Koninklijk Actuarieel Genootschap

Sustainability Committee

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REPORT

Guidance on long-term scenario analysis in climate risk assessments

A practical guide for the Dutch insurance and pension industry to include climate risks in their own risk assessments provided by the Koninklijk Actuarieel Genootschap.

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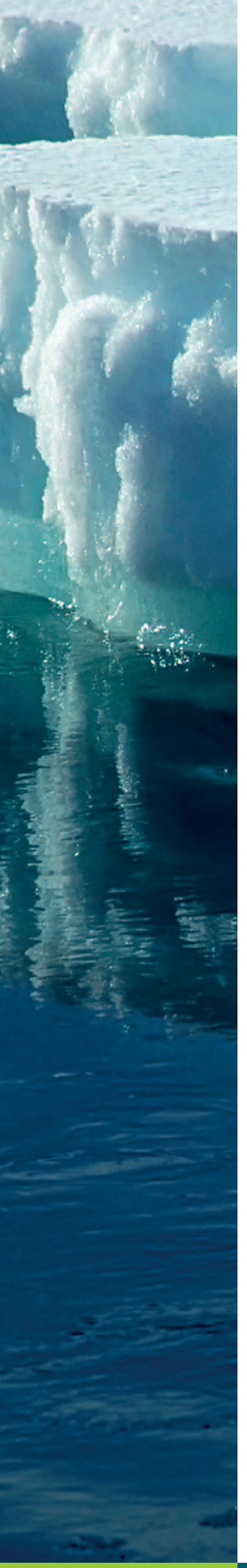

Management summary

Actuaries and risk managers will play a crucial role in assessing the impact of climate change risk on the balance sheet of insurers and pension funds.

Scenario analysis is a well-established tool that can be used to gain a better understanding of the impact of climate-related risks, and multiple papers have been published on the subject in recent years. The purpose of this document is to provide practical guidance on constructing climate change scenarios and applying long-term scenario analysis in climate risk assessments for insurers and pension funds. This can be used by actuaries and risk managers to analyse the potential short-term and long-term impact on their entity.

The key steps in constructing climate risk scenarios are as follows:

1. Select and describe relevant climate scenarios. Here, a distinction is made between physical risks (which can either have an acute or chronic effect) and transition risks. Examples of these scenarios are a disorderly transition or a hot-house world.

   Our recommendation to insurers and pension funds in the Dutch/European market is to disclose at least the following two NGFS scenarios:
   - Disorderly transition to a 1.5°C world;
   - Current policies scenario, resulting in 3.0°C warming world.

   For the choice of the time horizon, we recommend that a short-term (i.e. 2030) and longterm (i.e. 2050) horizon is considered, and that the liability duration is kept in mind.

2. The risk exposure for these scenarios should be identified. These risks depend on the entity's characteristics. We recommend that Dutch insurers and pension funds carefully consider the risks listed in Section 5.

   For Dutch insurers and pension funds, its exposure to an increasing water level is a serious threat as a large part of the Netherlands is below sea level. This risk is mitigated as plans for maintenance and improvements of dikes are made for the long term. Further considerations on this risk are given in Sections 2 and 6.

3. To calculate the financial impacts on the entity based on each scenario, the scenario narratives have to be supplemented with explicit assumptions. Information given in literature or by the regulator on (the quantification of) these assumptions is provided. However, each entity should assess whether these assumptions are relevant to them. This document provides guidance to entities on how to perform this step.

When performing these key steps in the climate risk scenario analysis, the entity will encounter various decisions to be made. The most material decision topics are summarized in Table 1, including proposed sources to base the decision on as well as a proposed value, or range of values, that is deemed reasonable and defendable. The values are provided in the two scenarios that are probing the extremes of the future state of the world, viz. a scenario in which transition risk is dominant and one in which physical risks prevail.

The three key steps above are part of a longer scenario analysis process, which also includes 0) the organization and set-up of the scenario analysis, 4) the inclusion of risk mitigation and strategic decisions in the analysis and 5) its disclosures. These elements are elaborated on in Sections 3, 7 and 8 respectively.

It should be noted that this document is based on the resources and methodologies available at the time of writing. We acknowledge that there will be continuous development on the topic over time. This document is not expected to be updated on a regular basis to reflect these developments. Yet, the approach and recommendations can be applied and extended when new information becomes available.

Decision topic	Proposed source	Proposed (range of) values	
		Transition	Physical
Exposure analysis			
Risks for non-life insurers	EIOPA	At least the following risks are expected to be relevant: - Acute & chronic physical risk on underwriting risk & counterparty default risk - Legal risk on underwriting - Market sentiment risk and physical risk on strategic risk - Transition risk on underwriting risk - Transition risks and physical risks on market risk - Reputation and legal risk on strategic risk	
Risks for life insurers and pension funds	EIOPA	At least the following risks are expected to be relevant: - Policy risk on market risk - Market sentiment risk on market risk - Acute & chronic physical risk on market risk and credit risk - Acute & chronic physical risk on underwriting risk - Reputation and legal risk on strategic risk	
Scenario selection			
Temperature pathways	NGFS, EIOPA	1.5°C Net zero 2050	3°C Current policies
Horizon	NGFS, EIOPA	2030, 2050. Hereby taking into account the liability duration	
Granularity	NGFS	High level of granularity (geography, sector, product categories, age cohorts) is preferred, to the extent feasible.	
Assumption setting			
Climate-related perils	KNMI, IPCC	Relevance depends on the entity's portfolio, with a focus on changes in frequency and impact of flood, drought and hail events.	
Longevity & mortality	WHO, KNMI, academic papers (see Section 6.2)	Limited impact expected due to offsetting trends	Limited impact expected but with larger uncertainty
Inflation	NGFS, (ECB)	Mid-term increase with slight long-term decrease	Long-term increase
Interest rates	NGFS	No impact	Decrease of 0.5 basis point
Equity indices and bond yields	NGFS, DNB, EIOPA	Short-term a decline. Mid-term: There will be more policy uncertainty leading to more risk premium. Long-term the equity returns gradually return to their baseline.	Limited impact on the outcomes, but more volatile. The impact is very region-specific. One should look at the underlying physical risk in the region.

Table 1: *Summary of decision topics relevant in the scenario analysis process, proposed sources and range of values.*

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1 Introduction

The purpose of this document is to provide practical guidance[1] to assist entities in first selecting climate change scenarios and subsequently analysing the potential short-term and long-term impact on the entity in isolation as well as in the context of its economic base. The guidance focuses on the Dutch insurance and pension fund industry. Climate change is expected to increase frequency and severity of weather-related events like extreme rainfall, hail and drought. More fundamental and long-term changes are expected around sea level rise and tipping points.

In an effort to mitigate these physical impacts, the goal agreed at the 2015 Paris COP is to limit temperature increase to below 2°C above pre-industrial levels – ideally 1.5°C. The implication is policy measures resulting in near term transition risk to asset portfolios, materialising as credit or market risk.

Insurers and pension funds face potential impact on both the asset (mainly transition risk), and the liability side (mainly physical risk) of the balance sheet. Scenario analysis provides a tool to analyse such forward looking impacts and associated risk management techniques, informing general strategic decision making. Hence, although the analysis itself is technical at times and actuaries and risk managers will play an important role in incorporating climate change risk on the balance sheet and ORSA and ERB of insurers and pension funds, the purpose of the analysis and this document is to enhance the role of actuaries and risk managers as key partners in strategic decision making.

Regulators and supervisors with a remit for systemic financial stability (including the [BoE], [EIOPA] and [DNB]) are increasing focus on how financial institutions consider climate change and the associated risks. While individual institutions may be immune to climate risk, as a whole the industry is causing and facing systemic risk. Incorporating climate risk metrics in existing structures is a challenge for insurance companies and pension funds.

The scope of this guidance is on climate scenarios and does not include wider biodiversity, ESG and SDG analysis other than the natural overlap. The probabilities of the different climate scenarios are not quantified, but the scenarios give insight into the effects of potential developments.

This application is specific to the Dutch insurance and pensions market, but a similar process can be applied to other geographic regions. For transition risk, the criteria would be largely similar in an EU context. For physical risk, the need for and level of adaptation as well as the perils and time horizon can vary greatly. While the Netherlands is mainly concerned with flooding and sea level rise, Southern European countries likely face more severe impacts from heat stress and water shortages.

Leading guidance and scenario providers include the following entities, to which this document adds in terms of practical decisions and considerations for the Dutch insurance and pensions market:

i. The Intergovernmental Panel on Climate Change (IPCC): the United Nations body for assessing the science related to climate change, which aims to provide governments with scientific information that can be used to develop climate policies.
ii. The Task Force on Climate-Related Financial Disclosures (TCFD): a non-regulatory, non-prescriptive framework, which aims to provide information to investors about what companies are doing to mitigate the risks of climate change.
iii. The Network for Greening the Financial System (NGFS) scenarios aims to exchange experiences, share best practices and contribute to the development of environment and climate risk management in the financial sector.
iv. The International Energy Agency (IEA): an autonomous intergovernmental organisation providing authoritative analysis, data, policy recommendations and solutions to ensure energy security and help the world transition to clean energy.

1 – Guidance ("leidraad") provides actuaries and actuarial analysts AG with support in a specific area of the practice of their profession. Although a careful process of consultation and consideration preceded the production of this publication, practitioners are not obliged to follow the views expressed in these publications [AG]. This guidance document is based on the resources and methodologies available at the time of writing. We acknowledge that there will be continuous development on the topic over time. However, this document will not be updated on a regular basis to reflect these developments. A careful consideration has been made to present general guidance that is useful to all insurers and pension funds, with the aim to facilitate standardization of the technical analysis and provide good practice on the desired level of complexity of the analysis. However, the guidance cannot be seen as a minimum nor maximum set of requirements, since entities will supplement the proposed approach with their own view and vision. This will indeed be needed for those elements that are specific to the entity.

2 Climate risk in a Dutch context

2.1 Physical climate-related risks

The Netherlands has a long-standing tradition of water management and a system of excellent flood protection. Flood protection is defined in legislation and the maintenance of flood protection is governed via the [DeltaProgramme]. Plans for maintenance and improvements of dikes are made for the period up to 2050. As the Delta Programme also takes the expected climate change into account, flood defence is expected to be stable for the upcoming decades. However, extremities in weather conditions might still result in additional flood risk and drought.

Flood

Short-term:

The Netherlands is expected to face increased direct losses from extreme rainfall [KNMI'23]. Insurance coverage for floods has historically been excluded from property insurance since the flood disaster of 1953, though it has not been excluded for Engineering (including Construction All Risk), Motor Other and Marine, Aviation and Transport insurance. In 2018 the Dutch Insurance Association (Verbond van Verzekeraars) published a report on the inclusion of floods caused by the failure of non-primary flood defences to the property insurance coverage [VVV'18A], [VVV'18B]. Since then most Dutch insurance companies have included this coverage in their property insurance policies [VVV]. The Dutch Insurance Association has put the inclusion of the failure of primary flood defences for property insurance in cooperation with the government on the political agenda [VVV'23].

Long-term:

Sea level rise poses a significant threat since a large part of the country is below sea level. The polders behind the dikes of the large rivers are often lower than the water level. This reconfirms the importance of continuous strengthening of the Delta Programme, to account for higher sea levels in the future and a greater water-carrying capacity of the river delta.

Drought

The risk of drought is expected to increase in the future. Direct damage is related to crop failures while indirect damage is expected to be most relevant in the form of damage to foundations of houses. The soil in the polders in the western and northern part of the Netherlands is often peat or clay. Due to low water levels, peat and clay can shrink and this can lead to subsidence or pile rot. This is a risk for houses and buildings. Drought can lead to more subsidence and pile rot [Deltares'20], which are not covered by insurance in the Netherlands. Subsidence and pile rot are a risk for the owner of the house and therefore indirectly for the mortgage provider, as the repair costs are relatively high.

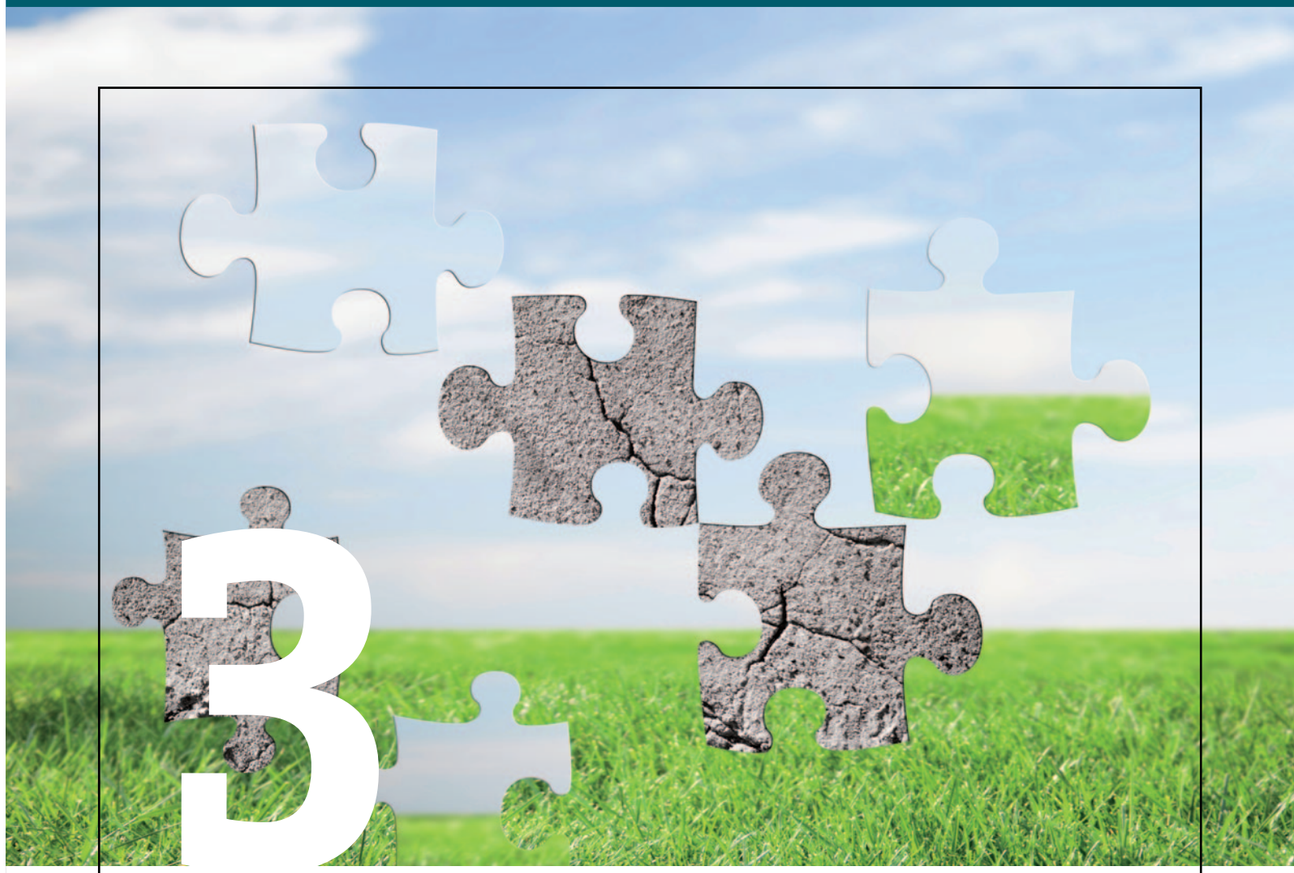
2.2 Dynamic adaptation uncertainty

The impact from short-term effects and especially long-term effects will depend on the policymaker's decisions, e.g. with respect to flood defence maintenance and groundwater levels in the polders. The government has already written guidelines to make the Netherlands more climate adaptive [Rijksoverheid'22]. However, multiple future visions are possible and there is uncertainty with respect to government decisions. The Netherlands Environmental Assessment Agency (Planbureau voor de Leefomgeving) has developed four different scenarios for 2050 [PBL'23]. These scenarios give different directions for the spatial development of the Netherlands and also different adaptation strategies. These different adaptation strategies influence insurance risk and physical risks of real estate investments.

Sea level rise is expected to have a large impact on the Netherlands in the long run. Especially in the emission scenarios sea level rise can happen faster than expected. This has impact on choices with respect to flood defences. Deltares has developed different strategies for the Netherlands to deal with a faster than expected sea level rise [Deltares'22].

The groundwater levels are managed by the water boards ("waterschappen"). However, different stakeholders have different interests with respect to the groundwater level. For farmers and residents with a house without piles a low groundwater level is advantageous. For residents with a house built on wooden piles a high groundwater level is advantageous, as a low groundwater level can lead to pile rot [Deltares'20]. The Dutch government is developing standards for climate adaptive construction. These standards can reduce the vulnerability of buildings to extreme weather risks in the long run [Rijksoverheid'23].

Thus, although part of the risks that arise from climate change can be managed, uncertainty in the route chosen by policymakers should be an active consideration in any scenario narrative for future climate pathways applied to the Netherlands.



3 Climate risk scenario analysis

Scenario analysis is a well-established tool for entities to assess and manage risk, and can also be applied to climate risk. Due to the long-term nature and interdependent complexity of climate-related risks, it is proving a vital addition to the risk management toolbox and resulting strategic considerations [Deltares'22].

A holistic scenario process requires careful collaboration between technical experts and other internal and external disciplines involved in the strategic decision-making process. In this paper we focus on the strategic and asset portfolio implications following the scenario analysis process. This is done by selecting relevant scenarios and elaborating how they can be applied at an insurer or pension fund.

Various approaches and guidances to conducting the scenario analysis process exist, including those defined in [TCFD'17], [EIOPA'22A], [EIOPA'22B] and [GARP'22]. DNB provides guidance on their expectations regarding business model & strategy,

governance, risk management and disclosures [DNB'23]. This includes the use of scenario analysis techniques and various good practice examples. The CRO Forum published a report on stress and scenario testing for the ORSA that describes general principles of long-term scenarios [CRO'23]. As a final, recent, example the Institute and Faculty of Actuaries emphasize the need for actuaries to understand more profoundly and challenge the underlying assumptions in climate scenario models [IFoA'23]. They point out that scenario analysis should inherently seek to probe uncertainty and improve the understanding of the potential impact of climate change to the entity, and linking these scenario analysis activities to the core principles for actuarial work.

A high-level summary of these includes the following steps:

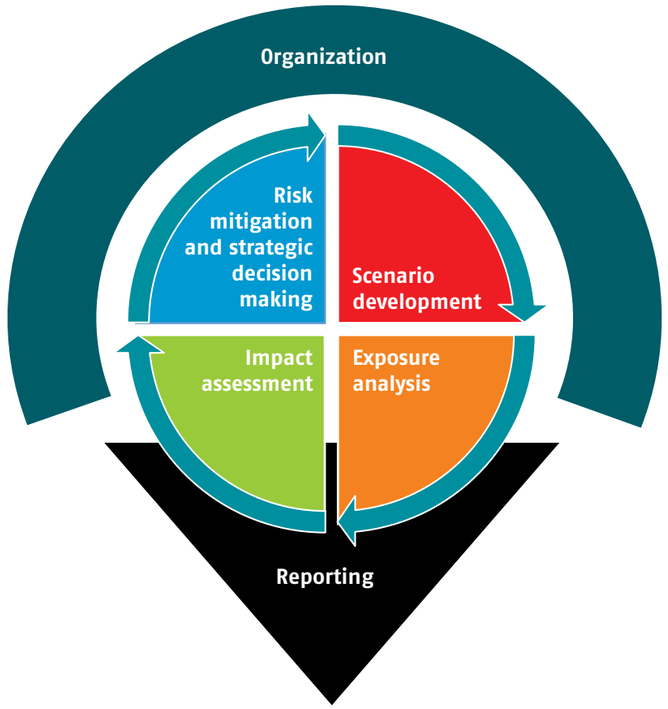


Figure 1: *the scenario analysis process consists of 4 core steps that are run in iteration, with overarching organization governance in place and continuous internal and external reporting to be done.*

0. **Organization**: As emphasized in [TCFD'17], before an effective scenario analysis process can start, it is important that its structure and governance is well organized. This includes setting an explicit goal for the analysis, as well as an appropriate time horizon over which to conduct the analysis. Please also refer to Section 4.

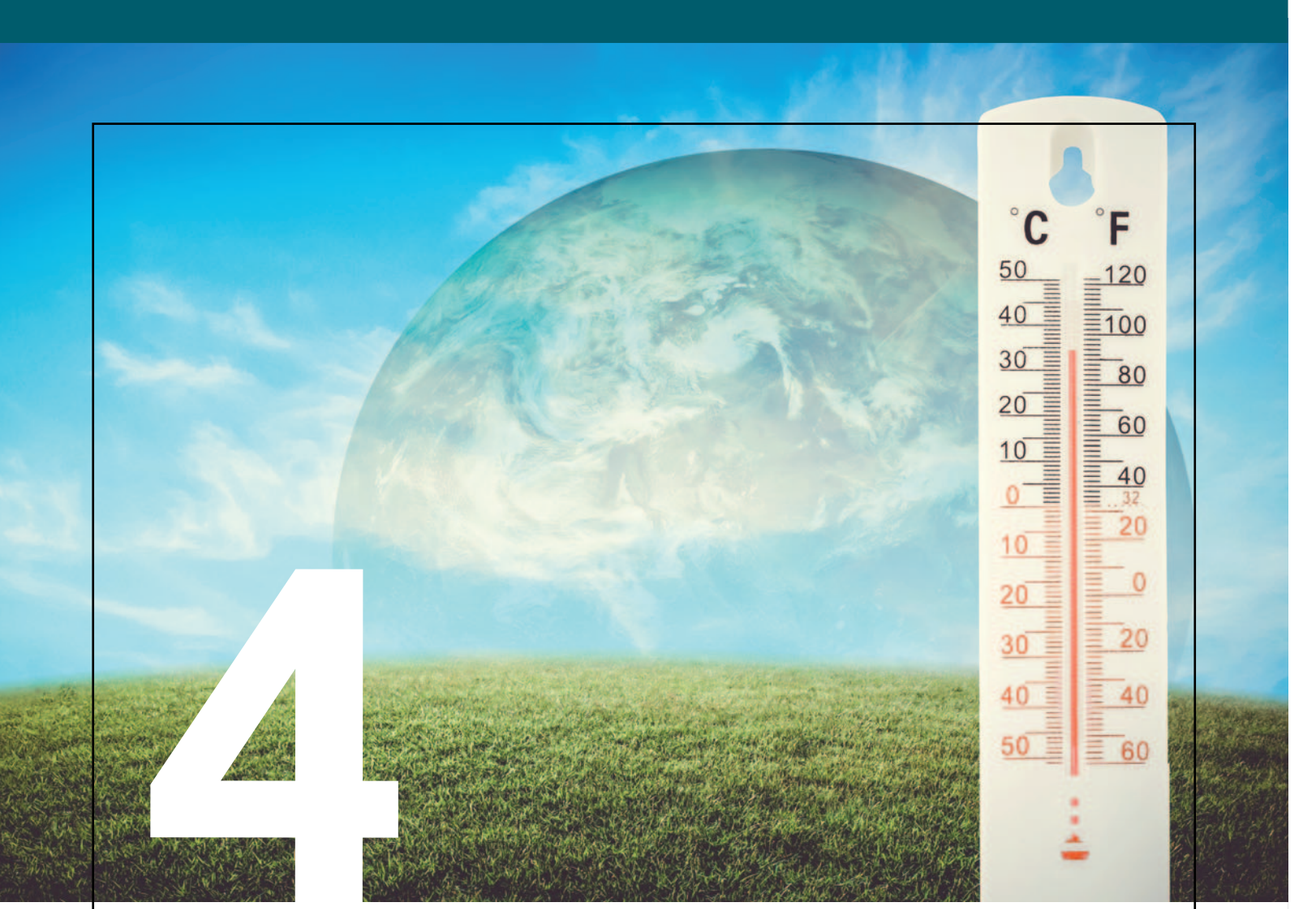
I. **Scenario development (pathway selection and impact horizon)**: The scenario narratives are developed considering various external driving forces, describing in detail different plausible scenarios of the future. The qualitative narratives are generally constructed by sustainability and/or economic disciplines. Scenario narratives should reflect the entity-specific view of the future. However, from a standardization perspective and given the lack of deep climate and socio-economic expertise currently available, pre-defined scenarios such as those provided by the IPCC, IEA, NGFS are an excellent starting point. For physical scenarios for the Netherlands, the KNMI published updated climate scenarios in October 2023 [KNMI'23]. Please refer to Section 4.

II. **Exposure analysis**: Climate-related risks impact the entity via a multitude of different transmission channels. A distinction is made between physical risks (which can either have an acute or chronic effect) and transition risks arising from social, economic, technology, reputation, political and legal trends [TCFD'17], [EIOPA'22B]. Through an exposure analysis, the relevant climate-related risks are identified. This enables the entity to decide which risks to further consider in the scenario analysis. The initial qualitative materiality assessment will typically leverage on insights across the entity and will not be performed based on a technical analysis. This is more expected for the quantitative materiality assessment [EIOPA'22B]. Please also refer to Section 5.

III. **Impact assessment**: In order to calculate the financial impacts on the entity within the various scenarios, the qualitative scenario narratives have to be supplemented with explicit assumptions. In Section 6 we further explore for the Dutch insurance and pension industry what are the relevant assumptions, considerations feeding into defendable values, and how they can be included in the impact assessment of the scenario.

IV. **Risk mitigation and strategic decision making**: The insights gained from the scenario analysis in turn feeds identification of risk mitigation options. Given the long-term and entity-wide impact of climate-related risks, these risk mitigation options are typically strategic decisions to be made by the entity. To draw correct conclusions on decision making, limitations and uncertainties regarding the assumptions underlying the scenario analysis need to be well understood. As another next step, it is expected that the outcome of the analysis will trigger a desire to further refine the analysis and will establish data needs for future analyses.

V. **Reporting**: The process itself, the outcomes of the scenario analysis study and the resulting strategic decisions made are subject to internal and external reporting in order to inform all relevant stakeholders. As a minimum, long-term scenarios are to be included in the ORSA and ERB ("eigenrisicobeoordeling", i.e. "own risk assessment"), and in the TCFD paragraph in the annual report. The ORSA is an internal document that is only shared with the regulator and not publicly disclosed. The long-term scenarios in the TCFD paragraph are a summary of the ORSA or ERB report. In line with EIOPA's expectations, at least two scenarios should be described, reflecting both a physical risk scenario and a transition risk scenario. As part of the entity of the scenario analysis process it is expected that the further reporting requirements have been defined. In Section 8 these requirements are explored.



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Step I: Scenario development/selection: temperature pathway and impact horizon

EIOPA requires reporting on two climate scenarios: a climate change risk scenario where the global temperature increase remains below 2°C, preferably no more than 1.5°C, in line with the EU commitments; and a climate change risk scenario where the global temperature increase exceeds 2°C [EIOPA'22B]. The considerations for the choice of the two pathways are important to be mentioned and we would expect that the following dimensions of these considerations are included:

1. **Temperature choices**: To appropriately assess both transition and physical risks, it is important to consider the extreme temperature pathways (e.g. 1.5°C and 4°C). These scenarios should be translated to e.g. the NGFS terminology. The NGFS has defined different combinations of physical risk and transition risk. However, the NGFS has not specified a scenario with both high physical and high transition risk. This combination could be possible, if for example Europe is successful in realizing a fast transition and other parts of the world are not. It is recommended to consider all possible combinations and to choose the scenario best aligning with the entity-specific view.

2. **Transition pathway**: The type of transition, i.e. orderly vs. disorderly, impacts the scenario narrative and implications. Therefore, this should also be a described consideration.

3. **Horizon**: For the choice of the time horizon a short-term (e.g. 10 years) and long-term (e.g. 30 years) horizon should be chosen, or at least 2-3 future periods. The availability of assumptions should be taken into account when selecting the scenario and impact horizon. For example, since a 2060 NGFS scenario is not available, it is impractical to choose such an impact horizon.

4. **Entity-specific changes**: Since the NGFS and the other generally accepted scenarios are global frameworks, it is important to qualitatively and quantitatively refine the relevant NGFS scenarios in line with the entity-specific views, in particular relating to the specific market circumstances. Insights from Dutch climate projections should be included to an analysis of Dutch insurance or pension risks. These include dynamic adaptation as mentioned in Section 2, actions from parties such as [Urgenda], local implications of European policy goals, energy needs and social stability following from inflationary pressure.

An overview of available "standard" scenarios is provided in figure 2 below.

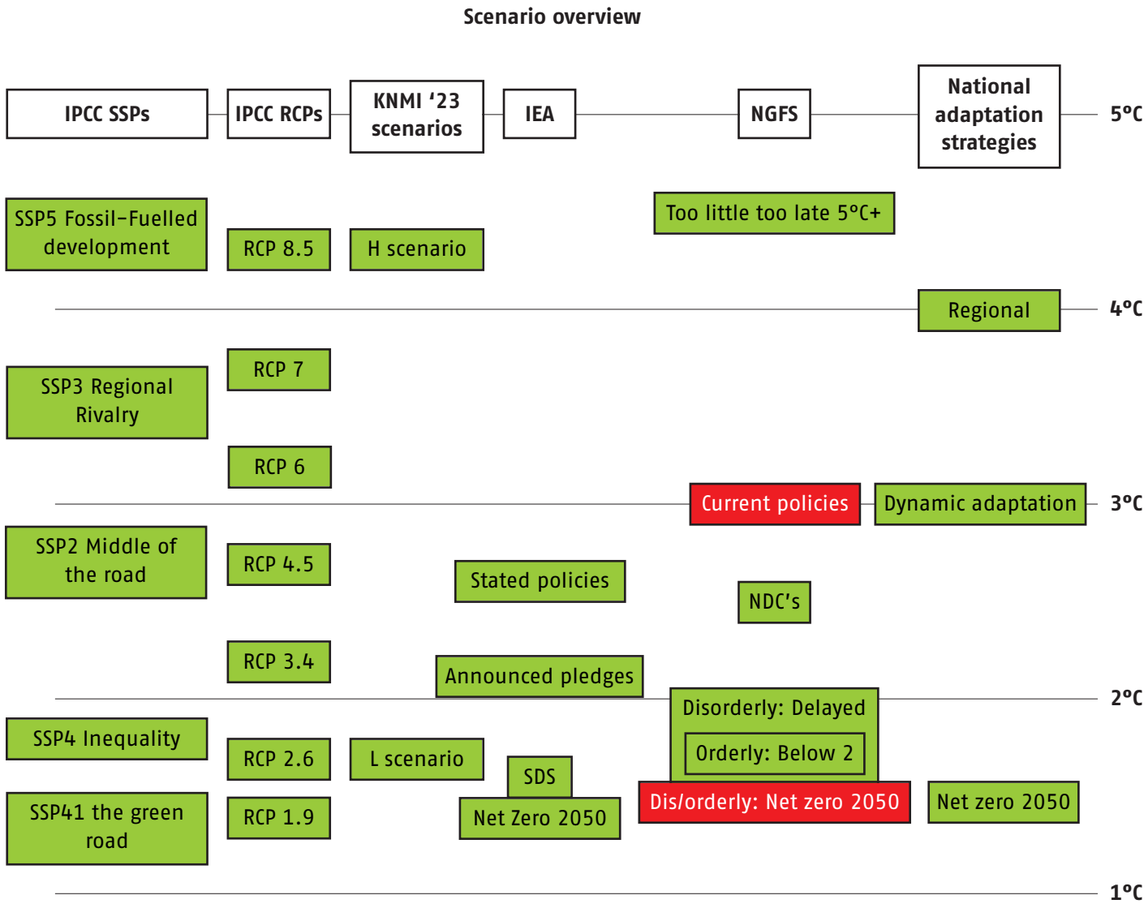
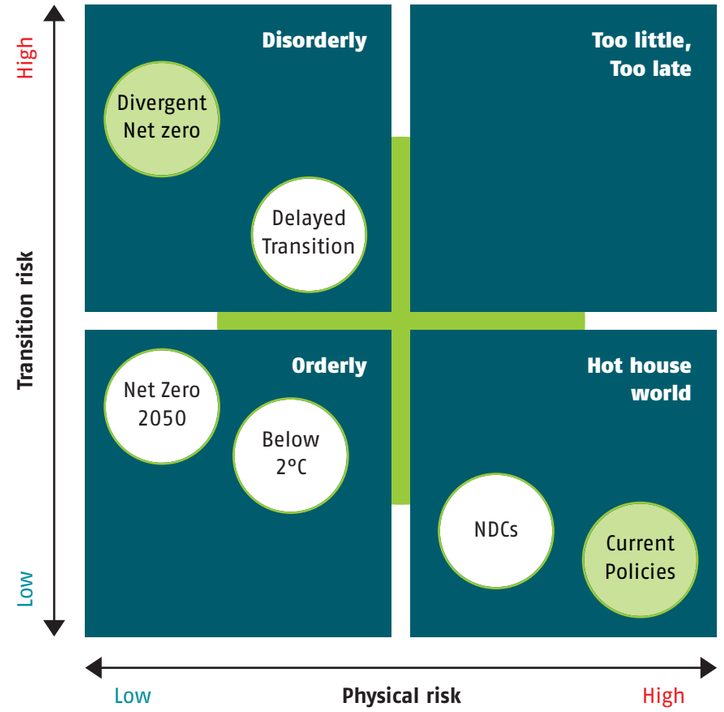


Figure 2: *Long-term scenarios decision tree in the Dutch Insurance & Pension Market context by public institution source.*

Our recommendation to insurers and pension funds in the Dutch/European market is to disclose on two scenarios: a transition risk scenario and a physical risk scenario. In this paper we discuss the Divergent/Disorderly Net Zero 2050 (DNZ or 1.5°C) and the Current Policies (CP or 4°C) scenarios. These scenarios are chosen because they give a wide scope of climate impact.*



The table below elaborates on the suggested scenarios and further details the link with other existing scenarios.

Transition risk scenario	Physical risk scenario
• Disorderly transition to a 1.5°C warming world (an orderly transition seems less plausible with the current reality of the Ukraine-Russian conflict, high inflation and energy market economics). • In line with the EU and NL energy transition targets, and commitments made by many financial institutions in 2018 as part of the Spitsbergen Ambition. • High level based on SSP1 / RCP 1.9-2.6 / KNMI L scenario / Net zero IEA / Disorderly: Net Zero 2050	• Current policies scenario, with an expected 3.0°C global temperature rise. • This is a best estimate scenario which represents a relatively high level of physical risk, with limited transition risk, and risk exposure highly dependent on the National Adaptation Strategy i.e. investment in flood infrastructure and drought measures. • High level in line with SSP2-3 / RCP 4.5-6 / Stated policies IEA. • For P&C insurers we recommend doing an additional physical risk assessment corresponding to the KNMI H scenario/RCP8.5. Because the asset side of the balance sheet is much lighter for a P&C insurer, the lack of a full economic impact (NGFS) scenario is less significant.

* Note that an RCP 8.5 / SSP5 scenario would result in a temperature increase of ca. 5°C and ultimate systemic collapse. The expectation is that no entity will remain solvent in such a scenario.

It is important to consider the purpose for which the scenarios will be used when selecting a scenario, as alternative scenarios may be more relevant depending on the purpose. For example, when performing stress testing, a "Too little too late" scenario will be relevant. A similar remark is made by [IFoA'23] who emphasize that current climate scenario models are significantly underestimating climate risk and, thus, even more extreme scenarios should be taken into consideration.

5 Step II: Exposure analysis

Within the scenarios it can be assessed which climate-related risks the entity is exposed to. The climate-related risk identification process will initially leverage on a thorough understanding of the business as well as future trends and driving forces that might result from climate change or its preventing activities during the transition period. Therefore, stakeholders in this process will certainly include experts from various parts of the business, internal or external sustainability expertise and to a lesser extent technical experts. However, the latter group will be much more involved when the qualitative materiality assessment will be supplemented with a quantitative analysis.

The transmission channels that are relevant to an entity will depend on its precise activities. This not only applies to the current exposure based on current activities but also to the future exposure of any future activities the entity is targeting. Both the exposure level and the applicable activities may change in the future. The exposure is changing since the risk levels are changing, e.g. pandemics might become more frequent. Targeted activities might be different from current activities, either as a voluntary strategic change in direction or because changes in insurability of risks force the change in

business model [EIOPA'22B]. EIOPA has provided a mapping from various trends and transmission channels into the Solvency II risk, which includes the impact on a variety of business lines and insurer's business models, ranging from credit and surety insurance to marine insurance [EIOPA'22B]. It is up to the entity to identify the relevant climate-related risks based on such a mapping or an alternative taxonomy. However, for P&C insurers, (Dutch) life insurers and pension funds, we would expect that at least the risks indicated below are carefully considered in a qualitative exposure analysis, where the lists are in order of expected priority. We follow the terminology and mapping of [EIOPA'22B], which also provides further context and examples. The risk exposure of health and disability insurers can be identified in a similar way.

Non-Life insurers

Climate risk channel	Sub Type	Underwriting Risk	Market Risk	Credit / Counterparty Risk	Operational / Reputational / Strategic Risk
Transition Risk	Policy				
	Legal				
	Technology				
	Market Sentiment				
	Reputation				
Physical Risk	Acute				
	Chronic				

Life insurers & Pension funds

Climate risk channel	Sub Type	Underwriting Risk	Market Risk	Credit / Counterparty Risk	Operational / Reputational / Strategic Risk
Transition Risk	Policy				
	Legal				
	Technology				
	Market Sentiment				
	Reputation				
Physical Risk	Acute				
	Chronic				

Table 2 and 3: *Climate-related risks impact the traditional prudential risks of insurers and pension funds via different transmission channels. In principle, each intersection is to be assessed for its relevance for the entity. Given the nature of their business, the highlighted cells are expected to be of higher priority and relevance for non-life (P&C) insurers and life insurers/pension funds in Table 2 and 3 respectively.*

5.1 Non-Life (P&C) insurance

1. **Acute & chronic physical risk on underwriting risk & counterparty default risk**: business lines that provide protection against natural (weather) events will face a direct impact from a climate change, both through acute events as well as chronic changes, while taking adaption measures into account. But the indirect impact of climate-related change in typical weather conditions will also need to be considered, for example the impact on underwriting, pricing, claims and the business model of motor insurance. In all cases, any change in the availability and affordability of reinsurance (and its associated counterparty default risk) is a factor to consider as well.

2. **Legal risk on underwriting**: insurers underwriting liability policies such as directors & officers or professional indemnity policies will need to consider how the transition associated to climate change will impact their underwriting risk.

3. **Market sentiment risk and physical risk on strategic risk**: while performing risk management many insurers focus on their existing portfolio. However, looking far into the future and imagining a vastly different society and environment will trigger different needs for insurance protection. Insurability or appetite of traditional policies might reduce, while new opportunities may appear.

4. **Transition risk on underwriting risk**: in a combination of the transmission channels mentioned under 1 & 3, the current policy coverages can also see a change in combined ratios as a result of the energy transition. The easiest example is solar panels increasing the fire risk in home insurance. Other examples are the increasing share of electric vehicles in the motor portfolio with a different risk profile and the fire risk of charging stations.

5. **Transition risks and physical risks on market risk**: compared to life insurers and pension funds, the balance sheet does not pose as much market risk. However, within the non-life insurers themselves the exposure of their assets to both physical risks and transition risks should be assessed and considered, while being conscious of the relative impact compared to the exposure in their underwriting business.

6. **Reputation and legal risk on strategic risk**: many insurers are setting targets regarding their impact on the environment, with their own operations and in the underwriting and investment portfolio. These targets include considerations regarding inclusion/exclusion of certain investment classes and underwriting clients. Failing to meet these targets, or judging the ambition level incorrectly, results in reputation risk, where clients and other stakeholders disagree with the strategic decisions of the entity. This may have a legal transmission channel as well via claims and litigation of the entity's strategic course.

5.2 Life insurance & pension funds

1. **Policy risk on market risk**: life insurers and pension funds hold sizeable asset portfolios and their role in sustainable finance receives an increasing amount of emphasis. Therefore, the intersection of transmission channels with market risks are obviously of priority to these entities [CRTF'22]. Policy risk includes the treatment of greenhouse gas emissions in the asset portfolio. Of direct concern are the potential carbon pricing mechanisms and how that could change the volume, decomposition and/or profitability of the assets.

2. **Market sentiment risk on market risk**: closely related to the previous risk, the market sentiment risk on market risks extends from the governments and policymakers to the consumers, who might change their behaviour and preferences. In an ever-evolving landscape, the entity needs to judge what asset strategy matches the current and future needs of their stakeholders.

3. **Acute & chronic physical risk on market and credit risk**: the values of the entity's assets can be impacted by physical climate-related events. This can be acute effects (flood, storm), e.g. on the mortgage portfolio, corporate or government bonds, or chronic where the value of the mortgage portfolio depreciates as the probability of events increases or where certain governments or corporations face an economic headwind as a result of physical distress.

4. **Acute & chronic physical risk on underwriting risk**: humankind is often seen as quite well adaptable to its surroundings. At the same time, population growth and population health are easily affected at least to some degree. Life insurers, pension funds and disability insurers hold long-term commitments that require an extensive, well-tested assumption setting. Changes in temperature, air quality, disease proliferation are expected to cause a structural break from historic observations. As the core product these entities sell are depending on life, death and health, responsible underwriting requires an increased understanding of exactly how well-adaptable their clients/members are.

5. **Reputation and legal risk on strategic risk**: many insurers and pension funds are setting targets regarding their impact on the environment, with their own operations and in the investment portfolio. These targets include considerations regarding inclusion/exclusion of certain investment classes. Failing to meet these targets, or judging the ambition level incorrectly, results in reputation risk, where clients and policy holders and other stakeholders disagree with the strategic decisions of the entity. This may have a legal transmission channel as well via claims and litigation of the entity's strategic course.

5.3 Practical suggestions to approach the exposure analysis and impact analysis

The activities resulting in the climate-related risk identification and their materiality are further elaborated on in e.g. [TCFD'17], [EIOPA'22A] and [EIOPA'22B]. For the technical, quantitative exposure analysis, in particular the latter reference provides extensive examples of possible approaches. As is clear from the document, standardized approaches do not exist at this moment, since lack of data forces bespoke solutions per risk and per entity. Nevertheless, the following ingredients are relevant:

A. **Extensive (internal) documentation and substantiation**: for a transparent process, all considerations and underlying (qualitative) assumptions, be it explicit or implicit, should be documented. In this way, even when an identified climate-related risk is deemed to be immaterial, it is documented why and based on which considerations. Then, in case those considerations prove to be incorrect over time, it is possible to update earlier conclusions.

B. **Establish a frequency for reassessment**: the assessment will be in need of reassessment periodically. The duration of that period depends on the purpose of the exercise and the stability of the underlying assumptions. However, given the long-term nature of climate-related risks the frequency is unlikely larger than once per year.

C. **Be open to different scenarios and risk interactions**: When performing a qualitative or quantitative exposure analysis to identify the material risks, effects both from the transition perspective and physical perspective should be considered. Also, ensure to think beyond the direct impacts but "think through" the effects: e.g. in a global hot house world, a particular business line might not be directly impacted, but scarce resources and a general crisis situation will put its mark on economic development and e.g. interest rates and inflation, which may be much different from what we currently consider normal variations.

D. **Perform a comparative scoring**: as emphasized in [EIOPA'22B] from both the qualitative and quantitative exposure analysis a materiality assessment can be done. Our suggestion is to focus on the potential impact at different time horizons, rather than the probability of events. The latter is of less relevance in the context of scenario analysis, as long as the scenario explores the impact of uncertain but plausible situations. The scoring of the different risks can be used to prioritize the efforts for further scenario analysis. Yet, it may still be worthwhile to also consider risks with lesser priority, since the impact analysis itself will be a test of the initial expectations in terms of priority.

5.4 Granularity and data availability

The level of granularity at which the scenarios are defined depends on the risk under consideration, the purpose of the impact assessment and the availability of data.

Once the scenario narrative has been specified at a high level (Section 4), the following additional details can be specified as part of the scenario definition (in order of increasing granularity):

- At the highest level, the scenario definition would specify the **key assumptions** about the development of the climate outcomes, the climate transition and the timing.

- A more detailed definition could include the translation of the scenario narratives into specific climate outputs, with pathways for physical and transition climate factors (e.g. temperatures, carbon prices, emissions, frequency and severity of perils).
- These climate factors can be split into **broad economic factor** output pathways (e.g. GDP, interest rates, inflation).
- At a more granular level, the impacts can be further split into the various **economic sectors / countries**.
- The **individual firm implications** can also be derived based on the climate sensitivity of the underlying activities of the companies.
- Lastly it would also be possible to derive the economic **activity-level implications**, requiring the identification and mapping of economic activities of individual counterparties or individual assets.

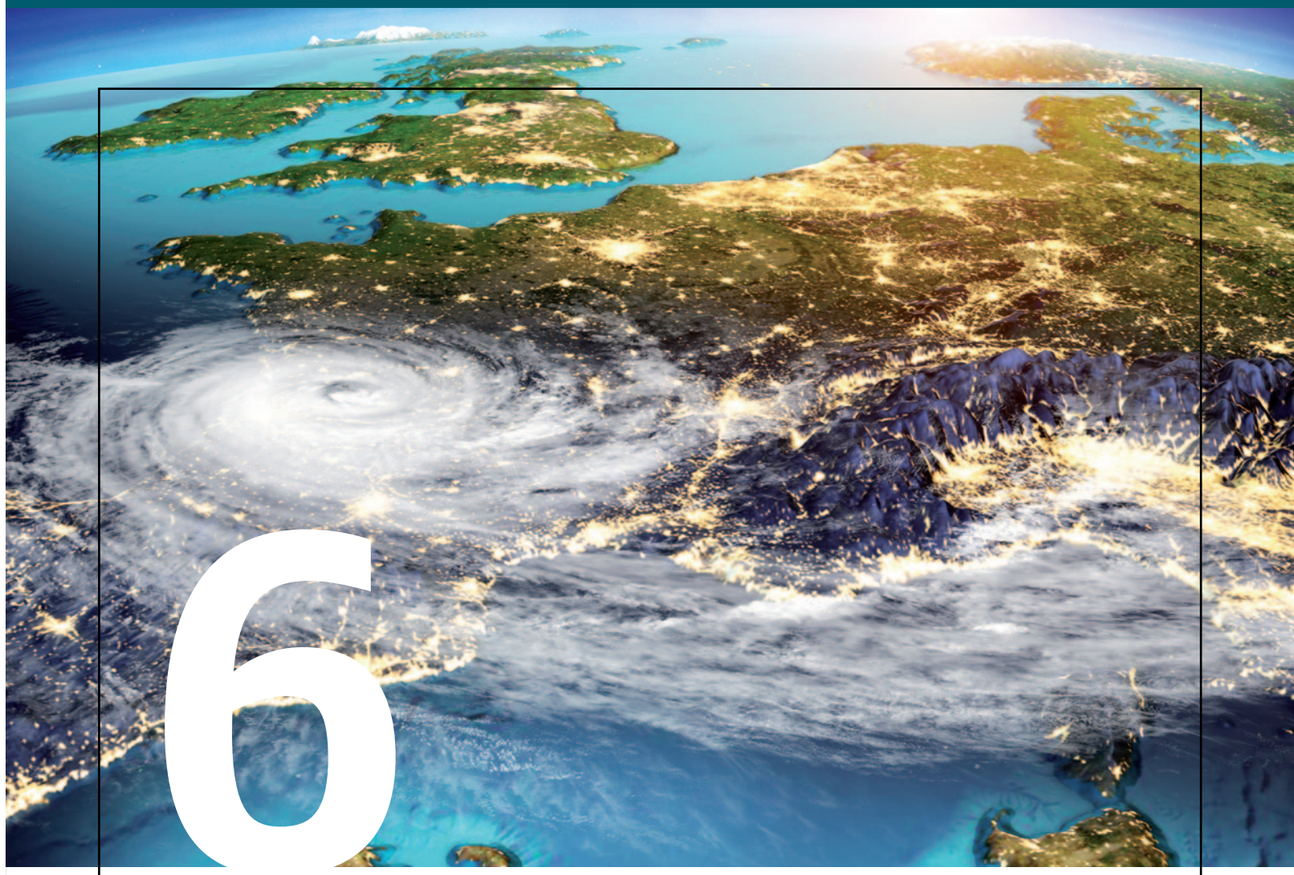
Within the exposure analysis, the required level of granularity should be assessed by considering the assets and liabilities of the entity. A few practical examples of how the level of granularity can be specified are shown below:

1. Assets can be split into geography (country level) and sector.
2. The life underwriting book can be split into product categories and age cohorts.
3. The non-life underwriting book can be split into geography (physical locations) and sector.

In deciding on the level of granularity, it is important to find a balance between simplicity and sufficiently considering the entity-specific impacts. In general, a higher level of granularity is preferred as the impacts can be very specific for each entity. However, by increasing the level of granularity, availability of (historic) data could pose a challenge for entities.

The preferred granularity for the scenario development should follow from this analysis. A starting point can be the latest NGFS scenarios. These already provide the scenario definition data at the level of economic sector implications, which is the granularity recommended by EIOPA. A more granular scenario definition can be specified by including firm-level and activity-level implications, which are specific to each entity and dependent on the risk exposure.

Over time the granularity of the analysis is expected to further mature. This is needed to allow sufficient focus on the material elements of the analysis where a lack of granularity will ultimately lead to too much uncertainty to properly make decisions and manage the risks. Diligently performing initial scenario analyses, even at a higher granularity level, are crucial to start appreciating the data need. With this experience, the entity can start to organize the availability of data and establish a data gathering process, including controls over it. See also section 7.



6

Step III: Proposed impact assessment approach

After the climate scenarios have been defined and an exposure analysis has been performed, the relevant assumptions can be set for each scenario to facilitate the impact assessment under these scenarios. This section provides guidance on this assumption setting, specifically for:

1. Physical perils that impact P&C liabilities and property valuation;
2. Mortality assumption;
3. Macro-economic variables (inflation, interest rates, equity and bond prices).

These three items are relevant driving assumptions to the scenarios for insurers and pension funds, although they do not cover all risks. The relevant risks depend on the entity's characteristics and may change in time. It depends for example on whether an insurer is active in P&C business and the extent to which physical risks are mitigated.

Other risks not focused on in this document are risks that affect people's health, which would be relevant for health insurers.

In each paragraph below the primary source of information and potential alternative sources are given, together with key considerations.

6.1 Frequency & severity of specific climate-related perils in regions with material exposure

Currently P&C insurers are (partially) underwriting the financial impact from (catastrophic) weather events such as hail, drought, windstorm, whirlwind, coastal flood, pluvial flood and fluvial flood. The long-term scenario assumption setting of the underlying frequency and severity of these physical perils will primarily rely on expert judgement. In this case the KNMI provides the best available science-based insights into changes in Dutch weather patterns. They rely on the global IPCC reports and translate it to what is relevant for the Netherlands. The most recent insights are available in the [KNMI'23].

In the [KNMI'23] it is noted that:

1. Sea levels are rising and are expected to have risen by 26 – 124 centimeters by 2100. This increases the probability of coastal flooding.
2. Severity of heavy thunderstorms is increasing, with higher probability of extreme rainfall.
3. Large hailstones might become larger and wind gusts and downbursts stronger.
4. Drought is increasing with the agricultural environment resembling more the Southern European climate.
5. More extreme river levels.
6. Intensity of hurricanes increases in the Caribbean, both in terms of wind and rain. This also impacts Europe with wind and rain.
7. Windstorm on the North Sea is not expected to become more frequent nor more intense.

The KNMI is not very explicit on hail projections. A study that can be used is the [Rädler'19] publication on the development of severe thunderstorms in Europe. The conclusion of this study is that the risk of hail, lightning and wind gusts will likely increase over Europe until the end of this century. It is up to the entity to decide on the view on climate change. Model vendors are releasing catastrophe models that include long-term climate scenarios. Aon has recently added long-term climate scenarios in the Impact Forecasting Severe Convective Storm model, which can be used for the assessment of hail risk.[2]

2 – https://aon.mediaroom.com/news-releases?item=138220

In applying such insights into the entity's assumption setting, the following aspects should be taken into account:

A. The application will consist of material **expert judgement**, where it needs to be decided how to separate temporary short-term fluctuations from long-term historical trends and how historical trends relate to future expected weather patterns. **Sensitivity analyses** on the assumption setting can help to understand the criticality of assumptions.

B. Acknowledging the **uncertainty** in the future predicted weather patterns is also essential to provide sufficient caveats on how to interpret the results. KNMI is considered as the leading expert and it will also provide their expectations including uncertainty ranges.

C. To understand the financial implications for the own underwriting portfolio a **materiality-driven** approach is suggested, where it is first considered what parts of the portfolio are not only most exposed, but also most material. More attention and research should go to that part of the portfolio that is both material and has a large exposure.

D. KNMI provides their expectations on the changes in weather perils. Since they are following IPCC global scenarios, this includes the various mitigation scenarios. However, the policy response in terms of **adaptation** is not incorporated, while this is essential for the financial implications of the underwriting portfolio. Therefore, in the assumption setting process, and especially for the most relevant combinations of peril and portfolio, dedicated research to the impact of potential adaptation measures should be incorporated.

E. Weather-related perils and their impact on the underwriting portfolio are common to P&C insurers. However, a similar approach would be appropriate to the (property) **asset portfolio** of any insurer or pension fund. Even though property is not yet affected by adverse weather events, its value is impacted by the fact that its exposure to these events increases.

F. For P&C insurers commercial aspects on pricing and insurability should be taken into account, including the development of the **relative purchasing power** of the client base: when the cost of climate perils increases disproportionally compared to economic growth, appetite for ever more expensive insurance products will diminish.

6.2 Longevity & mortality

To establish mortality assumptions for the climate change scenarios, an entity should rely on insights from academic studies and expert judgement. A recent assessment by the [GenevaAssociation'22] offers a starting point for a framed qualitative process to explore physical and transition risks on the liability side. This framework includes to methodically list the relevant trends. Physical risks include the chronic change in summer and winter temperatures and to a lesser extent the acute effects from extreme events. Transition risk also impacts longevity and mortality expectations. Due to the energy transition, air pollution is expected to decrease. This can lead to better health and therefore to lower mortality [RIVM'19].

A quantitative analysis of the precise effects on Dutch mortality is currently not yet considered in the mortality projections as provided by the AG committee on mortality research. As a result, at the moment it is up to the entity to absorb the academic studies and determine its vision on future mortality assumptions.

Relying on this literature, we observe that the impact of climate change on mortality (due to temperature changes) depends on the time horizon. According to [Botzen'20] at first, climate change is expected to decrease total net mortality in the Netherlands due to a dominant effect of lowered cold-related mortality. Over time this is reversed under high warming scenarios. The largest mortality changes from climate change occur in the population group with age ≥ 80.

This study, focusing on the Netherlands, is supplemented by European studies. [Gasparinni'17] presents the excess mortality in the scenarios RCP2.6, RCP4.5, RCP6.0 and RCP8.5 for several world regions. Northern Europe, which includes Finland, Sweden but also Ireland and the UK, is characterized by a relatively small projected warming and increase in heat-related mortality. A similar result for Northern Europe is shown in [Carleton'22].

Based on these insights, we come up with the following illustrative assumptions:

Divergent Net Zero: No adjustment is made for this scenario. It is assumed that the AG mortality table is extrapolating past data to the future. One could argue whether or not 1.5°C warming would be a significant deviation of the past. For our purposes, we consider that less deaths during winter and more deaths in summer occur due to milder winters and more severe and more frequent heat waves [KNMI'23] [Vanos'20] [Rocklov'12]. Hence, on average (and as indicated depending on the time horizon) no significant effect is expected. In addition, it is expected that people will adapt to global warming. Nevertheless, these expectations are uncertain as it is not exactly clear how mortality rates will change due to global warming.

Current policies: An increase in mortality rates among the elderly (age ≥ 60) could be assumed in this scenario in the absence of significant preventive measures. The impact of this scenario depends on the entity's characteristics and is surrounded by even more uncertainty than in the Divergent Net Zero scenario. We leave it to the entity to base its expert judgement on the underlying academic insights, to set assumptions and to carefully monitor and acknowledge the associated uncertainty.

6.3 Macro-economic variables

Macro-economic variables are part and parcel of basic liability assumptions for long term providers, and should be specified for each climate risk scenario. There are various macro-economic variables that are considered by the NGFS, including interest rates, unemployment rates, GDP, inflation, equity prices and productivity levels. Interest, inflation rates, equity returns and bond yields are key elements in the insurance and solvency framework potentially impacted by climate risk (both transition and physical). The following subsections provide guidance for selected economic assumptions based on the NGFS scenarios.

Limitations

It is important to note that modelling macro-economic variables within climate risk scenarios is a complex and evolving field. The following should be taken into account when choosing the pathways for the macro-economic variables under consideration in the climate risk scenario's:

- Macro-economic variables are prone to a large number of transmission channels. The NGFS has incorporated the interaction of these channels through a range of assumptions and scenarios to capture the potential different outcomes. This means that the chosen outcomes are highly dependent on the modelling assumptions and input used by the NGFS.

- Spillover effects: The specific ways in which climate change impacts these economic variables can vary based on numerous factors, including geographical location, sectoral exposure, and policy responses. Climate risk models typically incorporate a range of scenarios and assumptions to capture different potential outcomes. However, not all spillover effects can be captured in the models.

6.3.1 Inflation

Consumer price inflation can significantly impact the value of real policy/pension holder benefits, especially a non-index linked pension fund. On entity level the asset and liability side is likely hedged/matched for inflation resulting in lower overall risk exposure. Physical Climate development as well as the transition to net-zero can have a material impact on future inflation.

In Phase III of the NGFS climate scenarios set-up, the NGFS outlines the pathways in Figure 3 for European inflation rates across the different scenarios.

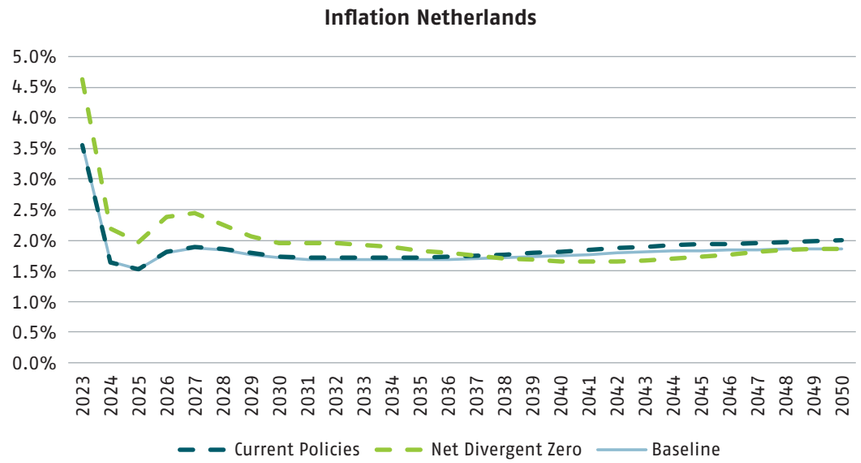


Figure 3: *The baseline is a fictional scenario. This is an economic expectation if there were no climate change at all with the result that there would be no climate risks. The other two scenarios show the difference in expectations relative to each other and the baseline.*

Inflation is affected by both the external shocks in climate risk scenarios and policymaker choices to either safeguard price stabilization or to set targets on long term inflation. Table 4 provides the relevant elements and considerations behind the inflation shocks given above.

Short term impact (0–5 years)	Mid long-term (6- 15 years)	Long term impact (16+ years)
Inflation considerations: Divergent Net Zero (Transition risk)		
Suggested Impact on baseline expectation: From +10 bps to +5 bps over term period. **Clarification:** Stringent policies are needed to direct the economy to net-zero. This means less room for other monetary policy which is needed for price and output stabilization, resulting in poor consumer support and changes in consumer spending and preferences. Besides, as a rule for fiscal policy, the income tax is reduced, leading to a boost in private consumption.	**Suggested Impact on baseline expectation:** From +5 bps to 0 bps over term period. **Clarification:** For the medium term the correct identification of the shocks relevant for the inflation outlook will interfere with monetary policy.	**Suggested Impact on baseline expectation:** -1 bps over term period. **Clarification:** The NGFS has set a negative shock to business confidence in the Divergent Net Zero scenario on the long run due to uncertainties.
Inflation considerations: Current policies (Physical risk)		
Suggested Impact on baseline expectation: 0 bps **Clarification:** No additional rules regarding fiscal or monetary policy have been set and extreme physical impact is not yet expected.	**Suggested Impact on baseline expectation:** Volatility increases, which lead to more frequent temporary raises to inflation, smoothened in the medium term. Suggested Impact on baseline expectation: 0 bps **Clarification:** Physical impact of extreme weather events on inflation is expected to be of temporary nature due to subsequently offsetting behaviour. **NB**: *Identifying the correct shocks relevant for the medium-term inflation outlook is difficult due to the uncertainty around regulatory and consumer response.*	**Suggested Impact on baseline expectation:** 0 bps **Clarification:** Regulatory intervention and response of monetary policy is needed to account for the impacts on inflation and to maintain price stabilization.

Table 4: The main elements and considerations behind the inflation shocks over the short term, mid-long term and long term when considering the Divergent Net Zero and Current Policies scenarios.

Disclaimer – Uncertainty about the magnitude of the effects of climate change and the horizon over which they will play out in the economy.

Other suggestions

The ECB also did research on the sensitivity of inflation rates in different climate scenarios [ECB'21]. The ECB specifically investigates the chain effects of monetary policy and reflects this in the inflation numbers for each of the scenarios.

Since the NGFS's Phase III reflects monetary policy in the climate risk scenarios under consideration and is supported by a sensitivity analysis, we propose to employ the inflation projections as outlined above. However the ECB assumptions could also be considered. These represent a combination of different elements of the NGFS scenarios under a slightly different approach, where the chain effects from monetary policy tradeoffs obtain a more significant weight in the projections.

6.3.2 Interest rates

Another important macro-economic variable to take into account in the climate risk analysis is the long-term interest rate. The development of the long-term interest rate under the different scenarios based on the latest phase of the NGFS climate scenarios is as follows:

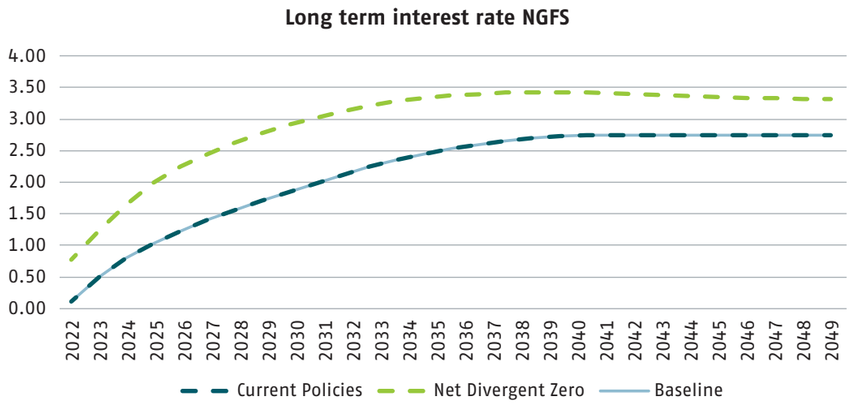


Figure 4: *Long term forward nominal interest rates as per the REMIND-MAgPIE model from NGFS version 3.4. The baseline is a fictional scenario. This is an economic expectation if there were no climate change at all with the result that there would be no climate risks. The other two scenarios show the difference in expectations relative to each other and the baseline.*

The long-term interest rate is shown to be 50-100bps higher in the disorderly net-zero transition scenario, whereas the current policy scenario coincides with the baseline scenario. This reflects the inflationary pressure which is created by carbon prices under the Divergent Net Zero scenario, but may also be caused by higher demand for investment for adaption and reconstruction purposes. An increase in productivity related to innovation may also exert upward pressure on the interest rate.

6.3.3 Equity indices and bond yields

Physical and transitional risks could impact the value of equity and bond investments. Physical impacts are due to damage of land, crops, buildings and infrastructure because of droughts, floods and storms. Transition impacts arise from the move to a low-carbon economy resulting in clean energy requirements and stranded assets. The impact due to transition risks is expected to materialize in the upcoming decades, during the transition period (up to 2050), while the impact due to physical risks is expected to materialize over a longer period. The market could (further) reprice these risks either smoothly or by shock, depending among other things on the regulatory response.

The NGFS published the following expectations for the return of equity for different countries. Based on the portfolio of the insurance company or pension fonds, the impact will be different.

Divergent Net Zero:

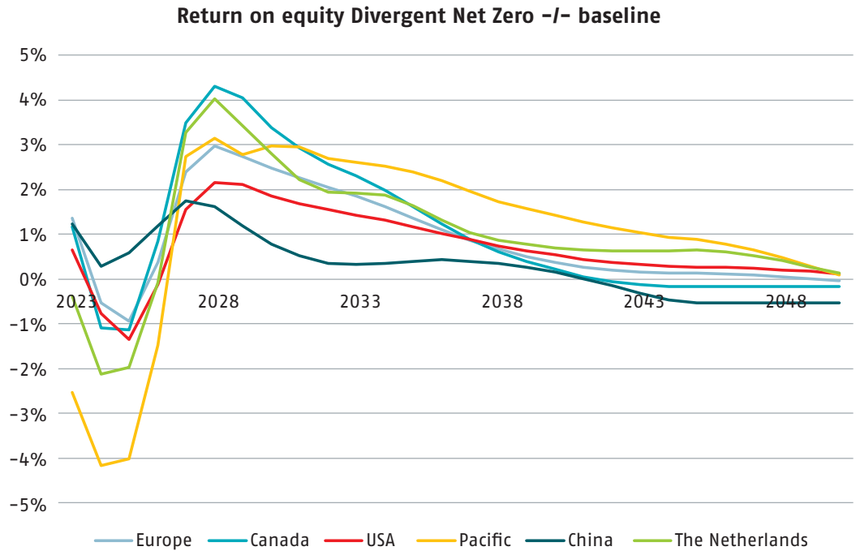


Figure 5: *The baseline is a fictional scenario. This is an economic expectation if there were no climate change at all with the result that there would be no climate risks. Since the baseline is different in every region, the expectation of the Divergent Net Zero scenario is subtracted by the baseline of the region respectively.*

Observing the graph above, we see a decline in the return on equity in the first few years. This can be explained by a decline in inflation, as inflation is slowly returning to the central bank's target after some extremely high years. In the Divergent Net Zero scenario, there is an immediate policy reaction and a fast change in technology. Carbon prices are implemented in the transition scenarios, which tend to raise energy costs. This initially weighs down on prices and leads to an increase in inflation. However, the NGFS research emphasizes a trade-off between inflation and GDP, arising from the carbon taxation. Besides this, it is assumed in the model that policy uncertainty leads to a higher investment premium. Lastly, the long-term interest rate tends to increase in the Delayed

Net Zero scenario, reflecting both the increased inflationary pressure and an increased demand for investment. We can see these effects last for some years, whereafter the equity returns gradually return to their baseline. Regional differences can be explained by variation in policy. Besides, regions which can decarbonise less easy are likely to be affected more than the other sectors [NGFS'22].

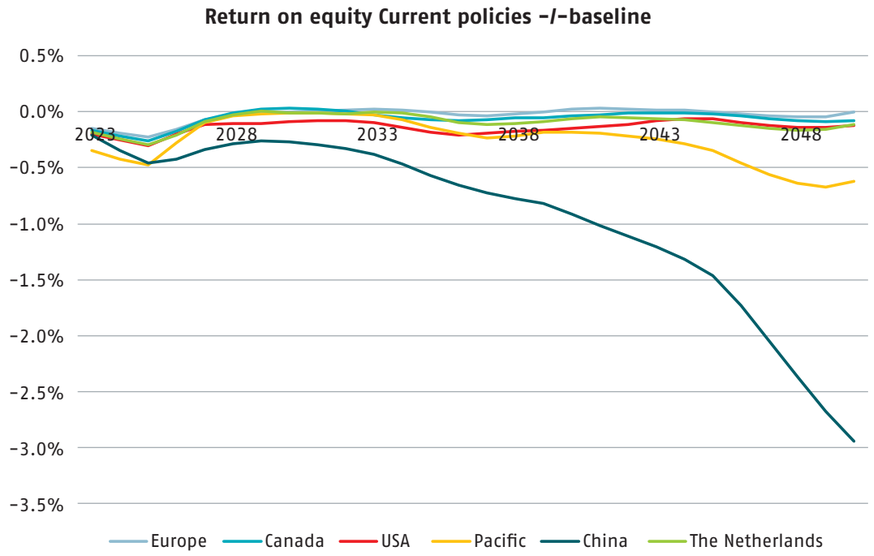


Figure 6: *The baseline is a fictional scenario. This is an economic expectation if there were no climate change at all with the result that there would be no climate risks. Since the baseline is different in every region, the expectation of the Current Policy scenario is subtracted by the baseline of the region respectively.*

In the Current Policies scenario, we observe negligible impact on equity returns for most regions (except for China[3]). On the one hand, this is because there is only a limited amount of transition risk in this specific scenario. Next to this, only productivity is modelled as a potential physical risk channel. More information and research is needed in order to model potential climate impact on other variables. The loss in GDP arising from physical risk varies in line with different temperatures and increases in later decades [NGFS'22].

Disclaimer
The data currently available is typically missing the granularity needed, which prevents an appropriate analysis of the impact of physical risk on different types of asset prices and thus different types of investment portfolios. When seeking to imply a higher level of granularity based on the characteristics of the asset classes within an investment portfolio, the DNB stress scenarios for transition risk provide shocks per NACE code. It can be argued that the double confidence shock scenario could also be used for Physical risk scenario analysis, giving the analysis more granularity in the investment section.

3 – According to WWF 2022, China is highly dependent of emission in their production chain and has a high exposure to drought risk. [WWF Index]

Other suggestions

Both EIOPA and DNB has published their view on investment risk associated with climate change.

DNB
In 2018 DNB published the impact on equities and bonds for four disruptive energy transition scenarios [DNB'18]. These scenarios are strictly transition risk scenarios and cover different angles in which shocks can prevail. From the four proposed scenarios, the "Double Shock" scenario is mostly in line with the NGFS Divergent Net Zero scenario. Although the NGFS has taken into account the outcomes of this research and it thus can be argued that the NGFS scenario has a more recent take on the scientific background and developments, the DNB analysis do provide a shock indicator per NACE code. This allows for more specific shock analysis on an investment portfolio level as it allows for shocks per asset class, rather than only on an equity level.

EIOPA
EIOPA developed the transition scenario for EIOPA's occupational pensions stress test (also with impacts per NACE code) in 2022 [EIOPA'22D]. It reflects a sudden, disorderly transition to climate neutrality due to delayed policy action, which results in a sharp rise in carbon prices. This abrupt carbon price increase triggers transition risk effects to the entire economy. Here also a stress on equity prices and bonds is taken into account.

The ECB as well put effort on climate risk scenarios. For example in [ECB'22] the ECB shared real-estate price projections disaggregated by energy performance certificates for the three long-term scenarios (orderly, disorderly and hot house world).

EIOPA published a discussion paper (December 2022) that covers the investment risk associated with climate change [EIOPA'22A]. Several questions are posed to stakeholders about modelling climate risk. A point of interest is that appropriate data needed for an appropriate risk-based analysis. However EIOPA does provide practical examples of how insurance companies can quantitatively assess the materiality of climate change risks on their investments in their application paper on running materiality assessments [EIOPA'22B]. The general approach followed in these examples is to analyse the exposure of the assets to different countries and locations, and assessing these exposures for each location relative to physical hazard maps (for property and corporate bonds) and a vulnerability index (for government bonds) to identify any exposures that could potentially be impacted by the physical impacts of climate change.

6.3.4 Different views

Several asset/investment managers have acknowledged the importance of incorporating climate risks into their return forecasts. However, these institutions do not always share the same views. Besides, different scenarios from the IPCC as well as the NGFS are combined with own assumptions and views, which complicates comparing the outcomes.

7

Step IV: Risk mitigation and strategic decision making

With the insights gained from the scenario analysis, the entity will naturally want to take action to mitigate or manage the risks and opportunities that have been identified. This constitutes a creative decision-making process, where – per vulnerability - options are explored and shortlisted. Examples of potential actions lay within the technological / innovation domain, to reconsider the own business service model or to reduce or offset any adversities in the scenarios. The scope of the business decisions is not only the own operations but the whole value chain, from business partners and investees to the consumers and their behaviour.

By quantifying the potential impact of the scenarios the entity can perform the usual decision making activities: prioritize actions, identify no-regret actions and to assess their business case. Furthermore the insights from the scenario analysis may warrant to establish a more holistic decision framework. Historic decisions will most likely have been made on a gut feeling or after a cost-benefit analysis containing a certain set of performance indicators to be weighed off each other. This set of indicators may be extended, since the long-term scenario facilitates the longer view where indicators will see a change in their relative importance. As an example, the decision to launch a new product will certainly depend on its short-term profitability, but as a result of the scenario analysis the long-term feasibility of the product can be assessed as well. In the investment management domain, *stranded assets* are another example, where we would expect that the scenario analysis will inform an extension of indicators to be considered in the investment decision framework.

Since the impacts are across the value chain and given the possible actions and the long-term, strategic nature of the analysis, multiple disciplines will typically be involved, with final decisions made at board level. Actuaries and risk managers are conversation partners in the decision-making process, due to their grasp on the limitations and uncertainties involved in long-term scenario analysis.

Related to this, when a decision is to be based on the outcome of the scenario, it is expected that in some cases the conclusion is that the level of uncertainty is still quite large. The wish for a further reduction of uncertainty plants the seed to refine the scenario analysis, in terms of modelling, and in terms of data availability. By understanding what data is missing to be able to make well-informed decisions, this data need can be incorporated into the data management architecture. Not all data will be available, but the granularity of (historic) data can often be improved once it is clear which decisions such data availability supports.

8

Step V: Disclosure and communication

For insurers and pension funds, notable ESG reporting requirements are presented through the [NFRD], [SFDR] and [CSRD]. Further insights into these requirements are the topic of a separate paper from the Sustainability committee of the Actuarial Association [AG'23]. These reporting requirements can help the entity in structuring its climate (and ESG) approach.

In this section we will focus on internal reporting requirements of the climate scenario analysis process, the outcomes and communication thereof, and the associated strategic decisions. The primary focus will be on internal reporting (Section 8.1), with specific attention to the ORSA and ERB (Section 8.2) and actuarial function report (Section 8.3). We briefly consider external disclosures (Section 8.4).

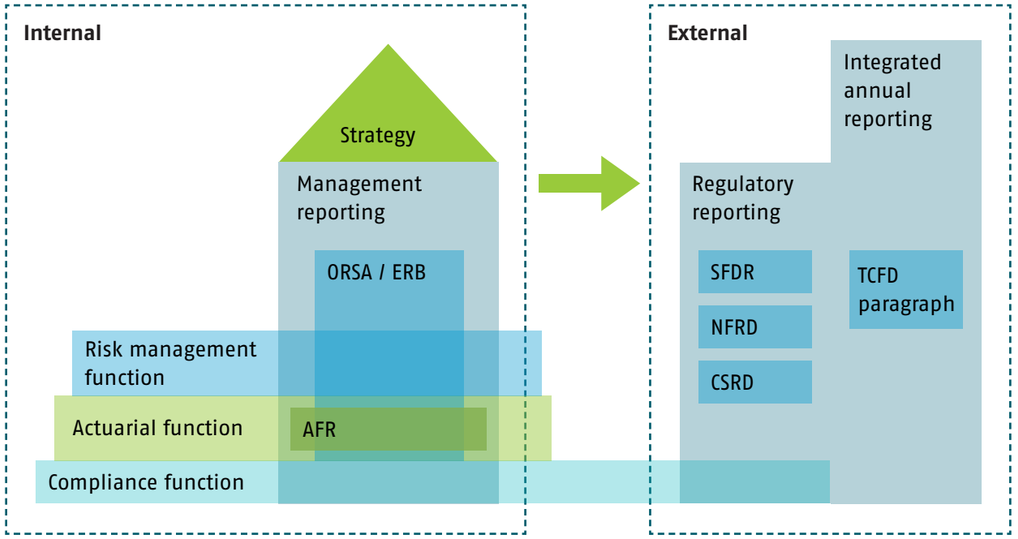


Figure 7: *Many functions support management reporting, which itself supports the entity's strategic course. Internal reporting includes the ORSA or ERB, and the actuarial function report (AFR) that is partially supporting the scenario analysis. External reporting is fed with this information. To a large extent this is compliance-driven mandatory reporting, with the exception of a TCFD paragraph within the annual report.*

8.1 Internal reporting

To inform all relevant (internal) stakeholders, the whole process of scenario analysis, from set-up to its outcomes and consequences on risk mitigation and strategy, is subject to internal reporting. To be able to steer the entity, reporting requirements should be defined. These can be different for different purposes. Relevant examples of externally suggested requirements are detailed in [EIOPA'22B], [BMA'23], [DNB'19], [DNB'23]. The BMA covers areas such as corporate governance, roles & responsibilities, risk management and materiality & scenario analysis [BMA'23]. DNB provides guidance on their expectations regarding business model & strategy, governance, risk management and disclosures [DNB'23].

What these requirements illustrate is that for internal reporting purposes, entities can simply follow the structure as defined by the building blocks introduced in Section 3.1: Organization, Scenario development, Exposure analysis, Impact assessment, Risk mitigation and strategic decision making. For each of the different steps, explicitly stating the structure chosen or choices made, formalises roles and responsibilities and establishes a possibility for an entity-wide sign-off of the outcomes of the analysis.

8.2 The Risk Management Function, ORSA and ERB

As part of the risk management system, insurers and pension funds already prepare a report on scenario analysis: for insurers this is the ORSA [SolvencyII], for pension funds this is the ERB ("eigenrisicobeoordeling", i.e. "own risk assessment") [DNB'19]. These reports are an internal document that is only shared with the regulator as part of their prudential supervisory responsibility. The review of the ORSA and ERB is the responsibility of the risk management function. The Actuarial Function supports the risk management system and, thus, the creation of the ORSA and ERB.

Long-term scenarios find their natural place in these existing internal reports, although consideration is to be given that the minimum requirements from the previous section may be more extensive than the usual content of the ORSA and ERB. Thus by properly reporting on the long-term scenarios in the ORSA and ERB, the scope of these reports becomes more extended.

Moreover, and more importantly, the timeline under consideration in the ORSA and ERB is usually shorter than the long-term horizon of climate-risk scenarios. While this means the scope of the ORSA and ERB becomes more complex, incorporating long-term scenarios directly in these reports has the benefit that long-term strategic analyses can be integrated with the shorter-term business planning. As a result, alignment of the business planning with the long-term strategy is automatically monitored and enforced by the report's structure.

8.3 The Actuarial Function Report

Some of the ingredients listed in the previous sections are technical in nature and are expected to be created with involvement from the Actuarial Function within the insurer or pension fund. As such, the Actuarial Function Report is expected to be updated to specifically reference climate risk and long-term scenario analysis. The Actuarial Function Report is one of many management reports being written in the entity, but would be a prime document to consider some of the more technical aspects mentioned in Section 8.1.

Considering the requirements and guidelines as set out by [AG'17] and referencing sections within those guidelines, we would expect the Actuarial Function Report to at least be updated as part of the assessment of data, models and assumptions (3.2.7.1–3.2.7.4) and on the sensitivity analysis (3.2.9.1). The latter is not necessarily focusing on the sensitivity of the technical provisions only but of the business model and risk analysis as a whole, as part of the opinion on risk management and particularly the contribution to the ORSA (3.5.2).

Furthermore, an update is expected to appropriately embed climate risk in the Actuarial Function Report as part of the opinion on the underwriting policy (3.3.1.1–3.3.1.4 and 3.3.3.1, 3.3.4.1) and reinsurance arrangements (3.4.1.1–3.4.1.3). This should focus on sustainability of the underwriting policy, including considerations and an opinion on (future) availability, changes in pricing and effectiveness (3.4.3.1).

8.4 External disclosures

Typically, external disclosures will follow the same lines of internal reporting, albeit less granular and less extensive. For example, long-term scenarios are to be included in the TCFD paragraph in the annual report, which is a summary of the ORSA or ERB report. We would expect insurers and pension funds to incorporate the same elements in their public, integrated reporting as listed in Section 8.1, but are conscious of necessary political and/or commercial considerations to not fully disclose.

However, with emerging pressure to disclose scenario analysis outcomes, metrics and targets [TCFD'17], [DNB'23], [EIOPA'22B], [CSRD] it is expected that an increasing number of entities are including insights on these to the wider public. We would welcome that the reporting standard will be to support this, e.g. by disclosing underlying assumptions and data when disclosing outcomes and metrics. For comparability between entities, and for the external stakeholders to be able to interpret the outcomes, such underlying information is vital. Therefore, sufficient detail is proposed to be included in disclosures on scenario analysis outcomes, including a list of assumptions, their values and a list of data, including sources.

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