

Network for Greening the Financial System  
Technical document

# Nature-related Financial Risks: a Conceptual Framework to guide Action by Central Banks and Supervisors

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## Foreword



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**A**t the end of last year, governments from around the world reached a landmark agreement at the fifteenth meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 15) to adopt the Kunming-Montréal Global Biodiversity Framework (GBF). The GBF aims to halt biodiversity loss and restore ecosystems through concrete measures to reverse nature loss, and to protect at least 30% of the world's lands, oceans, coastal areas, and inland waters by 2030. This agreement underlines the importance and urgency of the nature crises, a message firmly rooted in scientific evidence. The 2019 Global Assessment Report of Biodiversity and Ecosystem Services by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), along with many other scientific documents, have provided overwhelming evidence that biodiversity and nature are being deteriorated worldwide at unprecedented rates. Left unaddressed, the twin crisis of environmental degradation and climate change poses a significant threat to stability, sustainable prosperity, and life on this planet.

Central banks and supervisors have clear reason to be concerned and involved as economies and financial sectors are not isolated from these existential challenges. The degradation of nature, and actions aimed at preserving and restoring it, can have material macroeconomic, macroprudential, and microprudential consequences.

We created this conceptual framework for nature-related financial risk to help guide policies and action by central banks and supervisors. Building on previous work, it establishes a common understanding of these risks to help central banks and supervisors navigate the complexities and challenges collectively. The conceptual framework charts an important first step towards an integrated assessment of climate and broader nature-related risks. While climate change may be the starting point for action, science also tells us that broader nature-related risks cannot be analysed or addressed in isolation.

This document is merely a beginning. We will continue to develop knowledge and experience, but the lack of absolute certainty and perfect knowledge should not prevent us from acting now. Otherwise, we will almost certainly slide into a 'too little, too late' scenario.

We genuinely appreciate the commitment and dedication of all Task Force members, who have contributed to this document, as well as the valuable engagement of other stakeholders who have provided inputs in the past year. Our special thanks go out to the team lead and the NGFS Secretariat.

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# 1. Introduction

As is widely acknowledged, nature is fundamental to human well-being, a healthy planet, and economic prosperity. Without always realising it, humans depend on nature for food, medicine, energy, clean air and water, security from natural disasters, recreation, and cultural inspiration (among many other things). But human demands have exceeded the ability of the planet to provide such services, resulting in a degradation of nature and its diversity at unprecedented rates.<sup>1</sup> For example, monitored wildlife populations have declined by an average of 69% since 1970<sup>2</sup>, and the global rate of species extinction is tens to hundreds of times higher than it has been over the past 10 million years.<sup>3</sup> Furthermore, numerous boundaries that maintain the resilience and stability of the Earth have been exceeded.<sup>4</sup> This continued degradation poses a threat to well-being<sup>5</sup> and, more fundamentally, to the planet's habitability<sup>6</sup>. In response, the Kunming-Montreal Global Biodiversity Framework ("GBF") was adopted in 2022 with a set of goals and targets to halt and reverse biodiversity loss. Its overarching vision is for humans to live in harmony with nature by 2050. 23 targets are set for 2030 to achieve this vision.<sup>7</sup>

The degradation of nature, and actions aimed at preserving and restoring it, will affect our economies and financial systems. To illustrate, the GBF requires, among other things, the alignment of all financial flows by 2030 with its targets and goals.<sup>8</sup> Based on the findings of a joint NGFS-INSPIRE study group, the NGFS has acknowledged that nature-related financial risks could therefore have significant macroeconomic implications, and that failure to account

for, mitigate, and adapt to these implications is a source of risks relevant for financial stability.<sup>9</sup> To effectively address these risks, the NGFS has set up a task force on Biodiversity Loss and Nature-related Risks ("Task Force"). The objective of the Task Force is to help **mainstream the consideration of nature-related financial risks across the NGFS**. As part of this effort, the Task Force is mandated to **develop a conceptual framework on nature-related financial risks to guide action by central banks and supervisors**.<sup>10</sup>

This document contains the **beta version of an NGFS Framework for nature-related financial risks** (the "Framework"). It adopts an integrated approach, meaning that climate-related financial risks are strongly interconnected with the broader environmental-related financial risks, and therefore considered within the scope of nature-related financial risks (without prejudice to the relevance of the NGFS' work on climate).<sup>11</sup> The Framework seeks to create a common science-based understanding of, and language for, these nature-related financial risks among NGFS members. The aim is to provide greater clarity on the meaning of key concepts and the way these interrelate. It also contains a principle-based risk assessment framework to help operationalise that conceptual understanding. In this way, the Framework aims to help central banks and supervisors consider the relevant elements of nature-related financial risks and to develop policies and actions in respect of it, while taking into consideration their jurisdictional context. Considering that purpose, the Framework draws attention to the considerations that are most likely to be material from a microprudential, macroprudential or

1 Kunming-Montreal Global biodiversity framework (CBD/COP/DEC/15/4), December 2022.

2 Living Planet Report 2022 – Building a nature-positive society, World Wildlife Fund ("WWF"), 2022.

3 Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services ("IPBES"), 2019.

4 Rockström, J. et al. (2023) *Safe and just Earth system boundaries*, Nature.

5 Kunming-Montreal Global biodiversity framework (CBD/COP/DEC/15/4), December 2022.

6 Final Report, NGFS-INSPIRE Study Group, March 2022.

7 Kunming-Montreal Global biodiversity framework (CBD/COP/DEC/15/4), December 2022.

8 Ibid. See Target 14.

9 Statement on Nature-Related Financial Risks, NGFS, 24 March 2022.

10 Task force "Biodiversity Loss and Nature-related Risks" Mandate April 2022 – April 2024, NGFS, 2022.

11 Consequently, nature-related financial risks cover both "climate-related risks" and "environmental-related risks" as previously defined in: *A call for action – Climate change as a source of financial risk*, NGFS, 2019 (p. 11).

macroeconomic perspective, and therefore could affect financial stability or price stability. At the same time, it is acknowledged that other facets of nature and its degradation – such as effects on well-being or nature-related economic opportunities - could merit consideration outside the context of this Framework.

**The beta Framework is a starting point for analysis and action.** Its content is not meant to be comprehensive or set in stone. As knowledge and experience develops, the Framework can be refined and supplemented. This approach allows for the timely engagement with nature-related financial risks.

## 2. Understanding nature-related financial risks

To mainstream the consideration of nature-related financial risks beyond climate across the NGFS, **it is important to start with a shared understanding of the meaning of, and language for, these risks.** This chapter defines **nature-related financial risks and related concepts that are needed for a high-level understanding of these risks.** Full definitions for the key concepts (highlighted in **bold**), and references to their sources, can be found in [Annex 1](#).

### The natural world

As a starting point, it is necessary to reflect briefly on the meaning of **nature**. Nature itself is challenging to define, and its interpretation depends strongly on the context in which it is used.<sup>12</sup> In the IPBES Conceptual Framework, it has been described as: “The natural world with an emphasis on the diversity of living organisms and their interactions among themselves and with their environment.”<sup>13</sup> **For this Framework, the key consideration is that the term ‘nature’ captures both the biotic (living) and abiotic (non-living) elements on our planet, including biodiversity but also climate.** Some of these elements, such as natural resources (plants, animals, air, water, soils, minerals etc.), are sometimes also referred to as natural capital.<sup>14</sup>

**The living and non-living elements of nature combine in ecosystems, which yield a flow of benefits described as ecosystem services** (or nature’s contribution to people<sup>15</sup>). Ecosystem services provide society with tangible goods

(e.g., timber or food); the regulation of natural processes (e.g., carbon sequestration, surface temperature cooling, watershed protection and erosion control); supporting services (e.g., nutrient cycling and soil formation); and cultural services (e.g., recreation and tourism). See [Annex 2](#) for more details on different types of ecosystem services.

The ability of nature to provide these ecosystem services depends on biodiversity.<sup>16</sup> **Biodiversity refers to variability among living organisms, which includes the diversity within species, between species and of ecosystems.** There is strong scientific evidence that this variability is critical for the resilience, adaptability and productiveness of ecosystems.<sup>17</sup> Biodiversity should therefore be understood as an integral characteristic of healthy ecosystems.

### Degradation of nature

Human society and the global economy cannot exist without ecosystem services. Yet, human activities have driven an unprecedented degradation of nature and its biodiversity that threatens the continued provision of the very ecosystem services on which humans depend. **Five main drivers of nature degradation have been identified, starting with the most impactful drivers at a global level: (i) changes in land and sea-use; (ii) over-exploitation (i.e., extraction of living and non-living materials); (iii) climate change (iv) pollution; and (v) invasive alien species.**<sup>18</sup>

12 [Final Report](#), NGFS-INSPIRE Study Group, March 2022.

13 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.

14 Although not a key concept to understand or act on nature-related financial risk, the term is referenced in the Framework to place it into context. This terminology focuses especially on nature’s contributions to human economic activity, emphasising that nature is a stock of assets that provide a flow of benefits to people. For completeness, a full definition is provided in the glossary.

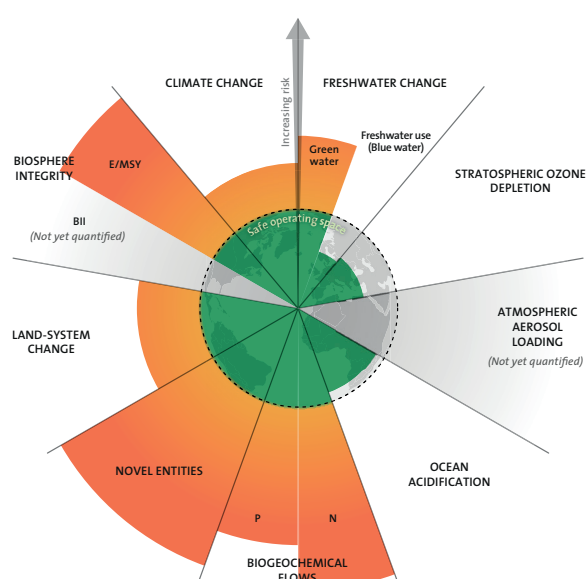
15 See Díaz, S. et al. (2018) *Assessing nature’s contributions to people*, Science.

16 [Final Report](#), NGFS-INSPIRE Study Group, March 2022.

17 See for example *The Economics of Biodiversity: The Dasgupta Review*, February 2021.

18 Described as direct drivers of change in nature in the *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*, IPBES, 2019.

Figure 1 **Planetary boundaries**



Source: Azote for Stockholm Resilience Centre based on analysis in Wang-Erlandsson et al., 2022.

The degradation of nature can be **acute** (i.e. shocks such as oil spills, forest fires or pests affecting a harvest) and/or **chronic** (i.e. gradual changes such as pollution stemming from pesticide use or climate change).<sup>19</sup> This degradation is often difficult to measure or predict. Among other things, this is because changes in the natural environment are not linear and characterised instead by compounding effects and ‘tipping points’.<sup>20</sup> These tipping points are abrupt and possibly irreversible shifts between alternative ecosystem states.<sup>21</sup>

The likelihood of reaching tipping point increases when ‘planetary boundaries’ are crossed. Planetary boundaries are a concept that indicate limits of the Earth’s ‘safe operating space’. Leaving the safe operating space increases the risk that large-scale abrupt or irreversible environmental changes occur.<sup>22</sup> Evidence suggests that,

because of human changes and pressures, **several of these boundaries have already been exceeded** (see figure 1).<sup>23</sup> To illustrate, climate change and human alterations to water bodies and land have led to global-scale river flow changes and shifts in water vapour flows. Such shifts in the hydrological system can be permanent and occur abruptly.<sup>24</sup>

The crossing of planetary boundaries could be therefore interpreted as an indication of the Earth’s susceptibility to physical hazards or shocks. For example, in the case of climate, multiple tipping points could already be triggered when 1.5°C global warming is exceeded (e.g. collapse of ice sheets, coral reef die-off and permafrost thaw).<sup>25</sup> Crossed boundaries could also indicate domains where action might be expected to bring the Earth back to its safe operating space and reduce the risk of reaching tipping points (e.g., in respect of freshwater, plastics or nitrogen emissions). The latter is in recognition of the fact that, driven by various motives and values<sup>26</sup>, **nature degradation has triggered action to protect, restore, and/or reduce negative impacts on nature**. Such action can manifest as changes in regulation and policy, legal precedent, technology, or investor sentiment and consumer preferences.

## Physical and transition risks

Like climate-related risks<sup>27</sup>, nature-related financial risks can thus be categorised as **physical risks** (stemming from the degradation of nature and loss of ecosystem services) or **transition risks** (stemming from a misalignment of economic actors with actions aimed at protecting, restoring, and/or reducing negative impacts on nature). With regard to transition risk, the misalignment often results from the negative impacts that economic actors have on nature. But, it is important to note that risks could

19 Final Report, NGFS-INSPIRE Study Group, March 2022.

20 Kedward, K., Ryan-Collins, J., & Chenet, H. (2020) *Managing nature-related financial risks: a precautionary policy approach for central banks and financial supervisors*; Lenton, T. M. (2013) *Environmental tipping points*. Annual Review of Environment and Resources.

21 Dakos, V. et al. (2019). *Ecosystem tipping points in an evolving world*. Nature, Ecology and Evolution. Description referenced in Final Report, NGFS-INSPIRE Study Group, March 2022.

22 Rockström, J. et al. (2009) *Planetary boundaries: exploring the safe operating space for humanity*. Ecology and Society.

23 The planetary boundary concept has recently been updated to ‘earth system boundaries’. See Rockström, J. et al. (2023) *Safe and just Earth system boundaries*, Nature.

24 *The nine planetary boundaries*, stockholmresilience.org.

25 Armstrong McKay, D. I., et al. (2022) *Exceeding 1.5 C global warming could trigger multiple climate tipping points*, Science.

26 The Framework emphasises the relevance of nature for economic activity, but a broader spectrum of values and ways of relating to nature may motivate actions to restore nature. See also *Methodological Assessment Report on the Diverse Values and Valuation of Nature*, IPBES, 2022.

27 *A call for action - Climate change as a source of financial risk*, NGFS, 2019.

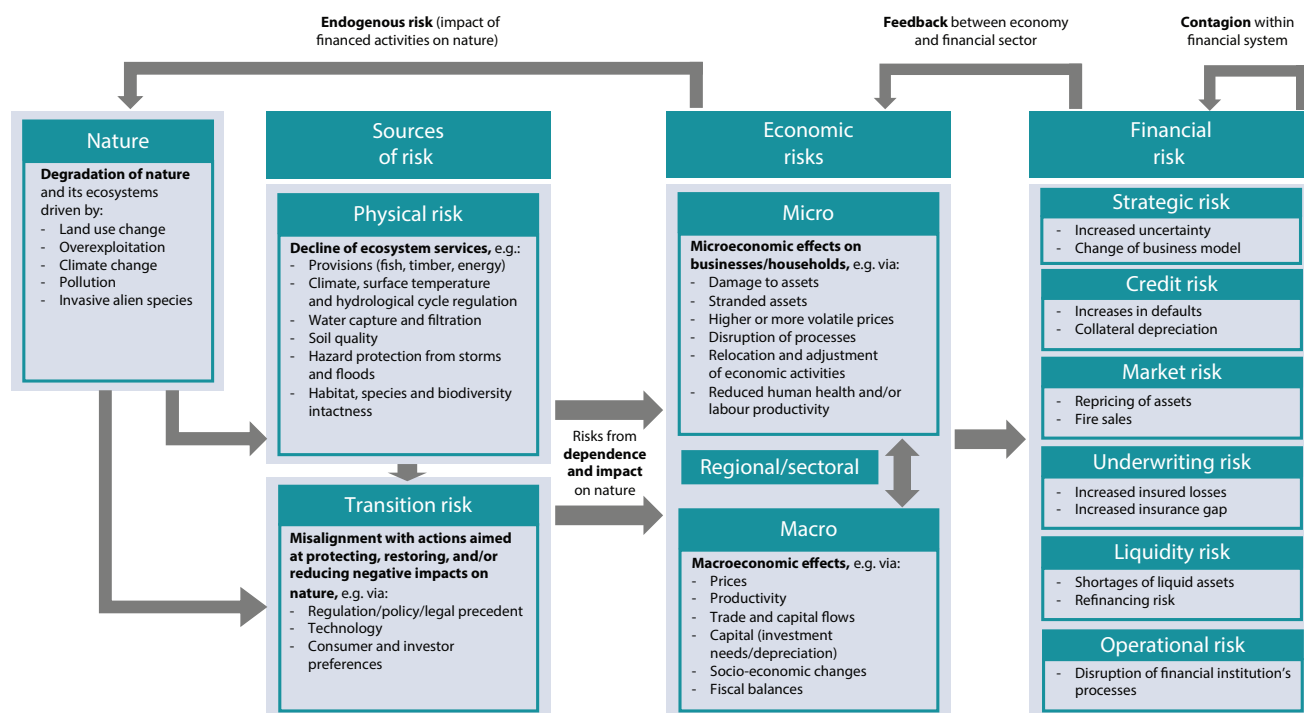


also arise from activities aimed at restoring nature that no longer align with, for example, revised policies.

Consistent with the NGFS approach for climate change, **litigation risk is considered in this Framework as a subset of both physical and transition risks.**<sup>28</sup> Litigation risks can arise from a variety of factors, including liability claims, policy and regulatory changes, and misconduct. In the case of physical risks, litigation may be brought against a company that is alleged to be responsible for causing harm to ecosystems (which, given the often more localised impacts on nature, may be easier to attribute to a particular company). Equally, as part of transition risks, litigation risk may arise when businesses fail to adapt to new regulations and face legal consequences.<sup>29</sup> Mismanagement of nature and climate risks can also lead to legal action, including cases against directors who intentionally mislead investors.<sup>30</sup>

Physical and transition risks can affect the economy at micro, sectoral/regional and macro levels (including as effects on price stability). Those effect include potential effects, but also effects that are expected as a result of permanent changes in nature that have occurred. Economic risks can subsequently translate into financial risks that adversely affect individual financial institutions or financial systems as a whole. In this context, **it is important to note that nature-related financial risks are also endogenous: the impacts that economic and financial actors have on nature affect the financial risks these actors need to manage.** For instance, through the economic activities that they finance, financial institutions can contribute to the build-up of nature-related financial risks (or contribute to the reduction of such risks).<sup>31</sup> Figure 2 provides an overview of the relevant transmission channels.

Figure 2 **Transmission channels**



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

28 Climate-related litigation: Raising awareness about a growing source of risk, NGFS, 2021. It is recognised that other frameworks may adopt a different approach, for instance viewing litigation risk as a separate risk category.

29 Ibid. The approach for climate-related litigation could be extended to broader nature-related litigation risks.

30 Biodiversity Risk: Legal Implications for Companies and their Directors, Commonwealth Climate and Law Initiative, December 2020.

31 Final Report, NGFS-INSPIRE Study Group, March 2022.



In light of the above, **nature-related financial risks are defined as follows for the purposes of this Framework:**

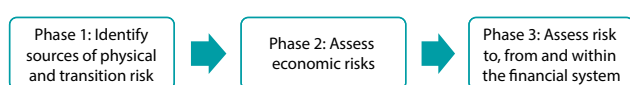
*Nature-related financial risks refer to the risks of negative effects on economies, individual financial institutions and financial systems that result from:*

- i. the degradation of nature, including its biodiversity, and the loss of ecosystem services that flow from it (i.e., physical risks); or*
- ii. the misalignment of economic actors with actions aimed at protecting, restoring, and/or reducing negative impacts on nature (i.e., transition risks).*

### 3. Assessing nature-related financial risks

Based on the understanding of nature-related financial risks, this chapter offers a framework to help central banks and supervisors identify and assess nature-related financial risks.<sup>32</sup> Its aim is to help operationalise the conceptual understanding of nature-related financial risks. At the same time, it should be noted that analytical methodologies and risk management practices are still being developed (see also [Next Steps](#)). Furthermore, actions taken will depend on the context in each jurisdiction and organisation, including differences in mandates. Considering this need for flexibility, the current Framework adopts a principle-based approach (as opposed to providing detailed, prescriptive guidance at this stage).

The principle-based risk assessment framework consists of three phases.<sup>33</sup> A few guiding questions are provided at the end of each phase to capture the key elements that central banks and supervisors could consider as part of their risk identification and assessment. For an overview, see [Annex 3](#).



#### Phase 1: Identify sources of physical and transition risk

As a first step, central banks and supervisors could identify the sources of risk that are potentially material from a microprudential, macroprudential or macroeconomic risk perspective. This section provides a **high-level approach to the identification and prioritisation of sources of physical and transition risk based on exposures**. As part of the approach, particular attention is drawn to the relevance of forward-looking, location-specific and systemic dimensions. Further details are also provided

on the interlinkages between climate and the broader dimensions of nature. The latter is intended to help supplement existing climate-related efforts and enable a more integrated approach to risk management.

#### Exposures to impacts and dependencies

Analysing the exposures to dependencies on nature and/or impacts of economic activity on nature can be a first step to identify sources of physical and transition risks (both as defined in chapter 2). Examples of such exposure analyses include the physical risk analyses based on the ENCORE database as conducted in the Netherlands, France, Brazil, Malaysia and Mexico.<sup>34</sup> The outcomes of the initial exposure analysis can help to identify sectors and/or ecosystems services that are more likely to be sources of material risk (and could therefore be prioritised as a starting point for the assessment of risk in phases 2 and 3).

- **Sector-based prioritisation:** Identify key economic activities or sectors that are more likely to be at risk based on the level of their dependencies/impacts on nature (including via value chains) as well as their relevance to the economy, individual financial institutions or financial sector (e.g. the value of the exposure compared to the total value of exposures analysed). To illustrate, economic activities with high impacts and dependencies on nature occur in sectors that include agriculture, aquaculture and fisheries, forestry, metals and mining, power generation, textiles and apparel, chemicals and pharmaceuticals, construction and infrastructure;<sup>35</sup> and/or
- **Ecosystem-based prioritisation:** Identify key ecosystem services on which economic activities depend, thereby considering the ecosystems from which they originate and the vulnerability of those ecosystems given negative impacts on them (see also [Annex 2](#) for more detail on the different ecosystem services).

32 In doing so, effect can be given to the call for action in the *Statement on Nature-Related Financial Risks*, NGFS, 24 March 2022: “The NGFS is therefore of the view that nature-related risks are relevant for central banks and supervisors: given the macroeconomic, macroprudential and microprudential materiality of nature-related financial risks, such risks should be adequately considered for the fulfilment of their mandates.”

33 Adapted from the approach for forward-looking risks assessments in the *Final Report*, NGFS-INSPIRE Study Group, March 2022.

34 For a more detailed description and references to the risk assessments, see the *Final Report*, NGFS-INSPIRE Study Group, March 2022. For more recent work, see also: Martinez-Jaramillo, S. et al. (2023) *Dependencies and impacts of the Mexican banking sector on ecosystem services*; ECB Blog – *The economy and banks need nature to survive*, European Central Bank (“ECB”), June 2023.

35 Based on prioritised sectors in *The TNFD Nature-Related Risk and Opportunity Management and Disclosure Framework (beta v0.2)*, TNFD, June 2022; *WWF Risk Filter - Overview - dependencies and impacts*, WWF; *The Biodiversity Crisis Is a Business Crisis*, Boston Consulting Group (“BCG”), 2021; *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*, World Economic Forum (“WEF”), 2020.

The above analysis may only yield a partial picture of potential sources of risk due to remaining uncertainties and data constraints. Other indications of potential risks (both quantitative and qualitative) may therefore need to be considered. The sections below seek to complement the initial exposure analysis by drawing attention to the relevance of forward-looking, location-specific and systemic dimensions.

### Forward-looking dimension

The initial analysis as described above provides a static snapshot of current exposures. This could be supplemented with scenario analyses to explore exposures – and therefore sources of physical and transition risks – on a forward-looking basis.<sup>36</sup> For physical risks, the source of risk can be the extrapolation of a trend or hypothetical shock in which one or more ecosystems or ecosystem services degrade or collapse.<sup>37</sup> For transition risks, existing and announced nature-related policies on a global, regional and/or national level could provide a starting point to develop scenarios (for example the GBF, which defines 2030 targets on, among other things, protecting 30% of land and water<sup>38</sup> or the reduction of harmful subsidies<sup>39</sup>). It is relevant to understand and consider the expected time horizon for these scenarios (i.e., will they materialise in the short, medium or long term).

Lessons can be learnt from previous work on climate scenarios when developing such forward-looking exposure analyses (and, if feasible, forward-looking risk assessments in phases 2 and 3). But nature presents a number of open questions and unique challenges that must be carefully accounted for.<sup>40</sup> Work within the Task Force is underway to provide technical recommendations on the development of nature-related scenarios.

### Scale: local and systemic dimensions

Nature is spatially explicit. In other words, nature is distinct for each location and differs across locations. This is also the case for the impacts and dependencies on it. For example, activities may rely on ecosystem services provided by local ecosystems, or negative impacts may occur in ecosystems that are already fragile. Therefore efforts to identify and prioritise risks should take into account the geographical location of impacts and dependencies.

At the same time, local impacts and dependencies can have systemic implications due to spill-over and feedback effects. In addition to any direct effects of impacts and dependencies on a limited number of individual parts or actors in the system (such as a particular ecosystem, household, company or financial institution), risk may therefore also originate from more complex and indirect causal chains.<sup>41</sup> Considering these systemic dimensions may help to prioritise, e.g. by focusing efforts on identifying critically important ecosystems and the different risk transmission channels that stem from them. These considerations include:

- **Compounding effects:** The degradation of one ecosystem or ecosystem service may trigger a degradation or a collapse of others.<sup>42</sup> To illustrate, the collapse of globally important ecosystems like the Amazon may disrupt other ecosystems at a global level, including via effects on climate change. Physical and transition risks also interact over time. In particular, the loss of certain ecosystems may trigger local, regional or global policy responses that result in transition risk.
- **Cascading effects:** Physical and transition risks may cascade and amplify via value chains (included in the Framework as part of phase 2 under Direct and indirect effects). When taking a sector-based approach to

36 And, in phases 2 and 3, assess risk on a forward looking basis (e.g. via a stress test).

37 See for instance: *An Exploration of Nature-Related Financial Risks in Malaysia*, World Bank Group and Bank Negara Malaysia, 2022; For an assessment of economic risk (i.e. phase 2), see also: Johnson, J.A. et al. (2021) *The Economic Case for Nature: A Global Earth-Economy Model to Assess Development Policy Pathways*.

38 See e.g. *Indebted to nature: Exploring biodiversity risks for the Dutch financial sector*, De Nederlandsche Bank (DNB) and The Netherlands Environmental Assessment Agency (PBL), 2020.

39 More information on the targets is at [www.cbd.int/gbf/targets/](http://www.cbd.int/gbf/targets/). For a discussion, see also *COP15 marked a decisive moment for central banks and supervisors to address nature risks in the Anthropocene*, Grantham Research Institute on Climate Change and the Environment, January 2023.

40 For further details: *Final Report*, NGFS-INSPIRE Study Group, March 2022. See also *The TNFD's proposed approach to scenario analysis*, TNFD, November 2022.

41 *Final Report*, NGFS-INSPIRE Study Group, March 2022. See also Crona, B., Folke, C., & Galaz, V. (2021) *The Anthropocene reality of financial risk*. One Earth.

42 For instance, regulating and maintenance ecosystem services are complementary to one another, meaning that if one of them is disrupted sufficiently, the others will be disrupted as well. See *The Economics of Biodiversity: The Dasgupta Review*, February 2021.

prioritisation, this systemic dimension should particularly be kept in mind to avoid an underestimation of risk.<sup>43</sup>

- **Contagion:** The effect of physical and transition risks on individual financial institutions has the potential to spread throughout financial systems and/or create feedback loops to the real economy (included in the Framework as part of phase 3 under Contagion).

### Climate-nature nexus

As already highlighted, nature is multifaceted, which, as stated previously, covers both biotic and abiotic elements such as water, land use, nitrogen and phosphorus flows, biodiversity as well as climate. Previous work of the NGFS has focused largely on climate, and firmly established the relevance of climate-related risks for central banks and supervisors. However, the relevance of the broader nature dimensions – described as environmental risks – has been recognised by the NGFS.<sup>44</sup> This has led to a positioning of climate and environmental risks as two distinct but interrelated issues.

The various dimensions of nature have unique features, and are distinct in some respects. However, it is important to recognise that the different dimensions of nature are also closely interconnected.<sup>45</sup> Therefore, even as the NGFS continues its work in further understanding climate-related

financial risks, it is equally important to consider risks stemming from climate and the other dimensions of nature in an integrated manner. To facilitate such an integrated assessment, **nature-related financial risks as defined in this Framework incorporate the full spectrum of climate and environmental risks.**<sup>46</sup> In other words, for the purposes of the Framework, climate-related risks are considered to be part of nature-related financial risks.

There may be pragmatic reasons why an integrated assessment of nature-related financial risks is not always possible or desirable (e.g., as a result of modelling challenges). Furthermore, from a practical perspective, climate-related financial risks are more established and will in many cases be the starting point for action on broader nature-related financial risks. To enable the shift towards an integrated assessment of nature-related financial risks, the Framework has therefore generalised the existing NGFS approach to climate where possible. In addition, the table below describes some of the key interlinkages between climate and broader-nature-related financial risks that could be considered when taking first steps toward a more integrated approach.<sup>47</sup> In short, the physical dynamics driving climate change and the degradation of nature are mutually reinforcing. Additionally, climate mitigation and nature restoration present potential trade-offs and synergies.<sup>48</sup>

43 For a recent example of an indirect exposure analysis, see *ECB Blog – The economy and banks need nature to survive*, ECB, June 2023.

44 *A call for action - Climate change as a source of financial risk*, NGFS, 2019

45 See for example Pörtner, H.O. et al. (2021) *IPBES-IPCC co-sponsored workshop report on biodiversity and climate change*. IPBES and IPCC.

46 “Climate-related risks” and “environmental-related risks” were previously defined in: *A call for action - Climate change as a source of financial risk*, NGFS, 2019 (p. 11). It is noted that some may define or interpret environmental-related risks to already cover all these dimensions, including climate change. However, as phrasing like “climate and environmental risks” might also suggest a narrower interpretation of environmental-related risks, i.e. excluding climate-related risks, this statement clarifies that climate is explicitly captured by nature-related financial risks.

47 Based on, inter alia: *Final Report*, NGFS-INSPIRE Study Group, March 2022; Pörtner, H.O. et al. (2021) *IPBES-IPCC co-sponsored workshop report on biodiversity and climate change*. IPBES and IPCC.

48 Kedward, K., Ryan-Collins, J., & Chenet, H. (2022) *Biodiversity loss and climate change interactions: financial stability implications for central banks and financial supervisors*. Climate Policy.

Connection	Description
Climate change as a driver of nature risk	Climate change, and the resulting rising global temperatures, is one of the direct drivers of nature degradation. For example, climate-induced flooding, wildfires, ocean acidification and cyclones can disrupt the water cycle, alter soil temperatures and accelerate habitat and wildlife loss. Consequently, combating climate change can slow the climate-driven deterioration of ecosystems.
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 change mitigation and adaptation as a potential driver of nature risk	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 to capture carbon dioxide emissions (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 (i.e. nature-based solutions)	Conservation of ecosystems contributes substantively to mitigating climate change. As suggested above, 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. 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.

### Questions for members to consider when identifying sources of physical and transition risks:

- 1) **Current exposures:** Which dependencies does the economy and the financial sector (incl. via financed activities) have on ecosystem services? Which negative impacts does the economy and the financial sector have on nature? Which of those dependencies and negative impacts could be material sources of physical and transition risk from a microprudential, macroprudential or macroeconomic risk perspective?
- 2) **Priorities:** What are the key sectors with the highest impacts and dependencies (both direct and indirect) on nature? What are the critical global, regional and/or local ecosystems these key sectors, or the economy/financial sector as a whole, interact with, and where are they located? What is the current or estimated state of these critical ecosystems?
- 3) **Forward-looking view:** Are there any future developments that should be considered when assessing sources of physical and transition risks such as emerging policy frameworks or the sudden collapse of one or more ecosystem services? Over what time horizon are these forward-looking developments expected to materialise?
- 4) **Climate-nature nexus:** How does the consideration of climate change (and related mitigation/adaptation strategies) affect the identification of potential nature-related financial risk? Could sectors with large dependencies or impacts on nature be contributing to climate change, or be affected by it? Which strategies for climate change mitigation have the potential to cause inadvertent negative effects on ecosystems, thereby amplifying nature-related financial risks?

## Phase 2: Assess economic risks

Analysing exposures in phase 1 only provides an indication of potential physical and transition risks, which does not yet equate to a risk assessment. **As a second step, central banks and supervisors could assess the potential economic effects and risks that can stem from these exposures.**<sup>49</sup> These may be relevant in their own right as macroeconomic risks (e.g., inflationary pressures) or transmit physical and transition risks to the financial sector. **This section draws attention to three elements that should at least be considered when assessing economic risks:** (i) direct and indirect effects; (ii) micro, sectoral/regional and macro effects; (iii) substitutability.

## Direct and indirect effects

Physical and transition risks affect households and businesses via their direct dependence or impact on nature. This effect on primary producers (e.g. farmers) and consumers is also described as the direct effect (or first-order effects). However, the economic effects of physical and transition risks are not limited to direct effects. Instead, as also mentioned in phase 1, **risks may cascade through value chains - and between sectors - to other parts of the economy and/or across borders.** Indirect effects (or second-order effects) capture this transmission of direct effects via value chains.

<sup>49</sup> For more information on measurement approaches, see also: *Assessing biodiversity-related financial risks: Navigating the landscape of existing approaches*, OECD, April 2023.

## Micro, sectoral/regional and macro level effects

Via direct and indirect transmission channels, physical and transition risks can have both microeconomic and macroeconomic effects. **On a micro level, physical and transition risks can affect businesses and households dependent on ecosystem services to sustain their livelihood.** For instance, households may suffer a loss of income and higher livelihood costs as a result of weather-related damages or the effects of nature degradation on an individual's health and productivity. **On a macro level, physical and transition risks may have implications for**

prices, productivity, investment, socio-economic changes, fiscal balances and trade and capital flows (in particular affecting inflation and gross domestic product ("GDP")).

The micro and macro level effects are not isolated. Microeconomic effects can translate into macroeconomic effects, while macroeconomic effects also can in turn affect households and businesses (potentially giving rise to feedback loops). Introduction of a sectoral/regional level effects in the analysis might be beneficial to better capture this dynamics (see also figure 2). The table below highlights some of the key economic effects<sup>50</sup>:

Micro level effects		Macro level effects
<b>Capital destruction:</b> Damage to assets arising from physical shocks and hazards such as flooding or landslides.	<b>Regional/ sectoral level</b>	<b>Prices:</b> Changes in prices of commodities, energy or water could create inflationary pressure.
<b>Stranded assets:</b> New regulations or changing consumer preferences resulting in premature write-offs of assets, for instance because a factory is located in an area that becomes designated as protected.		<b>Productivity:</b> Effects on GDP from a diversion of investment or lower risk appetites for innovation, reduced labour productivity (e.g. as a result of heat or pollution), the loss of provisioning or regulating service productivity (e.g. affecting agriculture) or damage and disruptions to assets.
<b>Price volatility of raw materials:</b> Higher or more volatile prices of commodities due to, for instance, failed harvests of food crops.		<b>Capital:</b> Higher investment needs for mitigation or adaptation to prevent nature degradation and potentially accelerated depreciation of the current capital base.
<b>Disruptions of production processes and value chains:</b> Increases in costs as a result of temporary disruption to businesses or households processes, such as a suspension of services due to flooding.		<b>Socio-economic changes:</b> Effects from changing societal preferences, arising inequalities, migration or conflict.
<b>Relocation and adjustment of economic activities:</b> Relocation or alteration of economic activities to account for a reduction or loss of ecosystem services, or to reduce negative impacts, such as planting different crops on a farm.		<b>Trade and capital flows:</b> Changes to trade and capital flows may result from shocks in ecosystem service provision, potentially amplified via value chains, which affects exchange rates and sovereign credit ratings.
<b>Pricing of externalities:</b> Cost increases as a result of pricing in negative (or positive) impacts on nature, for instance a tax on certain pollutants.		<b>Fiscal balances:</b> The lack of access to ecosystem services may necessitate an increase in social protection spending on, for instance, water or food. Losses in production and employment may also reduce fiscal revenues.

## Substitutability

To assess the economic effects and risks, it is relevant to account for the fact that actors react differently to shocks depending on their sensitivity to the shock and their ability to adapt.<sup>51</sup> The notion of substitutability is particularly relevant in that regard. Two dimensions can be distinguished: geographical substitution and technological substitution.

- **Geographical substitution (i.e., between ecosystem services):** In the case of direct effects, the ability to adapt and rely on different ecosystem services may be limited. For example, when ecosystem services decline in a particular location, it could require a business to move its operations or make expensive alterations to its production processes. Businesses which are indirectly affected – i.e., through their value chain – may be in a better position to substitute, for example by changing suppliers or using

50 Based on, *inter alia*: *Indebted to nature: Exploring biodiversity risks for the Dutch financial sector*, DNB and PBL, 2020; *Handbook for Nature-related Financial Risks*, Cambridge Institute for Sustainability Leadership ("CISL"), 2021; *Final Report*, NGFS-INSPIRE Study Group, March 2022.

51 *Final Report*, NGFS-INSPIRE Study Group, March 2022; Svartzman, R. et al (2021) *A "Silent Spring" for the Financial System? Exploring Biodiversity-Related Financial Risks in France*.



different products (although such substitutes may not always exist). Consequently, jurisdictions or businesses with a higher reliance on primary sectors could be more exposed to economic effects.<sup>52</sup> At the same time, the large scale global degradation of ecosystems could make it increasingly difficult to find alternative sources of the required ecosystem services, including for jurisdictions and businesses that are indirectly exposed.

- **Technological substitution (i.e., between natural and manufactured/human capital):** There is a broader question to consider around the ability of businesses to adapt to physical shocks by substituting the loss of ecosystem services with technologies and other alternatives. For example, loss of pollinators may be replaced by mechanical pollination technologies. But if nature cannot be fully substituted – or substituted at all – the effects of losing ecosystem services will be far larger than if replacement technologies are used. Assumptions on the availability of replacement technologies in a particular sector or region are therefore important because they influence the size of estimated

potential economic effects. Standard macroeconomic models generally assume a high degree of possible substitutability, and therefore have tended to estimate relatively small economic costs of nature degradation as a percentage of GDP.<sup>53</sup>

When accounting for substitution, it may be appropriate to consider how it changes over time. For instance, there may be very low or even no adaptation options in the short-term period following a physical shock (e.g. due to contractual obligations or technological limitations). However, this might change as replacement technologies become available over the medium term. Equally, it is possible to imagine some substitution possibilities for quite small changes in ecosystem services, but these might reduce drastically for substantial nature degradation (such as those resulting from tipping points). Other factors such as costs (especially in the short run) and negative impacts on nature may also influence the availability and effects of substitutes over time.

#### Questions for members to consider when assessing economic risks:

- 1) **Value chains:** Are direct economic risks located domestically or abroad? Can direct effects transfer across borders and/or amplify (including domestically) through value chains, thereby resulting in indirect economic effects?
- 2) **Micro-macro interaction:** To what extent do economic effects on households and businesses as a result of nature-related financial risks lead to macroeconomic deterioration, including lower productivity or inflationary pressures? Are there any risks that directly create effects at the macro level? Could macroeconomic deterioration affect or create a feedback loop to the micro level?
- 3) **Vulnerability and substitution:** How vulnerable are economic actors given their ability to adapt (e.g. via substitution)? For the identified economic transmission channels, what technological or geographical substitution possibilities are available that could mitigate the effects of shocks and hazards? How would these possibilities change as the size of the shock or hazard increases?

### Phase 3: Assess risk to, from and within the financial system

As a third step, central banks and supervisors may want to consider the financial risks that stem from the exposures to sources of physical and transition risks (directly, or more likely, via financed activities).

### Effects on the financial system

The effects of nature degradation and related policies on the economy can transmit to financial institutions and can have an impact on the financial system. Similar to climate-related risks, they can lead to the impairment of assets and collaterals; lower corporate profitability and the impairment of insurability, affecting traditional financial risk categories. The table below illustrates this.<sup>54</sup>

<sup>52</sup> See for instance: Johnson, J.A. et al. (2021) *The Economic Case for Nature: A Global Earth-Economy Model to Assess Development Policy Pathways*. The higher decline in GDP that was measured for low-income and lower-middle-income countries was due, in part, to a high dependency on forestry or pollinated crops along with limited possibilities to switch to other production and consumption options.

<sup>53</sup> *The Economics of Biodiversity: The Dasgupta Review*, February 2021. See also Svartzman, R. et al (2021) *A “Silent Spring” for the Financial System? Exploring Biodiversity-Related Financial Risks in France*.

<sup>54</sup> Based on, inter alia: *Final Report*, NGFS-INSPIRE Study Group, March 2022; *Indebted to nature: Exploring biodiversity risks for the Dutch financial sector*, DNB and PBL, June 2020; *Handbook for Nature-related Financial Risks Key concepts and a framework for identification*, CISL, 2021.



Prudential risk categories	Examples of potential nature-related factors affecting prudential risks
Strategic and business model risk	The loss of ecosystems affects the ability of pharmaceutical companies to rely on particular natural resources for their drug development or production.
Credit risk	Soil degradation affects agricultural productivity, influencing the collateral value of agricultural land or the ability of farmers to repay debt.
Market risk	The market value of a company is affected by assets that have decreased in value because there is insufficient fresh water for the production process, or the value of the business' production process is reduced by the emergence of new technologies that require less water to operate.
Underwriting risk	Pandemic causes more claims under insurance than usual or soil erosion leads to more damaging effects of floods.
Operational risk	Financial institution faces regulatory, reputational, or litigation risks as a result of financing a company engaged in activities that contribute to deforestation. Facilities/suppliers of the financial institution are affected by flooding or landslides.
Liquidity risk	There may be pressure to liquidate assets due to rapid nature degradation as a result of crossing a tipping point or new regulations affecting particular assets that influence cash flows and collateral values.

## Contagion

The effect on individual financial institutions has the **potential to spread throughout financial systems and/or create feedback loops to the real economy**. These dynamics may amplify shocks that are initially relatively mild, but may have the potential to propagate across financial institutions and therefore merit consideration. Similarly, shocks that affect financial stability could trigger further macroeconomic deterioration, e.g. via market losses or credit tightening.<sup>55</sup> Potential examples might include inflationary shocks from rising food prices causing a rise in interest rates and weakening balance sheets of financial institutions such as banks. Likewise, uncertainty around policy measures could affect credit conditions and therefore the ability of economic actors in the system to transition.

## Endogenous risk: effects of the financial system on nature

Economic actors are not only exposed to nature-related physical and transition risks, **via the negative impacts they have on nature, these actors also contribute to the risks they need to manage**. That effect is not always symmetrical. Some businesses may have a large negative impact on nature but are not most directly and significantly exposed to the physical risks stemming from nature degradation. Instead, they increase physical risks for the system as a whole.<sup>56</sup> Those activities that give rise to endogenous risks are also likely to be a source of transition risks, particular when the negative impacts attract the attention from policy makers, innovators, investors or consumers.

**The financial sector is not solely responsible for economic activities that exert negative impacts on nature, but it does play a role as enabler of economic activities.** In this context, it should be noted that economic actors may also exert a positive impact on nature via their activities, e.g. by financing activities that contribute to the restoration of nature and thereby decreasing physical risks.

### Questions for members to consider when assessing financial risks:

- 1) **Transmission:** How can economic risks transmit to traditional financial risk categories?
- 2) **Systemic dimension:** How can nature-related financial risks amplify via feedback loops within the financial sector, or between the financial sector and the real economy?
- 3) **Endogenous risk:** Is the financial sector materially contributing to the physical risks to which it is exposed to?

<sup>55</sup> [Interim Report](#), NGFS-INSPIRE Study Group, October 2021.

<sup>56</sup> [Final Report](#), NGFS-INSPIRE Study Group, March 2022.

## 4. Next steps

By providing a common understanding of nature-related financial risks and a principle-based risk assessment approach, this document has created a beta framework for central banks and supervisors to assess the interactions between nature, the macroeconomy and the financial system in a way that is intended to be comprehensive and actionable. The Framework, including its guiding questions, may also prove relevant to facilitate a dialogue with the financial sector about the identification, assessment and management of nature-related financial risks.

Based on feedback received and knowledge gained, the Framework will be refined and supplemented over time. In particular, before the end of its mandate in the first half of 2024, the Task Force aims to supplement the framework with illustrative case studies and evaluate – based on the case studies and progress made in the other Task Force teams – whether the Framework needs to be updated. Some issues deserve particular consideration as part of this process:

- a) Identifying relevant data, metrics, tools and examples to help NGFS members further operationalise the principle-based framework. In doing so, it may be possible to leverage on emerging global disclosure guidelines, frameworks and standards developed by, such as the TNFD and the International Sustainability Standards Board (“ISSB”).
- b) Identifying which ecosystems and ecosystem services are likely to be most macro-financially critical given the size and location of dependencies, and which of those are at risk of decline/collapse (thereby taking into account the relevance of regional differences).
- c) Considering in more detail the linkages between climate change and broader nature degradation as well as the associated economic and financial risks, including opportunities to achieve an integrated identification, assessment and management of risk.
- d) Exploring how to assess economic effects through value chains in order to capture a more complete picture of macro-financially relevant effects.

In accordance with the NGFS Statement on Nature-Related Financial Risks, the next task is to bridge modelling and data gaps that emerge from the Framework.<sup>57</sup> One notable gap that already emerged is the need for scenarios to facilitate forward-looking risk assessments of nature-related financial risks. With that in mind, the Task Force has set up a team dedicated to scenarios that is working in parallel to develop a technical document with specific recommendations towards the development of such nature-related scenarios. In parallel, the Task Force will continue to explore how efforts to bridge data gaps – including via disclosure guidelines, frameworks and standards by stakeholders such as the TNFD and ISSB – may strengthen the Framework and its application.

The final task, as expressed in the NGFS Statement on Nature-Related Financial Risks, is using the Framework and emerging datasets to align policies with environmental sustainability and inform the assessment of nature-related financial risks. To support that effort, the Task Force will be collaborating closely with the four NGFS workstreams to recommend how nature-related financial risks could be integrated in their work plans.<sup>58</sup> At the same time, it is important to consider how the Framework could inform – and be made interoperable with – efforts of stakeholders beyond the NGFS such as regional and global standard setters (e.g., the Basel Committee on Banking Supervision (“BCBS”) and the International Association of Insurance Supervisors (“IAIS”).

In the meantime, the Framework offers a common starting point for action across NGFS membership. Considering the respective relevance of nature-related financial risks for their mandates<sup>59</sup>, central banks and supervisors are encouraged to assess and – where relevant – act on economic and financial risks stemming from material dependencies and impacts on nature, and their nexus with climate change, on the basis of the Framework. While doing so, differences in mandate, capacity, experience and context should be taken into account. These differences not only inform the starting point, but can also enrich the understanding of nature-related financial risks and the spectrum of actions available to address them.

<sup>57</sup> Statement on Nature-Related Financial Risks, NGFS, 24 March 2022.

<sup>58</sup> Task force “Biodiversity Loss and Nature-related Risks” Mandate April 2022 – April 2024, NGFS.

<sup>59</sup> Statement on Nature-Related Financial Risks, NGFS, 24 March 2022.

## Annex 1 – Glossary

**Biodiversity:** The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.<sup>1</sup>

**Ecosystem services:** A range of material and non-material benefits that humans, directly and indirectly, obtain from nature and that sustain and fulfil human life.<sup>2</sup>

**Ecosystems:** A dynamic complex of plant, animal and microorganism communities and the non-living environment, interacting as a functional unit.<sup>3</sup>

**Natural capital:** The stock of renewable and non-renewable natural resources (e.g., plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people.<sup>4</sup>

**Nature:** It is difficult to define nature, given that various meanings attached to it depend on the context in which it is used. To illustrate its meaning, reference is made to definition used in the IPBES Conceptual Framework: “The natural world with an emphasis on the diversity of living organisms and their interactions among themselves and with their environment.”<sup>5</sup> The key consideration for the purposes of this framework is that the term ‘nature’ captures both the biotic (living) and abiotic (non-living) elements of our planet, including biodiversity but also climate.

**Nature-related financial risk:** The risks of negative effects on economies, individual financial institutions and financial systems that result from: (i) the degradation of nature, including its biodiversity, and the loss of ecosystem services that flow from it (i.e., physical risks); or (ii) the misalignment of economic actors with actions aimed at protecting, restoring, and/or reducing negative impacts on nature (i.e., transition risks).<sup>6</sup>

**Physical risks:** The risk of economic costs and financial losses resulting from the degradation of nature and consequential loss of ecosystem services that economic activity depends upon. Physical risks can be chronic (e.g. a gradual decline of species diversity of pollinators resulting in reduced crop yields, deforestation, or water scarcity) or acute (e.g. an increased probability of new pandemics).<sup>7</sup>

**Transition risks:** The risk of economic costs and financial losses resulting from the misalignment of economic actors with actions aimed at protecting, restoring, and/or reducing negative impacts on nature. Transition risks can be prompted, for example, by changes in regulation and policy, legal precedent, technology, or investor sentiment and consumer preferences.<sup>8</sup>

1 *Convention on Biological Diversity*, 1992, Article 2. This definition is, *inter alia*, also used in: the *Final Report*, NGFS-INSPIRE Study Group, March 2022; and *Glossary of Key Terms*, TNFD.

2 The *Final Report*, NGFS-INSPIRE Study Group, March 2022. Derived from *Ecosystems and human well-being: Biodiversity synthesis*, Millennium Ecosystem Assessment, World Resources Institute, 2005.

3 *Convention on Biological Diversity*, 1992, Article 2. This definition is, *inter alia*, also used in: *Glossary of Key Terms*, TNFD; and the *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*, IPBES, 2019.

4 *Natural Capital Protocol*, Natural Capital Coalition, 2016. This definition is, *inter alia*, also used in: *Final Report*, NGFS-INSPIRE Study Group, March 2022; *Glossary of Key Terms*, TNFD; and the *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*, IPBES, 2019.

5 Díaz, S. et al. (2015) *The IPBES Conceptual Framework – connecting nature and people*; This definition is, *inter alia*, also used as working definition in the *Glossary of Key Terms*, TNFD.

6 This definition covers both “environmental-related risks” and “climate-related risks” as defined in *A call for action – Climate change as a source of financial risk*, NGFS, 2019 (p. 11). Environmental-related risks were defined in that report as: “risks (credit, market, operational and legal risks, etc.) posed by the exposure of financial firms and/or the financial sector to activities that may potentially cause or be affected by environmental degradation (such as air pollution, water pollution and scarcity of fresh water, land contamination, reduced biodiversity and deforestation). Climate-related risks were defined as: “risks posed by the exposure of financial firms and/or the financial sector to physical or transition risks caused by or related to climate change (such as damage caused by extreme weather events or a decline of asset value in carbon-intensive sectors)”.

7 Adapted from *Guide for Supervisors Integrating climate-related and environmental risks into prudential supervision*, NGFS, 2020; and the *Final Report*, NGFS-INSPIRE Study Group, March 2022.

8 Ibid.

## Annex 2 – Ecosystem Services

Table 1 Categorisation of ecosystem services using various levels of granularity (adapted from Handbook for Nature-related Financial Risks, CISL, 2021)

Millennium Ecosystem Assessment (4 ecosystem services)	CISL Based on Swiss Re Institute (5 ecosystem services)	IPBES (18 nature's contributions to people)	ENCORE Based on CICES (21 ecosystem services)	TNFD Based on SEEA/IUCN (25 ecosystem services)
• Provisioning Services	• Food and other goods provision	<ul style="list-style-type: none"> <li>• Food and feed</li> <li>• Energy</li> <li>• Materials and assistance</li> <li>• Medicinal, biochemical and genetic resources</li> </ul>	<ul style="list-style-type: none"> <li>• Fibres and other materials</li> <li>• Animal based energy</li> <li>• Genetic materials</li> <li>• Ground water</li> <li>• Surface water</li> </ul>	<ul style="list-style-type: none"> <li>• Biomass provisioning</li> <li>• Genetic material</li> <li>• Water supply</li> <li>• Other provisioning services</li> </ul>
• Regulating Services	<ul style="list-style-type: none"> <li>• Air quality and local climate</li> <li>• Water security</li> <li>• Hazard regulation</li> <li>• Habitat intactness</li> </ul>	<ul style="list-style-type: none"> <li>• Regulation of air quality</li> <li>• Regulation of climate</li> <li>• Pollination and dispersal of seeds</li> <li>• Regulation of ocean acidification</li> <li>• Regulation of hazards and extreme events</li> <li>• Regulation of organisms detrimental to humans</li> <li>• Regulation of freshwater quantity, location and timing</li> <li>• Regulation of freshwater and coastal water quality</li> </ul>	<ul style="list-style-type: none"> <li>• Ventilation</li> <li>• Climate regulation</li> <li>• Filtration (air)</li> <li>• Filtration (water)</li> <li>• Pollination</li> <li>• Disease control</li> <li>• Pest control</li> <li>• Water flow maintenance</li> <li>• Bio-remediation</li> <li>• Dilution by atmosphere and ecosystems</li> <li>• Mass stabilisation and erosion control</li> </ul>	<ul style="list-style-type: none"> <li>• Air filtration</li> <li>• Local/Global climate regulation</li> <li>• Pollination</li> <li>• Flood/storm mitigation</li> <li>• Rainfall pattern regulation</li> <li>• Biological control</li> <li>• Noise attenuation</li> <li>• Soil quality regulation</li> <li>• Water flow regulation</li> <li>• Water purification</li> <li>• Other regulating and maintenance services</li> </ul>
• Cultural Services	• Habitat intactness	<ul style="list-style-type: none"> <li>• Habitat creation and maintenance</li> <li>• Learning and inspiration</li> <li>• Physical and psychological experiences</li> <li>• Supporting identities</li> <li>• Maintenance of options</li> </ul>	<ul style="list-style-type: none"> <li>• Maintain nursery habitats</li> <li>• Dilution by atmosphere and ecosystems</li> </ul>	<ul style="list-style-type: none"> <li>• Nursery population and habitat maintenance</li> <li>• Recreation-related services</li> <li>• Visual amenity services</li> <li>• Education, scientific and research services</li> <li>• Spiritual, artistic and symbolic services</li> <li>• Other cultural services</li> </ul>
• Supporting Services	• Habitat intactness	<ul style="list-style-type: none"> <li>• Formation, protection and decontamination of soils</li> <li>• Habitat creation and maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• Soil quality</li> <li>• Buffering and attenuation of mass flows</li> <li>• Mediation of sensory impacts</li> <li>• Water quality</li> <li>• Flood and storm protection</li> </ul>	<ul style="list-style-type: none"> <li>• Soil and sediment retention</li> <li>• Solid waste remediation</li> </ul>

## Annex 3 – Overview of guiding questions

Phase 1: Identify sources of physical and transition risk	Phase 2: Assess economic risks	Phase 3: Assess risk to, from and within the financial system
<b>Current exposures:</b> <ul style="list-style-type: none"> <li>• Which dependencies does the economy and the financial sector (incl. via financed activities) have on ecosystem services?</li> <li>• Which negative impacts does the economy and the financial sector have on nature?</li> <li>• Which of those dependencies and negative impacts could be material sources of physical and transition risk from a microprudential, macroprudential or macroeconomic risk perspective?</li> </ul>	<b>Value chains:</b> <ul style="list-style-type: none"> <li>• Are direct economic risks located domestically or abroad?</li> <li>• Can direct effects transfer across borders and/or amplify (including domestically) through value chains, thereby resulting in indirect economic effects?</li> </ul>	<b>Transmission:</b> <ul style="list-style-type: none"> <li>• How can economic risks transmit to traditional financial risk categories?</li> </ul>
<b>Priorities:</b> <ul style="list-style-type: none"> <li>• What are the key sectors with the highest impacts and dependencies (both direct and indirect) on nature?</li> <li>• What are the critical global, regional and/or local ecosystems these key sectors, or the economy/financial sector as a whole, interact with, and where are they located?</li> <li>• What is the current or estimated state of these critical ecosystems?</li> </ul>	<b>Micro-macro interaction:</b> <ul style="list-style-type: none"> <li>• To what extent do economic effects on households and businesses as a result of nature-related financial risks lead to macroeconomic deterioration, including lower productivity or inflationary pressures?</li> <li>• Are there any risks that directly create effects at the macro level?</li> <li>• Could macroeconomic deterioration affect or create a feedback loop to the micro level?</li> </ul>	<b>Systemic dimension:</b> <ul style="list-style-type: none"> <li>• How can nature-related financial risks amplify via feedback loops within the financial sector, or between the financial sector and the real economy?</li> </ul>
<b>Forward-looking view:</b> <ul style="list-style-type: none"> <li>• Are there any future developments that should be considered when assessing sources of physical and transition risks such as emerging policy frameworks or the sudden collapse of one or more ecosystem services?</li> <li>• Over what time horizon are these forward-looking developments expected to materialise?</li> </ul>	<b>Vulnerability and substitution:</b> <ul style="list-style-type: none"> <li>• How vulnerable are economic actors given their ability to adapt (e.g. via substitution)?</li> <li>• For the identified economic transmission channels, what technological or geographical substitution possibilities are available that could mitigate the effects of shocks and hazards?</li> <li>• How would these possibilities change as the size of the shock or hazard increases?</li> </ul>	<b>Endogenous risk:</b> <ul style="list-style-type: none"> <li>• Is the financial sector materially contributing to the physical risks to which it is exposed to?</li> </ul>
<b>Climate-nature nexus:</b> <ul style="list-style-type: none"> <li>• How does the consideration of climate change (and related mitigation/adaptation strategies) affect the identification of potential nature-related financial risk?</li> <li>• Could sectors with large dependencies or impacts on nature be contributing to climate change, or be affected by it?</li> <li>• Which strategies for climate change mitigation have the potential to cause inadvertent negative effects on ecosystems, thereby amplifying nature-related financial risks?</li> </ul>		

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