INTRODUCTION TO CLIMATE SCENARIOS

SAA Sustainability Working Group

Authors:
Corina Grünenfelder, Elisa Barbieri,
Jeta Limani, Christoph Möhr,
Angelika Zakrzewska, Markus Haas

SAV ASA ASA
Schweizerische Aktuarvereinigung
Association Suisse des Actuaires
Associazione Svizzera degli Attuari

INTRODUCTION

Climate Scenarios Overview

As part of the Sustainability Working Group of the Swiss Association of Actuaries (SAA), the climate scenario sub-group was founded in 2022 to assess climate scenarios and their implications for insurers.

Using climate scenario analysis, insurers are increasingly trying to understand potential implications of climate change risks in the short, medium and long term, with the aim of strengthening their resilience and defining actions for climate mitigation and adaption.

Regulatory requirements in this area are fast-evolving and heterogeneous across jurisdictions. Some regulators are requiring institutions to perform holistic climate scenario or stress testing analyses to assess the consequences of physical and transition risks on the financial sector, while others have not yet defined a granular regulatory framework. Similarly, the market practice in the insurance sector with respect to climate scenario analysis is not yet established, with insurers currently developing their approaches to better estimate the impacts of climate risk under different scenarios.

This article will first discuss climate scenarios and their analysis in the context of insurer concerns, and how both physical and transition risks can impact the financial standing and prospects of insurers. In the second section, we summarize selected current regulatory and supervisory guidelines and stress tests implemented until year-end 2023.

Introduction to climate scenario analysis

This section introduces high-level concepts and terminology used to describe climate change, climate risk, climate scenarios, and their impact on insurers. It aims to provide a basis for understanding the main common concepts, terms, and their relationships used within the large amount of existing literature.

According to the IAA Glossary for IAA Climate-Related Risk Publications (May 2023)[1], climate change is «the statistically defined change in the average and/or variability of the climate system, which includes the atmosphere, water cycle, land surface, cryosphere [parts of the Earth's surface where water is frozen] and biosphere and their interactions.»

Climate scenario analysis refers to the analysis of impacts of man-made climate change. In this article, we narrow this focus to the implications for insurance companies and other financial institutions. The broad structure of approaches to climate scenario analysis can be illustrated by the following Figure 1, which we explain below.

Schematically, starting on the left-hand side from a climate scenario corresponding to a specific climate future from now to the year 2100, e.g. the «high» scenario, the impact on the balance sheet of an insurer is assessed over potentially different time horizons (center), leading to risks and opportunities for the insurer and its business model under the selected climate scenario (right). According to the IAIS draft application paper,[2] «climate-related scenario analysis exercises can be used to identify and assess emerging risks that may arise over time and use that information to make forward-looking business

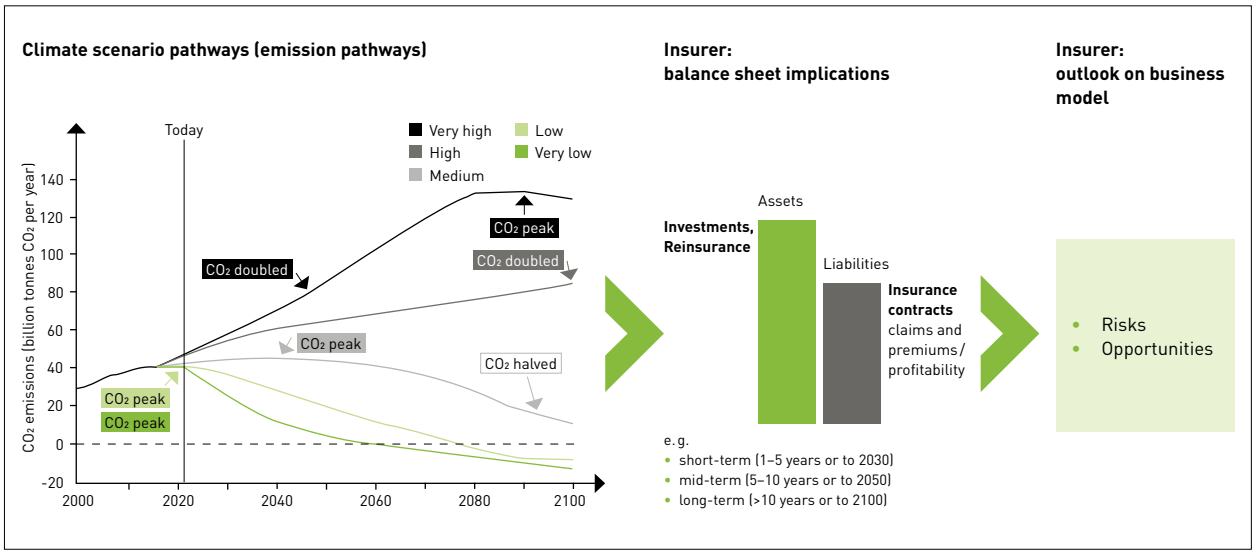

Figure 1 Source: left picture: Climate Science: A Summary for Actuaries, IAA; March 2022; other pictures: own design

strategy and investment decisions. [...] Climate-related scenario analysis can highlight these risks so that insurers can take appropriate action to effectively and proactively manage them» and: «climate-related scenario analysis, when designed and implemented appropriately, is a tool that can help insurers build resiliency in their business models over the long-term, spanning multiple decades, which goes beyond the regular business planning cycle.»

The focus of this paper is on «inward risks», i.e. the impact of climate risk on insurers, but scenario analysis can also be used to assess «outward risks» of insurers on climate risk, the financial system, and the real economy.

Climate scenario pathways, greenhouse gas emissions and concentrations, acute and chronic physical risk

The picture on the left-hand side above shows so-called Representative Concentration Pathways (RCPs) of different climate scenarios from the Sixth Assessment Report (AR6) of the UN Intergovernmental Panel on Climate Change (IPCC). The different pathways in the picture are emission scenario pathways represented by the trajectories of (projected) annual CO_2 emissions until the year 2100.

CO_2 emissions are an important component of the emissions of «radiatively active substances» such as greenhouse gases (GHGs) and aerosols. The emissions of radiatively active substances are an important measure for man-made climate change, as they are related to climate characteristics such as global warming, rainfall, heatwaves, and droughts.

Emission scenario pathways are used to derive concentration scenario pathways of radiatively active substances in the atmosphere, which in turn are an important input for trajectories of the change in average temperature relative to pre-industrial times, specifically the temperature change by the year 2100.

In general, the higher the climate scenario pathway, the higher the resulting so-called physical risk, that is, the risk of damages or losses from adverse effects of climate change including climate variability and extremes. Acute physical risk arises from particular (catastrophic) events, especially weather-related events such as storms, floods, fires, or heatwaves, which could, for example, cause damage to production facilities and the disruption of value chains. Chronic physical risk, on the other hand, arises from longer-term changes in the climate, such as temperature changes, rising sea levels, reduced water availability, biodiversity loss, and changes in land and soil productivity.[3]

A collection of scenarios such as the RCP in the IPCC AR6 is intended to cover a reasonably comprehensive range of possible climate futures, in principle capturing potential climate system tipping points, and should not be viewed as a collection of rare extreme events.

Transition, mitigation and adaptation, transition risk and litigation risk

The climate development projections in climate scenarios are the result of current and future human behavior. Human behavior may change in response to climate change and may lead to a «transition», specifically to a lower carbon

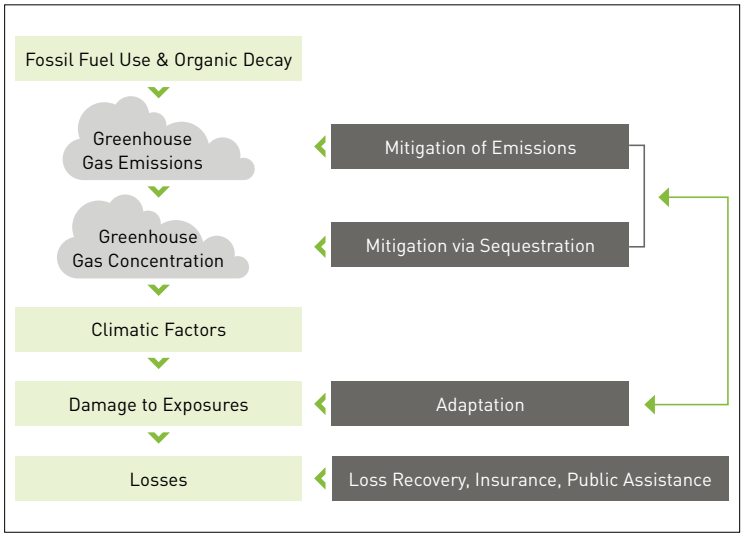

Figure 2 Source: IAA Climate Risk Task Force, The Climate Change Adaptation Gap: An Actuarial Perspective, May 2023

economy with reduced GHG emissions. A transition is characterized by human actions taken to mitigate and/or adapt to climate change, which may involve policy, legal, technology, and market developments/actions.

Mitigation actions aim to limit the change in climate, in particular by reducing GHG emissions.[4] Adaptation actions aim to adapt to the actual or expected (changed) climate and its effects, in order to moderate harm or exploit beneficial opportunities. An example of an adaptation action is building flood defenses. Some actions, such as planting trees, may benefit both mitigation and adaptation. For other actions, there may be a trade-off. For example, increased air conditioning is an adaptation to higher temperatures but may increase GHG emissions and thus be detrimental to mitigation.

Figure 2 illustrates by example where mitigation and adaptation actions could attach along the chain of physical risk from fossil fuel use and organic decay to losses. Mitigation of GHG concentration can be achieved by emitting less or by capturing, securing, and storing emissions, known as sequestration.

Transition risk denotes the risk of losses to stakeholders including insurance companies induced by the process of changes (e.g. policy, legal, technology, market sentiment, etc.) linked to a transition.[5] For example, energy efficiency requirements may increase the price of products using fossil fuels; a technology that is more damaging to the climate may be replaced by a technology that is less damaging; social norms and choices of customers may shift towards products and services that are less damaging to the climate. This can also lead to stranded assets and potential related losses. Transition risk depends on the timing, speed, and scale of change.

Failing to avoid or minimize adverse climate impacts can expose companies to litigation, fines, restrictions in doing business, reputational risk, etc. This is sometimes subsumed under transition risk in the literature, and sometimes considered separately as litigation risk.

Climate risk as considered here comprises acute and chronic physical risk, transition risk, and (or including) litigation risk.

Shared Socioeconomic Pathways (SSP), Shared Policy Assumptions (SPA)

In the Sixth Assessment Report AR6 of the UN Intergovernmental Panel on Climate Change (IPCC), climate scenarios are formulated on the basis of one of several Shared Socioeconomic Pathways (SSP) together with Shared Policy Assumptions (SPA). SSPs are pathways for the global evolution of society/future human behavior relevant to climate change, and SPAs describe broad approaches to mitigation and adaptation policies.[6] The process is illustrated in the following Figure 3, which we explain below.

In a scenario, broadly speaking, the SPA provides the mitigation and adaptation actions intended to be implemented and the SSP represents characteristics of society that pose stronger or milder challenges to implementing these actions. Combining these two allows an assessment of which mitigation and adaptation actions are implemented and at which points in time, and the deriving of resulting projections of, for example, energy use, emissions, and land use.[7] This determines what kind of transition (if any) is likely to be realised in the scenario,

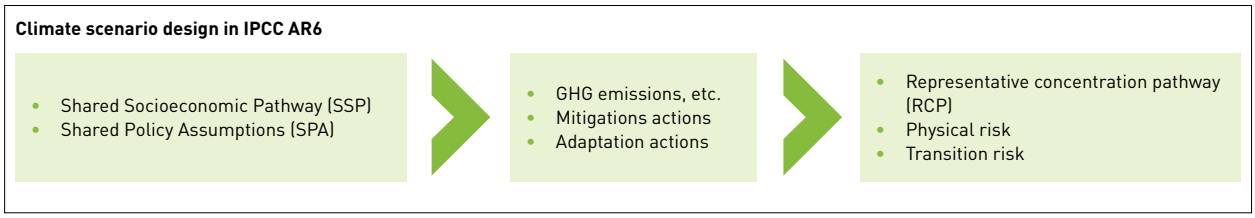

Figure 3 Source: own design

which in turn leads to the RCP in terms of e.g. average temperature change or GHG concentrations and to the physical and transition risk in the scenario. Different combinations of SSPs and SPAs can in principle lead to similar RCPs.

The SSPs include societal factors over the 21st century relevant to climate change, such as demographics, human development (e.g. health and education), economic growth, inequality, governance, technological change, and policy orientation. Most factors are given in the form of narratives that sketch out the broad patterns of change globally and for major world regions. A subset of factors (population, GDP, urbanization, and educational attainment) is provided as country-specific quantitative projections.

The SSPs were developed to span a wide range of possible transitions. In the IPCC AR6, they include for example SSP1, «sustainability – taking the green road», in which there is a gradual but pervasive shift to a more sustainable path, and SSP3, «regional rivalry – a rocky road», in which countries increasingly focus on national or at best regional issues and environmental concerns are a low international priority. The resulting climate scenarios in the AR6 are denoted by a combination of SSP and RCP:
SSPx-y (e.g. SSP2-4.5)
with

x = Shared Socioeconomic Pathway (SSP)

y = Representative Concentration Pathway (RCP), represented by the change in Earth's energy balance and broadly corresponding to the degree of warming relative to pre-industrial times by the end of the 21st century.

Scenario pathways, physical and transition risk, climatic impact drivers

The following Figure 4 illustrates a collection of scenario pathways (RCPs) for SSPx-y climate scenarios from the IPCC AR6 in terms of annual CO_2 emissions. For example, the SSP2-4.5 scenario corresponds to the emission pathway denoted by «Medium».

Such a collection of scenarios is intended to cover a reasonably comprehensive range of possible climate futures and resulting physical and transition risk, and is not limited to rare extreme events.

The following Figure 5 illustrates different types of transition scenarios, with the y-axis showing the annual net CO_2 emissions. Generally, the higher the cumulative GHG emissions, the higher the warming and thus resulting physical risk. Physical risk is therefore highest in the «no transition» scenario. In principle, there could also be a transition with only adaptation and no mitigation, in which emissions increase even further due to adaptation, e.g. more air conditioning, leading to an even higher physical risk.

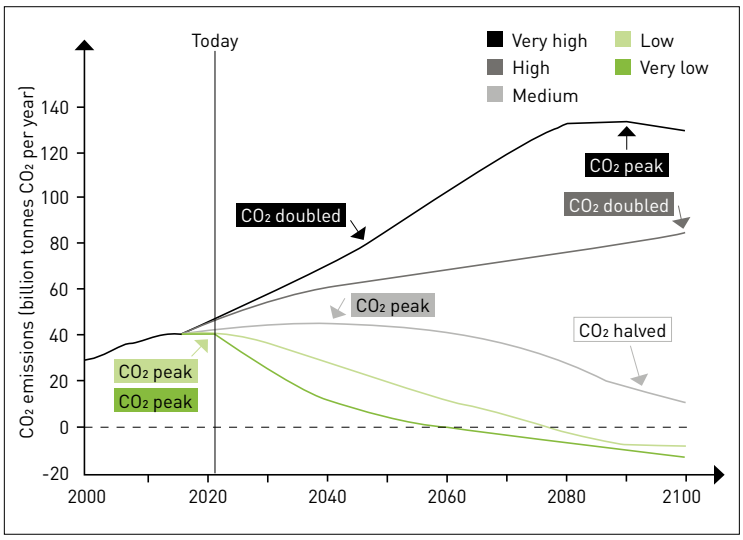

Figure 4 Source: Climate Science: A Summary for Actuaries, IAA; March 2022

Transition risk, on the other hand, comes from a downward shift of the curve. Generally speaking, in the «no transition» scenario, there is no transition risk (but very high physical risk). In case of an «orderly transition», there is potentially limited transition and physical risk. In the «sudden transition» scenario, physical risk may be limited but transition risk is high. In the «delayed transition», both physical and transition risk may be high.

For physical risk, climate scenarios such as in the IPCC AR6 provide information also on a relatively regional level through climatic impact drivers (CID). CIDs are «physical climate system conditions (e.g. means, events, extremes) that affect an element of society or ecosystems». For land and coastal regions, these include for

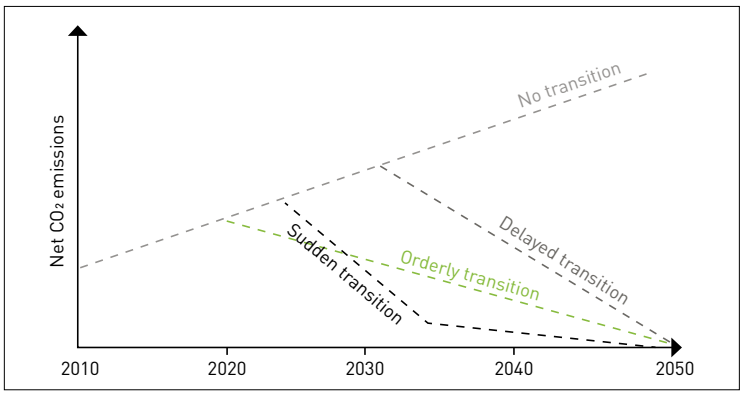

Figure 5 Source: Consultation paper on Application guidance on running climate change materiality assessment and using climate change scenarios in the ORSA, EIOPA -BoS-21/567, December 10, 2021.

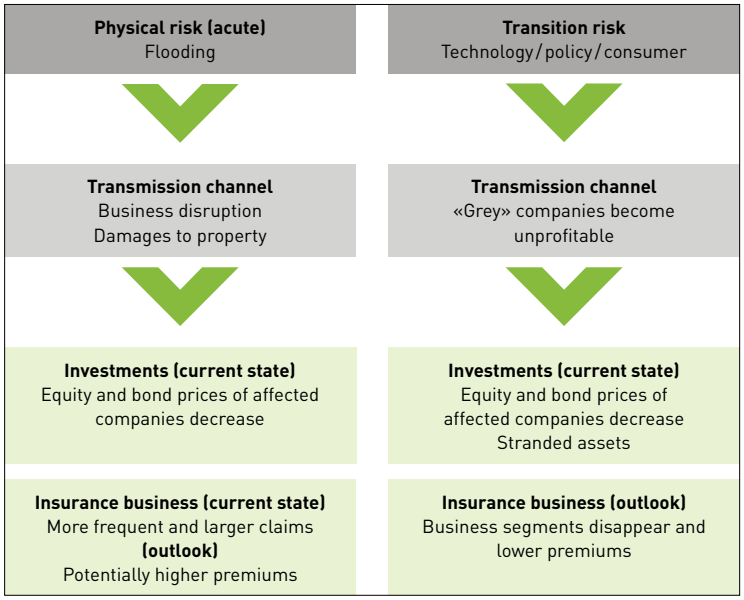

Figure 6 Source: own design

example «heat and cold» (e.g. extreme heat, cold, frost), «wind» (incl. windstorms), «snow and ice» (e.g. snow, glacier, ice sheet, permafrost), and «coastal» (e.g. coastal flood and erosion, marine heatwave, ocean acidity).

Impact on insurers through potential transmission channels

Climate scenarios may affect the balance sheet of insurers over the scenario lifetime. On the one hand, they may affect the balance sheet at a given date but on the other hand also (and potentially differently) the outlook of insurers at this date in terms of its business plan, specifically in terms of investments and new insurance business.

The impact can be represented as transmissions of physical and transition risk. Both physical and transition risk can affect the asset side, specifically the investments, as well as the liability side, specifically the insurance liabilities. Examples of the transmission of physical and transition risk to the balance sheet and the outlook of insurers are illustrated in Figure 6.

As illustrated, the impact of physical and transition risk on insurers is typically indirect through suitable intermediate effects, so-called transmission channels (light grey boxes in Figure 6). Transmission channels transmit physical or transition risks to insurers' risks through a (stochastic) causal chain. For physical risks given by Nat Cat events such as windstorms or floods, the impact on insurance business is fairly immediate and well-known. For example, floods damage houses and content and thus lead to insurance claims and could in addition affect insurers' operations. In particular, the right-hand side of Figure 6 shows an example of how transition risk may be transmitted to investment risk for insurers: a transition in terms of technology, policy or consumer behavior may lead to «grey» companies becoming unprofitable. This acts as a transmission channel for causing losses on investments.

The transmission channels, i.e. the mechanisms by which climate risk is transmitted to risks to insurers, might not always be obvious or well-known. As these are key elements for a scenario analysis for insurers, it might be useful to set up a repository of transmissions.

For analyzing the transmission of physical or transition risk to insurers, an intermediate step may be used in which physical and transition (and litigation) risk is expressed more concretely through climate variables and transition variables at local level. As stated in the IAIS draft application paper,[8] «while climate risk will be universal, risk factors will be jurisdiction-specific. Physical impacts will be regional or even more local. Transition risks will be driven by a range of national factors (e.g. the ambition of governments on net zero transition plans) and legal liability risks will vary depending on the local legal system.» Some of this information may be available as part of the description of the climate scenario used for the scenario analysis, specifically for physical risk through the climatic impact drivers (CID). The steps shown in Figure 7 formalize the Climate scenario design in IPCC AR6.

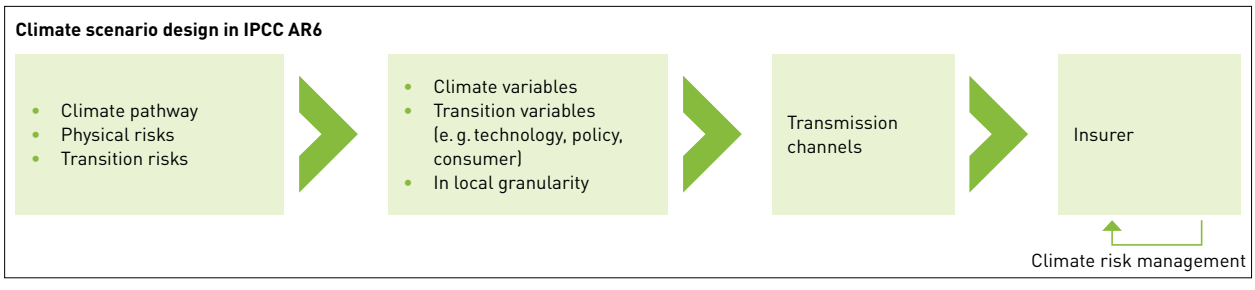

Figure 7 Source: own design

Transmissions of physical and transition risk as illustrated above can affect the risk categories underwriting, market, credit, and operational risk of an insurer. It can also affect the outlook in terms of threats to business plan and business model, e.g. by impairing the profitability of insurance business, but can also lead to new business opportunities.

Climate scenario analysis may involve a projection of the balance sheet of an insurer over a longer time-period, where this projection can be static, i.e. the balance sheet is assumed constant over time, or dynamic, i.e. allowing for the inclusion of management actions in reaction to future events.

In scenario analysis, insurers should also analyze possible consequences for their business plan and business model and the measures available to address or mitigate these risks as well as potentially take advantage of new opportunities. In this way, climate scenario analysis can inform strategic decisions and overall strategic direction.

Ways in which climate risk could affect insurers

In the following, we provide an illustration with examples of how climate change can affect the traditional risk categories of insurers, i.e. insurance risk, market risk, credit risk, and operational risk. The list is not exhaustive. In addition to affecting different risk categories, the systemic nature of climate risks implies that the correlation between the risk categories could increase. Further, tipping points could be reached leading to accelerated feedback loops and irreversible changes in the climate system, which in turn could cause geopolitical tensions and undermine global financial stability.

Insurance risk

Physical risk in terms of an increase in the frequency and severity of large climate events leads to an increase in claims and therefore to higher insurance risk. Examples are:

- more frequent/severe weather catastrophes
- more frequent pandemics (e.g. due to melting ice)
- new diseases (e.g. related to carbon emissions or water contamination)
- increase of premiums due to increase in risk may lead to protection no longer being affordable and thus to a protection gap
- increasing adverse selection e.g. caused by inadequate reflection of climate risk in the premiums
- changes in population distribution arising from mass migration and subsequent change in the geographical distribution of exposures and thus the risk
- faster melting of ice permafrost

Transition risk can lead to insurance risk, for example through increased severity of physical damage claims (property, agriculture, marine, motor) because of higher repair costs. The repair costs for selected materials might be higher due to the transition to a net-zero economy. This could also translate into an opportunity if repair costs decrease. Transition risk could also lead to higher third-party liability claims related to inadequate consideration and management of climate risk. Insuring emerging technologies with limited available information might lead to a mispricing of the risk.

Market risk

Physical risks can give rise to market risks, for example through their impact on asset prices such as

- changes in the market prices of equities and real estate – e.g. due to long-term shifts in climate (e.g. rising sea levels or changes in rainfall patterns)
- widening of credit spreads of debt issued by countries exposed to an increased frequency and severity of climate events

Transition risk can lead to market risk through changes in market prices during the transition phase, for example:

- widening of risk premiums for companies with a greenhouse gas-intensive business model
- real estate values decreasing for buildings that do not fulfil energy standards

Credit risk

Physical risk can lead to credit risk as major climate events can have an immediate impact on the creditworthiness of credit counterparties. For example, losses due to business interruption can reduce counterparties' ability to service debt. An increase in the frequency of pandemic events can also lead to the failure of commercial property projects, as consumers avoid public spaces and workers tend to work from home.

Transition risk can lead to credit risk on a longer-term horizon, for example:

- mortgage collateral values may also be impacted by new and stricter energy efficiency policies
- future changes in regulation or market sentiments may severely impact revenues of companies, hence increasing their likelihood of default. In turn, this could create systemic shocks within selected sectors, causing larger spillover effects in the economy

Operational risk

Physical risk, for example, in terms of severe climate events could cause (partial) failure of internal processes, affecting business continuity, infrastructure, employees, and systems of (re-) insurers. Transition risk can lead to operational risk. For example, underwriting guidelines will need to be revised during the transition phase to avoid possible higher liability claims arising from litigation, reduced business volume due to a portion of the business becoming uninsurable, or loss of market competitiveness due to inadequate product adoption in response to new regulatory/technological changes.

Market practice and regulatory development

Developments related to climate scenario analysis have evolved very quickly in the last years, including those involving insurers and their regulatory environment. This section aims at providing a broad overview of climate scenario analysis in the insurance sector as well as relevant regulatory developments in financial markets.

Building blocks of scenario analysis

The following design choices could be considered when conducting a climate scenario analysis:

- **Portfolio scope:** for example, selecting the sub-portfolio to be analyzed, specifically, focusing on assets or liabilities, life or non-life insurance, etc.
- **Type of climate risks:** determining appropriate types of risk (physical/transition, chronic/acute) that best fit the selected sub-portfolio.
- **Time horizon:** for instance, projecting scenarios up to 2030 or 2050, depending on type of risk and portfolio.
- **Granularity:** modelling macroeconomic/top-down scenarios (e.g. translation of GDP effects due to climate change to sector Gross Value Added (GVA) and to firm market share) or counterparty level / bottom-up modelling, depending on sub-portfolio, risk types, and time horizon.
- **Risk drivers:** identifying the macro- and microeconomic drivers of risk (historic trends) for the selected risk types and model the impact from physical or transition risks on those drivers in the chosen granularity (simulation of climate stresses with different likelihood and severity of risk drivers). Examples impacting liabilities: higher than expected insurance claims on damaged insured assets (non-life) or higher than expected mortality rates (life). Examples impacting assets:

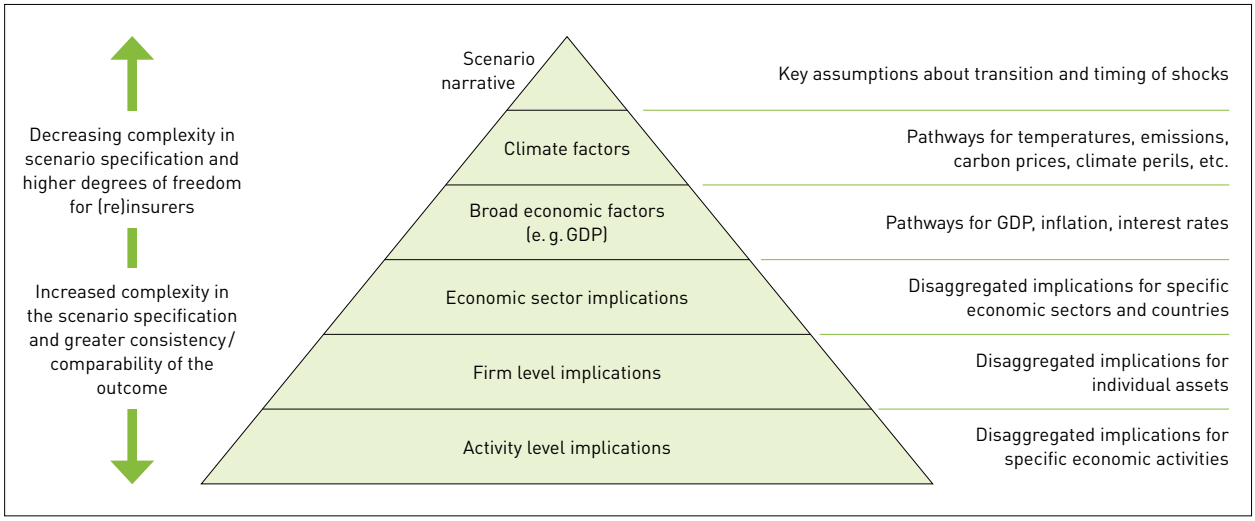

Figure 8 Source: EIOPA (2022), Methodological Principles of Insurance Stress Testing – Climate Change Component

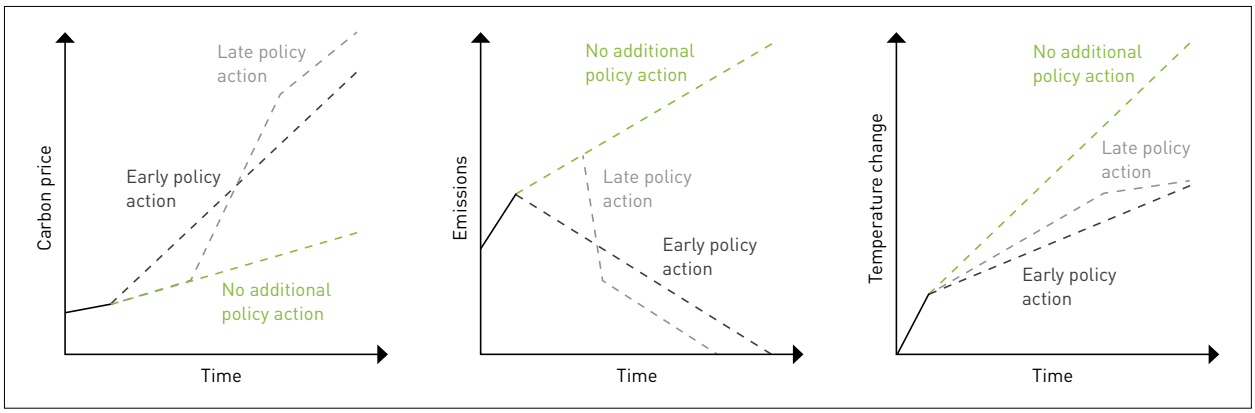

Figure 9 Source: Bank of England – the 2021 biennial exploratory scenario on the financial risks from climate change

increased impairment of asset values due to higher financial losses affecting profitability of firms, for example due to an increase in business interruption, increased damage to real estate (market risk), etc.

- **Financial modelling:** choosing appropriate metrics (e.g. Loss Ratio, Expected Loss) and transfer the impact to an impact on insurance, market, credit, or operational risk. Example: for market risk, impairment of asset Fair Value and CVaR.
- **Balance sheet:** making assumptions on the evolution of the balance sheet over the time horizon. For example, static or dynamically changing such that exposure to climate risks is minimized.
- **Second order effects:** the increased insurance premiums may exceed consumer willingness-to-pay, leading to underinsurance, increasing potential losses. The same effect could occur for countries that are most exposed to increasing natural disasters by raising their cost of debt.

A climate scenario analysis in particular requires the following key inputs:

- **Reference pathway(s):** for example, selection of one of the available reference pathways to serve as a benchmark (e.g., from International Energy Agency (IEA), the IPCC, or the NGFS).[9]
- **Scenario narrative:** narrative around the evolution of environmental (e.g. emissions) and macroeconomic variables consistent with the reference scenarios, e.g. development of policy, GDP, innovation, temperature, natural hazards, etc.

The graphs (Figure 9) show potential developments of climate risk drivers for the three policy action scenarios in the biennial exploratory scenario by the Bank of England.

Overview of regulatory guidelines and regulatory stress testing exercises

Most of the supervisory exercises conducted to date are exploratory in nature and at an early stage of development. They intend to assess vulnerabilities to severe but plausible adverse climate change scenarios and at the same time encourage financial institutions to build up capabilities in climate scenario analysis and climate risk management. Regulatory exercises differ in terms of scenario narratives (long-term vs. short-term horizons, acute shocks vs. forward-looking trajectories), types of risk (market, credit, underwriting), balance sheet assumptions (static vs. dynamic), granularity (top-down vs. bottom-up), and control variables in line with narratives (e.g. carbon price increase for transition risk, change in intensity and frequency of extreme events for physical risks, etc.). Below are some examples of how regulatory exercises treat these considerations:[10]

Six US Banks participated in the **US FED 2023 Climate Scenario Analysis (CSA)** pilot exercise.[11] It considers two different modules: a physical risk and a transition risk module. For physical risk, the exercise brings forward in 2023 climate-related events from 2050 as presented by the IPCC AR6 report[12] to better understand the resilience of participants' real estate credit portfolios to extreme climatic events: a common acute hurricane in the Northeast US region, and an appropriate idiosyncratic hazard shock of varying return period and insurance coverage. For transition risk, the FED uses the NGFS Current policies leading to 3°C warming in 2100 and Net Zero 2050 scenarios that limits warming to 1.5°C. It asks banks to translate projected risk drivers (carbon price, GDP, inflation, unemployment, and price indices) to impacts on

their wholesale credit exposures to corporate and commercial real estate loans by calculating changes in appropriate risk metrics such as PDs and LGDs. The physical risk module assumes an immediate physical shock to the December 31, 2022 balance sheet (metrics calculated as per January 1, 2023). In the transition risk module, the balance sheet is also assumed to be static as of December 31, 2022, although exposure to risk drivers runs over 2023–2032.

The **ECB 2023 climate risk stress test**[13] is an economy-wide climate stress test linked to the results of the first economy-wide stress test exercise from 2021 (see below). It should also be considered in conjunction with the ECB Banking Supervision climate stress test in 2022, which covered a bottom-up analysis of risks for individual banks. The 2023 edition had a wider scope and looking at firms, households, and the banking sector from a top-down perspective.

Three transition scenarios are reflected in the stress test analyses with the aim of analyzing the resilience of firms, households, and banks. The scenarios include 1) an «accelerated transition», which frontloads green policies and investment, leading to a reduction in emissions by 2030 in line with the goals of the Paris Agreement; 2) a «late-push transition», which continues on the current path, but does not speed up until 2026 (and is still intense enough to achieve Paris-aligned emission reductions by 2030); and 3) a «delayed transition», which also starts only in 2026, but is not sufficiently ambitious to reach the Paris Agreement goals by 2030.

The **ECB 2022 climate risk stress test**[14] asked 41 significant financial institutions (FI) to assess six scenarios: three long-term scenarios (up to 2050) based on the NGFS[15] «Orderly Transition», «Disorderly Transition», and «Hot House» scenarios, as well as three short-term scenarios focusing on significant increases in energy costs via carbon prices (immediate increase corresponding to the five most adverse years of the NGFS disorderly transition scenario), and on the impact of two extreme weather events in 2022, namely EU-wide extreme floods and heatwaves. Next to a series of qualitative questions aiming at enhancing supervisory understanding on questions aimed at the integration of climate change into operational and reputational risks, FI were also asked to quantitatively assess the effects of the scenarios on credit risk (all scenarios) and market risk (for the short-term transition scenario). The balance sheet was assumed to be dynamic under the three long-term scenarios (asset growth/portfolio reallocation was permitted in line with FI strategy) and static for the three short-term scenarios. The translation of climate scenarios to financial impacts was largely based on the bottom-up methodology developed during the **2021 ECB Economy-Wide Climate Stress Test.**[16]

The **2021 Climate Biennial Exploratory Scenario (CBES)**[17] of the (BoE) assessed the resilience of the UK financial system to a range of climate risks. Addressed at the largest UK banks and insurers, it aimed to measure the financial exposures of participants to climate-related risks, understand the challenges to participants' business models from these risks, and help them build climate risk management capabilities. It used three long-term scenarios that cover both key physical and transition risks based on the NGFS scenarios («Current Policies», «Orderly NZ 2050», «Divergent NZ 2050»). Adaptation measures (e.g. flood defenses) were also to be considered. Focus of the exercise was credit risk for all three scenarios. The BoE provided pathways for all key risk drivers to be used in a top-down fashion such as: falling productivity, damage to capital, supply chain disruption, inflation and unemployment rates, housing price index evolution, GVA paths, evolution of energy efficiency of buildings, etc.

The **2020 climate pilot exercise of BdF/ACPR**[18] brought together leading players from France's banking (9 participants) and insurance industry (22 participants). It provided four scenarios based on the NGFS: three for transition («Orderly», «Delayed» and an in-between called «Sudden») and one for physical risk that follows RCP8.5 of IPCC. This bottom-up exercise assumed a static balance sheet up to 2025 and a dynamic balance sheet from 2025 to 2050, where the latter allowed FIs to follow their strategies and climate commitments. The exercise also included 2nd-round effects between the banking and the insurance sectors to measure banks' indirect exposure to physical risk under the hypothesis of an increase in the insurance protection gap for certain assets due to the increase in the cost and frequency of extreme weather events. Focus of the exercise was on credit and market risk for assets based on the methodology developed for the exercise.[19] For the insurance industry the exercise further considered the effects of climate change on health and reinsurance premiums.

Turning purely to the insurance sector, EIOPA carried out a set of exercises in 2019, 2020 and 2022 that included sustainability considerations.

The **2019 IORP stress test**[20] exercise of EIOPA applied to Institutions for Occupational Retirement Provisions (IORPs) included an adverse market scenario characterized by a second-round effect whereby a sudden

reassessment of risk premiums and shocks to interest rates on short maturities applied, resulting in increased yields and widening of credit spreads to business sectors prone to GHG emissions. The aim of this exercise was for IORPs to understand their exposure to ‹brown› assets and the overall carbon footprint of their investment portfolios.

In its **2020 Sensitivity Analysis of Climate-Change Related Transition Risks**[21], EIOPA combined data reported under Solvency II with the PACTA methodology[22] to assess transition risks in the portfolio of European insurers in a top-down fashion. It did so by mapping individual holdings of corporate bonds and equity to issuers operating in carbon-intensive industries such as coal mining, steel/cement production, vehicle production and fossil-based utilities, and assessing changes in valuations (market risk) in a «policy shock» scenario that brings forward a sudden CO_2 price consistent with limiting global warming to 2°C by the end of the century.

The **2022 IORP stress test**[23] has been EIOPA's first pure climate stress test, aiming to develop insights into the effects of environmental risks on the European occupational retirement provisions (IORPs). This top-down exercise assumes an abrupt increase in carbon prices consistent with the carbon price in 2030 in the NGFS «Disorderly Transition» scenario. As the shock propagates in a sector-specific way, it provides insights into the IORPs' asset portfolios, reflecting the corresponding impairment of the investments, broken down by the most relevant sectors and business activities. Additionally, the potential impact on the pension liabilities was to be assessed through re-evaluation of assets and inflation/interest rate movements based on NGFS projections. To transfer aggregate scenario variables to firm-specific projections, the methodology of the **ECB Economy-Wide Climate Stress Test** is used (see footnote 8).

In November 2023, the **International Association of Insurance Supervisors (IAIS)** published its **«Draft Application Paper on climate scenario analysis in the insurance sector».** According to the paper, «the focus for this paper is the use of climate-related scenario analysis by both supervisors and insurers to understand the risks to which the insurance sector is exposed at a micro- and macroprudential level. The paper considers why and how climate-related scenario analysis exercises should be used and the extent to which they can overcome some of the shortcomings of existing methods for assessing risks.» Not considered is the development of climate scenarios themselves. It considers the Insurance Core Principles (ICPs) of the IAIS and «focuses in particular on how climate-related scenario analysis should be considered in light of the standards set out in [...] ICPs 16 (Enterprise Risk Management for Solvency Purposes) and 24 (Macroprudential Supervision).»

Regulatory development in the European Union

In September 2021, the European Commission (EC) proposed changes to **Solvency II directive** (2009/138/EC), including amendments related to the European Green Deal. One of the proposed changes is the addition of **Article 45a on climate scenario analysis.** Under the new provisions, insurance companies will need to identify any significant exposure to climate change risks and evaluate the potential impact of long-term climate change scenarios on their business as part of their ORSA. As stated in the proposal:
Where the undertaking concerned has material exposure to climate change risks, the undertaking shall specify at least two long-term climate change scenarios, including the following:

1. *a long-term climate change scenario where the global temperature increase remains below two degrees Celsius;*
2. *a long-term climate change scenario where the global temperature increase is equal to or higher than two degrees Celsius.*

To assist undertakings to conduct such analysis EIOPA published in August 2022 the **Application guidance on running climate change materiality assessment and using climate scenarios in the ORSA** (EIOPA-BoS-22/329) with methodological considerations and examples. Methodological aspects that relate to data requirements, analysis of market, credit, and underwriting risk both for risk and asset management, including considerations of climate change adaptation and forward-looking scenario analysis for prudential purposes are also presented in the discussion paper EIOPA-BoS-22-527, **Prudential Treatment of Sustainability Risks,** from November 2022.

Regulatory developments in Switzerland

Two recent Swiss regulatory developments relate to climate scenario analysis relevant for insurers.

Similar to the European NFRD regulation (which is being replaced by the more extensive CSRD regulation), the Counterproposal to the Responsible Business initiative led to an amendment of the code of obligations as of January 1, 2022. Non-financial reporting became mandatory

for large companies.[24] The Swiss Federal Council will bring into force as of January 1, 2024 the ordinance on mandatory climate disclosures for large companies[25], which specifies climate disclosure requirements. The ordinance obliges companies to publicly report on climate issues along the Task Force on Climate-Related Financial Disclosures (TCFD) framework. The TCFD asks for insurance companies to disclose on climate-related risks potentially via forward-looking scenario analysis.[26]

The **FINMA Guidance 01/2023**[27] expects supervised institutions to establish adequate climate risk assessment and management capabilities aligned to their risk profile. According to FINMA, climate risks should not form a separate risk category but should instead be understood as risk drivers for existing risk categories. FINMA mentions the possibility of a disorderly transition to a low carbon economy and that this carries additional risk. FINMA is currently focusing on Cat. 1 and 2 institutions but intends to intensify and expand its supervision. In the context of COP 28, FINMA issued a press release in December 2023 announcing that it implements the NGFS recommendations and will in particular focus the following four areas.[28]

1 FINMA has issued a new draft circular on climate- and nature-related risks[29] in 2024 that will apply to banks and insurance companies. FINMA aims to specify the risk management requirements for institutions regarding climate and other nature-related financial risks. The circular aims to include recommendations from the Basel Committee on Banking Supervision (BCBS), the International Association of Insurance Supervisors (IAIS), and the Network for Greening the Financial System (NGFS). The public consultation on the circular was closed in the first quarter of 2024.
2 FINMA will review the current disclosure requirements in 2024 and aims to adhere to overall developments of increasing climate and sustainability reporting requirements and potentially revise the current requirements. Further, the civil law in Switzerland enforces the Swiss ordinance on climate reporting from 2024 onwards, with many banks and insurers in scope. Despite FINMA not being responsible to ensure compliance with the civil law, supervised institutions are expected to ensure systematic compliance, and therefore must be managed and organized accordingly.
3 FINMA aims to strengthen the data collection and basis for assessing climate risks. Data collection will be carried out at larger institutions (supervisory cat. 1 to 3) for the first time in 2024 and will serve as basis for FINMA's obligation to report on climate risks (planned by parliament in the CO_2 act).
4 FINMA shares the view of the NGFS assessment that an integrated approach to climate- and other nature-related risks makes sense and announces to increasingly integrate this view of nature-related risks into its practice (where appropriate and possible).

Summary

This article provides a short introduction to general concepts and terminology related to climate change, climate risk, climate scenarios, and the impact on insurers. It also provides an overview of selected regulatory and supervisory guidelines, stress tests, and recent developments until year end 2023. We hope to have given you a better understanding and sparked your interest in topics such as: How might climate risk affect insurers? What are scenario pathways, physical and transition risk, climatic impact drivers…?

EIOPA and private and government institutions in the US, UK, Switzerland, etc. have participated in work on climate risk scenarios since an early stage.[30] Long-term projections inherent in climate scenarios are uncertain and significantly depend on definitions and assumptions, which can vary widely across current climate scenario exercises. To ensure transparency and comparability between climate scenario exercises, it is necessary to develop a shared understanding of sound methodologies and their underlying assumptions. Moreover, further work to integrate climate feedback loops and tipping points into current methodologies is of key importance to improve the reliability of the exercise. As the topic is constantly evolving, we expect new guidance, best-practices and insights to be published in near future (e.g. by EIOPA and FINMA).

1 https://www.actuaries.org/IAA/Documents/Publications/Papers/CRTF_Glossary.pdf
2 International Association of Insurance Supervisors (IAIS): Draft Application Paper on climate scenario analysis in the insurance sector, November 2023.
3 EIOPA: Consultation paper on Application guidance on running climate change materiality assessment and using climate change scenarios in the ORSA, EIOPA-BoS-21/567, December 10, 2021
4 According to the glossary from the IPCC AR6: Mitigation is a human intervention to reduce emissions or enhance the sinks of greenhouse gases (sink: process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere). In climate policy, mitigation measures are technologies, processes or practices that contribute to mitigation, for example renewable energy technologies, waste minimisation processes and public transport commuting practices.

5 According to the Glossary for IAA Climate-Related Risk Publications (May 2023) transition risks refers to «risks emanating from transitioning to a lower-carbon economy that may entail extensive policy, legal, technology and market changes to address mitigation and adaptation requirements related to climate. Depending on the nature, speed and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organizations.»
6 Achievements and needs for the climate change scenario framework, Brian C-O Neill et al, Nature Climate Change volume 10, pages1074–1084 (2020)
7 Achievements and needs for the climate change scenario framework, Brian C-O Neill et al, Nature Climate Change volume 10, pages1074–1084 (2020)
8 International Association of Insurance Supervisors (IAIS): Draft Application Paper on climate scenario analysis in the insurance sector, November 2023.
9 Network for Greening the Financial System (NGFS). https://www.ngfs.net/en/ngfs-climate-scenarios-phase-iv-november-2023
10 Further noteworthy regulatory climate scenario analyses include: DNB (2018); HKMA CRST (2021); APRA (2021); MAS (2022); BoC (2022). It should be also mentioned that climate risk assessment based on scenario analysis is part of the EU Taxonomy DNSH principles for climate change adaptation and CSRD reporting, and the TCFD reporting framework.
11 https://www.federalreserve.gov/publications/files/csa-instructions-20230117.pdf
12 https://www.ipcc.ch/report/ar6/syr/
13 https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op328~2c44ee718e.en.pdf?7793485730460e4e-0b4e170237eb7429
14 https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.climateriskstresstest2021~a4de107198.en.pdf
15 Explore the NGFS scenarios here https://www.ngfs.net/ngfs-scenarios-portal/
16 ECB's economy-wide climate stress test (europa.eu)
17 Key elements of the 2021 Biennial Exploratory Scenario: Financial risks from climate change | Bank of England
18 https://acpr.banquefrance.fr/sites/default/files/medias/documents/20210602_as_exercice_pilote_english.pdf#page=6
19 https://publications.banque-france.fr/sites/default/files/medias/documents/wp774.pdf
20 https://www.eiopa.europa.eu/browse/financial-stability/occupational-pensions-stress-test/occupationalpensions-stress-test-2019_en
21 https://www.eiopa.europa.eu/system/files/2020-12/sensitivity-analysis-climate-change-transition-risks.pdf
22 https://www.transitionmonitor.com
23 https://www.eiopa.europa.eu/browse/financial-stability/occupational-pensions-stress-test/climate-stress-testoccupational-pensions-sector-2022_en
24 SR 220 – Bundesgesetz vom 30. März 1911 betreffend die Ergänzung des Schweizerischen Zivilgesetzbuches (Fünfter Teil: Obligationenrecht) (admin.ch), 500 or more employees and at least CHF 20 million in total assets or more than CHF 40 million in turnover.
25 Federal Council brings ordinance on mandatory climate disclosures for large companies into force as of January 1, 2024 (admin.ch).
26 https://www.tcfdhub.org/scenario-analysis/
27 https://www.finma.ch/en/news/2023/01/20230124-meldung-am-01-2023/
28 Press release (finma.ch)
29 https://www.finma.ch/en/news/2024/02/20240201-mm-rs-naturbezogene-risken/
30 https://actuaries.org.uk/emperors-new-climate-scenarios

SAA Climate Scenarios Working Group

Corina Grünenfelder (president)
is an experienced sustainability professional and actuary. She has over 10 years of professional experience in insurance and banking. She is co-chairing the Sustainable Finance and Climate Risk working group of the Swiss Association of Actuaries.

Elisa Barbieri
Senior Manager at KPMG. She has over 10 years of professional experience in the insurance industries including ESG and she is a member of the Climate Risk working group of the Swiss Association of Actuaries.

Jeta Limani
is a certified member of the Swiss Association of Actuaries (SAA) and holds the Sustainability and Climate Risk (SCR) certificate from GARP. She has held various risk management roles in banking and insurance.

Christoph Möhr
is a mathematician and actuary SAA and DAV with over twenty years of experience in various risk management and actuarial areas working at reinsurance companies, in consulting, and insurance supervision.

Angelika Zakrzewska
Group Audit Manager at Zurich Insurance Company and actuary SAA. She has over 10 years of actuarial professional experience and she is also a member of the Climate Risk working group of the Swiss Association of Actuaries.

Markus Haas
is P&C Risk Actuary at AXA Switzerland. He has 9 years of risk management experience in different areas in banking and insurance. He is member of the SAA, DAV and holds the CERA certificate. He is also member of the Climate Risk working group of the Swiss Association of Actuaries.

The content of this article is a collaborative work of the SAA Sustainability Working Group and does not reflect the opinion or approach of the companies at which the authors are working, but the authors' personal views.

Schweizerische Aktuarvereinigung / c/o Swiss Re / Postfach / 8022 Zürich