Discussion paper on **Conducting advanced scenario analysis**

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For market consultation and feedback

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Taskforce on Nature-related Financial Disclosures

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This discussion paper is primarily intended for experienced users of scenarios who are interested in advanced nature scenario methods, mainly in financial institutions and large multinational corporates. All organisations looking to apply nature scenarios to inform their strategy, risk management and disclosures in line with the TNFD recommendations should refer to the TNFD guidance on scenario analysis. The TNFD's scenario analysis guidance will be updated by the TNFD over time as advanced methods for nature scenarios evolve and informed by feedback on this discussion paper.

1. Introduction and overview

As outlined in the TNFD guidance on scenario analysis, scenarios are a useful tool for organisations to explore the potential implications of uncertainties, assess risks, set targets and transition plans, and develop – and test the resilience of – their strategies. Nature scenarios, like climate scenarios, can incorporate changes in the physical environment and changes in policy or consumer behaviour to avoid and reduce negative impacts on nature and/or conserve or restore nature. They support a range of business decisions, including strategic planning, risk assessment and target setting.

Disclosure of analyses using climate scenarios, following the Task Force on Climate-related Financial Disclosures (TCFD) recommendations, has increased nearly three-fold over the past three years.[1] This has been supported by public scenarios developed by the Network for Greening the Financial System (NGFS), the International Energy Agency (IEA) and the Inevitable Policy Response (IPR), as well as many internal assessments.

Organisations using the TNFD's recommendations and guidance can now draw on a range of scenario tools, including the TNFD guidance on scenario analysis and accompanying scenario toolbox. Publicly available scenarios and data, although still limited in number and coverage, are now emerging, such as the IPR Forecast Policy Scenario + Nature (FPS + Nature).[2]

The NGFS is working on providing central banks and supervisors with recommendations on how to develop nature scenarios for assessing nature-related economic and financial risks. This work of the NGFS will be critical to the development of new, integrated nature-climate scenarios that support advanced analysis in the medium term. The TNFD has been coordinating its efforts on nature scenarios with the NGFS for the past two years, working towards an approach that conceptually connects the macro-prudential level scenarios being advanced by the NGFS with the institution-level scenarios recommended by the TNFD. The Taskforce hopes that this discussion paper will stimulate further feedback from, and learning by, market participants that can inform the NGFS in this important area of its work.

1 TCFD 2022 Status Report. The increase was from 6% in 2019 to 16% in 2021, based on an AI review of nearly 1,500 companies' publicly available disclosures. The TCFD's survey of 149 asset managers also showed that 51% conduct scenario analysis. This statistic is 74% for the 76 asset owners surveyed.

2 Available at: https://www.unpri.org/inevitable-policy-response/iprforecast-policy-scenario--nature/10966.article

User feedback on early beta versions of the TNFD guidance highlighted remaining issues on nature scenario analysis, including:

- Incorporation of a large and diverse set of nature-related variables into a nature scenario exercise; and
- Ways to accommodate advanced analytics or modelling, building on market experience using climate scenarios.

This discussion paper explores the open questions around these key issues (listed in Box 2) by outlining the advanced tools and approaches to nature scenario analysis that both financial institutions and corporates can already use, drawing on the experience of climate scenarios.

1.1. Objectives and outline

As outlined in the Recommendations of the TNFD, and further highlighted in the TNFD's LEAP approach, scenario analysis has a valuable role to play in supporting the assessment of nature-related issues. Specifically, it can support reporting of TNFD recommended disclosure Strategy C, which asks organisations to describe the resilience of the organisation's strategy to nature-related risks and opportunities. The TNFD has provided foundational guidance on scenario analysis. For many organisations looking to use scenarios to inform their assessments and disclosures, this foundational guidance will likely be sufficient.

This discussion paper outlines approaches to more advanced scenario analysis that can be used across a range of scenario types and use cases. The target audience for this discussion paper – and possible future TNFD additional guidance informed by feedback on this paper – is financial institutions and corporates that want or need to undertake advanced approaches to scenario analysis. This may include those taking action in anticipation of regulatory stress testing, as has occurred with climate-related risk assessment.

In summary, this discussion paper provides:

- An overview of four different scenario approaches, ranging from qualitative risk assessments examining future exposure to a single risk, through to quantitative assessments that span many different risks.
- Practical guidance on how to:
  - Implement each approach, following three stages (developing a narrative, conducting specification and producing outputs);
  - Use the scenario's outputs in different contexts, including risk analysis outputs, and meet different decision needs, based on use cases. The use cases are drawn from a range of sectors (including both corporates and financial institutions) and nature-related risks. They show practical examples of how an advanced approach can be applied and how a scenario's outputs can be used to inform a variety of qualitative and quantitative risk assessment types;
  - Explore alignment with the Kunming-Montreal Global Biodiversity Framework (GBF); and
  - Integrate climate and nature-related risks in integrated climate-nature scenarios.
- Examples of scenario development and application, using the development process of the FPS + Nature scenario as an illustration. FPS + Nature, a publicly available scenario, has been expanded for the purpose of this discussion paper to demonstrate how climate scenarios can cover a range of nature-related physical and transition risks.

This discussion paper does not attempt to reflect or establish a 'best practice' approach to advanced scenario development. It focuses on providing practical guidance on approaches that financial institutions and corporates can already apply, leveraging tools and approaches that are publicly available. In doing so, the TNFD aims to outline the issues surrounding these existing approaches and to provide illustrative examples, acting as a useful reference for organisations while standard approaches to integrated climate-nature scenarios are explored and developed by the NGFS and others.

References to the FPS + Nature scenario are provided throughout this discussion paper in boxes to offer a tangible example of the application of these steps through a publicly available nature-related scenario. FPS + Nature is presented as an illustration and is not the recommended or only approach aligned with the TNFD's recommendations.

The TNFD's objectives for this discussion paper are to:

- Elicit feedback from market participants and other interested stakeholders to inform potential further TNFD scenario guidance in the future; and
- Support market participants by outlining practical steps for building more advanced nature-related scenarios.

1.2. Open for consultation

As part of its ongoing open innovation approach, the TNFD welcomes feedback from market participants and other stakeholders on the proposed guidance on advanced approaches to scenarios outlined in this discussion paper. The Taskforce will update its scenario analysis guidance with further information on advanced approaches, based on the feedback received on this paper and progress by TNFD knowledge partners, including the NGFS.

Comments can be provided to the Taskforce through its website until 29 March 2024 at: https://tnfd.global/publication/guidance-on-scenario-analysis/#publication-content.

Feedback questions to market participants on the proposed advanced approaches to scenario analysis

- Do the overview and examples on advanced scenario approaches outlined in this discussion paper provide useful insights for report preparers?
- Will analyses using these advanced scenario approaches elicit decision-useful information for report preparers?
- Is the illustrative approach to advanced scenario analysis practical and proportionate, reflecting the capacity and cost constraints of report preparers?
- Are there any remaining critical questions, gaps and challenges with advanced nature scenarios not addressed in this paper that the Taskforce should prioritise for guidance? What are they?
- What are the aspects of this discussion paper that you think are key for the Taskforce to prioritise in future guidance on scenarios? Do you have any practical suggestions on how these could be outlined for report preparers?

2. The need for advanced application of nature scenarios

2.1. The role of nature scenarios in identifying, assessing, managing and disclosing nature-related issues

Scenarios can be useful for organisations seeking to identify, assess, manage and disclose nature-related dependencies, impacts, risks and opportunities using the TNFD framework, by supporting:

- **Portfolio risk assessment:** Identify risks, test the resilience of the organisation's existing strategy, and determine appropriate risk mitigation options;
- **Strategic planning:** Inform a range of strategic planning decisions, such as allocating investment and deciding on a new production location; and
- **Target setting:** Inform organisation-level targets and determine how an organisation needs to evolve over time to reach a given target. This can also inform the setting of internal prices, such as for carbon or water, which can be used by an organisation to reach a defined target. In this case, a scenario could be used that focuses on nature recovery aligned with global goals, such as those in the Kunming-Montreal GBF.

In alignment with NGFS and the Intergovernmental Panel on Climate Change (IPCC), the TNFD considers risks as the combination of three elements: hazard, exposure and vulnerability, with the following definitions:[3]

- **Hazard:** The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision and environmental resources.
- **Exposure:** The presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected.
- **Vulnerability:** The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

The concepts above are also applicable in the context of climate-related scenarios. When introducing a nature lens, the notion of limited *substitutability* is also often introduced to explain that nature, and the ecosystem services it provides, are not easily substitutable with produced capital and/or labour. *Interconnectedness* among ecosystems, and complementarities among ecosystem services, should also be considered.[4] These concepts are often used

3 Intergovernmental Panel on Climate Change (2022) Annex II: Glossary in: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, NGFS (forthcoming) Recommendations toward the development of scenarios for assessing nature-related economic and financial risks

4 Dasgupta, P (2021) The Economics of Biodiversity: The Dasgupta Review

to show how nature-related hazards are likely to propagate through value chains in ways that are not accounted for today in most climate scenarios and models.[5] These risk-specific elements are often assessed in conjunction with the location-specificity of nature-related dependencies, impacts, risks and opportunities, although it should be noted that climate-related physical risks are also highly influenced by location-specific characteristics.

> Existing climate scenarios do not capture the full set of drivers of nature change identified by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which means they do not account for the true economic and financial risks from nature loss and climate change.

Nature scenarios are required to understand distinct nature-related risks, drivers of nature loss and the transition to achieve nature-positive outcomes, including policy actions. Existing climate scenarios do not capture the full set of drivers of nature change identified by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[6], which means they do not account for the true economic and financial risks from nature loss and climate change.[7] For instance, understanding changes in pollinator populations requires scenarios that examine how drivers, including land-use change or pesticides (pollution), impact natural pollinators. These drivers are not included in most existing climate scenario assessments.

2.2. Building on the TNFD's existing guidance

This discussion paper builds on the TNFD guidance on scenario analysis, which sets out building blocks for nature scenarios and how they can be used by organisations to understand risks and test strategies under conditions of uncertainty, challenging thinking about what the future might be like and how an organisation might respond under circumstances different from those it faces today. The TNFD's existing guidance focuses mostly on a participatory workshop-style scenario approach for use by corporates, which is primarily qualitative but can be complemented with targeted quantitative analysis. For many organisations, when approached in detail and with significant time commitment, this approach will be sufficient to usefully inform their strategy, risk management and capital allocation decisions and support their TNFD-aligned disclosures (specifically the TNFD Strategy C recommended disclosure).

While all organisations looking to apply nature scenarios to inform their strategy, risk management and disclosures in line with the TNFD recommendations should refer to the TNFD guidance on scenario analysis, this discussion paper is primarily intended for experienced users of scenarios who are interested in advanced nature scenario methods, mainly those in financial institutions and large multinational corporates. The TNFD's scenario analysis guidance will be updated over time as advanced methods for nature scenarios evolve and will be informed by feedback on this discussion paper.

5 NGFS (2023) Nature-related Financial Risks: a Conceptual Framework to guide Action by Central Banks and Supervisors, NGFS (forthcoming) Recommendations toward the development of scenarios for assessing nature-related economic and financial risks

6 IPBES identified five drivers of nature change: changing use of sea and land, direct exploitation, pollution, invasive alien species, and climate change.

7 See also NGFS-INSPIRE (2022) Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability, NGFS Occasional Paper

The TNFD's existing guidance outlines four steps for scenario analysis using the TNFD's 2x2 critical uncertainties matrix (see Box 1).

Box 1: The critical uncertainties matrix in the TNFD scenario guidance

Organisations can use scenario analysis to break out of static, business-as-usual ways of thinking about the future and consider critical uncertainties that may create risks and opportunities over the medium to long term.

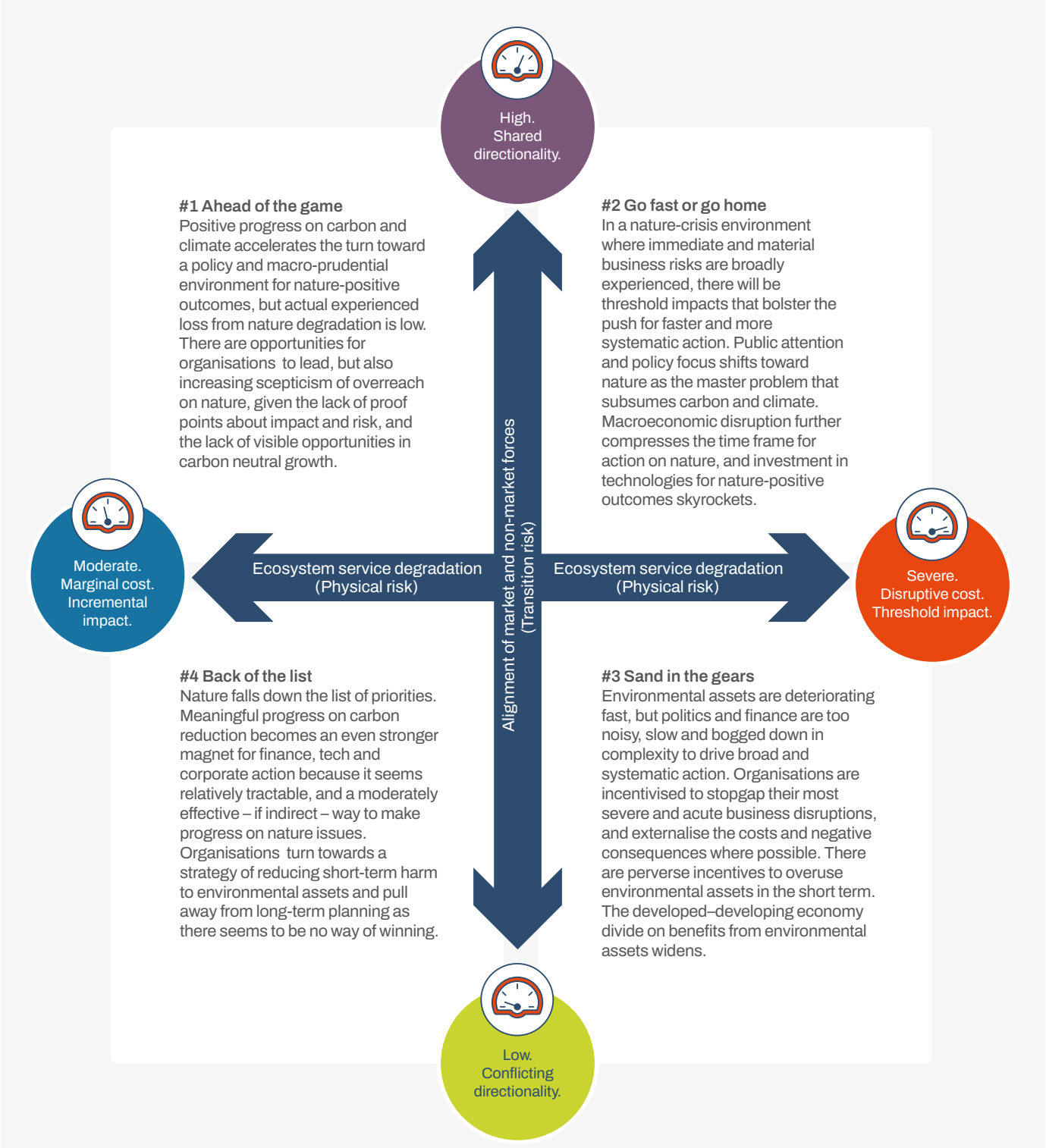
While users of scenarios can create a scenario analysis frame using any of the driving forces provided in the TNFD guidance, the TNFD guidance on scenario analysis proposes constructing scenario analysis as a default around two critical uncertainties – ecosystem service degradation (most closely correlated with physical risk) and alignment of market and non-market forces (most closely correlated with transition risk) – using the TNFD's 2x2 critical uncertainties matrix. The matrix includes four distinct and plausible scenarios for consideration and enables organisations to:

- Narrow down driving forces into two critical uncertainties, based on their potential to change the organisation's business environment (e.g. by affecting the provision of water or increasing the stringency of nature policy); and
- Frame critical uncertainties in a structured way along a continuum of outcomes, from moderate to severe or from low to high, for example.

In the TNFD guidance, the four scenario narratives derived from the matrix describe a broad range of plausible futures. These qualitative narratives are summarised in and can:

- Be tailored to the organisation's context to give flexibility and increase their relevance and usefulness;
- Enable qualitative assessment of a single organisation/facility/biome's potential risks;
- Prompt organisations to break out of static, business-as-usual ways of thinking about the future; and
- Be used, along with their components and outcomes (including scenario drivers, constraints, assumptions, and the logic identified and discussed within the organisation), as inputs to organisations' in-house models to quantify the effect of scenarios on costs and operations.

Figure 1: The TNFD 2x2 critical uncertainties matrix in the TNFD guidance on scenario analysis



Source: TNFD guidance on scenario analysis

2.3. The need for more advanced tools or approaches

The TNFD recognises that some organisations with operations and portfolios spanning many geographies, biomes and sectors of the economy (such as financial institutions and large multinational corporates) may need to use more advanced tools or approaches for scenario analysis. Some financial institutions may consider these in anticipation of nature-risk stress testing by regulatory authorities, as it has been seen in recent years for climate risk assessment.

The areas that potentially require advanced assessment include:

- Incorporating **multiple critical uncertainties, driving forces and their interactions**, moving beyond a framing of two critical uncertainties. Ideally, these would incorporate both climate and nature considerations to conduct an integrated nature and climate assessment.
- Considering risks and opportunities along **multiple time horizons**. This could focus on 2030 and 2050 as critical years in the context of the GBF goals and targets, but could also include intermediate years to illustrate how the speed of changes could affect exposure to risks.
- Considering risks and opportunities across **multiple geographies** and across **different sectors**.
- Moving towards **quantitative scenario outcomes and modelling approaches** to determine the potential financial implications of nature-related risks. Models can also be used to study the development of complex systems through time, such as how land use may be affected by agricultural policy changes, how quickly invasive pests could spread across tree species, or how water availability could be affected by urban development.[8]

The TNFD's 2×2 scenarios matrix and accompanying tools and guidance are for organisations starting their journey or refining their technique on scenario analysis and use qualitative scenario narratives to identify risks and opportunities and inform strategic thinking. The TNFD approach to scenario analysis was also built to allow organisations that are already experienced with scenarios but want to layer targeted quantification to the qualitative storylines, to apply those more advanced analytics and modelling techniques to further assess nature-related dependencies, impacts, risks and opportunities.

While this discussion paper provides possible methods to reach this level of advanced assessment, the TNFD guidance, in line with the TCFD's approach, also urges organisations to avoid rushing to quantification before nature-related dependencies, impacts, risks and opportunities are identified and understood qualitatively.[9]

8 As discussed in Section 3, the modelling approaches analysed in this paper allow for the specification of the driving forces identified in the narratives (for example, translating in impacts on GDP or on specific resources, such as forests and water), and for translating those scenario variables into estimates of financial impacts on corporates and financial institution portfolios. See also Box 9 and Box 10 for examples of modelling approaches analysed in this paper.

9 See Task Force on Climate-related Financial Disclosures (2020) Guidance on Scenario Analysis for Non-Financial Companies

Box 2 presents the feedback reported to the TNFD by a wide range of market participants on scenario analysis, which this discussion paper aims to address.

Box 2: Feedback to TNFD on advanced approaches to nature scenarios

Feedback from market participants to the TNFD, based on pilot testing and user consultation, has indicated there is a need and demand for additional guidance on the advanced application of scenarios. Market participants have requested guidance that relates to the following challenges and questions:

Incorporating multiple critical uncertainties, driving forces and their interactions:

- How to incorporate a large and diverse set of nature-related variables into a nature scenario exercise?
- How should a scenario incorporate the interactions between different driving forces that could create risks (e.g. policy, technology development and consumer preferences)?
- Which physical and transition risks should be incorporated?
- What does a GBF-aligned scenario look like?
- What is the relationship between nature scenarios and climate scenarios and how can this be incorporated into an integrated climate-nature scenario?

Moving beyond an assessment focused on a single organisation/facility/biome:

- How to account for multiple countries and regions in an organisation's operations and value chain?
- How to account for multiple sectors in an organisation's portfolio of activities?

Incorporating modelling and advanced quantitative approaches:

- How can the TNFD 2x2 critical uncertainties matrix be used to inform quantitative analysis, including estimating the financial consequences of nature-related risks to assess financial materiality?
- How can a nature scenario be modelled?
- Which quantitative variables should be incorporated in a scenario?
- What is the right spatial scale and level of geographic granularity?

3. Towards an advanced approach to scenario analysis

When using any approach to scenario analysis, organisations should be aware of the limitations of any forward-looking analysis. A scenario – basic or advanced – is a simplified representation of a plausible future. It may omit outputs that are difficult to gauge, qualitatively or quantitatively, sometimes due to lack of data, modelling capabilities or scientific understanding. A scenario is not a prediction or forecast of the future. An awareness of the limitations of any scenario is important to apply scenario analysis effectively and use its insights to inform business-relevant decisions. These issues are explored in Section 4.

A scenario is not a prediction of the future.

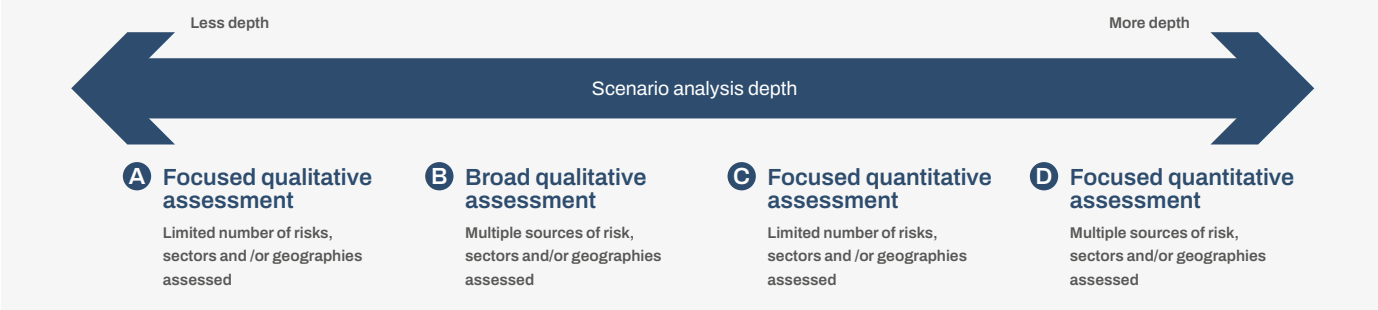
A clear understanding of how scenarios can be used and the practical approach to developing them is important. Section 3.1 discusses the purpose of scenarios and presents four widely applicable scenario-based assessment types. Section 3.2 outlines choices in scenario selection and development to help ensure that scenarios meet an organisation's desired use case. It should be noted that the following sections are not only relevant for those organisations seeking to implement a more advanced assessment, but they provide an overview relevant to all types of nature scenario analysis and outline the choices organisations can make based on their decision needs and internal capabilities. This content is not yet included in the TNFD's existing guidance on scenario analysis.

3.1. Defining a scenario use case

Defining the reason why a scenario is used and the decisions it will support is crucial before conducting any scenario analysis exercise.

Scenario analysis can be applied across a spectrum of qualitative and quantitative assessments. Figure 2: Spectrum of scenario assessment types – qualitative to quantitative assessments outlines how these assessment types can be defined by scenario analysis depth and scope. These range from qualitative assessments, incorporating a limited number of factors, to those with multiple sources of risk, sectors and/or geographies, and approaches that incorporate quantitative elements into scenario analysis. Each assessment type is described in turn in the sub-sections below. Section 5 contains worked examples of the illustrative use cases introduced below for each of the risk assessment archetypes.

Figure 2: Spectrum of scenario assessment types – qualitative to quantitative assessments



A. Focused qualitative assessment

Qualitative scenario analysis can drive initial exploratory discussions about risks, high-level business decisions and potential materiality. A focused qualitative assessment can identify and explore the implications of nature-related risks. It can use qualitative scenario narratives and focus on a single sector, biome or geography for assessment. The four possible scenario narratives outlined in the TNFD guidance on scenario analysis can be applied in this type of use case, as illustrated by the four scenario pilots in this guidance. These examples involve the application of qualitative scenarios to individual organisations, geographies and/or facilities.

B. Broad qualitative assessment

Qualitative risk assessment can also incorporate multiple sectors and/or geographies. A broader application of a qualitative scenario approach was adopted by the World Bank, which explored potential nature-related risks to the financial system in Malaysia. It examined 21 physical and seven transition risk drivers, including severe flooding and the introduction of policy to restrict water pollution. Each scenario explores one risk driver and is applied across multiple sectors to conduct a qualitative exposure-based risk assessment.[10]

The TNFD guidance on scenario analysis is a useful starting point for building qualitative risk assessments, which can be expanded and tailored to incorporate multiple risks, sectors and/or geographies.

C. Focused quantitative assessment

Quantitative scenario approaches and outputs can focus on a single sector and/or geography and/or value chain. This may have been identified as a priority through a qualitative assessment. For example, several reports by the Cambridge Institute for Sustainability Leadership (CISL) focus on quantifying the financial implications of nature-related risks for a single sector and geography using a scenario approach.[11] One CISL study examines the impact of land degradation under different scenarios, quantifying the potential impact on crop yields, costs and profits for farmers in the UK.[12]

10 World Bank and Bank Negara Malaysia (2022) An Exploration of Nature-Related Financial Risks in Malaysia

11 See https://www.cisl.cam.ac.uk/centres/centre-for-sustainable-finance/nature-related-financial-risks

12 University of Cambridge Institute for Sustainability Leadership and NatWest Group (2022) Nature-related financial risk: use case. Land degradation, UK farmers and indicative financial risk

Models can capture the effects of complex relationships and interrelated factors. They can also be used to test the sensitivity of the scenario to uncertainties by changing the model's input assumptions. For example, the World Resources Institute (WRI)'s Aqueduct model changes the demand and supply of water under three different scenarios.[13]

Modelling is not essential to build a robust quantitative scenario. Another approach is to develop scenarios based on a literature review or simple quantitative assumptions about possible impacts. This avoids the technical skills required for modelling but may not be suitable for capturing complex impacts. For example, in the CISL report referenced above, research is used to quantify a scenario output of 21% loss of yield across degrading land, following extreme weather.[14]

D. Broad quantitative assessment

Scenario analysis can also be used to assess nature-related risks quantitively across multiple sectors and geographies. Scenarios deployed in this use case can examine several driving forces at the same time, allowing organisations to assess the relative impact of different risks and explore their interactions. As highlighted in the TNFD guidance on scenario analysis, these scenarios are likely to be of most relevance to financial institutions and multinational corporations with portfolios or operations across many sectors and geographies. For example, five different nature and climate scenarios were used to understand the implications of changing nature-related policies, technologies and states of nature on the physical and transition risks to equity portfolios and loan books in the African financial sector.[15] Another example explored how nature and climate transition policies could affect the value of 40 of the largest food and agriculture companies across the globe.[16]

The use of models to assess the effect of multiple drivers of risk on scenario outcomes becomes valuable as scenario use cases become more multi-dimensional. A model can be used to explore the interaction between multiple drivers of risk in a consistent way. It can also help to define the implications of the scenario on business-relevant variables for multiple geographies and time horizons, allowing for the comparison of scenario outcomes across space and time. This use case is similar to the scenario-based risk assessment method described in Annex 4 of the TNFD guidance on the LEAP approach. Use of models typically requires some level of technical skill and the quality of the output depends on the quality of the assumptions.

3.2. Selecting an approach to developing a scenario

A report preparer that chooses to use scenario analysis will need to select or develop a scenario that matches the organisation's use case.

This section presents a set of key design questions that can help organisations decide on the characteristics they need from a scenario. Each set of questions is structured around the three stages that are involved in constructing

13 World Resources Institute (2015) Aqueduct Water Stress Projections: Decadal Projections of Water Supply and Demand Using CMIP5 GCMs

14 University of Cambridge Institute for Sustainability Leadership and NatWest Group (2022) Nature-related financial risk: use case. Land degradation, UK farmers and indicative financial risk

15 FSD Africa and McKinsey (2022) Nature and financial institutions in Africa: A first assessment of opportunities and risks

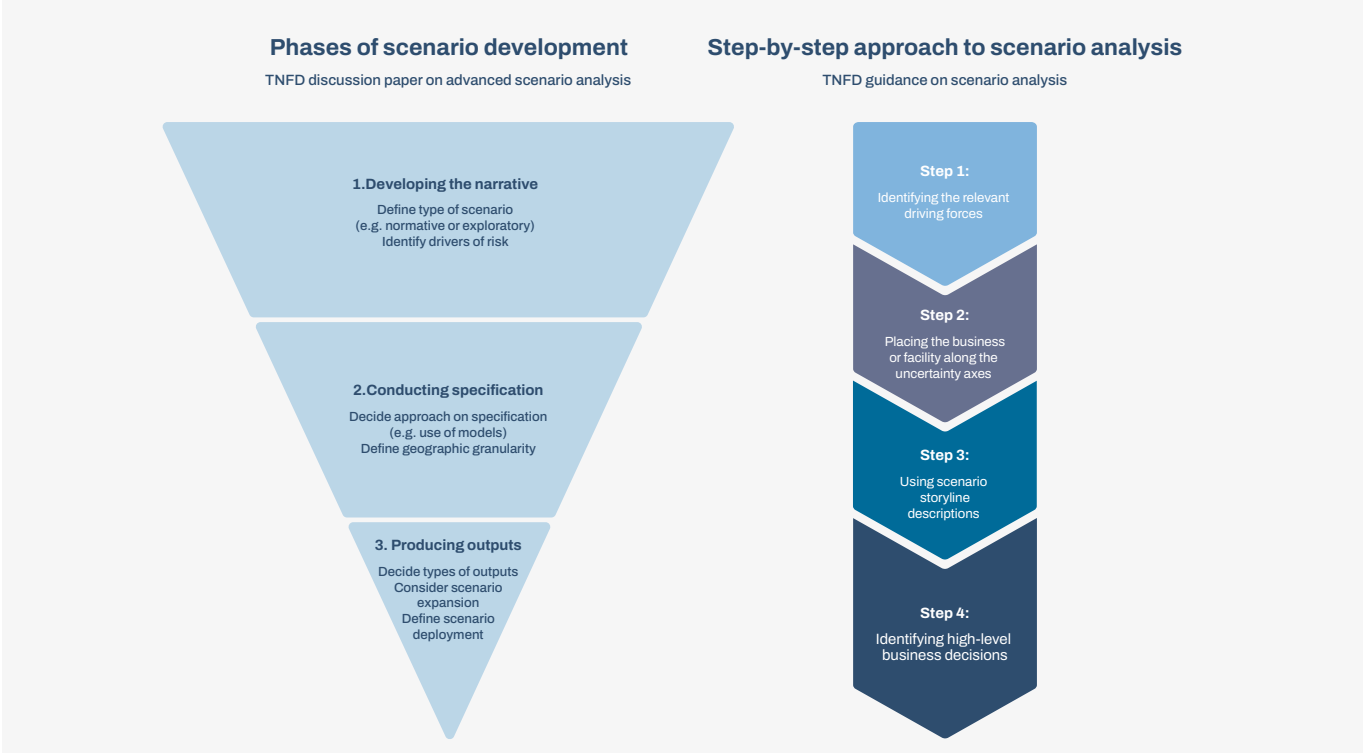
16 Race to Zero (2022) Assessing the financial impact of the land use transition on the food and agriculture sector

a scenario – developing a narrative, conducting specification and producing outputs, depicted in Figure 3: Scenario development involves three phases.

It should be noted that the three phases presented in this section are closely related to the steps provided in Section 2 of the TNFD guidance on scenario analysis. The TNFD guidance mainly focuses on how to approach scenario analysis, rather than presenting the different methods available for scenario development. In particular, the first three steps of the TNFD approach (identifying the relevant driving forces, placing the business or facility along the uncertainty axes and using scenario storyline descriptions) are most closely linked to narrative development and specification (phases 1 and 2 of scenario development depicted in Figure 3: Scenario development involves three phases).

Scenario narratives and specifications are also the main output of the two break-out session facilitation worksheets presented in the TNFD scenario toolbox. Step 4 (identifying high-level business decisions) is most closely related to phase 3, where organisations make use of the narratives and specifications developed to surface insights on the effects of the scenario on its business model and strategic decisions.

Figure 3: Scenario development involves three phases, which can be mapped to the TNFD steps to conducting scenario analysis



Organisations can evaluate a set of core design decisions when developing a nature scenario, as summarised in Table 1.[17]

17 Some questions may be relevant to more than one scenario component. Table 1 maps each question to the scenario component where it could be most applicable.

Table 1: Nature scenario characteristics

Scenario component	Theme	Scenario characteristic
Narrative	Type of scenario	Does the scenario describe what could happen or what should happen? • Is the scenario normative or exploratory? • How is the scenario aligned with the Kunming-Montreal GBF ?
	Drivers of risk	What creates risk in the scenario? • Which drivers of risk does the scenario incorporate? Are there multiple sources of risk? Are they relevant to the organisation? • How does the scenario reflect changes in the state of nature? How are the IPBES drivers of nature change accounted for? • How does the scenario incorporate climate-related drivers of risk, if at all? • Are low-probability events incorporated in the narrative? Are tipping points, tail events or systemic risks accounted for?
Specification	Approach to specification	Is the scenario going to produce qualitative and/or quantitative outputs? • Which tools are used to create the scenario? (e.g. models, assumptions) How does the scenario treat different risks? • How are physical risks incorporated? Do the scenario's physical risks overlap with climate? • How are transition risks incorporated? Do the scenario's transition risks overlap with climate? • How are low-probability events treated? • How does the scenario account for opportunities? Which assumptions are used to link narratives to outputs? How are these formulated?
	Geographic granularity	Which locations is the scenario relevant for? What is the geographic granularity of the scenario? (e.g. global, country, local)
Outputs	Type of outputs	Are the scenario outputs qualitative or quantitative? Which kinds of variables are produced?
	Scenario expansion	Are the outputs at the right level of geographic granularity or do they need to be expanded? Do the outputs capture all of the driving forces that the organisation cares about?
	Scenario deployment	What is the scenario's time horizon? Are multiple years considered?

4. Illustrating an advanced nature scenario prototype

This section illustrates how corporates and financial institutions might apply an advanced approach to scenario analysis. It outlines a number of key considerations and uses the FPS + Nature as an illustrative example of this approach. Box 3 provides an introduction to the FPS + Nature scenario.

Box 3: An illustrative example: Background on FPS + Nature

The FPS + Nature is the first integrated nature and climate scenario for use by investors to be developed and is used in this discussion paper for illustrative purposes. It seeks to fill a gap among risk assessment tools by providing companies with an exploratory, forward-looking view on how policy, technological and social trends could impact key land use and energy-related value drivers. It shows how nature-related policy can be incorporated into a climate scenario.

A first version of the scenario was publicly released in January 2023 and commissioned by the UN-supported Principles for Responsible Investment (PRI).[18]

The scenario was expanded in 2023 to better account for nature-related risks arising from changes in impacts or dependencies on nature. These can be both physical risks, where ecosystem services that organisations depend on are degraded, or transition risks, where policies are put in place or consumers act to reduce harmful impacts on nature and/or advance nature conservation and restoration. The newly expanded version is used as the reference in this paper.

4.1. Considerations for developing scenario narratives

Scenario narratives are storylines describing how the world could evolve in the future, considering likely socio-political, macro-financial and environmental trends. Narratives can be forged around a view of the most critical uncertainties facing an organisation in the future. Each individual narrative provides a foundation for the organisation to describe the core aspects of a scenario and changes to risks that may be faced by an organisation in the future. The future described by a scenario narrative is not a prediction of what will happen. Rather, it is a set of occurrences that could plausibly happen. These are set out in the form of a simple storyline to aide communication of the core aspects explored. As defined in the TNFD guidance on scenario analysis, a plausible future is described using a storyline that:

- Accounts for significant events that could create risks and opportunities (e.g. implementation of land protection policy);

18 Further information about this scenario can be found at https://www.unpri.org/inevitable-policy-response/ipr-forecast-policy-scenario--nature/10966.article.

- Speaks to the main actors and their motivations (e.g. governments or consumers); and
- Outlines how the world functions (e.g. how policy or consumer decisions influence economic outcomes relevant to the organisation, such as demand for certain products).

In nature scenarios, narratives can be used to characterise the transformation of the direct and indirect drivers of nature loss, or of the economy, that could take place. These can include different pathways of global development, such as shared socio-economic pathways (SSPs), assumptions about technological changes, changes in consumer preferences, regulatory shifts and changes in environmental conditions.[19]

Normative versus exploratory scenarios

Organisations have two options when deciding how to construct scenario narratives: asking 'what if' questions about the future (exploratory) or working backwards from a desired future outcome (normative). This choice is a crucial building block when developing a storyline because it determines many of the other choices involved in developing an effective scenario. The TNFD guidance on scenario analysis introduces the main characteristics and differences between these two types of scenario and focuses on exploratory scenario narratives, rather than normative.

The main use cases of **exploratory narratives** are to:

- Describe a future with severe negative nature outcomes, such as pollinator collapse, that could create risks for an organisation. This can be used to assess an organisation's resilience to extreme but plausible circumstances. This is analogous to some climate scenarios, such as the NGFS's Current Policies scenario. This narrative describes a "hothouse" world with "about 3°C of warming and severe physical risks" including "irreversible changes like higher sea level rise."[20]
- Describe a future where ecosystem decline is less severe. This can be used to inform strategic planning decisions, especially if it is aligned with an organisation's view of what is likely to happen. An analogous climate scenario could be the IEA's Announced Policies Scenario (APS). This narrative incorporates "all recent major national announcements [...] for 2030 targets and longer-term net zero and other pledges," assuming that these are achieved.[21] Under this narrative, warming is limited to just over 2°C, which could result in relatively less severe physical risks.[22]
- Assess risks arising from shorter, idiosyncratic or event-based shocks. For instance, CISL and HSBC conducted scenario analysis to explore the effects of drought and water stress on the credit ratings of heavy industry companies. The scenario narrative imagines a future where water supply is reduced for three months due to water resource mismanagement.[23] This type of exploratory narrative can help the organisation think about business continuity and operational resilience when faced with short-term nature-related risks.

19 NGFS (forthcoming) Recommendations toward the development of scenarios for assessing nature-related economic and financial risks

20 See the NGFS scenario portal: https://www.ngfs.net/ngfs-scenarios-portal/explore/

21 See https://www.iea.org/reports/global-energy-and-climate-model/announced-pledges-scenario-aps

22 IEA (2021) World Energy Outlook 2021: Scenario trajectories and temperature outcomes

23 University of Cambridge Institute for Sustainability Leadership and HSBC (2022) Nature-related financial risk: use case. Impact of water curtailment on credit rating of heavy industry companies in East Asia.

In contrast to exploratory narratives, normative scenarios inform decisions on what is needed to achieve a preferred future. They are typically used for the assessment and setting of specific targets and implementation plans, such as a 1.5°C or 2.0°C global climate change outcome, rather than the assessment of nature-related risks and uncertainties.

FPS + Nature, for example, is categorised as an exploratory scenario, as explained in Box 4.[24]

Box 4: An illustrative example: FPS + Nature is an exploratory scenario

FPS + Nature has an exploratory narrative rather than a desired future outcome. It is based on policy trends to describe a plausible future. FPS + Nature asks: 'What if expected policies are implemented?' The procedure followed existing and announced policy aims and expected trends in future policy development. This was based on:

- Compiling existing legislation and announced commitments;
- Evaluating the credibility of announced commitments; and
- Assessing the development of technology and market shifts.

Policy trends were then used to construct and describe a plausible future. In FPS + Nature, increased policy stringency on deforestation-linked commodities in importing countries could increase international momentum to halt deforestation in exporting countries. This is informed by existing and announced policies such as the EU's regulation on deforestation-free supply chains and the US's proposed FOREST Act. Market developments, such as financial institution pledges to eliminate deforestation and recent increases in certified deforestation-free production, support this trend.

More information on the details of the FPS scenario narratives (ahead of the 2023 expansion, which is covered in the next sections) is provided in the section 'Assessed policies and trends' of the FPS + Nature report.[25]

Normative scenarios aligned with the Global Biodiversity Framework

As highlighted in the TNFD guidance on scenario analysis, normative scenarios present narratives that are aligned with global or regional goals and targets.

Normative climate scenarios are usually aligned with the Paris Agreement's ambition to limit warming to 1.5°C above preindustrial levels. For example, the NGFS's Net Zero 2050 scenario limits warming to 1.5°C through stringent climate policies and a medium use of carbon dioxide removal.[26] Feedback collected during the TNFD's open innovation process suggested that the Kunming-Montreal GBF could be an anchor for a normative nature scenario

24 As highlighted in the TNFD guidance, exploratory scenarios are, for the moment, better suited at capturing the uniqueness and location-specificity of nature (compared to greenhouse gas emissions). For this reason, unless stated otherwise, all the examples provided in this paper are of exploratory scenarios rather than normative.

25 Inevitable Policy Response (2023) Forecast Policy Scenario + Nature (FPS + Nature): Preparing financial markets for climate-& nature-related policy & regulatory risks

26 NGFS (2021) Climate Scenarios for central banks and supervisors

narrative, analogous to a Paris-aligned climate scenario. The goals and targets set out in other relevant international conventions and global agreements could also be used.

There are some recognised challenges in aligning a narrative to the GBF, as there is no single goal, target, indicator or outcome that could be used to anchor a normative nature scenario that is analogous to temperature in climate scenarios. The narrative would need to be linked to the four long-term goals and 23 specific targets set by the GBF, some of which are not yet fully specified. For example, it is not clear whether the GBF's goal to protect 30% of terrestrial, inland water, marine and coastal areas would require 30% of each area type to be protected or 30% of the planet's entire surface area to be protected. The GBF also does not define differentiated responsibilities, such as how global targets should be realised at the jurisdictional level.

The TNFD also identified that climate change is a universal, global phenomenon, with one shared atmosphere where greenhouse gas emissions are mobile and fungible, and the central principle of a quantifiable global carbon budget, which enables an agreed distribution of that budget among many actors, including states, companies and cities. By contrast, nature is place-based and unique, with National Biodiversity Strategies and Action Plans (NBSAPs) still being updated and specific targets and sector-specific transition pathways needed for equivalent normative nature scenarios to be built.

A practical way to overcome these challenges could be to focus on elements of the GBF that could have material implications or well-specified goals:

- **Focus on a single aspect of the GBF:** For example, a water company may seek to understand how its business could be affected by a scenario where Target 7 of the GBF to "Reduce pollution risks and the negative impact of pollution from all sources by 2030, to levels that are not harmful to biodiversity and ecosystem functions and services" is achieved. To develop a GBF-aligned scenario narrative, the company can imagine a future where this target is met and consider how it is met.
- **Incorporate multiple GBF goals and targets:** For example, the GBF's land-related aspirations could be important to an agricultural company. The desired future outcome could reflect:
  - No loss of areas of high biodiversity importance by 2030;
  - 30% of terrestrial, inland water, marine and coastal areas are under protection by 2030; and
  - 30% of degraded ecosystems are under effective restoration by 2030.

The scenario narrative could describe how these desired outcomes are achieved (e.g. which policies are implemented, which actions do consumers take). This narrative could incorporate multiple drivers of risk.

Incorporating drivers of risk or opportunity into scenarios

A scenario narrative identifies the drivers of risk or opportunity (driving forces) that an organisation may be exposed to, and it can describe the way that these drivers change. Organisations can consider their underlying driving forces using Table 2 in the TNFD scenario analysis guidance. For example, a beef producer may be exposed to a range of driving forces connected to related risks or opportunities, such as global regulation on land conversion, a higher or lower cost of capital and consumer sentiment.

Nature-related risks

Organisations can consider different physical and transition risk categories when identifying the driving forces to incorporate in a narrative.

Table 2: Categories of nature-related risks[27]

Risk type	Category	Description
Physical risk	Acute risks	Occurrence of short-term, specific events that change the state of nature. For example, oil spills, forest fires or pests affecting a harvest.
	Chronic risks	Gradual changes to the state of nature. For example, pollution stemming from pesticide use or climate change.
Transition risk	Policy	Changes in the policy context due to new (or enforcement of existing) policies associated with creating positive impacts on nature or mitigating negative impacts on nature.
	Market	Changing dynamics in overall markets, including changes in consumer preferences, which arise from other risk categories because of changing physical, regulatory, technological and reputational conditions and stakeholder dynamics. For example, the market value of a company is affected by assets that have decreased in value because there is insufficient freshwater for the production process, or the value of the business production process is reduced by the emergence of new technologies that require less water to operate.
	Technology	Substitution of products or services with a reduced impact on nature and/or reduced dependency on nature. For example, the replacement of plastics with biodegradable containers.
	Reputational	Changes in perception concerning an organisation's actual or perceived nature impacts, including at the local, economic and societal level. This can result from direct company impacts, industry impacts and/or impacts of activities upstream and/or downstream in a value chain.
	Liability	Liability risks arising directly or indirectly from legal claims. As laws, regulations and case law related to an organisation's preparedness for nature action evolves, the incident or probability of contingent liabilities arising from an organisation may increase.

These same risk categories are used to classify climate-related risks by the TCFD and may be familiar to organisations that already conduct climate risk assessments.

Both physical and transition risks can be incorporated into one scenario narrative. This may be advantageous where risk drivers are overlapping and interrelated. For example, water scarcity may present both physical and transition risks, as physical limits to extraction are imposed or governments legislate to reduce water use. Similarly, a plausible

27 These are defined by the TNFD and aligned with the TCFD.

future in which transition risks are low due to limited policy action is likely to lead to higher physical risks, because declines in the state of nature are permitted to continue.

A comprehensive list of nature-related risks (taken from the TNFD's risk and opportunity registers or from external sources, such as the ENCORE database) can be shortlisted based on three criteria:

1. **Scale:** Does the risk account for global driving forces? Risks with global drivers and consequences are likely to be better suited to global scenario-based analyses, while highly localised risks and drivers may be better suited to local risk assessments.
2. **Data quality:** Are global, forward-looking data available to support a risk assessment? Forward-looking data are required to understand how risks could evolve in the future, as opposed to static data, which can only inform about risks today. Data with global coverage ensures risks from particular geographies are not overlooked.
3. **Magnitude:** Does this risk have significant effects on companies today or will it in the near future? Scenarios will not be exhaustive of all possible risks that could be faced by companies, so it is important to prioritise the risks that could be of greatest magnitude. This is also highlighted in the Assess phase of the TNFD's guidance on the LEAP approach.

Nature risk drivers that are global and significant but have poor data availability or lack a specific indicator can be accounted for qualitatively using a proxy indicator. For example, the links between biodiversity loss and zoonotic diseases is difficult to quantify. However, this can be accounted for qualitatively in a scenario by assessing directional trends in biodiversity intactness, because continued decline in biodiversity intactness could indicate heightened risk of zoonotic disease outbreak.

A practical application of this process is shown in ,Figure 5: Nature risk drivers shortlisting process (illustrative approach – impacts)5 and Box 5, where eight scenario variables (commodity production and price, biodiversity, water scarcity, greenhouse gas emissions, pollinator population and soil quality) are used to assess 20 of the ENCORE nature risk drivers. This is possible because single scenario output variables can be used to assess changes in multiple nature-related risks. Some of these are only assessed qualitatively due to the lack of a clear quantitative link.

Figure 4: Nature risk drivers shortlisting process (illustrative approach – dependencies)

Type of ecosystem service	Ecosystem service	Scale	Data quality	Materiality	Description	Scenario variable	Use in scenario analysis
Direct physical inputs	Animal based energy	Low	Low	Low	Very small and local materiality		
	Fibres & other materials	High	High	High	Materials are vital inputs to production	**Commodity production and price**	**Quantitative or qualitative**
	Genetic materials	High	Low	Low	Material for pharmaceuticals but poor data	**Biodiversity**	*Qualitative only*
	Ground water	High	High	High	Water is vital input to many sectors	**Water scarcity**	**Quantitative or qualitative**
	Surface water	High	High	High	Water is vital input to many sectors	**Water scarcity**	**Quantitative or qualitative**
Mitigates direct impacts	Bio-remediation	Low	Low	Low	Mostly localised dependencies with poor data		
	Dilution	High	Low	High	Limited data alone but closely linked to water scarcity	**Water scarcity**	*Qualitative only*
	Filtration	High	Low	High	Limited data alone but closely linked to GHG emissions	**GHG emissions**	*Qualitative only*
	Mediation of sensory impacts	Low	Low	Low	Highly locally specific with small materiality		
Enables production processes	Maintain nursery habitats	High	Low	High	Limited forward-looking data availability		
	Pollination	High	Low	High	Material for agri producers and good data	**Pollinator population**	**Quantitative or qualitative**
	Soil quality	High	Low	High	Material for agri producers and good data	**Soil quality**	**Quantitative or qualitative**
	Ventilation	Low	Low	Low	Very small and local materiality		
	Water flow maintenance	High	High	High	Water is vital input to many sectors	**Water scarcity**	**Quantitative or qualitative**
	Water quality	High	Low	High	Quality water is an important input for many sectors	**Water scarcity; soil quality**	*Qualitative only*
Protection from disruptions	Buffering of mass flows	Low	Low	Low	Locally material and limited global data		
	Climate regulation	High	Low	High	Vital service but mostly determined by GHG emissions	**GHG emissions**	**Quantitative or qualitative**
	Disease control	High	Low	High	Relationship to drivers difficult to quantify	**Biodiversity**	*Qualitative only*
	Flood & storm protection	Low	Low	High	Localised protection not suitable for global modelling		
	Erosion control	Low	Low	Low	Localised materiality	**Deforestation**	*Qualitative only*
	Pest control	Low	Low	Low	Relationship with drivers is local and difficult to quantify	**Biodiversity**	*Qualitative only*

Key: Low | Medium | High

Figure 5: Nature risk drivers shortlisting process (illustrative approach – impacts)

Type of ecosystem service	Ecosystem service	Scale	Data quality	Materiality	Description	Scenario variable	Use in scenario analysis
Land and sea use change	Terrestrial ecosystem use	High	High	High	High materiality and good quality data	**Deforestation**	**Quantitative or qualitative**
	Freshwater ecosystem use	High	Low	Low	Limited forward-looking data availability		
	Marine ecosystem use	High	Low	Low	Limited forward-looking data availability		
Climate change	GHG emissions	High	High	High	High materiality and good quality data	**GHG emissions**	**Quantitative or qualitative**
Pollution	Non-GHG air pollutants	Low	Low	Low	Limited forward-looking data availability	**GHG emissions**	*Qualitative only*
	Disturbances	Low	Low	Low	Mostly localised impacts with poor data		
	Soil pollutants	High	Low	Low	High materiality but difficult to project forwards	**Soil quality**	**Quantitative or qualitative**
	Solid waste	Low	Low	Low	Mostly localised impacts with poor data		
	Water pollutants	Low	Low	Low	High materiality but difficult to project forwards	**Soil quality**	**Quantitative or qualitative**
Resource use	Other resource use	High	Low	High	High materiality but poor data availability		
	Water use	High	High	High	High materiality and good data availability	**Water scarcity**	*Qualitative only*

Key: Low | Medium | High

Box 5: An illustrative example: Practical shortlisting of physical and transition risks for scenarios

Figure 4 and Figure 5: Nature risk drivers shortlisting process (illustrative approach – impacts) outline the shortlisting process. On the left are the different types of ecosystem services or drivers of nature change from ENCORE (associated with impacts on nature, grouped into categories). The three criteria are then applied qualitatively to each of these with a high-medium-low score:

1. **Scale:** Some risks are of insufficient scale to be appropriately modelled in a global scenario. In this example, mediation of sensory impacts, buffering of mass flows and solid waste pollution have very localised drivers and implications, which could make them inappropriate for inclusion in a global scenario.
2. **Data quality:** Some risks have global drivers and implications but do not have publicly available, forward-looking, global data on their state. For example, data on air quality is typically static, which does not easily facilitate assessment of how air quality variables could change over time.
3. **Magnitude:** Risks driven by ground water and surface water availability have clear, tangible links to company performance in a range of sectors, such as food, apparel, power and multiple sectors downstream. Risks driven by other changes in the state of nature, such as disturbance to ecosystems through light and noise pollution, could be considered to have low materiality, given limited policy related to these impacts.

To the right of the illustrative shortlisting criteria in and Figure 5: Nature risk drivers shortlisting process (illustrative approach – impacts), nature-related drivers with scale, data quality and materiality are linked to a scenario variable that can help describe – qualitatively or quantitatively – the magnitude of the risk over time. This may require reviews of external sources and consultation with experts to ensure that chosen scenario variables can accurately account for changes in nature risk drivers. Scenario outputs that cannot describe changes in the risk quantitatively can still be included in scenarios as a qualitative description of risk.

The TNFD recommendations also introduce the definition of systemic risks, distinguishing between two categories:

- Ecosystem stability risk: Risk of the destabilisation of a critical natural system so it can no longer provide ecosystem services in the same manner as before; and
- Financial stability risk: Risk that a materialisation and compounding of physical and/or transition risks leads to the destabilisation of an entire financial system.

While recognising that the assessment of systemic risk implications has also been an important objective for climate-related scenario analysis, existing assessment methods are often not well suited for capturing the systemic risks associated with climate change, the loss of ecosystem services and transformative policy changes.[28]

28 FSB and NGFS (2022) Climate Scenario Analysis by Jurisdictions, NGFS (forthcoming) Recommendations toward the development of scenarios for assessing nature-related economic and financial risks

Nature-related opportunities

TNFD opportunity categories are split into those related to business performance and those related to sustainability performance.

A narrative may consider changes in the future that could create opportunities for the user of the scenario:[29]

- Nature-related opportunities are present in existing markets and a scenario narrative could explore factors that contribute to market growth in these areas. For example, if customers come to demand deforestation-free products, a company with certified deforestation-free products may see increased demand as customers reduce purchases from competitors without robust supply chain monitoring.
- Opportunities could also result from the creation of new markets. These could include markets for technologies that reduce harmful nature impacts or help improve the state of nature. For example, FPS + Nature's narrative incorporates forces that could drive growth in the market for nature-based solutions (NbS).

Box 6: An illustrative example: Building from the TNFD's critical uncertainty matrix

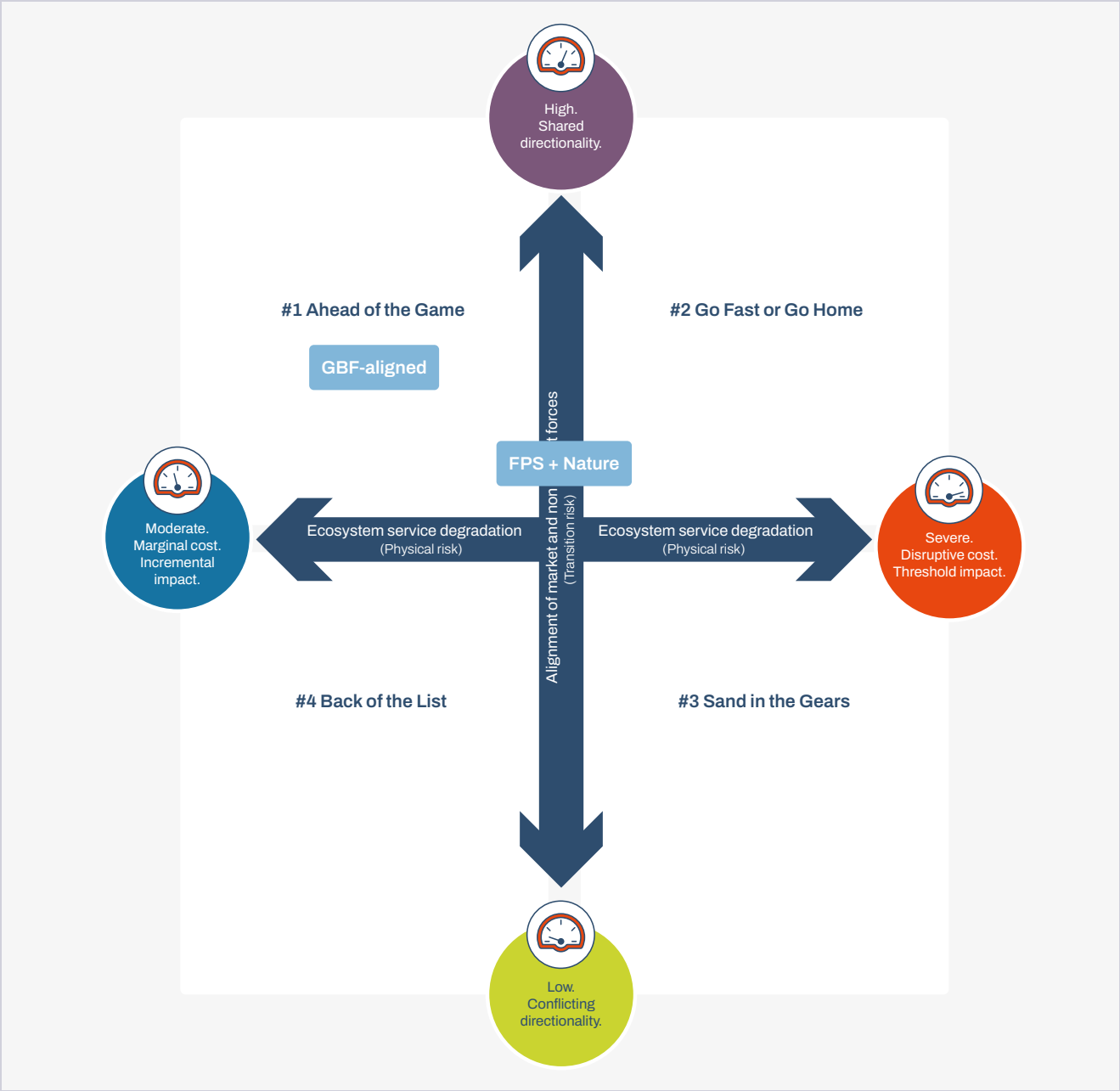
Advanced scenarios that incorporate multiple drivers of risks can be mapped onto the TNFD's 2x2 critical uncertainties matrix described in the TNFD scenario analysis guidance and summarised in the illustrative scenario matrix in Figure 6: FPS + Nature's narrative and a hypothetical GBF-aligned narrative mapped to the TNFD's critical uncertainties matrix. Organisations can map a scenario to the matrix even if the matrix was not explicitly used to create the scenario narrative. To do this, organisations can consider the level of ecosystem degradation described or implied by the narrative (e.g. moderate or severe) and the degree to which market and non-market forces are aligned (e.g. whether policy is synchronised with consumer attitudes).

Figure 6: FPS + Nature's narrative and a hypothetical GBF-aligned narrative mapped to the TNFD's critical uncertainties matrix depicts this mapping for FPS + Nature and also adds a GBF-aligned scenario narrative as an illustrative example. The GBF-aligned scenario narrative is positioned in the top left quadrant of the matrix (i.e. 'Ahead of the Game') as strong policy action before 2030 to limit nature loss will be required to achieve the GBF's targets. Coordination between policy and market forces will likely be required to achieve rapid improvements in the state of nature. Limited nature loss could also limit the severity of ecosystem service degradation.

By contrast, FPS + Nature is positioned closer to the middle of the matrix, reflecting a scenario where achieving positive outcomes for nature is less successful. Policy and market action are more fragmented and less ambitious compared with a GBF-aligned scenario, resulting in comparatively higher levels of ecosystem service degradation.

29 The TNFD Glossary defines categories of opportunities, including business performance opportunities (e.g. resource efficiency) and sustainability performance opportunities (e.g. ecosystem protection, restoration and regeneration)

Figure 6: FPS + Nature's narrative and a hypothetical GBF-aligned narrative mapped to the TNFD's critical uncertainties matrix



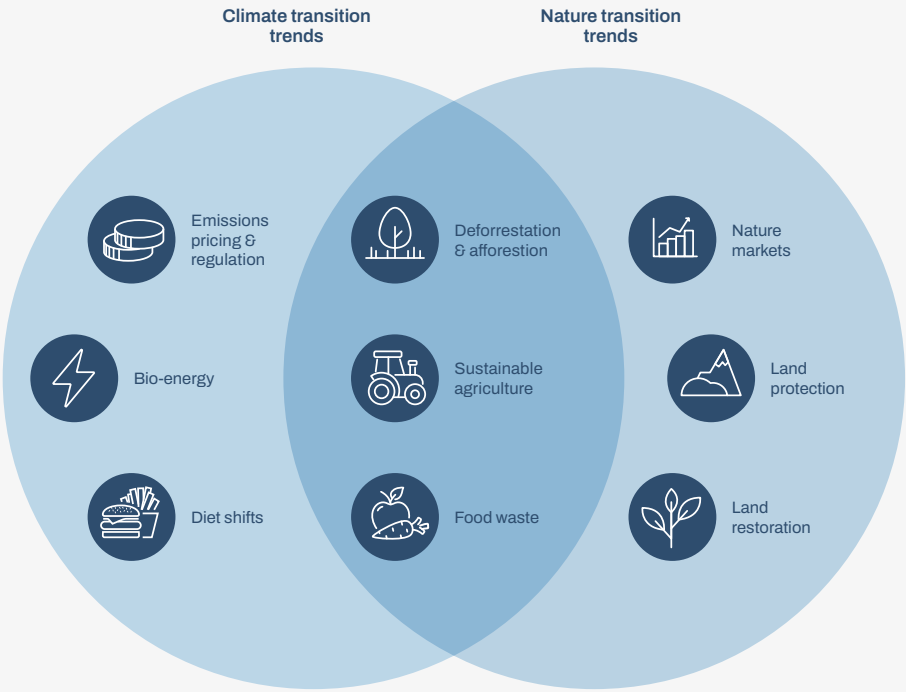
As shown in this illustration, narratives can explain potential interactions between drivers of risk, which could influence the overall risks that an organisation faces in a scenario.

While it is possible to consider individual driving forces in isolation by developing individual narratives for each driver, a more robust approach is to incorporate multiple overlapping and interacting drivers of risk when crafting a scenario narrative. The FPS + Nature narrative includes multiple driving forces as described in Box 7.

Box 7: An illustrative example: FPS + Nature's incorporation of multiple driving forces

FPS + Nature is an integrated climate and nature scenario incorporating nine policy-supported trends related to both climate and nature, including policy risks, such as the implementation of land protection regulation; the effects of technological development, such as the emergence of food waste reduction technologies; and market shifts, such as consumer preferences for alternative proteins.

Figure 7: The nine policy-supported trends related to climate and nature in FPS + Nature



For example, the implementation of sustainable agriculture policy could reduce carbon emissions from fertiliser use, while also reducing runoff of fertilisers into freshwater ecosystems.

Driving forces in FPS + Nature are used to shape an internally consistent scenario narrative:

- **Land protection and restoration:** Governments increase the area of land under protection, spurred by international commitments such as the GBF, and moves to restore degraded ecosystems through public and private restoration activities.
- **Nature markets and deforestation:** Voluntary biodiversity credit markets emerge to support positive nature outcomes while increasing stringency on forest protection and anti-deforestation legislation contributes to the end of net deforestation by 2030.
- **Diet shifts and food waste:** Ruminant meat consumption decreases, facilitated by policy support for alternative protein development. Food waste also decreases.

- **Emissions, bioenergy and sustainable agriculture:** Governments also introduce policies to reduce land-use emissions and fertiliser use and incentivise production of second-generation bioenergy.
- **Outcomes:** Nature benefits, including biodiversity recovery, are coupled with climate benefits; warming is limited to 1.8°C by the end of the century.

Incorporating state of nature measurement

Scenario narratives could include indicators of changes in the state of nature as part of the assessment of an organisation's impacts and dependencies.

As defined by the TNFD, nature-related risks can result from both dependencies and impacts on nature through:

1. Changes to the state of nature itself, caused by business impact drivers or external factors; and
2. Changes to the flow of ecosystem services associated with the changes to the state of nature.

A narrative could describe how physical and transition risks from changes in state of nature variables could materially affect the organisation.

Some state of nature variables could be considered a physical risk or a transition risk in the narrative, depending on what action is expected. For example, as highlighted in Annex 2 of TNFD guidance on the LEAP approach, ecosystems such as forests may decline in size and quality, reducing the provision of ecosystem services, such as flood protection. This may lead to increased flood risk and/or costs to replace the flood protection services that these ecosystems once provided. If the organisation is also driving deforestation, then it is also exposed to transition risks in the form of anti-deforestation legislation or consumer sentiment.

The TNFD recommendations recognise that there are not yet widely accepted metrics for the state of nature, but recognises the importance of its measurement, particularly for the direct assessments required to achieve Goal A of the GBF.[30] For this reason, the TNFD included 'placeholder' indicators on the state of nature, encouraging organisations to report on them, and additional indicators on ecosystem services. It will continue to work with knowledge partners to develop further guidance on these metrics. Additional guidance on the measurement of the state of nature is provided in Annex 2 of the TNFD LEAP approach.

Organisations may choose to focus on one or multiple metrics to reflect changes in the state of nature in their narratives. For example, a narrative could include a comment on overall levels of biodiversity, with metrics of ecosystem condition and species abundance, such as the Biodiversity Intactness Index or Mean Species Abundance. This approach is illustrated in Box 8.

30 The Global Biodiversity Framework sets out an ambitious pathway to reach the global vision of a world living in harmony with nature by 2050. Among the Framework's key elements are four goals for 2050 and 23 targets for 2030.

Box 8: An illustrative example: FPS + Nature's incorporation of state of nature metrics

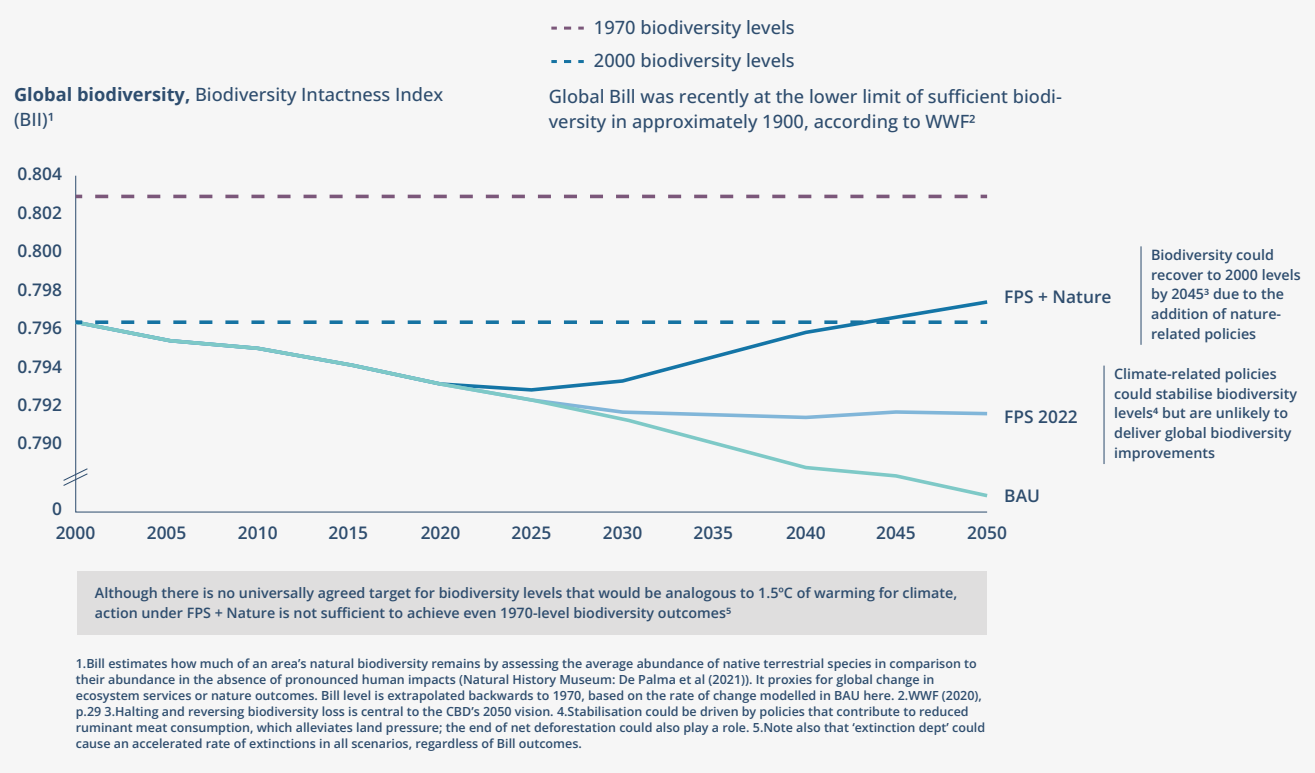
FPS + Nature uses biodiversity metrics to describe how the state of nature changes over time. Specifically, the scenario uses a metric that shows the change in biodiversity to describe the state of nature using a single variable. This variable captures the effects of land-use change on biodiversity, which could be influenced by deforestation, resource use and land protection policy. The index used is the Biodiversity Intactness Index (BII), which estimates how much of an area's natural biodiversity remains by assessing the average abundance of native terrestrial species relative to their abundance in the absence of human impacts.[31]

The scenario finds that nature and climate policy action by governments could halt and reverse global biodiversity loss, facilitated by land protection and restoration policies. In this scenario, the world could achieve 2000 levels of biodiversity intactness by 2045.

By contrast, a scenario accounting for just climate-related policy may only be able to stabilise existing biodiversity loss without achieving improvement in biodiversity outcomes. In this scenario narrative, stabilisation could be driven by policies and actions that contribute to reduced ruminant meat consumption, which alleviates land pressure. This is illustrated in Figure 8: Biodiversity could recover under FPS + Nature.

Changes in biodiversity can reflect – and have implications for – risk drivers faced by organisations. For example, increases in biodiversity may suggest that risks of zoonotic and plant diseases fall in this scenario.

Figure 8: Biodiversity could recover under FPS + Nature



31 De Palma, A., et al. (2021) Annual changes in the Biodiversity Intactness Index in tropical and subtropical forest biomes, 2001–2012. The BII can be found on the Natural History Museum website.

Incorporating climate-related drivers of risk

Climate- and nature-related risks can be overlapping, which means that both should be incorporated into the narrative in an integrated manner to facilitate integrated risk assessment.[32] Integrated climate and nature scenario narratives could incorporate the most important climate-related risk drivers along with additional, important nature-related risk drivers, such as land protection and water availability. For example, an integrated normative scenario could integrate a 1.5°C temperature outcome and critical goals and targets of the GBF, such as 30x30 goals.

Climate- and nature-related risks can be overlapping, which means they should be incorporated into the narrative in an integrated manner to facilitate integrated risk assessment.

The main climate-related risk drivers included in scenarios are carbon pricing and temperature outcome.[33] These are used by many organisations as simple metrics to assess exposure to transition risk (through carbon pricing) and to physical risk (through temperature-induced changes in risks, including sea level rise and increased severity and frequency of extreme weather events).

Table 3: Sample risk drivers for climate and nature (non-exhaustive) provides a non-exhaustive set of examples of risk drivers for both nature and climate. Nature-related risk drivers are based on the TNFD's Nature-related Risk and Opportunity Registers, while examples of climate-related risks are informed by the TCFD.[34]

For example, land protection policy could impact temperature rise, which in turn will have implications for water availability. As climate changes, ecosystems become disrupted and may reach thresholds and tipping points. Similarly, nature loss reduces the carbon storage capacity of ecosystems, which accentuates climate change.[35] An integrated climate and nature scenario narrative will increase the accuracy of the risks being assessed.

32 See Cambridge Institute for Sustainability Leadership (2021) Integrating climate and nature: The rationale for financial institutions

33 Focusing on only two drivers is also a limitation of climate scenarios. In particular, it is not possible to link a certain impact to a certain temperature change given local factors, and there are more dimensions to transition risk than just carbon prices. Climate scenarios may also therefore need to look at a broader range of risk drivers. See Ranger et al. (2022) Assessing Financial Risks from Physical Climate Shocks : A Framework for Scenario Generation; World Bank

34 The Coalition of Finance Ministers for Climate Action also gives examples of nature-related risks.

35 Cambridge Institute for Sustainability Leadership (2022) Integrating climate and nature: The rationale for financial institutions

Table 3: Sample risk drivers for climate and nature (non-exhaustive)

Type of risk driver	Climate-related risk drivers	Nature-related risk drivers (additional to climate)
Physical risks	• Temperature rise • Extreme weather events • Rising sea levels	• Pollinator abundance • Soil quality • Water quality • Ocean pH
Transition risks	• Carbon pricing policy • Climate-related reporting obligations • Customer preferences for low-carbon goods and services • Climate performance affecting reputation	• Water supply • Land protection policy • Nature-related reporting obligations • Customer preferences for goods and services with lower impact on nature • Nature performance affecting reputation

FPS + Nature, for example, considers both climate-related trends (e.g. carbon pricing) and nature-related trends (e.g. land protection). This is depicted in .

An integrated climate and nature scenario could also develop narratives that explore trade-offs and synergies between policies. For example:

- Land protection policies can prevent land conversion and biodiversity loss while also preserving valuable carbon sinks; and
- Increased demand for lithium for electric vehicle batteries involves mining that could drive deforestation and biodiversity loss.[36]

Organisations may also decide to include potential interactions with other forms of non-environmental risks as part of their narratives, including traditional forms of financial risks (credit, market, liquidity, etc.) that may amplify the risk. For more information on the interaction of nature-related risk with other forms of risk and the related transmission channels, see the Assess phase of the LEAP approach.[37]

Incorporating low-probability events in the narrative

An exploratory scenario narrative could incorporate low-probability events or tail events.[38] These could include tipping points, which are irreversible changes that reformulate the structure of a system. For example, further deforestation of the Amazon rainforest could breach a tipping point that irreversibly changes parts of the rainforest into savanna.[39]

36 Additional discussion about these interactions is provided by Finance for Biodiversity Initiative (2021) The Climate-Nature Nexus: Implications for the Financial Sector

37 See also OECD (2023), A supervisory framework for assessing nature-related financial risks: Identifying and navigating biodiversity risks, OECD Business and Finance Policy Papers.

38 This topic is not only relevant for nature or climate-risk scenarios. Regulatory requirements around risk-based capital assessment have been very significant, in particular on the formalisation of the appropriate level of acceptable capitalisation, especially for insurance companies.

39 Thomas E. Lovejoy, Carlos Nobre (2019) Amazon tipping point: Last chance for action. Sci. Adv.5, eaba2949

A narrative with tipping points could describe which events occurred to cross the tipping point (such as continued deforestation), what is implied by crossing the tipping point (such as loss of ecosystem services) and could be explicit about the extent that extreme risks or tipping points are included.

If a narrative is ambiguous about tipping points, it may be difficult for organisations to fully understand the implications of the narrative's risk drivers and whether, for example, a lack of policy action leads to fisheries decline or a complete collapse. It could be difficult to position this narrative against the ecosystem service degradation axis in the TNFD's uncertainties matrix as it may be unclear whether degradation is moderate or severe.

4.2. Specification: from narratives to decision-useful outputs

The next step is to convert nature scenario narratives into decision-useful outputs for consideration in an organisation's risk assessment. This step involves creating a set of qualitative or quantitative outputs:

- **Qualitative:** These could be directional qualitative outputs, such as an increase in demand for deforestation-free products or a reduction in deforestation, or categorical outputs, such as laws banning nature-harmful practices.
- **Quantitative:** These will be numerical, such as hectares of deforestation in a particular jurisdiction or megatons of deforestation-linked commodities produced.

This section summarises some of the most important issues for scenario users to consider when converting narratives into decision-useful outputs. The focus is on quantitative modelling, but it also points out considerations for qualitative approaches.

Tools to create scenarios

Tools used in the specification process translate a narrative's risk drivers into effects on the world. For example, these tools could help answer questions such as 'What is the effect of crop yield enhancement technologies on the amount of land used for agriculture?' or 'What is the effect of depleting water availability on levels of water stress?' These questions can be answered with a qualitative or quantitative approach:

- A set of **qualitative scenarios** may not require an advanced set of modelling tools. For instance, a company's exposure to future water stress could be determined by assessing directional change in water availability based on expert input or literature reviews.
- More **quantitative approaches** may require more advanced tools, such as hydrological models or models that examine the interaction between different systems, such as land use and hydrological models.

The production of quantitative outputs does not necessarily require in-house modelling or technical expertise. For example, quantification can be grounded in third-party datasets or research without the use of models. Another option is to use the quantified outputs of a third party's modelling exercise for a publicly available scenario (e.g. NGFS scenarios are used in many climate scenario assessments). As more publicly available nature scenarios are published, report preparers will have a greater variety of quantitative scenarios to choose from, without needing to model them from scratch. The expected development of nature scenarios by the NGFS will be important here.

Producing quantitative outputs does not necessarily require in-house modelling or technical expertise.

There are a variety of quantitative modelling approaches that could be used for this purpose, as described in Box 9.

Box 9: Multiple approaches to modelling nature scenarios[40]

Global nature-macroeconomy models
One approach is to examine how nature influences core macroeconomic variables like GDP. This type of approach has been deployed in one study by the World Bank.[41] It could involve a similar methodology to the Integrated Assessment Models (IAMs) used in climate.

System models (e.g. land-use models)
Several studies have deployed land-use models to understand how policy shifts relate to land-use implications, such as deforestation. One example of this is the Race to Zero report which draws on IPR's FPS + Nature.[42] Land-use models can reveal insights about how land is used and the related impacts on specific resources, such as forests and water. This has the advantage of capturing the effects of land-use change, which is an important driver of nature loss.

Ecosystem impact models
Ecosystem impact models could be appropriate for assessing the evolution of physical risk factors. For example, a hydrological model could be used to track changes in water availability over time.[43]

Regional/national/local models
Regional or national models can be used to focus on a smaller geography, with calibration at a more local level. For example, local-scale models of multiple ecosystem services have been widely tested and applied.[44] Organisations using a quantitative scenario for a single geography may find it useful to leverage these models instead of global-level models to achieve a more focused approach.

Multi-Regional Input-Output (MRIO) models
MRIO tables and models describe the production structure of multiple regions and economies by representing the economic activities as outputs and production sectors and categories of final demand as inputs. The Environmentally Extended MRIO models (EE-MRIO or Env-MRIO) add environmental information to MRIO tables and can be used to assess the transmission of nature-related risks throughout value chains. MRIO tables are particularly useful to compensate for the lack of substitutability for natural capital compared with other modelling approaches. They offer granular data on sectoral and regional linkages and can be linked to ecosystem services to understand the direct and indirect sectoral impacts from physical and transition risks.

40 Also see NGFS (forthcoming) Recommendations toward the development of scenarios for assessing nature-related economic and financial risks

41 World Bank (2021) The Economic Case for Nature: A global earth-economy model to assess development policy pathways

42 Race to Zero (2022) Assessing the financial impact of the land use transition on the food and agriculture sector

43 Examples of hydrological models are presented in Decsi, B. et al. (2022) From simple to complex – Comparing four modelling tools for quantifying hydrologic ecosystem services

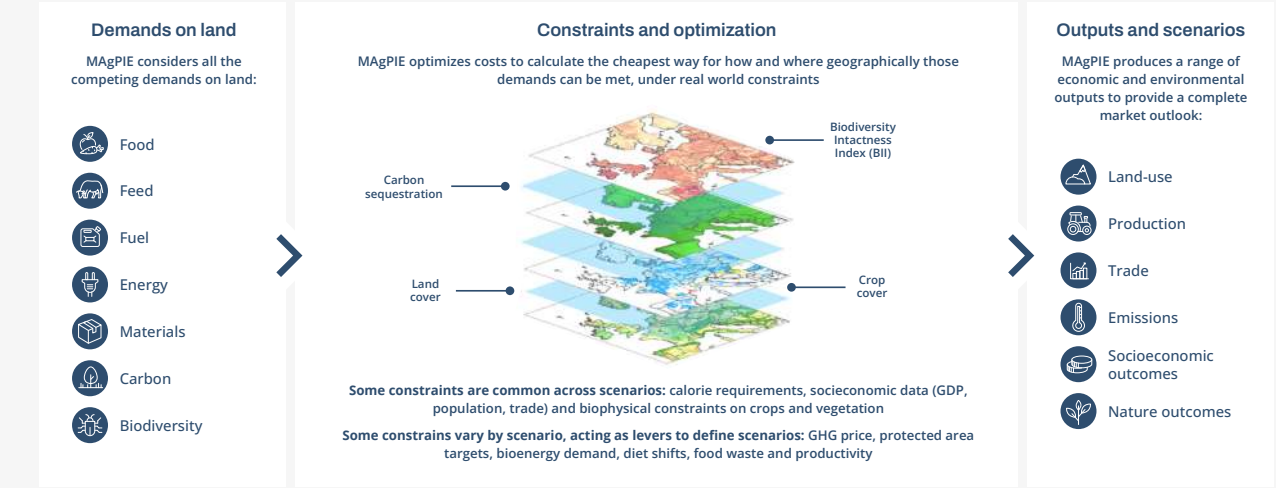
44 IPBES (2016) The methodological assessment report on scenarios and models of biodiversity and ecosystem services

Box 10: An illustrative example: The MAgPIE model

The MAgPIE model is a global land-use allocation model that has been used by the IPCC and NGFS and by FPS + Nature. It is designed to explore land-use dynamics in the context of global environmental policy. It takes possible future demands for materials from sectors that affect land use, such as food, energy and timber, and solves to meet these demands in the most cost-effective way.

When meeting demands is challenging, the model can respond by investing in yields, increasing imports or converting more land to cropland. Through this, it can be used to generate insights, for example, on the effect of changing meat consumption on deforestation. It also provides outputs on commodity prices, yield changes, greenhouse gas emissions and biodiversity.

MAgPIE is a land-use model and therefore does not account for dynamics in the wider economy, incorporate advanced nature linkages such as biophysical feedbacks or account well for the acute physical risks of climate change.



For more information about this model, see: Dietrich J, Bodirsky B, Weindl I, Humpenöder F, Stevanovic M, Kreidenweis U, Wang X, Karstens K, Mishra A, Beier F, Molina Bacca E, von Jeetze P, Windisch M, Crawford M, Leip D, Klein D, Singh V, Ambrósio G, Araujo E, Biewald A, Führlich P, Lotze-Campen H, Popp A (2023). MAgPIE – An Open Source land-use modeling framework – Version 4.6.6*. The MAgPIE model can be found at:* https://rse.pik-potsdam.de/doc/magpie/4.6.6/index.htm

Models can yield crucial insights when developing a scenario, but also have limitations. They usually tend to simplify complex processes and, in doing so, exclude certain factors or have biases that influence the outputs they produce.

Being aware of model limitations is crucial to using them effectively. Corporates, and especially financial institutions, consider model risk as an important part of operational risk, because the use of insufficiently accurate or relevant models can have negative implications for the decisions they inform.[45] Important model limitations are:

- **Modelling scope:** Models may not be able to capture all of the risk drivers and effects that are relevant to an organisation. For example, a land-use model may not be able to capture the impacts of increased extreme weather on crop yields. FPS + Nature's modelling scope is highlighted as an example in Box 11.
- **Model uncertainty:** There can also be uncertainty in model results and different models used to specify the same narrative can yield different values for specific outputs. For example, the NGFS modelling framework includes three models "[to allow] for exploring the uncertainty related to model structures and techno-economic (and potentially other) assumptions."[46]
- **Treatment of non-linear effects:** Integrated assessment models (IAMs), often used to develop scenarios, may not be able to account for non-linear effects. This could make it difficult to capture the effect of tipping points.[47]

Box 11: An illustrative example: IPBES drivers of nature change within FPS + Nature's modelling scope

FPS + Nature incorporates a number of IPBES drivers of nature change in its modelling. The scenario uses a land-use model to capture the drivers of land-use change, which is included because it has the largest impact on terrestrial ecosystems. As this scenario is an integrated climate and nature scenario, climate change is also included in the form of temperature variations. Resource use is included because it is closely related to land use (e.g. production of timber and other natural commodities requires land).

Ocean-use change, pollution and invasive alien species are drivers of nature change identified by IPBES that are not covered by the FPS + Nature scenario. The scenario does not account for policies regulating the ocean and freshwater realms; policies regulating pollutants not related to agriculture (such as plastic); and regulations on invasive alien species. Organisations affected by these drivers of nature change may model them separately to complement FPS + Nature outputs when specifying a scenario.

Incorporating physical risks

Nature-related physical risks are risks resulting from the degradation of nature, such as changes in ecosystem equilibria, including soil quality and species composition, and the consequential loss of ecosystem services upon which economic activity (and organisation-level risks and cashflows) depends. When incorporating nature-related physical risks in scenarios, organisations must consider several factors to derive decision-useful and robust outputs:

- **Accounting for a broad set of risk drivers:** Most climate scenarios use temperature as the central variable driving physical risk, although the limitations of this and the need to include broader variables is increasingly recognised.[48]

45 For further discussion on model risk in the context of financial models, see ECB (2007) MODEL RISK: AN OVERVIEW OF THE ISSUES

46 See NGFS' FAQs: https://www.ngfs.net/ngfs-scenarios-portal/faq/

47 For further discussion on this point and additional limitations of IAMs, see Asefi-Najafabady et al. (2020) The failure of Integrated Assessment Models as a response to 'climate emergency' and ecological breakdown: the Emperor has no clothes

48 Pitman et al. (2022) Acute climate risks in the financial system: Examining the utility of climate model projections. Environmental Research (1): 2.

The set of potential variables driving nature-related risks is much broader. Organisations aiming to assess changes in several nature-related risks over time would need to consider several different scenario drivers and risks.

- **Geographic granularity:** Physical risks vary in their spatial scale. Many nature-related physical risks are more highly location-specific than climate-related physical risks.[49] For instance, changes in soil quality over time depend on factors such as land-use intensity and land degradation, which may be highly localised. By contrast, climate scenarios focusing on temperature changes over time may rely on less granular data.[50]
- **Gradual or abrupt changes:** Physical risks may gradually increase as ecosystem services gradually decline, or they may develop abruptly if tipping points are crossed or following extreme (acute) events, especially when compounding effects are generated. There is a lack of scientific consensus around when tipping points could be crossed and tipping points are rarely included in publicly available climate scenarios, in part due to modelling limitations.[51] To conduct a 'worst-case' quantitative risk assessment, organisations could consider the possibility of abrupt changes in physical risk drivers, whether these are modelled or assumed exogenously.
- **Treatment of uncertainty:** Physical risks are an area of continued scientific exploration and there is still uncertainty about the interaction between complex ecosystem processes, functions and services. Organisations may consider conducting sensitivity analyses for specific physical risks to capture the effects of multiple possible outcomes to inform decision making.

Box 12: An illustrative example: FPS + Nature and physical risks

FPS + Nature has been expanded to incorporate some additional nature-related risks, including physical risks, that were not included in the initial release. When expanding the FPS + Nature physical risks, the full ENCORE risk database of 41 different impacts and dependencies on nature was considered and the drivers of risk were prioritised, as outlined in and Figure 5: Nature risk drivers shortlisting process (illustrative approach – impacts).[52]

Water scarcity has clear implications for organisations, is a material risk today and in the future, and there is good data on how it could evolve over time. The data used in the expanded FPS + Nature is from the World Resource Institute (WRI)'s water withdrawal and renewable surface water supply projections. The use cases here use WRI's RCP 4.5 aligned scenario, which WRI describes as "cautiously optimistic" and aligned to a temperature increase of 1.1-2.6°C by 2100.[53] This WRI scenario is consistent with the FPS + Nature temperature outcome, as FPS + Nature assumes a warming of 1.8°C by 2100.

Pollinator decline is a material risk for producers and downstream corporates and can be estimated using publicly available data. The data used in the expanded FPS + Nature derives from land-use changes in FPS + Nature, to which a relationship between land-use change and pollinator populations are applied.[54] This gives a percentage change in pollinator population from 2020, by region. This approach is consistent with FPS + Nature

49 Physical climate impacts are also highly influenced by location-specific characteristics.

50 Additional discussion on scenario granularity is included later in this section.

51 Trust et al. (2023) The Emperor's New Climate Scenarios

52 ENCORE risk database can be found at https://encorenature.org/en

53 Data is drawn from Version 3.0 of the WRI Aqueduct tool: https://github.com/wri/aqueduct30_data_download/blob/master/metadata.md

54 Taken from Koh I. et al. (2015) Modeling the status, trends, and impacts of wild bee abundance in the United States

because it directly uses land-use changes from FPS + Nature as an input and makes no additional assumptions apart from the relationship between land-use changes and pollinator populations. Organisations should consider that this accounts for only one driver of pollinator population change (land-use change) and that data on trends in pollinator populations is poor and over-represented by studies from the US and Europe.

Soil quality is a risk today and can be estimated using publicly available data.[55] Changes in soil organic carbon are a direct result of deforestation, projected in the FPS + Nature scenario, and unsustainable tilling practices.[56] This approach assumes that increasing deforestation and unsustainable tilling practices in agriculture increase the rate of soil quality loss.

Incorporating transition risks

Nature-related transition risks are risks to an organisation that stem from a misalignment of economic actors with actions aimed at protecting, restoring and/or reducing negative impacts on nature. Scenarios incorporating these risks enable organisations to consider how changes in policy, regulation, consumer preferences and/or technology evolve over time. These risk drivers affect scenario output variables that could have implications for a corporate or financial institution.

The approach used when modelling transition risks for nature is similar to that used for climate. This partially stems from the fact that the transition risk categories of nature risk types are similar to climate risk types. Transition risk categories are policy, market, technology, reputation and liability. A similar approach can be used to gather information about risk drivers in each of these categories to help organisations understand risk driver effects.

For example, specifying the effects of both climate and nature-related policies could involve research about current and emerging policies. In both cases, organisations could consider how policy introduced in a jurisdiction could influence their business risks over time. As such, a scenario used to examine the implementation of a carbon price on emissions could be built in the same way as a scenario examining the additional cost of operating in high biodiversity areas.

A wider set of dependencies and impacts may create a broader set of specific transition risks to consider when developing nature scenarios, compared to climate. Within the transition risk categories outlined above, drivers of nature risk could be more numerous than climate. Climate policy transition scenarios are more straightforward, as the primary policy variable of interest could be the carbon price.

55 The data used in FPS + Nature takes soil organic carbon (SOC) data from Soil Grids and soil bulk density data from Tomislav Hengl (2018) Soil bulk density (fine earth) 10 x kg / m-cubic at 6 standard depths (0, 10, 30, 60, 100 and 200 cm) at 250 m resolution, Zenodo to produce SOC concentration (%) estimates.

56 Unsustainable tilling practices are taken from Porwollik, V. (2019) Generating a rule-based global gridded tillage dataset

Box 13 describes how FPS + Nature incorporates some transition risks.

Box 13: An illustrative example: FPS + Nature and transition risks

Two of the main transition risks incorporated in the FPS + Nature scenario are:

- **Policy and regulatory changes**
  - *Climate:* The scenario considers carbon pricing policies and ambition to define a carbon price that changes over time and by jurisdiction. It also considers policies that encourage fertiliser use reduction, as these could reduce emissions in agriculture.
  - *Nature:* The scenario considers land protection policies and pledges to determine how and where the area of protected land could increase over time. Protection-related land-use restrictions influence scenario outputs such as commodity production and land price. Other nature-related policy risks include land restoration policy, which is not captured by climate scenarios.
- **Market shifts and consumer trends**
  - *Climate:* The scenario considers diet shifts that could reduce ruminant meat consumption and increase consumption of alternative proteins, due to concerns about greenhouse gas emissions. This market risk influences production of commodities such as animal meat and feeds, which are part of the scenario's outputs.
  - *Nature:* Concerns about beef-related deforestation and habitat loss could drive shifts away from ruminant meat consumption. In addition, the scenario accounts for consumer preferences for deforestation-free goods. For example, consumer preferences could enable more stringent anti-deforestation policies. These could affect scenario outputs, such as the amount of deforestation or production of commodities known to cause deforestation.

Consideration of low-probability events – Tipping points

In the absence of more sophisticated modelling approaches or advances in scientific understanding of tipping points, nature scenario analysis can begin to factor in tipping points in several practical ways:

- **Qualitative solution:** Perform a qualitative assessment of risks related to tipping points. For example, organisations could consider the qualitative implications of a world where pollinator populations collapse. This could include an assessment of the effects of serious food shortages on its supply chain.
- **Quantitative solution:** Make assumptions to quantify the effect of tipping points on ecosystem services without modelling. This could involve constructing an 'event analysis' of the tipping point and using quantitative evidence or assumptions to estimate the implications of tipping points.

In the long term, close collaboration with experts and scientists can help organisations develop a better understanding of tipping points and how to model them.

Consideration of opportunities

Scenarios can help organisations to assess opportunities alongside risks. Some of the upsides of the nature transition could involve the creation of new markets and products. This is also the case for the climate transition, where carbon pricing can drive demand for novel emissions reduction technologies.

A scenario's narrative could describe the evolution of risk drivers that influence the emergence and growth of new products. For example, consumer shifts away from ruminant meat could create opportunities in alternative protein products. However, the market size opportunities of entirely novel technologies and products, for example, the market for biodiversity credits or the demand for regeneratively-produced goods, can be difficult to capture in a scenario.

One solution could be to incorporate off-model assumptions and data about changing demand and market size to specify opportunity-related scenario outputs. For example, nature-positive targets and pledges by the private sector could drive demand for biodiversity credits. Organisations could research these pledges and parallel carbon markets to inform an understanding of the potential market size.

Box 14: An illustrative example: FPS + Nature incorporates opportunities using additional assumptions

FPS + Nature accounts for growth in markets that are nascent today, such as the market for alternative proteins. Such changes in consumer preferences could create risk for ruminant meat and feed producers but opportunities for companies that produce alternatives to conventional animal products. The alternative protein market is modelled with additional assumptions around alternative protein costs relative to conventional animal protein, learning rates as alternative protein technology matures, and the costs and benefits of scaling operations. Scenario outputs related to the price and production of alternative proteins can help organisations understand their market growth potential.

The scenario also incorporates growing demand for NbS, influenced by nature policy and an increasing number of private sector commitments to nature-positive and net zero targets. NbS can sequester or avoid carbon emissions while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits, and could present a new revenue stream for companies. Future investment and revenue data for NbS is included in the FPS + Nature scenario outputs. This is based on assumptions on demand for NbS, as well as the capital and operational costs of NbS. Scenario outputs can then help organisations assess opportunities related to NbS.

Assumptions used to link narratives to outputs

Narratives can be linked to outputs through assumptions that capture the evolution of risk drivers. When using a model, these assumptions are fed into the model as parameters, which provide the model with boundaries that allow it to produce outputs aligned with the scenario narrative and set the appropriate trajectory for scenario outputs.

There are two main approaches to setting a model's assumptions depending on whether the scenario is normative or exploratory. In both cases, organisations should interrogate a model's input assumptions to ensure that they align with the organisation's worldview for the scenario. This might require the involvement of stakeholders throughout the organisation to achieve consensus, potentially in a workshop-type setting, as indicated by the TNFD guidance on scenario analysis.

- **Normative scenarios:** Parameters are chosen based on assumptions that align with a desired outcome or state of the world. For instance, this could include an assumption about how quickly land protection policies are introduced and the amount of land under protection by 2030, aligned with global goals.[57]
- **Exploratory scenarios:** Modelling assumptions are aligned with the risk driver evolution described in a scenario narrative. For instance, a bank may assess the implications of announced nature policies on the value of its portfolio by researching announced policies and using this information to make assumptions about the speed of policy action, which is used as a modelling input.

Speed of policy action could be a relevant input assumption when modelling both normative and exploratory scenarios. However, the actual speed defined and used as a model input would vary based on the scenario's underlying logic. As an example, Box 15 discusses the approach to parameters used by FPS + Nature.

57 Organisations who wish to use the GBF as the basis of a modelled normative scenario could build on the two example approaches introduced in Section 4.1 in order to parameterise core variables related to the GBF and enable modelling of GBF-aligned scenarios.

Box 15: An illustrative example: The parameters used by FPS + Nature

FPS + Nature is an exploratory scenario based on policy trends. This first entails evaluating the credibility of announced commitments, which is supported by an assessment of technology development and market shifts.

Quantitative values are assigned to drivers of risk for the purpose of defining the parameters:

- Step 1: Trends across nine different areas drive risk in FPS + Nature. For example, policy trends suggest that 90 EJ of bioenergy could be produced annually by 2050.
- Step 2: This assumption is fed into a land-use model, which then balances competing demands for land (e.g. for bioenergy production and food production) to produce scenario outputs, such as the price of bioenergy or production of maize.

Figure 9: FPS + Nature parameterises changing trends to feed into a land-use model shows an array of parameters used in FPS + Nature scenario modelling.

Figure 9: FPS + Nature parameterises changing trends to feed into a land-use model

		FPS + Nature	
	2020	2030	2050
Emissions pricing and regulation USD/tCO_2 in the land use sector, implicit	<1	54	105
Bioenergy EJ production of second-generation bioenergy	8	17	90
Diet shifts Ruminant meat production (Mt DM/yr)	38	40	37
Deforestation and afforestation Forest land (Mha)	4,000	4,100	4,300
Sustainable agriculture Nitrogen uptake efficiency (%)	56	60	65
Food waste % of food wasted	26	24	20
Nature markets USD/ha/yr for a biodiversity credit	<1	12	45
Land protection % global terrestrial protected surface area	15	20	24
Land restoration % global terrestrial surface area under restoration	0	4	6

Relevance of scenarios for specific locations

Geographic granularity may be important for nature scenarios, as some nature-related risks may be localised or context-dependent. However, it is important to balance this against the additional complexity of creating a more granular scenario, as well as consideration of whether a high degree of granularity is needed to provide decision-useful scenario outputs.

To select an appropriate level of geographic granularity, organisations could consider both the risks being assessed and the decisions scenario analysis will inform:

- **Risk drivers:** Drivers of risk act on different geographic levels. For instance, a company's market could be global, policy could be implemented at the country level, and water scarcity could apply to local basins. FPS + Nature, for example, specifies outputs on the regional level since many of the transition risks the scenario seeks to explore are well captured at the regional level, such as the European Union. Differences in how transition risks evolve between particular countries within a region may not significantly impact model outcomes (see Box 16).
- **Decisions and use case:** Decisions informed by scenarios could affect entire organisations across multiple geographies of operation or apply to smaller, more local units, such as a single asset. For example, an organisation could use a scenario to decide whether to pursue deforestation-free traceability for its product, or it could decide which manufacturing centre to prioritise when reducing water use.
- **Example of physical risks:** If an organisation is assessing physical risks across multiple jurisdictions, country-level outputs could be sufficient. For example, an organisation could use country-level water scarcity indicators to decide where to focus initial water reduction initiatives (e.g. in its Brazilian office buildings or in its Indian manufacturing plants). However, an organisation assessing the risk of water scarcity for a specific agricultural asset located within a single water basin may find granular scenario outputs more specific and useful for its context. Some risks may also be more localised than others. For example, water scarcity can be experienced in specific catchments.

Box 16: An illustrative example: Geographic granularity in FPS + Nature

FPS + Nature specifies scenario assumptions and outputs at the **regional level**. This approach balances the level of geographic granularity with pragmaticism. For example, the USA is its own region, which reflects its land mass and legislative independence, while the European Union (EU) member states make up one region, which reflects the fact that nature and climate trends may not vary substantially within the EU.

Eighteen regions and countries that cover the whole globe are included. For example, the policies that underpin the scenario capture policies announced by the EU, which would affect its constituent countries.

Regions are aligned with the geographic granularity of the land-use model used to produce FPS + Nature outputs. This ensures continuity between the scenario narrative, the parameters fed into the model and the outputs produced.

4.3. Producing and using scenario outputs

Producing scenario outputs is the final stage of nature scenario development and is important to ensure scenarios are decision useful. This section sets out how different types of scenario outputs can be used and ways organisations could expand scenarios to include additional outputs to generate further insights.

Qualitative and quantitative scenario outputs

The decision to use qualitative or quantitative outputs should be informed by the use case to ensure that the scenario exercise generates insights that are useful for decision-making:

- **Qualitative outputs** could be directional trends or categorical variables that follow from a scenario's narrative. For example, a scenario output could be the directional trend of lower deforestation over time in some areas, which could be compared to trends in other areas. An example of a categorical variable could be the existence of a policy or regulation, such as the existence of laws banning certain practices that harm nature.
- **Quantitative outputs** could be a range of different metrics, including physical units, such as ecosystem quality or crop yield, or economic and financial units, such as amount of production, consumer demand or price of a commodity. Publicly available quantitative scenarios can lower the barrier for organisations to deploy quantitative scenario outputs without needing to model them from scratch.

Scenario outputs are linked to the nature-related changes in an organisation's business environment and affect potential risks and opportunities, such as changing demand for products and commodities, or changing availability of production inputs such as land or water.[58]

Figure 10: Types of scenario outputs classified based on the factors they describe summarises types of quantitative scenario outputs, classified based on the factors they describe. This was developed through a scan of existing climate and nature scenarios, including NGFS climate scenarios and IPR FPS + Nature. The categories include:

- *Socio-economic* outputs such as GDP, which can be used in macroeconomic models to assess economy-wide effects of risk;
- *Input prices* could indicate increased production costs, which could impact an organisation's competitiveness and profits;
- *Revenue/market size* variables could affect an organisation's revenue or indicate new pools of value;
- *Investment variables* can inform potential increases in cost (e.g. due to deployment of new technologies);
- *Production quantity* can influence an organisation's revenue from products that it already produces;
- *Demand (quantity)* can indicate shifting consumer preferences, which could affect an organisation's revenue or reputation;
- *Area/stock/capacity* variables can be used to inform market size or investment requirements that could have implications for an organisation; and
- *State of nature* outputs can be combined with additional assumptions to assess the financial implications of nature-related impacts, dependencies and risks.

58 See also Cambridge Institute for Sustainability Leadership (2021) Handbook for nature-related financial risks: key concepts and a framework for identification

Figure 10: Types of scenario outputs classified based on the factors they describe

Macroeconomic Macroeconomic (financial) Macroeconomic (non-financial) Physical

Output type	Detail
Socio-economic	Population; GDP; trade
Input price	Of technology; of commodities; of land; of carbon
Revenue / market size	Of carbon taxes; of carbon or biodiversity credits; of commodities
Investment	Capex, opex, cumulative investment - into technologies; into carbon/biodiversity credits
Production quality	Of commodities (e.g. meat; electricity)
Demand (quality)	For commodities; for services (e.g. transport); for resources (e.g. water); for energy
Area/stock/capacity	Of land types; of technologies (e.g. EVs); of floorspace; of land for NBS
State of nature	Biodiversity levels; pollutant concentrations; water availability; CO_2 removals

Box 17: An illustrative example: FPS + Nature's output variables

FPS + Nature produces an extensive spreadsheet of quantitative business-relevant outputs, which can be used to estimate the financial implications of risk. They include:

- **Price and production of commodities:** Scenario outputs include price indexes and production amounts for nature-intensive commodities, second-generation bioenergy and alternative proteins (including plant-based and cell-based alternatives). Nature-intensive commodities include crops (maize, oil palm fruit, rice, soybean, sugar cane, temperate cereals, coffee and cocoa), animal proteins (ruminant meat, monogastric meat, poultry meat and dairy) and industrial roundwood. These are selected because their production and prices could be affected by the climate and nature trends that the scenario narrative focuses on.
- **Other price variables:** A global land price index captures changes in land price, influenced by land-use restrictions (such as protected areas) and demand for agricultural land (for example, to produce meat or crops). A global food price index captures changing costs of food production, influenced in part by land prices. These outputs can be used to assess how a company's input costs may be affected.
- **Nature-based solutions (NbS) variables:** Scenario outputs include levels of investment in NbS, land area covered by NbS and annual revenue from NbS. These outputs are produced for the following types of NbS: peatland restoration, mangrove restoration, agroforestry (cropland improvement), silvopasture (pastureland improvement), afforestation and forest conservation. These can be used to assess the opportunities related to NbS market growth.
- **Crop yields:** Global average crop yields can link crop production to the amount of land needed for agriculture, also accounting for the development of crop yield technologies.

State of nature variables: Outputs linked to the state of nature include ecosystem extent and condition, species extinction risk and species abundance, and specific aspects of the state of nature that may be of particular interest in a scenario, such as pollinator populations, forest extent and condition, soil quality and water scarcity. These can be used to assess physical and transition risks associated with the state of nature. For example, scenario outputs on deforestation can be used to assess reputational risks (e.g. whether a company's input sourcing locations are likely to experience deforestation).

Outputs at the right level of geographic granularity

Further adaptation and expansion of scenario outputs may be useful before deploying scenario outputs in nature-related risk assessment. This may be necessary for several reasons, including a situation where outputs are not at the required level of granularity. This is most likely to be the case for quantitative scenarios where models or publicly available scenarios provide outputs in pre-defined ways.

Organisations can refine scenario outputs to generate insights more suited to their own decisions. For example, country-level scenario outputs describing potential water scarcity could be further localised or downscaled. Expanding scenario outputs to more localised levels will likely require additional research and expertise.

Capturing all driving forces that the organisation cares about

A scenario's outputs may not capture the impact of all of the driving forces (or risk drivers) that could affect an organisation. This may be because the scenario prioritises only the most material driving forces or because certain driving forces are difficult to model. One potential solution is to supplement scenario outputs with additional variables that speak to the missing driving forces.

Organisations may initially select a scenario with a limited number of driving forces and then expand it to additional driving forces. For example, an organisation conducting a scenario exercise to understand potential reputational risks from using certain products may have existing scenario outputs on possible trends in forest cover in Central Africa, where it sources several products. To understand reputational risks more fully, it could supplement the scenario with information from consumer preference surveys to estimate how consumer perceptions about deforestation-linked products could evolve in line with the scenario narrative.

Similarly, a scenario may not produce many outputs describing the state of nature to enable the assessment of physical risks. In this case, an organisation could supplement the scenario narrative with additional data sources. For example, if the scenario focuses on transition drivers, but an organisation is interested in water availability, the organisation could leverage additional data or modelling to understand this risk.

Quantitative scenario outputs could be plugged directly into an organisation's risk assessment models. Where scenario outputs do not permit this, organisations may need to modify them before conducting risk assessment. This could be especially relevant for report preparers that want to determine the financial implications of nature-related risks, as defined in the Assess phase of the LEAP approach. For example, banks and other financial institutions may not be able to conduct risk assessment without translating scenario outputs into economic variables relevant to their counterparties' financial performance (such as costs and revenues), which can be fed into the bank's credit risk models.

Similarly, some organisations may choose to convert quantitative scenarios into qualitative indicators, if conducting a qualitative risk assessment. For example, country-level hectares of deforestation could be converted into a high, medium, low rating of country-level deforestation risk. This scenario output could then be used to identify an organisation's geographies of operation that could experience high risk of deforestation or the implementation of policies to combat deforestation.

Box 18: An illustrative example: Deriving insights from outputs on FPS + Nature

FPS + Nature's outputs describe the effects of nature and climate policy action, market shifts and technology development on economic and nature outcomes:

- **Deforestation-linked commodities** could be associated with higher levels of risk, such as market access, liability and reputational risks before policy action comes to halt commodity-driven deforestation.
- **Ruminant meat production** could fall in developed regions and at the global level. This trend occurs despite increases in developing country demand due to increasing populations and incomes.
- **Alternative protein production** could increase by 50x from 2020 to 2050, with market share potentially reaching 24% of the market for protein by 2050. This could represent an opportunity both for companies currently in this market and for companies seeking to enter this market.
- **NbS-based carbon credits** could expand in scale. Total revenue potential of NbS could reach $200 billion in 2050, with cumulative investment of more than $1.1 trillion by 2050. Companies with land-based assets may be able to capitalise on this opportunity by generating NbS-based carbon credits.

Scenario time horizon

A scenario's time horizon determines the years for which an organisation will assess risks and outputs should be produced for these years. As summarised by the Climate Financial Risk Forum, "the scenario's coverage should span the intended time horizon of the analysis."[59] Scenarios can produce outputs for one or more years, potentially informed by the scenario use case.

A scenario could be tailored to produce outputs for a single year or for multiple years. This applies to both qualitative and quantitative outputs. The TNFD guidance on scenario analysis recommends using 2030 as the first key milestone in a nature scenario analysis because this is the target date for 'halting and reversing nature loss' established in the GBF.

59 Climate Financial Risk Forum (2022) Scenario analysis: guide for banks

Box 19: An illustrative example: FPS + Nature's time horizon

FPS + Nature produces outputs in five-year timesteps. Outputs are produced from 2020 to 2050 with linear interpolation between each timestep. This enables organisations to:

- Assess risks in 2030 and 2050, or in any of the intervening years; and
- Explore how the same risk drivers and business-relevant variables could evolve over time.

Publicly available climate scenarios have a similar time horizon. For example, the NGFS produces climate scenario outputs in five or ten year intervals, usually to 2100, depending on the output and the model used to produce it.

5. Usage: Application of an illustrative scenario to risk assessment

This section outlines a step-by-step approach to risk assessment using real scenario outputs, using the FPS + Nature scenario as an illustration, and including both physical and transition risks. The use cases include the spectrum of different risk analysis types outlined in Section 3.1: focused qualitative, broad qualitative, focused quantitative and broad quantitative.

A. Focused qualitative assessment: investor pollinator risk

Stonechat Investors, a specialist agriculture investor, has identified a high exposure to fruit and vegetable producers in its portfolio. It wants to understand where it is most at risk of pollinator collapse in the next 10 years.

In particular, by following the TNFD LEAP approach, Stonechat has identified that its portfolio is highly exposed to risks related to pollinators, as declines in pollinators could impact portfolio value by reducing producers' revenues from animal-pollinated crops. Alternatively, replacing natural pollinators with pollinator services would increase costs of production, while perceived contribution to pollinator collapse could also be a reputational risk.

Stonechat would like to understand its exposure through a qualitative analysis, producing a heatmap for risks related to pollinators. It will use this as a basis to engage companies in its investment portfolio on ways of mitigating risks related to pollinators.[60]

Scenario narrative

Stonechat wants to use a scenario that represents current trajectories, with some increased nature and climate ambition. The FPS + Nature scenario does not consider changes in pollinator populations in its scenario narratives, but it does consider changes in land use and sustainable farming practices, which will influence pollinator populations. Stonechat reads the FPS + Nature online report to help develop a narrative for pollinator collapse by understanding possible future trends in land-use change:

"Pollinator collapse continues, but at a reduced pace, as the rate of land-use change slows due to falling red meat consumption, particularly in developed regions. Additionally, carbon taxation in the land-use sector could reduce the application of carbon-intensive pesticides by making them more expensive, which could help slow the rate of pollinator decline."

60 Annex 4 of the TNFD LEAP approach includes examples of use cases for risk assessment methods, including scenario-based assessments, referring to engagement with portfolio companies as one of the main use cases for financial institutions. Also see CISL (2023) Let's Discuss Nature with Climate: Engagement Guide | Cambridge Institute for Sustainability Leadership (CISL).

Scenario specification

Stonechat decides to take a regional view, as it knows granular, global data on pollinator populations is not widely available. It will use an existing, publicly available scenario because it does not have expertise in land-use modelling or pollination. Stonechat wants to understand how risks related to pollinators could evolve to 2030, as this reflects the investment horizons of companies in its portfolio, with whom it wants to engage on nature-related risks.

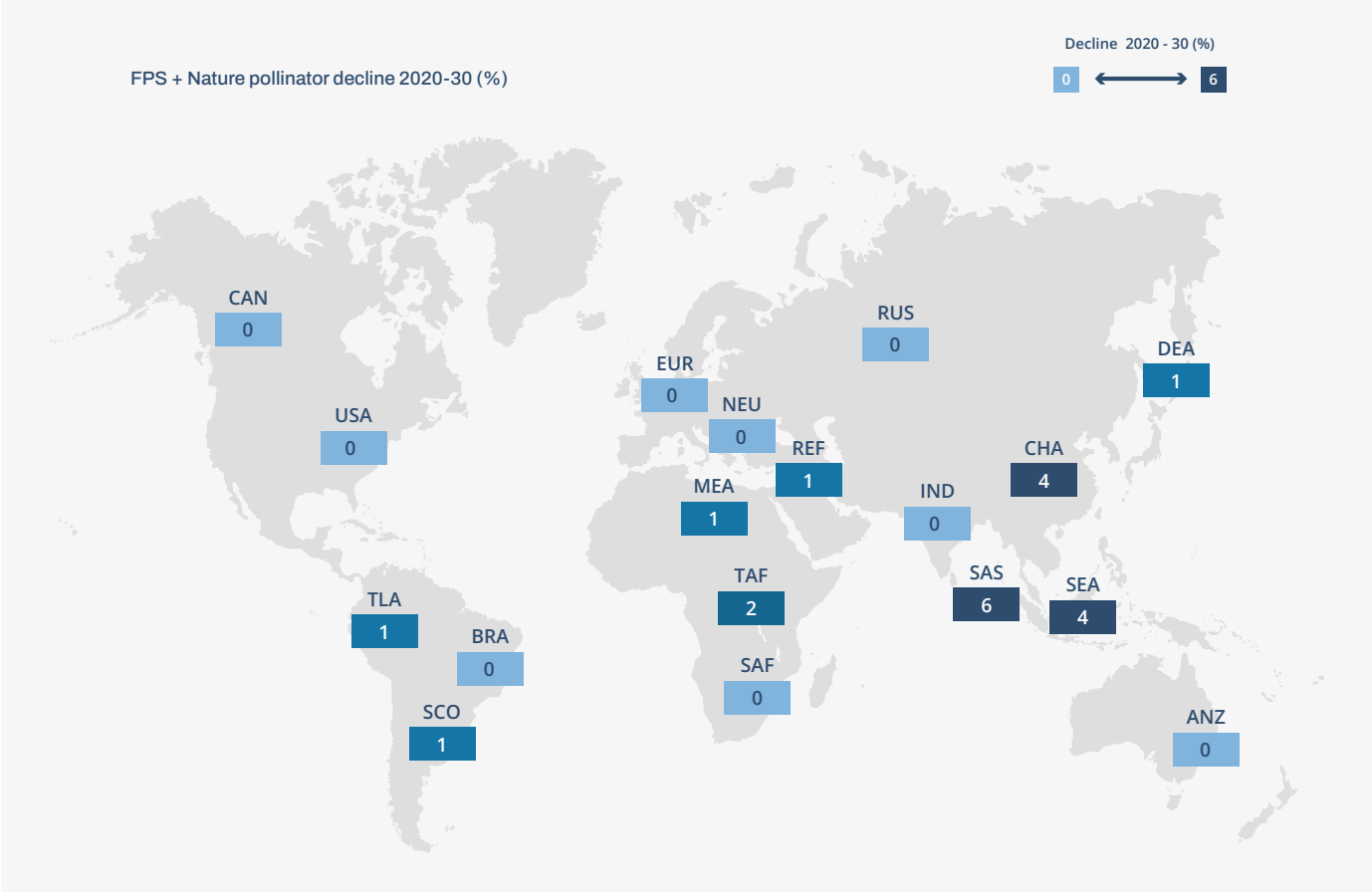
FPS + Nature provides data at the regional level for pollinator population change. It is expressed in index form where 100 equals the 2020 population. This data can be used to understand how pollinator population changes could evolve over time and between regions, helping the company understand when and where its pollinator-related risks could be greatest.

Scenario outputs

The scenario outputs are quantitative, so for this qualitative analysis the company converts them to qualitative variables by assigning the values high, medium and low risk labels. Stonechat could replace or supplement this with qualitative data generated using the TNFD guidance on scenario analysis.

The scenario shows that South Asia experiences the greatest decline in pollinator populations by 2030, with China and Southeast Asia closely behind. These regions could be considered high risk. Tropical Africa experiences a smaller decline by 2030, so could be considered a medium risk, with all other regions below this considered low risk. Although the population declines may appear small, the regional level data obscures potentially drastic localised falls in pollinator population, which could present more significant risks to the investor.

Figure 11: Map of FPS + Nature pollinator population decline from 2020 to 2030

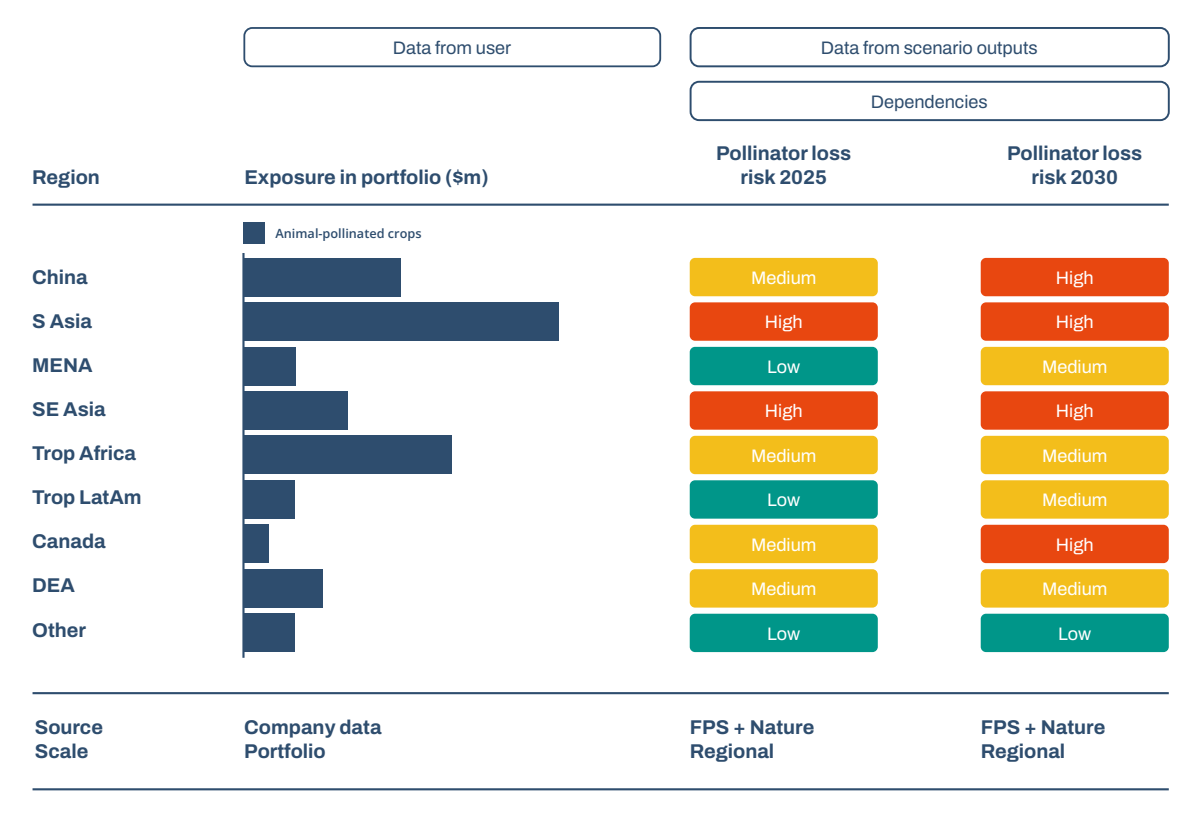


Risk analysis output

High-medium-low scores for 2025 and 2030 assigned to the different regions above are displayed in a heatmap format for the regions of interest, following Annex 4 of the TNFD LEAP approach that provides guidance on risk assessment methods, including heatmaps. Stonechat's financial exposure, in the form of invested capital in fruit and vegetable producers, is added to show how exposed its portfolio could be to these risks. For example, Canada may be at high risk of pollinator collapse, but the limited exposure to Canada in its portfolio means this is a lower risk. The investor's risk exposure may change over time as its portfolio changes.

Stonechat's heatmap shows that the company is most exposed to pollinator risks in South Asia, China and Southeast Asia. These regions are the source of a significant proportion of fruit and vegetable production value in its portfolio and have medium to high risk of pollinator collapse.

Figure 12: Pollination risk heatmap



How can this analysis be improved to better inform risk decisions?

More granular pollinator population data, alongside asset-level data on producer locations, would allow Stonechat to derive more targeted risk insights. For example, more granular data on future land-use changes would allow more precise location of pollinator decline. Stonechat could add an additional stage to the analysis by estimating the impact of pollinator declines on yields of different crops.

Next steps for the organisation

Based on this analysis, Stonechat Investors decides to use scenario findings to refine and structure its engagement approach and strategy to mitigate pollinator decline through on-farm practices. This strategy would prioritise South Asia, China and Southeast Asia. The risks identified will be reported following the TNFD's recommendations. The additional disclosure metric A8.0 is of particular relevance to this use case:

- **A8.0:** Description and value of assets/total annual revenue dependent on area affected by physical risk.

B. Broad qualitative assessment: apparel manufacturer deforestation and price risk

Crowfoot Clothing, an apparel manufacturer based in Europe, is concerned that nature-related risks could affect its financial performance in the next decade. It wants to understand which parts of its supply chain are exposed to nature-related risks.

In particular, using the Locate phase of the TNFD LEAP approach, Crowfoot has identified that the sourcing of its inputs could be located in areas of rapidly declining ecosystem integrity. Within this, it has identified two priority drivers of risks:

- **Deforestation legislation**, such as the EU's incoming requirements for deforestation-free supply chains, could present a policy and market risk to the manufacturer. This could be through additional monitoring costs, fines and reputational damage. The commodities of greatest concern are leather and rubber because of their historical links to deforestation, as well as cotton as it is a major input for Crowfoot.
- **Input costs** could increase for commodities that have high impact on nature. This could negatively affect revenues and damage competitiveness if competitors are less exposed to these market risks.

Crowfoot would like to understand its exposure through a scenario exercise, and in particular, through a qualitative analysis, producing a heatmap. It wants to do this in an internally consistent way across several risk types.

Scenario narrative

Crowfoot wants to use a scenario that represents current trajectories, with some increased nature and climate ambition. The FPS + Nature scenario is used because it matches the company's understanding of future trends, so it reads the online report to help develop narratives for the two risk drivers:

- *"Companies and governments act to reduce deforestation by 2030 through deforestation-free supply chain requirements and improved supply chain traceability. Net forest cover increases by 2030, but some deforestation may remain, particularly in regions with lower policy ambition, governance, or with a greater proportion of high-risk commodities."*
- *"Companies and governments make targeted interventions to reduce the impacts of high-risk commodities on nature, such as carbon pricing and protected areas. This could increase some input costs for high-impact commodities."*

Scenario specification

Crowfoot decides to take a regional view, as it does not currently have more granular data on its supply chain location. It will use an existing publicly available scenario because it does not have expertise in land-use modelling. Crowfoot wants to focus on a time horizon to 2030, as this reflects the company's investment horizon, and it is making investment decisions today that could determine its exposure to these risks.

It uses the FPS + Nature scenario outputs to understand how its risks change over time:

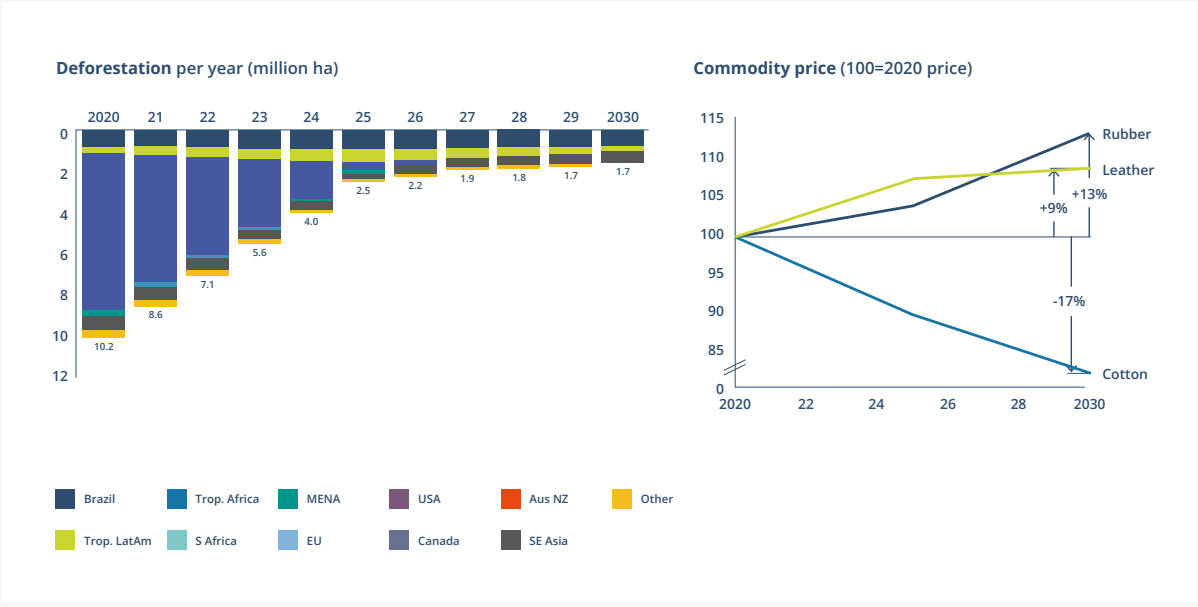
- For deforestation, the FPS + Nature scenario provides data at the regional level for **total deforestation of natural forests, in million hectares (Mha)**. This state of nature data can be used to identify which regions still experience deforestation in 2030 and therefore present a risk to the company.

- For input costs, the FPS + Nature scenario provides **price data for key commodities out to 2050**, including rubber and cotton, and ruminant meat, which can be used as a proxy for leather. This business-relevant price data can be used to assess possible input cost risks to the company for each commodity.

Scenario outputs

The scenario outputs are quantitative, so for this qualitative analysis the company converts them to qualitative variables by assigning the values high-medium-low risk labels. Crowfoot could replace or supplement this with qualitative data generated using the TNFD guidance on scenario analysis.

Figure 13: FPS + Nature deforestation and commodity price scenario outputs

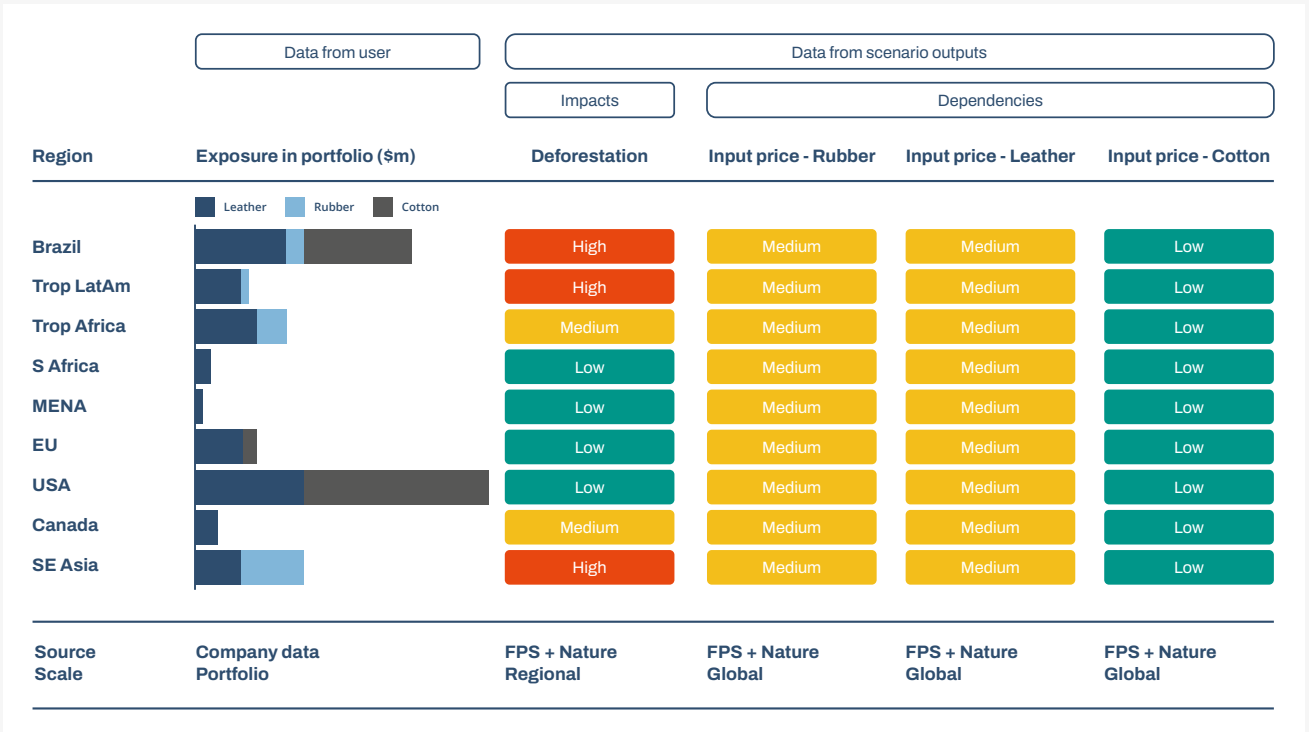


- In the FPS + Nature scenario, Brazil, Tropical Latin America and Southeast Asia still experience significant deforestation in 2030. Deforestation stops in Tropical Africa by 2030 but starts from a very high starting point in 2020. The company decides to assign Brazil, Tropical Latin America and Southeast Asia high risk, while Tropical Africa is considered medium risk and all other regions are deemed low risk.
- Global prices for rubber and leather increase by 13% and 9% respectively, by 2030, while cotton prices fall by 17%. The rubber and leather price increases are significant and could be sufficient to substantially increase costs for Crowfoot, which decides to assign these commodities as medium risk. Cotton falls in price, in part because it is not a major driver of deforestation, so this is considered a low risk by the company.

Risk analysis output

High-medium-low scores are assigned to the different risks above and are displayed in a heatmap format, following Annex 4 of the TNFD LEAP approach. Crowfoot's financial exposure is added to show how exposed its supply chain could be to these risks. For example, deforestation may be a medium risk in Canada, but the company sources very small amounts of inputs from Canada, so this risk is less tangible. The country's risk exposure may change over time as its supply chain shifts between geographies.

Figure 14: Deforestation and input price risk heatmap



Crowfoot's heatmap shows that it is most exposed to nature-related risks in Brazil, Tropical Latin America, Tropical Africa and Southeast Asia. These regions are the source of a significant proportion of leather and rubber supply for the company and have medium to high deforestation risks, with medium price risks. Despite being a major supplier, the USA is a lower risk because its deforestation risk is low and the company mostly sources cotton from here.

How can this analysis be improved to better inform risk decisions?

More granular scenario data, alongside more granular company supply chain data, would allow Crowfoot to generate more targeted risk insights. For example, using deforestation data disaggregated by commodity and by country would help identify specific commodities in specific countries that could be drivers of risk. Furthermore, regional or country data for commodity prices could help to scope alternative, lower-risk markets to source inputs from.

Next steps for the organisation

Based on this analysis, Crowfoot decides to develop traceability capabilities to ensure deforestation-free supply chains, with a priority on Brazil, Tropical Latin America and Southeast Asia. It also increases its monitoring of deforestation legislation to increase its understanding of emerging risks.

The risks identified will be reported following the TNFD recommendations. The additional disclosure metrics A12.1 and A13.0 are of particular relevance to this use case:

- **A12.1:** Description of exposure and costs related to raw material and natural resource price volatility.
- **A13.0:** Exposure to increased operational costs/loss of revenue due to reputational risks.

C. Focused quantitative assessment: beverage producer water scarcity risks

Following droughts across the globe in 2022 and 2023, Tilia Drinks, a beverage producer, wants to understand how water risks in its supply chain and operations could impact its revenues in 2030.

Using the Locate and Evaluate phases of the TNFD LEAP approach, Tilia has identified that its drinks manufacturing operations, and the food inputs to its drinks, could be located in areas of increasing water stress. Water use is a material impact of its business and water availability is a material dependency. Increased water scarcity could increase costs if it needs to invest in water-saving measures.

Tilia would like to understand what level of costs it could incur to reduce water use in its operations and supply chain by tagging assets against region-level water risks. It needs a scenario to understand how water risks could change over time.

Scenario narrative

Tilia wants to use a scenario that represents current trajectories, with some increased nature and climate ambition. It conducts research on water policy trends and consults the WRI Aqueduct website to help develop a narrative:

"Water scarcity worsens in most regions as climate change reduces water availability and water demand increases. As a result, companies are required to reduce their water consumption to bring water demand down to more sustainable levels."

Scenario specification

Tilia decides to take a regional view because this is the first water risk assessment it is conducting, and it does not currently have more granular data on its supply chains and operations locations. The company will use an existing, publicly available scenario because it does not have expertise in water modelling.

It uses the WRI RCP 4.5 scenario[61], with relevant scenario outputs published at the regional level in extended FPS + Nature scenario outputs. The following variables are used in the scenario analysis to estimate water scarcity:

1. **Water withdrawal, m^3.** This is adapted from WRI and is the annual water demand for each region from all sectors. This data is available from WRI at the catchment level, but in the FPS + Nature scenario outputs, these have been aggregated up to the regional level.
2. **Available freshwater supply, m^3.** This is adapted from WRI and is the average annual supply of surface water in each region. Note that this does not account for short-term acute shortfalls in water supply. This data is available from WRI at the catchment level, but in the FPS + Nature scenario outputs these have been aggregated up to the regional level.[62]

Water scarcity can be expressed as water withdrawal as a proportion of available freshwater supply. For example, in the USA, water withdrawals are 75% of available freshwater supply in 2030.

61 Available at https://www.wri.org/aqueduct/tools

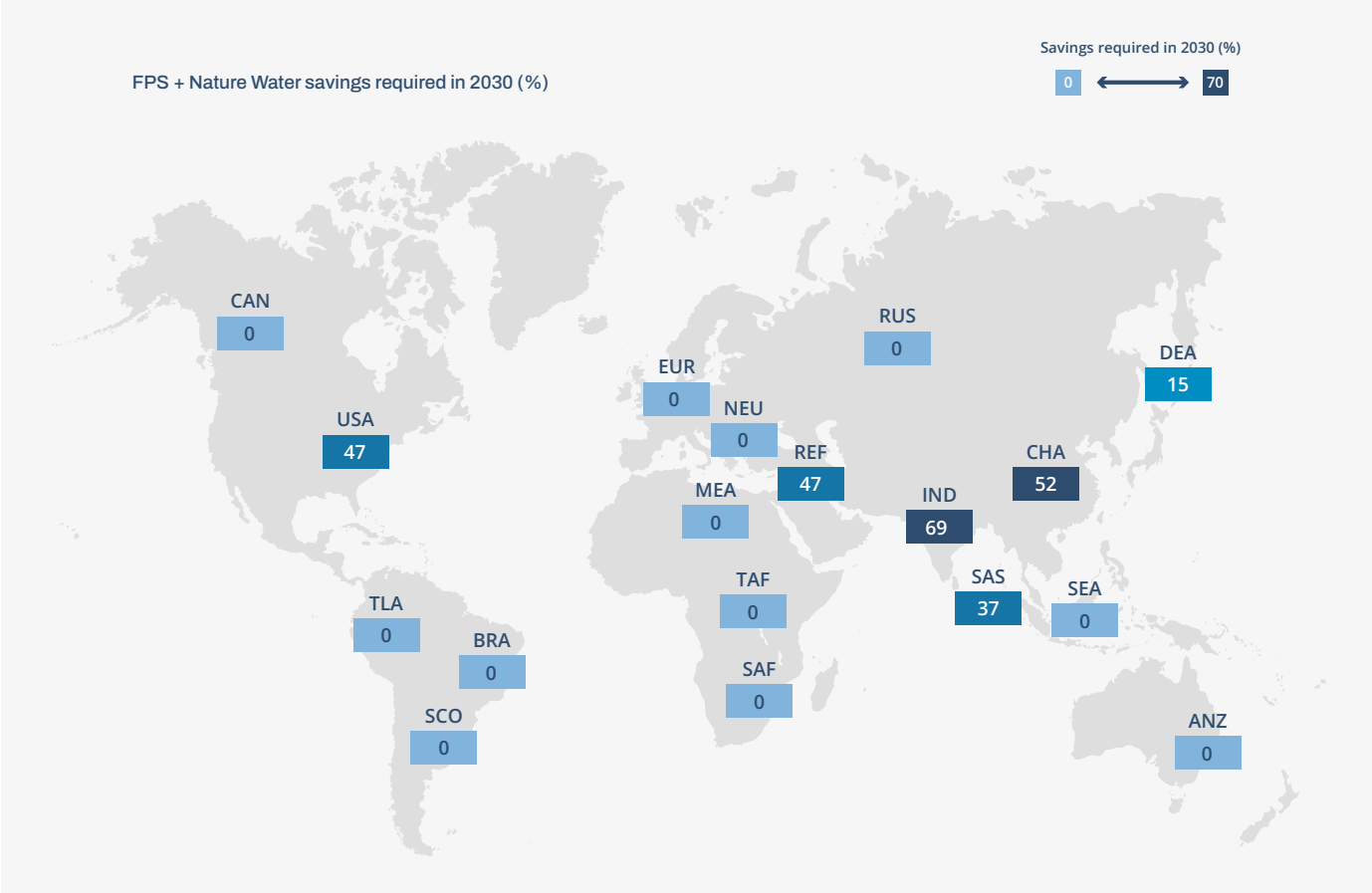
62 Additionally, ~15% of water supply is not available for withdrawal, in order to maintain freshwater ecosystem functions. See Biewald, A. et al. (2013) MAgPIE – Modelling Framework – 42. Water demand

Scenario outputs

Tilia decides to set a target for water withdrawals as a percentage of water supply in 2030 to determine what reductions in water consumption could be required. For example, the company thinks that USA water withdrawals could have to be reduced to 40% of available freshwater supply, which could mean it has to reduce its USA water consumption by 47%. This 40% reflects the boundary between medium and high water scarcity risks in WRI Aqueduct but can be modified in each region by the organisation.

Tilia's USA operations and supply chain could have to reduce water consumption by 47% and its India operations and supply chain could have to reduce water consumption by a significant 69%. In Canada and Europe, 2030 water withdrawals are already below this 40% target, so water consumption reductions are not needed.

Figure 15: Map of FPS + Nature water savings required in 2030

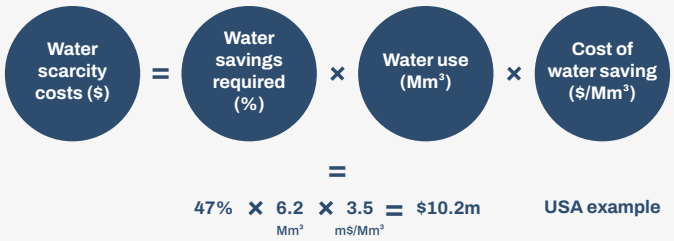


Risk analysis output

To use these quantitative outputs in a quantitative analysis, Tilia uses a simple method to convert the water savings required into a variable business cost in 2030. It does this by simply multiplying the water savings required (%) by water use (Mm^3) and the unit cost of water saving measures (million \$/Mm^3). The water savings required are from the

scenario outputs above, while the water use and cost of water savings measures are supplied by the company from internal data or from external literature estimates.

Figure 16: Water scarcity costs formula for risk analysis

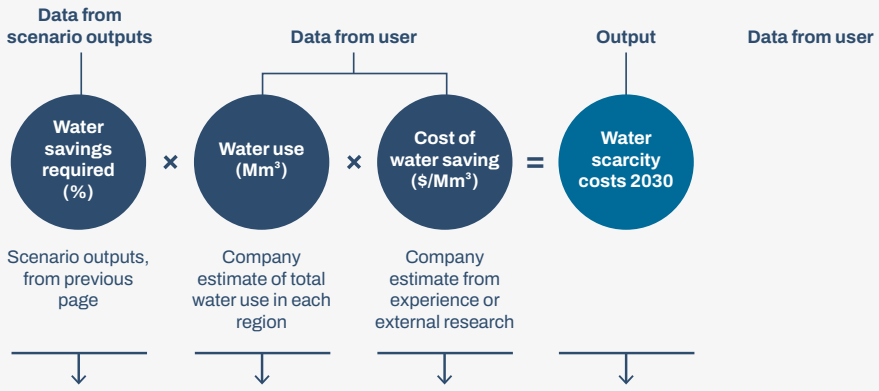


$10.2m is an estimate for the additional annual operation costs due to water scarcity in the USA in 2030.

Tilia's risk analysis indicates that the USA and India are high-risk regions for water scarcity in 2030 and estimates these annual costs will total $11.6 million in 2030. By contrast, Canada and Europe are of lower concern for chronic water security and so are not expected to incur additional operational costs. Tilia is mindful that this data obscures more localised incidences of water scarcity and does not account for the short-term impacts of acute water hazards such as droughts or floods.

The results of the asset tagging analysis, which is aligned with the risk assessment methods provided in Annex 4 of TNFD LEAP guidance, is shown in Figure 17: Water risk asset tagging.

Figure 17: Water risk asset tagging



Region	Water savings required (%)	Water use (Mm^3)	Water mitigation costs ($/$Mm^3$)	Water scarcity costs ($)	Revenues ($)
USA	4.7%	6.2	$3.5m	$10.2m	$320m
Canada	0%	4.5	$3.2m	$0.0m	$400m
Europe	0%	1.8	$4.2m	$0.0m	$170m
India	69%	1.7	$1.2m	$1.4m	$40m

How can this analysis be improved to better inform risk decisions?

Granular data on water availability and withdrawals, combined with asset-level data on operations locations, would allow greater insights into which specific operations are at risk of water scarcity. This would facilitate targeted interventions to reduce water use today or to consider relocating operations or supply chains.

Next steps for the organisation

Tilia creates a plan to invest in water saving measures in its USA and India operations and supply chain to reduce its total water footprint. It also considers relocating operations to less water-stressed areas.

Tilia also considers introducing internal water pricing to help achieve reductions in water use. This assigns an internal, shadow price for water that is used by the company to ensure that the need to reduce water consumption is factored into day-to-day decisions made across the organisation. Water prices could be set higher in regions experiencing higher water scarcity, in this case the USA and India.

The risks identified will be reported following the TNFD recommendations. The core disclosure metrics C7.0 and C7.1 are of particular relevance to this use case:

- **C7.0:** Value of assets, liabilities, revenue and expenses that are assessed as vulnerable to nature-related transition risks (total and proportion of total)
- **C7.1:** Value of assets, liabilities, revenue and expenses that are assessed as vulnerable to nature-related physical risks (total and proportion of total).

D. Broad quantitative assessment: bank quantitative risk assessment on lending portfolio

As part of its TNFD disclosure, Birch Bank wants to understand the extent to which its food and agriculture lending portfolio could be exposed to a broad range of physical and transition nature-related risks. It wants to understand the risks and geographies to which it is most exposed to inform its lending strategy and it needs a scenario to quantify how multiple risks affect counterparty credit risk over time.

Using the Locate, Evaluate and Assess phases of the TNFD LEAP approach, Birch has identified that it could be exposed to a range of transition risks, including market, technology and policy risks, and physical risks across its lending geographies. Counterparties in its lending portfolio will be exposed to these risks, which could affect its financial performance and ability to repay loans. This could in turn affect the bank's financial performance.

Birch Bank would therefore like to understand how company values in its lending portfolio could be materially impacted by a broad range of nature-related risks by 2030.

Scenario narrative

Birch wants to use a scenario that represents current trajectories, with some increased nature and climate ambition. It consults the FPS + Nature summary report and conducts additional research on water policy trends to help develop a narrative:

- *"Governments and companies begin to act to reduce impacts on nature, with a particular focus on deforestation before 2025. The state of nature continues to decline, however, with physical risks such as pollinator collapse and water scarcity continuing to heighten. Increased requirements for traceability and nature-related disclosure, as well*

as greater consumer awareness of impacts on nature, combine to create transition risks for corporates, particularly those operating in the US and Europe."

Scenario specification

Birch decides to use the extended FPS + Nature scenario outputs included in the spreadsheet. It decides to use an existing publicly available scenario because it does not have expertise in land use and water modelling, and because the range of different risks in FPS + Nature are internally consistent. The FPS + Nature scenario outputs are specified in Figure 18: FPS + Nature scenario specification.

Figure 18: FPS + Nature scenario specification

Trend 2020 to 2030

	Scenario outputs	Output value in 2030	Description
Physical risks	**Pollinator change**, by region (%)	Up to 6% decline	Driven mostly by land use changes in S and SE Asia
	Deforestation, by region (Mha)	~ 1 Mha globally	Driven by greater supply chain traceability and policy
	Water savings required by region (%)	Up to 69%	India is mostly affected by this as freshwater supply falls
Transition risks	**Rubber price change** (%)	+ 13%	Restrictions on deforestation increase prices
	Leather price change (%)	+ 9%	Restrictions on deforestation increase prices
	Cotton price change (%)	- 17%	Continued yield growth is expected to lower prices

Scenario outputs

Scenario outputs are converted into tangible outputs for the bank through transmission channels. Transmission channels express the scenario outputs in terms that will affect a counterparty's financial performance. Birch focuses on two transmission channels:

- **Costs** – Impacts on nature could incur fines or mitigation costs, while reductions in yield could necessitate further investment to offset.
- **Revenues** – Revenues could be impacted by a decline in the market size for high nature impact products, such as beef, soy or palm oil, or damage in reputation, or fall in yields.

Birch's counterparties will be affected by nature-related risks through impacts on their costs and revenues, as shown in Figure 19: FPS + Nature risk transmission.

Figure 19: FPS + Nature risk transmission

Scenario outputs	Risk transmission channel	
	Cost	Revenue
Pollinator change, in 2030 by region (%)	Companies incur costs to replace wild pollinators	Revenues fall as yields reduce due to loss of pollination
Deforestation, in 2030 by region (Mha)	Companies incur fines for non-compliance and higher monitoring costs	Revenues are impacted by reputational damage due to links to deforestation
Input price in 2030 (index)	Production costs increase as input prices increase	-
Output in 2030 by region ($)	-	Revenues are impacted by changes in market size, indicated by output
Water savings required in 2030 by region (%)	Costs increase as companies have to invest in water-saving measures	Revenues are impacted if output falls due to lower water availability

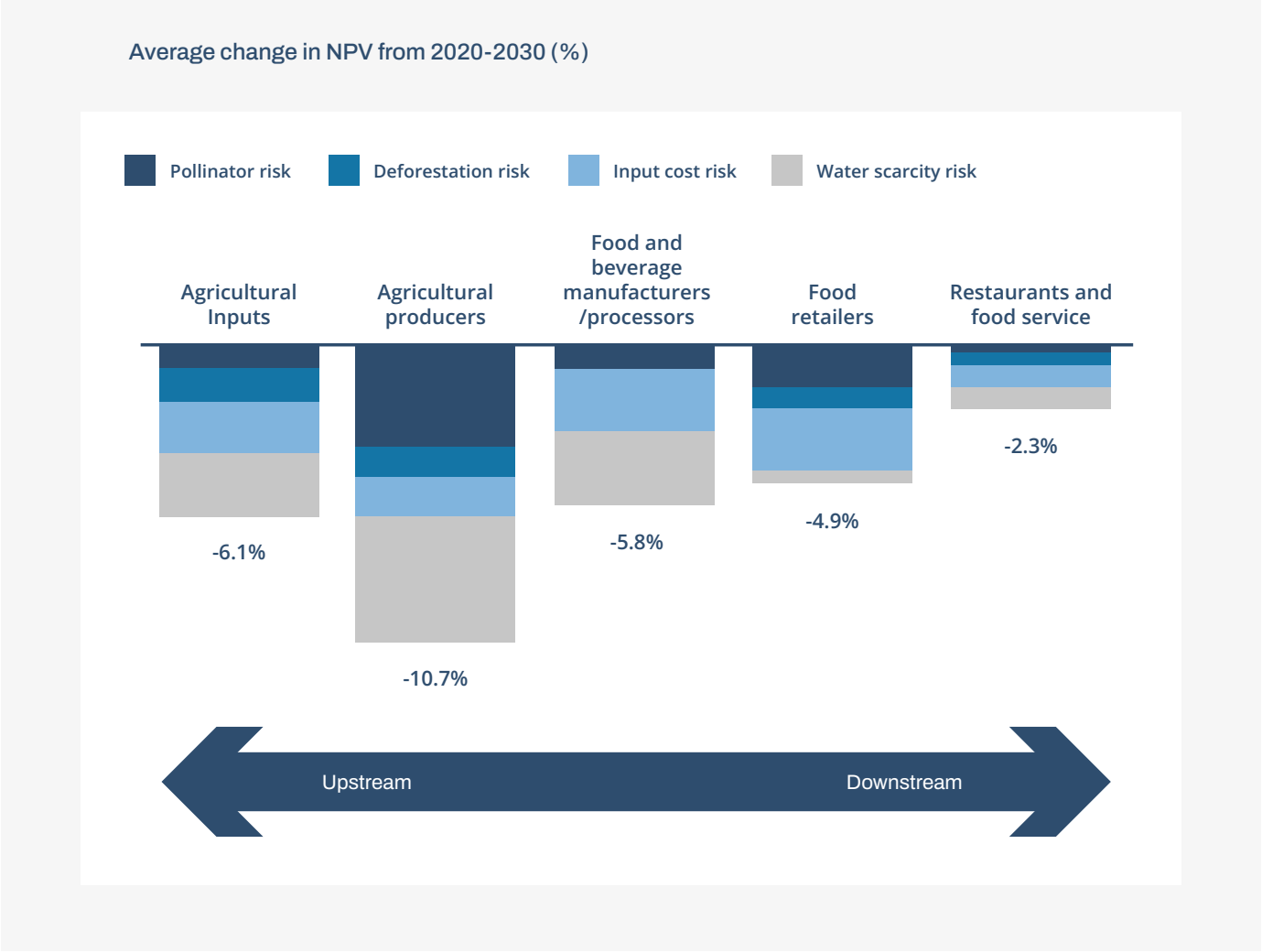
Risk analysis output

Birch uses changes in cost and revenues to assess changes in counterparty profitability and credit risk. Profitability data from the risk analysis exercise can be input into Birch's credit risk models to inform its lending and engagement strategy.

Risk analysis can distinguish between sectors, types of risks and geographies to generate insights into which counterparties are most affected by nature-related risks. This can be used to inform lending and engagement strategies. Figure 20: Illustrative counterparty average change in NPV 2020-30 for Birch Bank provides an illustrative example of how the scenario can impact the net present value (NPV) of the different lending portfolios.[63]

63 NPV is the value of all future cash flows over the life of an investment discounted to the present. It is usually used to calculate a return on investment.

Figure 20: Illustrative counterparty average change in NPV 2020-30 for Birch Bank



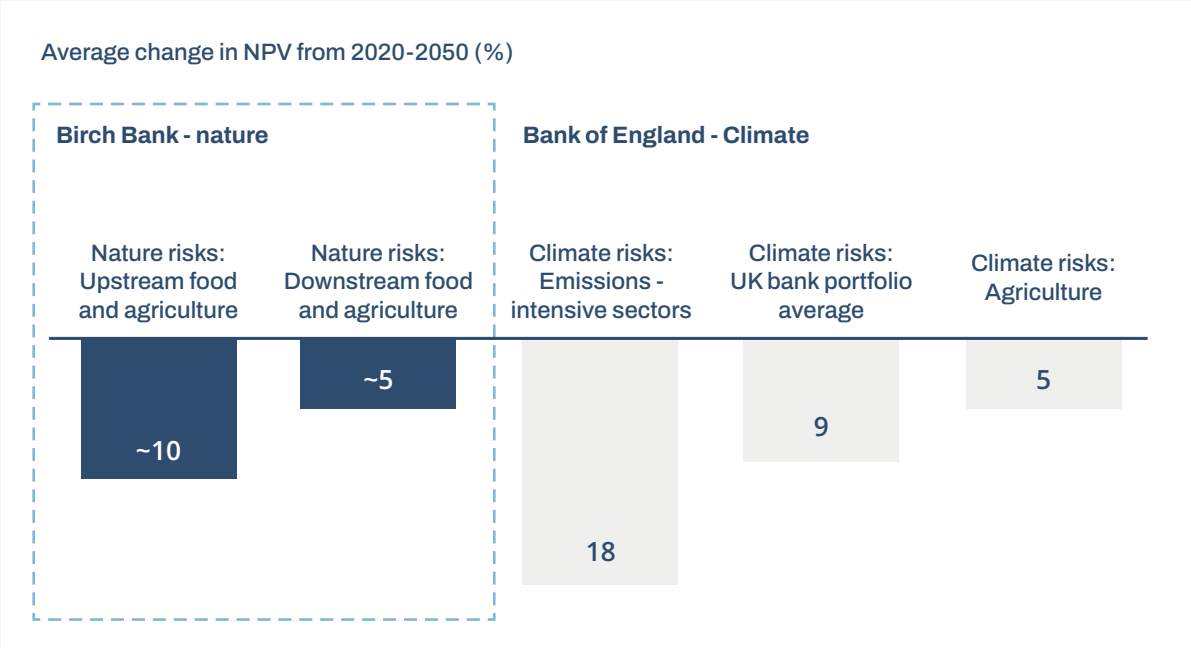
The illustrative example of Figure 20: Illustrative counterparty average change in NPV 2020-30 for Birch Bank presents a hypothetical weighted average change in value loss in the period 2020-2030 for the food and agriculture lending portfolio of Birch Bank. This is estimated under the nature scenario (i.e. calculated after taking into account changes in costs and revenues resulting from the physical and transition risks), compared to a business-as-usual future. It assumes that the companies in the bank's portfolio do not take any mitigating actions to reduce the risks that they face under the nature scenario. The average is weighted based on the exposure of the bank to individual companies in its portfolio.

There are three main takeaways for Birch Bank from this analysis:

1. Nature-related risks are most acute for upstream companies. Agricultural input providers are exposed to water scarcity risks in their operations and where their products increase water use downstream, while agricultural producers are particularly exposed to pollinator risk and water use given their high dependencies on these inputs.

2. Nature-related risks are passed downstream through higher costs and lower revenues. While physically removed from some risks, retailers and food services are impacted by price increases that occur upstream. Food and beverage companies are impacted by water risks, both passed down from upstream and experienced directly in operations, given their high direct and indirect water use.
3. Nature-related risks could be a similar magnitude to climate risk in some sectors. Birch compares its nature risk assessment results, adapted from 2030 to 2050, to the Bank of England's climate risk assessment, and finds that its impacts are of a similar magnitude to climate risks. For agriculture, accounting only for climate risks means that over half of coupled climate-nature risks are overlooked.

Figure 21: Comparison of Birch Bank nature risk assessment with Bank of England climate stress test



Source: Bank of England[64]

How can this analysis be improved to better inform risk decisions?

Granular data on all scenario outputs would allow greater insights into which risks are greatest and where these are located. Data at the country level, as opposed to regional level, would allow greater insights into locations of greatest risk. For example, some countries within the EU will be at greater risk of water scarcity than others.

Next steps for the organisation

Using this analysis, Birch creates a lending and engagement strategy to reduce nature transition and physical risks by 2030. It also implements a target for lending to companies with positive impacts on nature.

64 Bank of England (2022) Climate Biennial Exploratory Scenario (CBES)

The identified risks will be reported following the TNFD's recommendations. The financial institution core disclosure metric 1 and the cross-sector core global disclosure metrics C7.0 and C7.1 are of particular relevance to this use case:

- **Financial Institutions Metric 1:** Exposure to sectors: absolute amount or percentage of lending volume to a defined set of sectors considered to have material nature-related dependencies and impacts.
- **C 7.0:** Value of assets, liabilities, revenue and expenses that are assessed as vulnerable to nature-related transition risks (total and proportion of total).
- **C 7.1:** Value of assets, liabilities, revenue and expenses that are assessed as vulnerable to nature-related physical risks (total and proportion of total).
- **A 8.6:** Value of assets, liabilities, revenue and expenses that are exposed to nature-related physical risks (total and proportion of total).
- **A 9.0:** Value of assets, liabilities, revenue and expenses that are exposed to nature-related transition risks (total and proportion of total).

Annex: Nature-related scenario analysis in disclosure standards and frameworks

Framework/standard	Source	Details	Guidance provided
Taskforce on Nature-related Financial Disclosures	Recommendations of the Taskforce on Nature-related Financial Disclosures (2023) – Strategy	'C. Describe the resilience of the organisation's strategy to nature-related risks and opportunities, taking into consideration different scenarios.'	The TNFD guidance on scenario analysis (2023) draws from the TCFD Guidance on Scenario Analysis for Non-financial Companies and provides an approach to scenario analysis using exploratory narratives built around two critical uncertainties. The TNFD also provides an accompanying toolbox for scenario teams.
International Sustainability Standards Board (ISSB)	IFRS S1: General Requirements for Disclosure of Sustainability-related Financial Information (2023) – Strategy	'Resilience (...) – Other IFRS Sustainability Disclosure Standards may specify the type of information an entity is required to disclose about its resilience to specific sustainability-related risks and how to prepare those disclosures, including whether a scenario analysis is required.'	BC113 provides clarification on the relationship between the disclosure requirements for information about resilience and the disclosure requirements for information about current and anticipated financial effects, where the former is related to the entity's ability to cope with and withstand the effects of sustainability-related risks and related uncertainties in different scenarios.[65]

65 It should be noted that the guidance on scenario analysis provided as part of the S2 Application guidance (paragraphs B2–B18) also includes principles that could be applicable for nature-related scenarios, such as the proportionality principle, i.e. using an approach that: (a) is commensurate with an entity's circumstances and (b) enables it to consider all reasonable and supportable information that is available to the entity at the reporting date without undue cost or effort.

International Sustainability Standards Board (ISSB)	IFRS S1: General Requirements for Disclosure of Sustainability-related Financial Information (2023) – Risk management	'An entity shall disclose information about (...) the processes and related policies the entity uses to identify, assess, prioritise and monitor sustainability-related risks, including information about (...) whether and how the entity uses scenario analysis to inform its identification of sustainability-related risks'	Even though ISSB does not provide explicit guidance on scenario analysis, IFRS sustainability standards have embedded all the TCFD's recommendations and consequently its guidance, including the TCFD Guidance on Scenario Analysis for Non-financial Companies, which was referred to by the TNFD in its guidance on scenario analysis.
CDP	2023 Water security questionnaire[66]	(W7.3) Does your organization use scenario analysis to inform its business strategy? (W7.3a) Provide details of the scenario analysis, what water-related outcomes were identified, and how they have influenced your organization's business strategy.	CDP – Reporting guidance to W7.3 and W7.3a (2023) provides reporting guidance, explanations of terms, and recommendations of publicly available scenario analysis tools for assessing future water risks. CDP Technical Note on Scenario Analysis (2023) provides general guidance on how to conduct scenario analysis and how CDP has incorporated scenario analysis into its questionnaires. It mainly refers to climate-related scenarios, but also refers to water-related ones.

66 CDP's questions on scenario analysis are expected to be revised for the 2024 disclosure cycle.

European Sustainability Reporting Standards (ESRS)	ESRS 1 – Application Requirement	AR 15. 'Once the undertaking has identified its risks and opportunities, it shall determine which of them are material for reporting. This shall be based on a combination of (i) the likelihood of occurrence and (ii) the potential magnitude of financial effects determined on the basis of appropriate thresholds. In this step it shall consider the contribution of those risks and opportunities to financial effects in the short-, medium- and long-term based on: a. scenarios/forecasts that are deemed likely to materialise; and ii. potential financial effects related to sustainability matters deriving either from situations with a below the "more likely than not" threshold or assets/liabilities not, or not yet, reflected in financial statements. [...]'	None present for environmental standards other than climate change.

European Sustainability Reporting Standards (ESRS)	ESRS E4 – Disclosure Requirement related to ESRS 2 IRO-1 Description of processes to identify and assess material biodiversity and ecosystem-related impacts, risks, dependencies and opportunities	18. 'The undertaking may disclose whether and how it has used biodiversity and ecosystems scenario analysis to inform the identification and assessment of material risks and opportunities over short-, medium- and long-term time horizons. If the undertaking has used such scenario analysis, it may disclose the following information: a. why the considered scenarios were selected; b. how the considered scenarios are updated according to evolving conditions and emerging trends; and c. whether the scenarios are informed by expectations published by authoritative intergovernmental bodies, such as the Convention for Biological Diversity and, where relevant, by scientific consensus, such as that expressed by the Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services (IPBES).'	
GRI	GRI 303: Water and Effluents 2018	Guidance for Disclosure 303-1-b states that 'Tools and methodologies for identifying impacts can include life cycle assessments, environmental impact assessments, water footprint assessments, scenario analysis, and stakeholder engagement. If information is estimated or modeled, rather than sourced from direct measurements, the organization can explain its estimation or modeling methods.'	GRI 3: Material Topics 2021 includes guidance on how 'organizations can also use information from broader enterprise risk management systems', which could include nature-related scenario analysis.

Taskforce on Nature-related Financial Disclosures

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