as mentioned above, retrofitting costs are a key aspect of transition risk for mortgage holders. To date, current and planned policy in the EU and the UK has focused on EPCs (Energy Performance Certificates). In the UK, approximately two thirds of properties have valid EPC certificates. The uptake of the equivalent Swiss certificate (GEAK) is more limited. If regulation across domestic properties comes into force, those without certificates will be required to become certified to demonstrate compliance. In the meantime, KPMG has developed an EPC accelerator tool to impute the missing EPC ratings, taking into account property location, type and age to provide a 'best estimate' for properties without a certificate.



Find out more

In our next article we will focus on stage two of the climate scenario analysis process: impact quantification.

If you would like to discuss this topic further, please feel free to contact us.
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