The Case for a Task Force on Nature-related Financial Disclosures

global canopy

:vivideconomics

Foreword

The first half of 2020 served up a shocking reminder of how gravely nature-related risks can hit people and economies. Continued degradation of nature increased the chances of a viral disease like COVID-19 making the jump from animals to humans. Despite the origins of the crisis, the loss of nature has ramped up during the pandemic. Deforestation rates in the Amazon have increased compared to last year. Now, the finance sector needs to face up to the impact unrecognised nature-related risks can have on their portfolios.

Many highly respected organisations have released a range of estimates on the nature-related risks the global economy is exposed to:

- The world's ecosystems have declined in size and condition by 47% compared to what they were just a few decades ago.[1]
- The annual cost of this decline has been estimated to be at least US$479 billion per year.[2]
- Nature-dependent sectors are significant to the leading economies, accounting for US$2.7 trillion of China's GDP, US$2.4 trillion of the EU's GDP, and US$2.1 trillion of the GDP of the United States.[3]

Broad evidence of the materiality of nature in the global economy is increasing. But what does this mean for the finance sector? What are the nature-related financial risks? How pervasive and material are they?

In this report, Global Canopy and Vivid Economics answer these urgent questions.

The report details how nature-related risks are material to financial transactions, and in what sectors. Through a series of real-world examples, the report demonstrates that unrecognised nature-related risk can be material and impact across many sectors of the economy.

The report's findings make it clear that we must include nature-related disclosures in company reporting, alongside the standard financial disclosures.

At the moment, lack of data and disclosures lead to nature's missing materiality in financial transactions. The impacts of damaging nature do not show up in the share prices of the companies responsible for them. The effect is to overvalue companies that break down nature for short-term profit and undervalue those companies that invest in managing their natural capital for the long-term. Similarly, corporate dependencies on services from nature – like a beverage company's need for clean water, or an agricultural producer's dependency on insect pollination – also do not appear in valuations. As a result, nature-related risks are largely unrecognised by financial institutions.

The rising performance of Environmental, Social and Governance (ESG) funds is helping to prove the case that environmental considerations are material to a company's performance and therefore to the asset managers and banks that invest or lend to them, but the ESG-sector is still in its infancy. For the financial sector to start preserving natural capital that

[1] IPBES (2019): Global Assessment Report on Biodiversity and Ecosystem Services. Available from: https://ipbes.net/global-assessment

[2] WWF (2020): Global Futures: modelling the global economic impacts of environmental change to support policy-making. Technical Report. Available at: https://www.wwf.org.uk/globalfutures.

[3] World Economic Forum and PwC (2020): Nature Risk Rising. Available from: http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

critically underpins the global economy, we need comprehensive data on how individual companies impact and depend on nature.

Disclosure of these risks will help governments and regulators design the new equilibrium between the financial ecosystem and nature's ecosystem that we urgently need. System change of this magnitude needs to build from the bottom up and the top down. Bottom up, the financial sector needs data to drive common metrics set against robust methodologies and standardised frameworks for identifying and reporting on impacts and dependencies for all sectors of the economy. Top down, this can provide the information needed for robust and transformative policy setting and coordinated global, political and regulatory action. A global effort will be needed to define just how this can be done, and it is now getting underway.

The initiative to bring together a Task Force on Nature-related Financial Disclosures (TNFD) has already gained broad support. A significant number of financial institutions, as well as the UK, Swiss and other Governments, are joining the TNFD Informal Working Group, which will begin work in September 2020. Catalysed by Global Canopy, WWF, UNDP and UNEP FI, the finance-sector led working group aims to bring together the full TNFD by early 2021. By the end of 2022 a full reporting framework for Nature is planned for global use.

The TNFD will help shift financial flows from nature-negative to nature-positive investments. Achieving this shift is a monumental and urgent challenge for decision-makers across financial institutions, corporates, governments and civil society.

Nature cannot wait whilst we fix climate risk. With this report, Global Canopy and Vivid Economics cement the business case for urgently establishing a TNFD to advance the finance sector's understanding, and ability to quantify, nature's materiality. After the lessons of COVID-19, 2020 is the year to begin the process of tackling nature-related financial risks.

Andrew Mitchell, Founder and Senior Advisor to Global Canopy

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Executive summary

The deterioration of nature, and society's response to it, creates systemic and material risks for financial institutions – risks that are still largely not understood. Nature and the ecosystem services it provides are essential inputs to businesses across the economy. Policy and social norms are expected to increasingly penalise actions that harm nature. Yet at the same time, business activity and the financial services that support it continue to degrade nature at an unprecedented rate. In its 2020 Global Risks report, the World Economic Forum (WEF) ranked biodiversity loss and ecosystem collapse as one of the top five risks facing the world in terms of both likelihood and impact over the coming decade.[1]

This report aims to accelerate systemic change in the financial sector to address this issue. It has three objectives:

1. Introduce the financial sector to nature-related financial risk;

2. Illustrate the pervasive materiality of nature-related financial risks; and

3. Promote the case for the establishment of a Task Force on Nature-related Financial Disclosures (TNFD) to support development of financial sector mitigation of and resilience to these risks.

Nature-related risk framework

We define three types of nature-related financial risks: (i) physical risk, (ii) transition risk, and (iii) systemic risk. The framework builds out from the climate risk framework established by the Task Force on Climate Related Financial Disclosures (TCFD)(2017)[2] and harmonises across existing frameworks for nature-related financial risks provided by The Dutch Central Bank (DNB)(2020a)[3] and WEF (2020)[4]. Specifically, it further develops the categories of physical and transition risk and distinguishes systemic risk as a third category.[5]

Evidence of materiality

The financial sector is highly exposed to physical, transition and systemic risks indirectly through its investment, insurance and banking services to companies. While the physical risks to primary industries that rely on the use of natural resources are more obvious, risks to other sectors are often complex to identify and can originate from the hidden dependencies and impacts of their supply chains, as well as through system-wide impacts that depress demand.

If the world continues to use natural resources unsustainably, physical risks will increase due to the steady decline in the quality and quantity of these resources. Human activity has accelerated the rate at which plant and animal species

[1] World Economic Forum (2020): 'The Global Risks Report 2020'
[2] TCFD (2017): 'Recommendations of the Task Force on Climate-related Financial Disclosures'
[3] DNB (2020a): 'Biodiversity Opportunities and Risks for the Financial Sector'
[4] World Economic Forum (2020): 'Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy'
[5] The third category, 'systemic risk', aims to unify 'risks emerging from impacts of nature loss on society' from WEF (2020) and 'systemic risk' from DNB (2020a). Our framework differs from that set out in DNB (2020a), as we include liability risk in both 'transition risk' and 'systemic risk', depending on the reach of the impact across the economy. In contrast, DNB (2020a) places 'legal liability risks' solely under 'systemic risk'. To the best of the author's knowledge, the framework proposed here neatly incorporates and does not contradict past efforts to classify risk.

are becoming extinct by a factor of over 100 and annual usage rates of natural resources have increased more than 3-fold since 1970.[1, 6] This is driving unprecedented increases in physical risks associated with the loss of critical ecosystem services.

Similarly, transition risks will increase as stronger laws and policies expand the scope of activities that companies can be held liable for and improvements in data facilitate more effective enforcement. The UN General Assembly's 75th session will host a Biodiversity Summit in September 2020 and the outcome of next year's UN Convention of Biological Diversity (the biodiversity equivalent of the UNFCCC) will be instrumental in setting global ambition. In parallel, changing consumer preferences and public perceptions will further increase transition risk. Such shifts in social norms drive market, legal liability and reputational risks for companies.

Risks associated with dependencies and impacts on nature are highly interconnected. One company's impacts on nature can affect other companies in other industries through their own dependencies on nature, so risk exposure spreads horizontally as well as vertically across the economy. For example, the impact of land clearance at scale can have knock-on impacts of increasing soil erosion and reservoir sedimentation. This can damage dam infrastructure which can then affect a wide range of businesses through their dependency on the natural land cover, in combination with the dam, for flood protection services. This interconnectedness can create powerful feedback loops which can lead to cumulatively large impacts on companies' financial performance and financial institutions' portfolios. In this way, individual risks can together become systemic.

The COVID-19 pandemic is the clearest example we have of nature-related systemic risk and how large the resulting impacts can be. The continued destruction of natural habitats brings people in closer contact with wild animals and thereby increases the likelihood of pathogen transmission to humans (zoonosis). The human and economic costs of COVID-19 are significant to date, with over 900,000 lives lost and global economic growth forecast to fall at least 4.9% for 2020 relative to a 0.1% fall in 2009. This illustrates the staggering scale of risks to the real economy, and the financial sector in turn, if systemic risks remain unchecked. Pandemic-scale zoonotic disease outbreaks are currently occurring at the rate of one per decade.

These high costs demonstrate the substantial benefits of protecting and restoring nature as a lever to reduce the risk of future pandemics and other nature-related crises. Reversing biodiversity loss and habitat destruction will bring down transmission rates and reduce the risk of another zoonotic disease outbreak. While severe outbreaks are, and will remain, low probability events, the scale of damages means that even small changes to tail-end risks will result in tremendous shifts in the value at risk across the financial system.

Risk assessment capacity

There are three critical steps to estimating nature-related risk: nature dependencies, nature impacts, and forward-looking scenarios. Dependencies determine the level of exposure to physical risk, impacts determine the level of exposure to transition risk, and forward-looking scenarios determine the future evolution of both. Information and methodology gaps remain in each so that even the best tools currently available cannot yet offer a complete picture of risk.

Exposure to physical risk is measured by financial dependence on natural resources and a variety of tools and frameworks exist to do this. Most tools are at the sector- or product-level, matching economic activities with the ecosystem services they depend on or affect. However, existing efforts typically do not arrive at quantitative estimates and instead tag revenue against qualitative categories of dependence. Important data gaps exist around

[6] International Resource Panel (2019): 'Global Resources Outlook 2019: Natural resources for the future we want'

the location of specific assets, which are necessary to provide more granular estimates.

Assessment of exposure to transition risk faces more significant data gaps around geolocated company-level activity, but tools and frameworks are evolving rapidly. There have been some promising initial attempts at quantitatively measuring impacts at the financial institution- or company-level, most notably by ASN Bank and CDC Biodiversité. However, a lack of geolocated company- or asset-level data on business activity restricts the granularity of these approaches and remains an important barrier to rapid scale-up. To date, the tools that seek to overcome these obstacles have focussed on a handful of specific companies, commodities and geographies. This is in part due to the fact there is little public transition policy in place yet, but, as mentioned above, future policies are likely to follow international agreements of the type now under discussion.

Forward-looking scenarios are critical to identify financial risk at a given point in the future but are still at a very early stage of development. A handful of publicly available examples exist and have only just begun to reveal potential future pathways. These tend to focus on a specific sector or geography and consider a relatively narrow policy set. There is a clear need for greater convergence across the financial and data community around a set of clear potential biodiversity goals and further detail on policy and economic pathways.

Increasingly, Environmental, Social and Governance (ESG) data providers are building out nature-related data sets to underpin these tools and to plug important holes in their development. There are a number of initiatives that offer guidance to companies and financial institutions on how to incorporate natural capital considerations into their processes, such as the Natural Capital Protocol. Assessments to date have highlighted the need for location-specific and company-specific data (as mentioned above) and the lack of comprehensive, broadly-agreed metrics of impacts as key obstacles. Financial institutions have begun to tackle these issues themselves, as exemplified by the four French asset managers – AXA Investment Managers, BNP Paribas Asset Management, Mirova and Sycomore Asset Management – that issued a public request for better tools to measure and manage biodiversity risk and are investing to internally build this capacity.

Recommendations

There is a clear need for a systemic shift in how financial institutions manage risk, moving capital away from activities that harm nature and toward those that support it at scale. Currently, capital is systematically misallocated because financial decision-making fails to account for material nature-related financial risks. To address this and achieve effective systemic change, a broad set of actions are required across the entire financial system.

A TNFD is essential to act as a global convening institution and accelerate action on nature-related financial risks by both creating unified reporting standards and offering resources for capacity building. This should use the format and principles of the TCFD, building on lessons learned from its experience, while recognising that biodiversity is a much more complex issue and will require different approaches. The primary aim of the TNFD should be to develop an international reporting standard supported by regulators and financial institutions. In doing so, it should also facilitate information sharing and accelerate international uptake of best practices among financial institutions.

Even before a TNFD is established, financial institutions can act now to reduce risk exposure and position themselves to capitalise on nature-related financial opportunities. Navigating the sustainable transition will define company and investor success and failure over the coming decade. Financial institutions can benefit from starting this transition now, with proactive institutions able to leverage nature-related financial opportunities by (i) building capacity throughout their organisation to measure and account for emerging risks and (ii) engaging with investee and client companies.

Governments, regulators and data providers must also each play a role to achieve systemic change. Governments should implement nature-related targets and the policies required to meet them, providing clarity to companies and the financial sector on the future trajectory of policy. Financial regulations must provide natural capital-related macro and micro prudential oversight, including aggregate impact and risk progress assessments for their financial sectors. Data providers and aggregators have an opportunity to fill the current data gaps that inhibit our understanding of nature-related risks. Both public and private information sources will need to be blended to overcome this obstacle.

Acronyms and glossary

Table 1. Acronyms

DNB	De Nederlandsche Bank, the Dutch central bank
WEF	World Economic Forum
NDPE	No-deforestation, No-peat and No-exploitation
UNEP WCMC	United Nations Environment Programme World Conservation Monitoring Centre
GDP	Gross domestic product
GVA	Gross value added

Table 2. Glossary terms

Term	Definition
Nature	The global natural ecosystem in its entirety. This encompasses both the stock of natural capital assets as well as the way in which they interact with each other. In this sense, biodiversity is a characteristic of nature, insofar as it refers to the presence of diversity across the natural ecosystem.
Biodiversity[7]	"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".
Natural capital assets[8]	"The stock of renewable and non-renewable natural resources – such as plants, animals, water, soils and minerals – that combine to yield a flow of benefits to people".
Ecosystems[9]	"A dynamic complex of plant, animal and microorganism communities and the non-living environment, interacting as a functional unit".
Ecosystem services[9]	"The benefits people obtain from ecosystems".
Nature-related financial risk	The risk of loss of value, profits or revenue on an investment or business venture that stems from the investment's relationship to nature, including biodiversity and natural capital assets.
Impact drivers[8]	"A measurable quantity of a natural resource that is used as an input to production such as water use or a measurable non-product output of business activity such as non-greenhouse gas pollutants."
Drivers of environmental change[10]	"Natural or man-made pressures that can affect natural capital assets and their ability to continue providing ecosystem services."
High conservation value areas[11]	"Natural habitats, which are of outstanding significance or critical importance due to their high biological, ecological, social or cultural values".

Source: Multiple

[7] United Nations (1992): 'Convention on Biological Diversity'
[8] Natural Capital Coalition: 'Natural Capital Protocol'
[9] Millennium Ecosystem Assessment (2005)
[10] ENCORE tool https://encore.naturalcapital.finance/en
[11] High Conservation Value Areas (2005): https://www.biodiversitya-z.org/content/high-conservation-value-areas-hcva.pdf

1. Introduction

1. Introduction

The world's exposure to nature-related risks reflects its complex relationship with nature. Much has been made of climate-related risks to financial institutions over the past decade. This focus is warranted; climate change represents a threat to lives and livelihoods the scale of which can hardly be overstated. Unfortunately, this focus has overwhelmed the emergence of other risks, including those stemming from humanity's relationship with nature. The human and economic costs of the coronavirus pandemic make this painfully obvious. Nature related risks, including but not limited to a deepening biodiversity crisis, should not be ignored.

Climate and nature-related risks are linked but different, so climate tools will only cover part of nature-related risks. Many solutions to the climate crisis, such as restoration of carbon-dense habitats, can also reduce nature related risks, including those related to pollution and biodiversity loss. Others, like the adoption of energy efficiency measure or electric vehicles, represent important steps to reducing climate risks but only affect nature-related risks indirectly, and in the long-term. A third category can be actively harmful to nature despite contributing to carbon sequestration, such as irrigated or fertilised monocultures of bioenergy crops that can exacerbate land and water competition, or plantation afforestation of non-native species. While there are similarities between climate and nature, and the nature risk movement can learn from climate's experience, they are inherently different issues and will require different solutions.

As a result, nature-related risks demand new risk management infrastructure within financial institutions. Financial institutions are just starting to get processes in place to grapple with climate risks. The sector is taking a significant leap forward in its capacity to understand and reduce exposure to climate risks. This capacity will be a defining attribute of the institutions that are best able to navigate the net-zero transition in the coming years. However, that institutional infrastructure is not well equipped to handle nature-related risks. Similarly, those financial institutions that recognise this and develop risk management procedures capable of assessing nature-related risks will be those that are most financially resilient in the next decade and beyond.

There is great benefit in supporting financial institutions to ensure this transition is rapid and effective. The speed of the required transition and the high cost of error means that the sector must rapidly test, establish and share best practices and guidelines for building institutional resilience to nature-related financial risks. In the climate space, the Task force on Climate-related Financial Disclosures (TCFD) supported the institutional transition, but an equivalent body does not yet exist for nature. The aim of this report, therefore, is threefold:

1. Introduce the financial sector to nature-related financial risk;

2. Illustrate the pervasive materiality of nature-related financial risks; and

3. Promote the case for the establishment of a Task Force on Nature-related Financial Disclosures (TNFD) to support development of financial sector resilience to these risks.

The report makes this case for a TNFD in four components:

- **Section 2: Nature-related risk framework** provides a coherent framework to think about nature-related financial risk, coalescing the financial sector and related actors around a common understanding;

- **Section 3: Evidence of materiality** demonstrates how these risks are systemic and will soon become material;

- **Section 4: Risk assessment capacity** assesses the capacity of the financial and data community to robustly and comprehensively manage nature-related financial risks by examining currently available tools and identifying remaining gaps; and

- **Section 5: Recommendations** provides a pathway forward to systemic change in risk management across the financial sector, anchored by the establishment of a TNFD.

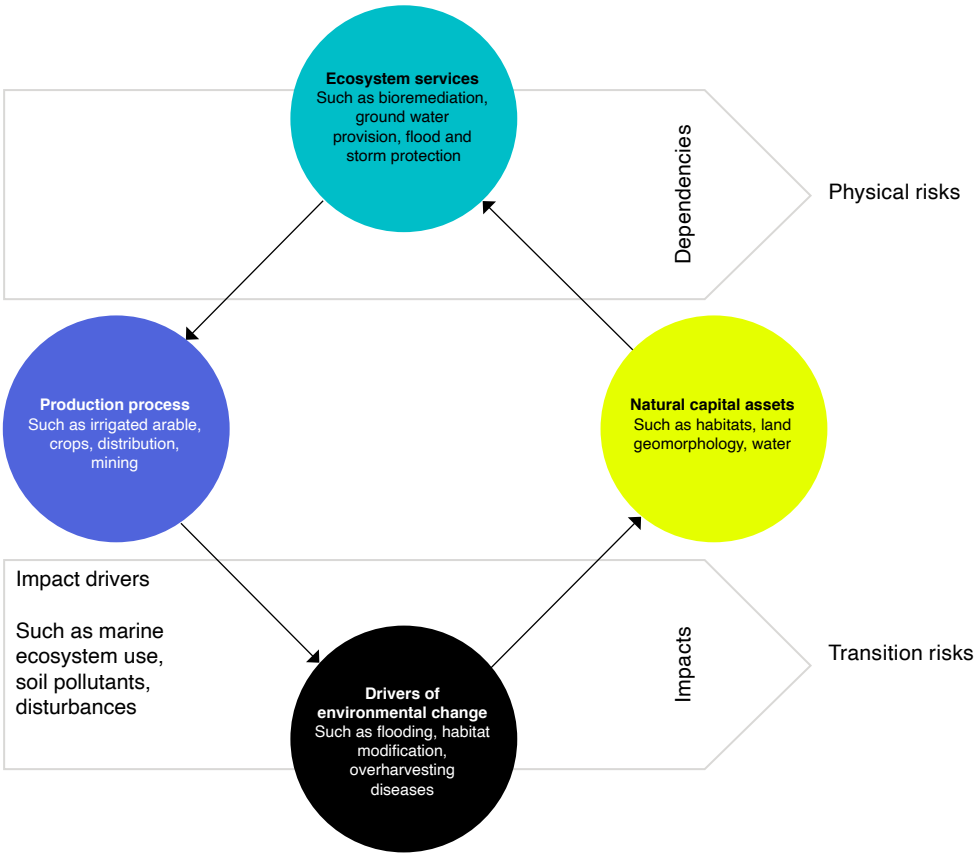
2. Nature-related risk framework

2.1 Context

Nature, and the ecosystem services it provides, are essential inputs to businesses across the entire economy. Stocks of natural capital assets provide ecosystem service flows that contribute to production processes of businesses in a cycle illustrated in Figure 1. For example, natural habitats enable the crop pollination services essential to agricultural production. While businesses rely on these ecosystem services, they are typically not traded on markets. As a result, their value is underestimated and the assets that produce them are mismanaged.

Businesses also significantly impact nature. Businesses' production processes drive environmental change not only by using natural resources as inputs but also by producing non-product outputs including emissions or pollutants. In turn, these impacts can influence natural capital assets' ability to continue producing ecosystem services, (see Figure 1). However, these impacts are usually externalities to production, meaning that they are often not priced appropriately.

Figure 1. Interaction between natural capital assets, ecosystem services, production processes and drivers of environmental change



Source: ENCORE tool; Vivid Economics

This section explains three types of nature-related financial risks: (i) physical risk, (ii) transition risk, and (iii) systemic risk. The framework builds out from the climate risk framework established by the TCFD (2017)[12], and harmonises across existing frameworks for nature-related financial risks provided by DNB (2020a)[13] and WEF (2020)[14]. Specifically, it further develops the categories of physical and transition risk and distinguishes systemic risk as a third category.[15] See Figure 9 in Appendix 2 for a more detailed comparison of these frameworks. The use of a standardised framework encourages convergence on metrics, approaches to measurement and management of the risk. Table 3 summarises the characteristics of these three types of risk, while Sections 2.2 through 2.4 detail each.

Table 3. Summary of nature-related financial risks

	Physical risk	**Transition risk**	**Systemic risk**
Definition	The risk that chronic depletion of natural resources and acute natural events arising from weakened ecosystem services lead to disruptions to businesses' production processes or to demand	The risk that businesses suffer financially due to stronger policies and/or social norms that penalise the direct or indirect harm that their production processes have on nature	The risk that destruction of nature, or society's response to it, disrupts a wide section of society and/or businesses significantly and simultaneously
Sub-categories	Operations, supply chain, real estate and business value, and resilience against natural disasters	Regulation, market, reputational and legal liability	Both physical and transition risks can accumulate to become systemic or lead to single systemic events
Sectors with most exposure	Logging, oil and minerals, agriculture, fisheries, power and water supply	Agriculture, utilities, energy and infrastructure	Cross-sectoral by definition
Example	Deforestation restricting supply of natural inputs to pharmaceutical industry	NDPE policies restricting market access in palm oil industry	COVID-19 pandemic
Driver of exposure	Driven by dependency on natural resources for financial value generation	Driven by the impacts of production processes on nature	A wide range of sectors highly exposed

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[12] TCFD (2017): Recommendations of the Task Force on Climate-related Financial Disclosures
[13] DNB (2020a): 'Biodiversity Opportunities and Risks for the Financial Sector'
[14] World Economic Forum (2020): 'Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy'
[15] The third category, 'systemic risk', aims to unify 'risks emerging from impacts of nature loss on society' from WEF (2020) and 'systemic risk' from DNB (2020a). Our framework differs from that set out in DNB (2020a), as we include liability risk in both 'transition risk' and 'systemic risk', depending on the reach of the impact across the economy. In contrast, DNB (2020a) places 'legal liability risks' solely under 'systemic risk'. To the best of the author's knowledge, the framework proposed here neatly incorporates and does not contradict past efforts to classify risk

	Physical risk	Transition risk	Systemic risk
Measurement of exposure	Data likely to be collected internally. Inputs, costs, outputs and revenues can be used to indicate exposure. Measuring exposure in this category is feasible with sufficient data access	Poor availability of high-quality data on attributable company-level impacts. This makes measuring exposure in this category challenging	Dependent on the nature of the crisis
Translation to financial risk	Requires scenarios around the future availability of quality resources	Requires scenarios around the future development of policy, markets, and changing social norms	Requires understanding of the likelihood of different nature-related crises

Note: Definitions and categories are based on a combination of the nature-related risk frameworks established by TCFD (2017), WEF (2020) and DNB (2020a). See Appendix 1 for more detail on risk sub-categories. NDPE = No Deforestation, No Peat Development, No Exploitation policies.
Source: Vivid Economics

2.2 Physical risk

2.2.1 Definition

Physical risk arises from chronic depletion of natural resources and acute natural events arising from weakened ecosystems leading to disruptions to businesses' production processes or to demand.[13] Businesses depend directly on nature for operations, supply chains, real estate values and resilience against natural disasters.[16] They rely on either the use of natural resources themselves or the ecosystem services they provide such as healthy soils, water quality and flood protection. Extractive and resource-intensive activities can cause slow onset depletion of natural resources and essential ecosystem services, while acute natural disasters can cause rapid loss. Both will lower the quantity and quality of business inputs, thereby lowering revenues or raising input costs and reducing firms' profits.

Company-level exposure to physical risk is driven by the degree to which businesses are dependent on natural resources for economic and financial value generation. Exposure depends on what share of a business' revenue, or its supply chain's revenue, is dependent on natural resources. The hardest hit are sectors that rely on direct use of raw materials such as logging, oil and minerals, agriculture, fisheries, power and water supply. Nevertheless, other sectors also have important nature dependencies, including the pharmaceutical industry (see Box 1).

Box 1. Physical risk example: Growth in the pharmaceutical industry[14]

- The sustained growth of the pharmaceutical industry depends on the discovery of new drugs and, in turn, on nature. No other sector spends as much on research and development.[17]
- Natural products form the basis of anti-fungal, antibacterial and cancer treatment products. Up to 50% of prescription drugs are based on a naturally occurring molecule in a plant;[18] 70% of cancer drugs are natural or nature-inspired synthetic products;[19] and approximately 75% of approved anti-tumour pharmaceuticals in the past 70 years have been non-synthetic.[20]
- The destruction of tropical forests threatens to significantly restrain future new drug development and industry growth. Tropical rainforests contain 50% of all terrestrial biodiversity, including over 2,000 plants with anti-cancer properties.[21]

[16] Appendix 1 describes the subcategories of physical risk in more detail and illustrates how our definition harmonises across those offered by WEF (2020) and DNB (2020a).
[17] European Commission (2015): 'The 2015 EU Industrial R&D Investment Scoreboard'
[18] B. Hawkins (2008): 'Plants for life: Medicinal plant conservation and botanic gardens'
[19] IPBES (2019): 'Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services'
[20] D. Newman (2012): 'Natural products as sources of new drugs over the 30 years from 1981 to 2010'
[21] Pandey *et al.* (2015): 'Review of Procedures Used for the Extraction of Anti-Cancer Compounds From Tropical Plants'

2.2.2 Measurement

Financial institutions can estimate the dependency of their portfolio if they have sufficient access to financial records from the businesses they fund. Data on inputs, costs, outputs and revenues can provide a good picture of a company's dependency on a natural resource and are frequently collected in existing disclosure arrangements. For example, it is estimated that from across 12 million hectares of EU agricultural land crop productivity falls by an estimated 0.43% annually, costing EUR 1.25 billion.[22]

The translation of dependency into financial risk[23] is difficult due to uncertainty around the future availability of quality resources. When one business causes loss of natural resources, it can disrupt many business operations across potentially large distances. The future availability of quality resources therefore depends on a company's own behaviour as well as that of others. Uncertainty around the actions of third parties, and often across a large geography, makes risk estimates uncertain. This is particularly the case for larger and often public resources. For example, the use of the ocean for fishing is not only dependent on the collective intensity of local fishing activity, but also a web of additional players that affect the ocean's health and quality as a habitat for fish.

[22] Panagos *et al.* (2018): 'Cost of agricultural productivity loss due to soil erosion in the European Union: From direct cost evaluation approaches to the use of macroeconomic models'
[23] Here and throughout this section, by 'financial risk' we refer to the financial value at risk, or expected loss, across a given portfolio.

2.3 Transition risk

2.3.1 Definition

Transition risk is the risk that businesses suffer financially due to stronger policies and/or social norms that penalise the direct or indirect harm that their production processes or products have on nature. These negative consequences can come about when nature-related policies are strengthened or when changes in social norms favour the environment, creating regulatory, market, reputational and legal liability risks.[24] Current business practices including the unsustainable use of freshwater, chemicals and land may conflict with environmental regulations such as certifications, limits on chemicals use and conservation targets.

When business practices and technologies adjust to meet these regulations, or face loss of market demand and sanctions for failing to do so, profitability can be hit by lower revenues, higher operating costs, increased compliance burdens and even the risk of litigation. In extreme cases, assets can become 'stranded', that is, it is no longer economically viable to operate an asset, leading to write-offs and downward revaluations.[14] Box 2 discusses how the palm oil industry is exposed to transition risk.

The negative impacts associated with business operations, coupled with policy change, drive exposure to transition risks. Companies with more adverse impacts on nature, – for example business-as-usual operations causing highly toxic land and air emissions or large-scale soil degradation or erosion, – face the risk of larger disruptions to their business activities and consequently higher costs due to changes in regulation and demand. The hardest hit are sectors with long-lived assets that may find it difficult or costly to adapt such as agriculture and forestry, utilities, energy and infrastructure.

[24] Appendix 1 describes the subcategories of transition risk in more detail and Appendix 2 illustrates how our definition harmonises across those offered by WEF (2020) and DNB (2020a).

Box 2. Transition risk example: stranded assets in the palm oil industry

- Palm oil is the world's most used vegetable oil; however, its production has a disproportionate negative impact on nature through deforestation, notably in Southeast Asia.[25, 26]
- The proliferation of 'no deforestation, no peat, no exploitation' (NDPE) policies voluntarily enforced across supply chains and increasingly stringent public regulations is putting pressure on the economic viability of palm oil production on forested lands.[27]
- As of April 2020, NDPE policies cover over 83% of palm oil refining capacity in Indonesia and Malaysia.[28] It is estimated these pressures have left 28% of Indonesia's palm oil land concessions as stranded assets.[29]
- The EU is revising its regulations around biofuels due to deforestation risks. This will likely require the phasing out of palm oil by 2030, placing the EUR 2.2 billion of palm oil imports to the EU each year at risk.[30]

2.3.2 Measurement

It is challenging for financial institutions to measure their exposure to transition risk because there is a lack of high-quality data on attributable company-level impacts. Companies typically do not collect and disclose data on their impacts on nature. While there has been some progress in broader environmental reporting, data is neither comprehensive nor standardised, and as a result is insufficient to accurately measure exposure at scale.

Without a clear trajectory for future policy, translation into financial risk is challenging. It is inherently difficult to project the future development of policy and even more so social norms. A conservative view is that policies will include no net loss or net gain biodiversity goals. An alternative is that policies align with an apex target based on our best understanding of planetary boundaries, similar to the 1.5 - 2 degrees Celsius target in the climate space. Even with a clear goal, there is still uncertainty regarding when and how policies will be implemented.

[25] https://www.statista.com/statistics/263937/vegetable-oils-global-consumption/
[26] WWF (2020): '8 Things to Know About Palm Oil'
[27] Environmental Investigation Agency (2019): 'Promises in Practice'
[28] Chain Reaction Research (2020): 'NDPE Policies Cover 83% of Palm Oil Refineries; Implementation at 78%'
[29] Chain Reaction Research. (2019): '28 Percent of Indonesia's Palm Oil Landbank Is Stranded'
[30] WEF (2019): 'Could the EU's ban on palm oil in biofuels do more harm than good?'; EU (2019): Palm Oil Fact Sheet

2.4 Systemic risk

2.4.1 Definition

We define systemic risk as the risk that the destruction of nature, or society's response to it, disrupts a wide section of society and/or businesses significantly and simultaneously. This occurs when risks to individual businesses are highly correlated. Systemic risk is a product of accumulated or system-wide physical or transition risk, where the aggregate system-wide impact is greater than the sum of impacts to individual businesses. The COVID-19 crisis (discussed in detail in Section 3.3) is an example of a systemic nature-related crisis in recent times.

Physical risks become systemic either when individual risks accumulate and lead to large-scale failure that spreads across the economy or when a single large-scale event affects a large cross-section of the economy. As risks accumulate and interact, low probability but high impact events become significantly more likely: some of the most serious impacts of destroying nature will not occur gradually but suddenly and disruptively in the form of nature-related crises such as ecosystem collapse, wildfires, and diseases. All companies in a region may be significantly impacted irrespective of their sector. Natural capital assets and the ecosystem services they produce not only contribute to production processes but also underpin the public goods that human societies rely on such as clean air and plentiful fresh water. The loss of these essential public goods can endanger political institutions.[14]

Transition risks become systemic when market, regulatory or legal liability risks significantly increase and affect a large cross-section of the economy. There is a growing appetite to hold businesses accountable for their negative externalities on nature. As better data, reporting and technology enables transparency, governments and other organisations will have stronger grounds to pursue claims. As these risks accumulate, they can become existential for entire business models or supply chains, spilling over into the networks of businesses and people that rely upon them. In the event of considerable international progress on safeguarding nature and with a growing body of evidence to identify and prosecute harmful actors, certain transition risks can turn into systemic risks.[13] Market risks will spread as better informed consumers and stakeholders find it easier to choose environmentally friendlier businesses and financial institutions. Legal liability risks will rise as individuals and organisations will have stronger grounds to pursue legal action, rapidly turning previously hidden costs into explicit liabilities.

Regardless of which sectors and regions are directly exposed, systemic risks have global implications due to global interconnectedness and regional industrial concentration.[13] For example, the 2011 flooding in Thailand destroyed many computer hard drive manufacturing complexes, driving up hard drive prices by 20-40% globally given around 25% of global production occurs in the country.[31]

[31] Finance Watch (2019): 'Making Finance Serve Nature'

3. Evidence of materiality

3.1 High exposure and increasing scale

This section explores the materiality of nature-related financial risks, demonstrating that they are wide-reaching and increasing over time:

- The first section outlines the materiality of nature-related risks due to the high level of asset exposure across the economy and the increasing scale of risk they face;
- The second section illustrates the interconnected nature of these risks by examining the case of a single asset, an arable farm. It first outlines how this asset faces multiple risks itself, and then demonstrates how it's own impacts create risks for other assets, propagating risk both up and down supply chains; and
- The third section examines the connection between nature and the COVID-19 crisis to demonstrate how the destruction of nature creates systemic risk, raising the likelihood of low probability events with very high impacts across the global economy.

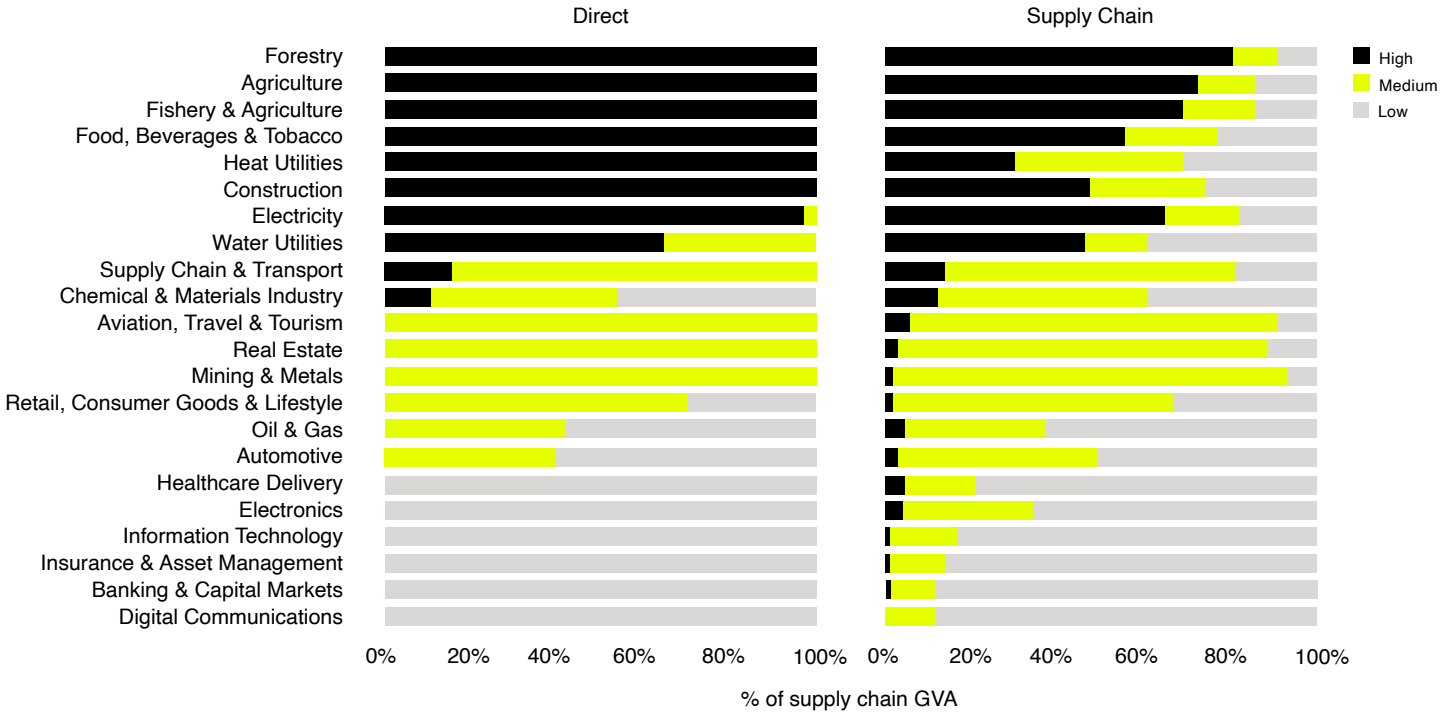
3.1 High exposure

The deterioration of nature, and society's response, creates large and material risks for financial institutions. In its 2020 Global Risks report, the WEF ranks biodiversity loss and ecosystem collapse as one of the top five risks to the world in terms of both likelihood and impact in the coming 10 years.[32] A separate WEF report finds that USD 44 trillion, over half global GDP, is moderately or highly dependent on nature and its services. For financial institutions, this adds up to correlated, systemic risks across their portfolios, rising as the world continues to degrade nature at an unprecedented rate and scale.

The majority of industries have significant exposure to physical or transition risks somewhere in their supply chain. While the physical risks to primary industries that rely on the use of natural resources are obvious, risks to other sectors are more complex and can be driven by the hidden dependencies and impacts of their supply chains. This is demonstrated by the difference between direct versus supply chain dependencies of six industries: chemicals and materials; aviation, travel and tourism; real estate; mining and metals; transport; retail, consumer goods and lifestyle. Although only 15% of their gross value added (GVA) is highly dependent on nature directly, their supply chains depend on nature for over half of their GVA, as illustrated in Figure 2.[14]

[32] World Economic Forum (2020): The Global Risks Report 2020

Figure 2. Percentage of direct and supply chain GVA with high, medium and low nature dependency, by industry.



Source: WEF (2020): 'Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy'

If the world continues to use natural resources unsustainably, physical risks will increase due to the steady decline in the quality and quantity of these resources. Human activity has accelerated the rate at which plant and animal species are becoming extinct by a factor of over 100 and annual usage rates of natural resources have increased more than three-fold since 1970.[32, 33] Currently, 93% of fish stocks are fished at or beyond maximum sustainable levels.[19] This is driving unprecedented increases in physical risks associated with the loss of critical ecosystem services.

Similarly, transition risks will increase as stronger laws and policies expand the scope of activities that companies can be held liable for and improvements in data facilitate more effective enforcement. Biodiversity has been steadily moving up the global policy agenda. Laws and regulations governing environmental liabilities are likely to tighten as governments across the world align domestic policy with new national targets. The UN General Assembly's 75th session will host a Biodiversity Summit in September 2020 and the outcome of next year's UN Convention of Biological Diversity (the biodiversity equivalent of the UNFCCC) will be instrumental in setting global ambition. In parallel, engaged jurisdictions such as the EU are already moving ahead on biodiversity, publishing a taxonomy of sustainable activities for the financial sector in 2022 alongside a Biodiversity Strategy for 2030.[34, 35] As data and technology enables transparency, governments and other organisations will have stronger grounds to pursue these claims.

In parallel, changing consumer preferences and public perceptions will further increase transition risk. Shifts in social norms drive market, legal liability and reputational risks and are already visible in areas such as meat consumption and single-use plastics.[36, 37] Climate change is now widely accepted as a systemic issue driven by human impact on the environment. This has and will continue to raise awareness and acceptance of the adverse impacts of human activity on the planet in other ways, including on biodiversity and nature. As scientific understanding and broader education

[33] International Resource Panel (2019): 'Global Resources Outlook 2019: Natural resources for the future we want'
[34] European Commission (2020): EU taxonomy for sustainable activities
[35] European Commission (2020): EU Biodiversity Strategy for 2030
[36] Guardian (2018): 'The plastic backlash: what's behind our sudden rage – and will it make a difference?'
[37] The Food and Land Use Coalition (2019): 'Growing Better: Ten Critical Transitions to Transform Food and Land Use'

in this area improve, there is significant potential for changing social norms to reinforce the direction of policy discussed above and generate additional channels through which companies and financial institutions face transition risk.

3.2 Interconnected nature

3.2 Interconnected nature

One company's impact on nature affects companies in other industries through their dependencies on nature, so risk exposure spreads horizontally as well as vertically across the economy. The impacts of one company drive environmental change that affect natural capital assets' ability to continue producing the ecosystem services that other companies may depend on for their production processes, as introduced in Figure 1 in the previous chapter.

Some of the largest physical risks for arable farms are reductions in pollinator populations and soil fertility. Many crop production systems rely heavily on pollinators such as bees. Up to 75% of food crop production for human consumption relies to some degree on animal pollination, an annual market value of between USD 235-577 billion globally.[38, 39] Habitat disruption caused by land use change and the excessive use of pesticides and herbicides has reduced pollinator populations by 40% in recent decades and contributed to falling crop yields.[40] Additionally, intensive farming activities are driving lower crop yields due to soil loss and exhaustion. Decreasing soil productivity is observed in 20% of the world's cropland, 16% of forest land, 19% of grassland and 27% of rangeland.[41] Many farming systems rely on fertilizers to offset soil degradation to maintain productivity.

Falling pollinator populations and over-reliance on fertilizer use increases farms' input and production costs and reduces company profitability. In more extreme cases, degradation can turn into desertification where once productive lands must be abandoned. Global losses from land degradation and land-cover change between 1997 and 2011 are estimated at USD 6-11 trillion and USD 4-20 trillion per year respectively.[39]

These same physical risks can have knock on impacts to businesses further down the supply chain. Lower crop yields directly impact downstream businesses such as food, beverage and retail companies that depend on farm inputs like wheat, barley, grapes and sugar. For example, the USD 2 billion retail market for avocados in the US is highly sensitive to pollinator efficiency and land degradation.[42]

Transition risk is generated by the introduction or strengthening of nature-related policies for agriculture.
This includes strengthening of soil standards, environmental set-asides, certification requirements, limits to nitrogen run off and non-point source pollution and bans on antibiotic use among livestock. The EU Biodiversity Strategy 2030 is expected to reduce nutrient losses on farms by at least 50% and fertilizer use by at least 20% by 2030.[35] It also commits to halve pesticide use and the sales of antimicrobials for farmed animals and aquaculture, as well as place 25% of total farmland under organic farming and 30% of total land under protected

[38] Winfree (2008): 'Pollinator-Dependent Crops: An Increasingly Risky Business'
[39] OECD (2019): 'Biodiversity: Finance and the Economic and Business Case for Action'
[40] Sánchez-Bayo and Wyckhuys (2019): 'Worldwide Decline of the Entomofauna: A Review of its Drivers'
[41] Guardian (2017): 'Third of Earth's soil is acutely degraded due to agriculture'
[42] Statista (2019): 'U.S. retail dollar sales of avocados 2014-2017'

areas. Farms exposed to already degraded soils and reliant on unsustainable practices must adopt new practices to meet output requirements that will increase production costs. The tight margins of many farm systems and their reliance on fertilizer means that transition risk may threaten their economic viability.

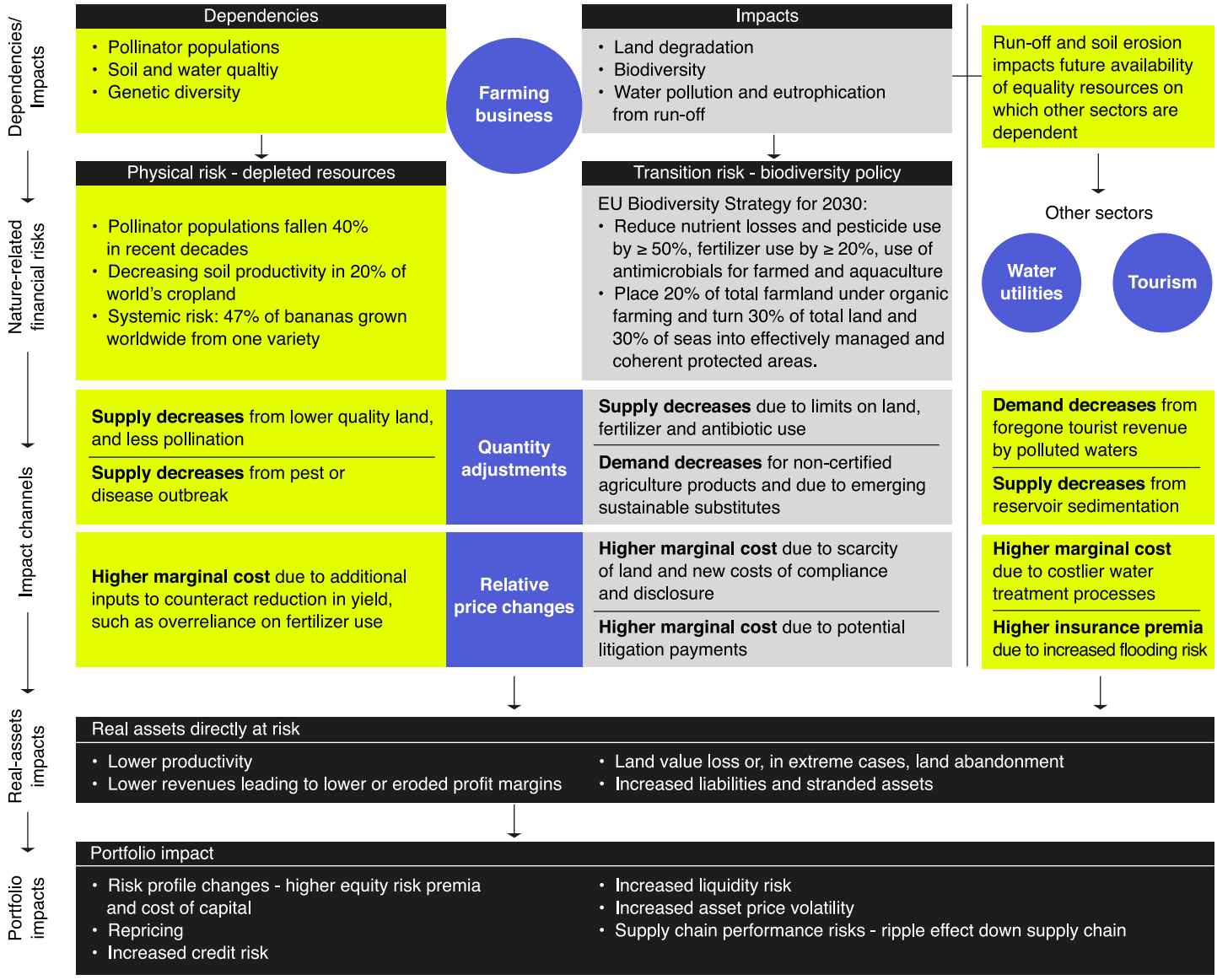
Across the economy, one business's adverse impacts on a natural resource might create financial risk for other businesses that are dependent on that same natural resource. Soil erosion causes reservoir sedimentation due to downstream siltation which impacts dam infrastructure and can lead to residential and industrial area flooding. For example, the 100 MW Binga Hydroelectric dam in the Philippines can only operate intermittently due to soil erosion-induced siltation.[13] Similarly, excessive fertilizer use causes run-off into local streams and rivers and ultimately into seas and oceans. The nitrogen and phosphates can cause algal blooms that significantly reduce water oxygen levels dramatically altering aquatic ecosystems. 115 million tonnes of mineral nitrogen fertilizers are applied to croplands globally each year, a fifth of this accumulating in soils and biomass and a third entering oceans.[43] This will increase costs in other sectors such as water utilities that invest in more expensive water treatment processes, and reduce revenue from tourism in the proximity of impacted sites.

Systemic risk is generated by the proliferation of monocultures which reduce the genetic diversity of crops and diminish resilience to shocks. Biodiversity is a characteristic of ecosystem assets. It is important to ecosystems in the same way that diversity is for financial portfolios: yield is inherently variable and uncertain.[44] Species and genetic variation allows ecosystems to respond to change, acting as a form of insurance and spreading risk. The more species that are lost, the less likely it becomes that other species can substitute for lost ecosystem functions.[44] For example, 47% of bananas grown worldwide and the majority sold in the western world are Cavendish variety.[45] This homogeneity makes plantations increasingly vulnerable to disease outbreaks. In fact, the Cavendish variety rose to dominance by replacing the Gros Michel variety when the latter was practically wiped out in the 1950s and 1960s due to a fungal disease called Fusarium wilt or Panama disease, bringing the sector to the brink of collapse.[46]

Together, the combination of the above risk channels will have a cumulatively large impact on companies' financial performance and financial institutions' portfolios. Real assets are at risk of lower productivity, lower profit margins and land value loss from degradation. The low-margin nature of global agricultural commodities leaves little room to absorb increases in costs or decreases in revenues. The correlation of these risks across businesses can also create important risk profile changes and portfolio impacts for financial institutions.

[43] FAO and IWMI (2018): 'More people, more food, worse water? A global review of water pollution from agriculture'
[44] The Dasgupta Review (2020): 'Independent Review on the Economics of Biodiversity, Interim Report'
[45] BBC (2016): 'The imminent death of the Cavendish banana and why it affects us all';
[46] Guardian (2016): 'The banana as we know it is in imminent danger'

Figure 3. Illustrated example of nature-related financial risks to a farming business



Source: Vivid Economics graphic

3.3 Nature and zoonotic diseases

3.3.1 Human activity and the risk of infection

The rise of COVID-19 is linked with humanity's relationship with nature. COVID-19 is part of a broader family called zoonotic diseases, infectious diseases that are transmitted from animals to humans. The way we manage natural resources and interact with nature directly shapes the risk of transmission to humans. COVID-19 is suspected to have originated in bats possibly jumping to pangolins before finally being transmitted to humans.[47] The pandemic has so far caused over 900,000 human deaths and its economic consequences are expected to greatly exceed those of the 2008 financial crisis.[48, 49]

The risk of zoonotic diseases reaching human circulation has been increasing over time.[50] In the past 20 years alone, we have experienced outbreaks of three coronaviruses (SARS-CoV-1 in 2003, MERS-CoV in 2012 and the current COVID-19), one influenza virus (swine flu in 2009), two arboviruses (Chikungunya virus in 2005 and Zika virus in 2015) and one filovirus (Ebola in 2014 and 2018).[51] Zoonotic diseases account for 60-80% of new infectious diseases.[52] There is evidence to demonstrate the link between the destruction of nature and the higher risk of transmission of zoonotic diseases to humans.

This is driven by our continued destruction of nature, which brings humans in closer contact with wild animals. Encroaching human activities such as deforestation and wildlife hunting destroy natural habitats. This increases the frequency of contact between wildlife and humans raising the likelihood of pathogens passing from one to the other.[53, 54, 55, 56] Land use and agricultural changes are commonly cited drivers of zoonotic disease outbreaks representing over a third of all events from 1940 to 2004.[56, 57] Ebola outbreaks in Central and West Africa have been linked with locations along the forest frontier that experienced forest losses within the previous two years.[58] Species that have adapted well to human-dominated landscapes and therefore have more frequent contact with humans – such as rodents and bats – carry the most potential to transmit diseases.[56, 59]

Moreover, species are likely to carry more zoonotic viruses as their population comes under increasing pressure. Those experiencing habitat loss hosted 1.8 times as many viruses and those being exploited through hunting and the wildlife trade hosted 2.3 times as many.[56] Areas under substantial human use have also be found to host greater proportion of disease-carrying species both in terms of species richness and total abundance being 18-72% and 21-144% higher respectively.[59]

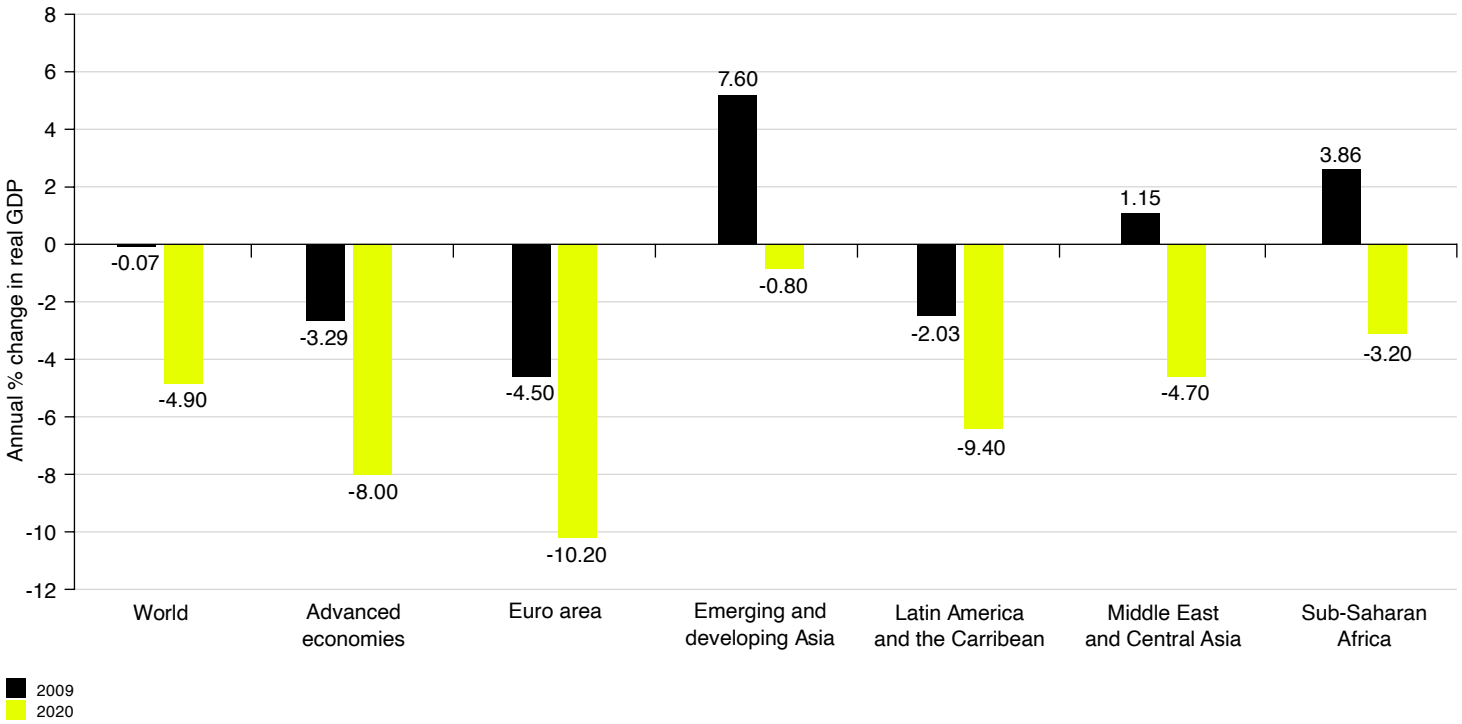
[47] T. Zhang et al. (2020): 'Probable Pangolin Origin of SARS-CoV-2 Associated with the COVID-19 Outbreak'
[48] John Hopkins University Coronavirus Resource Center accessed 12 August 2020
[49] IMF (2020): April 2020 World Economic Outlook
[50] K. E. Jones et al. (2008): 'Global trends in emerging infectious diseases'
[51] F. Baudron and F. Liegeois (2020): 'Fixing our global agricultural system to prevent the next COVID-19'
[52] D. M. Morens and A. S. Fauci (2013): 'Emerging Infectious Diseases: Threats to Human Health and Global Stability'
[53] R. Cho (2014): 'How Climate Change is Exacerbating the Spread of Disease'
[54] J. A. Patz et al. (2004): 'Unhealthy landscapes: Policy recommendations on land use change and infectious disease emergence'
[55] Guardian (2020): 'Human impact on wildlife to blame for spread of viruses, says study'
[56] C. K. Johnson et al. (2020): 'Global shifts in mammalian population trends reveal key predictors of virus spillover risk'
[57] C. L. Faust et al. (2018): 'Pathogen spillover during land conversion'
[58] J. Olivero et al. (2017): 'Recent loss of closed forests is associated with Ebola virus disease outbreaks'
[59] Gibb et al. (2020): 'Zoonotic host diversity increases in human-dominated ecosystems'

The loss of carbon sinks from habitat loss further drives up the risk of zoonotic disease transmission through climate change. This occurs in three ways. First, more extreme weather patterns such as droughts followed by heavy precipitation can cause a sudden surge in the growth of some plant species. This in turn can cause exponential increases in the population of disease-carrying animals who feed on these plants and therefore increased co-mingling with humans. Previous outbreaks of Ebola and the US hantavirus have been linked to this phenomenon.[53] Second, increased drought frequency is tied to malnutrition, which increases vulnerability to infection, as well as to greater consumption of wildlife such as apes and bats.[60, 61] Nearly half of Ebola outbreaks have been directly linked to bushmeat consumption.[53] Third, rising temperatures and more common droughts increase the risk of forest fires that drive wildlife closer to human populations.[53]

3.3.2 The economic consequences

COVID-19 demonstrates the staggering potential scale of economic damage that nature-related crises can cause. The economic crisis resulting from COVID-19 is expected to be the worst crisis since the Second World War, overshadowing the 2008 financial crisis.[62] Global gross domestic product (GDP) is expected to shrink by 4.9% in 2020 relative to a contraction of less than 0.1% in 2009 (see Figure 4).[63, 64] The outlook worsens with GDP falling an additional 4.6 percentage points in 2021 if there is a second wave of infections (see Figure 5).

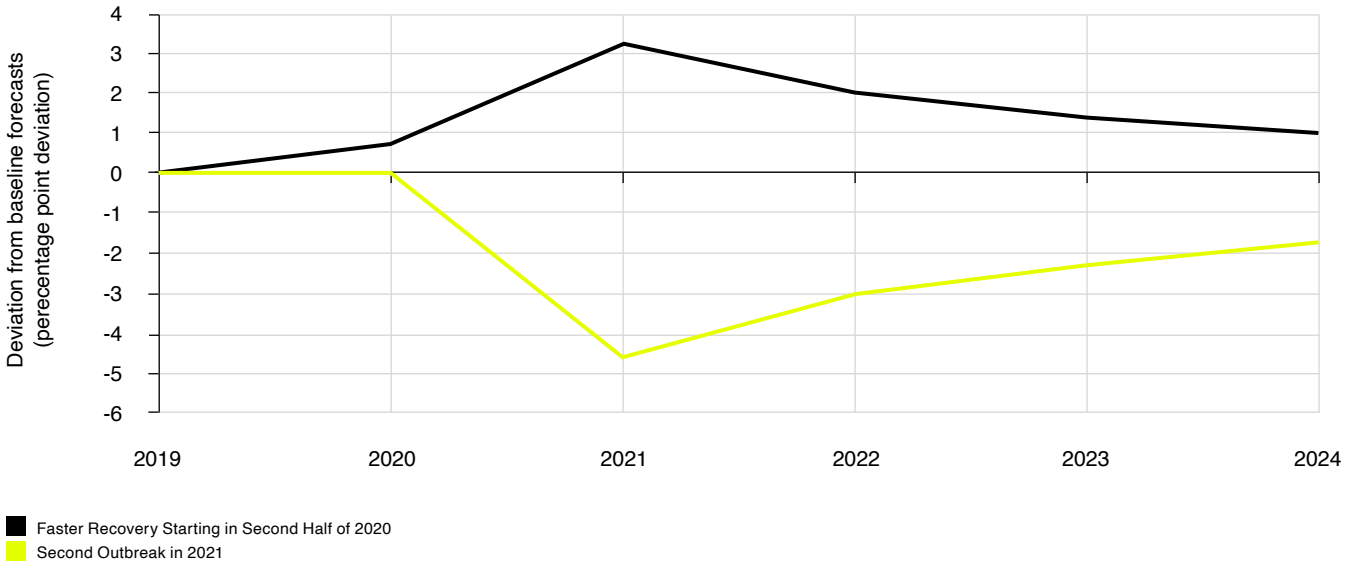
Figure 4. The economic fallout from COVID-19 is expected to far surpass that from the 2008 financial crisis



Note: Black bars represent the percentage change in annual real GDP between 2008 and 2009; yellow bars represent the expected percentage change in annual real GDP between 2019 and 2020
Source: June 2020 World Economic Outlook Update, IMF, Vivid Economics graphic

[60] N. D Wolfe et al. (2000): 'Deforestation, hunting and the ecology of microbial emergence'
[61] J. R. Rohr et al. (2019): 'Emerging human infectious diseases and the links to global food production'
[62] ILO (2020): 'ILO Monitor: COVID-19 and the world of work. Fifth Edition'
[63] IMF (2020): June 2020 World Economic Outlook Update
[64] Note: the World Bank's June 2020 Global Economic Prospects forecasts a larger 5.2% contraction in global GDP for 2020. The difference in values is driven partially by the timing of the publications as well as methodological differenes.

Figure 5. The economic outlook worsens significantly if there is an additional outbreak



Note: Zero represents the baseline IMF GDP forecasts, such as for 2020 in Figure 4. The lines reflect the percentage point deviations from this baseline. If there is a second wave in 2021 (yellow line), GDP will shrink by an additional 4.6 percentage points in 2021 relative to current IMF expectations.
Source: June 2020 World Economic Outlook Update, IMF, Vivid Economics graphic

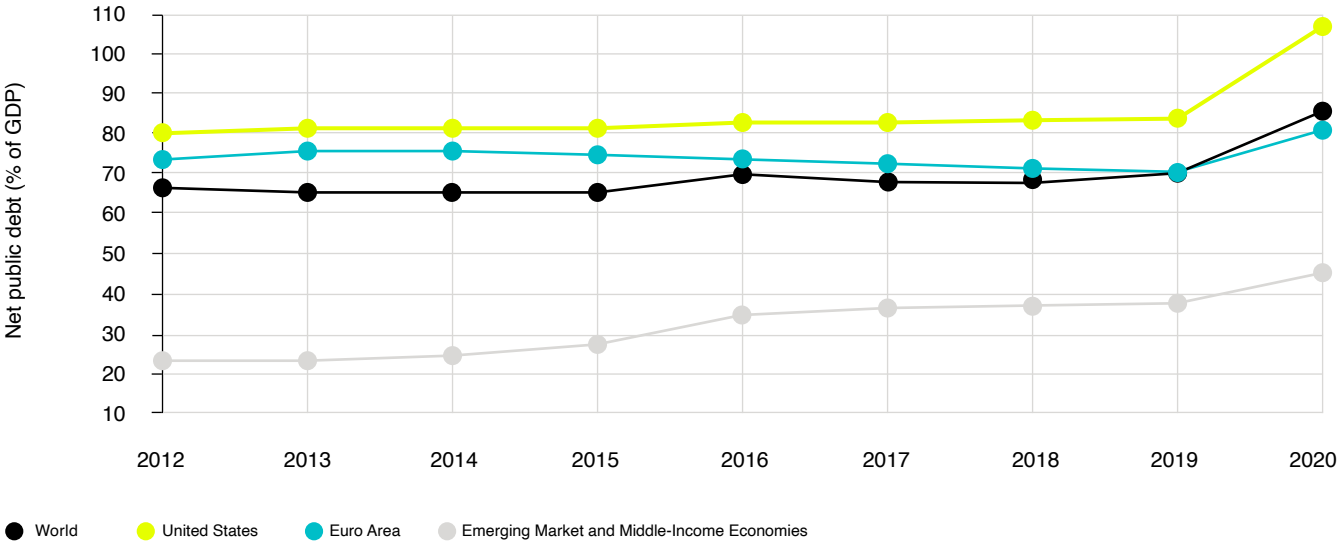
The need to halt economic activity to prevent disease transmission amplifies the short and long-term economic costs of infectious-disease related pandemics relative to other crises. In response to the COVID-19 crisis, governments around the world have imposed lockdowns bringing their economies to standstill. A large share of businesses face the risk of insolvency as they manage severely reduced or no revenue while still having to meet fixed costs. This unique set of circumstances would likely be the case for other pandemics driven by zoonotic diseases.

The COVID-19 lockdown has already had large and lasting employment impacts. The first half of 2020 saw 93% of the world's workers living in countries with some form of workplace closures and an equivalent of 155 million full-time jobs being lost.[62] This is expected to rise to 400 million in the second quarter of 2020. In the US, the unemployment rate rose from 4.4% to 14.7% between March and April.[65] This is expected to remain above 9% in 2020 and at 5.5% through 2022, wiping out a decade's worth of jobs growth.[66, 67] Several sectors will be operating under capacity for at least 12-18 months suggesting a likely future spike in unemployed workers between Q3 and Q4 as temporary or furloughed workers become fully unemployed in the future.[68] The crisis is expected to push around 49 million people around the world into extreme poverty.[69]

The unprecedented fiscal stimulus packages designed to counteract this will weigh heavily on long-term economic growth. Governments have spent more than USD 1.5 trillion on paycheque protection programmes that have protected family incomes.[70] As lockdowns ease, additional recovery measures will be needed, requiring additional public borrowing. Global net public debt is expected to climb from 69% to 85% of world GDP from 2019 to 2020 (see Figure 6 below).[71] This is likely to raise the cost of capital for governments worldwide, and put a large share of emerging markets at serious risk of default. In the longer-term, governments will face higher debt servicing costs and citizens higher tax burdens and higher interest rates that may stifle private sector investment. Compounding this, the erosion of human capital among the unemployed and the retreat from global trade and supply linkages may cause lasting damage to the fundamental drivers of long-term growth.[72]

[65] US Bureau of Labor Statistics (2020): 'April 2020 Employment Situation News Release'
[66] NY Times (2020): https://www.nytimes.com/2020/06/10/business/economy/federal-reserve-economy-coronavirus.html
[67] Guardian (2020): '20m Americans lost their jobs in April in worst month since Great Depression'
[68] Bachman et al. (2015): 'Labour market dynamics and worker heterogeneity during the Great Recession – Evidence from Europe'
[69] World Bank Blogs (2020): 'Why Sub-Saharan Africa might be the region hardest hit'
[70] IMF Policy Tracker and other sources; updated May 27, 2020
[71] IMF (2020): 'Fiscal Monitor April 2020'
[72] World Bank (2020): 'Global Economic Prospects June 2020 – Pandemic, Recession: The Global Economy in Crisis'

Figure 6. Global public debt will rise dramatically across the world in 2020



Source: Fiscal Monitor – April 2020, IMF, Vivid Economics graphic

These high costs demonstrate the substantial benefits of protecting and restoring nature as a lever to reduce the risk of future pandemics. Reversing biodiversity loss and habitat destruction will bring down transmission rates and reduce the risk of another zoonotic disease outbreak. While severe outbreaks are and will remain low probability events, the scale of damages means that even small changes to tail end risks will result in tremendous shifts in the value at risk across the financial system.

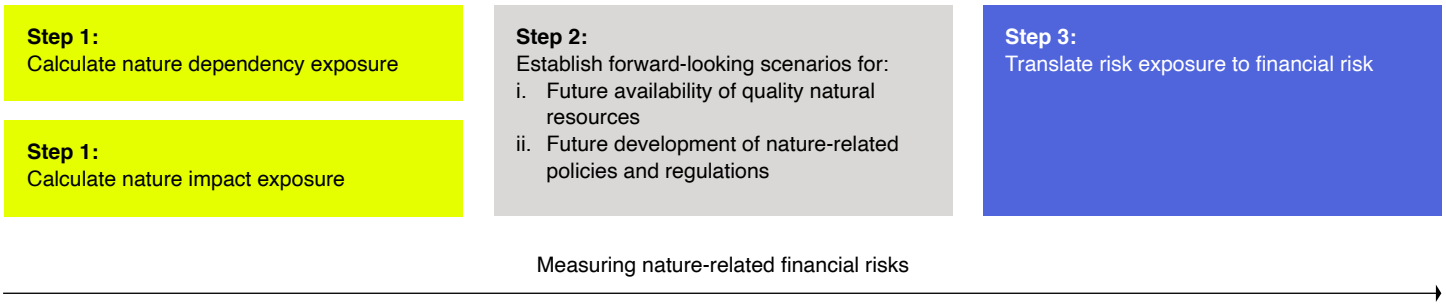
4. Risk assessment capacity

4. Risk assessment capacity

There are three critical steps to estimating nature-related risk. These are illustrated in Figure 7: nature dependencies, nature impacts, and forward-looking scenarios. Dependencies determine the level of exposure to physical risk, impacts determine the level of exposure to transition risk, and forward-looking scenarios determine the future evolution of both. Existing tools are best categorised along these three dimensions, each of which are at different stages of development and range from assessing risks at the sector- to company- or even asset-level.

This section presents the leading examples and tools for measuring these three dimensions, though in all categories, information and methodology gaps remain, so that the best tools available cannot yet offer a complete picture of risk. Although analyses reach quantitative estimates, these are often indicative rather than accurate measurements of risk. There is a need to enhance company- and asset-level information to reach more accurate and rigorous risk assessments and to converge on an accepted, standardised approach to measuring nature-related financial risks.

Figure 7. Steps to calculate nature-related financial risks.



Source: Vivid Economics

4.1 Identifying nature risk channels

There are two leading reports available to guide financial institutions through a natural capital risk assessment. The first is 'Connecting Finance and Natural Capital'[73], written by the Natural Capital Coalition, the Natural Capital Finance Alliance and VBDO, the Dutch Association of Investors for Sustainable Development. The second is 'Integrating Natural Capital in Risk Assessments: A step-by-step guide for banks'[74], produced by the Natural Capital Finance Alliance in association with PwC.

Any risk assessment begins with identifying the channels through which businesses and financial institutions are exposed to nature-related financial risks. It reflects the first step in both high-level qualitative risk assessments as well as in more rigorous quantified assessments.

The Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE) tool helps users better understand and visualise the impact of environmental change on the economy.[75] It was developed by the Natural Capital Finance Alliance in partnership with UNEP WCMC. It provides a list of the ecosystem services each production process depends upon and the natural capital assets that produce these services. It also details the impact drivers that drive environmental change that in turn affects natural capital assets' ability to continue providing ecosystem services. See Figure 1.

ENCORE assesses the materiality of each sector's dependency on ecosystem services for its production processes, providing a qualitative indication of physical risk. The tool assigns materiality ratings by considering the degree of disruption to production processes that would be caused by the loss of ecosystem functionality and its associated impact on company profits.[76]

ENCORE assesses the impact intensity of each sector's production processes on natural assets, providing a qualitative indication of transition risk. The tool assigns impact intensity ratings by considering a number of criteria in relation to impacts: likelihood, frequency, severity, time frame and spatial scale.[76]

The ENCORE tool provides financial institutions with the context of where and how nature-related financial risks are relevant for the businesses they invest in, loan to and insure. Its qualitative outputs can be used as a screen to identify sectors and ecosystem services to prioritise for further scrutiny. Materiality ratings and impact intensities can also be used for coarse comparative risk analysis across different economic activities.

[73] Natural Capital Coalition et al.(2016): 'Connecting Finance and Natural Capital'
[74] Natural Capital Finance Alliance et al (2018): 'Integrating Natural Capital in Risk Assessments: A step-by-step guide for banks'
[75] ENCORE website - https://encore.naturalcapital.finance/en/about
[76] UNEP, UNEP Finance Initiative and Global Canopy (2020): 'Beyond 'Business as Usual': Biodiversity Targets and Finance'

4.2 Measuring dependency exposure

Matching economic or financial value generation to ecosystem information is a core component of measuring dependency exposure. Most dependency analyses use similar methodologies to produce a monetary value for dependency exposure. The first step gathers relevant data on financial holdings and on individual dependencies such as pollination-dependent crops or ENCORE's production process materiality estimates. The second step aggregates these to the sector-level if necessary. Finally, using gross value added (GVA) or aggregated financial holdings data, they match economic value generated by, or financial value held in, each sector to the sector's respective level of nature dependency to calculate the total monetary value exposed to physical risk. The following three reports represent leading examples of quantifying dependency exposure: WEF (2020)[14], DNB (2020b)[77] and DNB (2019)[78]. See Appendix 3 for an outline of the individual methodologies.

Dependency assessments may also consider indirect nature dependencies across supply chains and portfolios. Hidden dependencies can cascade through supply chains with material financial impacts. Financial institutions can identify commercial relationships between sectors via disclosure requirements or by using input-output tables or models. Portfolio-level assessments can identify systemic risks which are only visible at the portfolio level.[74]

There is a need to improve asset- and company-specific data to improve the accuracy of dependency exposure analyses. As the intensity of unsustainable resource consumption varies by company, and ecosystem vulnerability varies by location, true dependency exposure is company- and location-specific. More accurately quantifying exposure to physical risk will therefore require company- and location-specific information.

However, companies often do not disclose or even collect the required geolocated environmental information, and financial data at the right granularity can be confidential. There is a need to push investees and lending counterparties to improve transparency and disclose the information required for robust quantitative estimates of dependency exposure at a more granular level.

Financial institutions can partially overcome the lack of company-level dependency information by overlaying the increasingly available geographic data on nature stress with businesses' facility coordinates. Geographic data on ecosystem metrics is increasing in availability with location-specific data on water stress and land use already reasonably well developed. The ENCORE website has links to a number of geospatial environmental data such as water stress by the World Resources Institute (WRI).[79] Financial institutions can match the geographic coordinates of businesses' facilities to location-specific environmental data.

[77] DNB (2020b): 'Indebted to nature: Exploring biodiversity risks for the Dutch financial sector'';
DNB (2020c): 'Methods for analyses in Indebted to nature: Exploring biodiversity risks for the Dutch financial sector'
[78] DNB (2019): 'Values at risk? Sustainability risks and goals in the Dutch financial sector'
[79] World Resource Institute: Aqueduct

See example of DNB (2019)[78] in Appendix 3. However, asset coordinates are rarely available and third-party sourcing of data may be required to uncover this information. This is especially pronounced for loans to small- and medium-sized businesses.

Finally, further progress could be made in matching frameworks. While the ENCORE tool makes an excellent first step into matching ecosystem services with production processes, a standardised framework that is consistent with commonly used business activity definitions and classification codes would be useful.

4.3 Measuring impact exposure

Financial institutions can measure their investees' and lending counterparties' nature impacts on specific natural capital assets or on biodiversity as a whole. Nature impacts come in many forms, including land use, land transformation, water use, pollution, and air emissions. Where impacts are particularly pronounced or important to consider due to specific regulatory or social changes, analyses may want to focus on specific natural capital assets. In other circumstances, it is useful to use biodiversity footprints as a proxy to combine numerous nature impacts.[80, 81, 82] In these cases, biodiversity is best measured as a whole rather than focussing on a specific species or habitats.[82] A holistic and neutral approach is preferred because biodiversity as a whole drives ecosystem functionality and resilience. These also ensure risk information is consistent, comparable and clear.

The Biodiversity Footprint for Financial Institutions (BFFI) and the Global Biodiversity Score (GBS) are leading methodologies for financial institutions to measure their biodiversity impact at a portfolio level. BFFI was developed by ASN Bank together with Pré Sustainability and CREM and represents the first framework to measure impact exposure across an entire investment portfolio. The GBS was developed and improved following consultation to reach common ground on the myriad of biodiversity impact metrics available.[82] The tools are useful as they measure impact exposure across the whole supply chain. They often use environmentally extended multi-regional input-output (EEMRIO) models, which not only take into account the flow of goods and services across sectors and countries to include the entire supply chain, but also allows for the inclusion of multiple impact drivers, such as land use and greenhouse gas emissions.

Existing methods calculate quantitative impacts on biodiversity but use relatively coarse geographical and sectoral averages, and hence do not account for highly localised impacts on nature. Sectoral and regional averages assume the same biodiversity impact per unit of currency unit generated for companies operating in the same sectors and same continents or countries. However, biodiversity impacts can vary significantly between locations within a country and companies. By using geographical and sector averages, financial institutions cannot distinguish between the level of sustainability underpinning different companies' practices and can therefore only approximate company-specific impacts.[82]

Company- and asset-level impact analyses are not feasible with currently available data, making accurate measurements of impact exposure difficult. Life cycle assessments (LCA) supported by company- and asset-specific data provide the most accurate indication of impact exposure, however this requires thorough and complex data collection processes.[82] There is a lack of high-quality data on attributable company-level impacts as companies typically do not collect and disclose data on what specific business activity occurs where, let alone their

[80] Pré Sustainability: 'Putting the metrics behind sustainability at the ASN Bank'
[81] Club B4B+ (2017): 'Global Biodiversity Score: measuring a company's biodiversity footprint'
[82] J. Berger et al. (2018): 'Common ground in biodiversity footprint methodologies for the financial sector'

impacts on nature. By contrast, the method described above using sectoral averages requires relatively simple data inputs - country- and sector-level expenditure data – and hence, a faster and cheaper approach. While this may be an easily scalable methodology, it provides only a first step to assessing portfolio level impacts and does not give the granularity required for credible comparisons across companies to inform investment decisions.

Matching geographical environmental data to asset locations can partially overcome the paucity of asset-level impact data. For example, Dutch asset manager ACTIAM is partnering with Satelligence geodata analytics firm[83] to monitor the deforestation impacts of its companies' activities and the Integrated Biodiversity Assessment Tool (IBAT)[84] provides a high-level approach to screening biodiversity risks at an asset level. While these do not provide quantified measures of impact exposure, they indicate which locations are associated with higher impacts and hence, may have greater exposure to transition risk.

That said, sectoral analysis has value in both providing a first approximation where more granular data doesn't exist and as a sectoral benchmark. The BFFI tool has flexibility in the choice of data: (i) direct environmental data from investees, (ii) ecoinvent databases[85] with location- and product-specific life-cycle assessments, or (iii) sectoral averages from the Exiobase database.[86] Asset-level analysis using company-specific data is important for high conservation value areas or when direct impacts from individual companies' operations are large. Nevertheless, sector-level analyses can complement company-level analyses by providing a broader view of impacts across the supply chain and allowing financial institutions to benchmark individual companies against the wider sector.[82, 87]

Some third-party providers such as Trase[88] and Chain Reaction Research (CRR)[89] have produced asset-level impact assessments for specific companies, commodities and geographies. Both offer strong assessments in relation to deforestation-related activities. The Trase tool links agricultural supply chains to specific environmental and social risks in tropical forest regions. Coverage includes Latin American soy, palm oil in Indonesia and Colombia, coffee in Colombia and beef in Brazil and Paraguay but by 2021, the tool expects to cover 70% of the total traded volume of major forest risk commodities adding timber, pulp and paper, aquaculture and cocoa. CRR often uses Trase data to conduct sustainability risk analyses for investors focusing on specific case studies on deforestation-related financial risk. Although these currently focus on climate-related financial risk, they will be extended to offer greater depth on biodiversity and nature in the future.

[83] ACTIAM (2019): 'ACTIAM employs satellite data to combat deforestation'
[84] https://www.ibat-alliance.org/
[85] https://www.ecoinvent.org/
[86] https://exiobase.eu/
[87] ASN Bank (2019): 'Positive Impacts in the Biodiversity Footprint Financial Institutions'
[88] https://trase.earth/
[89] https://chainreactionresearch.com/

4.4 Forward-looking scenarios

Forward-looking scenarios are necessary to determine the future evolution of both physical and transition risks. Physical risk depends on the future availability of quality natural resources and transition risk on the future evolution of nature- and biodiversity-related policies and norms. Creating forward-looking scenarios can jointly determine future resource availability and expectations of biodiversity-related policy and hence physical and transition risk.

Tools that offer forward-looking scenarios for nature-related risks are still at very early stages of development. Only a handful of publicly available examples of scenario analysis exist, though there are some initiatives hoping to build out relevant tools in the future. Their limited availability is in part a by-product of the difficulty in generating reliable forecasts. Scenarios rely on well-mapped natural dependencies and impacts, so the data limitations discussed in the previous sections are compounded here. Moreover, there is currently limited consensus as to what future nature-related policies are likely to be. While there is broad international agreement on targets limiting climate change to 1.5 and 2 degrees, action on biodiversity and nature is less coordinated, increasing the number of possible outcomes to be modelled. Despite this difficulty, a number of initiatives are beginning to explore this area.

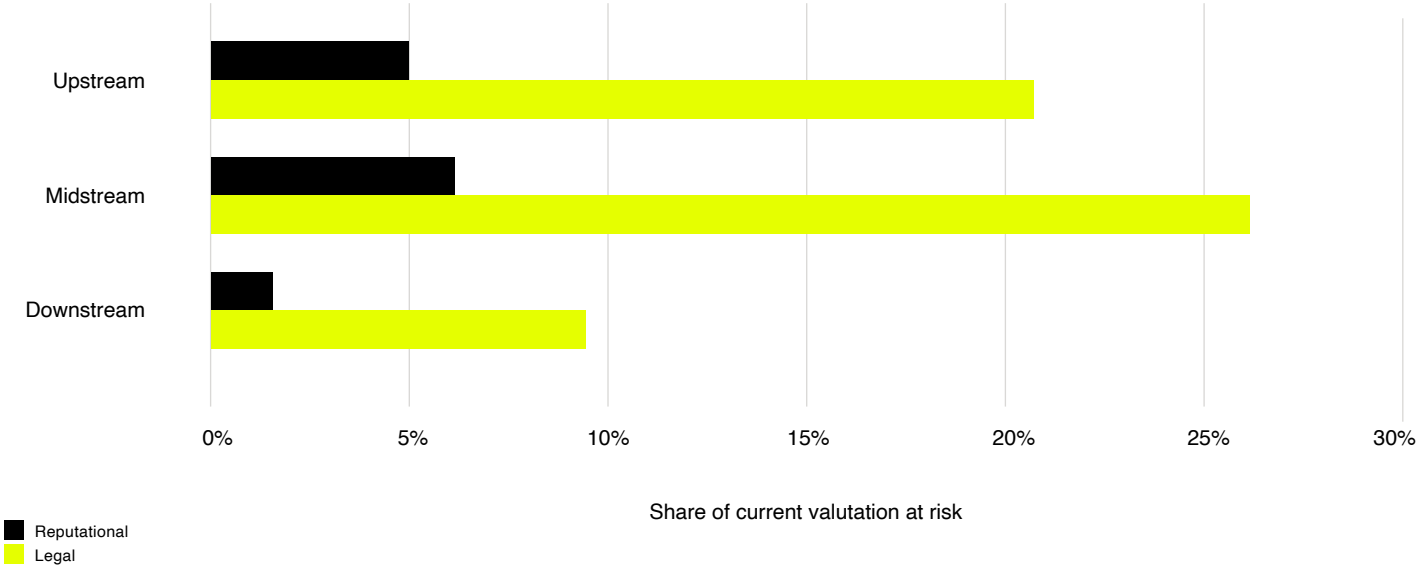
Robust quantitative scenario analysis exercises are available for a few narrow policy sets. For example, see DNB (2020b)[77] in Appendix 3 which assesses two forward-looking scenarios at the asset-level associated with transition risk from financing companies that operate in protected or valuable areas. Similarly, WRI's Aqueduct contains forecasts of a number of physical and transition risks associated with water.

Global scenarios exploring the cost of policy action using a more comprehensive view of biodiversity policy can give financial institutions a better sense of aggregate risks. The forthcoming Dasgupta Review on the Economics of Biodiversity[90], for example, is expected to highlight plausible pathways and comparative costs associated with global policy action. Understanding the total global costs associated with different timings and levels of ambition will help give financial institutions a better sense of the likely scale of transition risks, and the localities in which those transition risks are likely to be concentrated. Other initiatives, such as the UN Principles for Responsible Investing's Inevitable Policy Response (IPR) Initiative[91] have translated global policy scenarios into valuation impacts on listed assets and investment portfolios, including for nature-related activities like water consumption and deforestation.

[90] https://www.gov.uk/government/collections/the-economics-of-biodiversity-the-dasgupta-review
[91] https://www.unpri.org/inevitable-policy-response/what-is-the-inevitable-policy-response/4787.article

Figure 8 below offers an example of how accounting for water transition risks can severely impact company valuations across the Brazilian soy supply chain, where data is relatively good. Initiatives including IPR are currently working to incorporate biodiversity policies and associated transition risks more explicitly into company valuations, and welcome engagement from interested financial institutions.

Figure 8. Agricultural company value at risk from legal and reputational water risk factors



Note: Figures are calculated based on available information from published supply chain data for Brazilian soy and beef industries combined with reported cases of impacts on company bottom lines. Figures are indicative, and data restrictions currently limit the breadth achievable of such an analysis.
Source: Vivid Economics and the Inevitable Policy Response, based on Ceres Investor Water Toolkit, Chain Reaction Research, and Trase database.

4.5 Related action

4.5.1 Natural capital accounting

In addition to those tools mentioned in the previous section, there are a wide variety of initiatives working on natural capital accounting, and its integration within the financial community. Providers include commercial organisations such as data providers and ESG ratings agencies and a range of non-government organisations (NGOs).

A number of initiatives offer guidance to companies and financial institutions to help them incorporate natural capital considerations into their processes. The following table sets out some of the key private sector-focused initiatives in this space.

Table 4. Natural capital accounting initiatives.

Initiatives and tools	Description
Natural Capital Coalition	Originally established in 2012 as the The Economics of Ecosystems and Biodiversity For Business Coalition and hosted by Institute of Chartered Accountants for England and Wales, the Natural Capital Coalition quickly became the global leader in mainstreaming natural capital approaches in the private sector, and released the internationally recognized Natural Capital Protocol in 2016.
Shift Natural Capital Toolkit	SHIFT is an online platform that allows you to navigate the sea of sustainability tools and carve out your pathway to implementation. SHIFT is also a community of practitioners working together to review tools based on their own experiences. The toolkit contains more than 50 guides, tools and data sources for measuring natural capital, such as the Integrated Biodiversity Assessment Tool (IBAT), Bioscope, World Business Council for Sustainable Development's Global Water Tool and the World Resources Institute's Aqueduct Water Risk Atlas.

Initiatives and tools	Description
Natural Capital Finance Alliance	The Alliance and its Secretariat was originally formed to support the signatories of the Natural Capital Declaration, which was launched at the Rio+20 conference in 2012. The declaration has been signed by the CEOs of more than 40 financial institutions from around the world. It formalises their commitment to the integration of natural capital considerations into financial sector reporting.
Business for Nature	Business for Nature is a global coalition bringing together influential organizations and forward-thinking businesses. Together, they demonstrate business action and amplify a powerful business voice calling for governments to reverse nature loss.
Aligning Biodiversity Measures for Business	The Aligning Biodiversity Measures for Business initiative aims to form a common view amongst key stakeholders on the measurement, monitoring and disclosure of corporate biodiversity impacts and dependencies. It will encourage the development of more credible indicators of corporate contribution to global biodiversity goals into corporate reporting and global policy frameworks.
Natural Capital Impact Group	The Natural Capital Impact Group is composed of progressive companies, including market leaders and household names, with significant land footprints and dependencies upon natural capital, which aspire to understand and then mitigate their impacts upon natural capital.
The EU Business @ Biodiversity Platform	The EU Business @ Biodiversity Platform provides a unique forum for dialogue and policy interface to discuss the links between business and biodiversity at EU level. It was set up by the European Commission with the aim to work with and help businesses integrate natural capital and biodiversity considerations into business practices.
Global Footprint Network	Global Footprint Network, an international non-profit organization founded in 2003, envisions a future where all can thrive within the means of our one planet. They offer metrics that are simple, meaningful, and scalable; actionable insights about natural resource consumption and capacity; tools and analysis to guide informed decisions.

Five standards bodies also cover natural capital-related reporting: the Global Reporting Initiative (GRI), the Climate Disclosure Standards Board (CDSB), the Sustainability Accounting Standards Board (SASB), the International Integrated Reporting Council (IIRC) and the International Organization for Standardization (ISO).

4.5.2 Investor action on biodiversity and data gaps

As mentioned above, there are several challenges for private sector organisations to assess their impacts and dependencies on natural capital. These include:

- the need for location-specific and/or company-specific data;
- the lack of comprehensive, broadly agreed metrics for impacts;
- the sparsity of information for some elements of natural capital;
- the lack of a single measure of 'impact on nature' or 'dependency on nature'.

In particular, the need for company- and location-specific data presents difficulties which can only be addressed through collaboration across companies, financial institutions, NGOs and regulators. The solution to this problem requires significant capital investments that one organisation alone is unlikely to invest. Common action would help reduce the costs and bring together disparate datasets in a standardised manner suitable for further development into data products and services appropriate for use in the financial sector.

In March 2020, four asset managers, AXA Investment Managers, BNP Paribas Asset Management, Mirova and Sycomore Asset Management, issued a statement setting out the need for biodiversity impact metrics.[92] They noted that: 'We lack the tools to accurately and consistently measure these impacts, although we recognize that a wide range of industries are having a direct impact on biodiversity. We need better tools to allow us to measure and reduce the physical impact of investments on ecosystems.'

The investors have called for data providers to develop biodiversity metrics to capture physical impacts as well as financial materiality of companies and projects on ecosystems. They requested the following criteria:

- methodologies must follow a Life Cycle Assessment approach and should capture both negative and positive impacts;
- the scope of coverage should be as broad as possible;
- the development of these tools should maximize transparency, leveraging the already existing large base of information and data sources.

This was followed in May 2020 by an open statement[93], signed by 21 investors and companies, which stated:

'The CO_2 tonne-equivalent metric played a key role in mainstreaming climate issues and driving actions mitigating climate change. We need comparable metrics for biodiversity if we are to properly address biodiversity loss. That is, quantitative metrics depicting the state of biodiversity, broadly used and accessible to all, scientifically consensual and that can be aggregated or dis-aggregated at multiple levels of granularity. Such quantitative biodiversity metrics, coupled with qualitative analyses, are a necessary step in allowing states, companies and financial institutions to estimate and monitor their impacts, demonstrate gains and steer their operations.

To fulfil that need, we stand with the Mace et al. (2018) recommendation[94] to use three complementary indicators and their associated scientifically-renowned metrics to evaluate progress in biodiversity recovery. Namely, the conservation status (Red List Index); population trends (Living Planet Index); and biotic integrity or biodiversity intactness (Mean Species Abundance).'

[92] https://www.mirova.com/sites/default/files/2020-05/Press%20release_european%20investors%20rally%20around%20biodiversity_final.pdf
[93] https://www.responsible-investor.com/articles/we-need-sound-metrics-to-reverse-biodiversity-loss-at-a-global-scale
[94] Mace et al.(2020): 'Aiming higher to bend the curve of biodiversity loss'

5. Recommendations

5. Recommendations

This report argues that capital is currently systematically misallocated because financial decision-making fails to account for material nature-related financial risks. Section 2 presented a framework for that risk, offering a common standard for approaching nature-related financial risks. Section 3 demonstrated the materiality of that risk, and the evidence suggests that, without substantial action, materiality will continue to increase. Section 4 illustrated the work that still needs to be undertaken to develop the capacity to robustly and comprehensively manage nature-related financial risks. Together, they argue for a systemic shift in how financial institutions manage risk, moving capital away from activities that harm nature and toward those that support it at a large scale.

To address this and achieve effective systemic change, a broad set of actions are required across the entire financial system. This section explores recommendations for financial institutions alongside regulators, governments and other stakeholders, to help reduce the aggregate exposure of the financial system. These recommendations are organised into three categories:

1. **Establishing a TNFD**, to act as a coordinating authority to convene stakeholders, share best practice, and invest as a community in developing better risk management capacity;

2. **The role of financial institutions**, in proactively preparing for future client and regulatory demands as individual institutions; and

3. **The role of the wider financial system**, specifically those of governments, regulators and data providers.

5.1 Establishing a TNFD

A global convening institution is essential to accelerate action on nature-related financial risks by both creating unified reporting standards and offering resources for capacity building. Due to the urgency and scale of nature loss, we cannot afford to wait for financial institutions to individually untangle the complexities of nature-related financial risks. The process of incorporating nature-related financial risks into financial decision-making needs to be significantly accelerated.

The establishment of a Task Force for Nature-Related Financial Disclosures (TNFD) is best placed to act as this convening institution. This should use the format and principles of the TCFD, building on lessons learned from its experience, while recognising that biodiversity is a much more complex issue and will require different approaches.

The primary aim of the TNFD should be to develop an international reporting standard supported by regulators and financial institutions. As awareness of nature-related risks rises, a proliferation of different reporting practices will become more likely. It is critical that institutions converge quickly to a single standard to avoid confusion around the credibility of reported information, ultimately preventing effective risk management. The TNFD must work with stakeholders to distil disclosure proposals into a common framework endorsed by all parties. Once that framework is developed, the TNFD can further use its convening power to encourage widespread adoption and uptake, supporting institutions through the capacity building activities described below where necessary. The TNFD should also have a role working with regulators to advocate that these standards be incorporated into regulatory requirements, to ensure a level playing field.

The TNFD should facilitate information sharing and accelerate international uptake of best practices among financial institutions. Section 4 presents only a selection of the tools and metrics available for financial institutions to consider natural capital. There is currently no clear, comparable and consistent way to identify, measure and manage this information. A convening institution can act as a central point of contact for sharing experience and information and converge on best practice approaches and solutions. It can contribute to developing forward-looking scenarios on nature policies, behavioural and technological change and market dynamics to address the important capacity gaps identified in Section 4.

It can act as a unique platform, bringing together experts from private financial institutions, Development Finance Institutes (DFIs), data providers, regulators, NGOs, and academia. This mix of knowledge and experience will enable recommendations to be based on environmentally robust scientific understanding of nature while also tailoring them for use by businesses and financial institutions that will be implementing these.

5.2 The role of financial institutions

Even before a TNFD is established, financial institutions can act now to reduce risk exposure and position themselves to capitalise on nature-related financial opportunities. Navigating the sustainable transition will define company and investor success and failure over the coming decade. Long-term investors would benefit from starting this transition now, and proactive institutions will leverage nature-related financial opportunities by (i) building capacity throughout their organisation to measure and account for emerging risks and, (ii) engaging with investees. The subsections below outline a few examples of actions in each of these three categories, but institutions will need to move quickly and find the mix of actions that works best for their circumstances.

5.2.1 Build capacity

Financial institutions can get a headstart on good decision-making by incorporating natural capital thinking into their risk management processes. Building out institutional capacity for the management of nature-related risks can start now. Institutions can start by using the tools discussed in this paper to begin understanding nature-related risk exposure, or by familiarising themselves with the financial data streams that are starting to come out of initiatives like Trase and GIST Impact 360 (I360X). They can also develop the processes and teams required to incorporate this information into decision making at all levels. This will involve clear structures for upwards communication, integrating nature into existing and new risk management processes and setting out a strategy to tackle nature-related risks. For example, Kering uses the Environmental Profit & Loss methodology to assess and monetise its environmental footprint in order to guide its sustainability strategy, improve its processes and prioritise mitigation, sourcing and supply chain options.[95]

Financial institutions can join existing finance sector initiatives to help enhance their institutional capacity and understanding of nature-related financial risks. In parallel to, and potentially in support of, building internal capacity on nature-related risks, institutions can begin collaborating with some of the many big-tent initiatives already active in this space that welcome additional signatories or collaborators. There are many, some of which have already been discussed in this report, but examples include the UN Principles for Responsible Investing, Business for Nature[96], IUCN Netherlands pledges, the EU Business @ Biodiversity Platform[97] and the One Planet Business for Biodiversity (OP2B)[98]. Other initiatives that are more finance sector specific include the Natural Capital Finance Alliance[99], the Sustainable Finance Platform, and the Partnership on Biodiversity Accounting Financials. Many of these initiatives have useful guides and introductions for institutions just starting out in this space.

[95] https://www.kering.com/en/sustainability/environmental-profit-loss/
[96] https://www.businessfornature.org/
[97] European Commission: 'EU Business @ Biodiversity Platform' - https://ec.europa.eu/environment/biodiversity/business/index_en.htm
[98] https://op2b.org/
[99] https://naturalcapital.finance/

5.2.2. Engage with investees and lending counterparties

Financial institutions can leverage findings to inform engagement with investees and lending counterparties on governance, strategy and risk management processes. This may involve additional environmental and operational information from its investees and lending counterparties, which can feed into the new institutional decision-making frameworks that institutions develop. Even if additional information is not required, investors can push their investees to better understand and reduce their risk exposure or choose to divest before risks are realised.

5.3 The role of the wider financial system

5.3.1 Governments

Governments should implement nature-related targets and the policies required to meet them. Targets should be organised on a 'no net loss' or 'net gain' basis, and set as nationally determined contributions, crucially established in domestic law, and cascaded into plans and regulations. Governments should commit in statute law to publish plans to achieve promises on biodiversity targets and reports on progress.

5.3.2 Regulators

Financial regulations that provide nature-related macro and micro prudential oversight are needed. Well-designed regulation can supplement strong policy to ensure financial institutions make investments consistent with no net loss targets. Those regulators should publish aggregate impact and risk progress assessments for their sectors no less frequently than every five years. International institutions such as the International Monetary Fund, the World Bank and the Bank for International Settlements tasked with securing economic and financial stability should explicitly include nature-related risks and action in their mandates.

Regulators should introduce mandatory requirements to inform and consult citizens on the nature-related risks underpinning their funds. Citizens are the ultimate owners of a variety of financial assets and beneficiaries of pension and insurance policies. It is therefore important to communicate the nature-related financial risks their financial assets are being channelled towards. Financial institutions should communicate in a clear and accessible format.

5.3.3 Data providers

Data providers and aggregators have an opportunity to fill the current data gaps that inhibit our understanding of nature-related risks. Information on physical asset locations and activities as well as nature-related data which will be needed to feed into risk assessments. Both public and private information sources will need to be blended to support evidence-based decision-making. This represents a business opportunity to provide this service to financial institutions seeking to understand risk, while also helping accelerate better decision-making in the sector.

Appendix 1. Breakdown of risk framework

Table 5. Breakdown of risk framework

Category	Risk pathway	Examples
Physical risks	Operations / commodity	Direct dependency on ecosystem services for production processes such as water for production of raw materials, mining or beverages.
	Supply chain	Dependency on natural capital assets for raw materials inputs such as timber, minerals, food ingredients and genetic diversity (see pharmaceutical industry example in Box 1 in section 2.2); Increased prices for key raw materials due to decreasing yields or increased input costs from scarcity or new legislation.
	Real estate and business value risk	Nature enables the conditions necessary for maintaining the value of a business so losses in nature can cause losses in business or real estate values; Properties with persistent, fast-spreading and treatment-resistant species such as Japanese knotweed can reduce their asset prices and risk legal damages.
	Resilience against natural disasters	Destruction of vegetation by hillsides and coasts leads to more frequent landslides and flooding events respectively, causing damage to assets; Increased insurance premia due to more frequent natural disasters such as flooding or droughts.
Transition risks	Regulatory risk • Increased pricing of nature • Additional reporting obligations • Mandates and regulation of business-as-usual operations and products and services produced	Increased operating costs from subsidy removals, reporting burdens, new taxes and/or certifications causing higher compliance costs; Costs from disruptions to business-as-usual operations requiring adoption of new practices and processes, such as from new laws banning the use of certain pesticides; Changing legislation leads to stranded assets, (see Indonesian palm oil example in Box 2 of in section 2.3)

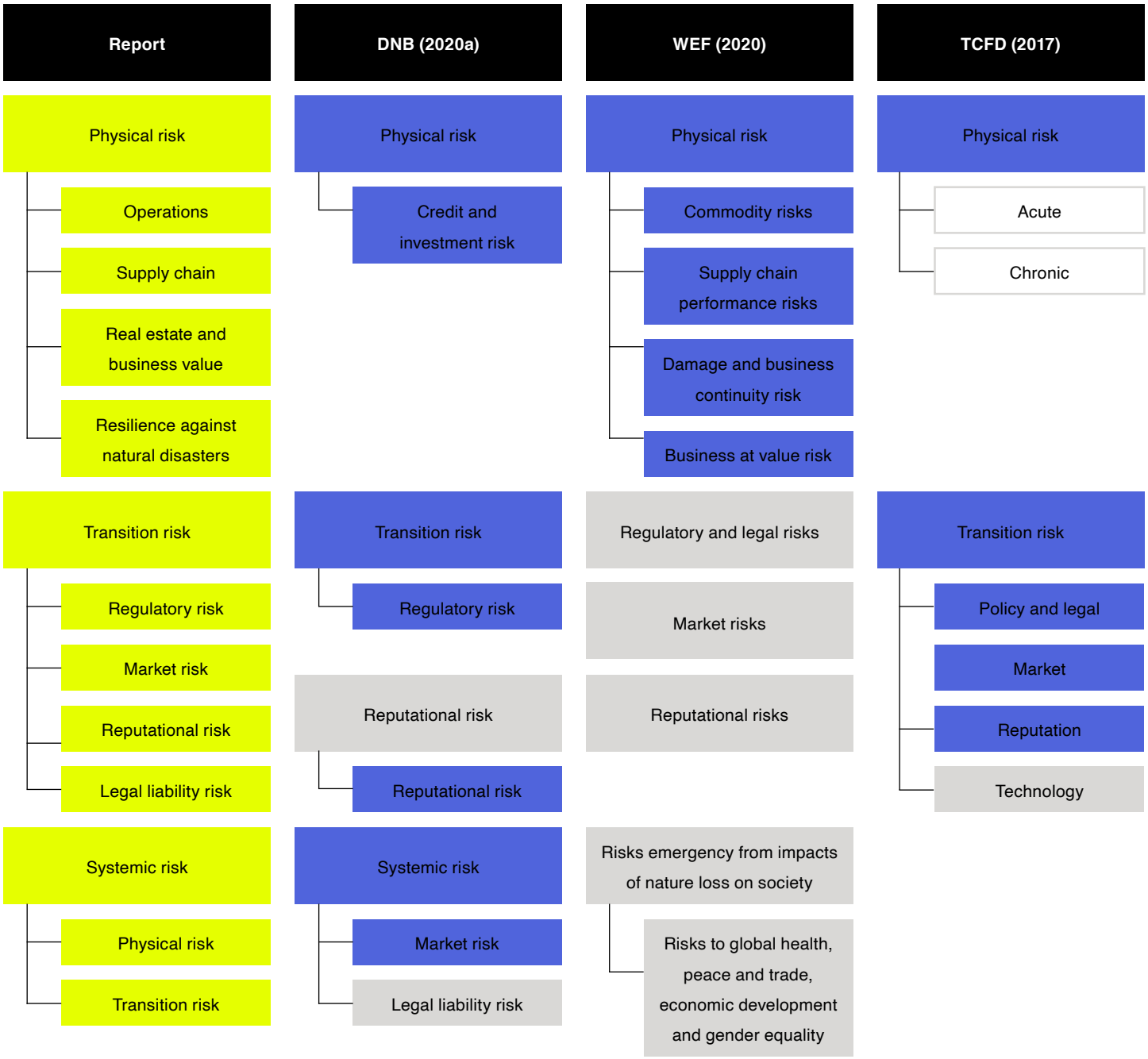
→

Category	Risk pathway	Examples
	Market risk • Shifts in supply and demand due to changing social norms • Emerging nature-neutral products, services, technologies and business models	Reduced demand for goods and services due to shifting behaviors such as the movement to eliminate single-use plastics and reduce packaging; Reduced demand and revenues for goods and services due to new competitors such as meat and fish alternatives;[6] Re-pricing of assets such as mineral reserves, land valuations, securities valuations;[12] Increased competition from newly evolved technologies or costs associated with adopting new technology requirements; Tightening requirements by financial institutions for loans or investments; Changing client requirements
	Reputational risk • Shifts in stakeholder sentiments such as consumer, client and wider public • Sector stigmatization	Reduced revenues from lower demand due loss of customer base; Increased insurance premiums due to higher threat of litigation; Reduced stock prices from investor concerns over reputation and lower brand value; Reduced revenue from lower production capacity due to delayed planning approvals and supply chain interruptions;[12] Lower capital availability due to negative stakeholder feedback
	Legal liability risk	Legal action against companies for polluting or causing environmental damage such as BP and Exxon Valdez being sued USD 65 billion for 2010 Deepwater Horizon oil spill[39]; Stranded assets due to removal of license to operate.

Note: This framework harmonises the frameworks outlined in the DNB (2020a) and WEF (2020) reports and also adapts the table in TCFD (2017) report to nature-related risks.
Source: Vivid Economics; DNB (2020a), WEF (2020); TCFD (2017)

Appendix 2. Harmonisation of risk frameworks

Figure 9. Harmonisation of risk framework with existing frameworks



Note: Dark blue boxes refer to elements from other frameworks directly included in the report's risk framework, grey to elements included but altered or recategorized.
Source: Vivid Economics

Appendix 3. Detailed examples of nature-related risk assessment capacity

A3.1 ENCORE tool

The ENCORE tool sets out the pathways in which sector and sub-industry production processes depend on and impact nature. Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE) was developed by the Natural Capital Finance Alliance in partnership with UNEP WCMC to help users better understand and visualise the impact of environmental change on the economy.[100] The tool relies on a mix of data sources, literature reviews, sector reviews as well as expert interviews to create a comprehensive picture of the interaction between 86 production processes and 21 ecosystem services, classified based on the Common International Classification of Ecosystem Services (CICES).[101] It covers 11 sectors and 167 sub-industries classified according to the Global Industry Classification Standard (GICS).[102]

ENCORE assesses the materiality of each sector's dependency on ecosystem services for its production processes, providing an indication of physical risk. ENCORE provides a list of the ecosystem services each production process depends upon, the natural capital assets that produce these and the drivers of environmental change that influence their provision. The tool assigns materiality ratings by considering the degree of disruption to production processes that would be caused by the loss of ecosystem functionality and its associated impact on company profits. A 'very high' materiality rating suggests that the loss of functionality prevents the production process from continuing which endangers the financial viability of the company. Table 4 shows the sub-industries with the highest dependency materiality ratings that are also most relevant to financial institutions based on financial flows analysis.[103]

[100] ENCORE website - https://encore.naturalcapital.finance/en/about
[101] Common International Classification of Ecosystem Services (CICES) - https://cices.eu/
[102] The Global Industry Classification Standard - https://www.msci.com/gics
[103] UNEP, UNEP Finance Initiative and Global Canopy (2020): Beyond 'Business as Usual': Biodiversity Targets and Finance

Table 6. Top 3 sub-industries with the highest dependency materiality most relevant for financial institutions

Sub-industry	Production processes	Dependency materiality reasoning
Agricultural products	• Small- and large-scale irrigated arable crops • Small- and large-scale rainfed arable crops • Small- and large-scale livestock (beef and dairy • Aquaculture	High or very high materiality identified from: • Direct physical input (animal-based energy, fibres and other materials, ground and surface water) • Enabling production (pollination, water and soil quality, water flow maintenance) • Protection from disruption (buffering and attenuation of mass flows, climate regulation, disease control, flood and storm protection, erosion control and disease and pest control).
Apparel, accessories and luxury goods	Natural fibre production	Very high materiality identified from: • Direct physical input (ground water and surface water) Medium materiality identified from: • Direct physical input (genetic materials) • Enabling production (water flow maintenance) • Protection from disruption (flood and storm protection)
Brewers	Alcoholic fermentation and distilling	Very high materiality identified from: • Direct physical input (ground water and surface water) Medium materiality identified from: • Direct physical input (genetic materials) • Enabling production (soil quality, water quality and water flow maintenance) • Protection from disruption (flood and storm protection)

Note: This table presents the top 3 sub-industries identified as having the highest dependency materiality and most relevant to financial institutions based on financial flows analysis.
Source: UNEP, UNEP Finance Initiative and Global Canopy (2020)

ENCORE assesses the impact intensity of each sector's production processes on natural assets, providing an indication of transition risk. Impact drivers are defined as a measurable quantity of a natural resource that is used as an input to production such as water use or a measurable non-product output of business activity such as non-greenhouse gas pollutants.[104] ENCORE matches impact drivers with production processes for each sector and sub-industry. It also outlines how impact drivers influence environmental change that in turn affects natural capital assets' ability to continue providing ecosystem services (see Figure 1). The tool assigns impact intensity ratings by considering a number of criteria in relation to impacts: likelihood, frequency, severity, time frame and spatial scale. A 'very high' intensity rating suggests it is operationally and financially impossible to redesign the project to avoid the impact, which is expected to occur in large volumes or areas continuously throughout the project life cycle and in all production locations. Table 5 shows the sub-industries with the highest impact intensity ratings that are also most relevant to financial institutions based on financial flows analysis.

[104] Natural Capital Coalition: 'Natural Capital Protocol'

Table 7. Top 3 sub-industries with the highest impact intensity most relevant to financial institutions

Sub-industry	Production processes	Impact materiality reasoning
Agricultural products	• Small-scale livestock (beef and dairy) • Large-scale livestock (beef and dairy)	Very high intensity due to impacts associated with: • Use of land and freshwater (extensive areas of land cleared for production, and large water footprint); • Use of natural resources (intrinsic use of animals, which form part of biological diversity) • Pollution (water and soil pollutants) • Climate change (emission of greenhouse gases, namely methane) Low intensity due to impacts associated with: • Invasive species (potential for livestock to spread pests)
Distribution	• Distributors • Food distributors • Health care distributors • Technology distributors	Very high intensity due to impacts associated with: • Climate change (emissions of greenhouse gases from vehicles and vessels) • Invasive species (high potential for spread of invasive species from movement of vehicles and vessels) • Disturbances (noise pollution from vehicles and vessels) Medium intensity due to impacts associated with: • Pollution (non-greenhouse gas air pollutants, water and soil pollutants)
Mining	• Aluminium • Coal and consumable fuels • Copper • Diversified metals • Gold • Precious metals and minerals • Silver	Very high intensity due to impacts associated with: • Land and freshwater use (direct use of natural habitats throughout operations) • Pollution (emission of water and soil pollutants, and solid waste) High intensity due to impacts associated with: • Climate change (emission of greenhouse gases) • Disturbances (seismic activity affecting species)

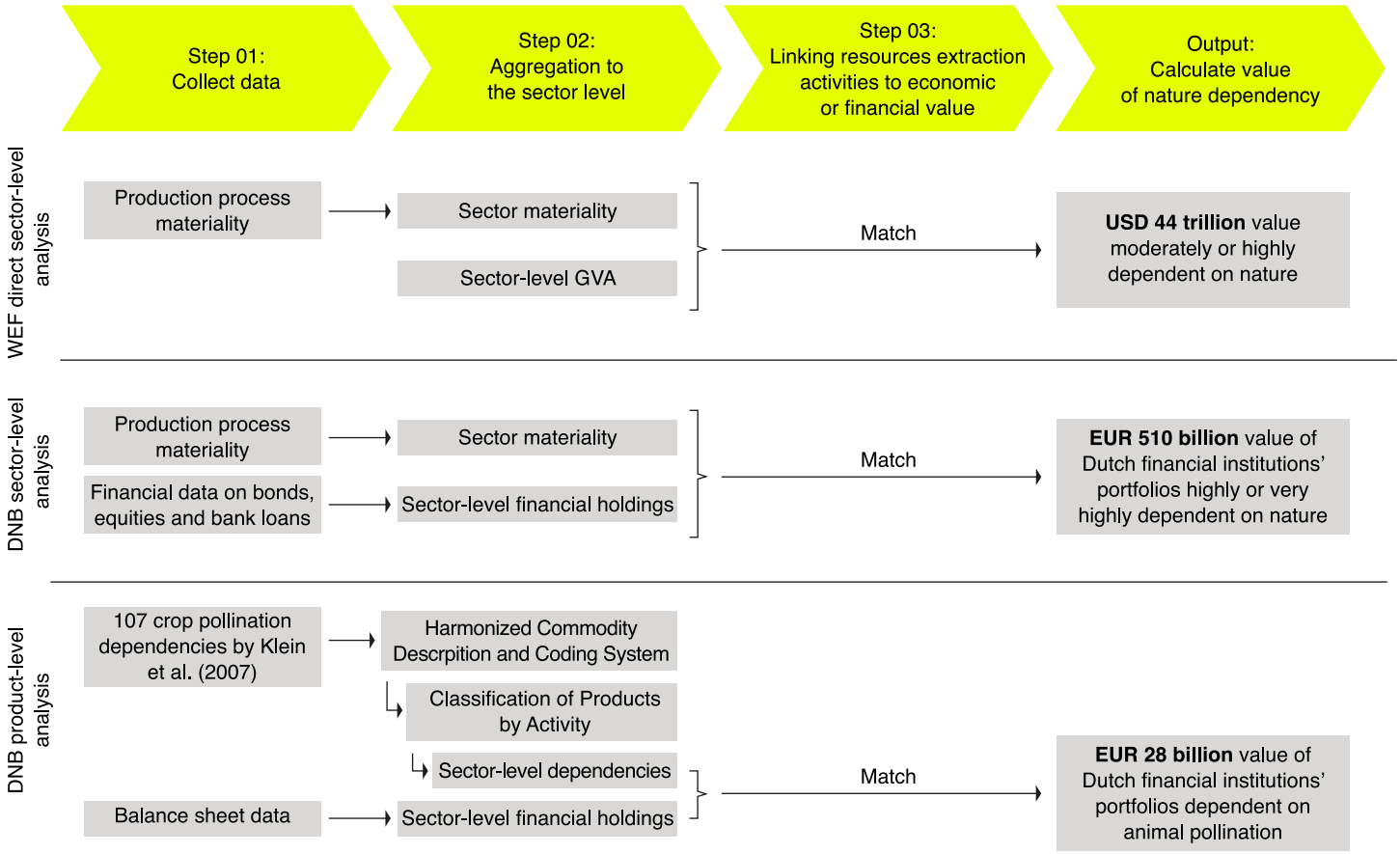
Note: This table presents the top 3 sub-industries identified as having the highest impact intensity and most relevant to financial institutions based on financial flows analysis.
Source: UNEP, UNEP Finance Initiative and Global Canopy (2020)

The ENCORE framework demonstrates that dependencies and impacts are relevant to all sectors. The tool outlines the multiple sources of nature-related financial risks for all sectors of the economy. For example, while the sub-industry of multi-line insurance is not obviously dependent on nature, the ENCORE tool highlights its dependence on ecosystem services supporting mass stabilisation and erosion control. Vegetation protects communities and businesses from landslides on slopes and from storm surges and flooding by coasts.[100] This is consistent with the finding that losing all mangroves would result in an additional 18 million people flooded and USD 82 billion in damages annually.[19]

A3.2 Dependency exposure

Most dependency tools have been developed for the sector- or product-level using similar methodologies, with matching economic and ecosystem information as a core component. Figure 10 illustrates the similarity between three leading tools. The first step gathers relevant data on financial holdings and on individual dependencies such as pollination-dependent crops or ENCORE's production process materiality estimates. The second step aggregates these separately to the sector-level where necessary. Finally, in step 3 they match sector-level data on economic value generated by, or financial value held in, each sector to the sector's respective level of nature dependency to calculate the total monetary value exposed to physical risk.

Figure 10. Summary of steps followed in WEF and DNB sector-level analyses and DNB product-level analysis

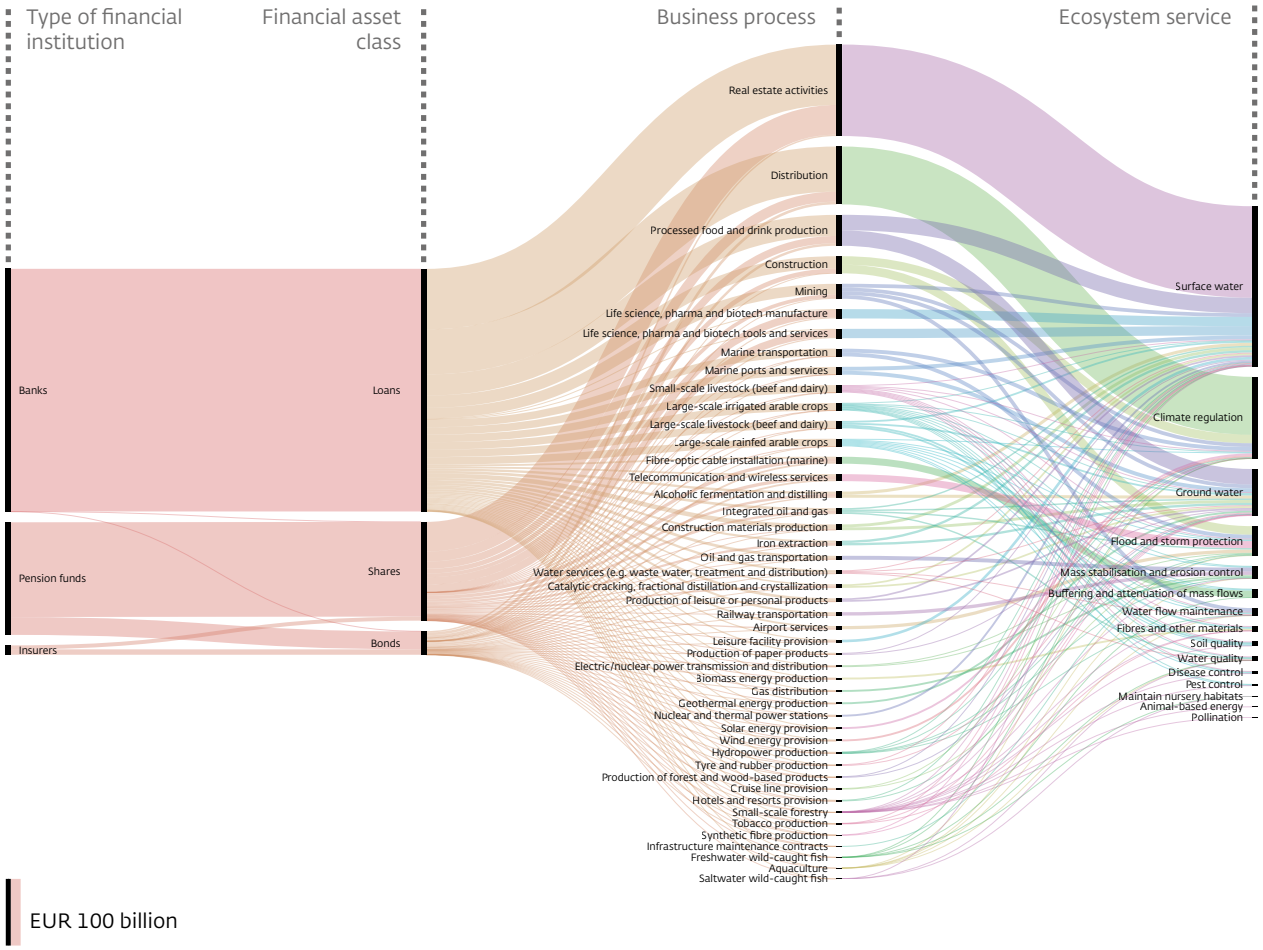


Source: Vivid Economics; based on WEF (2020) and DNB (2020b)

The WEF[14] expands on the ENCORE tool by using gross value added data to quantify direct nature dependencies of global sectors. The study assesses the reliance on natural capital assets of 163 economic sectors by matching aggregated ENCORE materiality ratings with aggregated GVA data. It finds that USD 44 trillion or over half of global GDP is moderately or highly dependent on nature. WEF takes an additional step by calculating not only direct but also supply chain nature dependencies. It uses a multi-regional input-output model, inputting each sector's total input-related demand on other sectors, to assess the commercial relationships between sectors and calculate the GVA generated in each sector's supply chain. Figure 2 in Section 3.2 illustrates the analysis's findings on nature dependencies by sector.

A second approach by DNB[77] also undertakes a sector-level analysis, finding a total of EUR 510 billion or 36% of Dutch financial institutions' portfolios to be highly or very highly dependent on nature. Although it also uses aggregated ENCORE materiality ratings, the tool matches these to aggregated financial data based on actual Dutch financial holdings in the form of bank loans and equity and bond investments. The output, in terms of dependency per euro invested, measures the level of dependency (i) for types of financial institutions, (ii) for financial asset classes, (iii) for sectors, or (iv) on specific ecosystem services. For example, one-quarter of every euro invested is highly or very highly dependent on ground and surface water provisioning. See Figure 11 for a graphical representation of the findings from the analysis.

Figure 11. The financial sector and ecosystem services dependencies per euro invested



Note: This diagram assesses the nature dependencies of Dutch financial institutions' total value of holdings in share and bonds (2018-IV) and major loans (2017-IV) of EUR 1,421 billion.
Source: Figure 3 from DNB (2020b): Indebted to Nature

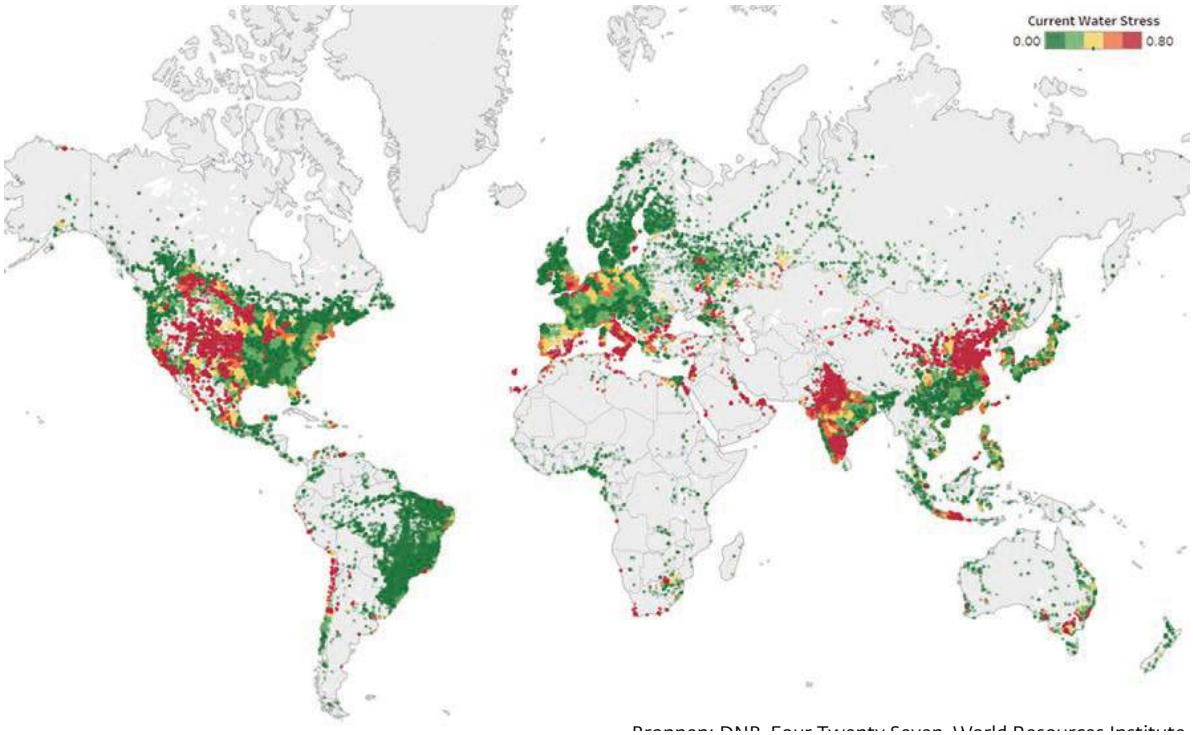
A third dependency approach by the DNB[78] undertakes a product-level analysis, calculating the dependency exposure of Dutch financial institutions to the specific ecosystem service of animal pollination, totalling EUR 28 billion. It mostly follows the same steps as previous tools but uses crop-level pollination dependency information from existing scientific research[105] rather than materiality ratings of production processes as previously.

Financial institutions can undertake the same types of matching exercises to assess dependency exposure, connecting the data they have access to from companies to available environmental information on dependencies. The three tools demonstrate the core logic of matching economic data to environmental information which financial institutions can emulate. Some of the information used is publicly available such as GVA data and ENCORE information whereas others need to be sourced privately from the businesses themselves or from data aggregators. Business metrics on inputs, costs, outputs and revenues are routinely collected by businesses and investors will have access to financial data from their investees. Using financial data, as in the DNB tools, is particularly useful for financial institutions because it assesses dependencies within particular investment portfolios and therefore provides a more tailored assessment of physical risks. More general analyses based on economic value generation, such as the exercise undertaken by WEF, offers a good overview of absolute USD dependency exposure and the relative dependencies of different economic sectors.

A fourth dependency analysis by the DNB (2019)[78] matches the geographic coordinates of around 918,000 of its investees' facilities to location-specific data on water stress by the World Resources Institute (WRI).[106] The former was compiled by Four Twenty Seven research company and covers 2,000 major listed businesses including almost all of the MSCI ACWI and S&P 500 indices. They place facilities into one of five water stress categories from low to extremely high and determine financial institutions' risk exposure pro rata to the number of business facilities held in each category. They find that Dutch financial institutions have invested EUR 97 billion in businesses operating in extremely water-stressed areas. This represents EUR 83 billion or 17% of the Dutch financial sector's equity portfolios and EUR 14 billion or 20% of bank loans issued to multinational corporations. See Figure 12.

[105] A. Klein et al. (2006): 'Importance of pollinators in changing landscapes for world crops''
[106] World Resource Institute: Aqueduct

Figure 12. Facilities of listed businesses in the equity portfolios of Dutch financial institutions



Note: The colours of the dots indicate the water stress level for the facility, ranging from green which signifies low water stress to red which signifies extremely high water stress.
Source: Figure 7 from DNB (2019) 'Value at risk?' report

In parallel to furthering asset-level analysis, it is also important to address remaining data gaps and matching obstacles.
The DNB only finds water stress data for EUR 346 billion of its total EUR 487 billion equity holdings and facility-specific data for only EUR 71 billion of the EUR 810 billion total of bank loans outstanding.[77] This is especially a problem for loans to small- and medium-sized businesses. This is also true for location data, with only EUR 389 billion of the EUR 636 billion containing location data in a scenario analysis discussed in section A3.4.[77]
The inability to match environmental and economic categories also inhibits analyses, as this is a core step in assessing dependency exposure. DNB's pollination-dependence analysis can only couple 55 of the 90 animal pollination-dependent crops it initially identifies to product codes in the Harmonized Commodity Description and Coding System[107].

If these gaps are addressed, financial institutions will benefit from a much more complete understanding of the dependency exposure in their financial portfolios which will enable better investment decision making.

[107] https://unstats.un.org/unsd/tradekb/Knowledgebase/50018/Harmonized-Commodity-Description-and-Coding-Systems-HS

A3.3 Impact exposure

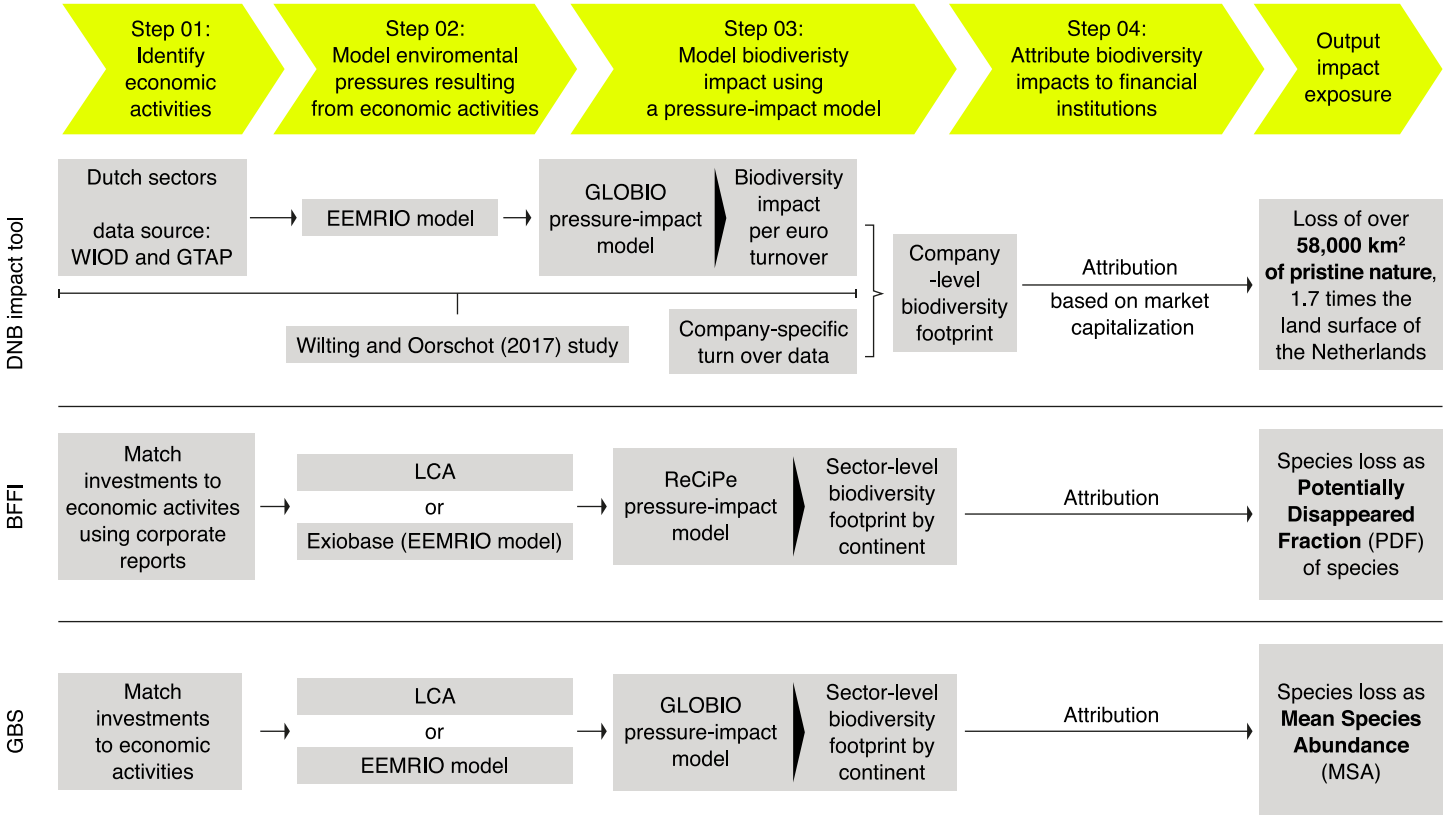
Most available impact tools use similar methodologies, building on identified pressure-impact relationships from existing research and relevant models. Figure 13 illustrates the similarity between three leading tools. The first step matches investments to economic activities. The second step models the environmental pressures induced by economic activities in terms of environmental intensities. This often involves using an environmentally extended multi-regional input-output (EEMRIO) model which not only takes into account the flow of goods and services across sectors and countries to include the entire supply chain but also allows for the inclusion of multiple impact drivers such as land use and greenhouse gas emissions.[108] The third step inputs these environmental pressures into a pressure-impact model to calculate the impact on biodiversity based on best available scientific knowledge.[109, 110] Finally, the impacts are typically attributed to financial institutions based on their share of asset ownership in companies.[111] This provides a quantified output of the total biodiversity impact of investment portfolios.

The DNB impact approach calculates the global biodiversity footprint of Dutch financial institutions, building on existing quantifications of Dutch economic sectors' biodiversity impacts by Wilting and Van Oorschot (2017).[108, 77] The paper is the first to calculate the supply chain impacts on biodiversity of all sectors of a country. It undertakes steps 1-3 calculating the biodiversity footprints of 47 sectors in the Dutch economy on a per euro of turnover basis. DNB multiplies these values by company-specific turnover data for 8,022 investee companies to produce relevant company-specific footprint measures which are then attributed to Dutch financial institutions. They calculate their impact exposure to be comparable with the loss of over 58,000 km^2 of pristine nature, 1.7 times the land surface of the Netherlands.

The Biodiversity Footprint for Financial Institutions (BFFI) demonstrates a systematic methodology to measure the biodiversity impacts of financial investments.[109, 110] It was developed for ASN Bank, a Dutch retail bank, and was the first in the world to measure impact exposure across its entire investment portfolio. It follows the steps identified earlier, using the Exiobase[112] EEMRIO model to measure environmental pressures and the ReCiPe[113] impact assessment toolkit to measure pressure-impact relations.[109] The final output is the nature impact exposure in terms of potentially disappeared fraction of species (PDF), where 10 PDF relates to all species being lost on a 10 m^2 area of land during an investment of a year relative to pristine conditions. Note that in addition to terrestrial biodiversity, BFFI also covers freshwater and marine biodiversity that the DNB analysis did not. As the final step they complement the analysis with qualitative considerations to guarantee the reliability of quantitative results and to consider impacts not covered by the indicator such as from invasive species.

[108] H. Wilting and M. Van Oorschot (2017): 'Quantifying biodiversity footprints of Dutch economic sectors: A global supply-chain analysis'
[109] ASN Bank (2019): 'Calculating the biodiversity footprint for the banking sector'
[110] ASN Bank (2019): 'Positive Impacts in the Biodiversity Footprint Financial Institutions'
[111] See page 22 in Berger et al. (2018) or Chapter 4 of the World Resources Institute (2004): 'The Greenhouse Gas Protocol'
[112] https://exiobase.eu/
[113] https://www.rivm.nl/en/life-cycle-assessment-lca/recipe

Figure 13. Summary of steps followed in sector-level impact analyses by DNB and ASN Bank



Source: Vivid Economics; based on DNB (2020b), Berger et al. (2018), ASN Bank (2019), CDC Biodiversité (2018)

The Global Biodiversity Score (GBS) by CDC Biodiversité is a similar systematic methodology to measure the biodiversity impacts of financial investments.[114] It follows the same steps, using the GLOBIO biodiversity impact model[115] to measure pressure-impact relations.The final output is in terms of mean species abundance (MSA), where 1 km^2 MSA loss relates to losing 1 km^2 of undisturbed natural land.

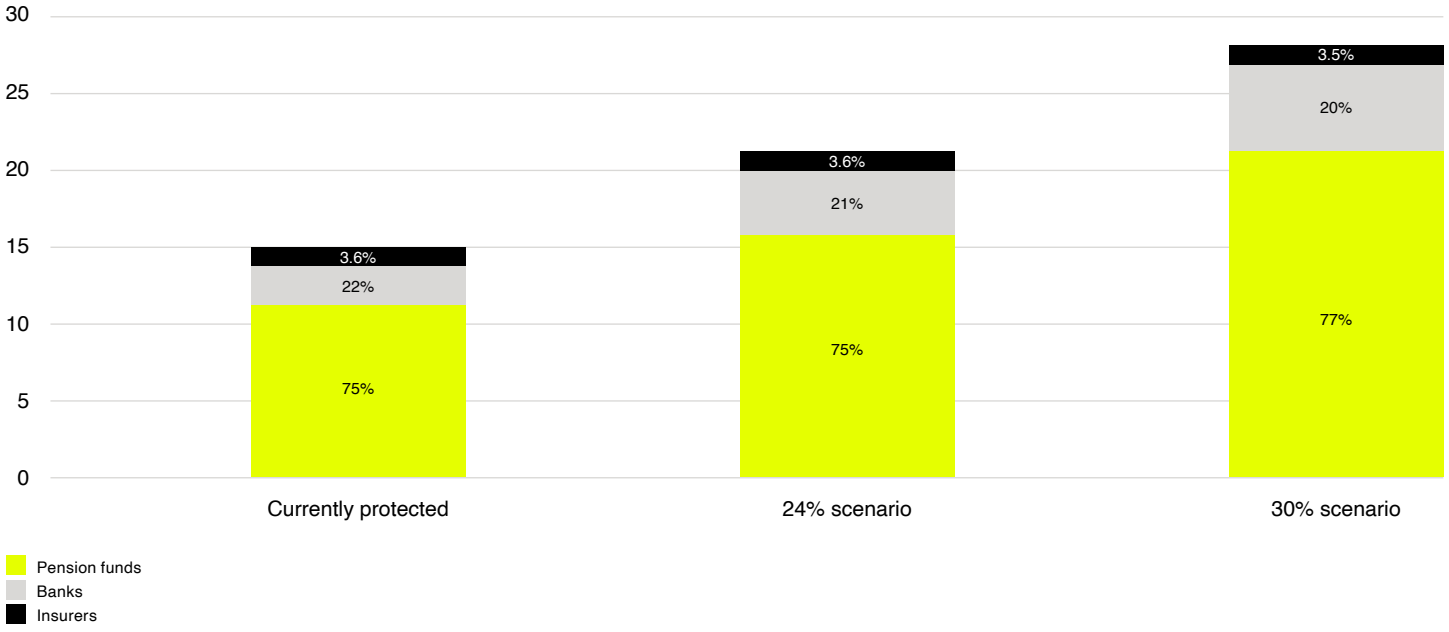
Trase.earth[116] and Chain Reaction Research (CRR)[117] both offer company and asset level impact exposure assessments in relation to deforestation-related activities. The Trase tool links agricultural supply chains to specific environmental and social risks in tropical forest regions in unprecedented detail. It uses publicly available production, trade and customs data to trace the supply chains of deforestation-linked commodities to sub-national production regions. CRR often uses Trase data to conduct sustainability risk analyses for investors focusing on specific case studies on deforestation-related financial risk. Although these currently focus on climate-related financial risk, they will be extended to offer greater depth on biodiversity and nature. Financial institutions can deploy this valuable tool for which investors are specifically the target audience.

[114] CDC Biodiversité (2018): 'Global Biodiversity Score: measuring a company's biodiversity footprint'
[115] https://www.globio.info/
[116] https://trase.earth/
[117] https://chainreactionresearch.com/

A3.4 Forward-looking scenarios

DNB (2020b)[77] assesses two forward-looking scenarios at the asset-level associated with transition risk from financing companies that operate in protected or valuable areas. In these relatively simple scenarios either 24% or 30% of global land and inland water ecosystems are classified as protected areas by 2030. Protected areas are then matched with the locations of 927,000 businesses worldwide using the database compiled by FourTwentySeven to determine which ones are operating in current or future protected areas. The Dutch financial sector's equity investments in these businesses are aggregated, with the DNB finding a total of EUR 15 billion exposure to companies already operating in protected areas which rises to EUR 28 billion in the 30% scenario. See Figure 14.

Figure 14. Exposure of Dutch financial institutions to protected and valuable areas, 2018-IV



Note: The shareholdings and major loans of Dutch financial institutions total EUR 636 billion and data on business locations are available for EUR 389 of this total.
Source: Figure 6 from DNB (2020b): 'Indebted to Nature'

Acknowledgements

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This work was undertaken by Global Canopy and Vivid Economics in support of the Task Force for Nature Related Financial Disclosures (TNFD) and Finance for Biodiversity (F4B) Initiatives. The TNFD initiative is supported by the Foreign, Commonwealth and Development Office (FCDO) with funding specifically provided towards this report. The F4B initiative is supported by the MAVA Foundation and aims to create systemic change across the financial sector by increasing the materiality of biodiversity in financial flows and decision-making.

global canopy :vivideconomics FINANCE FOR BIODIVERSITY Initiative

Company profile

Global Canopy is a data-driven think tank that targets the market forces destroying nature.

We work with partners around the world to mobilise the data needed to make supply chains and finance more transparent and sustainable. Our unique open data platforms unlock opportunities for systemic change - benefiting the climate, biodiversity and people everywhere.

We enable companies, investors and governments to identify their impacts on tropical forests and other vital ecosystems, and to take action accordingly. And by assessing the performance of the key market players, we enable campaigning organisations and the media to hold to account those that are failing to act.

Vivid Economics is a leading strategic economics consultancy with global reach. We strive to create lasting value for our clients, both in government and the private sector, and for society at large.

We are a premier consultant in the policy-commerce interface and resource- and environment- intensive sectors, where we advise on the most critical and complex policy and commercial questions facing clients around the world. The success we bring to our clients reflects a strong partnership culture, solid foundation of skills and analytical assets, and close cooperation with a large network of contacts across key organisations.

Suggested citation
Global Canopy and Vivid Economics (2020): The Case for a Task Force on Nature-related Financial Disclosures.