Developing an approach to nature risk in Financial Services

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Contents

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This chapter has been written by the Nature-related Risk sub-group of the Climate Financial Risk Forum (CFRF) Resilience Working Group.

It is largely written by practitioners, and is intended to support practitioners working in banks, insurers, and asset managers, who support risk identification and strategy for climate and/or the environment. It aims to enable firms to better understand their exposure to nature-related risks and opportunities and reflect outcomes from nature-related risk assessments within strategic decision making.

This chapter reflects the collective views of contributors and may not reflect the views of any individual member or their employers.

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Foreword

In 1911, John Muir, the Scottish born environmentalist observed that "*when we try to pick out anything by itself, we find it hitched to everything else in the universe*[1]." But this 'picking out things by themselves' is at the root of our modern society and economy. Scientific discoveries are made by going deep into a topic, doctors focus on a specific piece of the human anatomy and our economy is built on the advantage through specialisation that Adam Smith identified in 1776[2].

This reductionist mindset has enabled so much technological and economic progress, but it has come at a price. We have diminished our ability to see the connections between things, to think in systems. We struggle to see the wood for the trees.

This paper builds on the first CFRF Nature-related risk publication[3] ('first nature paper'), the introductory handbook for financial institutions, to explore in more depth some of these critical connections that may not always be front of mind. In particular:

- The dependence of our human society and economy on the natural world
- The interconnectivity of the global climate and the natural world
- How climate and nature risks might materially impact society and the economy
- What actions financial institutions can take to manage these risks

It bears repeating that our society and economy is very much hitched to the natural world. The Earth system provides the essentials that underpin all our activity: air, food, water, species, energy, raw materials and climate regulation. Many of these critical support functions, or ecosystem services, are not substitutable. This means they must be protected if we are to avoid potential disruptions to economic health and human prosperity.

A novel framing of this is the concept of Planetary Solvency[4], defined as managing human activity to minimise the societal disruption from the loss of these critical support services from nature. In the same way that a solvent financial institution is one that continues to be able to provide future cashflows to meet liabilities, a solvent Earth system is one that continues to provide the services we rely on.

Much effort has been invested in developing climate metrics for financial services, to support the management of that dimension of Planetary Solvency. But the degradation of natural carbon sinks through deforestation or trawling, or the acidification and pollution of the ocean, are a risk multiplier on the impacts of climate change and vice versa. Reductionist risk management techniques that focus on single risks in isolation are likely to miss network effects and interconnections, thus underestimating systemic (cascading, compounding) risks.

This paper therefore focuses heavily on the climate-nature nexus and practical steps that Financial Institutions can take to manage this risk by building on the investments they have already made with climate change risk, to develop systemic risk assessment capability.

The sooner we can recognise the opportunities presented by nature – with some of the most significant being the repair of natural marine and terrestrial carbon sinks – the sooner we can take advantage of the vast benefits ranging from cheaper commodity prices to an acceleration of global net zero delivery and the reduction of or lowering of the overall systemic risk profile society faces

[1] John Muir, My First Summer in the Sierra, 1911.
[2] Adam Smith, The Wealth of Nations, 1776.
[3] https://www.fca.org.uk/publication/corporate/cfrf-nature-related-risk-handbook-financial-institutions-2024.pdf
[4] https://actuaries.org.uk/planetary-solvency

1: Overview

Background

In 2024, the CFRF published its first nature paper. This publication was positioned as an introductory guide for banks, insurers, asset managers or asset owners ("firms") who are embarking on their nature journey. It included information on:

- The context on nature-related risk for firms, including a definition of nature and how nature risks can be transmitted to financial institutions.
- The links between nature, ecosystem services, the economy and financial risks, including references to the materiality of nature risk.
- Emerging practice on how to incorporate nature into Financial Services risk management frameworks, including emerging practice on nature scenarios.
- Case studies showing how a range of financial institutions are performing pilots to assess nature-related risks and opportunities across their portfolios.
- An overview of the nature data landscape and key applications of nature-related data and tools for financial institutions.

This first document also signposted several other relevant resources on nature that financial institutions may find helpful. An accompanying Nature data handbook provided firms with further information on the Nature data landscape, covering:

- The different types of nature data available for use by financial institutions.
- An introduction to Earth Observation, an example of a novel source of science-based and independent geospatial data
- Available instruments and products that could improve outcomes for biodiversity.
- Practical interpretations of the TNFD's Locate, Evaluate, Assess, Prepare ("LEAP") approach, as well as future expectations.

Purpose and audience

This second handbook on nature risk builds on the first nature paper, focusing in particular on the 'climate-nature' nexus, which was introduced in the first set of publications. In addition to defining the nexus, this paper provides:

- Examples of reinforcing and dampening climate-nature interactions, demonstrating the materiality of climate to nature and vice versa.
- An illustration of how an organisation could leverage the LEAP framework to assess vulnerabilities to climate and nature risks.
- A systemic risk discussion, recognising the need to consider how to assess combined climate and nature risks, as well as wider socio-economic risk drivers.
- A discussion of the difference between planetary, socio-economic and financial risks, recognising firms have limited agency to manage broader categories of risk.
- Observations on limitations of first-generation climate risk assessment models to highlight the complexity and model risk challenge.
- A methodology for developing a specific, plausible but severe climate-nature scenario resulting in significant (e.g. 15% to 20%) global GDP contraction over a 5-year period.
- A data section, focusing on climate to nature risk data and examples of recent climate-nature risk events.

The primary audience for the paper is firms. However, regulators and policymakers with mandates related to financial and economic stability may find sections of the paper relevant.

2. Introduction: The Climate-Nature Nexus

In this section we define the climate-nature nexus, provide examples of the materiality of nature risk on climate change and vice versa, re-emphasize the potential financial materiality of these risks at a macro-economic level, provide guidance on systemic risk assessment and a worked example of how a firm could use the TNFD LEAP framework to assess vulnerabilities to combinations of climate and nature risk. The evidence of the financial materiality of nature-related risks has never been clearer - The TNFD and the Global Reporting Initiative ("GRI") have published over 600 case studies[5] demonstrating that nature-related risks are already materializing today, underscoring the urgent need for action.

2.1 Defining the climate – nature nexus and why it is important

In the first nature paper, we defined Nature as the entire natural world, including ecosystems, biodiversity, land, oceans, and the atmosphere. It includes all the physical, chemical, and biological processes that sustain life. Climate refers to the long-term patterns of temperature, precipitation, and atmospheric conditions on Earth. It is one aspect of the natural world, shaped by interactions between the atmosphere, oceans, land and living organisms. Through capturing living and non-living elements of our planet, the term nature includes climate.[6]

However, the term 'nature' can have many different meanings dependent on its usage. For the basis of discussing the climate-nature nexus, the IPBES Conceptual Framework definition of nature will be used in this paper: "**The natural world with an emphasis on the diversity of living organisms and their interactions among themselves and with their environment**."[7]

Some studies estimate that $44trn of economic value generation annually (more than half of global GDP) is moderately or highly dependent on nature and its services and is therefore exposed to nature loss.[8] Others more simply state '*the simple truth that 100% of the global economy is 100% dependent on nature.*'[9]

There is emerging recognition that Nature presents both a systemic risk to the global economy, but also micro-level risks that will emerge across regions and sectors. Financial institutions will have to consider both macro and micro nature-related risks and the impact on their portfolios.

Financial regulation has initially focused on climate rather than broader nature risks. The introduction of PRA SS 3/19 in 2019 and a number of complementary requirements at other regulators means firms are generally more familiar with climate related risk, which is now more quantifiable, model driven and increasingly acknowledged as more financially immediate through crystallization of physical risk impacts. Climate risk assessment thus benefitted from earlier framework publication, lower complexity of climate risk assessment and the associated regulatory momentum. Nature risk, in contrast, lacks a single metric like GHG emissions, meaning there are many possible assessment approaches making it harder to measure, quantity and compare nature risks. As flagged in the first nature paper, it is inherently more complex.

5

6 *Conceptual Framework on Nature-related Risk,* NGFS September 2023.

7 Díaz, S. et al. (2015) The IPBES Conceptual Framework – connecting nature and people. This definition is also referenced by the Taskforce on Nature related Financial Disclosures ("TNFD") to describe nature.

8 Research by the World Economic Forum, based on 2019 World Bank Data – WEF, New Nature Rising: Why The Crisis Engulfing Nature Matters For Business and the Economy, January 2020, p.13

9 The Future of Nature Markets | Taskforce on Nature Markets

Figure 1: Journey taken by financial services organisations in developing capability across sustainability topics

However, there is increasing recognition that climate and nature are deeply connected, from COP statements on climate and nature[10], to NGFS[11] publications acknowledging these are 'interrelated issues that cannot be treated in silos'. This interconnectivity has become known as the climate-nature nexus. Some firms are now building on approaches developed for climate risk to incorporate nature and capture synergies.

This does not mean all nature risks are climate risks and vice versa. For example, land degradation due to intensive farming, may not be directly connected to climate change. These risks can arise from unsustainable agricultural practices, overexploitation of resources, or pollution, and can have significant impacts on ecosystems and biodiversity independently of climate factors.

Why is the climate-nature nexus important?

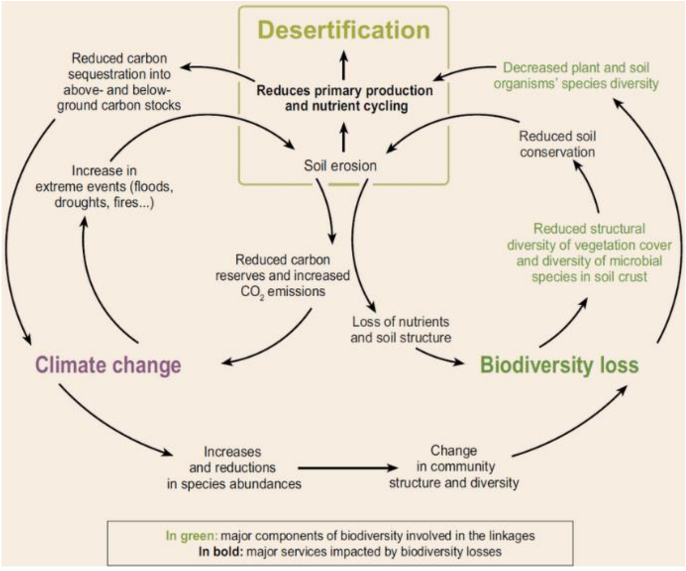
The climate-nature nexus is critical because of the deep interconnectedness between climate change and nature degradation – they intensify each other. For example, the Amazon rainforest, tropical peatlands and mangroves currently sequester around 220 GtCO2 – the equivalent of around 20 years of global CO2 emissions based on current rates[12]. Releasing even a portion of this by degrading these carbon sinks would make stabilizing the climate significantly more challenging. Oceans have played a major part in mitigating global warming impacts to date, absorbing around 30% of carbon emissions as well as absorbing around 90% of the excess heat from global warming[13]. Again, there is potential to degrade this capacity through over-fishing and destruction of marine carbon sinks such as seagrass meadows[14].

Nature-based solutions also have the potential to significantly support climate action. For example, wetland restoration can provide one-third of the cost-effective climate mitigation needed by 2030[15]. Yet, we are losing nature at an unprecedented rate, with the knock-on effect of nature degradation already being felt today. In 2024, emissions from deforestation, primarily for agriculture and as a result of forest fires, were estimated to be larger than the emissions of India, over 5% of global emissions, at 3.1GtCO2[16].

The climate-nature nexus recognises that nature and climate are so interlinked and material to each other that they must be considered together. Climate improvements that overlook nature considerations may fail to prevent or even cause damage to the natural world, create reinforcing feedback loops and ultimately lead to increased harm to the planet, while also failing to capitalise on nature based decarbonisation opportunities.

[10] https://www.cop28.com/en/joint-statement-on-climate-nature
[11] NGFS: Network for Greening the Financial System
[12] Marsden, L., Ryan-Collins, J., Abrams, J., and Lenton, T. (2024). Ecosystem tipping points: Understanding risks to the economy and financial system. UCL Institute for Innovation and Public Purpose, Policy Report 2024/03
[13] ESSD - Heat stored in the Earth system 1960–2020: where does the energy go?
[14] Good fisheries management is good carbon management | npj Ocean Sustainability
[15] The principles of natural climate solutions | Nature Communications
[16] https://gfr.wri.org/latest-analysis-deforestation-trends

Figure 2: Linkages & Feedback Loops among Desertification, Global Climate Change, and Biodiversity Loss[17]



NGFS state that nature impacts can be material at both the macro and the micro level.[18] At the micro level, nature may impact individual businesses through damage to assets. As an example, environmental decline in a region could weaken its natural protection from storms, giving way to a flood event could in turn cause more volatile prices and disruption of business. The combination of these impacts across businesses, sectors and regions can cause macroeconomic impacts on factors such as price, productivity and trade flows.[19] Mahecha et al (2022) investigate the bidirectional feedback loop between biodiversity loss and climate extremes, concluding that integrated policies that address both nature preservation and climate adaptation, are required to ensure climate mitigation efforts are successful.[20]

Indeed, a joint climate-nature transition is not only consistent with Net Zero but also has net-positive impacts on nature. This view is supported by the UK's 7th Carbon Budget, that includes nature-based solutions as a key lever for achieving Net Zero.[21]

It then becomes clear why an interconnected climate-nature approach may also be important to financial institutions, as an integrated approach that seeks to address climate change while also incorporating nature impacts, will likely result in a better understanding and quantification of risks.

2.2 Examples of climate – nature risk interconnectedness

The interconnectedness between nature and climate is not a theoretical concept—it is observable, measurable, and increasingly central to both policy and financial risk landscapes. Nature influences the climate, and the climate shapes nature, often through feedback loops that can either exacerbate or alleviate environmental and economic risks. Understanding these relationships through specific examples can inform more integrated and strategic decision-making. The NGFS summarise these interactions as follows:

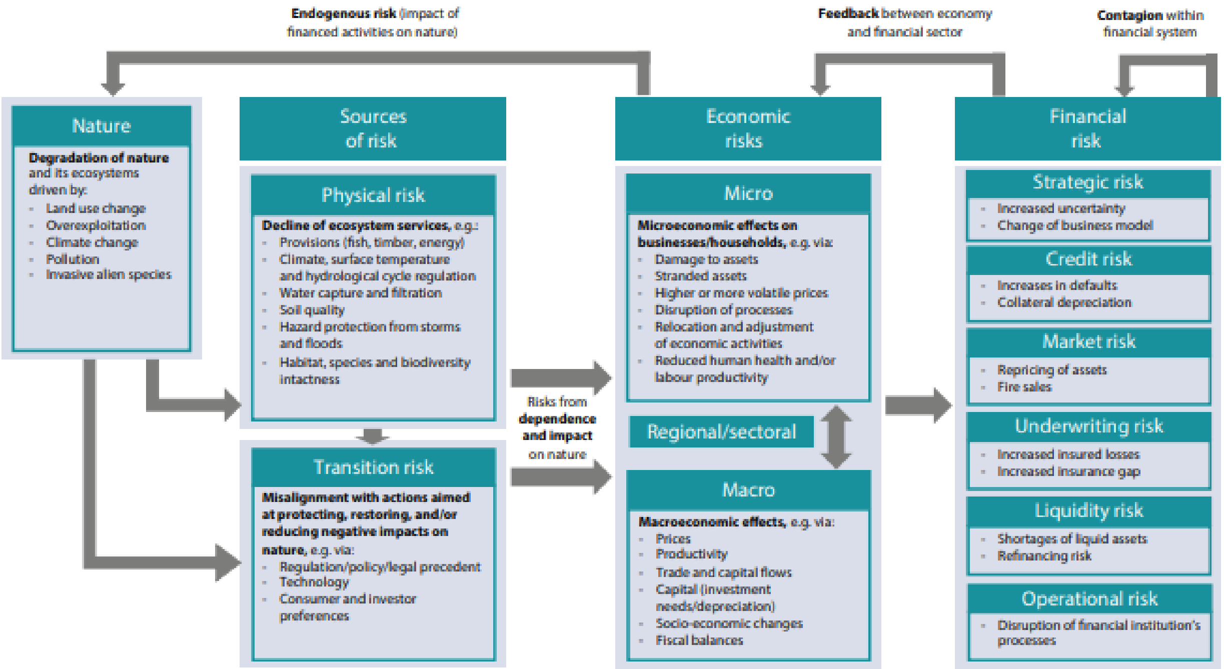
[17] Yengoh, Genesis et al, 'Applications of NDVI for Land Degradation Assessment', *Springer* (2015
[18] *Conceptual Framework on Nature-related Risk,* NGFS September 2023.
[19] *Conceptual Framework on Nature-related Risk,* NGFS September 2023.
[20] Mahecha, M. D. *et al.* Biodiversity loss and climate extremes — study the feedbacks. *Nature* **612**, 30–32 (2022).
[21] Climate Change Committee, 'The Seventh Carbon Budget', 26th February 2025.

Table 1: NGFS summary of key interlinkages between climate and nature risk

Connection	Description
Climate change as a driver of nature risk	Climate change, and the resulting rising global temperatures, is one of the main direct drivers of nature degradation. For example, increases in flooding, wildfires, ocean acidification and cyclones as a result of climate change can disrupt the water cycle, alter soil temperatures and accelerate habitat and wildlife loss.
Nature degradation as a driver of climate risk	Loss of key ecosystems increases the pace of climate change through adverse changes in the carbon, nitrogen, and water cycles. Additionally, the destruction of forests, peatlands, and other carbon-sequestering ecosystems may accelerate climate change through the release of long-stored carbon into the atmosphere alongside a reduced ability to sequester future carbon. The destruction of ecosystems such as wetlands or mangroves may also alter natural infrastructure that is important for climate resilience.
Climate mitigation and adaptation as a driver of nature risk	Combating climate change can slow the climate-driven deterioration of ecosystems. But, certain strategies for climate change mitigation/adaptation and achieving net-zero goals have the potential to cause inadvertent negative effects on ecosystems. For example, biodiversity can be harmed by poorly planned tree planting (e.g. of non-native species and monocultures), mining of materials for battery storage technology, destruction of natural areas to install solar installations, or land use changes to fulfil bioenergy needs (e.g. deforestation for wood or planting biofuel crops).
Nature as a solution to decrease climate risk	Restoration and preservation of ecosystems contributes substantively to mitigating climate change. Combatting deforestation and peatland destruction can prevent the release of stored carbon and facilitate future carbon sequestration. Conservation or extension of natural systems can also help to adapt to the effects of climate change (e.g. disaster risk reduction). For example, ecosystems such as wetlands, forests, mangroves and dune habitat increase resilience to physical shocks (e.g. storms, wildfires, landslides or floods) by providing protective barriers or buffers.

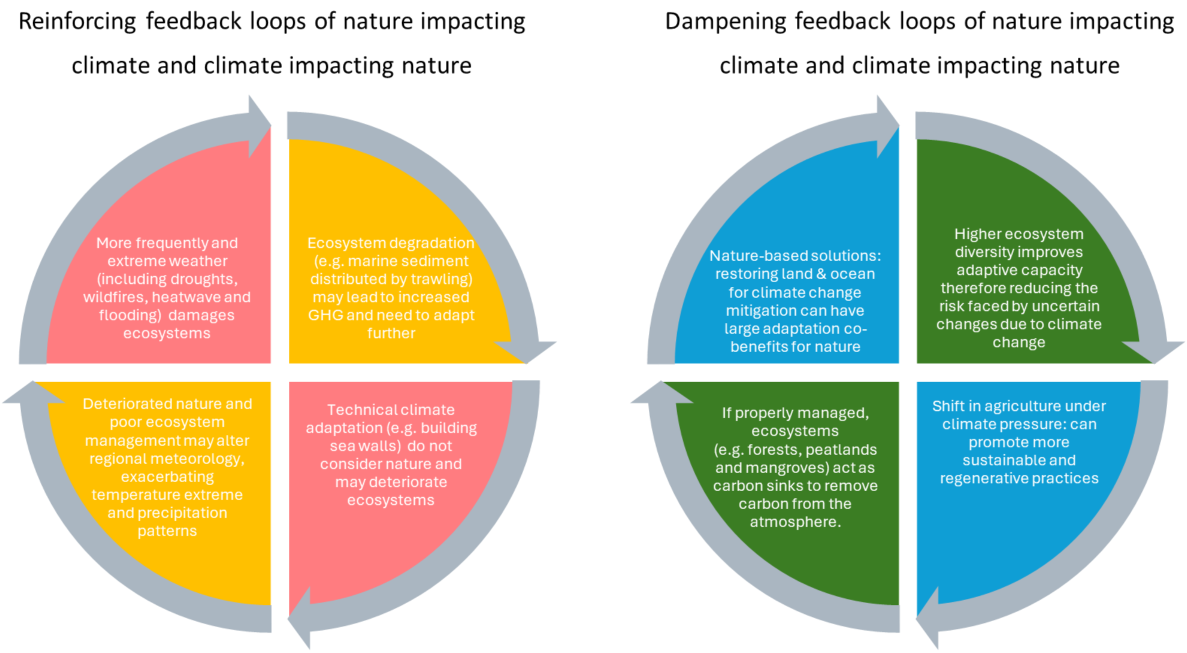
Like climate-related risks, nature-related financial risks can transmit throughout the financial system heightening legacy and well-understood risks (e.g., credit, reputational). As noted in the above table, climate change is one of the five drivers of nature risk, and as highlighted in the graphic below, can manifest in physical (e.g. nature degradation) and or transition risks (e.g. policies aimed at protecting nature) – mechanisms that we are familiar with through previous climate analysis.

Figure 3: Nature Transmission Channels & Feedback Loops[22]



Source: Adapted from Svartzman, R. et al. (2021) A "Silent Spring" for the Financial System? Exploring Biodiversity-Related Financial Risks in France.

Figure 4: Feedback loops between climate and nature systems



Feedback loops in climate and nature systems play a critical role in amplifying or stabilizing environmental change. Reinforcing feedback loops accelerate change by amplifying the effects of a disturbance. In contrast, dampening feedback loops counteract change and promote stability. Understanding these dynamics is essential for assessing systemic risks and designing effective interventions in both climate and nature contexts.

One example of reinforcing feedback loops from climate to nature is illustrated by rising ocean temperatures which have been linked to stronger El Niño events. This has intensified coral

[22] Nature-related Financial Risks: a Conceptual Framework to guide action by Central Banks and Supervisors, NGFS, September 2023

bleaching, threatening entire reef systems. Meanwhile, the loss of Arctic Sea ice contributes to permafrost thaw and carbon release (accelerating climate change), while monsoon shifts can destabilize both marine and terrestrial biodiversity.[23] These cascading impacts highlight the potential for abrupt and irreversible ecological changes, or tipping points, which reduce nature's capacity to adapt and compound climate challenges.

Conversely, ecosystems that are already degraded—through deforestation, soil erosion, overfishing, or wetland drainage—contribute to climate instability as illustrated in the Amazon deforestation case study below.

Case Study 1 – Nature's role in accelerating climate change:
Deforestation in the Amazon reduces the region's capacity to recycle moisture through forest evapotranspiration, weakening the hydrological feedback essential for maintaining rainfall. This accelerates forest degradation, making the biome drier and more vulnerable to fire, drought, and tree mortality. As a result, climate tipping points—once thought to occur at higher global temperatures—are being approached sooner. Models suggest that deforestation-induced feedback can lower the threshold for forest collapse, from 3°C to 1.5°C (today's temperatures), thereby increasing greenhouse gas emissions and altering rainfall patterns across South America[24].

Similarly, trawling in marine ecosystems releases stored carbon from seabed sediments, while also destroying biodiversity and reducing ocean resilience. This degradation impairs the regulatory functions of ecosystems and pushes them closer to tipping points—thresholds beyond which change becomes irreversible.[25]

Dampening feedback loops can arise from healthy ecosystems which provide powerful nature-based solutions that simultaneously mitigate greenhouse gas emissions, enhance climate resilience, and support biodiversity. For instance, peatlands, mangroves, and forests are highly efficient carbon sinks.[26] Their restoration not only removes carbon from the atmosphere but also enhances water retention, buffers against flooding, and stabilizes local climates. In agriculture, diverse ecosystems improve soil health and reduce vulnerability to climate shocks. In cities, green infrastructure such as urban forests can reduce heat stress and improve air quality.[27]

Dampening feedback loops can work both ways: taking ambitious climate action—such as staying within the 1.5°C target—also protects ecosystems from tipping points. Stabilized climate conditions reduce the risk of extreme events and give ecosystems time to recover and adapt. When protected, nature becomes a cost-effective ally in adaptation strategies. For example, protecting and restoring coastal wetlands often delivers better flood protection and co-benefits (like fisheries and tourism) than engineered defences.[28]

Case Study 2 – Restoring peatlands, a beneficial nature-climate feedback:
Healthy peatlands act as carbon sinks, removing significant amounts of CO_2 from the

[23] Wunderling, N., von der Heydt, A. S., Aksenov, Y., Barker, S., Bastiaansen, R., Brovkin, V., ... & Willeit, M. (2024). Climate tipping point interactions and cascades: a review. Earth System Dynamics, 15, 41–74. https://doi.org/10.5194/esd-15-41-2024
[24] Flores, B. M., Montoya, E., Sakschewski, B., Nascimento, N., Staal, A., Betts, R. A., ... & Hirota, M. (2024). Critical transitions in the Amazon forest system. Nature, 626, 555–561. https://doi.org/10.1038/s41586-023-06970-0
[25] Finance for Biodiversity (F4B) & UNEP-WCMC. (2022). An investor guide to expanding from climate- to nature-data. The Climate-Nature Nexus: An investor guide to expanding from climate- to nature-data – TNFD
[26] Green Finance Institute. (2024). Assessing the Materiality of Nature-Related Financial Risks for the UK. London, UK. Green Finance Institute
[27] Finance for Biodiversity (F4B) & UNEP-WCMC. (2022). An investor guide to expanding from climate- to nature-data. The Climate-Nature Nexus: An investor guide to expanding from climate- to nature-data – TNFD
[28] University of Cambridge Institute for Sustainability Leadership (CISL). (2022). Integrating climate and nature: The rationale for financial institutions. Cambridge, UK. Integrating climate and nature: The rationale for financial institutions | Cambridge Institute for Sustainability Leadership (CISL)

atmosphere, while also improving water retention and reducing flood risks. In regions like the UK and northern Europe, peatland restoration has led to measurable decreases in flood-related insurance claims. A study by Cambridge Econometrics[29] estimates that for every £1 invested in peatland restoration in the UK, there is an average return of £4.62 in economic and social benefits. This figure reflects avoided damages from flooding, enhanced carbon sequestration, and improved land productivity. These findings demonstrate that investing in ecosystem recovery strengthens natural climate resilience while also reducing economic vulnerabilities, delivering both environmental and financial gains for local communities, businesses, and insurers.

In summary, nature-climate feedback loops can amplify and accelerate environmental and economic disruptions beyond the capacity for individual institutions or sectors to manage, creating conditions for systemic risks that propagate through financial systems and threaten broader economic stability. Understanding how to assess these systemic risks could help maintain system stability and prevent localised shocks from evolving into broader economic disruption.

2.3 Principles for systemic risk assessment

Systemic risks are defined in this context as risks to an institution that are not triggered by individual agents failing but by a breakdown of the entire economic system often triggered by interconnected vulnerabilities and cascading failures. Traditional risk management approaches often consider risks in isolation, attempting to estimate the likelihood and severity of a particular risk, to inform whether any action is required to avoid or adapt to the risk. However, as evidenced by the Global Financial Crisis, even though the capability of individual organisations may be limited when it comes to managing systemic risk, their exposure may still be significant.

Systemic nature-related risks ("systemic risks") are risks driven by the degradation of nature, and its ability to provide key ecosystem services (such as freshwater availability, pollination, and climate regulation). The economic system relies heavily on nature's ability to provide such services[30], whose degradation can lead to systemic risks via different channels such as (but not limited to) supply chain disruptions, commodity price volatility, geopolitical and social instability, and climate-nature nexus and tipping points breaches. Importantly, ecosystem services are in many cases not substitutable, meaning they must be protected to avoid disruption. Nature risks can then translate into financial risks[31] across different market participants (including governments, financial institutions, corporations and households) via spill-over effects onto productivity, trade, inflation and GDP growth.

The Network for Greening the Financial System ("NGFS") recognises[32] three effects through which nature loss may become a systemic financial risk:

i. **compounding** (i.e. loss of an ecosystem service triggers the loss of other services);
ii. **cascading** (i.e. risks propagate via global supply chains);
iii. **contagion** (i.e. risks on a single market agent propagates to other market participants).

[29] Cambridge Econometrics. (2020). Economic costs and benefits of nature-based solutions to mitigate climate change. Final Report for the Royal Society for the Protection of Birds (RSPB). Cambridge, UK. Retrieved from https://www.camecon.com/wp-content/uploads/2021/03/The-economic-costs-benefits-of-nature-based-solutions_final-report_FINAL_V3.pdf?
[30] https://www.weforum.org/press/2020/01/half-of-world-s-gdp-moderately-or-highly-dependent-on-nature-says-new-report/
[31] https://www.ngfs.net/system/files/import/ngfs/medias/documents/ngfs_occasional_paper_green-scorpion_macrocriticality_nature_for_finance.pdf
[32] https://www.ngfs.net/system/files/import/ngfs/medias/documents/ngfs-conceptual-framework-nature-risks.pdf

Systemic risks cannot be fully diversified and are inherently hard to mitigate. This makes the identification, assessment and monitoring of systemic risks essential for financial institutions and requires a holistic view of the non-linear interrelations between climate and nature risk.

A useful risk taxonomy is provided by Sachs et al in '*Distinguishing Among Climate Change-Related Risks*[33]' where the argument is put forward that risks need to be disaggregated into three categories, defined as:

1. **Planetary risks** - broad, systemic changes to Earth's ecosystems and human societies resulting from climate change, and physical impacts on people, biodiversity, and ecosystems.

2. **Economic risks** are costs of degradation of assets, societal costs associated with physical impacts, such migration and economic costs of the energy transition.

3. **Financial Market Risks** are fluctuations in financial asset and portfolio valuation, which may arise as a consequence of planetary and economic risks.

Sachs et al posit that a taxonomy of this nature may help financial institutions to consider which risks they are exposed to, how they transmit to relevant financial metrics that impact balance sheets and which risks they can in fact manage. This links to a broader discussion on the extent to which idiosyncratic financial institutions are able to manage systemic risks, with increasing recognition that their agency may be limited for a number of reasons[34].

While there are systemic risk assessment methodologies, it is a relatively new area for firms with market practice developing. Nonetheless, there are a number of systemic risk tools that may be helpful for firms. The Accelerator for Systemic Risk Assessment[35] provides guidance on analytical techniques including causal loop diagrams, systems mapping, systems dynamics and Bayesian belief networks[36]. Examples of systemic risk assessment can be found in the WEF Global Risk[37] outlook, which uses a systems mapping approach, the UN's 2023 Interconnected Disaster Risk report[38], which analyses six interconnected risks that represent large global issues, and the IPPR's security blind spot[39], which examines the risks to UK national security from cascading climate change impacts and tipping points (AMOC[40] & SPG[41] collapse). The Cascade Institute has developed a framework for 'polycrisis analysis'[42], designed to support governments with assessing and responding to global risks more effectively.

The systems mapping approach allows users to identify interactions between risks visually and see risk clusters: groups of risks which might not individually cause concern but which in aggregate require attention.

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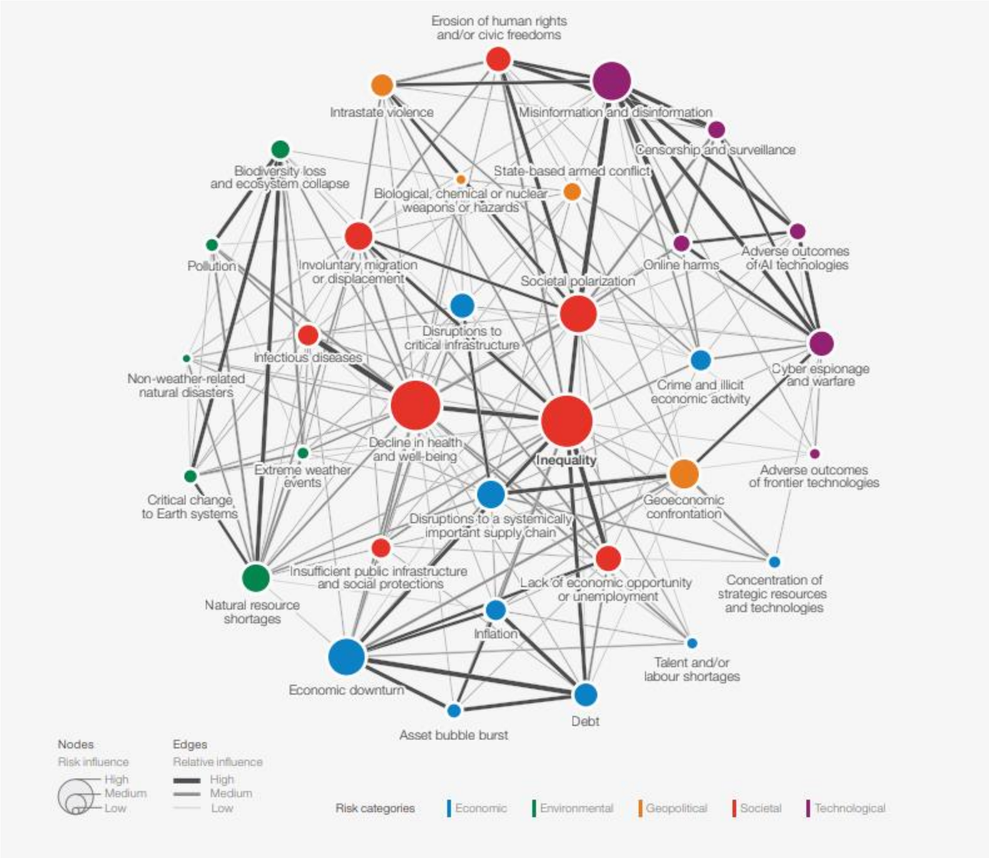
[33] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5169770
[34] https://ccsi.columbia.edu/sites/ccsi.columbia.edu/files/content/docs/publications/ccsi-institional-investors-responsibilities-systemic-risks-fiduciary-duty-report.pdf
[35] https://www.asranetwork.org/
[36] ASRA Network | Tools & Insights
[37] www3.weforum.org/docs/WEF_The_Global_Risks_Report_2024.pdf
[38] Home 2023 - Interconnected Disaster Risks
[39] The security blind spot
[40] AMOC: Atlantic Meridional Overturning Circulation
[41] SPG: North Atlantic subpolar gyre
[42] Framework on Management of Emerging Critical Risks - Polycrisis

Figure 5: Global risks landscape: An interconnections map[43]



Recognising that systemic risk assessment may be a developing field for some firms where they need to build capacity, a practical first step may be considering results from the TNFD's LEAP framework to formulate top-down and/or bottom-up scenario-based outcomes, subject to data and tool availability.

TNFD's LEAP as base framework (see case studies in first nature paper)

Financial Institutions can use the Locate, Evaluate, Assess and Prepare (LEAP) framework as structured by TNFD (Taskforce on Nature-related Financial Disclosures) to (i) identify systemic hotspots (geographical and sector-based) where lending/investment/underwriting exposures might face heightened nature-related transition and physical risks, and (ii) understand how increasing nature-related transition and physical risks could directly affect credit and liquidity conditions. The first nature paper provides a number of case studies.

A qualitative scoring approach (also based on expert judgement) based on the Locate and Evaluate steps can grade the level of risks firms face in their portfolios and inform focus areas for further evaluation and assessment. The materiality of these risks and their financial impacts can be assessed by employing scenario-based analysis combining elements of physical climate risks and nature risks, to explore the impact of cascading, compounding and contagion effects.

Introducing nature-driven shocks into existing climate scenarios

A top-down approach considers impacts for nature-climate feedback loops by leveraging and adjusting macroeconomic variables in existing scenarios. For example, this can be carried out through an extensive literature review on macroeconomic impacts[44] (such as decreasing GDP growth, lower productivity, higher inflation) from selected drivers of nature degradation (such as

[43] WEF_Global_Risks_Report_2025.pdf

[44] Examples of literature covering macroeconomic impacts from nature include "The Economic Case for Nature" from the World Bank and "Assessing the Materiality of Nature-Related Financial Risks for the UK" from the Green Finance Institute

pollution, land use change) and embedding them into existing physical risk scenarios. Analysis can be tailored to consider firms' exposures to selected geographies and sectors (as per output of the Locate and Evaluate steps of the LEAP framework) (direct impacts) as well as considering how to incorporate systemic impacts from specific risk events such as tipping points (indirect impacts, such as the dieback of the Amazon Forest) (see Section 3 for more).

A bottom-up approach, instead, drills down into the granularity of firms' books by conducting desktop reviews of key clients'/investees' exposures and assets to the nature-climate feedback loop. The desktop review might consider direct and indirect impacts, via supply chain. This could be carried out by leveraging existing databases that firms have built using clients/investees' key operating assets to assess their physical risk exposure, alongside a review of their value chain position. Sector and geographical heatmaps, alongside expert judgement, can be leveraged to this end. Results of the analysis can be used for overlaying results from climate physical risk scenarios to inform engagement with clients to develop strategies and products to mitigate these risks.

Whether analysis is carried out using a top-down, bottom-up approach or in a combination, uncertainty underpinning estimations, sector heatmaps, assumptions on supply chain interlinkages and the non-linearity of the nature-climate nexus are important limitations to consider. As with climate, this is likely to be an iterative process, that develops in sophistication over time.

2.4 Case studies for systemic risk assessment

The Green Finance Institute (GFI) developed the UK Nature-Related Risk Inventory (NRRI)[45], which outlines key risks to the UK from nature-related threats. While it's difficult to fit all of these risks neatly into the climate-nature nexus categories (Section 2.3), their interconnections are clear. Key UK-based risk examples include:

- Flooding from deforestation and soil degradation
- Algal blooms in water ecosystems
- Water shortages affecting energy and agriculture
- Air pollution from wildfires
- Tourism risks from environmental damage

We provide below two illustrative case studies based on flood risk assessment for a home insurance company and a financial impact assessment for the mining and European power industries[46].

Case Study: Financial impact assessment for the mining and European power industries

This section presents a case study performed by Barclays focused on an assessment of potential financial risks in the mining and power industries, which is relevant for financial institutions with exposure to those sectors. Barclays have developed a quantitative methodology for calculating the associated financial risks across large financial portfolios using scenario analysis. Stress tests estimate potential cumulative negative earnings impact of around 25% across the six scenarios for in scope Mining companies over five years, mainly driven by transition risks, and approx. 10% for in-scope Power companies. The impact on the mining sector is partially offset by rising demand for certain critical minerals linked to the climate transition.

[45] UK Nature-Related Risk Analysis Update, GFI, Feb 2024
[46] Navigating Nature Risk: Applying the TNFD's LEAP Framework, Batclays, September 2025

Figure 6: Excerpt from Barclays' aggregation of risks and scenario drivers table

Impact/ dependency	Transition/physical risk and related scenario narrative	Year 1	Year 2	Year 3	Year 4	Year 5
1 **Ground water & surface water *(dependency)***	**Drought scenario:** Droughts take place for several months in two consecutive years. This impacts ground water and surface water availability in the affected regions. Water mismanagement and a failed prioritisation of critical industries are leading to widespread water stress.	Production impact				
2 **Flood and storm protection *(dependency)***	**Flood scenario:** Flooding caused by heavy rainfall taking place simultaneously in several regions damages access roads, bridges and power lines, cutting off power plants and mines from infrastructure and/or disrupting mining operations temporarily.	Production impact				
3 **Water use *(impact)***	**Water policy scenario:** In response to the sustained and repeated droughts, affected countries implement instantaneous and stringent policies. The policies contain abstraction and discharge charges to reduce water stress.		Cost impact			

Case Study: Flood-related systemic risk assessment by a UK-based home insurance company

This section presents a case study focused on systemic risk exposure from the nature-climate nexus, particularly for financial institutions with exposure to flood risk. It does not assess financial materiality (Section 3) or data types used (Section 4). The case study uses the TNFD's LEAP framework to explore how risks can compound, cascade, and spread across systems, as discussed in Section 2.3, and is summarized in the following table. While written from the perspective of a UK-based home insurer we hope the principles and approach will be practically useful for other types of firms and exposure.

Table 2: Systemic risk exposure across the LEAP framework

UK Home Insurance: Systemic risk assessment for nature climate nexus triggers				
	Locate	**Evaluate**	**Assess**	**Prepare**
Risk 1: Compounding	Understand whether the loss of ecosystem services triggers loss of other services. In this case, the company will identify properties where flood risk is compounded by a combination of climate and nature factors: extreme rainfall, soil degradation, and loss of wetlands.	Score identified locations based on physical risk criteria, such as: 1) Frequency, likelihood and intensity (severity) of extreme weather events (e.g. Met Office data), 2) Condition of ecosystems (wetland health, soil compaction, riparian buffer loss), and 3) Land cover/use changes (e.g. % of impermeable surface in flood-prone areas) If data is available, include scoring based on individual homes' flood adaptation measures.	Assess present-day risk using 'bottom up' scenarios based on a review of its whole book based on geographic heat maps, or a risk matrix that combines indicators for rainfall, ecosystem health, and land use changes. Assess future risk using 'top down' scenarios, such as different climate modelling pathways or different land use trajectories (e.g. agricultural intensification vs. nature-based solutions)	Prepare risk mitigation measures insured properties, with a focus on nature-based solutions to mitigate flood risk.
Risk 2: Cascading	Understand whether flooding caused by the nature-climate nexus could cause knock-on effects; in this case, within its flood claims supply chain. Identify trigger points at which the supply chain's capacity is overwhelmed, and delays/changes in claim indemnification cause a surge in claims costs and other effects.	The company will score resilience of its claims supply chain by looking at: 1) Reliance on infrastructure. This could include interdependence of infrastructure systems (e.g. proximity of roads to flood zones), and preparedness/resilience ratings of infrastructure (e.g. from National Infrastructure Commission or local resilience forums). 2) Ranking of centrality by supplier types. Use a RAG/traffic light system to understand time-based cruciality of suppliers, e.g. emergency services, home drainage and drying, and assessors. 3) Critical service disruption frequency during past flood events (e.g. tendency toward delays from particular supplier types)	Assess future risk by simulating a major storm event under future climate and nature conditions. It can use network analysis to trace how disruption spreads across systems like transport. The company can also map likely failure points (e.g. flooded substation, closed motorway) and downstream impacts (e.g. food supply interruption) to evaluate the potential for widespread economic impact.	Prepare supply chain resilience measures for its flood suppliers. This can include retaining more suppliers for central areas or understanding alternate methods of transport for time-sensitive suppliers.
Risk 3: Contagion	Understand where the risk is concentrated and who depends on the insurance to fix assets post-flood. Through traditional risk types: **Credit**: including Mortgage lenders, SME loan books, municipal bonds, property-backed securities. **Liquidity**: Real estate and infrastructure funds, reinsurance markets, banks with high exposure to physical assets in flood zones. **Operational**: - Data centres, call centres, and logistics hubs located in low-lying areas. - NHS trusts, local councils, and banks relying on single-site infrastructure. - Firms with inadequate disaster recovery and supply chain resilience.	**Credit vulnerabilities:** - Inadequate pricing of flood risk in property values and credit assessments, or - dependence on insurers to absorb property losses—assumes stable reinsurance market. **Liquidity vulnerabilities**: - Concentration of investor funds in real estate-heavy portfolios. - Thin secondary markets for flood-exposed municipal debt or SME loans. - Short-term liabilities backing long-term, illiquid physical assets. **Operational vulnerabilities**: - Lack of backup infrastructure for critical operations (e.g., power, data, logistics). - Just-in-time supply chains unable to withstand multi-day disruptions. - No integration of nature degradation in Business Continuity Planning (BCP).	Plausible stress scenarios: **Credit Risk** - Mortgage default rates rise in affected areas. - Property-backed bonds lose value → investor losses - Local councils downgraded → borrowing costs rise. **Liquidity Risk** - Insurance claims surge → reinsurance squeeze → insurers suspend new underwriting. - Redemption pressures on real estate and infrastructure funds → fire sales. - Bank treasuries face cash flow strain from flood-damaged loan portfolios. **Operational Risk** - Key payment systems and customer service ops go offline (e.g., due to flooded data centres or outages).	Mitigation actions: **Credit** - Require flood-risk-adjusted collateral valuation in lending. - Expand mandatory nature risk disclosures aligned with TNFD/ISSB for lenders. - Local authority debt stress tests incorporating flood and nature loss metrics. **Liquidity** - Pre-position central bank liquidity tools for post-flood confidence shocks. - Develop climate-nature risk-aware redemption gates for at-risk funds. - Require longer duration matching for real asset funds in high-risk zones. **Operational** - Mandate flood resilience planning for critical infrastructure (e.g. dual-site operations, cloud-based redundancies). - Incentivise firms to map nature degradation in their BCP and supply chain risk assessments. - Cross-sector drills between financial institutions, local authorities, and regulators to simulate multi-site flood events.

3. Potential Financial Materiality of Nature-related Risks

In this section we discuss the potential materiality of climate and nature-related risks. Rather than exhaustively referencing relevant studies, we highlight the importance of understanding the limitations and assumptions of approaches, building on the learnings from 5 years of climate change scenario analysis in financial services. As well as covering limitations and assumptions we discuss:

- The importance of considering the increasing likelihood of tipping points, as a material and salient feature of the risks being assessed
- How firms should approach scenarios, given the wide range of outputs
- The rationale for selecting scenarios which show higher economic impacts
- The observable trend with climate risk of sooner than expected, worse than expected
- Reference sources for a specific, plausible but adverse scenario resulting in significant GDP contraction (15% to 20%) over a 5-year period
- How firms could leverage existing components of their risk management frameworks to assess these risks in a pragmatic way
- Whether a collaborative, sector approach may be more valuable than focusing on results from individual firms

3.1 Importance of consideration of tipping points

Risk management is an exercise in imagination, imagining what could go wrong in relation to achieving a set of objectives, in order to take any identified action required to manage risks that are deemed to be outside appetite. Key principles of risk management include identifying the biggest risks and considering the full range of probabilities. Low probability, high impact events should be considered.

It is important to consider salient real-world characteristics of relevant systems, particularly if these are not fully captured in models. As the Global Financial Crisis evidenced, material risks can crystallise and spread quickly, even if they are not represented in quantitative analysis.

A particularly salient real-world characteristic of both climate change and nature risks identified in the scientific literature is the approach of ‘tipping points’[47] – thresholds which, once crossed, trigger irreversible changes, such as the loss of the Amazon rainforest (see Case Study 1) or the West Antarctic ice sheet. Some tipping point thresholds have already been reached, while others are getting closer as global warming and nature degradation continues.

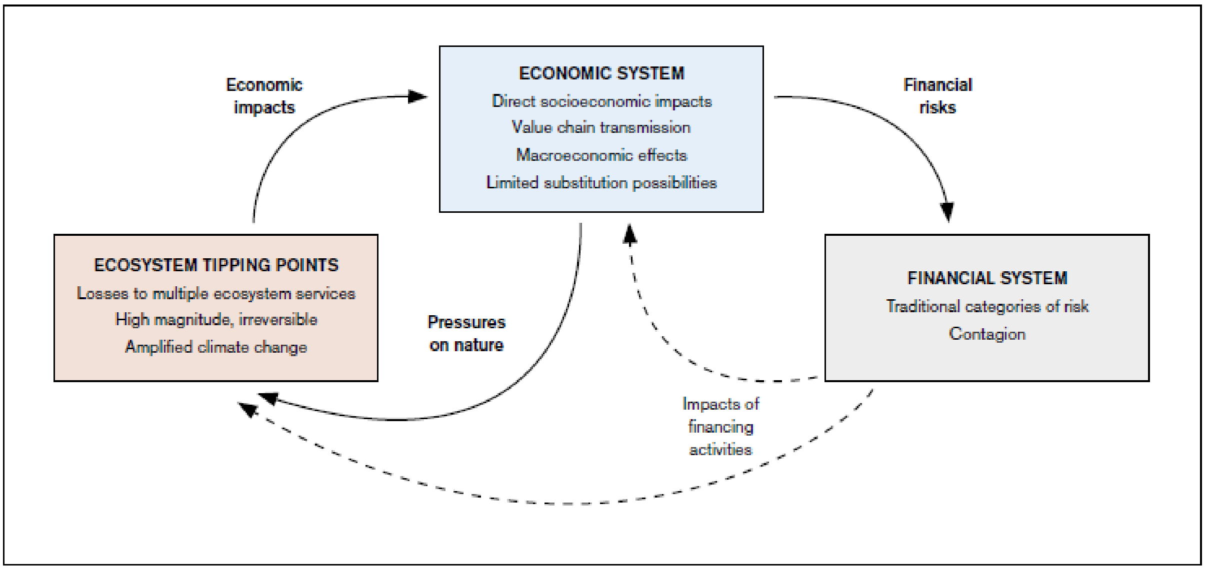
Once crossed, many tipping points act as risk accelerators, amplifying the cascading and compounding risks discussed in the previous section. While the economic repercussions of tipping points are hard to quantify due to complexity and interactions of earth systems, the likelihood of tipping points occurring significantly increases with every increment of heating above 1.5C[48].

[47] https://report-2023.global-tipping-points.org/

[48] Marsden, L., Ryan-Collins, J., Abrams, J., and Lenton, T. (2024). Ecosystem tipping points: Understanding risks to the economy and financial system. UCL Institute for Innovation and Public Purpose, Policy Report 2024/03.

While the literature has generally focused on tipping points in relation to climate change, a number of terrestrial 'ecosystem tipping points' (ETPs) have also been identified[49], which could drive risks with the potential to transmit to the economy and financial system.

Figure 7: Potential macro-financial dynamics associated with crossing ETPs



Note: Losses to multiple ecosystem services in a high-magnitude way will cause substantial economic and financial risks. This is characterised by the solid lines. The financial system may play a role in amplifying risk through feedback effects, and by enabling economic activities linked to ETP drivers in specific ecosystems ('double materiality'). This is represented by the dotted lines.

The five ETPs highlighted by Marsden et al are:

1. The dieback of the Amazon rainforest into a non-forested state;
2. Transitions in boreal forest cover;
3. Tropical peatland collapse;
4. Coral reef die-off to marine deserts; and
5. Mangroves dying back to tidal flats.

The loss of these ecosystems and risks amplified by related climate change tipping points have the potential to impact the economy via transmission mechanisms described in the first CFRF nature paper including: reduced food and energy security; damages to assets such as real estate, croplands and infrastructure; and health risks that impair household productivity.

For example, scientists estimate that severe negative impacts to food security could result from changes to ocean currents caused as a result of a climate change tipping point (AMOC collapse), with significant reductions in the staple crop growing season in the Northern Hemisphere[50]. Should such an event occur societal and economic repercussions may be more significant than the small dip in GDP represented by a reduction in agricultural activity.

While there is uncertainty about tipping points, this does not offer reassurance given the level of risk associated with these. Tipping points should no longer be considered high-impact, low-

[49] https://www.ucl.ac.uk/bartlett/publications/2024/apr/ecosystem-tipping-points-understanding-risks-economy-and-financial-system

[50] https://www.scri.org.uk/publications/the-security-blind-spot

likelihood tail risk events as they have historically been treated. They are now high impact, high uncertainty and increasing likelihood events[51]. This implies a precautionary approach is required to mitigate and plan for them.

To support decision-making under uncertainty, these tipping points can and should be incorporated into qualitative scenario narratives by embedding plausible ecosystem disruptions—such as the ETPs outlined above—into storylines that explore cascading socio-economic consequences. Quantitatively, while precise modelling remains difficult, financial services firms can consider the scope that climate and ETPs possess to materially impact the financial sustainability of their organisation or the clients they service. This allows financial institutions to explore a broader range of outcomes, including non-linear and irreversible changes, to better understand their exposure to systemic climate and nature-related risks.

3.2 Limitations of economic impact estimates

Efforts to quantify the economic impacts of climate change date back over four decades. In 1979, d'Arge presented one of the first estimates at the World Meteorological Conference in Geneva, calculating a 0.6% welfare loss for each 1 Degrees Celsius of global cooling[52].

More than 45 years later, there remains a wide range of estimates on the economic effects of climate change, with more papers published at an increasing rate[53]. For example, recent comparison compiled by NGFS[54], of the economic impact of a hot-house world scenario (defined as 3°C of warming by 2100) has found estimates ranging from 2% GDP loss *(Nordhaus & Boyer)* to 44% GDP loss *(Bilal & Känzig)* by 2100.

However, a critical examination of the assumptions underpinning these early results show they simply exclude many of the risks that are now anticipated. For example, one early methodology (Nordhaus) excludes nearly 90% of the economy from analysis, making the assumption that those who work indoors won't be impacted by climate[55]. Firms must understand these limitations in order to make appropriate adjustments for excluded factors to support risk informed decisions.

Another meta study[56], derives an approximate average of 36% GDP loss under a higher warming scenario (defined as 4.3°C of warming by 2100). Despite the broad range, it is important to consider which are most credible, based on accompanying analysis of climate risks and the limitations associated with the different methodologies (in line with financial services model validation principles). The more recent and higher estimates are more credible (in line with NGFS) and should be used.

At a high level, there is a trend towards higher damage estimates in more recent studies, which is consistent with the risk analysis produced by the scientific community, which we analyse in the following 'burning embers' section to reinforce this. This is driven by more recent studies generally including more risk factors, as well as methodological changes.

[51] actuaries.org.uk/media/g1qevrfa/climate-scorpion.pdf
[52] d'Arge, R.C., 1979. Climate and economic activity. In: Proceedings of the World Climate Conference, a Conference of Experts on Climate and Mankind, Geneva, 12-13 February 1979. World Meteorological Organization, Geneva, pp. 652–681.

[53] A meta-analysis of the total economic impact of climate change - ScienceDirect
[54] See NGFS: "Damage functions, NGFS scenarios, and the economic commitment of climate change An explanatory note"
[55] https://actuaries.org.uk/media/qeydewmk/the-emperor-s-new-climate-scenarios.pdf

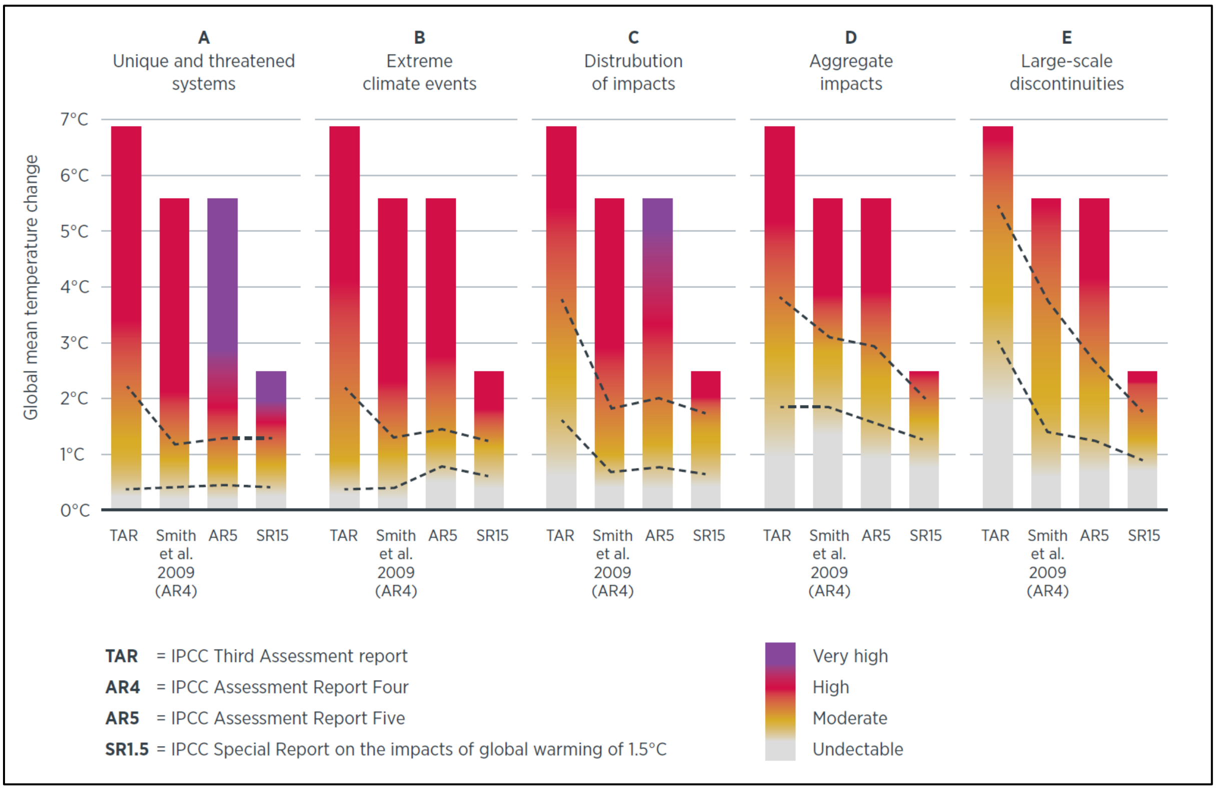
[56] A meta-analysis of the total economic impact of climate change - ScienceDirect

Climate risk external environment, burning embers

The Reasons for Concern (RFC) framework was introduced in the IPCC's Third Assessment Report[57] ('TAR') and categorises risks from temperature rises into several categories (unique and threatened systems, extreme climate events, distribution of impacts, aggregate impacts, and large-scale discontinuities). The burning embers diagram (see Figure 5 below) shows how the level of each risk changes with different levels of warming.

Zommers et al. evaluated changes in these risks across the various IPCC reports. Figure 5 shows how estimates of the temperature at which severe climate impacts will occur have consistently reduced over time. Put another way, the level of risk at a given temperature has increased with each subsequent assessment. For example, the temperature at which large-scale discontinuities (tipping points) become high risk was estimated at around 5.5°C above pre-industrial in TAR in 2001. 17 years later these risks were assessed as high risk at around 2°C of warming in the IPCC's special report *Global Warming of 1.5°C*.

Figure 8: The risks associated with temperature rise in successive climate models



Source: Reprinted by permission from the Licensor: Springer Nature, Nature Reviews Earth & Environment; Burning embers: towards more transparent and robust climate-change risk assessments, Zinta Zommers et al, © 2020..

This is consistent with scientific analysis over the period. In 2001 the first scientific analysis of tipping points by Lenton et al[58] had not yet been published, 17 years later there was much higher awareness of these and other risks. We can say that as global warming has progressed so too has our understanding of both the level of risk and the proximity of the risk, as illustrated in the Planetary Solvency risk dashboard[59]. This in turn is consistent with the trend towards higher

[57] https://www.ipcc.ch/assessment-report/ar3/
[58] https://www.pnas.org/doi/10.1073/pnas.0705414105
[59] https://global-tipping-points.org/risk-dashboard/

estimates of economic damage in the hot house world scenarios and supports using more recent and higher damage estimates. This is in line with NGFS direction of travel, which have seen steady increases in physical risk economic impacts estimates in each iteration of NGFS scenarios[60].

This evolving understanding highlights a critical risk in climate modelling: the tendency to anchor to earlier, lower estimates of risk and damage. Such anchoring can lead to underestimation of future impacts, particularly in financial and policy decision-making. As scientific knowledge advances and models are updated, it becomes increasingly important to prioritise the most recent and comprehensive assessments. Relying on outdated or conservative estimates may obscure the urgency and scale of the risks, especially in high-warming scenarios. This reinforces the need for scenario analysis to reflect the upper bounds of plausible risk, not just central or historical estimates.

Model limitations and assumptions

Although model limitations and assumptions are carefully documented, they are rarely front of mind, with reporting and headlines typically focused on numerical results. Given the broad range of economic estimates and the complexity of the field, including multiple linked models, it is practically challenging for anyone to fully understand the implications of the huge number of assumptions and methodology decisions embedded in climate change and/or nature scenario analysis.

However, a simpler and more pragmatic approach can yield value. This could be as simple as checking whether or not salient real-world characteristics are represented in models, recognising there will always be a tension between model complexity and parsimony.

NGFS have listed a number of important limitations and assumptions in Section 4 of the accompanying document to Phase V scenarios, '*Damage functions, NGFS scenarios, and the economic commitment of climate change*[61]', which include:

- A global economic recession caused by climate change is not foreseen, even in the worst-case scenario
- Physical climate risks are still not exhaustively modelled
- Sea level rise and ocean acidification are excluded
- Tipping points are excluded
- No allowance for conflict or migration
- Nature-related risks excluded
- Human health impacts not covered

Another important point to note is that the GDP loss estimates are relative to a baseline for all scenarios of ongoing GDP growth. Thus, despite large negative physical risk damage estimates, economic output is still expected to be higher compared to the scenario start point.

In conclusion, a number of salient real-world characteristics are currently excluded from models, increasing the likelihood of results under-stating the level of risk. This is similar to risk models

[60] *N.B.: Editor's Note: Readers are alerted that the reliability of data and methodology presented in this manuscript is currently in question. Appropriate editorial action will be taken once this matter is resolved (The economic commitment of climate change | Nature)*

[61] https://www.ngfs.net/system/files/import/ngfs/media/2024/11/05/ngfs_scenarios_explanatory_note_on_damage_functions.pdf

prior to the Global Financial Crisis, as models did not see the interconnections between financial institutions they under-estimated the level of risk.

Learnings for economic estimates of impact of ecosystem service disruption

Over $44 trillion of global GDP is moderately or highly directly dependent on nature with the ECB noting that at least 72% of EU companies are highly dependent on at least one ecosystem service. While our understanding of macro-level nature dependency is growing, there remains a significant gap in reliable literature outlining the economic consequences of acute nature-related events. Several studies have attempted to estimate the economic impact of acute nature events, such as droughts and chronic nature degradation, including topsoil depletion. The economic loss estimates in the form of Gross Value Added (GVA) or GDP range from -2.3% to -16% at the global level, but tend to be more immediate compared with GDP losses for climate scenarios with closer endpoints around 2030 or 2035[62] [63] [64] [65].

Impacts become larger when looking at more granular sector and regional estimates. Sectors directly dependent on nature, such as agriculture, experience significantly higher decreases. For example, Pineau et al. (2024) estimate an output loss of 12.9% for agriculture compared to an average economic loss of 5.0%[29]. At the regional level, the World Bank (2021) study estimates that vulnerable countries like Bangladesh (-20.4%), Madagascar (-19.9%), Angola and the Democratic Republic of Congo (-19.3%), Pakistan (-15%), Ethiopia (-14.7%), Indonesia (-11 %), and 44 countries in the Rest of Sub-Saharan Africa (-10.4%) could see a decline in real GDP by 2030 in a future characterised by a partial ecosystem collapse[31].

While a regional heterogeneity in GDP loss estimates exists, this does not imply that regions with relatively low estimates of GDP losses due to nature degradation, such as the US in the World Bank (2021) study, do not need to be concerned[31]. As outlined in section 2.3, due to the interconnectedness of the global economy, regional economic tragedies can cascade, compound, and ultimately result in systemic risk to the global economy and contagion in the financial sector.

The exposure of the financial system to nature-related risk is further highlighted by studies from central banks which have derived estimates of the broader economic consequences. A World Bank (2023) study, across selected emerging markets, indicates heterogenous exposure across countries and economic sectors, with Mauritius (73 percent), Pakistan (60 percent), and Argentina (56 percent) showing the highest potential direct dependencies on ecosystem services in their banking credit portfolios. The lowest dependencies were observed in Chile (37 percent) and the United Arab Emirates (41 percent). The De Nederlandsche Bank stated an exposure of 36% while the Banque de France reported numbers of 42% high to very high dependency on nature[66].

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[62] Green Finance Institute. (2024) Assessing the Materiality of Nature-Related Financial Risks for the UK. London: Green Finance Institute.

[63] Pineau, E., Riano Sanchez, J. A., Bres, J., and Schrapffer, A. (2024). Nature Stress Testing and Value at Risk. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4923237.

[64] Ranger, N. et al (2023). The Green Scorpion: the Macro-Criticality of Nature for Finance - Foundations for scenario-based analysis of complex and cascading physical nature-related risks. Oxford-NGFS Occasional Paper

[65] World Bank. (2021). The Economic Case for Nature: A Global Earth-Economy Model to Assess Development Policy Pathways. Washington, DC: World Bank.

[66] World Bank. (2023). Biodiversity and Finance – A Preliminary Assessment of Physical Risks for the Banking Sector in Emerging Markets. Policy Research Working Paper 10432. Washington, DC: World Bank.

All the mentioned climate and nature studies have treated climate change and nature in isolation. One study by Ranger et al. (2023) combined impacts from qualitative nature scenario impacts and climate change to derive comprehensive estimates for UK-GDP loss[30]. While large (up to -14% by 2035), the damage estimates are conservative, given that this study, like others, does not incorporate feedback mechanisms between climate and nature, treating them only as additive. In addition, there are nature-related risks that go beyond the climate-nature nexus (such as, for example, water quality) and are therefore further additive relative to economic losses due to climate change alone.

Despite the likely conservative estimates, the estimated magnitude of economic damage from nature loss, like those for climate change, should be treated with caution due to methodological issues. Tol (2024) criticizes the focus on cost estimates while ignoring price changes and sectoral interactions, making them poor measures of overall welfare loss. Computable General Equilibrium ("CGE") models, used for climate and nature scenarios, include price effects but leave out direct health and environmental impacts. Econometric studies, though useful, often assume no adaptation[67] and rely on historical differences in temperature between regions and (environmentally extended) input-output tables to project future global and sectoral impacts.

Further because models are trained on historical variability, they struggle to represent larger future changes accurately in systems, such as technology or consumption patterns—limiting their usefulness for future projections[24,68]. Also, country-level fixed effects in these models remove long-term growth effects unless temperatures return to pre-change levels. As Neal et al. (2025) argue, using national climate and nature changes to estimate national GDP changes overlooks broader global systematic shifts[69].

<u>Developing climate and nature related risk scenarios</u>

In the first nature paper we highlighted TNFD scenario guidance and the Appendix to this paper signposts a number of other reference sources on nature scenarios (table 9). When selecting a scenario that combines climate and nature risks, it is important to understand the drivers of these risks since they differ. Physical climate hazards—such as heatwaves, storms, and sea level rise—are primarily driven by global temperature increases. While socio-economic pathways (e.g., policy choices, technological development) influence the rate of warming, they do not directly reduce the occurrence of these hazards in the short term. In contrast, physical nature risks—such as deforestation, biodiversity loss, and soil degradation—are more directly influenced by local socio-economic factors. For example, regional land-use policies, agricultural practices, and consumer preferences can significantly alter the pace and severity of nature degradation, even in the absence of global temperature change. This distinction is important when designing scenarios, as nature risks require more granular, locally tailored assumptions. For physical nature risks the direct drive from temperature is less distinct, as the socio-economic pathway plays a significant role in mitigating local level/regional hazards, such as through policy or consumer preference.

[67] Kotz, M., Levermann, A., and Wenz, L., 2024. The economic commitment of climate change. In: Nature, Vol. 628, pp. 551-557. *N.B.: Editor's Note: Readers are alerted that the reliability of data and methodology presented in this manuscript is currently in question. Appropriate editorial action will be taken once this matter is resolved.*

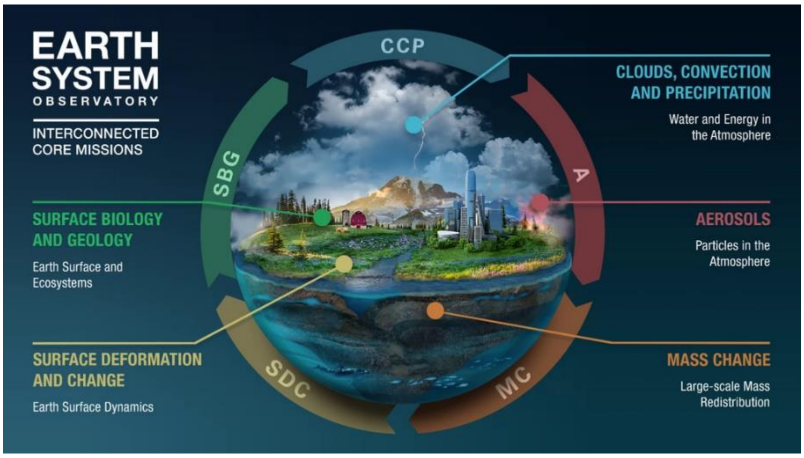
[68] Brunetti, C., Crosignani, M., Dennis, B., Kotta, G., Morgan, D.P., Shin, C., and Zer, I., 2024. Climate-Related Financial Stability Risks for the United States: Methods and Applications. In: Federal Reserve Bank of New York – Economic Policy Review, Vol. 30, No.1.

[69] Neal, T., Newell, B.R., and Pitman, A., 2025. Reconsidering the macroeconomic damage of severe warming. In: Environmental Research Letters, Vol. 20, 0444029.

Development of nature risk scenarios

Guidance on development of nature risk scenarios[38,70,71,72] recommends that scenarios should follow an 'Earth System' or interconnected approach, which considers the feedback mechanisms between human activity and the earths system through environmental ecosystem services provided to society, and societal acceleration or mitigation of depletion of ecosystems. Furthermore, the precautionary principle – which states that 'where there are threats of serious or irreversible environmental damage, a lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation' - has recently been reinforced in law as an environmental principle with the UK Environmental Act 2021. This could feasibly include financial sector operations, paving the way for increased financial nature-litigation risk if breached.

Figure 9: Earth System Approach showing the earth as an interconnected system[73]



Modelling frameworks should ideally be designed to incorporate the linkages and interconnectedness within the environment, and consider the full probabilistic range of nature risk drivers and the array of potential outcomes. In addition, there is a need to consider the time horizon over which nature risks emerge, their spatial scale, and an appropriate estimate of tipping points in both base case and stress scenarios. Nature risks can be highly localised, requiring a good understanding of the extent and state of ecosystems to explore potential impacts.

From a pragmatic standpoint, the development of nature risk scenarios and integration with climate risk scenarios will require taking a staged approach. Firms may consider the below:

- **Sensitivity analysis:** While probabilistic assessment of nature risk drivers may not be feasible initially, sensitivity analysis of nature risks can help define the range of impact and support understanding of transmission channels.

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[70] Trust, Sandy., Joshi, Sanjay., Lenton, Tim., Oliver, Jack (2023) The Emperor's New Climate Scenarios: Limitations and assumptions of commonly used climate-change scenarios in financial services. University of Exeter and Institute & Faculty of Actuaries

[71] Ranger, N., Alvarez J., Freeman, A., Harwood, T., Obersteiner, M., Paulus, E. and Sabuco, J. (2023). The Green Scorpion: the Macro-Criticality of Nature for Finance – Foundations for scenario-based analysis of complex and cascading physical nature-related risks. Oxford: Environmental Change Institute, University of Oxford

[72] TNFD_Discussion_paper_on_conducting_advanced_scenario_analysis_2023.pdf

[73] NASA SVS | Earth System Observatory

- **Enhancing climate scenarios with nature add-ons:** Using climate scenarios as a base to establish the temperature and macroeconomic impact pathways could then enable incorporation of nature risk through idiosyncratic shocks.
- **Adding nature risk drivers to climate scenarios:** In order to build capabilities, single nature risk drivers could be incorporated into climate scenarios allowing the consideration of interactions and compounding effects.

In the following section we outline a possible approach to putting this jigsaw together that may be more practical in the near term, than embracing the full complexity of all the factors outlined above.

3.3 A specific, plausible and adverse scenario reflecting nature-related risk

An alternative to developing standalone nature scenarios, or building these into climate, is to explore a specific, plausible but adverse scenario that incorporates additional real-world stress factors such as geo-political and economic shocks. This can then be incorporated into business resiliency planning and/or reverse stress testing exercises, to integrate this more fully into wider risk management and/or strategy work, mitigating the risk of siloed activity that may not be considered outside the team of SMEs undertaking the work.

Developing a severe but plausible scenario

As outlined in the first CFRF nature handbook, like climate risks, nature risks have the potential to transmit through to economic shocks and so onto impacting financial institutions. While we cannot be sure exactly what combination of events will occur in the future, we can follow a process to explore this.

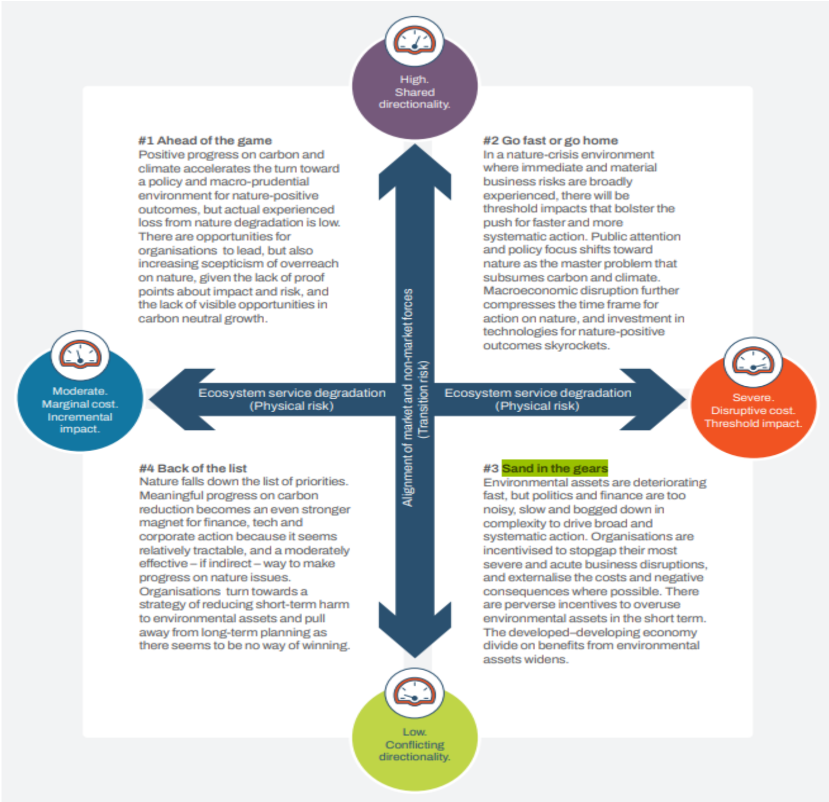
- Understand exposures, following the LEAP process to assess vulnerabilities
- Build a qualitative severe but plausible scenario narrative
- Host workshops to assess vulnerabilities to scenario events and develop responses
- Leverage existing financial sensitivity analysis to estimate potential impacts
- Take forward any recommended actions

In considering how to take this forward in practice and consider how to develop a methodology for assessing tail risks, it may be useful for firms to leverage, reverse-stress testing and operational risk capital assessments. Both these exercises require firms to leverage relevant sources and use their imagination to define specific, adverse but plausible scenarios.

We lay out here some possible sources of information and pragmatic steps that could be taken for firms seeking to assess the impact of a severe but plausible combined climate and nature scenario. This is congruent with the example given at the end of section 2 in which a hypothetical home-insurance company explores how flood and nature risks may interact to impact its business model.

The suggestion is that rather than attempting to accurately model all the potential outcomes of such a scenario, firms can instead develop a qualitative narrative, set an appropriately severe economic shock (e.g., 15% or 20% GDP contraction over 5 years) and then explore potential impacts using existing financial sensitivity analysis.

Figure 10: TNFD critical uncertainties matrix, with four possible narratives of plausible futures



Scenario 3 of the TNFD's uncertainties matrix contains some of the narratives that you might expect in a severe but plausible scenario.

A severe but plausible combined nature and climate scenario

A severe but plausible scenario might contain a number of factors including:

- Disease outbreaks as a result of anti-microbial resistance spreading
- Another global pandemic
- Partial tipping point impacts, such as an accelerated partial shutdown of the AMOC
- Global warming past 2C due to ongoing emissions, high climate sensitivity and degradation of carbon sinks
- Increasingly severe climate impacts driving food (both terrestrial and marine) and water shocks
- Structurally high inflation due to shocks and negative impacts to growth
- Ongoing geo-political tension and uncoordinated climate policies

There is a huge array of scientific information on climate and nature, alongside an ever-increasing number of standard and bespoke scenarios. As such, the indicative approach laid out here is one of many that could be taken. Firms could leverage a small number of publicly available documents which provide scenario narratives and in some cases economic impact estimates:

I. Lloyds of London systemic risk scenarios[74]

Lloyds of London partnered with the Cambridge Centre for Risk Studies to develop a set of systemic risk scenarios that occur over the next 5 years and estimate the impact on the global economy for each scenario at 3 different severity levels major, extreme and severe. The 'extreme weather leading to food and water shock' and the 'human pandemic' could be used to define a specific, plausible but severe climate and nature risk scenario. The output includes global and national economic impact breakdowns as well as scenario narratives. The 'severe' impact is calibrated to a 1-in-1000 level but given the limitations described in this report, a pragmatic adjustment could be to assume either a higher frequency, or severity.

Impacts for the severe scenario are set at $18 trillion for the food and water scenario and $41.7 trillion for the pandemic scenario, over a 5 year period.

II. USS / Exeter University 'No Time to Lose' scenarios[75]

USS partnered with Exeter University to develop a set of short and medium-term scenarios that switch the focus away from climate pathways and towards changes in politics, economics, asset prices and extreme weather events. The aim is to present a richer, broader, and more realistic range of possible scenarios on which to base decisions. The 'Meltdown' scenario could provide the baseline for a scenario narrative, in which policy failures compound weak growth. Its key characteristics are:

- **Politics:** Nationalism and division, populism, geopolitical conflict
- **Growth:** A protracted recession (also because of climate physical shocks), pandemic recurs, energy trade war
- **Investment:** Weak. Nationalist governments support home fossil fuel industries and (in consuming nations) renewables to achieve 'energy security'
- **Energy and asset prices:** Energy trade war keeps fossil fuel prices volatile. Asset stranding hurts financial system
- **Ongoing high physical risk:** This paper assumes as a base case for all scenarios ongoing high physical climate risk and provides a hypothetical narrative of specific physical risk events.

Other recent analyses provide either economic impact assessments, or connected risk analysis to support scenario narratives:

- **Green Scorpion – the macro-criticality of nature**[76] - assesses impacts of nature shocks highlighting a 7% to 9% global GDP shock due to water risk.

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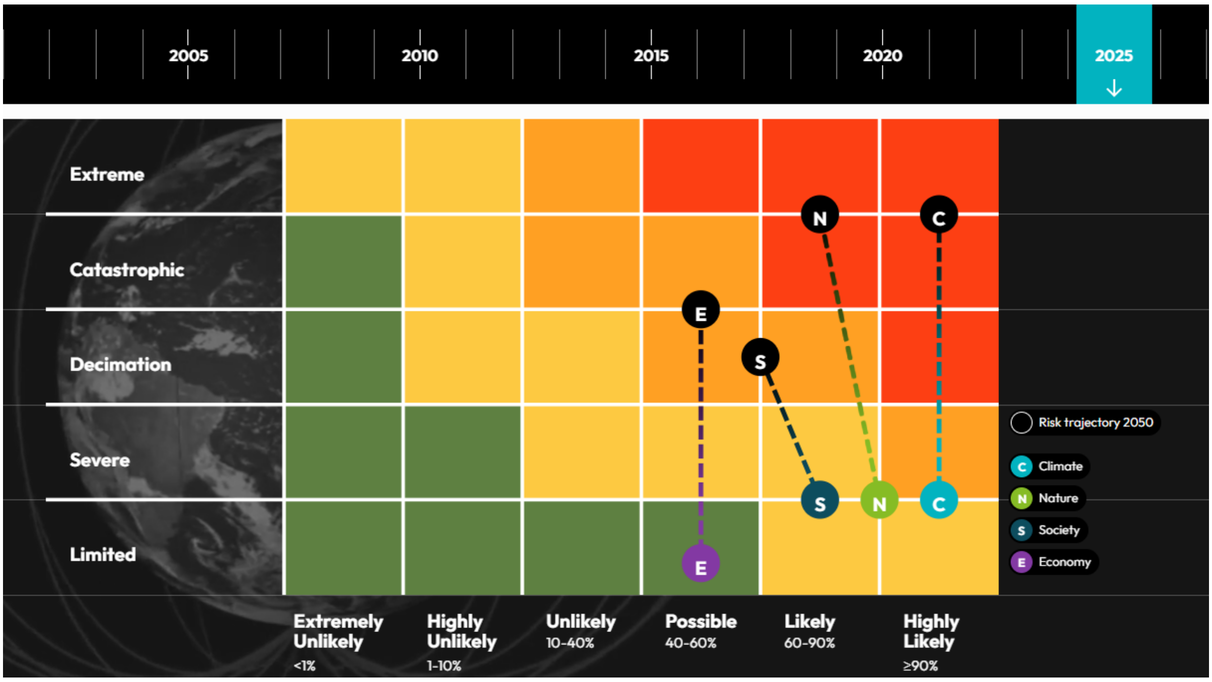
[74] https://www.lloyds.com/news-and-insights/futureset/futureset-insights/systemic-risk/our-scenarios

[75] https://greenfuturessolutions.com/wp-content/uploads/2023/09/No-Time-To-Lose-New-Scenario-Narratives-for-Action-on-Climate-Change-Full-Report.pdf

[76] https://www.eci.ox.ac.uk/sites/default/files/2023-12/INCAF-MacroCriticality_of_Nature-December2023.pdf

- **European Central Bank research**[77] (forthcoming) – shows that 15% of the euro area's economic output is at risk due to water scarcity.
- **European Climate Risk Assessment**[78] - provides risk assessment and narratives, including consideration of cascading risks across 36 climate risks
- **Planetary Solvency Risk Dashboard**[79] – provides high level risk narratives for climate, nature, societal and economic risks

Figure 11: Planetary Solvency Risk Position & Trajectory in 2025



Taken together it is not unreasonable to suggest a combined risk scenario might result in a significant economic contraction of the 15% to 20% order.

We suggest below that a pragmatic modelling approach might be to leverage existing financial stress and sensitivity testing, ie, rather than attempting to model in detail a complex, systemic risk scenario, make some pragmatic assumptions on GDP, national and sectoral impacts to define an assumption set of relevant stresses for financial risks.

3.4 Practical next steps for financial institutions

There are many things to consider when integrating nature into financial materiality analyses, especially for a topic that is relatively nascent and lacking widespread consensus on how to manage. While there will be varying maturity depending on the size and complexity of your organisation, the following steps represent a suite of steps to consider when developing your long term approach:

1. Conduct a Nature "Heatmap Assessment"
Most financial services firms start with a heatmapping assessment that helps them to understand what sectors are most material from an impact (inside out) and dependency (outside in) perspective. Tools like ENCORE[80] ("Exploring Natural Capital Opportunities, Risk and Exposure")

[77] https://www.ecb.europa.eu/press/key/date/2025/html/ecb.sp250522~b371549cb6.en.html
[78] European Climate Risk Assessment | European Environment Agency's home page
[79] https://global-tipping-points.org/risk-dashboard/
[80] ENCORE

can be a great help for underpinning this analysis and can be overlayed with portfolio data from financial institutions. This approach supports the prioritisation of sectors to be considered for deeper analysis and guides the selection of focus areas for pilot assessments.

Figure 12: Sample Heatmap Outputs[81]

	Dependencies		Impacts						Low – High
			Land use	Water use	Pollution				
SASB Sectors	Soil quality	Water quality	Land use	Water use	Air pollution	Solid waste pollution	Soil pollution	Water pollution	AUM (% of total)
1 Agricultural products and tobacco	High	High	High	High	Low	Low	High	High	2%
2 Consumer goods	Low	Low	Low	High	Moderate	Low	Moderate	Moderate	5%
3 Extractives and minerals processing	Low	Moderate	High	High	High	High	Moderate	High	14%
4 Financials	Low	Low	Low	Low	Low	Low	Low	Low	16%
5 Food and beverage (ex. agriculture and tobacco)	Low	Moderate	Low	High	Low	Moderate	Low	Low	11%
6 Health care	Low	High	Low	High	Low	Moderate	High	High	6%
7 Infrastructure (ex. utilities and generators)	Low	High	High	Low	Low	High	Low	Low	2%
8 Renewable resources and alternative energy	Low	High	Low	High	Low	Low	High	High	3%
9 Resource transformation	Low	Low	Low	High	Moderate	High	High	High	6%
10 Services	Low	Low	Low	Moderate	Low	Low	Moderate	High	12%
11 Technology and communications	Low	Low	Low	Low	Low	Low	High	High	15%
12 Transportation	Low	Low	Moderate	High	Moderate	Moderate	High	High	5%
13 Utilities and electricity generators	High	High	High	High	High	High	High	High	3%

AUM: Assets under management

2. Bolster Customer Engagement
While not all firms will have the required capacity or budget to conduct detailed nature scenario analysis, most firms are in a position to engage with their customers – especially those in sectors deemed to be materially exposed to nature. This could range from a discussion point in relationship management meetings, to add-ons to existing environmental risk questionnaires.

3. Develop Integrated Scenario Narratives
Construct specific, plausible, and adverse scenarios that combine climate and nature-related risks with socio-economic and geopolitical stressors. Institutions may begin by enhancing existing climate scenarios with nature-related “add-ons” before progressing toward fully integrated systemic risk scenarios.

4. Educate Decision-Makers on Model Limitations and Apply Margins of Conservatism
Ensure that senior stakeholders are aware of the limitations embedded in current models—such as the exclusion of tipping points, feedback loops, and ecosystem service disruptions. Where appropriate, apply conservative adjustments to assumptions (e.g., increasing the frequency or severity of shocks) to reflect these gaps.

5. Leverage Existing Risk Management Tools
Utilize established frameworks such as reverse stress testing and operational risk scenario analysis to explore the implications of systemic nature-related risks. These tools can help identify vulnerabilities in business models and inform capital planning.

6. Translate Planetary Risks into Financial Impacts
Use existing financial sensitivity analysis to assess how systemic environmental risks could affect income statements, balance sheets, and capital adequacy. Frameworks such as Sachs et al. can help bridge the gap between planetary boundaries and financial exposures.

[81] TNFD, Guidance on the identification and assessment of naturerelated issues: The LEAP approach, October 2023

7. Collaborate to Build Capability and Share Insights
Engage with regulators, peers, and scientific institutions to co-develop methodologies and share best practices. Participation in industry-wide initiatives (e.g., TNFD, NGFS) can accelerate the development of consistent approaches and standards.

8. Integrate Nature Risks into Enterprise Risk Frameworks
Embed nature-related risks into existing enterprise risk management (ERM) structures to ensure a holistic view of risk. This includes aligning governance, risk appetite, and reporting processes with emerging expectations from regulators and stakeholders.

4. Evolving Data Landscape

Reviewing the analyses presented thus far through a *data* lens, we underscore the fact that the nature data challenge is greater and more complex than the climate data challenge. Good quality data is a prerequisite to unlocking nature-related insights, which relies on the reliable and scalable translation of the climate-to-nature transmission channel. To address the evolving data landscape, the following chapter aims to showcase a small number of climate and nature risk overlaps, the observed impact of severe climate events on nature, as well as exploring potential next steps for financial institutions.

The Prudential Regulation Authority's (PRA) recent Consultation Paper CP 10/25 builds on the PRA's existing expectations for climate risk management. While the paper primarily focuses on climate-related risks, its principles and expectations are highly relevant to nature-related risks as well—especially as the understanding of the climate-nature nexus deepens.

4.1 Climate (physical) risk and Nature risk overlaps

The inaugural Nature-related Technical Data Guidance[82] paper, published in October 2024, considered the climate-nature nexus and suggested making use of data that underpins the commonality between climate and nature as a useful starting point to solve the immense nature data challenge. Indeed, the atmospheric (and associated thermal) systems on which most of life relies[83], is usually a source of both positive and negative impacts on nature and the wider biosphere. This is an observable pattern where first-order climate risks trigger second-order nature risks. Hence, to avoid repeating the discussion from earlier chapters on other non-climate related impacts on Nature; the focus of this subsection is the climate-to-nature transmission channel only.

Table 3: Nature Transmission Channels

Transmission Channel	**Acute** Climate Physical Risk		**Chronic** Climate Physical Risk	
First-order Climate Trigger	Drought-intensified Wildfire		Rising Sea Levels	
Climate Data	million hectares burnt per year (mha/yr)		relative change in mm per year (mm/yr)	
Nature Risks	Physical (Dependency)	Transition (Impact)	Physical (Dependency)	Transition (Impact)
Second-order Nature Example	Loss of insects and wildlife, impacting pollination and Agricultural yields[84]	A rapid hike in commodity market prices, inflationary pressures	Saltwater intrusion erodes habitats, decreases coastal biodiversity[85]	Declining tourism, consumers may also boycott coastal industries

[82] Inaugural Data Paper: https://www.fca.org.uk/publication/corporate/cfrf-nature-related-risk-technical-data-guidance-financial-institutions-2024.pdf
[83] Global Atmospheric Change Paper: https://www.nature.com/scitable/knowledge/library/global-atmospheric-change-and-animal-populations-13254648/
[84] Wildfire impacts Agriculture: https://www.nature.com/articles/s43016-023-00803-z
[85] Coastal Habitat Loss: https://www.nature.com/articles/s41586-023-06448-z

As the table above shows, both nature physical risks and/or nature transition risks can be a function of climate physical risks. Note, we adopt the current convention of using the terms 'dependencies' and 'impacts' to denote a company's financial exposures to physical and transition nature risks, respectively. This climate-to-nature transmission channel necessitates the use of high-quality data to ensure nature-related dependencies and impacts are not inadvertently over or under-estimated. However, such nuanced relationships are not yet exhaustively parameterised, over any regions, in a standardised way. Some early efforts to overcome parts of this data gap have been put forward, for example the development of sector-specific nature-related Value at Risk (nVaR) scores[86] from Oxford University.

Figure 13: Outline of macro and micro level nature-impacts

While general climate conditions or trends at macroregion and national level are fairly well understood, what is less clear are the diverse and ever-changing localised climate peril events and their influence on nature. This sub-national detail can be regarded as the 'missing link' in the translation of risk from climate to nature. A review of academic literature demonstrates these specific climate-to-nature relationships and local nature-to-socioeconomic linkages (more commonly associated with nature transition risks) across multiple biomes - each with their own data source or metric tracking solution. We draw on three recent papers below:

Table 4: Summary of Nature Tracking Solutions

Specific Climate Event	Late Spring Frosts[87] (Acute)	Ocean Acidification[88] (Chronic)	Sudden Warming[89] (Chronic)
Regions of Study	North America, Europe	Africa, South and Southeast Asia	Global
Sub-national Climate Data / Metrics	Temperature, precipitation, humidity, sunshine hours, etc	Ocean temperature, circulation, dissolved oxygen concentrations	Temperature, precipitation, humidity, sunshine hours, etc
Nature Degradation	Limited growth, health, competitive ability and distribution or spread of a variety of plants.	Death of marine life, coral bleaching and increased vulnerability of aquatic food systems.	Keystone species disappear from an ecosystem at the *same time* rather than gradually.
Local Nature Data / Metrics	NDVI (Normalized Difference Vegetation Index)[90]	OBIS Species Richness[91] + National Marine Fish Surveys	ICUN Red List[92] + National Biodiversity Surveys
Socioeconomic Impact	Poor Agricultural Harvest.	Disruption to Nutrition, Trade, Tourism.	Poor Harvest, Disruption to Trade, Tourism.

As exemplified in the table above, sub-national data associated with specific climate events are more readily available than local nature-related data and metrics. Moreover, most climate data are often standardised across regions and are frequently collected, allowing for easily interpretable comparisons. As the true scale of the nature data challenge is becoming clearer, so too are methods to address it. The remaining sections of the chapter highlights some of the ways to conduct a risk assessment of the climate-nature nexus.

[86] Oxford University nVaR: https://www.oxfordmartin.ox.ac.uk/publications/assessing-the-materiality-of-nature-related-financial-risks-for-the-uk
[87] Late Spring Frosts: https://www.nature.com/articles/s41558-021-01090-x
[88] Ocean Acidification: https://www.nature.com/articles/s43016-021-00368-9
[89] Sudden Warming: https://www.nature.com/articles/s41559-023-02070-4
[90] NDVI: https://gisgeography.com/ndvi-normalized-difference-vegetation-index/
[91] OBIS Species Richness: https://obis.org/indicators/
[92] ICUN Red List: https://www.iucnredlist.org/

Physical Climate Risk vs. Biodiversity Hotspots
This section takes a physical climate risk data point (weather events in 2024) and overlays a nature data point (Biodiversity Hotspots) to show one approach to assessing the resulting risks contained within the climate-nature nexus.

Understanding the Data Set
Biodiversity hotspots are defined as geographical regions where very high concentrations of endemic species are undergoing exceptional habitat losses (Myers et al., 2000). The potential loss of rare, range-restricted endemic species from hotspots has serious implications for ecosystem function. Any change in nature impacts these ecosystem pathways, and in turn, a reduction in biodiversity could thereby exacerbate climate extremes.

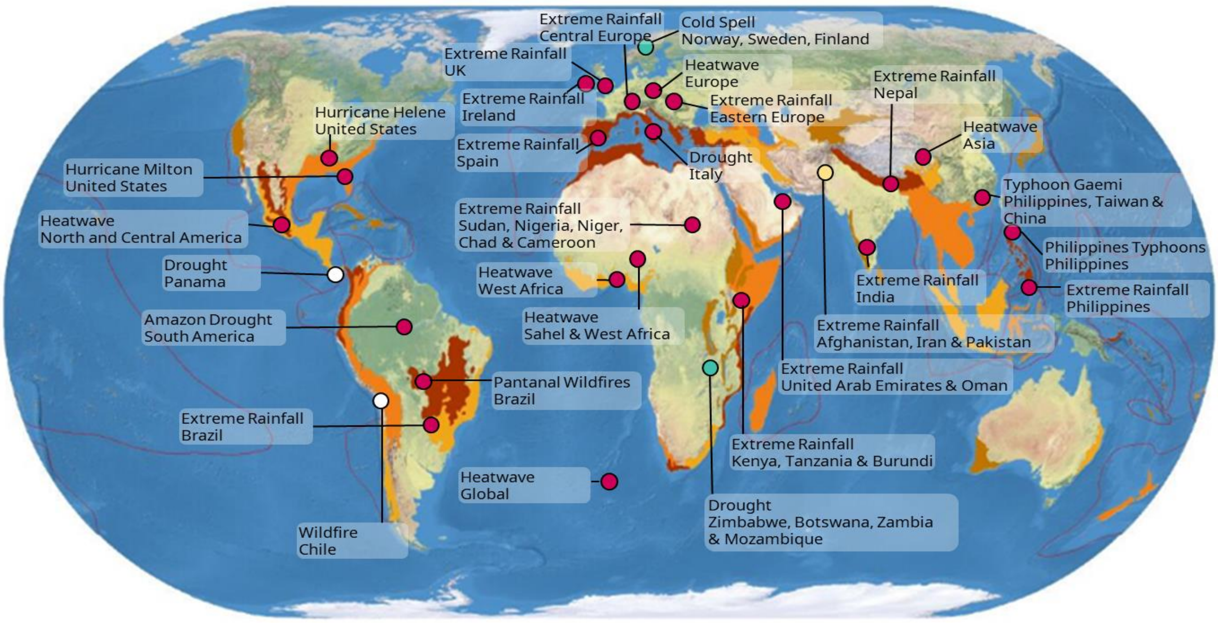
In 2024 we also saw record-breaking temperatures which fueled heatwaves, drought, wildfires and storms. The increase in physical events has been linked to climate change; for example, a warmer atmosphere can hold more water vapor, leading to heavier downpours.[93] Rising temperatures make droughts worse by increasing water loss from soils through evaporation and plant transpiration.

As part of the climate-nature nexus risk assessment, this analysis has taken data from the World Weather Attribution Review 2024 and overlapped these events with Biodiversity Hotspots. As shown in map below, many of the planet's biodiversity hotspots are vulnerable to impacts by physical climate risk events. This indicates that an integrated consideration of nature degradation and climate change would support financial institutions in their identification of the highest risk areas of their portfolios.

Table 5: Climate-Nature Nexus Risk Assessment Source Data

Data point	Source	Information Provided
Biodiversity Hotspot	World Weather Attribution Review 2024[94]	Identification of 36 regions known as Biodiversity Hotspots.
Severity of 2024 Weather Events	Conservation International[95]	Analysis of severity of main climate events that occurred in 2024.

Figure 14: 2024 Weather Events and Impact on Biodiversity Hotspots



[93] NGFS: https://www.ngfs.net/ngfs-scenarios-portal/
[94] WWA: https://www.worldweatherattribution.org/when-risks-become-reality-extreme-weather-in-2024
[95] Conservation: https://www.conservation.org/priorities/biodiversity-hotspots

Biodiversity Hotspots	Red and orange shaded areas
2024 Weather Events	Labelled circles
Event severity (compared to historic events between 1994-2023)	Colours indicate different categories = Pink: More Severe, White: Same Materiality, Green: Less Severe, Yellow: Inconclusive.

CASE STUDIES

Wildfire in Brazil's Pantanal wetlands
In June 2024 Brazil's Pantanal, a biodiversity hotspot and the world's largest tropical wetland, saw its worst blaze on record since Brazil started tracking fires in 1998. According to World Weather Attribution, the wildfires were made at least four times more likely and 40% more intense by human-caused climate disruption. Significant causes of these wildfires are the combined effects of climate factors (prolonged droughts and heatwaves) and significant land use changes from natural areas to agriculture and pasture.

Natural wetlands occupy only 5%-8% of the world's surface, however store 20%-30% of its soil carbon, and play a key role in the regulation of atmospheric CO_2, thereby driving increased emissions as a result of the wildfires as well as atmospheric pollution. The economic impact of this event is widespread across sectors and geographies. Service sectors such as tourism, and industries such as manufacturing and agriculture, were particularly affected given the ramifications which extend to global supply chains (through decreased yields, increased costs, reputational impacts etc.), which underscore the spatial distribution of wildfire economic impacts.[96]

Hurricane Helene
Hurricane Helene in 2024 impacted the Blue Ridge Parkway, a biodiversity hotspot, which includes five different ecosystems, including spruce-fir forest "sky islands" and grassy balds. The hurricane caused sudden flash flooding. This resulted in significant destruction of both land and water environments and contamination of water supplies in many areas.
Such damage to Biodiversity Hotspots results in the acceleration of ecosystem degradation and critically for climate change actions, reduces the carbon sequestration role that these ecosystems can play. In fact, such flooding can release existing carbon in the soil into the atmosphere further contributing to emissions and climate change.[97]

The economic impact of this event is still being quantified. It saw wide-spread effects including macro impacts such as decreased agricultural yields as well as individual company impacts such as increased costs for freshwater due to reduction in supply. In addition, given climate change is enhancing conditions conductive to powerful hurricanes this will likely result in further and more wide-reaching nature degradation, further reducing ability of these regions to act as carbon sink.[98]

Conclusion
Biodiversity hotspots are expected to be especially vulnerable to climate change because their endemic species have smaller geographic ranges. These individual species are unlikely to be able to shift their distributions easily or respond quickly to the unprecedented speed of environmental changes caused by anthropogenic climate change.

Additionally, human-caused climate disruption, as well as land use change (such as deforestation for agricultural use) has been shown to increase the severity and frequency of severe weather events, thereby causing a reinforcing risk within those biodiversity hotspots.

[96] https://mpra.ub.uni-muenchen.de/119399/8/MPRA_paper_119399.pdf
[97] Schindler, T., Mander, Ü., Machacova, K. et al. Short-term flooding increases CH4 and N2O emissions from trees in a riparian forest soil-stem continuum. Sci Rep 10, 3204 (2020). https://doi.org/10.1038/s41598-020-60058-7
[98] https://www.c2es.org/content/hurricanes-and-climate-change/

4.2 Real-world case studies for synergistic climate/nature risk assessment

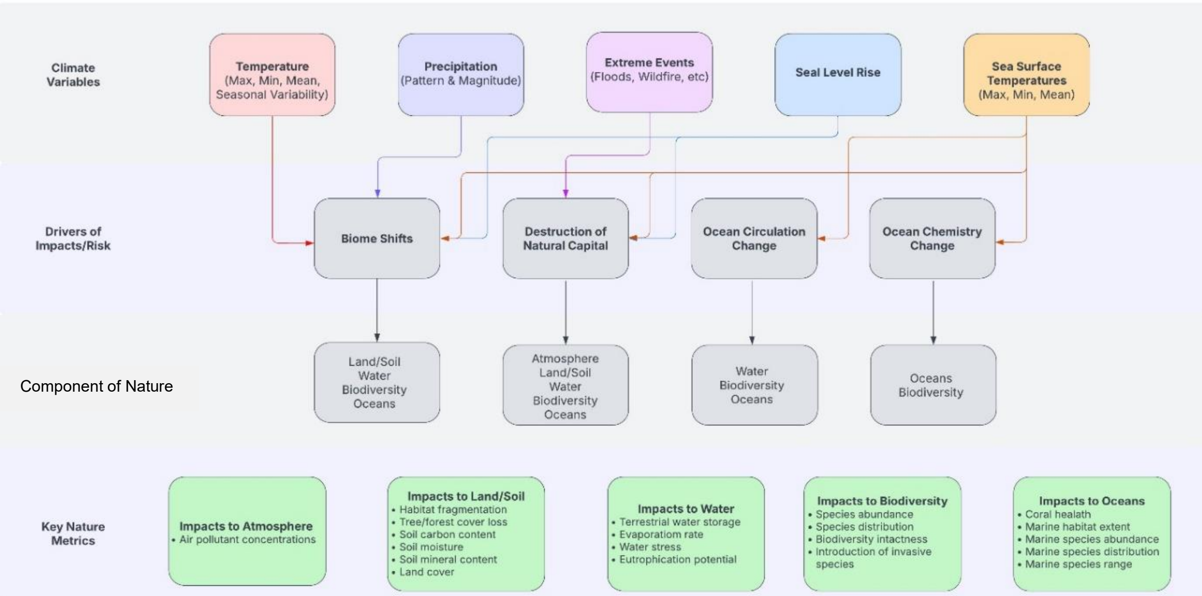
Climate variables can directly influence natural systems, affecting nature in numerous ways. For example, shifts in average temperatures or seasonal temperature patterns can render climatic conditions unsuitable for the specific biomes, plants, and animals native to a particular area. These changes can lead to several significant risks and impacts on local ecosystems, such as:

- **Loss of biodiversity** as conditions become inhospitable for species that have historically thrived there,
- Alterations in local **terrestrial water storage** and
- Changes in **vegetation cover**.

Understanding these connections is crucial for integrated climate-nature risk assessments. Such assessments enable a comprehensive evaluation of how climate change and natural ecosystems influence one another. By examining and understanding these linkages, we can better predict and mitigate the impacts of climate change on the environment. This joint climate-nature assessment would yield an additional layer of insight when evaluating financial risks, which would otherwise be missing.

See Figure 11 below for key climate-nature variable linkages and associated transmission channels.

Figure 15: Flow chart of climate to nature variable linkages.



The following sub-sections share two real-world case studies exploring the risks and impacts to local ecosystems following such events.

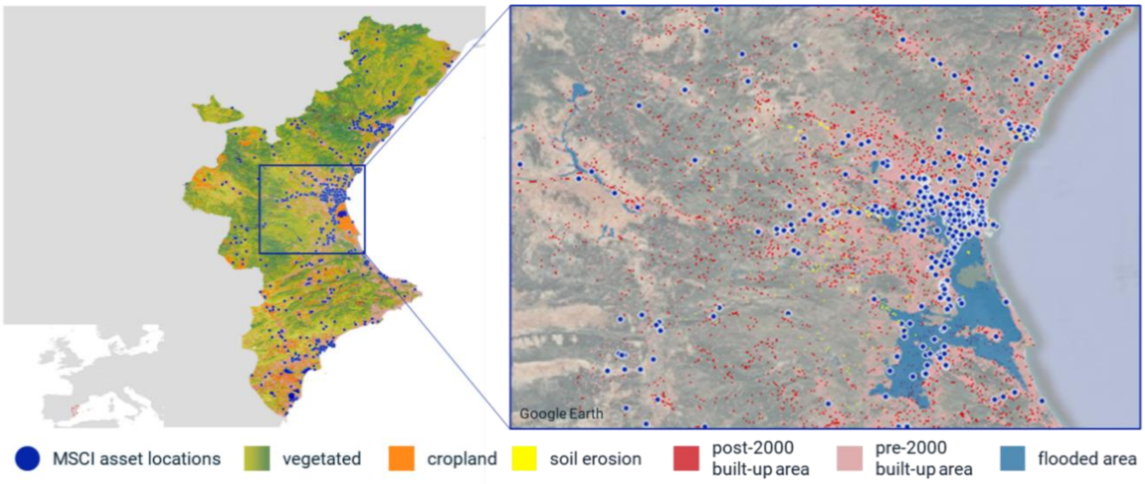
Valencia, Spain flooding (Oct 2024)

On October 29, 2024, the Valencia region of Spain experienced a devastating rainfall event that led to widespread flooding. Many areas received nearly a year's worth of precipitation in less than 24 hours.[99] High river levels led to the inundation of 56,600 hectares, affecting over 81,000 people and resulting in more than 200 casualties. The total economic damage was estimated at €20.6 billion.[100,101]

Spain's meteorological agency attributed the extreme rainfall to a DANA[102] event, a weather pattern where warm, humid air from the Mediterranean collides with a cold front from the high latitudes.[103] These stalled systems unleash intense rainfall, and climate change is making such events more frequent. The World Weather Attribution initiative found that 1.3°C of warming has doubled the likelihood of such events and made them 12 times more intense.[104]

Two-thirds of the area that flooded during the October 2024 event (35,000 ha) were built-up areas - 8% of Valencia Municipality's total, with newer developments (post-2000) hit harder (22% affected) than older ones (4%). In some areas, the flood exceeded 200-year return period projections, highlighting the extreme nature of the event. It affected 7% of assets in the Valencia region tracked in MSCI's Geospatial Asset Intelligence, 4% of which have less than a 0.5% annual probability of flooding.

Figure 16: Impact of flooding on built assets and land cover.



Mediterranean agriculture is highly vulnerable to intense rainfall, which erodes soil, depletes nutrients.[105] The Valencia floods stripped fertile topsoil, causing severe gullying and arable land loss (Figure 16 in yellow).

Runoff from the floods transported large sediment and debris loads downstream, with satellite imagery capturing the Turia River flushing sediment-laden waters into the Mediterranean (Balearic Sea) and L'Albufera coastal lagoon (see Figure 13). These inflows caused significant hydrochemical shifts in the lagoon, degrading water quality and disrupting local ecosystems.[106]

[99] Miteco: https://www.miteco.gob.es/es/prensa/ultimas-noticias/2024/noviembre/octubre-de-2024-fue-el-mas-lluvioso-de-la-serie-historica.html
[100] Copernicus: https://rapidmapping.emergency.copernicus.eu/EMSR773/download
[101] Reuters Article: https://www.reuters.com/world/europe/bank-spain-estimates-floods-cost-02-gdp-fourth-quarter-2024-11-20/
[102] DANA: Depresión Aislada en Niveles Altos
[103] Earth Observatory: https://earthobservatory.nasa.gov/images/153533/valencia-floods
[104] https://www.worldweatherattribution.org/extreme-downpours-increasing-in-southern-spain-as-fossil-fuel-emissions-heat-the-climate/
[105] Kaffas, K. et al. Forecasting soil erosion and sediment yields during flash floods: The disastrous case of Mandra, Greece, 2017. Earth Surface Processes and Landforms, 47, (2022). https://doi.org/10.1002/esp.5344
[106] Soria JM, et al. Flash-Flood-Induced Changes in the Hydrochemistry of the Albufera of Valencia Coastal Lagoon. *Diversity*., 17 (2025). https://doi.org/10.3390/d17020119

Beyond sediment, the floodwaters carried substantial waste—plastic debris, wrecked vehicles, and raw sewage—posing direct threats to biodiversity.[107]

Flood-driven changes in water quality and habitat can directly impact marine-dependent economies. For example, small-scale fisheries and the local fishing industry can be severely impacted by mass die-off of fish and crustaceans caused by oxygen depletion and algal blooms from nutrient-heavy runoff.[108] Nature-based solutions like reforestation and terraced landscape restoration can curb runoff and so protect farmland and coastal ecosystems.[109]

Given the direct impacts to physical assets and the knock-on effect for agricultural and fisheries economies, financial institutions have a role to play in (i) identifying and mitigating nature-related risks using available spatial and environmental data (see Table 7), and (ii) facilitating adaptation and mitigation through targeted financial instruments.

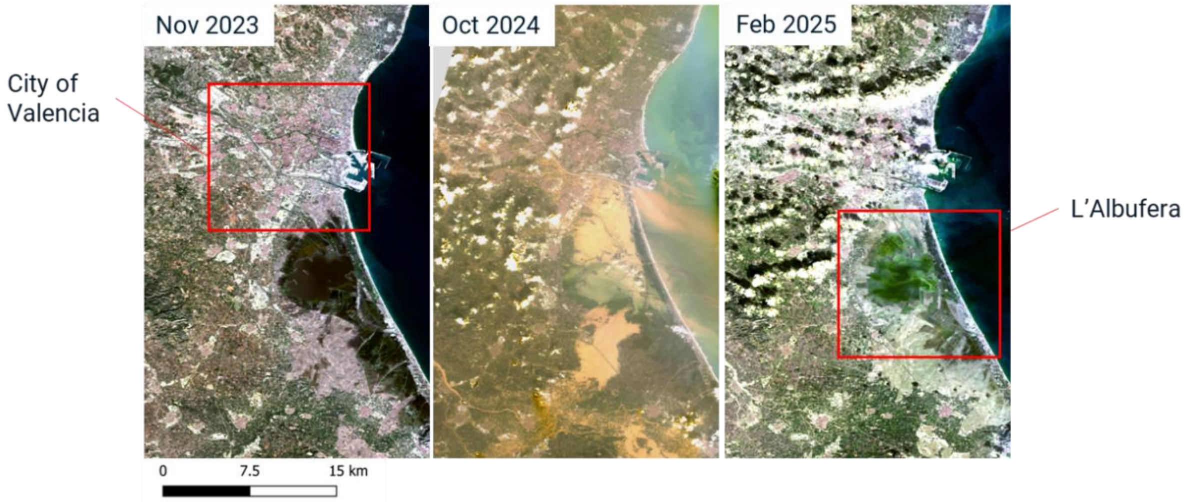


Figure 17: Landsat 8 images of the city of Valencia, surrounding towns and L'Abufera wetland from November 2023, just after the event on Oct 30th 2024, and 3 months after the event (Feb 2nd 2025). The high sediment input from flooding can be seen in yellow in Oct

Los Angeles, Palisades Wildfire (Jan 2025)

The Fire Weather Index (FWI) in Los Angeles County, California in early January 2025 was well above 50.[110] FWI is commonly used in wildfire risk monitoring and uses a combination of factors such as temperature, humidity, precipitation, and windspeed to measure fire danger levels on a scale from 0 to 100. An area with a FWI over 50 is considered to be at extreme wildfire risk.[111] The high FWI coupled with the presence of Santa Ana winds - powerful winds that blow from the mountains towards the California coast - which are typical in LA from fall through early winter,[112] made the Pacific Palisades highly exposed.

The Palisades fire, which ignited on January 7, 2025, quickly spiraled out of control, burned for close to a month, and destroyed over 23,000 acres and close to 7,000 commercial and

[107] https://www.reuters.com/business/environment/washed-up-detritus-valencia-floods-puts-albufera-wetland-jeopardy-2024-12-04/
[108] Machado, T. M. et al. Extreme Flooding Events in Coastal Lagoons: Seawater Parameters and Rainfall over A Six-Year Period in the Mar Menor (SE Spain). Journal of Marine Science and Engineering, 10, (2022). https://doi.org/10.3390/jmse10101521
[109] López-Ballesteros, A. et al. Assessing the effectiveness of potential best management practices for science-informed decision support at the watershed scale: The case of the Mar Menor coastal lagoon, Spain. Science of The Total Environment, 859, (2023). https://doi.org/10.1016/j.scitotenv.2022.160144
[110] https://climate.axa/publications/the-2025-la-wildfires-a-warning-for-californias-future/
[111] https://climate-adapt.eea.europa.eu/en/metadata/indicators/fire-weather-index-monthly-mean-1979-2019
[112] https://www.sciencealert.com/how-santa-ana-winds-push-deadly-california-wildfires-to-new-heights

residential structures.[113] Losses are still being assessed but estimates are between 76 billion and 131 billion USD with insured losses around 45 billion USD.[114] Additionally, Intercontinental Exchange (ICE) municipal bond reference and geospatial data saw immediate impacts on bond pricing following the wildfires[115] and ICE Mortgage and Valuation saw a 26 percent increase in mortgage delinquencies in the Palisades wildfire zone between December and February.[116]

The Pacific Palisades is located in a Wildland-urban interface (WUI), or area defined as having structures and people in close proximity to vegetation. Despite the known fire risks, building in WUIs have gained popularity and are on the rise in the United States.[117]

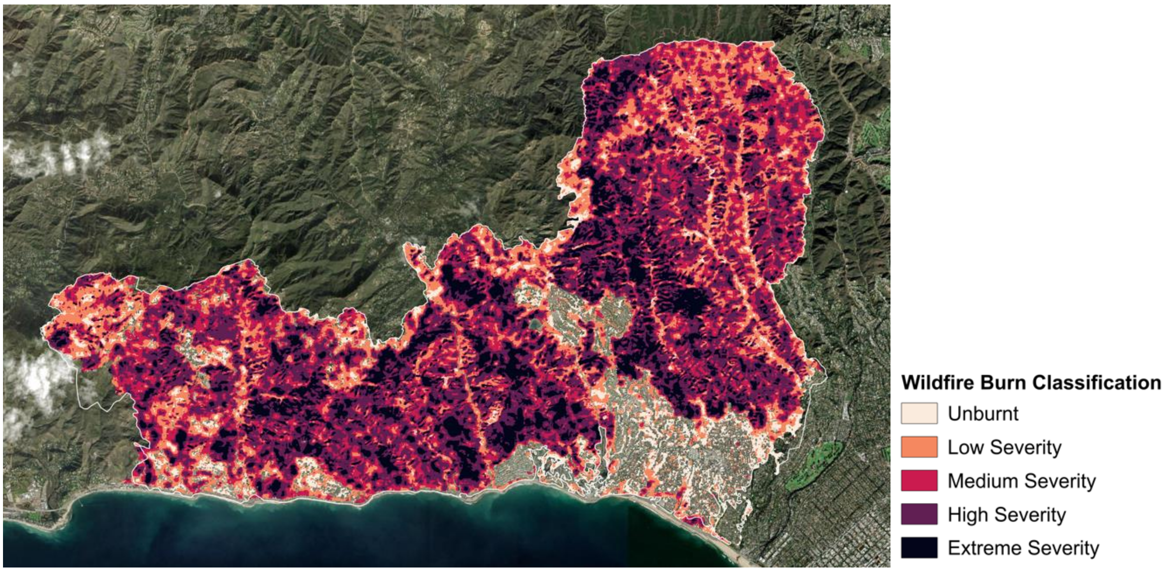
Beyond the damage to human life and property, the impacts of the Palisades wildfire were also felt on nature. 82 percent of the area burned was forested, and while some fire-resistant trees are likely to have survived, many local animal species were either unable to escape the flames because of limited mobility or have high reliance on the local habitat which is now scorched.[118]

Given the proximity to the ocean, it is likely that this wildfire affected both terrestrial and marine life. After the fire burned, atmospheric concentrations of volatile organic compounds and other toxic air pollutants were well above safe levels.[119] Soil contamination, likely from the firefighting techniques and chemicals in household products, raised concern about drinking water, agriculture, and also runoff into the ocean that may affect the aquatic ecosystems and marine life.[120]

Using geospatial analysis, preliminary research was performed by combining data on the fire perimeter with land cover classification data from 2023.[121] Most of the developed area within the perimeter, which accounted for 18 percent of the burned area, was low intensity development. The built-up areas abutted forested areas which accounted for 82 percent of the burned area and consisted mostly of mixed forest and shrubbery. While 7 percent of the area (all of which was developed) did not burn, 74 percent of the wildfire perimeter was in areas of medium to extreme burn severity (see map below).

[113] https://www.fire.ca.gov/incidents/2025/1/7/palisades-fire
[114] https://www.anderson.ucla.edu/about/centers/ucla-anderson-forecast/economic-impact-los-angeles-wildfires
[115] https://www.ice.com/publicdocs/mortgage/february-2025-mortgage-monitor-report.pdf
[116] ICE Mortgage Monitor preliminary research as of March 2025
[117] https://www.pnas.org/doi/10.1073/pnas.1718850115
[118] https://environmentamerica.org/california/articles/wildfires-in-los-angeles-impacts-on-wildlife-and-ocean-ecosystems/
[119] https://www.ecmwf.int/en/about/media-centre/science-blog/2025/2025-california-wildfires-insights-ecmwf-forecasts
[120] https://environmentamerica.org/california/articles/wildfires-in-los-angeles-impacts-on-wildlife-and-ocean-ecosystems/
[121] https://www.mrlc.gov/data/legends/national-land-cover-database-class-legend-and-description

Figure 18: Geospatial mapping of Los Angeles, Palisades Wildfire



Source: ICE Climate, data as of March 2025, Background imagery from ESRI

To further assess the Nature-related risk within the wildfire perimeter, 5 randomly selected points within the wildfire boundary were selected with a 5 km buffer which was run through NatureAlpha's Nature sense platform. The results showed that the entirety of the area has high ecosystem services provision meaning it is considered critical for biodiversity, climate mitigation, and people, and should be prioritized for conservation and sustainable management. The definition of high ecosystem services provision is based on a number of factors including coastal risk reduction, carbon storage, sediment retention, and water quality control. Unfortunately, these now scorched areas will no longer retain their conservation value and biodiversity importance.

The Palisades region, once a carbon sink with potential to support climate offset strategies with its vast tree cover and healthy ecosystems has now become a source of emissions due to the wildfire. The ecological degradation, coupled with widespread property damage, poses heightened risks for financial institutions and lenders through increased insurance claims, reduced asset values, and potential business interruptions.

4.3 Next steps for nature data in financial institutions

The Taskforce on Nature-related Financial Disclosures (TNFD) provides guidance to financial participants on understanding their nature impacts, risks, and opportunities. In the next section, we will focus on two key aspects: development of risk narratives and the LEAP approach.

Scenario analysis for nature is in its nascent phase. Although nature and climate are closely related, the early assessment of nature risk is still evolving, raising questions about the best approaches, particularly around scenario analysis. This is due to the recognized complexity of nature systems, which can be greater than those of climate and are indeed correlated with climate pathways. A sensible first step is to better understand expected risk pathways and develop robust narratives to support scenario development.

This section emphasizes the importance of a holistic approach to environmental risk assessment, considering nature and climate side-by-side. It also highlights key activities to help financial institutions begin their journey in assessing nature-related risks:

Table 6: Key steps in developing approach to nature-related risks for financial institutions

Step 1: High-level heatmapping	This can provide a view of the direction and magnitude of nature risks and impacts that sit in an investment portfolio. This helps to identify key sectors and geographies in which a portfolio may have exposure to nature risks and impacts, as well as thematic areas that may be present across the portfolio in aggregate, such as deforestation, water quality or land use change. There are a number of freely available tools to support this initial assessment, including ENCORE, SBTN materiality screening tool or the UNEP FI portfolio impact analysis tool. These tools have inherent assumptions and limitations that will influence results and should be understood. As an example, the materiality ratings within ENCORE indicate typical level of materiality at global level whereas the actual levels may vary significantly based on company and the location being assessed.
Step 2: Developing narratives that identify potential risks and opportunities related to nature.	To develop forward-looking scenario narratives, it will be important to understand how risks and opportunities may emerge over the time horizon of your assessment. Consideration should be given to the impact of future changes and their likelihood of occurring. Examples may include emerging risks such as anticipated legislation or technological improvements like precision fertilization. There may also be opportunities that take time to realise. Many nature-based solutions to carbon sequestration, such as forestry or peatland restoration can take a minimum of 10 years to produce notable results. Investment in such solutions would need to happen over the short term to realise their benefits for the longer duration.
Step 3: Explore how pathways may differ with changes to underlying levers.	Physical risk scenarios might explore the potential impacts of higher-than-anticipated deforestation rates on soil quality, flood risk, and other cascading effects. Transition risk scenarios, on the other hand, would be anchored in the expectation that regulations or national legislation will drive specific changes in the real economy, enabled by technological solutions.
Step 4: Expansion of climate scenario modelling for nature.	Climate and nature are inextricably linked. Climate models are well established and are increasingly understood by relevant professionals. Rather than developing standalone nature models, a sensible first step would be to calibrate existing climate risk models to consider the impact of changes in nature. Using scenario narratives defined in the previous steps, judgement should be applied to model outputs to describe whether results may be over- or under-stated depending on expected changes in nature, the degree to which such changes may impact results, and whether any mitigating actions could be put in place.
Step 5: Prepare for nature-related disclosures	In addition to a qualitative assessment on how nature-related risks have been identified and are being managed, there may be additional metrics that are required to be disclosed under emerging regulatory regimes, such as ISSB. The International Sustainability Standards Board (ISSB) has formalised its alliance with the Taskforce on Nature-related Financial Disclosures (TNFD). We may therefore expect that ISSB reporting expectations on nature are closely aligned to standards already published by the TNFD, including suggested core metrics and additional metrics that may be relevant for Financial Services firms. Measurement, reporting and verification of nature-related data is likely to be non-trivial and will likely require deployment of geospatial data as reporting evolves. Firms should allow themselves adequate time to prepare in advance of reporting deadlines. Firms can begin by establishing a baseline of nature-related impacts, risks and opportunities, using data that is currently available via existing licenses and publicly available sources. Where data gaps are identified, a roadmap can be developed to explore how required data can be identified, sourced and onboarded in advance of reporting deadlines.

TNFD LEAP Approach: The TNFD LEAP approach is gaining traction in the financial community and market players are using it to help define nature risk and impacts. There are several commercial data providers offering TNFD reporting solutions, including Bloomberg, MSCI, and ICE Climate with NatureAlpha. The following chart shows the different offerings of these three data providers and how they align to the TNFD LEAP approach.

Table 7

	Locate	Evaluate	Assess	Prepare
Bloomberg ESG NATURE<GO>	The asset location database covers over a million assets for 40k companies. The platform overlays these locations on biodiversity intactness and water stress enabling assessment at the asset level.	Users can identify what percentage of a company's business segments are in one of the sectors which TNFD defines as having high material nature-related impact and dependency risks in addition to digging deeper into the drivers.	The model identifies metrics and policies which are relevant to a company, split between governance and strategy, and actions on the drivers of nature loss. The screen also helps the user understand deforestation risk of a company.	Field mapping allows clients to ingest and report on the metrics required by the TNFD framework.
ICE Climate and NatureAlpha Nature and Biodiversity Solution	The asset location database contains over 1 million assets for approximately 11k companies. Each asset is assessed using 20 different geospatial layers that follow the TNFD criteria for sensitive locations that combined measure whether a corporate asset is within a sensitive location.	A materiality assessment was built using a large language model trained to learn the biodiversity impacts and nature dependencies for 163 subindustries. The model considers the direct and indirect (supply chain) operations of a company.	The Unmanaged Risk considers a company's management of nature and biodiversity-related risks through corporate policies, targets, and initiatives or, lack thereof.	The TNFD module providing users with 24 metrics to seamlessly respond to the core metrics of the TNFD framework.
MSCI Nature and Biodiversity data solutions	MSCI maintains an asset location database with 2 million locations. Each location is given a Mean Species Abundance (MSA) metric and compared against data from the WWF Biodiversity Risk Filter (BRF) and sensitive areas.	MSCI uses a combination of business segment breakdown of assets and revenue with biodiversity footprint metrics to identify nature and biodiversity risks.	Various metrics assess the existence and strength of policies, targets, and management of risk	180+ metrics across impact on nature, nature risks and opportunities to enable users to prepare key information for public disclosure.

Additionally, below are some open-source options that may help Financial Institutions get started on assessing nature and biodiversity risks and reporting to the TNFD:

- **ENCORE**[122] is a collaboration between Global Canopy, the UNEP Finance Initiative and the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) which was developed to assess impacts and dependencies related to economic activities.
- **TRASE**[123] is a not-for-profit initiated in 2015 by the Stockholm Environment Institute and Global Canopy to bring transparency to commodity trading and its influence in deforestation.
- **WRI's**[124] **Global Forest Watch dataset** leverages satellite data and advanced algorithms to determine the annual loss of tree cover. It can be used to track deforestation or forest loss over time.
- **UN Biodiversity Lab**[125] is a free open-source platform with access to over 400 data layers on nature, climate change and sustainable development.

[122] ENCORE: https://encorenature.org/en/data-and-methodology/limitations
[123] TRASE: https://trase.earth/
[124] WRI: https://www.wri.org/initiatives/global-forest-watch
[125] UN Biodiversity Lab: https://unbiodiversitylab.org/en/

Appendix

Table 8: Characteristic differences between climate and nature physical financial risks[126]

Characteristics	Climate related physical financial risks	Nature related physical financial risks
Driver	Global. Increasing GHG emissions and changes in natural sinks directly attributable to human activities	Local (albeit could occur as a global trend). Wide range of drivers directly attributable to human activities
Acute and chronic	Both acute (shocks) and chronic (gradual) impacts	Both acute (shocks) and chronic (gradual) impacts
Diversity of impacts	Wide range of potential impacts on natural and human systems	Range of potential impacts on natural and human systems is arguably even wider and more direct than for climate change, including changes in genetic materials for medicines etc.
Timescales	Immediate but time delay before the physical impacts of GHG emissions fully manifest	Impacts of nature degradation can be immediate or can build up over time
Spatial scales and localisation	The impacts of rising GHG concentrations are global, albeit are spatially heterogeneous and determined by a combination of local nature and socioeconomic factors (including nature loss)	Impacts of nature degradation are local, and determined by local natural and socioeconomic factors, however can also have a global impact, due to connections across natural and social systems
Linearity, uncertainty and predictability	The relationship between climate change and local and global physical climate risks can be strongly non-linear, with potential for compounding and cascading risks that can amplify local effects, making prediction difficult	The relationship between nature and related local and global physical nature risks can be strongly non-linear, with potential for compounding and cascading risks that can amplify local effects, making prediction difficult
Thresholds and tipping points	Climate change can drive tipping points in nature and socioeconomic systems with extreme impacts	Nature degradation can drive tipping points in natural and socioeconomic systems with extreme impacts
Climate-Nature Risk amplifiers	Nature degradation and associated socioeconomic vulnerabilities are risk amplifiers of climate risks	Climate change, natural climate variability and socioeconomic vulnerabilities are risk amplifiers of nature risks
Status of modelling	Integrated assessment models for climate are well known to capture only a fraction of potential physical climate risks. Models include many sources of uncertainty and collaborative efforts such as ISIMIP play an important role in helping to ensure model comparability.	Integrated assessment models for nature are at a nascent stage, capturing only certain processes and so likely underplay the risks. Projections that exist are uncertain. Model comparability is challenging due to lack of structured comparison efforts analogous to ISIMIP.

[126] Source: Ranger et al. (2023)

Nature Scenario considerations

When constructing nature scenarios, there are several parameters to consider:

- **Spatial scales and location**. The locations which the scenario is relevant for – this could be global, national or local. However, it is important to note that localized impacts can have far-reaching implications, given dependencies across complex global supply chains.
- **Time horizon.** A scenario can be tailored to produce outputs for a single year or multiple years. The TNFD recommends using 2030 as the first key milestone for scenario analysis given this is the year for 'halting and reversing nature loss' under the Global Biodiversity Framework. 2050 is often used as a longer term milestone.[127]
- **Risks.** Given nature is multi-faceted, there are many potential risks. These can broadly be categorised as physical risks and transition risks. Physical risks are associated with ecosystem service degradation whereas transition risk is reflective of alignment of market and non-market driving forces. There is currently no consensus around which risks nature scenarios should centre around. Risks drivers have their own timeframes – either classified as chronic or acute.
- **Severity of risk.** Some risks will be inherently more severe than others. For example, a pollution tax may be less impactful to a business than a chronic drought. However, scenarios can also be constructed around differing levels of severity within one risk. For example, several scenarios could be created around a pollution tax which varies in cost. Therefore, when constructing a scenario, the severity of the risk can be scaled up or down to alter the output.
- **Desired output.** 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. There are several types of outputs that can be created from scenario analysis.

Over the last 3 years, there have been a number of scenarios released from different sources, all of which tackle the above parameters in different ways. Table 9 shows a summary of the most applicable studies available today as identified by this working group.

Table 9: Nature scenario comparison

Source	Scenarios	Risk drivers	2x2 axes	Spatial risk scale
University of Exeter - No Time to Lose (UoE)	• Roaring 20s • Green Phoenix • Boom and Bust • Meltdown	Physical risk, Transition risk	Policy Intervention X Market Dynamism	Global
Taskforce on Nature-Related Financial Disclosures (TNFD)	• Ahead of the Game • Go Fast or Go Home • Sand in the Gears • Back of the List	Physical risk, Transition risk	Nature loss and ability of the company to adapt X Alignment of market and non-market driving forces	NA
Aled Jones (Global Sustainability Institute) et al. (2018) (GSI)	• Insufficient UK Food • Food distribution problem	Physical risk, Transition risk	NA	United Kingdom
Green Finance Institute: Assessing the Materiality of	• Domestic • International • AMR-Pandemic	Physical risk, Transition risk	NA	United Kingdom

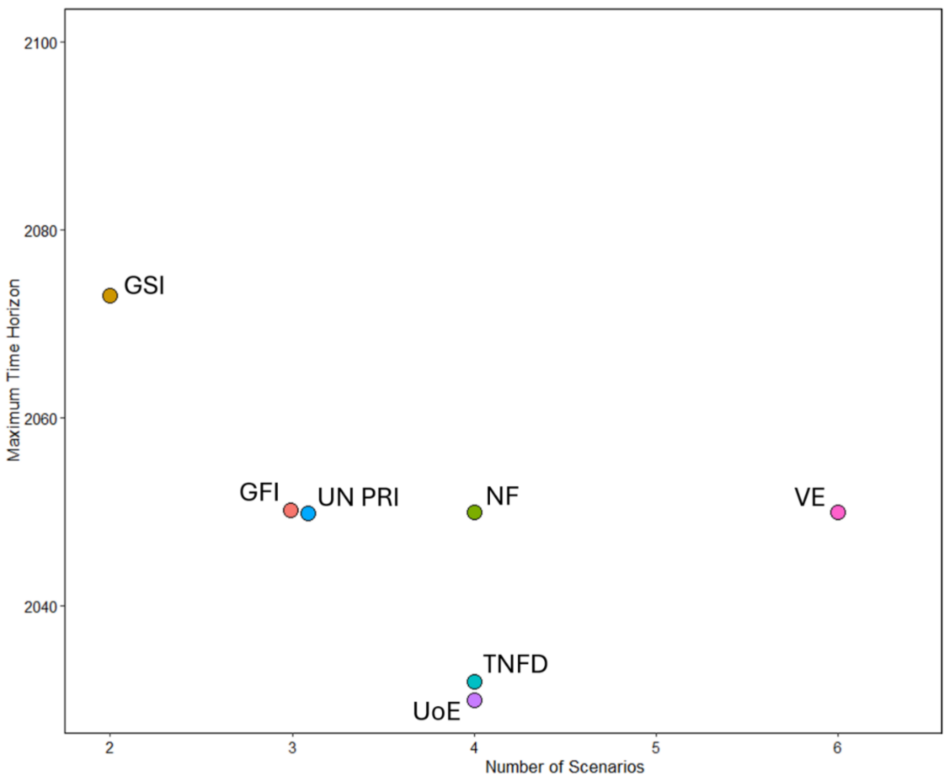
[127] Guidance_on_scenario_analysis_V1.pdf

Nature-Related Financial Risks for the UK (GFI)				
UN PRI IPR	• Disruption to commodity production and supply chains • The development and evolution of new products and technologies • NBS-based carbon credits and emerging nature markets	Physical risk, Transition risk	NA	Global
Vivid Economics (VE)	• Baseline • Current Policies • Climate Only • Climate + Protection • Climate + Nature Future • Climate + Nature Now	Physical risk, Transition risk	NA	Africa
Nature Finance, ECB, PIK (NF)	• Degraded World • Managed Ecosystems • Climate-Nature Equilibrium	Physical risk, Transition risk	Climate Policy Ambition X Nature Policy Ambition	Global

Source: CFRF Nature Working Group

Source: GFI - Assessing the Materiality of Nature-Related Financial Risks for the UK. The Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) is a framework for consistently projecting the impacts of climate change across affected sectors and spatial scales.

Figure 19: Maximum Time Horizons and Number of Scenarios considered by each source.



Sources: GSI = Jones et al. (Global Sustainability Institute)11, GFI = Green Finance Institute, University of Oxford6, UN PRI = UN Principles for Responsible Investment, Inevitable Policy Response12, NF = Nature Finance, European Central Bank10, VE = Vivid Economics7, TNFD = Taskforce on Nature-related Financial Disclosures8 and UoE = University of Exeter, Universities Superannuation Scheme9.