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SIF SCOPING STUDY:

NATURE-RELATED RISKS IN THE GLOBAL INSURANCE SECTOR

NOVEMBER 2021



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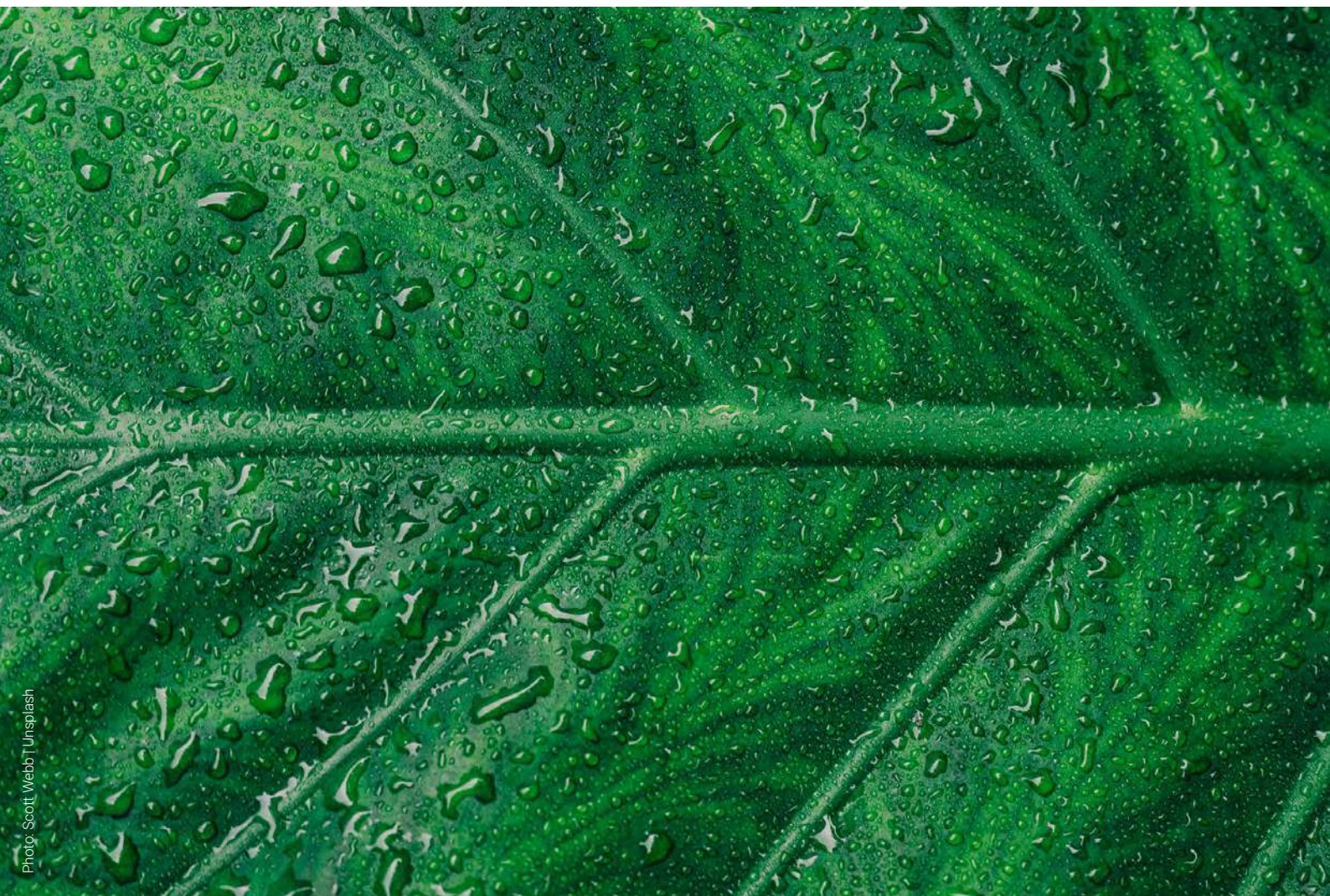
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About this report

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Comments are welcome and should be sent to Mr. Prajwal Baral prajwal.baral@undp.org.

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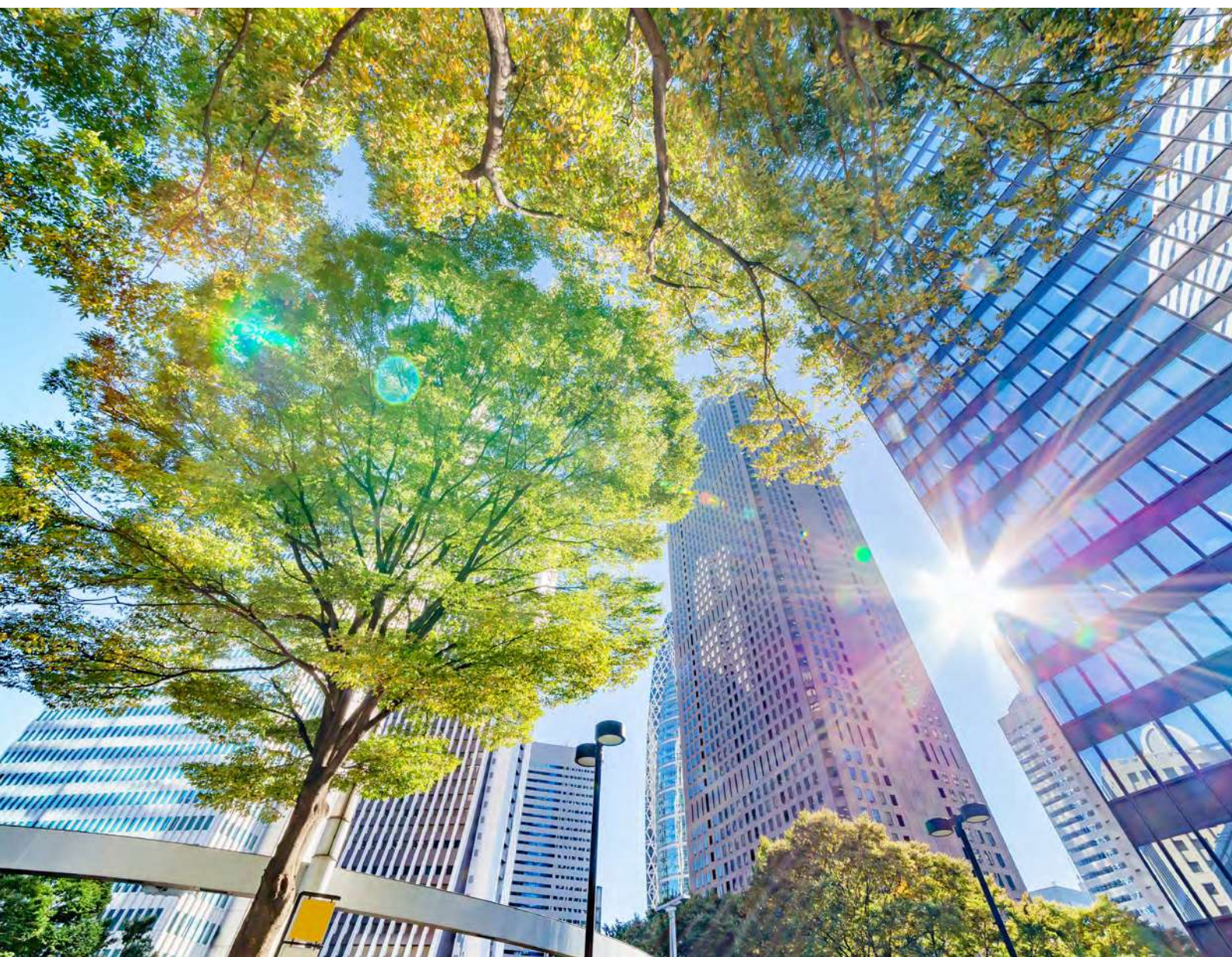
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Abbreviations

BES	Biodiversity and ecosystem services
CBD	United Nations Convention on Biological Diversity
ES	Ecosystem services
ESG	Environmental, social and governance
ETF	Exchange-traded fund
G7	Group of Seven
G20	Group of Twenty
GDP	Gross domestic product
GHG	Greenhouse gas
IAIS	International Association of Insurance Supervisors
IASB	International Accounting Standards Board
IFRS	International Financial Reporting Standards
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
ISSB	International Sustainability Standards Board
IT	Information and technology
L&H	Life and health (Insurance)
NGFS	Central Banks and Supervisors Network for Greening the Financial System
P&C	Property and casualty (Insurance)
SIF	Sustainable Insurance Forum
TCFD	Task Force on Climate-related Financial Disclosures
TNFD	Taskforce on Nature-related Financial Disclosures



Executive Summary

The world's natural capital has been declining globally at rates unprecedented in human history. The global insurance sector is beginning to take a wider view of nature-related risks,¹ expanding beyond climate and natural hazard risks. In 2020, the SIF members agreed to build on existing work by exploring how losses in nature can translate into financial risks for the insurance sector. The SIF Secretariat has produced this report with input from SIF members, experts and industry participants to support insurance supervisors and insurance companies in better understanding and responding to these risks.

Nature loss can manifest into two main types of financial risks for the insurance sector's underwriting and investing business: physical and transition. Physical risks result from the material destruction of natural capital, leading to the disruption to natural services, which in turn leads to financial losses for businesses, insurance companies and other financial institutions. Transition risks include those risks that occur due to global policy, regulatory, economic and market shifts toward a "nature-positive" future.

The effects of nature loss are first transmitted to the real economy at the micro and macro levels, which then manifest into financial risks for the insurance industry. The transmission of micro- and macroeconomic shocks to financial risks for the underwriting and investing business of the insurance sector occurs in the form of insurance, operational, liquidity, market and credit risks. The macroeconomic risks and financial risks resulting from such nature loss can amplify each other.

In principle, as the loss of natural assets increases, associated financial and economic risks could increase in magnitude and frequency, and thus pose potential threats to the safety and soundness of insurance companies and broader financial stability.

Given the infancy in understanding nature-related financial risks, this study has employed a mixed research methodology and a survey of 108 insurance sector participants from 32 countries, 57 percent of whom were insurers and reinsurers, 10 percent insurance industry associations and 5 percent insurance brokers. At the global level, the re/insurance sector's capacity to understand nature-related risks, collect relevant data and design tools to assess these risks is at an early stage of development. The lack of data and information, including relevant methodologies, was the reason most cited by re/insurers for not assessing nature-related risks.

Some re/insurers have started taking steps to develop measurement tools and methods to understand, disclose and respond to these risks. Industry frontrunners, despite the limited availability of uniform metrics and indicators for nature-related risks, have typically used ESG or sustainability frameworks and (very recently), climate change frameworks to incorporate some potential nature-related risks into their assessment, disclosure and management practices.

Building on supervisory and regulatory work on frameworks and processes to supervise climate-related risks, increased supervisory attention is also turning to broader nature-related risks. When nature-related risks are established as material, re/insurance supervisors may wish to develop guidance, recommendations and standards for their regulated entities. This report presents examples of such guidance and recommendations from a range of jurisdictions – Australia, California, Germany, the Netherlands, and Singapore. Similarly, although industry-led, the Taskforce on Nature-related Financial Disclosures (TNFD) has gathered support from several governments and is aiming to develop and test disclosure metrics and methodologies for nature-related financial risks and disseminate those for proposed wider adoption by 2023.

An acceleration in global policy developments to mitigate nature loss could raise expectations that supervisors would act on nature-related financial risks. In June 2021, the G7 leaders agreed to a historic 'Nature Compact', which supports new global targets to protect and conserve at least 30 percent of global land and at least 30 percent of the global oceans by 2030. In July 2021, the G20 Environment Ministers committed to continue and increase their efforts to address the interconnected challenges of nature-related risks and climate change. The upcoming second part of the UN Biodiversity Conference (COP 15) in Kunming is also expected to adopt a "Post-2020 Global Biodiversity Framework" with ambitious targets for increasing protected areas and recognition of nature-based solutions in global climate mitigation efforts.

Recommendations

- To the re/insurance industry:
 - » Continue to identify and build data, analytical tools, forward-looking metrics, and indicators to assess and measure nature-related risks.
 - » Disaggregate asset-level nature-related risks by regions, sub-regions and countries as well as by types of risks.
- To re/insurance supervisors:

¹ The risks related to climate change and natural hazards, together with risks from broader environmental issues such as pollution, desertification and water depletion make up nature-related risks.

- » Deepen understanding and raise awareness of nature-related risks among regulated entities.
- » As a more accurate understanding of nature-related risks to the insurance sector is under way, consider supporting the development of non-prescriptive guidelines, options and tools towards the better assessment and management of forward-looking nature-related financial risks.
- » Consider encouraging regulated entities to undertake voluntary disclosure of nature-related financial risks in incremental steps and complement industry-specific reporting metrics for nature-related risks in the insurance sector, preferably aligning with relevant initiatives by other standard-setting bodies.

Next Steps for the SIF

- Organize webinars to disseminate the finding of this study.
- Develop an online self-learning tutorial on understanding and assessing nature-related financial risks.
- Facilitate supervisor- and industry-led collaborative workshops to discuss challenges as they relate to nature-related financial risks.
- Facilitate, design and develop a survey questionnaire that the supervisors could use to understand how domestically regulated insurers are considering nature-related issues.
- Carry out further research to quantify insurance premium and investment exposure to nature-related risks, which will be done after nature-related risk measurement methodology and metrics are developed.



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BACKGROUND

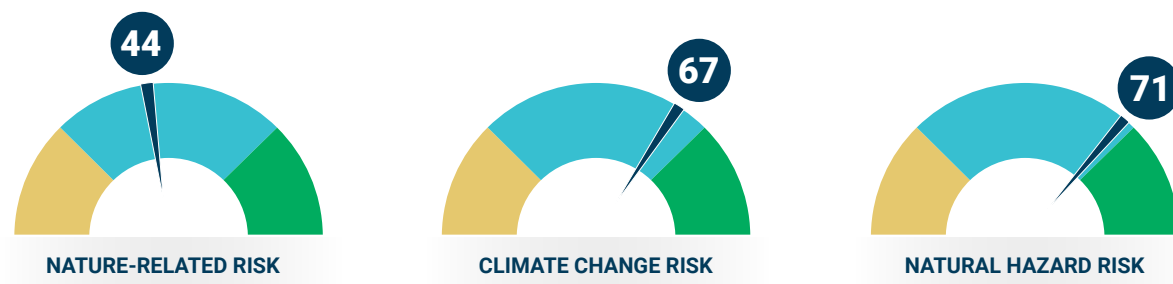


1. Background

1.1 Rationale for and objective of the study

This study marks a pioneering effort to explore and understand the global insurance sector's dependence on nature, what nature-related risks² could be, and whether and how nature-related risks are financially material to the sector's underwriting and investing business. The latest global risk perception survey³ by the World Economic Forum¹ of 35 global risks⁴ ranked human environmental damage and biodiversity loss among the top five risks by likelihood; it also ranked biodiversity loss, natural resources crises and human environmental damage among the top six risks by impact. As this is a relatively nascent area of research compared to climate change, the levels of understanding of nature-related financial risks within the global financial community are uneven, as acknowledged by the Central Banks and Supervisors Network for Greening the Financial System (NGFS).² Due to the perceived urgency of the topic, regulatory work is often concentrated on climate-related risks, sometimes also incorporating environmental risks as a less specific and broader concept. A recent study of 127 European financial companies conducted by the Alliance for Corporate Transparency on the disclosure of environmental and societal risks and impacts pursuant to the European Union (EU) legislation³ found that only 2.2 percent of companies identified specific risks for the use of natural resources, less than 1 percent for polluting discharges, and 2.2 percent for biodiversity and ecosystem conservation compared with 31.9 percent for climate change. This illustrates that while the perception of nature-related financial risks at the global level has increased significantly due to the spotlight thrown by COVID-19 on the link between nature and human health, the actual understanding of what such risks could be and how they could impact corporates and the financial institutions that lend to, invest in and insure these corporates is very low. A recent global survey of the insurance industry conducted by SIF similarly found that the current level of understanding of nature-related risks is the lowest among other related risks such as climate change and natural hazard risks⁵ (see Figure 1).

Figure 1 Insurance industry's current level of understanding of risks in both underwriting and investing business (on a scale of 0 to 100, from left to right)



Source: SIF 2021 Global Survey

² This report uses the term 'nature' to broadly refer to the concepts of natural capital, ecosystem, ecosystem services and biodiversity; further explained in Section 1.3. The terms 'nature-related risks', 'nature loss risks' and 'risks related to nature loss' are synonymous, and have been interchangeably used in parts of the report wherever use of one term gives more clarity than the others. Similarly, the term "environmental risk" is synonymous with "nature-related risk".

³ The survey respondents were 39 percent from business sector, 16 percent from government and the rest from other sectors such as academia, NGO and international organizations. Similarly, 46 percent of respondents were from Europe, 17 percent from North America, 9 percent from East Asia and the Pacific, and the rest from other regions.

⁴ These 35 global risks were (A) Economic (Asset bubble burst in large economies; Collapse of a systemically important industry; Debt crises in large economies; Failure to stabilize price trajectories; Proliferation of illicit economic activity; Prolonged economic stagnation; Severe commodity shocks); (B) Environmental (Biodiversity loss and ecosystem collapse; Climate action failure; Extreme weather events; Human-made environmental damage; Major geophysical disasters; Natural resource crises); (C) Geopolitical (Collapse of a multilateral institution; Fracture of interstate relations; Geopolitization of strategic resources; Interstate conflict; State collapse; Terrorist attacks; Weapons of mass destruction); (D) Societal (Collapse or lack of social security systems; Employment and livelihood crises; Erosion of social cohesion; Failure of public infrastructure; Infectious diseases; Large-scale involuntary migration; Pervasive backlash against science; Severe mental health deterioration; Widespread youth disillusionment); (E) Technological (Adverse outcomes of technological advances; Breakdown of critical information infrastructure; Digital inequality; Digital power concentration; Failure of cybersecurity measures; Failure of technology governance).

⁵ Definitions of the terms 'nature-related risk', 'climate change risk', and 'natural hazard risk' are given in Section 1.3.1. The latter two are subsets of the former. 'Nature-related risk' comprises risks from climate change, natural hazard as well as risks from broader environmental issues such as pollution, stratospheric ozone depletion, etc.

Chapter 1 of the study discusses the central concepts of nature and nature-related financial risks and sets the boundaries for this study. Chapter 2 then extends the discussions in Chapter 1 to the insurance sector and takes a deep dive into the sector's dependency on nature along with risks arising from nature loss and their impacts. Chapter 3 explores the risk management and response strategies adopted or planned by the insurance sector in response to nature-related risks. Finally, Chapter 4 proposes issues that need further deliberation and research.⁶

1.2 Methodology of the study and limitations

The study employs a mixed research methodology – desk research, structured interviews of and consultations with relevant stakeholders (i.e. insurance supervisors and regulators, insurers, reinsurers, insurance brokers, legal professionals, academic researchers, and professionals from not-for-profits, think tanks and international development organizations; see Annex I), and a survey of 108 insurance sector participants from 32 countries⁷ (both developed and developing), hereafter called 'SIF 2021 Global Survey' (surveying insurers, reinsurers, insurance brokers and agents, and insurance associations, among others, see Annex II). The SIF Secretariat conducted this survey, supported by the UN Environment Programme's Principles for Sustainable Insurance (PSI). The survey was open for two weeks in June 2021 and received 108 responses from insurance sector market participants. 57 percent of the respondents were insurers and reinsurers, 10 percent insurance industry associations and 5 percent insurance brokers – a total of 72 percent from the private insurance industry. The remaining were insurance sector professionals and experts from academia, non-governmental organizations (NGOs), regulatory bodies, accounting firms, asset management companies and others.

This study covers property and casualty (P&C) insurance,⁸ and life and health (L&H) insurance⁹ along with reinsurance for P&C and L&H insurance.

Since the current understanding around nature-related financial risks is extremely limited, this study has employed some proxies to get a directional estimate of such risks and these estimates must be interpreted accordingly. Furthermore, data for this study come from several public sources and SIF cannot guarantee their validity. However, SIF has applied its expert judgment in using and contextualizing external data sources.

1.3 Central concepts of nature

Defining nature and nature-related terminologies

Since several terms such as nature, environment, natural capital, natural resources, environmental resources, ecosystem, ecosystem services and biodiversity are interchangeably used in popular literature, fora and the media, it can often complicate communication among various stakeholders. Figure 2, therefore, simplifies the understanding of these terms by taking 'nature' or 'environment' as an all-encompassing term for everything natural. Below are streamlined definitions of each of these widely used terms. In Annex III, the most commonly used scientific definitions of these terms are also presented for a more thorough understanding.

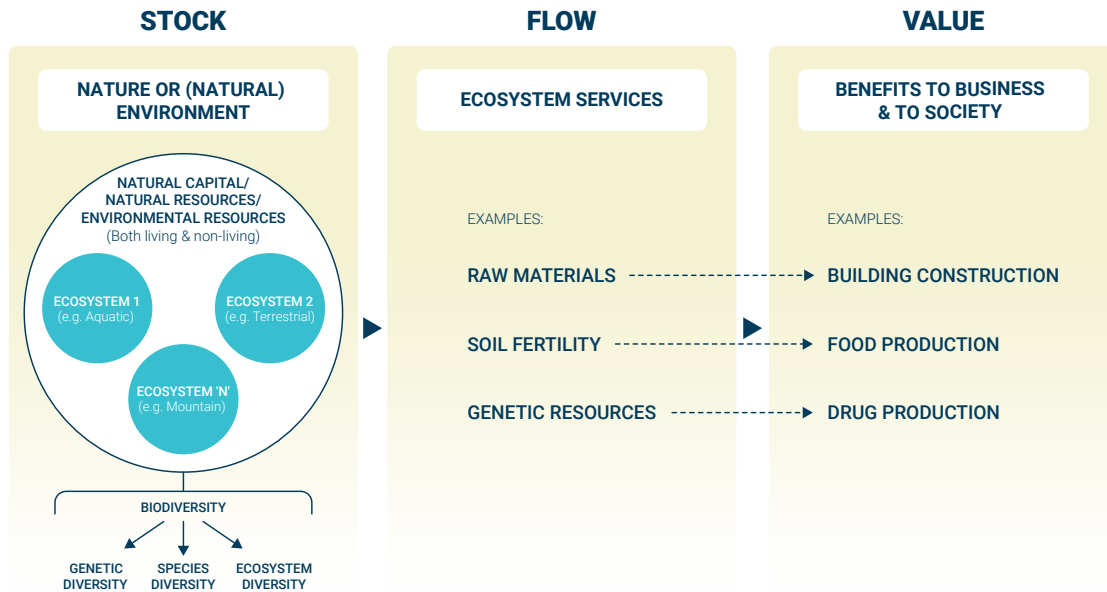
6 The annexes provide more details on several topics and annexes describe the interviewees and experts consulted; the survey questionnaire; nature-related terminologies, natural capital and ecosystem services; key characteristics of the global insurance industry; an assessment of nature-related physical risks to various economic sectors; and methodology adopted for determining physical risks to economic sectors.

7 Europe (14); South-east Asia (6); Latin America and the Caribbean (4); Africa (3); South Asia and the Pacific (2); North America (2); Middle East (1)

8 The term "property and casualty (P&C)" is more commonly used in the United States while in many other parts of the world, it is also called "general" or "non-life" insurance. Property insurance provides protection coverage against most risks to property such as fire, smoke, explosion, vandalism and theft, and weather-related damages. Popular policies under property insurance include, among others, homeowner's insurance, condo insurance, auto insurance, renter's insurance, landlord insurance and flood insurance. Casualty insurance typically offers liability coverage to an individual or organization for negligent acts or omissions. Liability losses are losses that occur as a result of the insured's interactions with others or their property. It covers losses stemming from accidents, injuries and damage to other people or their belongings (for example, auto accident insurance, event cancellation insurance, travel insurance, workers' compensation insurance, business interruption insurance, trade credit insurance and fidelity insurance).

9 Life insurance offers coverage for the risk of loss of life, where the insurer promises to pay a designated beneficiary a sum of money upon the death of an insured person. Some life insurance contracts trigger payment in events of terminal or critical illness as well. Life insurers also offer investment products such as annuities. Health insurance provides coverage for medical expenses related to illness or injuries. Under the OECD classification of insurance activities, health/accident and sickness insurance are classified as non-life businesses. In this report, non-life or P&C insurance does not include health insurance.

Figure 2 **Conceptual framework for defining the concepts of natural capital, ecosystem, biodiversity, nature, and ecosystem services**



Source: adapted from Capitals Coalition and Cambridge Conservation Initiative, 2020⁴

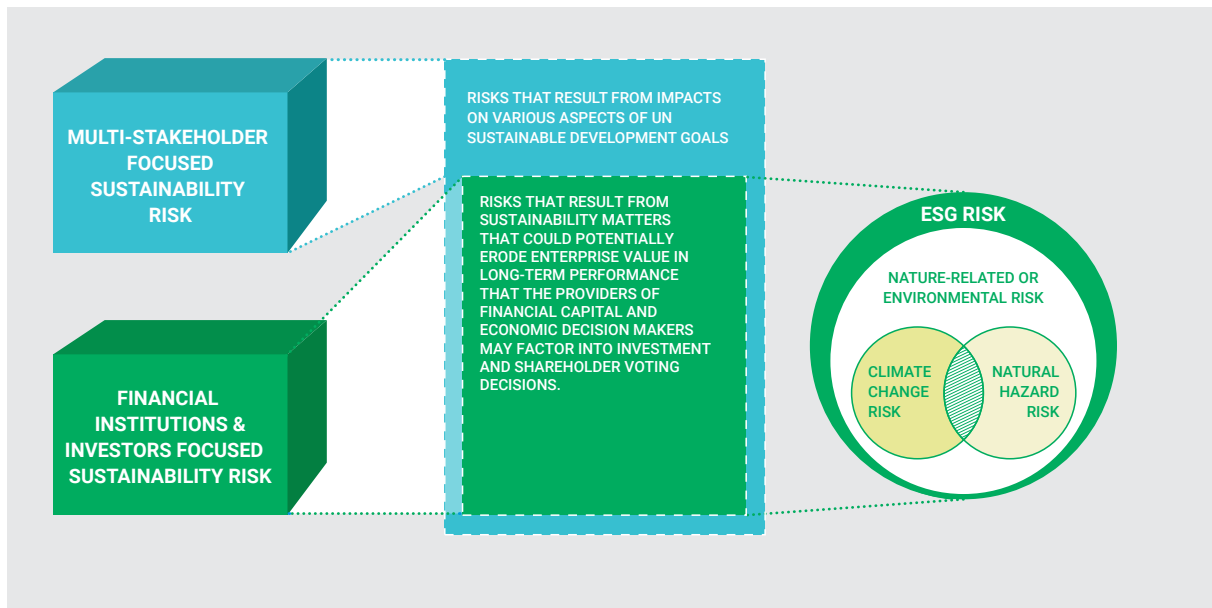
It is common among international development practitioners and the financial community to use the terms 'environment', 'nature', 'biodiversity' and 'ecosystem' interchangeably. The Taskforce on Nature-related Financial Disclosures (TNFD),⁵ launched in 2020, uses the term "nature" and "nature-related" (adopted by this report) and aims at developing a framework for corporates and financial institutions to assess, manage and report on their dependencies and impacts on nature, aiding in the appraisal of nature-related risk and the redirection of global financial flows away from nature-negative outcomes and towards nature-positive, or at least nature-neutral, outcomes. The term 'biodiversity' is used by the NGFS and the International Network for Sustainable Financial Policy Insights, Research, and Exchange (INSPIRE), who jointly announced the launch of a study group on biodiversity and financial stability⁶ in April 2021. In addition, in the recent Dasgupta Review on the Economics of Biodiversity,⁷ terms such as 'nature', 'natural capital', 'natural environment', 'biosphere' and 'natural world' are used interchangeably. While different initiatives use different terms, the end objective in all cases is to understand risks emanating from environmental degradation and deterioration and their impacts on the economy and the society. With this acknowledgement, this report uses the term 'nature' to broadly refer to the concepts of natural capital, ecosystem, ecosystem services and biodiversity.⁸ Wherever needed, specific terms will be used for better clarity.

1.3.1 Framing nature-related risks in the context of ESG and broader sustainability risks

A useful framework to analyse the various kinds of risks is presented in Figure 3. This framing is not intended to establish one layer as more or less important than any other. Since the financial industry is conversant with sustainability and environmental, social and governance (ESG) concepts, the attempt here is to illustrate where nature-related risks fit within the industry's current understanding of broader risks. Care must be taken to assess the relative importance/weighting of E, S, G, and other categories such as the broader Sustainable Development Goals (SDGs) when looking at potential risks for a company or the industry.

Sustainability risk in a broader and multi-stakeholder sense comprises risk arising from impacts on one or several aspects of the SDGs. Sustainable development has been defined most frequently as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".⁹ As such, sustainability is a broader concept which incorporates evolving societal and stakeholders' expectations. ESG risks form a subset of the multi-stakeholder definition of sustainability risks, and comprise information that investors and other providers of financial capital require to identify sustainability factors that are material to short-, medium- and long-term enterprise value.

Figure 3 Framework to understand nature-related risks vis-à-vis ESG and sustainability risk



Source: Adapted from International Federation of Accountants, 2021¹⁰ and UN Environment, 2016¹¹

ESG is the most commonly used framework by financial institutions and authorities. Below the ESG layer comes nature-related or environmental risks. Nature affects E and S, and one needs strong G to deal with the E and S. Most existing ESG frameworks in the market, under the component “E”, already include nature-related elements to varying extents. For example, the European Framework, as specified in the European Banking Authority’s 2021 report on management and supervision of ESG risks for credit institutions and investment firms¹² includes water, air, soil pollutants, biodiversity and protection of healthy ecosystems, waste management, land degradation, desertification, soil sealing, water use and management, energy use and efficiency, and greenhouse gas (GHG) emissions. Similarly, some international frameworks¹³ even include innovation in environment-friendly products and services under “E”.

The innermost layer consists of climate change- and natural hazard-related risks, which together with risks from broader environmental issues such as pollution, desertification, water depletion, etc. make up “nature-related risks”.

- Climate change risk: The United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.”¹⁴ Risk induced by climate change is defined as climate change risk.
- Natural hazard risk: This refers to risk from hazards that are due to natural variability (i.e. not human-induced). Examples of natural hazards include geologic hazards (earthquakes, tsunamis, volcanic eruptions, landslides, floods), atmospheric hazards (tropical cyclones, tornadoes, droughts, severe thunderstorms, lightning), and other hazards (insect infestations, naturally occurring wildfires). The variability in nature is a regular and normal phenomenon (e.g. natural cycles of droughts), but climate change has increased the frequency and intensity of natural hazards. This is the reason some natural hazards overlap with climate change-induced events.
- Nature-related risk: A decline in the quantity and quality of nature (i.e. biodiversity/nature loss), hence resulting in the decline in the provision of ecosystem services is nature loss. Examples of this include reductions in the quality of the air and local climate, reduced water security, and reduced pollination. Risk because of such nature loss is termed in this report as “nature-related risk”.

There are varying degrees of overlaps and feedback loops among climate change, natural hazard and broader nature-related risks, which are discussed in the following section.

1.3.2 Relationship among climate change, natural hazard, and broader nature-related risks

First, the overlap between climate change and natural hazard risks is large – the risks in the innermost layer of the framework in Figure 3. There is strong evidence that human-caused climate change has increased the likelihood and intensity of weather-related natural hazards, including droughts, fires and floods.¹⁵ These extreme weather events will continue to worsen if no strong action is taken to curb climate change.

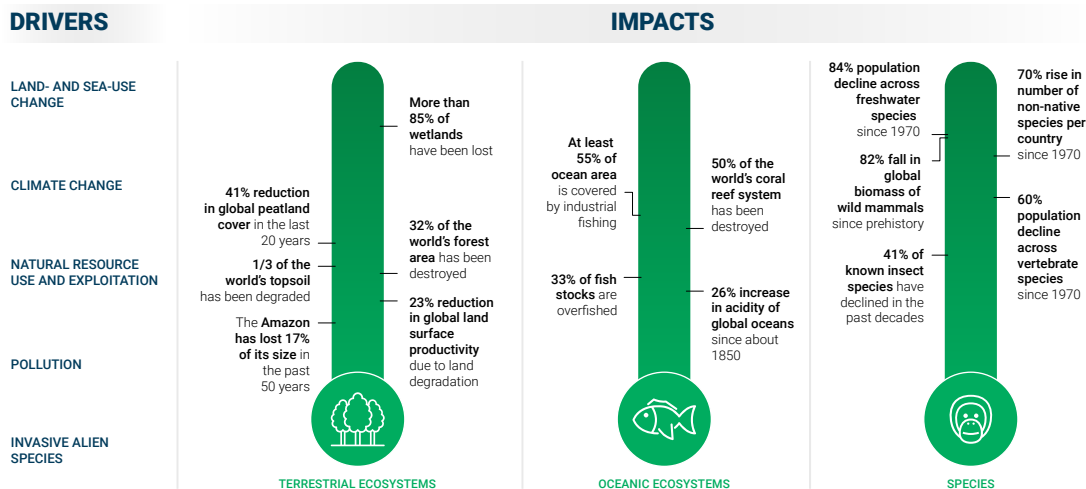
Second, there is also a close relationship between climate change and broader nature-related risks such as the deterioration of air, water and soil quality, the degradation of forests, the depletion of fish stocks and seagrasses in oceans. On the one hand, climate change is both a driver and amplifier of nature-related risks. For example, the absorption of excess carbon dioxide (CO₂) by oceans has increased their temperature and acidity, making it difficult for many marine species such as shellfish to form their calcium shells. As a result, many such species at the bottom of marine food chains are disappearing, with negative impacts on the growth and distribution of fish stock higher up in the food chain. On the other hand, nature loss could also become a driver and amplifier of climate change. For example, the destruction of marine life in the oceans leads to a decrease in the capacity of oceans to sequester CO₂ from the atmosphere, hence accelerating global warming. The destruction of marshes, mangroves and seagrasses alone releases an estimated 0.15–1.02 billion tonnes of CO₂ per year – equivalent to 3–19 percent of emissions from global deforestation.¹⁶ The Amazon rainforest, which has served as a carbon sink for centuries, has now turned into a net emitter of CO₂ due to logging for soy and beef as well as mining for gold and mercury.¹⁷ Another illustration of a linkage and feedback loop between climate change and nature loss is soil erosion.¹⁸ On the one hand, soil erosion triggers the release of carbon from organic soils into the atmosphere – hence contributing to climate change, which might lead to more soil erosion through an increase in extreme events such as floods and droughts. On the other hand, soil erosion leads to a loss of nutrients and soil moisture that reduces the structural diversity of the vegetation cover, which could lead to reduced soil conservation and hence more soil erosion.

It is important to recognize the self-reinforcing feedback loops between nature loss and climate change. As such, talking about climate change in isolation misses the complete picture.

1.4 Current state of nature

According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)'s global assessment on biodiversity and ecosystem services,¹⁹ 90 percent of nature loss in the past 50 years can be attributed to five direct drivers: land- and sea-use change, climate change, natural resource use and exploitation, pollution and invasive alien species. Figure 4 illustrates these drivers and the major impacts on nature.

Figure 4 Drivers and status of nature loss across different ecosystems



Source: WEF, 2020²⁰ with updates from WWF, 2020²¹ and IPBES, 2019²²

The drivers of nature loss across different ecosystems include:

Land- and sea-use change: As per IPBES (2019), 75 percent of the total land surface and 40 percent of the ocean area are severely altered because of the expansion of agricultural land as well as the increase in cattle ranching, fisheries and aquaculture. The impacts of land use change are most severe in tropical and subtropical savannas and grasslands, and are associated with increased soil degradation, including soil erosion, acidification and salinity – directly affecting land surface productivity.

Climate change: Global climate change has caused long-term geophysical and biological changes in nature. These include, increased precipitation in tropical areas and decreased precipitation in subtropical areas, increased frequencies and intensities of extreme events, and faster than normal warming of land and oceans. These have directly altered land and marine productivity, and increased damages to property, infrastructure, livelihoods and service provision.

Natural resource use and exploitation: The extraction of living and non-living materials has increased considerably, mainly for use in construction, agriculture, fishery, forestry and mining. Such overexploitation has cascading effects, manifested as biodiversity loss, freshwater depletion and climate change, seen most prominently in tropical forests, marine, coastal and polar ecosystems. The unsustainable extraction and use of these resources have also caused land- and sea-use change, hence further amplifying nature loss.

Pollution: The industrial and agricultural runoffs, dumping of waste and toxic compounds in rivers, lakes and oceans, and increasing particulate matter in air due to industrial and transportation emissions have led to unprecedented levels of air, water and land pollution. These have caused loss of nature in most ecosystems. In coastal waters, for example, nutrient runoff from fertilizers applied to agricultural land has stimulated excessive algae growth that depletes oxygen levels and blocks sunlight from underwater plants. Some algal blooms are harmful to people due to elevated levels of toxins and bacterial growth. The resultant aquatic hypoxia (“dead zones”) can devastate the primary and secondary productivity of marine lives. Similarly, plastic fragments in waste dumped into water or land are ingested by fish, birds and other animals, leading to their untimely death, disturbance of the natural food pyramid and the introduction of microplastics into human food chains via trophic transfer.

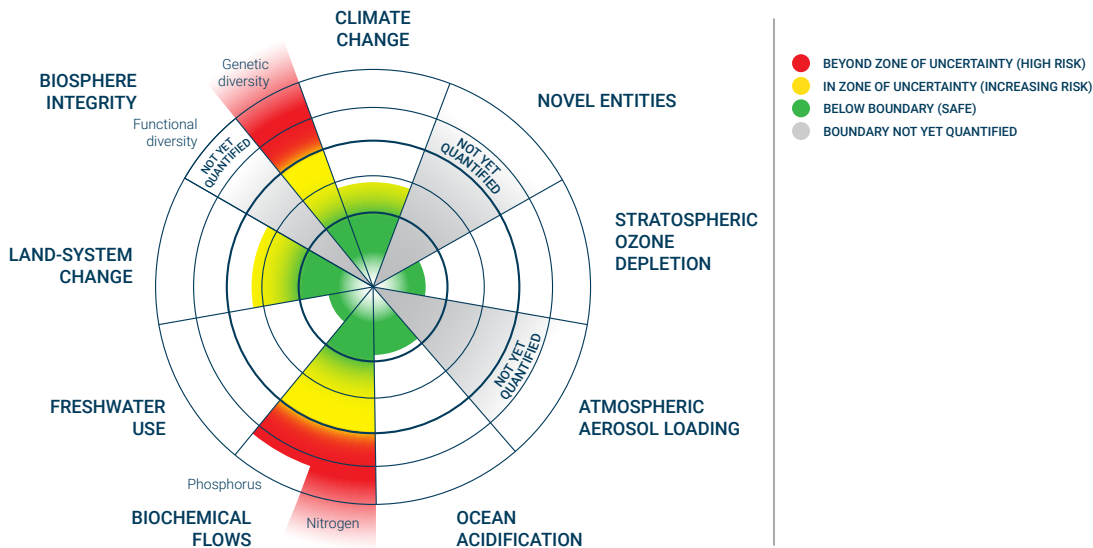
Invasive alien species: IPBES (2019) estimates that non-native species have increased by 70 percent in the last 50 years, and their rates of invasion on native species and ecosystem services have also risen. The introduction of alien species is further aggravated by increased trade and transport and accelerated climate change. The invasion by alien species has caused extinction of local species that are important to maintain ecosystem functions.

According to a 2021 analysis by Environmental Business International (EBI),²³ out of US\$38 quadrillion²⁴ of the Earth’s economic value, US\$5 quadrillion has already been damaged by humans, mostly through continued deforestation and atmospheric pollution. This alarming level of nature loss is equivalent to 60 times the current global gross domestic product (GDP).

1.4.1 Why it is time to move beyond climate change envelope and start assessing nature-related risks

In 2009, Rockström *et al.*²⁵ published a landmark study proposing a framework for the Earth system called planetary boundaries within which humanity can continue to develop and thrive for generations to come. The authors used the Holocene – the last 10,000 years of the period of stability where the planet’s environment was unusually stable – as a reference point. During the Holocene, environmental changes occurred naturally within the Earth’s regulatory capacity. However, since the Industrial Revolution, human activities have driven a global environmental change, pushing the Earth system outside the stable environmental state of the Holocene, hence exceeding planetary boundaries of some of the nine control variables that the authors identified in Figure 5.

Figure 5 Current global status of the control variables for seven of the nine planetary boundaries



Source: Steffen *et al.*, 2015²⁶

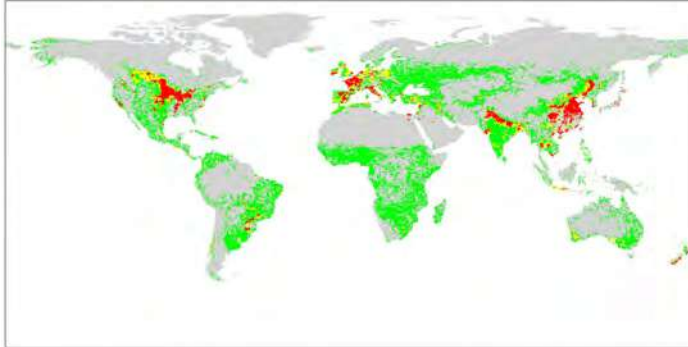
In an updated and extended analysis of the original planetary boundary framework, Steffen *et al.* (2015) found that anthropogenic perturbation levels of four of the Earth system processes/features (climate change, biosphere integrity, biogeochemical flows and land-system change) have already exceeded the proposed planetary boundary. Two more – stratospheric ozone depletion and ocean acidification – are also close to crossing the safe boundary.

The global business and financial community, including the insurance sector, therefore urgently needs to understand nature-related risks rather than limit their risk horizon to climate and natural hazard risks only. Chapter 1.4 has already established that we have entered an era of “ecological emergency”, which could be bigger than “climate emergency” by an order of magnitude. One estimate shows that only 11–16 percent of biodiversity loss is currently attributable to climate change.²⁷

In a further sub-global level analysis (see Figure 6), Steffen *et al.* (2015) found that some control variables that indicate a safe operating space at the global level have already been exceeded in many parts of the world.

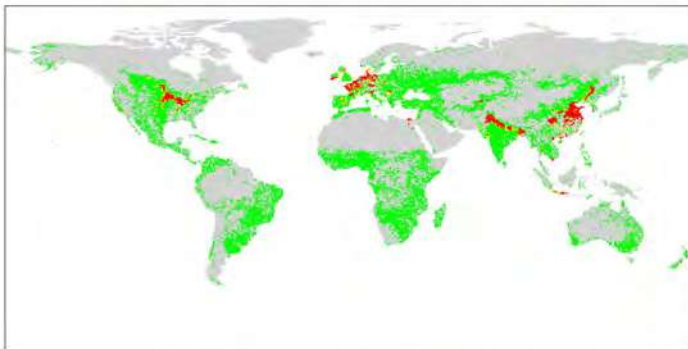
Figure 6 Sub-global distributions and current status of the control variables for biogeochemical flows of phosphorus and nitrogen, land-system change and freshwater use

A Phosphorus

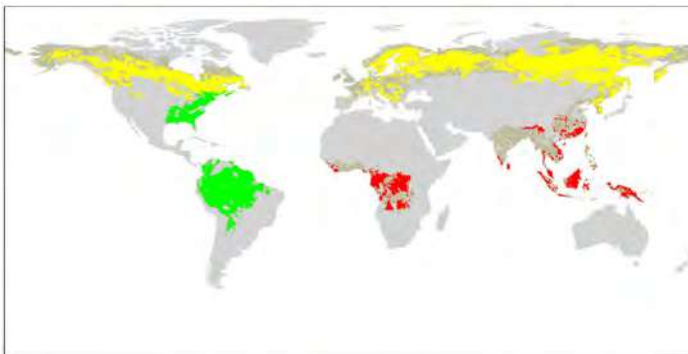


- Beyond zone of uncertainty (high risk)
- In zone of uncertainty (increasing risk)
- Below boundary (safe)

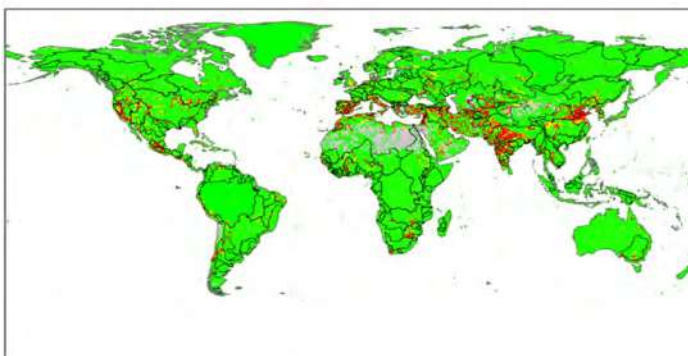
B Nitrogen



C Land-system change



D Freshwater use

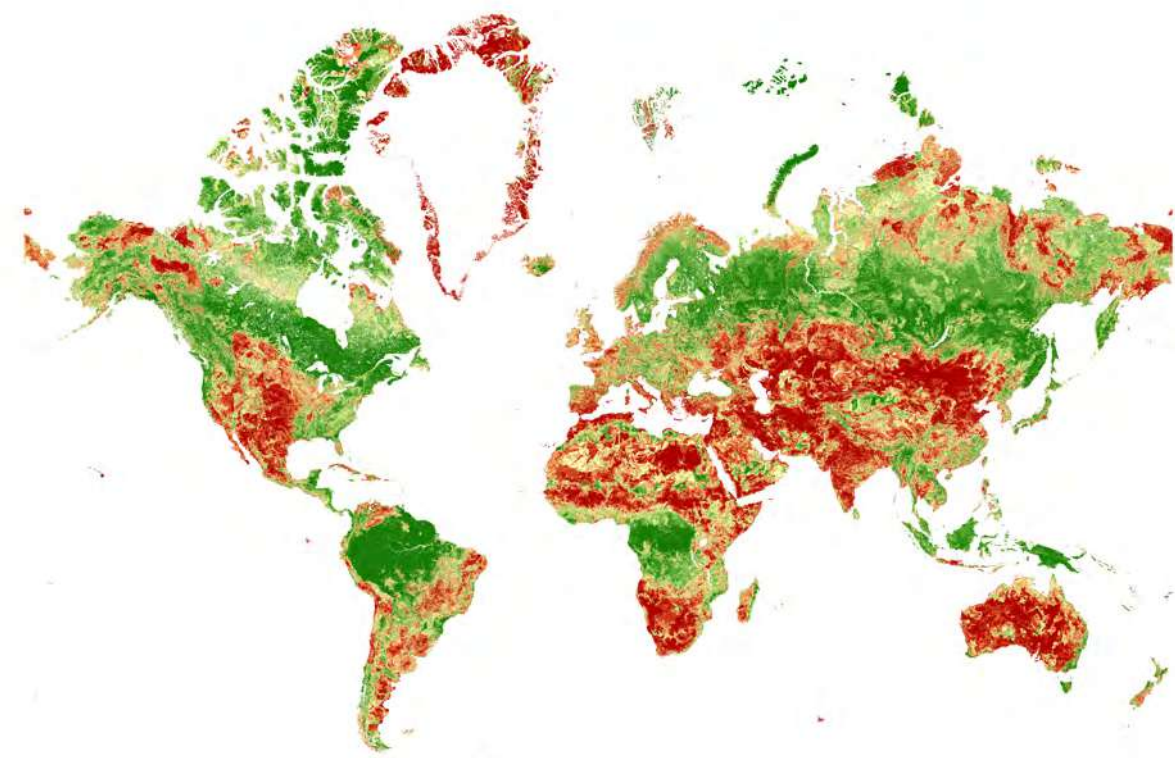


Note: Grey areas in (A) and (B) are areas where P and N fertilizers are not applied; in (C), they are areas not covered by major forest biomes; and in (D), they are areas where river flow is very low so that environmental flows are not allocated.

Source: Steffen et al., 2015²⁸

For localized analysis, the Swiss Re Institute has identified ten ecosystem services (ES)¹⁰ that are relevant to insurance business and developed a biodiversity and ecosystem services (BES) index²⁹ by aggregating those ten ES. The index provides a visualization of the state of ecosystem services for every square kilometre on Earth (see Figure 7) and shows wide disparities across the globe (red indicating areas where BES are comparatively fragile).

Figure 7 Global Swiss Re Institute biodiversity and ecosystem services index map at 1 km² resolution



Biodiversity & Ecosystem Services (BES) Index



Source: Swiss Re Institute, 2020³⁰

Figures 6 and 7 illustrate that the balance sheets of companies in different parts of the world might be differently exposed to nature-related risks. Hence, depending on each company's resources as well as data and information availability, regional, national, and local level risk analysis can be carried out to gain a thorough understanding of the landscape of nature loss and potential risks and impacts originating from such loss.

¹⁰ These ecosystem services focus on "terrestrial ecosystems" only and include (1) habitat intactness; (2) pollination; (3) air quality & local climate; (4) water security; (5) water quality; (6) soil fertility; (7) erosion control; (8) coastal protection; (9) food provision; and (10) timber provision.

2

GLOBAL INSURANCE INDUSTRY: NATURE-RELATED DEPENDENCIES, RISKS AND IMPACTS



2. Global insurance industry: nature-related dependencies, risks and impacts

2.1 Key characteristics of the global insurance industry

The global insurance industry can be broadly divided into three lines – life, property and casualty, and health. Key financial characteristics of both underwriting and investing businesses are discussed in Annex V.

2.1.1 Underwriting

The global insurance premiums written in 2019 amounted to US\$6 trillion, including the reinsurance industry.³¹ As illustrated by Figure 24 in Annex V, North America and Western Europe comprised about 66 percent of the global total, followed by Asia-Pacific (28 percent), Latin America, the Middle East, Eastern Europe and Africa (jointly a total of about 6 percent). However, developing Asia-Pacific countries had the fastest growth of premiums across all insurance lines, most prominently in health.

An initial estimate by the author found that the total global P&C insurance premium is distributed among 18 economic sectors,¹¹ as illustrated by Figure 25 in Annex V. When combined with global health insurance (i.e. P&C plus health insurance), the business sector contributing the most to global insurance premium is pharmaceutical, healthcare, life sciences and biotechnology, followed by the automotive or motor sector.

2.1.2 Investing

The global insurance industry is one of the largest groups of institutional investors, holding about US\$33 trillion of financial assets.³² These assets are mostly exposed to bonds (corporate and sovereign/municipal) or other fixed income securities and stocks. Mortgage loans on real estate and real estate constitute two other important areas of investment for the insurers, more so for L&H than P&C. The overall exposure of the insurance investment to economic sectors is illustrated by Figure 26 in Annex V. The highest exposure is to financial services followed by real estate; telecom, IT, media, and entertainment; utilities; and pharmaceutical, healthcare, life sciences and biotechnology.

2.2 Dependency of economic sectors on nature and risks from nature loss

The economic value of global ecosystem services is estimated at US\$160–180 trillion per year,³³ which is almost twice the size of global GDP. According to the World Economic Forum³⁴ and as further reassessed by Swiss Re Institute,³⁵ 55 percent of the world's GDP, or nearly US\$50 trillion, is moderately or highly dependent on nature and its services.¹² However, there is little research on individual economic sectors' dependency on nature – the very sectors that are either insured by or form part of the investment portfolio of the global insurance industry. Based on Figures 25 and 26, and a global survey conducted by SIF, the underwriting and investing activities of the insurance sector are predominantly concentrated in 17 economic sectors¹³ that are dependent on nature to varying degrees. Figure 8 illustrates the potential dependency of these economic sectors on various ecosystem services¹⁴ and natural capital using the Natural Capital Finance Alliance's ENCORE database. This assessment also aligns with results from similar dependency exercises conducted by Swiss Re Institute³⁶ and the World Economic Forum.³⁷

Annex VI elaborates on each economic sector's level of potential dependency on various ecosystem services and assigns nature-related physical risk level to each economic sector. The level of nature-related physical risk is derived using the framework for planetary boundaries in Figure 5 and in consultation with experts in nature and biodiversity. The risk level is assigned by mapping the potential dependency with the level of nature loss, whose methodology is further explained in Annex VII.

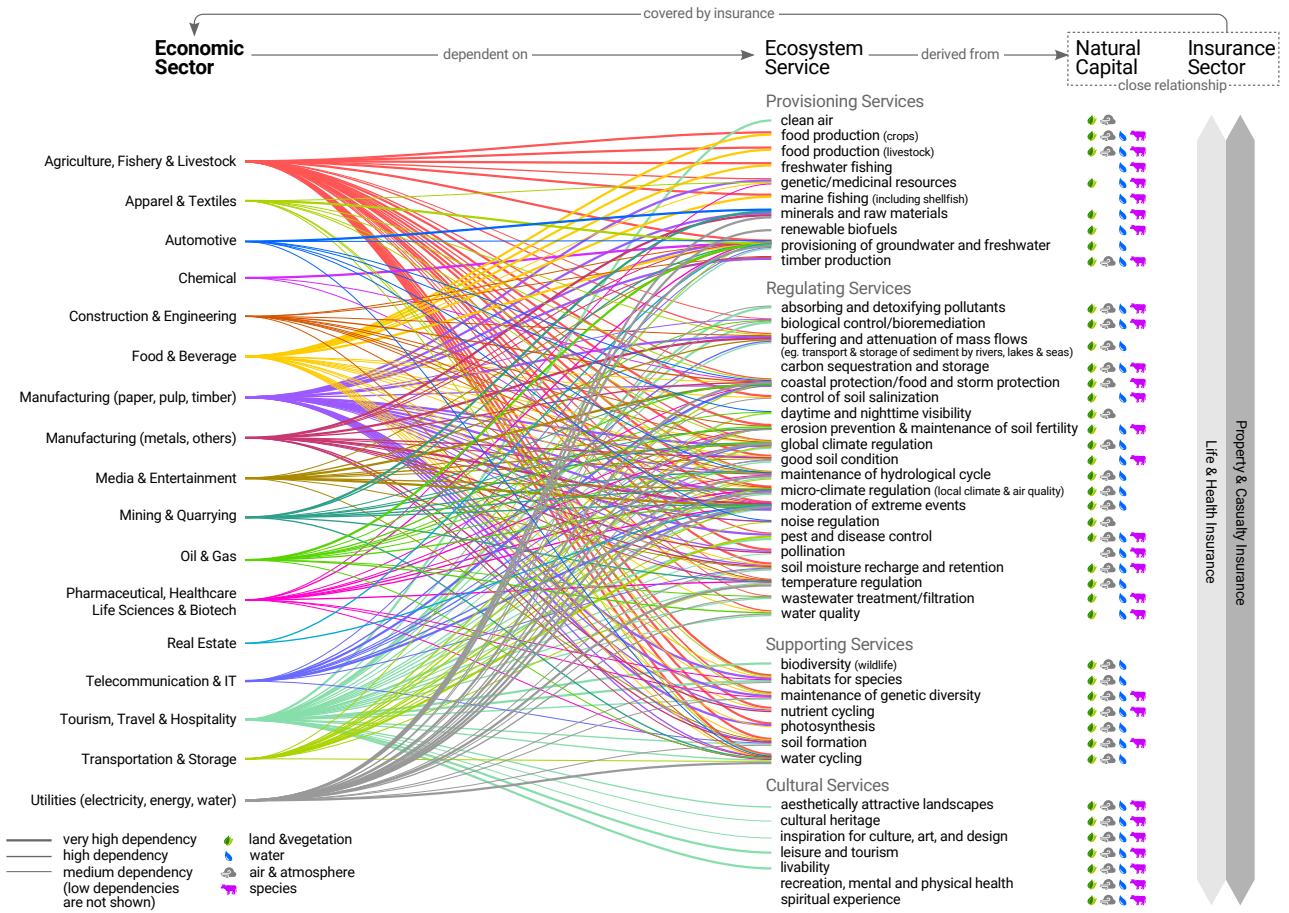
11 These sectors are: (1) agriculture, fishery & livestock; (2) apparel (clothing, footwear, etc.) & textiles; (3) automotive; (4) chemical (excluding pharmaceuticals); (5) construction & engineering; (6) financial services; (7) food & beverage; (8) manufacturing (paper, pulp, timber); (9) manufacturing (others; e.g. metals); (10) media & entertainment; (11) mining & quarrying; (12) oil & gas; (13) pharmaceutical, healthcare, lifesciences & biotech; (14) real estate/home; (15) telecommunications & IT; (16) tourism, travel & hospitality; (17) transportation & storage; (18) utilities (electricity, energy, water).

12 29 percent highly dependent and 26 percent moderately dependent.

13 Financial services excluded because financial services contribute to functioning of rest of the other sectors in the economy.

14 The list of ecosystem services derived from natural capital stocks is given in Annex IV.

Figure 8 Inter-relationship among business sectors, ecosystem services, natural capital stocks and insurance industry

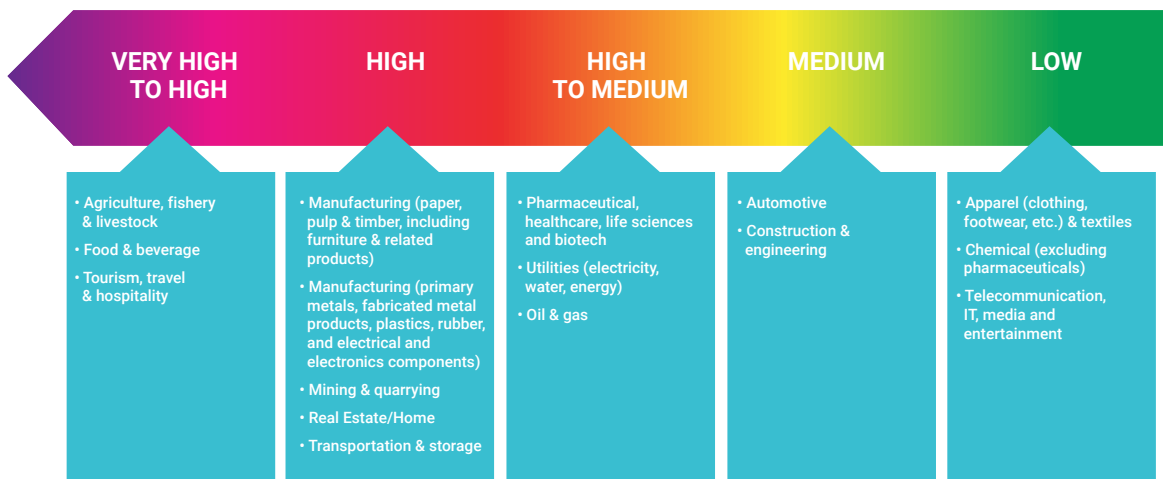


Source: WEF, 2020³⁸ NCF, 2021³⁹ Watson and Newton, 2018⁴⁰

2.2.1 Nature-related physical risks to business sectors

Based on an extensive analysis shown in Annex VI, Figure 9 illustrates the level of nature-related physical risks in several business sectors. The physical risk levels in this report also align with a recent assessment of environmental exposure of several business sectors,⁴¹ conducted by Allianz Global Corporate & Specialty.

Figure 9 Nature-related physical risks to business sectors



2.2.2 Moving beyond physical risks: transition risks to economic sectors

Transition risks encompass those that arise as a result of the global governmental and economic shift towards a nature-positive or nature-neutral future. When businesses negatively impact the natural functioning of ecosystem services and affect the broader society and the economy, they are more exposed to transition risks than the businesses with a negligible, low or even positive impact (e.g. ecotourism) on ecosystem services. The drivers for transition risks include: changes in policy and regulation; shifts in consumer behaviour; reduced demand for products and services; increased cost of research and development to design and develop products responding to new market preferences; changes in legal landscape (liability and litigation risks); and reputational damage caused by failure to address and adapt to the changes mentioned above. The bigger and more catastrophic the *expected* physical risks are, the stronger these drivers get, causing increased transition risks. The various transition risks are discussed below.

Stronger global and national nature-related targets

Globally, there is an increasing recognition of the planetary emergency and hence a push to have an international deal for nature, similar to the 2015 Paris Climate Agreement. In June 2021, the G7 leaders agreed to a historic ‘Nature Compact’,⁴² which supports new global targets to protect and conserve at least 30 percent of global land and at least 30 percent of global oceans by 2030. In addition, the leaders agreed to ‘lead by example, effectively conserving or protecting at least the same percentage of their national land, including terrestrial and inland waters, and coastal and marine areas by 2030, according to national circumstances and approaches, including, where appropriate, with legislation and adequate resourcing and enforcement to drive delivery’.⁴³ In 2019, the United Nations General Assembly also declared 2021–2030 the UN Decade on Ecosystem Restoration,⁴⁴ following a proposal for action by over 70 countries. The upcoming second part of the UN Biodiversity Conference (COP 15) in Kunming in April 2022 is also expected⁴⁵ to adopt a “Post-2020 Global Biodiversity Framework” with ambitious targets for increasing protected areas and a recognition of nature-based solutions in global climate mitigation efforts.

Similarly, on a national level, 192 of the 196 Parties to the CBD¹⁵ have submitted their National Biodiversity Strategies and Action Plans (NBSAPs).

Given that only 16.64 percent of terrestrial and inland water areas and 18.1 percent of marine areas are globally covered as protected or conservation areas,⁴⁶ global targets to increase such areas considerably could pose transition risks to businesses operating in or benefiting from those areas. Sectors such as mining, agriculture, fishing, timber and non-renewable energy could be impacted in the short term and negatively impact local economic activity. The impacts could come in the form of compliance and maintenance costs to operate in or near the protected areas or loss of profits resulting from the banning of activities in or near those areas or the stranding of assets located in those areas. However, given that local economic activity could be strengthened by diversifying businesses or avoiding future losses by investing in natural infrastructure, decreased activity in some resource extraction industries could provide for more stable local economic activity in the long term.

Change in policy and regulation

As nature loss has recently gained global attention partly due to COVID-19 and the spate of wildfires across the United States of America, Siberia, Australia, the Amazon, etc., it is likely that countries around the world will enact more and enhanced policy and regulatory measures to conserve and restore nature and increase sustainable practices. These measures could come in the form of new standards for air and water quality, green taxes on water, land and other natural resources, moratoriums on new permits to operate in certain areas, licensing and permitting procedures with higher environmental standards, enforcement of payment for cleanup or compensation cost in case of environmental damage, and restrictions on or limited access to natural resources.⁴⁷ Such measures could increase the cost of operations and, in extreme cases, completely or partially shut down certain businesses. The latter could also generate stranded assets along the way. For example, land use regulations such as the implementation of land-clearing controls could prevent grazing or cropping activities, hence negatively affecting the market value of farmland – a potential driver of asset stranding.⁴⁸ Stranding risks could affect several actors along the supply chain, from farmers to food processing companies and consumer companies. Another example is the EU Biodiversity Strategy⁴⁹ that mandates at least 25 percent of the EU’s agricultural land to be farmed organically by 2030, which can materially impact the business and cost structure of chemical companies but also support a more sustainable farming sector for the long term.

Shifting consumer behaviour

The transition risk is immediate for consumer-facing sectors such as automobile, apparel, and food and beverage. 81 percent of the respondents in a global consumer confidence survey⁵⁰ felt strongly that companies should help improve the environment and were extremely or very concerned about environmental issues such as air/water pollution, packaging/food waste, water shortages and pesticides use in agriculture. Demand patterns in these markets are beginning to reflect these changes in consumer preferences. For example, a 2019 study by Kantar UK⁵¹ found that 77 percent of British grocery shoppers switched, avoided or boycotted buying certain products based on environmental policies of the brands.

¹⁵ Note that the United States is the only country that has not yet ratified the agreement.

Increased research and development cost for transition technology and business models

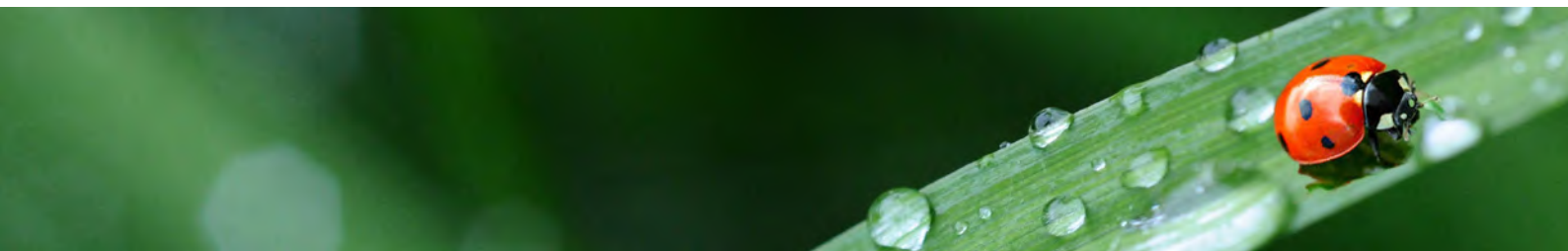
As natural resources become scarce, consumer preferences change and environmental regulations proliferate, business sectors are compelled to look for alternatives that are resource-efficient and environmentally friendly. This will likely necessitate increased research and development expenditure for companies. Although certain businesses may eventually⁵² recoup such expenditure through increased production efficiency and reduced input costs, this will likely hit the balance sheets of the companies in the short to medium term. Similarly, the emergence of innovative companies as a response to growing environmentalism could displace business-as-usual companies from the market. For example, plant-based meat companies are growing much faster than traditional meat companies,⁵³ as customers are increasingly concerned about the large-scale deforestation caused by cattle ranching and soy-based animal feed.

Changing liability landscape

Businesses are increasingly finding that the scope of what is traditionally considered environmental damage has been expanding in recent years and falls out of standard commercial general liability policies. The magnitude of nature-related liability risks depends on the unique characteristics of the legal framework and economy within which the business operates.⁵⁴ Nature-related liability risks are also broader than litigation, and unlike litigation, are not confined to court orders for damages. This is an important distinction because liability risks affect actors in the economy beyond the direct claimants and defendants, through, for instance, regulatory fines or a determination outside the courtroom of who is legally responsible.⁵⁵ The claimants could go beyond prevailing or additional 'environmental' or 'conservation' laws and utilize causes of action under a broad range of prevailing commercial and administrative laws.⁵⁶ For example, a claim of breach of fiduciary or statutory duty could be brought (by shareholders or creditors) against the directors of a company if the company's business model depends on ecosystem services and suffers financial losses as a result of physical or transition risks associated with unmanaged and unmitigated deterioration of ecosystem services.⁵⁷ In a similar vein, a claim could be brought against a company (e.g. an automobile company) for being unable to manage the foreseeable consequences of nature-related loss (e.g. supply chain disruption of metals due to water scarcity at a mine location).⁵⁸

In 2020, at the request of Swedish parliamentarians, the Stop Ecocide Foundation⁵⁹ launched a project to draw up a legal definition of "ecocide" as a potential international crime that could sit alongside war crimes, genocide and crimes against humanity. A draft law was unveiled in June 2021, which defines ecocide as "*unlawful or wanton acts committed with knowledge that there is a substantial likelihood of severe and widespread or long-term damage to the environment being caused by those acts*". Even if it fails to get the support of the International Criminal Court,¹⁶ several countries might enact their own national ecocide laws in the future, which could potentially increase the number of nature-related liability claims against companies and governments contributing to the destruction of nature in those countries. Although not enforced fully, ten countries already have national ecocide laws. It is important to note that "future possible liabilities may be a relevant driver of materiality, notably in jurisdictions that tend to favour intense, extended litigation".⁶⁰

Similarly, the concept of giving nature legal rights is also gaining momentum. Nearly 30 countries already have existing or pending legislation giving legal rights to nature (e.g. rivers and forests).⁶¹ In 2008, Ecuador became the first country to enshrine the rights of nature in its constitution in 2008. Following this, when the provincial government of Loja violated in 2011 the Vilcabamba river's right "to exist, to be maintained and to the regeneration of its vital cycles, structures and functions" by constructing a road next to it, the defendant was required by the court later "*to adhere to environmental recommendations made by the Ministry of Environment, including performing rehabilitative and corrective actions like storing the rubbish from the construction elsewhere*".⁶² Such concepts have widened the net of nature-related liability risks for companies around the world.



Reputational risks

Nature-related reputational risks arise when businesses degrade natural resources through their direct operations or supply chain activities and fail to mitigate such degradation. These actions expose businesses to reputational risk linked to increasingly stringent expectations from consumers, policymakers and the civil society, and underpin the growing pressure from capital providers to assess, manage and report nature-related risks.

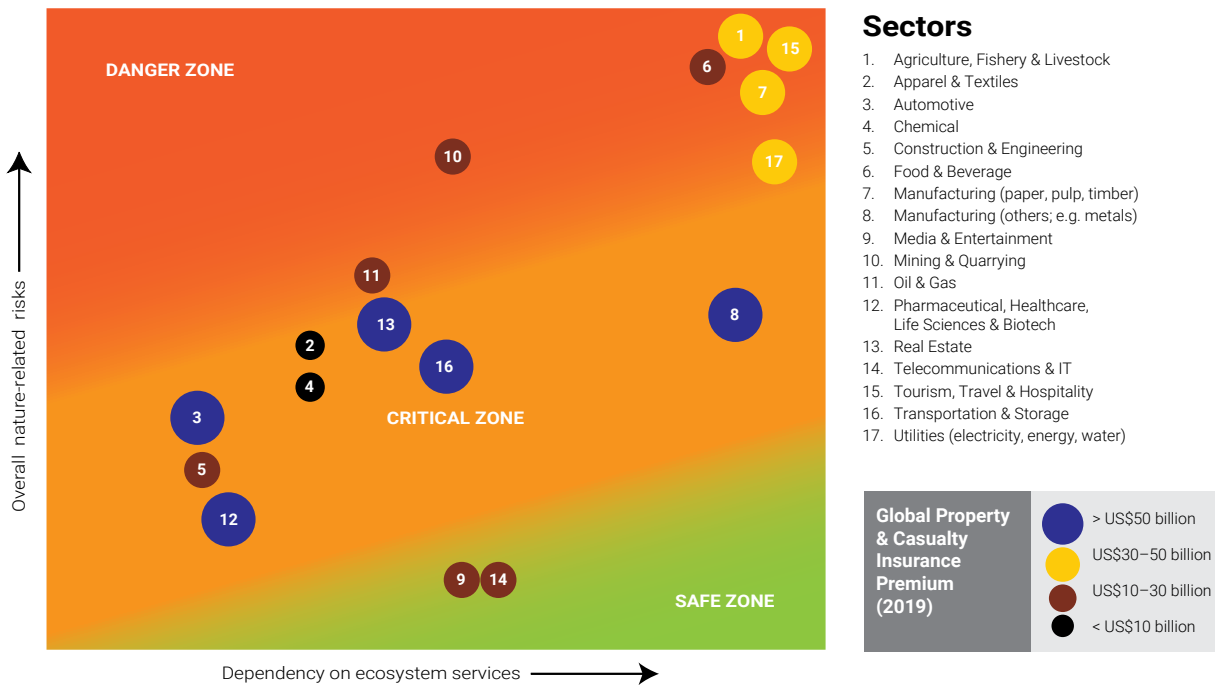
¹⁶ Countries such as China, India, the Russian Federation and the United States are not members of the International Criminal Court, but executives of corporations of one of those countries with operations in one of the member states could fall under the court's jurisdiction.

Transparency is key and potentially the first step in addressing reputational risks arising from nature-related risks. In 2019, CDP¹⁷ requested water-related data⁶³ from 139 Climate Action 100+ (CA100+)¹⁸ companies (mostly energy producers) for reporting to investors. However, over 40 percent (59 companies) declined to provide data. These companies generate substantial proportions of their revenue from activities with potential negative impacts on water quantity or quality across the entire value chain. Similarly, CDP requested forest-related data from 65 CA100+ companies (mostly energy and automobile producers), of which nearly 80 percent (52) declined to provide data. This lack of transparency may mask significant reputational risks for businesses.

2.2.3 Overall risks to economic sectors

Figure 9 has already provided a directional estimate of nature-related physical risks for 17 business sectors studied in this report. Based on expert consultations and qualitative research, a directional estimate of the overall risks, including transition risks, is presented below vis-à-vis the dependency of each business sector on nature, as shown in Figure 10. This estimate does not take into account risks cascading from one business sector to the next, which could be severe for sectors such as chemical (which depends heavily on mining and quarrying), or automobile (which depends on the manufacturing of metals and electronic equipment).

Figure 10 Directional estimate of overall nature-related risks for economic sectors¹⁹



Danger Zone: Where business operation will potentially be highly disrupted
Critical Zone: Where business operation will potentially be moderately disrupted
Safe Zone: Where business operation will likely continue as business-as-usual

Source: Author's estimations and calculations based on McKinsey & Company's Global Insurance Pools database, publicly available insurance premium data from various market research firms and consultation with insurance industry experts

17 CDP is a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts. It tracks company level disclosure on water security and deforestation, in addition to climate change.

18 Launched at the end of 2017, this is a five-year investor initiative to engage with the world's largest corporate greenhouse gas emitters to curb emissions, strengthen climate-related financial disclosures and improve governance on climate change. The initiative acts a global coordination body between five investor networks: Asia Investor Group on Climate Change (AIGCC); Ceres; Investor Group on Climate Change (IGCC); Institutional Investors Group on Climate Change (IIGCC); and Principles for Responsible Investment (PRI). www.unpri.org/collaborative-engagements/climate-action-100/6285.article

19 A partial quantification of insurance premium at risk is done only for P&C insurers. The same could not be done for L&H insurers and investment portfolio because of lack of disaggregated data by sectors, which is recommended for future research.

Figure 10 suggests that seven economic sectors, contributing to about 10 percent²⁰ of the global P&C insurance premium, could be exposed to significant disruption as nature-related risks become more severe. However, such disruption might not be evenly spread among firms and geographies because of firm- and geography-specific characteristics. Similarly, the next eight economic sectors, contributing to approximately 77 percent²¹ of the global P&C insurance premium, could experience moderate disruption. When the global health insurance premium is also considered, more than 90 percent of the global non-life insurance premium depends on economic sectors that are at high or moderate risk from nature loss. Only two economic sectors (media and entertainment, and telecommunications and IT) are currently in the safe zone. Figure 10 also aligns with similar studies conducted by ISIS Asset Management (now F&C)⁶⁴ and the World Economic Forum.

It is also important to examine the geographical exposure to nature-related risks of these economic sectors. It is likely that some sectors currently in the critical zone might move to the danger zone if both the dependency of those sectors on nature and the corresponding nature loss are very high in a particular geography that the sectors or their supply chains are located in. For terrestrial ecosystems, Figure 7 provides some directional indication of countries or regions where the degradation of nature is already severe. By overlaying these data with a business sector's operational or supply chain dependency on specific countries or regions, location-specific business risks could be estimated. This is beyond the scope of this study and recommended for future research.⁶⁵

2.3 Transmission of nature-related business risks into financial risks – impacts on the insurance sector

Insurers are exposed to nature-related risks on both their assets and liabilities. While large insurers could be exposed to nature-related risks in multiple geographies and business lines, small insurers could have risks concentrated in limited geographies and business lines without the diversification enjoyed by larger peers.

To understand how nature-related risks translate into financial risks for the insurance industry, a transmission mechanism framework (see Figure 11) is used. The transmission of (physical and transition) nature-related risks, as discussed in the preceding chapter, into financial risks for the insurance sector can be direct or indirect.

2.3.1 Direct transmission

Physical and transition risks can impact re/insurance companies directly (without an intermediary channel). Some examples are presented below.

Physical risks

- A water utility company insured against disruption of water availability of submits claims resulting from the depletion of an underground reservoir that is the primary source of water for the company.
- Individuals or a large population with life and health insurance coverage submit claims resulting from the unexpected impacts of zoonoses due to the destruction of the natural habitat of pathogens.

Transition risks – Market and technology

- Without enough data and market insights, re/insurance companies could suffer from a potential underpricing or mispricing of new insurance products on or investments in new nature-tech (e.g. data-driven precision agriculture) and business models.
- An insurance company has invested in a company's equity that is exploiting resources in a rainforest area that is put under environmental protection prohibiting any commercial use.

Transition risks – Liability

- An insurer could suffer underwriting losses if the potential risks of nature-related litigation have not been efficiently priced into relevant products or if the policy terms are not clear. The risks are somewhat mitigated with the short-term policies written, a movement away from occurrence policies²² by P&C insurers, and imposing caps on the total coverage offered on occurrence policies.

²⁰ Based on author's estimations and calculations. Please refer to Figure 25 in Annex V for a breakdown of premiums for sectoral blocks. The insurance premium corresponding to an individual sector was estimated based on McKinsey & Company's Global Insurance Pools database, publicly available insurance premium data from various market research firms and consultation with insurance industry experts.

²¹ Idem.

²² An occurrence policy has lifetime coverage for incidents that occur during its policy period, regardless of when the claim is reported.

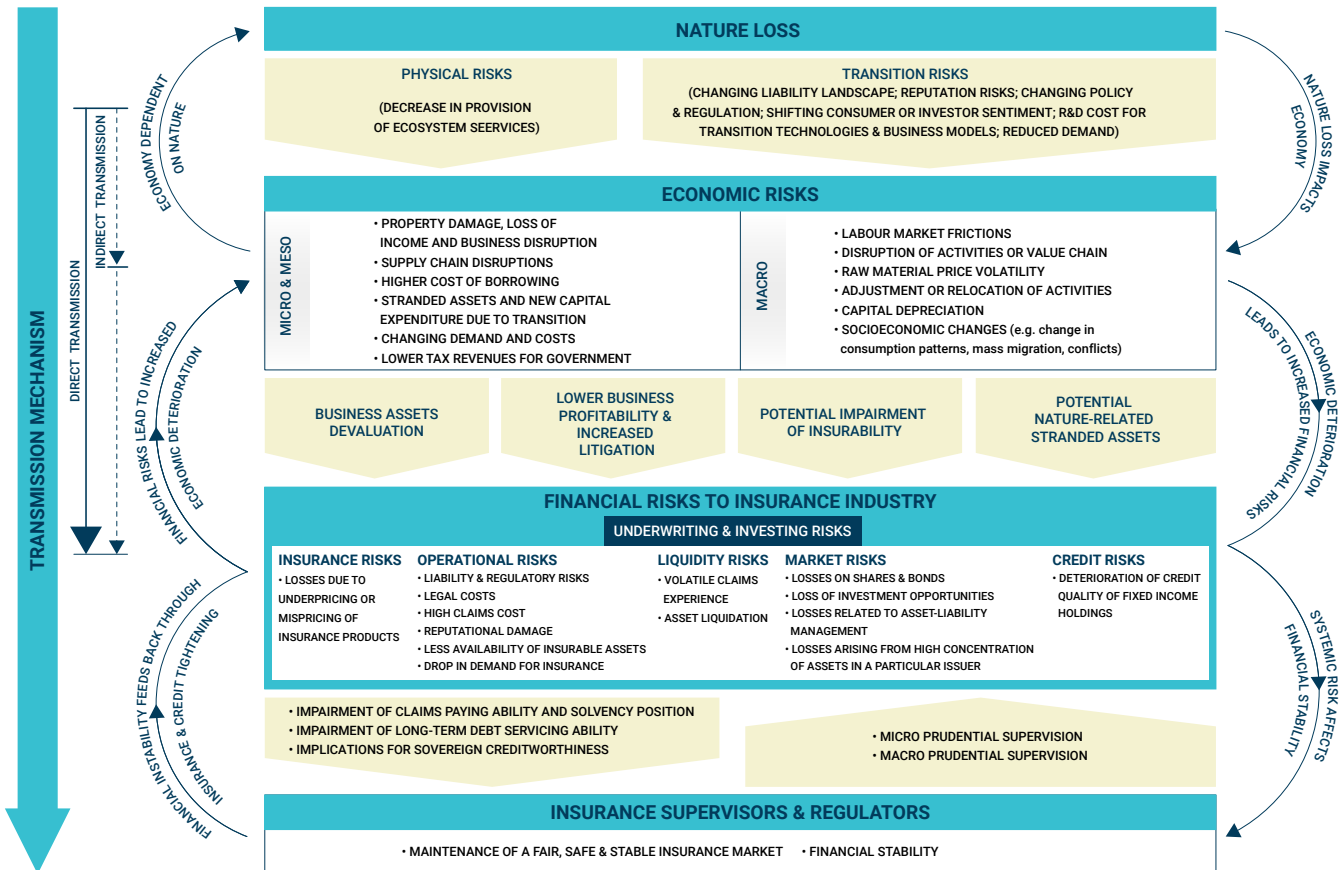
Transition risks – Reputation

- An insurer could face negative publicity for underwriting businesses or investing in companies that directly contribute to the deterioration of nature. This, in turn, could result in potentially significant costs from the loss of clients/policyholders and divestment of stakeholders along with damaged stakeholder relationships going forward.

2.3.2 Indirect transmission

An indirect transmission occurs through the propagation of physical and transition nature-related risks through clients/policyholders or investees of insurance companies that are embedded into our broader economy (see Figure 11).

Figure 11 **Transmission mechanisms: Nature-related business risks to economic and financial risks**



Source: adapted from NGFS and INSPIRE, 2021⁶⁶ CISL, 2021⁶⁷ Coalition of Finance Ministers for Climate Action, 2021⁶⁸ NGFS, 2020⁶⁹ Swiss Re Institute, 2020⁷⁰

2.3.2.a Business risks to economic risks

Chapter 2.2 laid out physical and transition nature-related risks for various economic sectors (businesses) that constitute a significant part of the global real economy. While a global study examining the economic impact of a nature-related disruption of all business sectors covered in this report is not available, studies looking at sub-sectors of the economy give a directional estimate of potential impacts. For example, a recent study by Johnston *et al.* (2021)⁷¹ estimates at 2.3 percent (US\$2.7 trillion) the annual drop in global GDP by 2030 as a result of the collapse of selected ecosystem services (see Figure 12), impacting sectors such as agriculture, forestry, fisheries, and related industries that rely on a select number of ecosystem services, namely crop pollination by wild pollinators, climate regulation from carbon storage and sequestration, provision of food from marine fisheries, and provision of timber. A previous study by the World Wide Fund for Nature (WWF)⁷² had estimated GDP losses of over 0.67 percent annually by 2050.²³

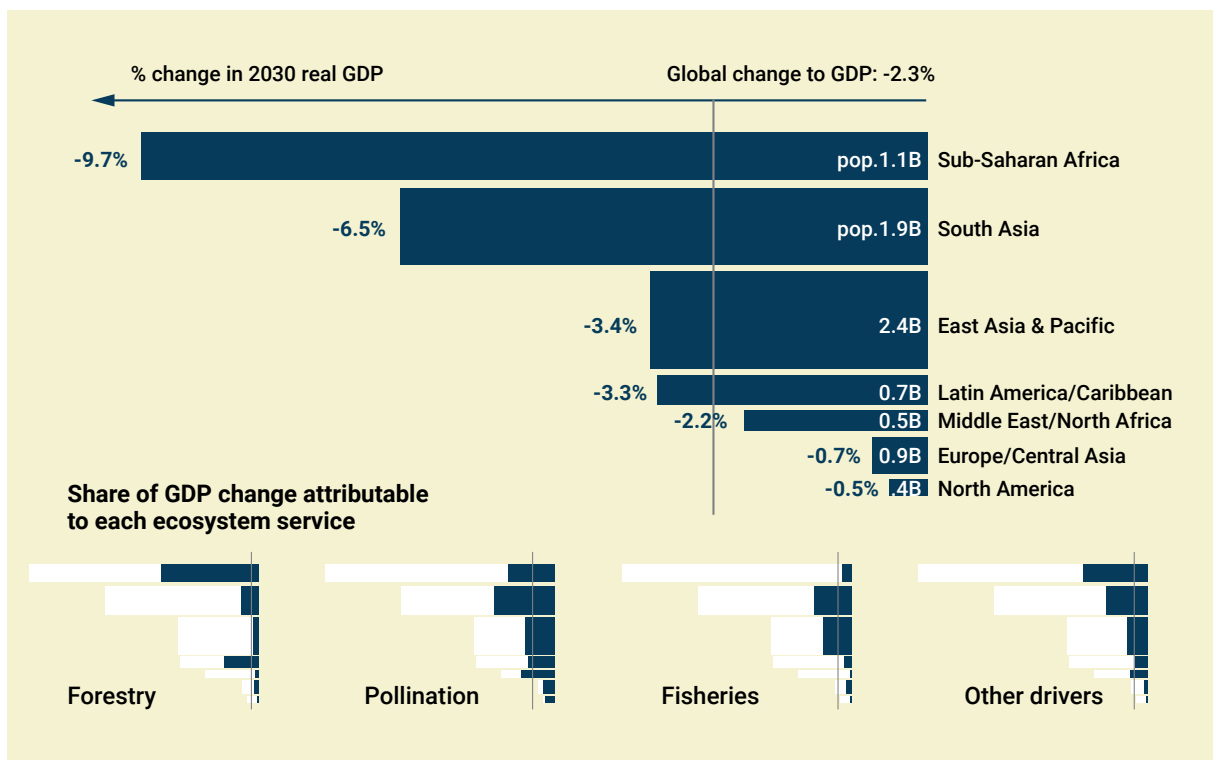
²³ The model employed by WWF included only the following ecosystem services: pollination; coastal protection; water yield; timber provision; carbon storage (climate regulation); and marine fish provision.

Since the studies to date have considered only limited ecosystem services and business sectors, the economic impact of the collapse of multiple other ecosystem services could be on a larger scale. Multiple ecosystem services are likely to be interlinked with one another, and the deterioration of one could have cascading impacts on others. For example, the Dasgupta Review (2021) highlights that the processes governing the supply of regulating and supporting ecosystem services are complementary to one another, which means that if one of them is disrupted sufficiently, others will be disrupted as well.⁷³

As shown in Figure 11, the nature-related risks for businesses are transmitted to the broader economy at the micro, meso and macro levels. An accumulation of economic impacts at the micro level (e.g. disruption at a coastal manufacturing facility because of coastal erosion from the degradation of nearby mangroves that used to protect the coastline, causing loss of income and supply chain disruptions) can lead to impacts at the meso level (e.g. governments losing tax revenues from a manufacturing plant shut down by a nature-related disaster). When nature loss occurs at a larger scale (country-wide, regional or global), it leads to macroeconomic impacts such as the disruption of economy-wide value chains, raw material price volatility, the adjustment or relocation of business activities (e.g. in response to emerging environmental compliance regulations), or an increased rate of capital depreciation.

As an example, the Amazonian forest’s water recycling system (one of the ecosystem services) has been severely damaged over the last decade because of deforestation. This, in turn, has resulted in water shortages for irrigation and the loss of soil moisture, directly impacting Brazil’s farming industry, which accounts for 30 percent of the country’s GDP. The water shortages also mean less water for the country’s hydroelectric plants, causing competition among several industries for limited electricity production. This, along with the increasing use of more expensive thermal power as an alternative, is projected to increase electricity prices for businesses and households up to 40 percent in 2021.⁷⁴ Since Brazil is one of the leading global exporters of agricultural commodities like soy, these price increases can have a global macroeconomic impact.

Figure 12 Change in 2030 real GDP under the partial ecosystem collapse scenario compared with the no-tipping-point scenario, by region



Source: Johnson et al., 2021⁷⁵

Research (2021)⁷⁶ shows that the economic impact resulting from ecosystem collapse is likely to be significantly more pronounced in low-income regions such as sub-Saharan Africa and South Asia, where the relative contraction of real GDP is estimated to be 9.7 percent and 6.5 percent per annum respectively by 2030 (see Figure 12). This illustrates that the economic impact is likely to be uneven around the world, and that it should also be a concern for those companies that are located in relatively safer regions but still have a global business footprint through their supply chains. In turn, it should be a concern for insurance companies underwriting or investing in those companies, which is discussed further in the following section.

2.3.2.b Economic risks to financial risks for the insurance sector

The transmission of macroeconomic shocks to the insurance sector is discussed below for both underwriting and investment of insurers.

Underwriting risks

An indirect transmission of nature-related underwriting risks could occur in the form of insurance, operational and liquidity risks.

As nature-related physical risks rise in frequency, intensity and concentration, the affected policyholders (both companies and individuals) are likely to submit increasing numbers and amounts of claims. Such claims will likely have geographic or sectoral concentrations in the short term. As risks start becoming systemic because of the non-linear characteristic of nature loss, the claims could become widespread globally in the long term. When risks are widespread, risk diversification starts to fail. In extreme cases, where the claims volume is much larger than normal, insurers might need to liquidate assets at a loss to cover those claims where insurers are not holding significant shorter-term assets. To factor in future claims of a similar nature and remain profitable, insurers then might start raising premiums for covering those risks. The prospective policyholders, however, might not be willing to pay higher premiums for insurance, particularly in an economy where there are frequent nature-related business disruptions and corresponding increases in unemployment and poverty. This could make insurance products unaffordable, hence leading to reduced demand and loss of existing subscriptions.

The rise in insurance premiums, for instance, for coastal property at risk (from sea level rise or coastal erosion), may also have a negative macroeconomic impact through a reduction in property value and a corresponding decrease in property tax revenues for the local government, in particular for countries with a long coastline. This illustrates a self-reinforcing feedback loop between financial impacts and macroeconomic impacts.

Further, as nature-related physical and transition risks increase, assets of businesses and geographies that are heavily dependent on nature could become stranded, hence reducing the availability of insurable as well as investable assets for the insurance companies in these businesses and geographies.

The uncertainties associated with the future path of nature loss as well as changing consumer environments also means that there are pure-play financial risks of structuring relevant underwriting products.

Case study: Underwriting deep sea mining (DSM)

Most existing insurance policies do not yet cover nature-related losses such as groundwater depletion and the destruction of wetlands. It is, therefore, challenging to get any hard number on underwriting losses as a result of physical risks from nature loss. However, as nature loss becomes more severe and transition risks kick in, insurance companies might not be completely immune to indirect nature-related claims.

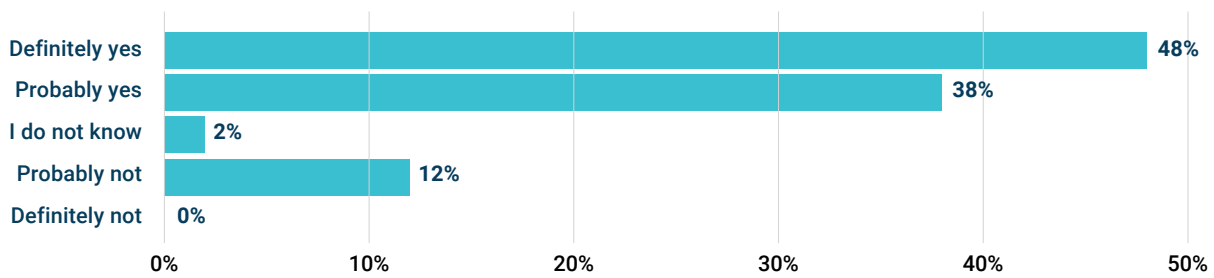
DSM is one such area where transition risks (e.g. potential liability claims) resulting from evolving global rules on seabed mining²⁴ could affect underwriting coverage provided to more than 20 companies that have received exploration contracts from the International Seabed Authority and could soon start mining deep sea metals. Furthermore, a global call for a moratorium on seabed mining has already come from leading global NGOs such as WWF and multinational companies such as BMW Group, Samsung SDI, Google and Volvo Group. This poses a reputational risk for insurers who provide coverage to the DSM companies. Although the insurance coverage might be limited to physical risk insurance for ocean-going equipment, the indirect environmental liability and reputational risks are hard to ignore. A corollary could be drawn from the 2015 Bento Rodrigues dam disaster in Brazil, where the Samarco joint venture between BHP and Vale faced multiple lawsuits from individuals, utility companies and churches, amounting to billions of dollars of losses in settling environmental liability claims and clean-up costs. The insurers were estimated to face up to US\$600 million in claims⁷⁷ in this disaster with a single underwriter liable to pay 80 percent of the covered amount.

According to a 2018 analysis⁷⁸ of 100,000 insurance industry claims over five years, environmental liability losses such as those resulting from pollution and agricultural run-off are increasing in frequency.

The recognition that nature-related underwritten risks are financially material to the industry is also reflected in the latest global survey conducted by SIF (see Figure 13). Nearly 50 percent of re/insurers surveyed recognized the financial materiality of these risks for their underwriting business.

²⁴ The International Seabed Authority (ISA), a 168-member body created by the United Nations to both promote and regulate seabed mining, is in the process of drafting regulations that govern seabed mining in the High Seas. The regulations will also affect the Exclusive Economic Zone (EEZ) seabeds of nation states as the United Nations Convention of the Law of the Sea (UNCLOS) requires its signatory states to govern their seabeds as per the ISA standards.

Figure 13 Number of re/insurers agreeing that nature-related risks are financially material to the underwriting business



Source: SIF Global Survey 2021

Investment risks

The indirect transmission of nature-related risks also occurs in the form of investment risks. These risks could cascade from impacts of nature loss on businesses and financial firms in the broader economy and occur in the form of market and credit risks.

As illustrated by Figure 26, insurers are one of the largest groups of institutional investors, and are invested in bonds, stocks and other products. Increased nature loss could lead to underperformance and depreciation in value of these investments. The underperformance and depreciation in value could result from physical risks to underlying assets, hence impacting revenue and debt servicing capacity, or from transition risks impacting the market valuation of the company. No matter whether the insurance company is directly or indirectly invested in that company as an equity or bond holder, the underperformance or depreciation in value of that company will directly affect the insurer's balance sheet.²⁵

In a macroeconomic environment with increasing environmental scrutiny, there may be a mismatch between supply and demand for low nature-risk opportunities, creating a risk of a nature bubble, akin to what some market participants see as a green bubble building up in renewable energy.⁷⁹ The investment opportunities could also be impacted by the repricing of certain assets (transition risk) due to market shifts driven by environmental regulations or changes in consumer behaviour.

Nature-related risks could potentially impair the valuation of insurers' fixed income holdings, including their sovereign bond holdings. For example, if an insurer is invested in real estate debt, cash flow from that investment can be impacted by nature loss events such as coastal erosion, reducing the debt servicing capacity and collateral valuation of the underlying properties.⁸⁰ The feedback loop between nature loss and climate change described earlier can result in climate-vulnerable economies having lower resilience to climate risks such as sea level rise, inland flooding and wildfires if they do not protect their natural defense mechanisms, e.g. mangroves, forest cover, soils or wetlands. High climate vulnerability and low resilience can result in a higher cost of sovereign borrowing. Insurers that hold large amounts of sovereign debt from such affected economies may see their valuations being impaired over time.

Case Study: Insurers' risk in Brazilian sovereign bonds

Brazil's sovereign health⁸¹ is highly dependent on its natural capital base as income from exporting soft commodities (e.g. soy, corn and meat) makes a significant portion of the country's national income. For instance, the agribusiness sector accounted for 27 percent of Brazil's GDP in 2020. Among the G20 countries, Brazil ranks second in terms of dependency of export income on natural capital assets. However, the degradation of nature, particularly illegal deforestation, has increased in recent years. In 2020 alone, 11 000 square kilometres of the Brazilian Amazon were deforested, the highest figure since 2008. The deforestation has threatened the potential of double cropping of soy and corn with an estimated loss of gross revenue of US\$3.8 billion by 2050 compared with 2016. An estimated 75–80 percent of Brazil's pastures have also been heavily or moderately degraded, which could make it progressively more challenging to achieve continued crop yield improvements. In addition to these nature-related challenges, importers of Brazilian products in various continents and industries have adopted increasingly more stringent deforestation policies, which threatens Brazil's exports, leading to a higher revenue-at-risk. The reputational risk value has also increased due to more NGO and media attention to the impacts of deforestation on global climate change. In contrast, Brazil's revised Nationally Determined Contribution (NDC) submitted to the UNFCCC in 2020 has no commitments to reducing deforestation, and the Ministry of Environment faced a budget cut in 2021, reducing environmental monitoring expenditures.

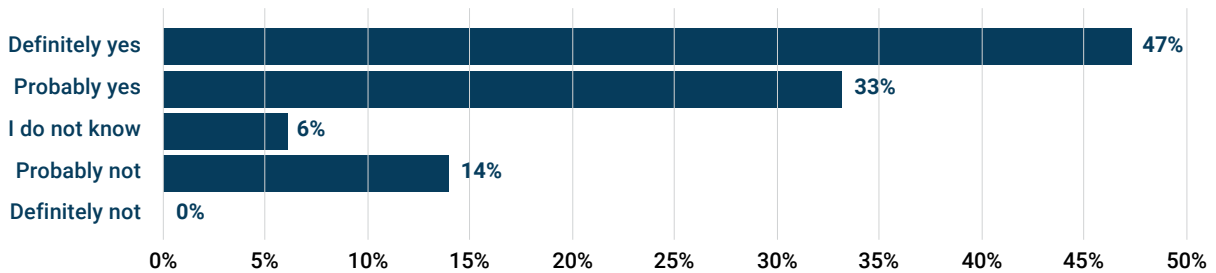
²⁵ It should be noted that in jurisdictions where insurers' fixed income holdings are held at amortized costs and held to maturity, only a credit event would have an adverse effect.

Global insurance companies, as institutional investors, invest a major share of their assets in traditional asset classes such as sovereign bonds. While accurate data are not available, many insurers are invested in Brazilian sovereign bonds, either as direct investors or investment through asset management companies. Planet Tracker’s updated assessment of Brazil’s sovereign health shows that it remains on an environmentally unsustainable path to 2030 and beyond (despite encouraging moves by the Brazilian central bank over the past year), bringing systemic risks to its sovereign bonds, particularly to foreign investors holding the US\$113 billion of Brazil’s debt repayable after 2030. If structural changes are not made, Brazil will potentially face negative implications for the cost and availability of sovereign and commercial capital. Existing credit ratings, which mostly discount the impact of longer-term problems such as nature loss and do not easily allow investors to differentiate between countries with strong ESG credentials and those with weaker credentials, are not providing investors with sufficient warning of the risks created by Brazil’s depletion of its natural capital.

Source: Adapted from Elwin et al., 2021⁸²

The recognition that nature-related investing risks are financially material to the industry is also reflected in the latest survey conducted by SIF (see Figure 14). Nearly 50 percent of re/insurers surveyed recognized the financial materiality of these risks for their investment business.

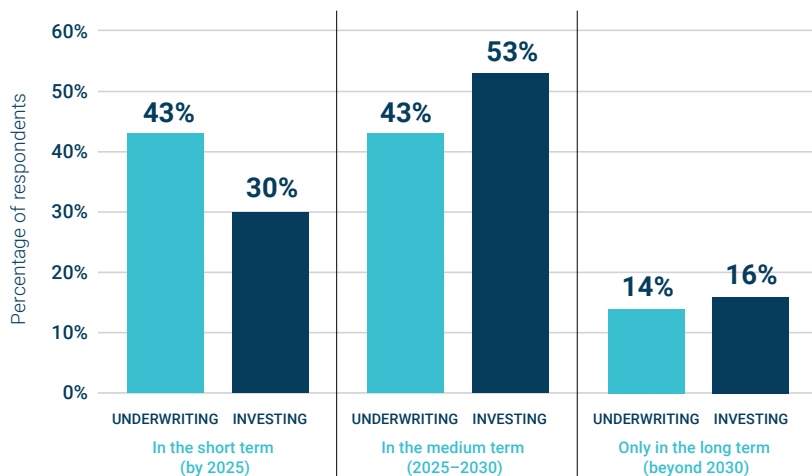
Figure 14 Number of re/insurers agreeing that nature-related risks are financially material to the investing business



Source: SIF Global Survey 2021

Although there is a fair degree of consensus among re/insurers on the potential financial materiality of nature-related risks to the insurance sector, the same level of consensus is absent on the expected time horizon of such materiality for the underwriting versus investing business. The SIF Global Survey 2021 (see Figure 15) shows that re/insurers consider that materiality for both underwriting and investing is foreseeable before 2030, with the underwriting business experiencing materiality sooner than the investing business.

Figure 15 Time period by when re/insurers foresee the impacts of nature-related risks on underwriting and investing activities of the insurance sector



Source: SIF Survey 2021

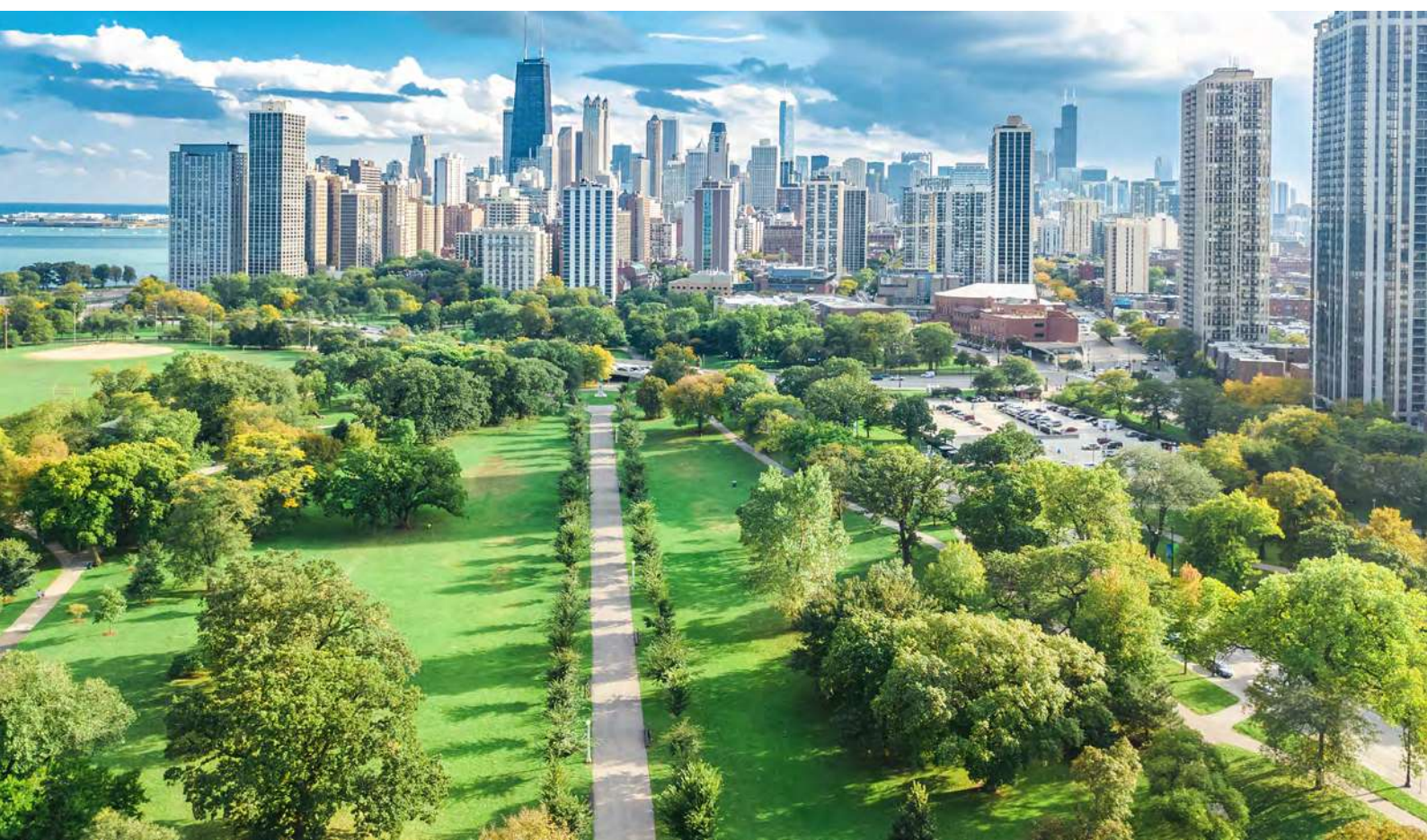
However, bilateral interviews with several re/insurers indicated that the potential materiality is expected to surface sooner in the investing business than on the underwriting side. This is because transition risk signals are underpinned by policy direction and controversy alerts, and are more near-term in nature, hence financial markets could reprice these risk signals quickly if insurance firms are not well prepared for the possible change of policy direction. The physical and liability risks are expected over a relatively longer term compared to transition and reputational risks, hence the materiality for the underwriting business will likely surface later.

The investment risks for L&H insurers are also expected to be larger than for P&C insurers whose investment portfolios tend to comprise shorter tenor instruments, so longer-term market/credit fluctuations are not that much of an issue. L&H insurers have asset portfolios with longer duration instruments and may have to crystallize losses on underperforming assets if liquidity is needed prior to the maturity date.

2.3.2.c Financial risks for the insurance sector to potential financial stability risks

As described above, ongoing nature loss could significantly hamper real economic activities, the adverse effects of which could then result in direct and indirect insurance sector-specific financial risks. These financial risks and economic risks can amplify each other. For example, if more assets start becoming uninsurable because of increased nature loss (hence a loss of insurance sector clients – a financial vulnerability), a continued economic activity based on those assets could trigger further nature loss through spillover effects (hence potentially causing irreversible damage to the relevant part of nature and an eventual halt to those economic activities – a macroeconomic shock). The macroeconomic shocks can therefore be both a cause and a result of financial vulnerability. As nature loss increases, these financial and economic risks could increase in magnitude and frequency, thus posing a potential financial stability threat.

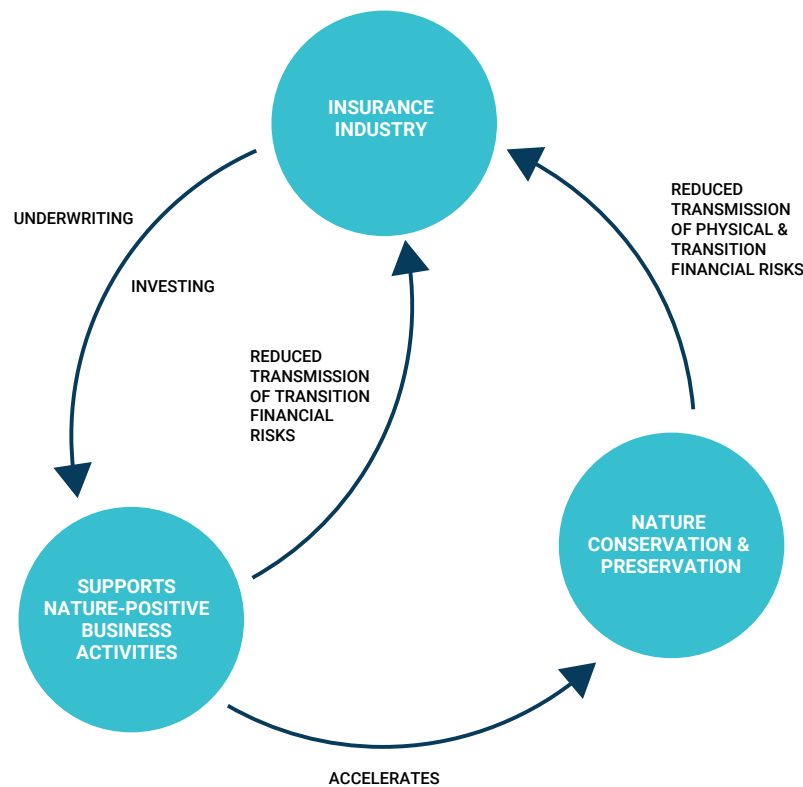
In the insurance sector, any widespread significant mispricing of nature-related risks may pose a financial stability risk due to increased payments that could further lead to liquidity and solvency issues, as well as the potential limitation or withdrawal of coverage, in particular for P&C insurance, if proper risk management and risk control fail in the short term. Hypothetically, if nature-related risks are underpriced by the entire insurance industry within a given jurisdiction over a period of time, the solvency positions of affected insurers could deteriorate. In response, the industry is likely to seek capital support to increase its capital buffers. In times of severe nature loss and assuming a challenging economic environment that constrains profit-making, the setting aside of additional capital buffers amidst a period of underwriting losses can amount to a dual impact to the insurance industry, with possible knock-on effects on the stability of the financial system of that jurisdiction. Furthermore, should a large number of insurers abruptly raise premiums or withdraw coverage from assets exposed to nature-related risks within a jurisdiction, this can bring about systemic financial shocks through self-reinforcing business failures. In extreme cases, the state and local governments might be required to intervene and provide coverage to absorb nature-related losses in the economy (i.e. unpriced liabilities) that is already impacted by underperforming or failed businesses. As the tax base is eroded by economy-wide disruptions, the state may face increasing fiscal pressures and become less able to service its debt. This could result in a higher probability of municipal bond defaults, impairing the state's sovereign creditworthiness.⁸³



2.4 Impacts of the insurance industry on nature

Some stakeholders expect insurers to conduct their business responsibly and limit the negative impacts on nature of their underwriting and investing activities (i.e. impact lens). The smooth functioning of the insurance industry is underpinned by the conservation, restoration, and the sustainable use of nature (i.e. financial risk lens). As illustrated by Figure 16, nature-positive or nature-neutral business activities insured or financed by the insurance industry contribute to the conservation and preservation of nature, feeding back to reduced physical and transition risks to the businesses, which are otherwise transmitted as financial risks to the insurance industry. It is, therefore, critical to take stock of whether and how the insurance industry is contributing to nature loss.

Figure 16 **Financing nature-positive business activities reduces nature-related financial materiality through feedback loops**



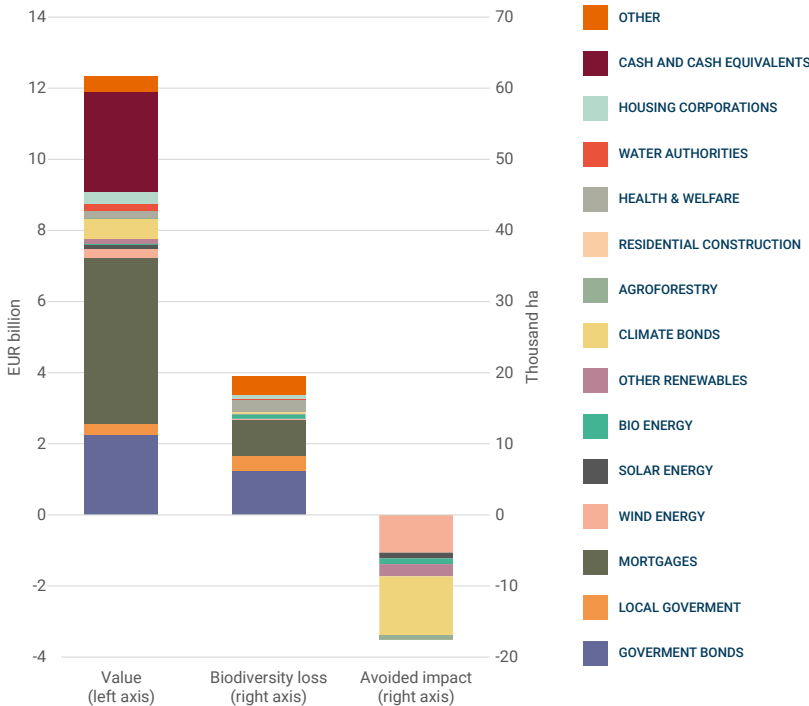
Source: adapted from SUERF, 2021⁸⁴

From its direct operations, the insurance industry neither emits a large amount of carbon nor consumes a large amount of natural resources compared to other sectors. However, the activities that it underwrites or invests in can create negative impacts on nature. While there is no global study on the extent of nature-related externalities generated by the insurance industry, some examples are presented below.

- To get an indication of how the investing business of the insurance industry could negatively impact nature, the Dutch bank ASN Bank⁸⁵ recently conducted an exercise to calculate its biodiversity footprint (see Figure 17). The bank expressed its impacts on nature in terms of the number of hectares where all biodiversity is lost by assessing the impacts of economic activities²⁶ facilitated by its loans and investments. The assessment found that most of the negative biodiversity impacts were attributed to mortgages (26 percent) and government bonds (32 percent), while the most avoided impacts were achieved with investments in climate bonds (48 percent of all avoided impacts) and wind energy (30 percent of all avoided impacts). The total net impact for the bank's balance sheet was estimated at 78,600 hectares where all biodiversity was lost. The assessment also found that land use resulting from construction and government bonds contributed to the highest negative impact on biodiversity. An analogous study could be performed for an insurance company to assess the net impact of its investment on nature.

²⁶ The impact categories used were marine water ecotoxicity; fresh water ecotoxicity; terrestrial ecotoxicity; freshwater eutrophication; acidification; terrestrial ozone formation; water use; land use; and climate change.

Figure 17 Total value and total biodiversity impacts of investments on the ASN Bank balance sheet in 2019



- Another recent study from Portfolio Earth⁸⁶ found that the world's largest 50 banks invested more than US\$2.6 trillion in 2019 in sectors that are the primary drivers of nature loss, and none of them have put in place a measure to monitor or measure the impact of their loans on nature. As seen in Figure 26, the insurance sector, being one of the major investors in financial services including banking, could be indirectly contributing to the nature loss through its investments.
- Another recent survey of 70 of the world's largest insurance companies⁸⁷ found that the current engagement of insurers with their clients on how their business operations impact nature is very low. It also found that there is a low level of understanding among insurers of how their underwriting activities may be contributing to nature loss. For insurers that are committed to creating positive impacts on society, and for supervisors that have mandates beyond financial risks, starting to develop such understanding would be a first step.

Source: PRé Sustainability, 2021⁸⁸

Case study: Nature-related impacts of beached and illegal, unreported, and unregulated (IUU) fishing vessels

A study done by Planet Tracker has shown that between 2014 and 2020, fishing vessels with a cumulative gross tonnage of at least 219,000 tonnes were dismantled and removed from the global oceans. 75 percent of the dismantled vessels can be traced back to companies from the Russian Federation, the United States, Taiwan (Province of China), or the Republic of Korea, in tonnage terms. Half of those dismantled vessels ended up in India and Bangladesh, where they are beached (i.e. laid ashore or grounded deliberately in shallow water), and broken apart. Since ship recycling costs ship owners US\$3–7 million more than shipbreaking, and the environmental cost of doing so is much lower in countries with lax environmental regulations, India and Bangladesh have become the preferred destinations. Some companies also change their vessels' flags of convenience before being scrapped to bypass the shipbreaking legislation of their countries and send them instead to India or Bangladesh for beaching and breaking.⁸⁹

Beaching in India and Bangladesh has resulted in grave consequences for the local marine environment. Hazardous materials from ships along with metal remnants and rust have contaminated sands and sediments, and are transported to the marine environment through ocean currents and tides. In Chattogram (Bangladesh), 21 species of fish and crustaceans have been wiped out by the local shipbreaking industry, and at least 60,000 mangrove trees have been cut along a 14 km coastline to make way for more dismantled ships.⁹⁰

While it is difficult to estimate how many of these dismantled ships can be traced back to insured companies, it is likely that some of those companies contributed to the 2019 global marine insurance premium of US\$28.7 billion.⁹¹ Underwriting such companies could pose significant reputational risk to the global insurance industry. In addition, fishing vessels linked to IUU fishing act as another source of nature-related reputational risk to the insurance industry. For example, vessels involved in IUU fishing use prohibited gear such as drift nets that not only damage reefs, seamounts and other vulnerable marine ecosystems but also reduce the number of marine species by catching nontarget species such as sharks, turtles or dolphins.⁹²

This is an example of how the insurance industry has both a responsibility and financial imperative to ensure that its underwriting and investing practices do not lead to the unintended damage of nature and in turn to their own financial bottom line through both nature-related physical and transition risks. The general provisions for the investment, such as the prudent person principle, and underwriting activities, such as actuarial principles, have to be complied with.

3

RESPONSE TO NATURE-RELATED RISKS



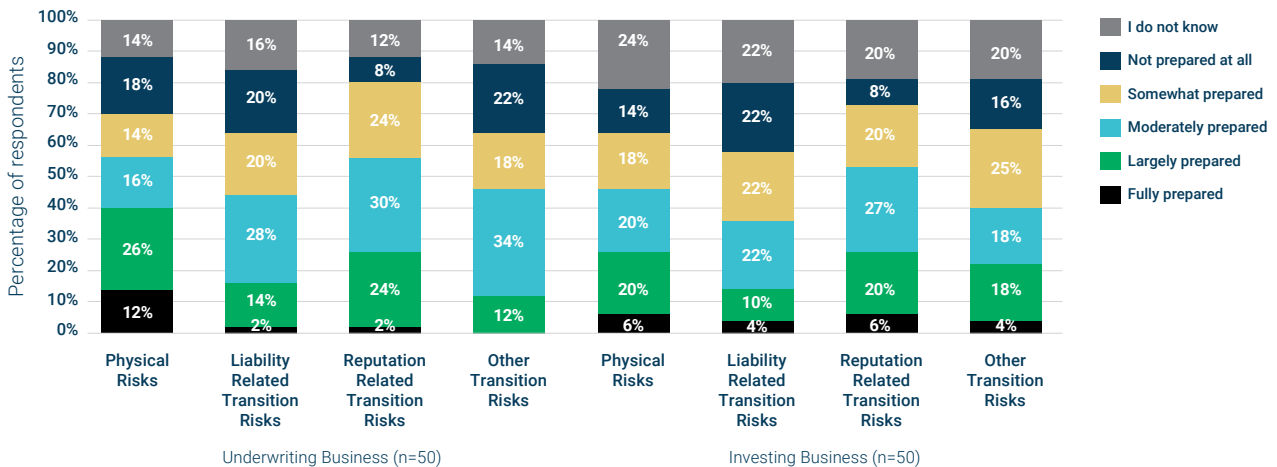
3. Response to nature-related risks

3.1 Resilience of the insurance industry

The insurance industry’s underwriting promotes macroeconomic stability by absorbing risks in the economy. Through risk-based pricing, the industry also provides critical economic signals of the changing risk environment.⁹³ Traditionally, the industry has relied on the principle of statistical stationarity of risks and used historical patterns for the actuarial modelling of future risks.⁹⁴ However, as ecological thresholds are exceeded for various elements of nature, the resulting risks and impacts start to show signs of statistical non-stationarity and non-linear trends. How accurately potential risks can be modeled and reflected in product pricing determines the adaptive capacity or resilience of the industry. For this, forward-looking scenarios and stress testing are critical.

As of today, the capacity to understand ecological interactions, collect relevant data and design tools to forecast nature-related risks are at an early stage of development. The capacity for modelling and quantitatively understanding nature-related risks is slowly increasing. As illustrated by Figure 18, across most risk categories, many re/insurers say they are moderately or somewhat prepared to respond to the potential impacts of nature-related risks. However, a considerable percentage of the industry is not yet fully or largely prepared to respond to such risks.

Figure 18 Level of preparedness of the insurance industry to respond to the potential impacts of nature-related risks



Source: SIF 2021 Global Survey

While the industry is not able to accurately model and quantify future nature-related risks, mispricing risks could potentially overexpose insurers to nature-related risks. In a 2021 study by the French Museum of Natural History, the authors already argue that “if correctly priced, it could appear that the insurance industry is already overexposed to nature-related risks, and they would either need a higher reserve capital to meet the regulatory capital requirements or they would need to reduce their exposure to underwriting and/or investing positions, hence losing some profit potential”.⁹⁵ As can be seen from Figure 10 and the explanation that follows, the underwriting and investing arms of the insurance industry are indeed already exposed to many economic sectors that are at high risk from nature loss.

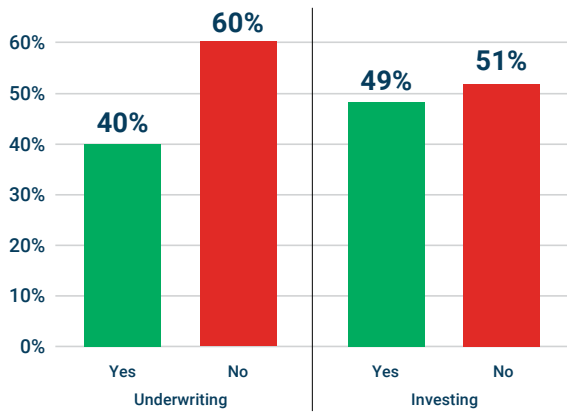
3.2 Insurance industry’s response to risks and impacts

This paper examines the insurance industry’s responses to nature-related risks in four ways – (1) whether and how they are assessing these risks, (2) the level of risk disclosure, (3) how these risks are being managed and the public commitments to avoid, reduce and restore nature loss, and (4) the development of appropriate insurance and financial products to address emerging risks.

3.2.1 Assessment of risks and impacts

The preceding chapters in this report along with survey results (Figures 13 and 14) indicate that many re/insurers do believe that the nature-related risks are material. The CRO forum, which counts some of the largest global insurers as its members, has identified five nature-related areas posing a medium level of risk to the industry – resource scarcity, new frontiers for resource extraction, environment pollution, food and water supply, and plastics and microplastics in its 2021 update of emerging risks.⁹⁶ Bassen *et al.* (2019)⁹⁷ have also presented with confidence that nature-related risks have adverse effects on the equity market, banking and real estate – all three areas where the insurance industry is moderately invested in. The SIF 2021 Global Survey asked the re/insurers whether they are currently assessing nature-related risks in their businesses. As illustrated in Figure 19, nearly 60 percent do not currently assess these risks in their underwriting businesses and 51 percent do not do so in their investing businesses.

Figure 19 Number of re/insurers assessing nature-related risks currently

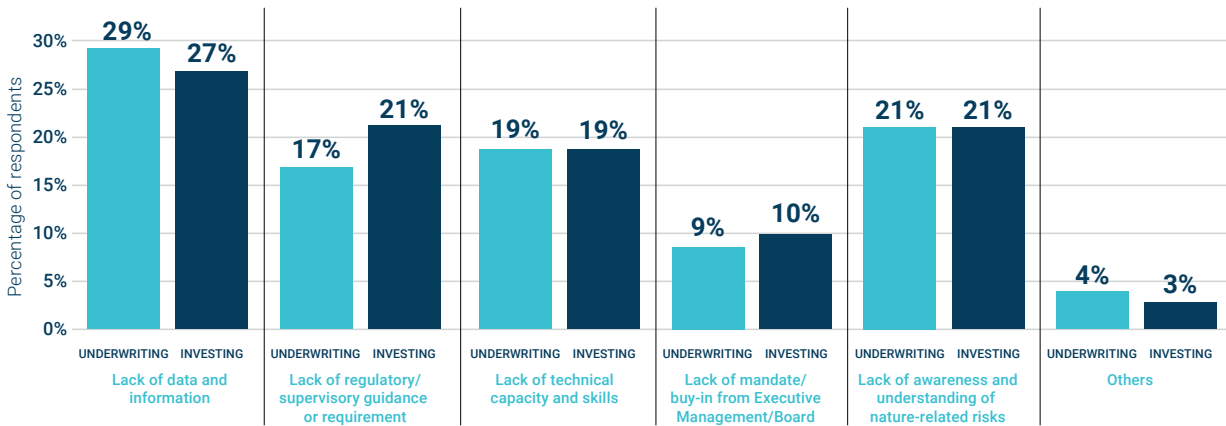


Source: SIF 2021 Global Survey

The lack of data and information, including relevant methodologies, was the reason most cited for not assessing nature-related risks (see Figure 20). Lack of awareness and understanding, lack of regulatory/supervisory guidance or requirement, and lack of technical capacity and skills were three other reasons commonly cited. On the lack of understanding and awareness, many companies also pointed to the general inability of most re/insurers to handle complex systems thinking and decision-making as that relates to nature-related risks. This is because nature-related risks are complex, interconnected and often overlap with climate and natural hazard risks, and are still poorly understood. It is hard to pinpoint a specific event, link the event to nature loss and then separate the actual value-at-loss attributable to the loss of a specific ecosystem service.

On the investing side, some re/insurers highlighted the unavailability of a GHG-equivalent protocol or metrics for nature and biodiversity as an impediment, similar to the finding from a recent Credit Suisse survey.⁹⁸ Many respondents also noted that concentrated focus on climate risks was taking attention away from nature-related risks. However, of the companies currently not assessing these risks, 53 percent have plans to do so while 9 percent do not plan and 38 percent do not know yet.

Figure 20 Barriers to assessing nature-related risks in underwriting and investing business

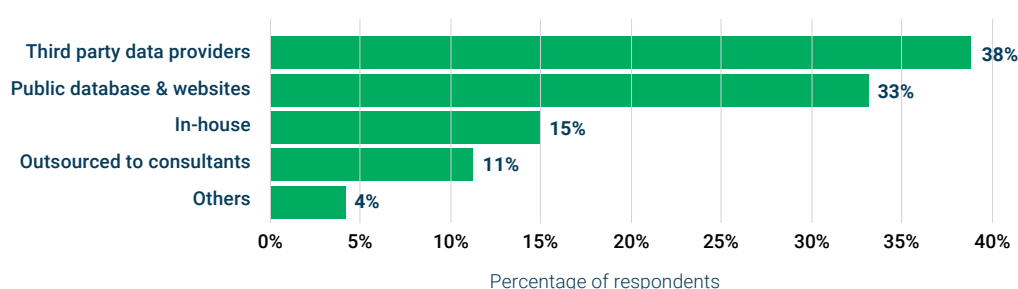


Source: SIF 2021 Global Survey

Of the companies assessing nature-related risks (as shown in Figure 19), less than 10 percent are using an exclusive quantitative approach and the rest are using either qualitative or a combination of qualitative and quantitative approaches. The companies have been using a combination of third-party data providers, public databases and websites, external consultants, and in-house experts to collect data and information on nature loss and its risks and impacts on insurers (see Figure 21). Companies use third party tools such as Global Forest Watch (GFW),⁹⁹ FAIRR,¹⁰⁰ IRIS+,¹⁰¹ Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE),¹⁰² Integrated Biodiversity Assessment Tool (IBAT),¹⁰³ and TRASE forest-risk commodity supply chain database.¹⁰⁴ Re/insurers can also leverage technology, such as Application Programming Interfaces (APIs) and Internet of Things (IoT) devices which can enable more accurate data acquisition while technologies like block chains can help to verify and share data on a trusted basis. For example, IoT devices could be deployed on-site to directly capture and assess relevant real-time data, such as consumption of water and other ecosystem services.

Some re/insurers have an in-house team of nature and biodiversity experts, however the majority do not have a dedicated expert team. However, nearly 45 percent of the surveyed companies plan to train their existing staff on nature and biodiversity.

Figure 21 **Re/Insurers' sources of data and information related to nature loss and associated risks and impacts**



Source: SIF 2021 Global Survey

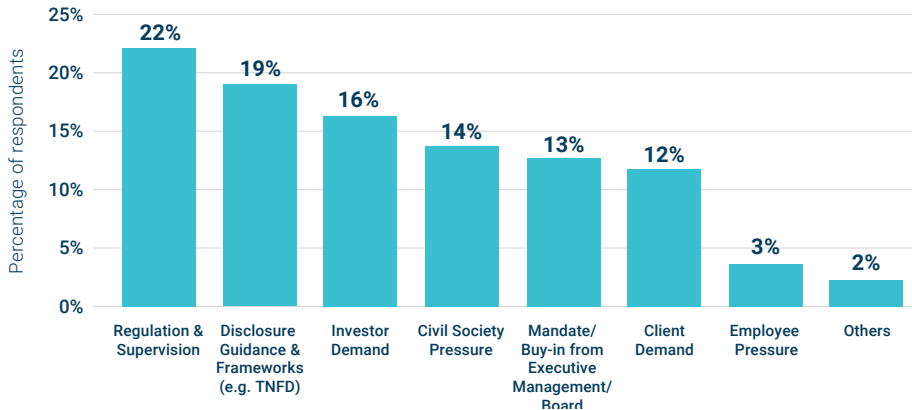
3.2.2 Reporting and disclosure of nature-related risks

In the financial industry, including insurance, there is no industry-wide ESG, sustainability, climate, or nature-related disclosure standard for disclosing or reporting on environmental, climate or nature-related risks. In addition, in most jurisdictions with notable exceptions like the European Union (with its Sustainable Finance Disclosure Regulation¹⁰⁵) re/insurers are not required by law to disclose or report on one or more of these risks. However, with increasing awareness of the regulators to prioritize disclosure of these risks and the global regulations slowly starting to converge as well as increasing market pressures for insurers to make voluntary disclosures, many re/insurers have started to realize the potential future regulations around disclosure of and reporting on some of these risks. Most notable is the growing adoption of voluntary standards for ESG and climate risk-related financial disclosure. For example, nearly 80 re/insurers¹⁰⁶ have already supported the Task Force on Climate-related Financial Disclosures (TCFD), although the growing adoption of ESG and climate-related reporting and disclosure is more prominent in investing than in underwriting.¹⁰⁷ In general, it is important that insurers disclose relevant information, and that insurers themselves can find and get relevant information about, for instance, companies they consider investing in/underwrite business with in order to assess the potential impact.

The International Financial Reporting Standards (IFRS) Foundation is currently working towards the establishment of an International Sustainability Standards Board (ISSB) to sit alongside the International Accounting Standards Board (IASB). The ISSB will issue a global baseline of investor-focused sustainability standards to improve the consistency, comparability and reliability of sustainability reporting across jurisdictions. The standards are intended to be interoperable with complementary reporting requirements that seek to capture wider sustainability impacts. The ISSB will start with a climate disclosure standard and will then issue standards for other ESG matters, such as biodiversity. This work has been welcomed by both the G7¹⁰⁸ and G20¹⁰⁹ Finance Ministers and Central Bank Governors.

When it comes to nature-related financial disclosure, the general opinion of the insurance industry is that we are at an early stage. Despite that, the SIF 2021 Global Survey finds that 60 percent of the surveyed re/insurers are supportive of disclosure of nature-related risks while 35 percent are undecided. Only less than 5 percent are not supportive of such disclosure. Most respondents pointed to regulation and supervision as key enabling factors to enhance disclosure, as illustrated by Figure 22. Respondents highlighted other enabling factors such as disclosure guidance and frameworks, investor demand, civil society pressure, corporate mandate/executive buy-in, client demand and employee pressure. Some noted the need to raise awareness of nature-related financial risks and impacts.

Figure 22 Key drivers needed to kickstart assessment and disclosure of nature-related risks in the insurance industry



Source: SIF 2021 Global Survey

The timely disclosure of nature-related financial risks across business sectors, including financial services, is expected to present opportunities to insurance companies by helping them grow pools of risk, price risks properly and identify unseen investment opportunities. The TCFD experience showed that disclosures based on an initial set of metrics are refined over time, which can enable the insurance sector to measure risks with greater precision.

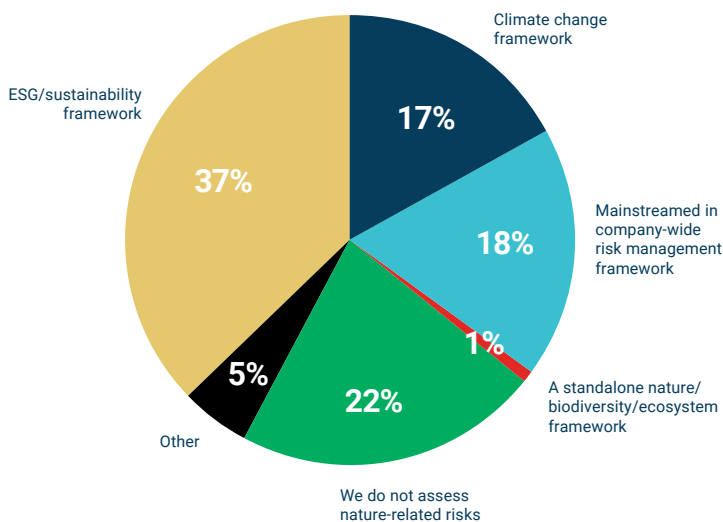
Moreover, the disclosure of risks will support wider stakeholder groups to focus their research and deliberation on cost-effective mitigation measures, which will ultimately benefit both insurers and their clients. Last, the increased transparency enabled by timely risk disclosure by the insurance industry also allows the broader financial system, including supervisors, to gradually respond to existing mispricing, avoiding a sudden nature risk-induced financial shock.

3.2.3 Current management of nature-related risks and commitments to nature-positive practices

Risks must first be assessed and measured before they can be managed and appropriately priced. There are no uniform metrics and indicators available for nature-related risks, hence industry frontrunners have typically used ESG or sustainability frameworks and very recently, climate change frameworks to incorporate some of the potential nature-related risks in their assessment and management practices. Thus far, this approach has only been used by the investing arms of the insurance industry to reduce negative impacts, through shareholder engagement and exclusions.

According to the SIF 2021 Global Survey, 18 percent of the surveyed insurers have mainstreamed nature-related risks in company-wide risk management frameworks and another 1 percent (see Figure 23) have a standalone nature-related risk management framework.

Figure 23 Framework used by re/insurers to assess nature-related risks



Source: SIF 2021 Global Survey

The development of approaches and methodologies to measure nature-related risks as well as nature-positive or nature-neutral investment opportunities is at an early stage. In the financial sector, AXA Investment Managers, BNP Paribas Asset Management, Sycomore Asset Management and Mirova partnered in early 2020 to develop and implement a tool to measure the impact of investments on nature.¹¹⁰ Later that year, they partnered with two consulting firms to expand the Corporate Biodiversity Footprint, a metric that quantifies corporates' wider supply chain impact on biodiversity, to help investors integrate nature into risk assessments and research.¹¹¹ Similar initiatives for the insurance industry would provide the tools to allow insurance companies to assess risks and potential impacts on financial performance.

An increasing number of re/insurers are expressing their commitment to nature-positive or nature-neutral practices. For example, several insurers along with asset managers, banks and investment funds are signatories to the 'Finance for Biodiversity Pledge', who collectively represent over US\$10 trillion in assets.¹¹² Similarly, Swiss Re's Sustainable Business Risk Framework¹¹³ states that the company will exclude insurance coverage for projects and activities located in UNESCO World Heritage Sites or protected areas, wetlands protected by the Ramsar Convention, International Union for Conservation of Nature (IUCN) listed protected areas and habitats for IUCN Red list species, as well as those without credible environment impact assessments or in violation of local, national or international laws or binding agreements on illegal logging. Similarly, Achmea, one of the largest Dutch insurance companies, has engagement guidelines¹¹⁴ that state portfolio companies should have a policy to protect biodiversity. In a similar vein, AXA has publicly committed to not knowingly underwrite vessels involved in IUU fishing – decreasing nature-related liability and reputational claims risks.

3.2.4 Development of nature-aligned insurance products

Nature-aligned insurance products can also lower underwriting losses for insurance companies, boost the growth of insurable assets, and simultaneously contribute to the restoration of damaged natural capital. The European Insurance and Occupational Pensions Authority (EIOPA), in its recent report on non-life underwriting and pricing,¹¹⁵ used the concept of impact underwriting to refer to products and services developed to help insurers lower their exposure to climate-related risks and to limit GHG emissions. This could be an interesting concept to develop for nature-loss related risks as well. The Nature Conservancy, University of California Santa Cruz, and AXA¹¹⁶ assessed the feasibility of developing and deploying a mangrove insurance product in the Caribbean region with positive results. The policy could be targeted at residential and commercial customers as well as public infrastructure, and policyholders would receive initial payouts quickly through parametric covers and assessed payouts through indemnity cover at a later stage. In a similar study conducted by Willis Towers Watson and the Nature Conservancy,¹¹⁷ risk reduction and premium savings associated with ecological forestry were modeled and analysed for a range of parametric wildfire insurance structures in northern Sierra Nevada. The results showed that aggregate residential premiums decreased by over 40 percent from ecological forest management¹¹⁸ of wildfire risk areas. If a 'community-based insurance' policy is written by an insurer and purchased directly by local government to cover homes in that community where homeowners pay a proportionate fee for such coverage, then the premium savings could be used by local government to issue wildfire resilience bonds to fund or finance ecological forestry. This in turn would reduce the fire risk and reduce the premium of wildfire resilience insurance. With such insurance products, wildfire insurance across California can continue to be available and affordable even for higher risk areas.

Case study: World's first coral reef insurance policy

The Mesoamerican Reef in Mexico is the second largest barrier reef in the world and protects Mexico's Caribbean coastline, which supports a US\$10 billion tourism sector from environmental risks such as hurricanes. However, pollution, bleaching and other types of environmental degradation, as well as the extreme storms that the reef protects against, put the reef at risk. This has led the Mexican government, The Nature Conservancy (TNC), and others to establish the Coastal Zone Management Trust, which, in addition to its already established activities focusing on ongoing maintenance of the reefs and beaches, will now make payments to beneficiaries in the event that a storm hits to repair the coastline and reef damages. The solution is also cost-effective, with estimates from TNC stating that while repairing the reef could cost anywhere from US\$50,000–150,000, an artificial measure like a seawall could easily cost US\$1 million per half mile of protection.

Funding for the Coastal Zone Management Trust comes from an existing fee on beachfront property owners with contributions from both local government taxes and from the local tourism industry in Cancún and Puerto Morelos. Part of this will cover the cost of insurance premiums, paid to the Mexican-based insurer Afirme Seguros. The parametric insurance product states that in the case that a storm with wind speeds in excess of certain benchmarks, starting with 100 knots, hits predefined areas covered by the insurance, a payout would immediately be made to the trust, up to a maximum of US\$3.8 million. For example, if wind speeds reach 110 knots, then 40 percent of the maximum payout would be delivered, while if they reach 130 knots and 160 knots then 80 percent and 100 percent of the maximum payout would be delivered, respectively. The terms state that 50 percent of the payout funds must be used for preliminary rehabilitation and restoration of beaches and 50 percent must be used for similar activities for the reef.

The administration of the payouts and delivery of the funding is managed by the Coastal Zone Management Trust.

Source: Global Canopy, 2021¹¹⁹

3.3 Supervisory and policy response to risks and impacts

3.3.1 Supervisory response

In the last few years, supervisors and regulators have developed and adapted frameworks and processes to supervise climate risks. More recently, supervisory attention is being paid to broader nature-related risks. The mandate of an insurance supervisor is typically related to key objectives of policyholder protection, financial stability and market conduct. A supervisory response to nature-related risks can therefore begin with an assessment of the relevance of nature-related risks to these objectives. For example, the Dutch Central Bank (DNB) found in its 2020 assessment that up to 36 percent (over EUR510 billion) of investments by Dutch financial institutions, including insurers, were highly or very highly dependent on one or more ecosystem services.¹²⁰ A similar 2021 assessment by the Banque de France found that 42 percent of the value of securities held by French financial institutions come from issuers that are highly or very highly dependent on one or more ecosystem services.¹²¹

When nature-related risks are established as relevant or material, the insurance supervisors may wish to develop guidance, recommendations and standards for their regulated entities.

- The DNB assessment recommended that “*supervisory authorities must ensure – for example through good practices – that financial institutions report in such a way that they produce a clear picture of their risk profile and resilience*”¹²² as it relates to nature loss.
- The Australian Security Exchange Corporate Governance Council, in its fourth edition of the Corporate Governance Principles and Recommendations, recommended that “*a listed entity should disclose whether it has any material exposure to environmental or social risks and, if it does, how it manages or intends to manage those risks*”.¹²³
- The Guidelines on Environmental Risk Management for Insurers issued by the Monetary Authority of Singapore promote the adoption of sound environmental risk management practices. They cover the areas of governance, risk management, underwriting, investment and disclosures. They also have a broad focus on environmental issues, including climate change, loss of biodiversity, pollution and changes in land use.
- The BaFin has issued a “Guidance Notice on Dealing with Sustainability Risks”,¹²⁴ which encourages supervised entities to focus more strongly on climate change risks but also take into account other environmental and social risks, such as the risk of biodiversity loss, acknowledging that the latter could have the same kind of serious financial impact as the former.
- The California Department of Insurance, in its recent Climate Insurance Report,¹²⁵ has made recommendations that include supervisory responses that encourage insurance company investments in nature-based solutions, and the insurance regulator to become a catalyst for pilot projects that link the risk reduction power of nature to community-wide insurance policies and potential risk pools for risks that have a very limited history of insurance coverages.

A recently published occasional paper, by the research initiative led by INSPIRE and the NGFS,¹²⁶ has also identified the need for a strategic and structured approach by central banks and supervisors to address the challenge of nature loss and the knowledge gaps around it. In its 2020 guide for supervisors in integrating climate-related and environmental risks into prudential supervision,¹²⁷ the NGFS recommended supervisors take adequate qualitative and quantitative measures to address environmental risks.

The recently launched TNFD,¹²⁸ although industry-led, has also gathered support of several governments along with sustainable finance platforms such as the Principles for Responsible Investment (PRI). Among others, the TNFD is expected to develop and test disclosure metrics and methodologies for nature-related financial risks, and finally disseminate those for wider adoption by 2023. In France, a new secondary legislation under Article 29 of the French Law on Energy and Climate requires all French financial institutions, including insurers, to disclose biodiversity-related risks in addition to climate risks.¹²⁹

The Dasgupta Review, commissioned by the UK Government, has also acknowledged that emerging risks from the unsustainable use of nature are not currently incorporated in financial decisions and “there is a role for precautionary policy intervention by governments and financial regulators, to compensate for the inability of markets to react in the face of potentially catastrophic losses related to tipping points”.¹³⁰

3.3.2 Global policy response

An accelerated global political development on nature-related issues could raise expectations from supervisors to act on the risk of unprecedented nature loss. In June 2021, the G7 leaders agreed to a historic ‘Nature Compact’,¹³¹ which supports new global targets to protect and conserve at least 30 percent of global land and at least 30 percent of the global ocean by 2030. In July 2021, the G20 Environment Ministers¹³² committed to continue and increase their efforts to address the interconnected challenges of nature-related risks and climate change. The ministers welcomed the additional impetus towards achieving the vision of “Living in Harmony with Nature” by 2050 provided by the UN Decade on Ecosystem Restoration 2021–2030. The ministers also recognized the importance of work on nature-related financial disclosures and took note with interest of the establishment of the TNFD.

In March 2021, the European Commission approved a new statistical framework to better account for biodiversity and ecosystems in national economic planning and policy decision-making.¹³³ As the next step, the Commission will propose a revision of the Regulation on European Environmental Economic Accounts to expand its coverage to include a new module on natural capital accounting, following which the EU could become the first jurisdiction reporting on changes in ecosystems and their services.¹³⁴ The upcoming second part of the UN Biodiversity Conference (COP 15) in Kunming in April 2022 is also expected¹³⁵ to adopt a "Post-2020 Global Biodiversity Framework" with ambitious targets for increasing protected areas and recognition of nature-based solutions in global climate mitigation efforts. Just as the Paris Climate Agreement triggered climate-related global supervisory action, the focus on nature risks at a global policy level may trigger a similar supervisory response.



4

CONCLUSION AND RECOMMENDATIONS



4. Conclusion and recommendations

This study qualitatively discussed the potential dependencies of the global insurance sector on nature, and the risks and impacts of nature loss. The assessments in this report demonstrate that nature-related risks, although less well understood than climate-related risks, could have impacts on the insurance sector. There is also a fair degree of consensus among insurance industry experts that nature-related underwriting and investing risks can be financially material to the industry. However, most re/insurers do not currently assess these risks in their underwriting and investing businesses because of several barriers, namely lack of data and information, including relevant methodologies; lack of regulatory/supervisory guidance or requirement; lack of technical capacity and skills; lack of mandate or buy-in from executive management or board of the company; and lack of awareness of nature-related risks. The supervisory response to nature-related issues, though picking up pace, has been limited thus far on this particular risk. This is partly also because insurers and supervisors are busy grappling with climate change risks and their impact to the insurance sector, and have limited resources and bandwidth to start assessing other risks. Considering these challenges and constraints, this report proposes the following recommendations and the next steps.

4.1 Recommendations

For the re/insurance industry

1. Continue to identify and build data, analytical tools, metrics and indicators to assess and measure nature-related risks.

There is a lack of reliable decision-useful data to quantify the negative impacts of nature loss on the insurance sector. The data and information derived from global environmental-energy-economic models provide some directional indication of potential impacts but are not accurate enough to base financial decisions on. The global insurance sector may consider starting collaboration with academics, companies in the real economy, the civil society, governments and other stakeholders to help them generate accurate and reliable data and enhance their capacity to analyse such data for the insurance sector's decision-making. However, as re/insurers invest in/underwrite business with companies from the real economy, it is important that they also get relevant data from those companies in order to assess the potential impact. The insurance sector can consider leveraging resources from existing global data initiatives such as the G20 Data Gaps Initiative,¹³⁶ the NGFS Bridging Data Gaps¹³⁷ and the Future of Sustainable Data Alliance¹³⁸ and from other public and private data providers that have collected nature-related data at the global and local level.

Following the activities mentioned above, the re/insurers may consider developing risk management tools such as forward-looking metrics and indicators to quantify nature-related dependencies, risks and impacts, which will help them factor in these variables in mitigating potential future risks. This may help, in the long run, designing nature-aligned insurance products and constructing a nature-aligned investment portfolio while complying with prudential rules for investing and underwriting. This may help them meet any forthcoming disclosure guidelines and requirements on nature-related risks.

Until insurance industry specific standards, metrics and indicators become widely available, the risk transmission framework used in this report (Figure 11) may be employed to qualitatively assess nature-related risks arising from various sectors that re/insurance companies are supporting. Re/insurance companies could also consider existing third-party risk assessment tools such as FAIRR, IRIS+, ENCORE, IBAT and TRASE forest-risk commodity supply chain database.

2. Assess nature-related risks by regions, sub-regions, and countries.

While some industry frontrunners have developed models to understand nature-related risks by regions, sub-regions, and countries (e.g. Global Swiss Re Institute's Biodiversity and Ecosystem Services Index) and started providing these assessments internally, there is still no publicly available model to assess insurance sector-specific nature-related risks in different regions. The global insurance community could benefit from collaborating and partnering with existing similar initiatives such as the Spatial Finance Initiative²⁷ and leveraging their own local models and databases to develop models to disaggregate asset-level nature-related risks by regions, sub-regions, and countries as well as by types of risks. This will help re/insurers with a globally diversified portfolio to better strategize risk management practices such as risk pooling.

For re/insurance supervisors

3. Become educated and raise awareness of nature-related risks among regulated entities.

For supervisors to be effective on supervising nature-related risks, they need to first become educated. This can be done through engaging with industry leaders, academics, and their peers in SIF. Supervisors can also play an important role in raising the awareness of nature-related risks and facilitate peer-learning among its regulated entities.

²⁷ The Spatial Finance Initiative's GeoAsset project is a public goods endeavour focused on making accurate, comparable, and comprehensive asset-level data tied to ownership publicly available across all major sectors and geographies. spatialfinanceinitiative.com

In order to fulfill this task, supervisors need to understand how domestically regulated firms are thinking about nature-related issues. For example, when the climate change-related discourse was at an early stage, supervisors conducted initial surveys of the insurance sector²⁸ that helped both engagement on the issue and supervisory understanding of how domestic firms thought about the issues. Similar work on nature-related issues at the domestic level would complement this report's work at the global level.

4. As a more accurate understanding of nature-related risks to the insurance sector is under way, support the development of non-prescriptive guidelines, options and tools towards a better assessment and management of nature-related risks.

Based on the best-known scientific evidence of nature-related risks and industry data calls, supervisors may consider developing non-prescriptive guidelines, options and tools to encourage risk management frameworks in their jurisdictions to systematically address both existing and forward-looking nature-related financial risks. After the general guideline is developed, the supervisors may consider collaborating with their regulated entities to develop sector-specific risk management guidelines for insurers (e.g. policies on deforestation, World Heritage Sites, water) for the sectors most at risk from nature loss in the long run.

5. Supervisors may consider encouraging regulated entities to voluntarily start disclosing nature-related financial risks in incremental steps and complement industry-specific reporting metrics for nature-related risks in the insurance sector, preferably aligning with relevant initiatives by other standard setting bodies.

The disclosure and reporting of risks along with other datasets is an important part of sound decision-making by both supervisors and the financial community and is conducive to market efficiency. The insurance supervisors may consider encouraging regulated entities to voluntarily start disclosing nature-related financial risks in incremental steps, based on aligned and common practices, bearing in mind the limitations on data availability from underwriting counterparties and investee companies.

In particular, supervisors can consider how to contribute to or leverage on the work of the International Financial Reporting Standards Foundation, which will establish an International Sustainability Standards Board to improve the global consistency, comparability and reliability of sustainability reporting. The ISSB will issue investor-focused sustainability standards, starting with climate, and then for other environmental risks, such as nature-related and social risks. The standards will include industry-specific guidance. The IAIS has stated that the consultative committee to be set up by the IFRS Foundation to promote interoperability with complementary reporting requirements should include the insurance supervisory community and stands ready to assist in the development of insurance industry-specific guidance.¹³⁹

The SIF members may also consider following developments in the finance sector pertaining to sustainability disclosure and biodiversity within the ISSB, TNFD and other major initiatives. Given the need to develop capacity expeditiously, SIF members can collaborate by identifying common capacity needs and sharing best practices and expertise on supervision of nature-related risks.

4.2 Next steps

1. Organize webinars to disseminate the finding of this study.

SIF will organize webinars or in-person events on the sidelines of the upcoming biodiversity COP and relevant international conferences to disseminate the key findings of this study – in the form of easily understandable presentations and infographics. Such sessions will be recorded and uploaded on the SIF website or the Climate Training Alliance (CTA) platform.

2. Develop a self-learning tutorial on understanding and assessing nature-related risks.

In partnership with SIF members, observers or partners, SIF will develop an online self-learning tutorial that guides insurance supervisors/SIF members in understanding the fundamentals of nature loss and risk transmission channels from nature loss. The tutorial can also have a module on supervisory best practices in this space. The tutorial will be hosted by the CTA portal, facilitated by the Financial Stability Institute (FSI) of the Bank for International Settlements (BIS).

²⁸ For example, the Australian Prudential Regulation Authority (APRA) conducted climate change survey of 38 large entities across the ADI, superannuation, and general, life and private health insurance industries. in mid-2018. The survey was designed to assist APRA in understanding and assessing industry maturity in responding to climate change risks and to inform APRA's supervisory approach. www.apra.gov.au/sites/default/files/climate_change_awareness_to_action_march_2019.pdf

3. Supervisor- and industry-led collaborative workshops to discuss challenges as they relate to nature-related risks.

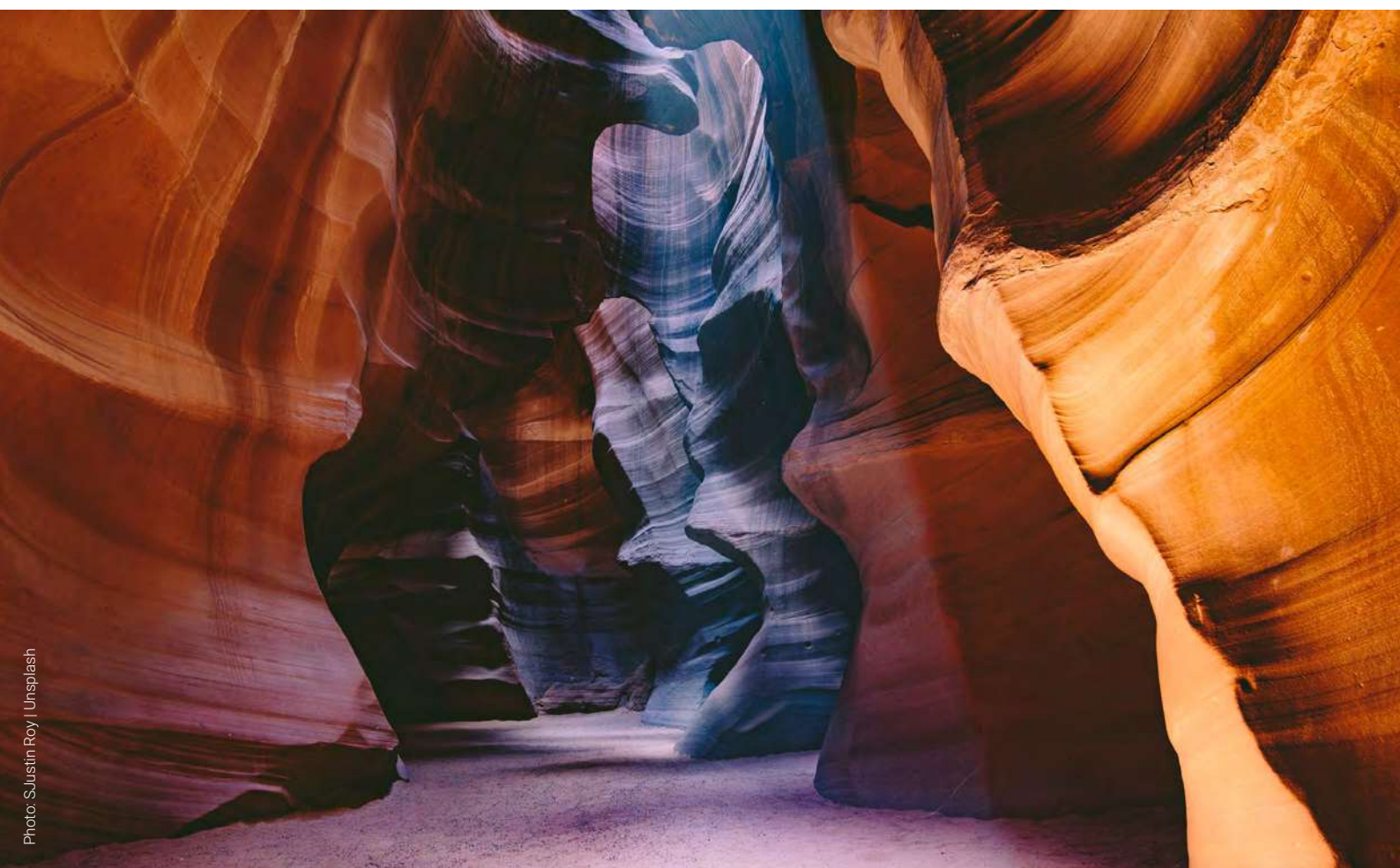
SIF will facilitate a workshop inviting supervisors and industry executives to discuss key nature-related challenges that the insurance sector is likely to face. The industry executives are expected to walk through how they have been addressing nature-related issues, if at all, in their underwriting and investment decision-making, and what key challenges are. If any insurer has already applied a benchmark or standard to identify, assess, measure and respond to nature-related risks, such a case study will be further developed and shared widely with the global insurance community.

4. Conduct a survey of regulated entities to understand nature-related issues.

SIF will facilitate the design and development of a survey questionnaire that the supervisors could use to understand how domestically regulated insurers are thinking about nature-related issues – from nature-related definitions to data sources and metrics used to take stock of nature-related risks. The survey could be qualitative to start with. At a later date, results from surveys from different jurisdictions could be analysed by SIF to understand and collate best practices by both supervisors and industry and taken forward as an input to the TNFD process or a similar international initiative.²⁹ The findings from the survey could also feed into future research as proposed in the fifth next step below.

5. Conduct further research to quantify exposure to nature-related risks.

After nature-related risk measurement methodology and metrics are developed, future research could work to quantify the insurance premium and investments that are most exposed to sectors that are most sensitive to nature-related risks such as forestry and agriculture. In the long run, supervisor-led data collection could be used to inform nature-related risk exposure. However, it is important that sufficient conceptual consultation on data collection and credibility be done among insurers and insurance regulators and supervisors to make the process convincing enough for an eventual reporting on nature-related risks.



²⁹ For example, the 2020 Issues Paper on the Implementation of the Recommendations of the Task Force on Climate-related Financial Disclosures drew on the results of a SIF Survey on the implementation of the TCFD recommendations and supplemental guidance, which was conducted during the first half of 2019. This survey was designed by SIF-IAIS and then SIF members individually sent it out their regulated entities. www.sustainableinsuranceforum.org/view_pdf.php?pdf_file=wp-content/uploads/2020/11/eb1f0b_365cc83062254d509c20d79313143868-2.pdf

ANNEXES



Annex I

List of interviewees and experts consulted

Name	Organization
United Nations, not-for-profit organizations, think tanks, academia, specialized consulting firms	
Ellie Mulholland	Commonwealth Climate and Law Initiative (CCLI)
Chris Hart	Global Canopy Programme Company
Pauline Becquey-Helary Roland Nussbaum	French Insurance Federation (FFA)
Odile Conchou	Secretariat of CBD
Faraz Uddin Amjad	UNDP (Insurance & Risk Finance Facility)
Butch Bacani	UN PSI
Nataliya Fedorenko Philipp Klais Shitij Gupta	McKinsey & Company
Insurance and re-insurance industry, insurance brokers, rating agencies	
Pedro Nascimento de Oliveira	AEGON
Lucy Saye Maeve Sherry Miba Stierman Ria Exworthy	Aviva plc
Sylvain Vanston	AXA Group
Laurent Montador	Caisse Centrale de Réassurance SA (CCR)
Alex Wittenberg Amy Barnes Jennifer McPhillips Josh Darr Koenraad De Stickere Rob Bailey	Marsh McLennan
Jon Richter	MetLife
Ernst Rauch	MunichRe
Allison Spector	Nuveen, a TIAA company
Xiang Fei	PICC Property and Casualty Company Limited
Dennis Sugrue Maurice Bryson	S&P Global
Martin Weymann	Swiss Re
Oliver Schelske	Swiss Re Institute
Gerald Sussmann Peter Quell	Versicherungskammer Bayern
Insurance supervisors/supervisory associations	
Giorgis Hadzilacos James Orr	Bank of England (UK)
Emily Bell Joris van Toor	De Nederlandsche Bank (DNB) (Netherlands)
Elizabeth F. Brown Lindsey Baldwin Stephanie T. Schmelz	Federal Insurance Office, US Department of the Treasury
Saori Takahashi Yuri Ikeda	Financial Services Agency (FSA) (Japan)
Daniel Wang Jeanne Stampe	Monetary Authority of Singapore (MAS) (Singapore)
Yue (Nina) Chen	New York State Department of Financial Services (NYDFS) (US)
Gustavo Adolfo Araujo Caldas Paulo Roberto Miller Fernandes Vianna Sergio Luis Franklin	Superintendência de Seguros Privados (SUSEP) (Brazil)

Annex II

Survey questionnaire

1. Which best describes your organization?

- Insurer
- Reinsurer
- Agent
- Broker
- Insurance regulator
- Insurance association
- Academia
- NGO
- Other (please specify)

2. If you are an insurer, which one of the following best describes your business? (Choose more than one, if applicable)

- Property & Casualty/Non-Life
- Life & Health
- All lines/Composite
- Other (please specify)
- Not applicable

3. What is your current role in your company?

- Chief Executive Officer
- Chief Underwriting Officer
- Chair/Vice-Chair/Member of the Board
- Chief Sustainability Officer
- Risk Manager
- Sales & Marketing Manager
- Broker
- Investment Manager
- Chief Financial Officer
- Chief Risk Officer
- Chief Investment Officer
- Legal/Compliance Manager
- Claims Manager
- Underwriting Manager
- Regulator/Supervisor
- Other (please specify)

4. In which country are you located?

5. On a scale from 0–10, how dependent are your company's business activities on nature? (The term 'nature' broadly refers to the concepts of natural capital, ecosystem, ecosystem services and biodiversity.)

6. Please rank the following elements of nature (technically called 'natural capital stocks') according to the level of dependence of your business on them.

- Land, including vegetation
- Water
- Air/Atmosphere
- Species (plants, animals, microorganisms)
- Other (please specify)

7. Please rank the following in order of sectors most at risk because of nature loss.**(Please use “nature loss” lens, and not “climate change” lens although there is an overlap between the two)**

- Agriculture, Fishery & Livestock
- Apparel (clothing, footwear, etc.) & Textiles
- Automotive
- Chemical
- Construction & Engineering
- Food & Beverage
- Manufacturing (paper, pulp & timber)
- Manufacturing (e.g. metals, plastics, rubber, electrical & electronics equipment)
- Media & Entertainment
- Mining & Quarrying
- Oil & Gas
- Pharmaceutical, Healthcare, Lifesciences & Biotech
- Real Estate/Home
- Telecommunications & IT
- Tourism & Travel
- Transportation (incl. distribution) & Storage
- Utilities (electricity, energy, water)
- Other (please specify)

8. What is your company's current level of understanding of the following risks in your overall business (both underwriting and investing)?

- Climate change risk
- Natural hazard risk
- Nature-related risk

9. Does your company assess nature loss-related risks in your underwriting process?

- Yes
- No

10. Does your company assess nature loss-related risks in your investment process?

- Yes
- No

11. If your company's underwriting process assesses nature loss-related risks, how have you been doing it?

- Quantitatively
- Qualitatively
- Mixed

12. If your company's investment process assesses nature loss-related risks, how have you been doing it?

- Quantitatively
- Qualitatively
- Mixed

13. What framework is your company using to assess nature-related risks? (Choose more than one, if applicable)

- ESG/Sustainability Framework
- Climate Change Framework
- A standalone Nature/Biodiversity/Ecosystem Framework
- Mainstreamed in companywide Risk Management Framework
- We do not assess nature-related risks
- Other (please specify)

14. How difficult is it for your company to draw links between nature loss and financial risk?

15. Do you agree that nature-related risks are financially material to your underwriting business?

- Definitely yes
- Probably yes
- Probably not
- Definitely not
- I do not know

16. Do you agree that nature-related risks are financially material to your investing business?

- Definitely yes
- Probably yes
- Probably not
- Definitely not
- I do not know

17. Which part of your company's business is/will be more impacted by nature-related risks?

- Underwriting
- Investing
- Both equally
- Both, but depends (please elaborate)

18. Has your company already observed impacts from nature loss-related risks on your underwriting performance?

- Yes
- No
- Not assessed yet
- I do not know

19. Has your company already observed impacts from nature loss-related risks on your investment performance?

- Yes
- No
- Not assessed yet
- I do not know

20. In terms of time scale, by when do you foresee the impacts of nature-related risks on underwriting vs investing activities of the insurance sector?

	In the short term (by or before 2025)	In the medium term (2025–2030)	Only in the long term (beyond 2030)
Underwriting			
Investing			

21. How prepared is your company to respond to the potential impacts of nature-related risks on your underwriting business?

	Fully Prepared	Largely Prepared	Moderately Prepared	Somewhat Prepared	Not Prepared at all	I do not know
Physical Risks						
Transition Risks						
Liability Risks						
Reputation Risks						

22. How prepared is your company to respond to the potential impacts of nature loss-related risks on your investing business?

	Fully Prepared	Largely Prepared	Moderately Prepared	Somewhat Prepared	Not Prepared at all	I do not know
Physical Risks						
Transition Risks						
Liability Risks						
Reputation Risks						

23. If your company does not assess nature-related risks today, do you have plans to assess these risks?

Yes

No

I do not know

24. If your company plans to assess these risks, when are you planning to start doing this?

Within 1 year

Within 1–3 years

Within 3–5 years

Other (please specify)

25. If your company does not assess nature-related risks today, could you please explain why?**26. What are the major barriers to assessing nature-related risks in your underwriting business? (Choose more than one, if applicable)**

Lack of data and information

Lack of awareness and understanding of nature-related risks

Lack of technical capacity and skills

Lack of regulatory/supervisory guidance or requirement

Lack of mandate/buy-in from Executive Management/Board

Other (please elaborate)

27. What are the major barriers to assessing nature-related risks in your investing business? (Choose more than one, if applicable)

Lack of data and information

Lack of awareness and understanding of nature-related risks

Lack of technical capacity and skills

Lack of regulatory/supervisory guidance or requirement

Lack of mandate/buy-in from Executive Management/Board

Other (please elaborate)

28. Where do you find data and information related to nature loss and associated risks and impacts? (Choose more than one, if applicable)

Third party data providers

Public databases and websites

In-house

Outsourced to consultants

Other (please elaborate)

29. Does your company currently have an in-house team of experts on nature and biodiversity? (Please note that 'nature and biodiversity' experts are a subset of sustainability experts, and hence different.)

Yes

No

May be

I do not know

30. If your company currently has an in-house team of experts on nature and biodiversity, who do they report to?

- Chief Executive Officer
- Chief Underwriting Officer
- Chief Risk Officer
- Chief Investment Officer
- Chief Financial Officer
- Chief Sustainability Officer
- Other (please specify)

31. Does your company plan to build an in-house team of experts on nature and biodiversity?

- Yes
- No
- I do not know

32. Does your company plan to train its existing staff on nature and biodiversity?

- Yes
- No
- I do not know

33. Is your company supportive of disclosure of nature-related risks by the insurance industry?

- Yes
- No
- I do not know

34. Has your company disclosed nature-related risks already?

- Yes
- No
- I do not know

35. What are the key drivers needed to kickstart assessment and disclosure of nature-related risks in the insurance industry? (Choose more than one, if applicable)

- Regulation & Supervision
- Investor demand
- Disclosure guidance and frameworks (e.g. Taskforce on Nature-related Financial Disclosures - TNFD)
- Mandate/buy-in from Executive Management/Board
- Employee pressure
- Client demand
- Civil society pressure
- Other (please elaborate)

36. Is your company aligned with any one of the following nature- or biodiversity-related goals or targets? (Choose more than one, if applicable)

- Aichi Biodiversity Targets
- National Biodiversity Strategies and Action Plans (NBSAPs)
- European Union's 2030 Biodiversity Strategy
- Other (please specify)

Annex III

Nature-related terminologies – accepted definitions

Natural capital is a way of thinking about nature as a stock that provides a flow of economic benefits to people and the economy.¹⁴⁰ It consists of natural assets such as water, forests and clean air. In simple terms, natural capital means natural resources or environmental resources, consisting of both living beings and non-living things. The term “capital” simply represents an economic-utilitarian perspective on nature, specifically those aspects of nature that people use (or anticipate to use).¹⁴¹

Ecosystem means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.¹⁴²

Ecosystem services are the economic benefits people obtain from ecosystems. According to the original formulation of the Millennium Ecosystem Assessment (MEA), ecosystem services were divided into provisioning, regulating, supporting and cultural. Provisioning services describe material or energy outputs from ecosystems; regulating services regulate processes like quality of air, water or soil; supporting services underpin all other ecosystem services; cultural services include non-material or intangible benefits such as aesthetics or spiritual experiences elicited by nature. This classification, however, is superseded in the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services assessments by the nature’s contributions to people (NCP) system. IPBES has identified 18 categories of NCP;¹⁴³ grouped into three overlapping categories – material contributions, non-material contributions and regulating contributions. NCP are all the contributions, both positive and negative, of living nature (i.e. all organisms, ecosystems and their associated ecological and evolutionary processes) to people’s quality of life. Beneficial contributions include e.g. food provision, water purification, flood control and artistic inspiration, whereas detrimental contributions include e.g. disease transmission and predation that damages people or their assets.¹⁴⁴ It should be noted that in some cases those contributions only have a detrimental effect due to people’s lack of adaptation to nature, e.g. non-resilient buildings. For the purpose of this report, the widely understood MEA classification will be used while acknowledging IPBES’s recognition that many services fit into more than one of the four categories.¹⁴⁵

Nature, according to Global Canopy and Vivid Economics,¹⁴⁶ is the global natural ecosystem in its entirety. This encompasses both the stock of natural capital as well as the way in which they interact with each other.

Biodiversity is the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities, and ecosystems.¹⁴⁷ Using the term ‘biodiversity’ to refer to natural capital and nature is extremely limiting, and should be avoided to provide better clarity to the financial practitioners.



Annex IV

Natural capital and ecosystem services

According to the original formulation of the Millennium Ecosystem Assessment, ecosystem services were divided into provisioning, regulating, supporting and cultural. Provisioning services describe material or energy outputs from ecosystems; regulating services regulate processes like quality of air, water or soil; supporting services underpin all other ecosystem services; cultural services include non-material or intangible benefits such as aesthetics or spiritual experiences elicited by nature.

Natural Capital	Flow of Ecosystem Services ¹⁴⁸			
	Provisioning Services (products from ecosystem)	Regulating Services (regulation of ecosystem processes)	Cultural Services (non-material benefits from ecosystem)	Supporting Services (necessary for all other ecosystem services)
Land, including vegetation	<ul style="list-style-type: none"> • Clean air • Food production (crops) • Food production (livestock) • Genetic/Medicinal resources • Minerals & raw materials • Renewable biofuels • The provisioning of groundwater & freshwater • Timber production 	<ul style="list-style-type: none"> • Absorbing and detoxifying pollutants • Biological control/ Bioremediation • Buffering & attenuation of mass flows (e.g. transport & storage of sediment by rivers, lakes and seas) • Carbon sequestration and storage • Coastal protection/ Flood and storm protection • Control of soil salinization • Daytime and nighttime visibility • Erosion prevention & maintenance of soil fertility • Global climate regulation • Good soil condition • Maintenance of hydrological cycle • Micro-climate regulation (local climate & air quality) • Moderation of extreme events • Noise regulation • Pest and disease control • Soil moisture recharge and retention • Temperature regulation • Waste-water treatment/ Filtration • Water quality 	<ul style="list-style-type: none"> • Aesthetically attractive landscapes • Cultural heritage • Inspiration for culture, art, and design • Leisure and tourism • Livability • Recreation, mental and physical health • Spiritual experience 	<ul style="list-style-type: none"> • Biodiversity (wildlife) • Habitats for species • Maintenance of genetic diversity • Nutrient cycling • Photosynthesis • Soil formation • Water cycling

Natural Capital	Flow of Ecosystem Services ¹⁴⁸			
	Provisioning Services (products from ecosystem)	Regulating Services (regulation of ecosystem processes)	Cultural Services (non-material benefits from ecosystem)	Supporting Services (necessary for all other ecosystem services)
Water	<ul style="list-style-type: none"> • Food production (crops) • Food production (livestock) • Freshwater fishing • Genetic/Medicinal resources • Marine fishing (including shellfish) • Minerals & raw materials • Provisioning of groundwater & freshwater • Renewable biofuels • Timber production 	<ul style="list-style-type: none"> • Absorbing and detoxifying pollutants • Biological control/ Bioremediation • Buffering & attenuation of mass flows (e.g. transport & storage of sediment by rivers, lakes and seas) • Carbon sequestration and storage • Control of soil salinization • Erosion prevention & maintenance of soil fertility • Global climate regulation • Good soil condition • Maintenance of hydrological cycle • Micro-climate regulation (local climate & air quality) • Moderation of extreme events • Pest and disease control • Pollination • Soil moisture recharge and retention • Temperature regulation • Waste-water treatment/ Filtration • Water quality 	<ul style="list-style-type: none"> • Aesthetically attractive landscapes • Cultural heritage • Inspiration for culture, art and design • Leisure and tourism • Livability • Recreation, mental and physical health • Spiritual experience 	<ul style="list-style-type: none"> • Biodiversity (wildlife) • Habitats for species • Maintenance of genetic diversity • Nutrient cycling • Photosynthesis • Soil formation • Water cycling

Natural Capital	Flow of Ecosystem Services ¹⁴⁸			
	Provisioning Services (products from ecosystem)	Regulating Services (regulation of ecosystem processes)	Cultural Services (non-material benefits from ecosystem)	Supporting Services (necessary for all other ecosystem services)
Air/Atmosphere	<ul style="list-style-type: none"> • Clean air • Food production (crops) • Food production (livestock) • Timber production 	<ul style="list-style-type: none"> • Absorbing and detoxifying pollutants • Biological control/ Bioremediation • Buffering & attenuation of mass flows (e.g. transport & storage of sediment by rivers, lakes and seas) • Carbon sequestration and storage • Coastal protection/ Flood and storm protection • Daytime and nighttime visibility • Global climate regulation • Maintenance of hydrological cycle • Micro-climate regulation (local climate & air quality) • Moderation of extreme events • Noise regulation • Pest and disease control • Pollination • Soil moisture recharge and retention • Temperature regulation 	<ul style="list-style-type: none"> • Aesthetically attractive landscapes • Cultural heritage • Inspiration for culture, art, and design • Leisure and tourism • Livability • Recreation, mental and physical health • Spiritual experience 	<ul style="list-style-type: none"> • Biodiversity (wildlife) • Habitats for species • Maintenance of genetic diversity • Nutrient cycling • Photosynthesis • Soil formation • Water cycling
Species	<ul style="list-style-type: none"> • Food production (crops) • Food production (livestock) • Freshwater fishing • Genetic/Medicinal resources • Marine fishing (including shellfish) • Minerals & raw materials • Renewable biofuels • Timber production 	<ul style="list-style-type: none"> • Absorbing and detoxifying pollutants • Biological control/ Bioremediation • Carbon sequestration and storage • Coastal protection/ Flood and storm protection • Control of soil salinization • Erosion prevention & maintenance of soil fertility • Good soil condition • Pest and disease control • Pollination • Soil moisture recharge and retention • Wastewater treatment/ Filtration • Water quality 	<ul style="list-style-type: none"> • Aesthetically attractive landscapes • Cultural heritage • Inspiration for culture, art and design • Leisure and tourism • Livability • Recreation, mental and physical health • Spiritual experience 	<ul style="list-style-type: none"> • Maintenance of genetic diversity • Nutrient cycling • Soil formation

Annex V

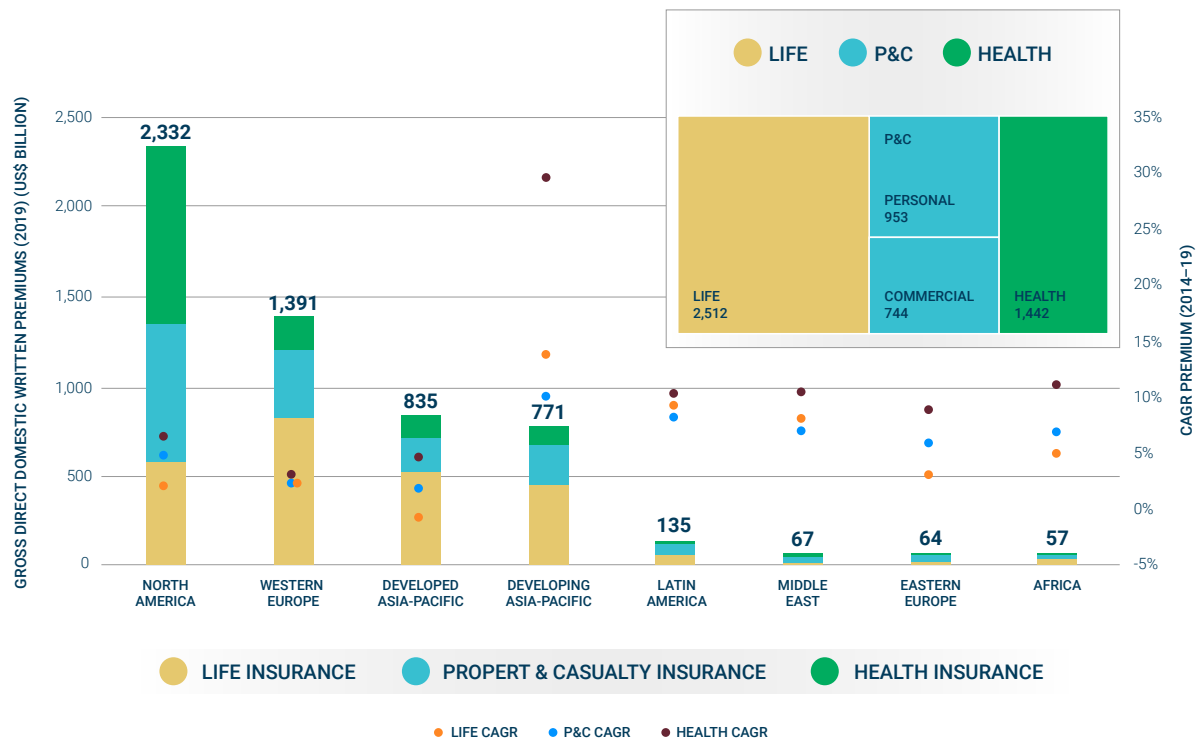
Key characteristics of the global insurance industry

Underwriting

According to McKinsey Global Insurance Pools,¹⁴⁹ life insurance accounted for 44 percent of global insurance premiums in 2019. Annuity products comprised the bulk (30 percent) of life insurance products globally, followed by group, endowment, unit-linked products, and term life respectively.¹⁵⁰ P&C insurance contributed to 30 percent of global insurance premiums in 2019, 45 percent of which is motor insurance premiums. Lastly, health insurance accounted for 26 percent of global insurance premiums in 2019. Taken together, life and health comprised the majority (70 percent) of global insurance premiums written in 2019.³⁰

P&C insurance can be broken down into personal and commercial lines, with personal comprising 56 percent of the total and commercial 44 percent in 2019.

Figure 24 Gross domestic written premiums and their compound annual growth rate (CAGR) by region



Source: McKinsey Global Insurance Pools³¹

30 A similar breakdown for life and health exists but has not been presented here due to lack of disaggregated data.

31 This data has been sourced from regulatory/ industry reports for 66 markets (amounting to more than 90 percent of the global insurance market) that constitute these regions; figures have been converted to US\$ using the 2019 fixed exchange rate. Developed APAC included Australia; China, Hong Kong SAR; Japan; New Zealand; the Republic of Korea; Singapore; and Taiwan, Province of China. Developing APAC included China, mainland; India; Indonesia; Malaysia; the Philippines; Thailand and Viet Nam.

In total, the global insurance premiums written in 2019 amounted to US\$6 trillion, including the reinsurance industry.¹⁵¹ As illustrated by Figure 24, North America and Western Europe comprised about 66 percent of the global total, followed by Asia-Pacific (28 percent), Latin America, the Middle East, Eastern Europe and Africa (jointly a total of about 6 percent). However, in terms of growth of premium, developing Asia-Pacific countries led the pack across all insurance lines, most prominently in health (CAGR of nearly 30 percent between 2014 and 2019). Between 2014 and 2019, North America and Western Europe, currently the regions with the highest premium volume, grew at a rate below the global average for all insurance lines.

An initial estimate by the author found that the total global P&C insurance premiums is distributed among 18 economic sectors, as illustrated by Figure 25. When combined with global health insurance (P&C plus health insurance), the business sector contributing the most to global insurance premiums is pharmaceutical, healthcare, life sciences and biotechnology. It is followed by the automotive or motor sector.

Figure 25 Distribution of global P&C insurance premium among economic or business sectors



Note: Total insurance premium for each block is within the indicated range.
 Source: Author's research, supported by data from McKinsey Global Insurance Pools

Investing

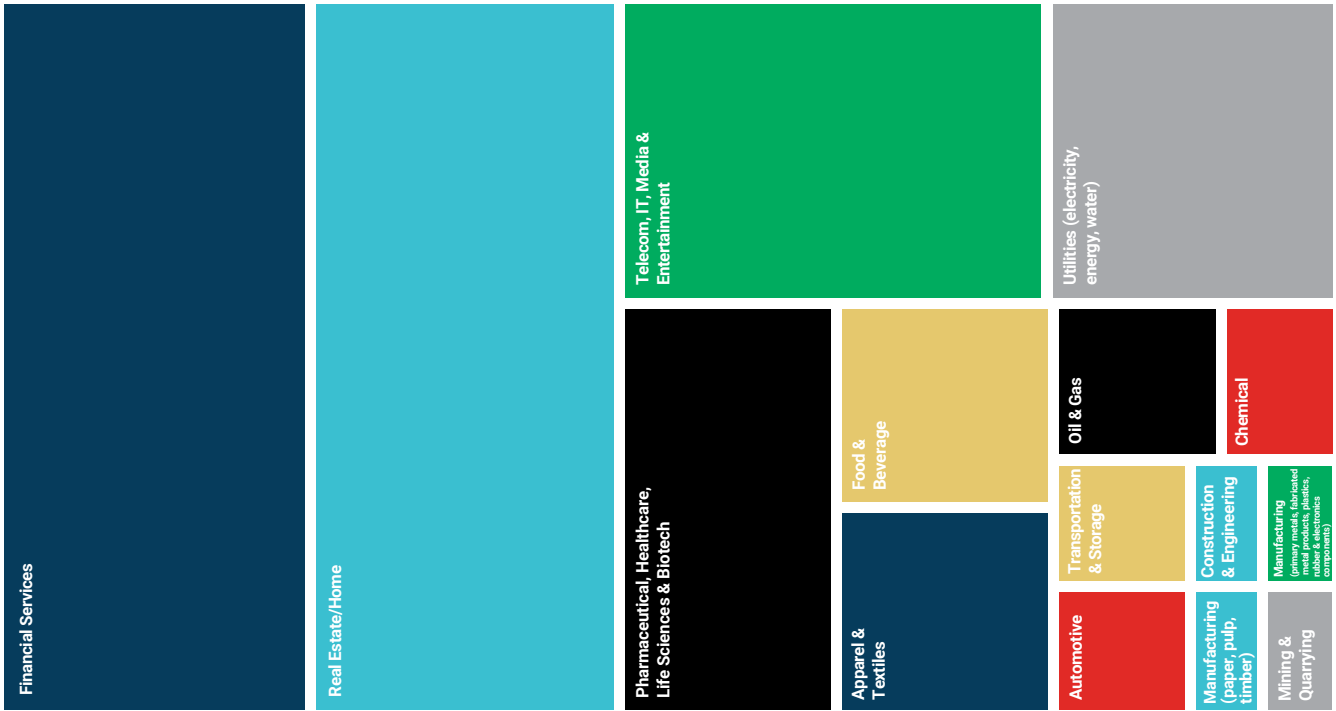
The global insurance industry is one of the largest groups of institutional investors, holding about US\$33 trillion of financial assets.¹⁵² It is therefore critical to understand the industry's investment exposure as it is estimated that approximately 90 percent of the industry's profit is derived from investment income¹⁵³ with the rest from underwriting.³² Although the investment profit is relatively larger for life and health insurers, the ratio of investment to underwriting profit is still significantly large for P&C insurers, as indicated by NAIC's analysis of US P&C insurers in 2019.¹⁵⁴

The investment data from US insurers indicate that about 60 percent¹⁵⁵ of P&C assets are invested in investment-grade bonds (mostly corporate, followed by municipal and other government bonds) or other fixed-income securities such as fixed-income exchange-traded funds (ETFs) while the same goes up to 90 percent¹⁵⁶ for L&H insurers. Similarly, P&C stock market exposure is around 25-30 percent while it is less than 10 percent for L&H insurers.¹⁵⁷ Apart from bonds and stocks, mortgage loans on real estate and real estate constitute two other important areas of investment for the insurers, more so for L&H than P&C. For a global average of the entire insurance industry, a 70 percent bond exposure could be assumed¹⁵⁸ while noting that regional variations do exist. Reinsurers have an investment exposure similar to P&C, with 65 percent in bonds and the rest in stocks and other investment products.¹⁵⁹

32 Both underwriting and investing are subject to cyclical fluctuations and data from a single year should not be used towards establishing the characteristics of industry profitability. Also, the investment portfolios are not used solely for profit but to be able to pay out claims as they arise.

Since the investments of the global insurance industry, in aggregate, are predominantly exposed to sovereign and corporate bonds followed by stocks,¹⁶⁰ one could examine the economic sector exposure of the industry by analysing the top sectors for bonds and stocks, by volume. For corporate bonds, the US corporate investment-grade bonds³³ are used, for lack of better data, as a proxy¹⁶¹ for getting an indication of the size of industry’s corporate bond exposure. For municipal and sovereign bonds, the top sectors are public utilities, transportation, construction, health, education, industrial, and housing/real estate. For stocks, a broad market ETF could be a reasonable proxy³⁴ to get an indication of the insurance industry’s stock market exposure. The overall exposure³⁵ of the insurance investment to economic sectors is illustrated by Figure 26 below.

Figure 26 Distribution of global re/insurers’ investments among economic sectors



Note: The size of each sector represents the relative size of investments in that sector.

Source: Author’s estimations

33 First, insurance industry’s bond exposure is mostly investment grade (BBB-rated or above). Second, since the global corporate bond market, in terms of country of incorporation, is dominated by the US followed by Europe, China, and emerging markets, it is reasonable to use the US corporate bond market as a proxy to understand the global corporate bond exposure to business/economic sectors. It is, however, duly noted that the regional differences between investment mixes exist, and in some jurisdictions, the differences might be quite large. See International Capital Market Association (ICMA), 2020. Bond market size. www.icmagroup.org/Regulatory-Policy-and-Market-Practice/Secondary-Markets/bond-market-size

34 Since ETFs vary by sector weightings and each insurance company might have its own preference, S&P 500 Index sectors and their weights are used as a proxy for the insurance sector’s equity exposure. www.etf.com/sections/etf-strategist-corner/sector-sector-sp-500?nopaging=1

35 More relative weightage is given to sectors with bond investments than stock investments to get a relative size of sectoral investments. This is based on the author’s own assessment.

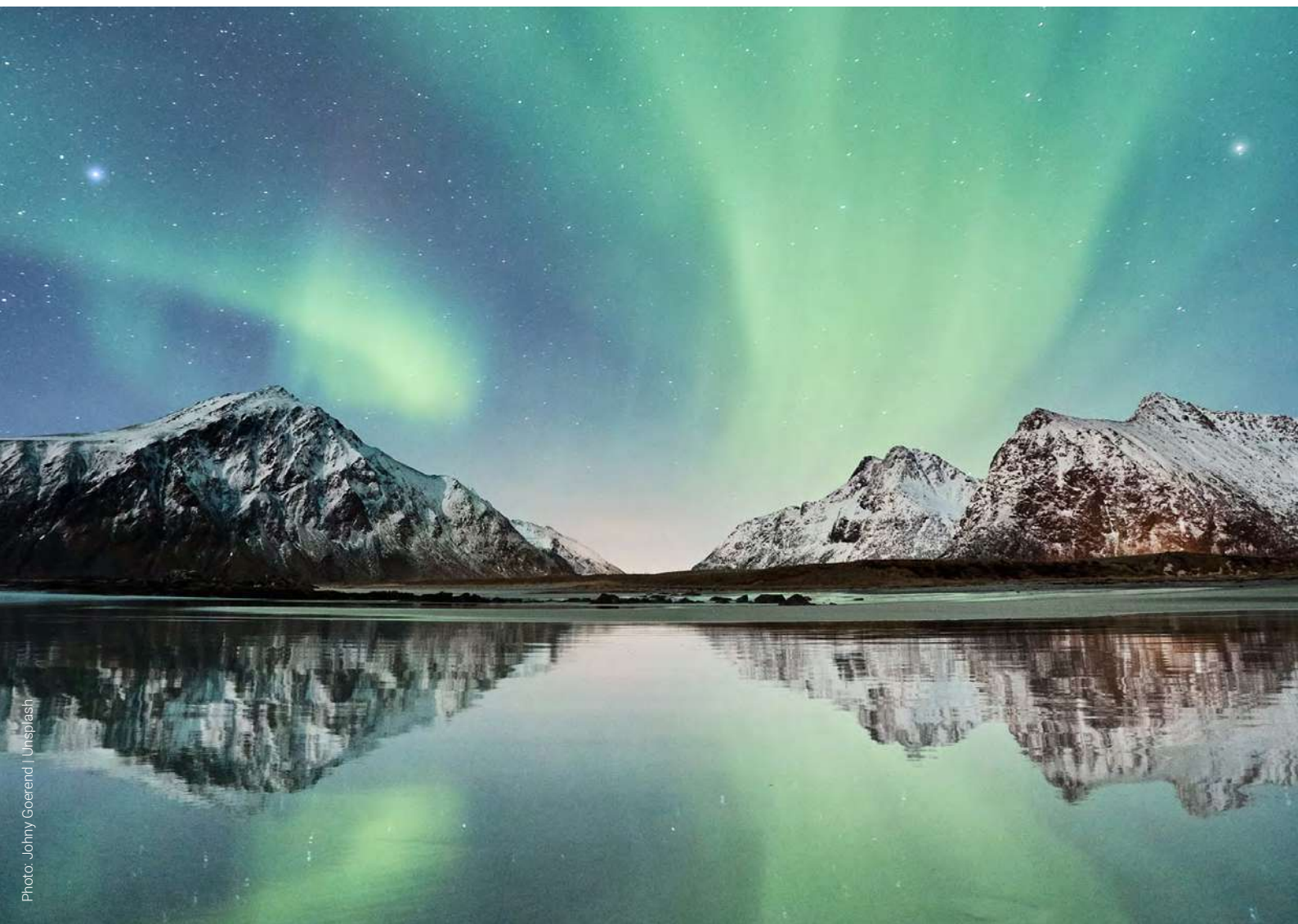
Annex VI

Assessment of nature-related physical risks to various economic sectors

Using Natural Capital Finance Alliance's ENCORE database, the following sections elaborate on each economic sector's level of dependency on various ecosystem services (very high, high and medium) and assign nature-related physical risk level to each business sector (very high, high and medium). The level of nature loss is derived using the framework for planetary boundaries in Figure 5 and in consultation with the experts in nature and biodiversity. The risk level is assigned by mapping the potential dependency with level of nature loss (very high, high and medium). The methodology is further explained in Annex VII.

Even though each of the following economic sectors depends on several ecosystem services, the illustration (in radial charts below) is provided only if physical risks corresponding to those services are very high, high, or medium. The ecosystem services that are at low physical risks or not applicable to the economic sector, are excluded from the illustration for clarity purposes. For a full picture of the dependency of each sector, please refer to Figure 8.

This assessment is important because a re/insurance company insures or invests in companies or businesses in the real economy, and the changes of the risk profile of an economic sector arising from nature loss makes them pertinent to the re/insurance companies.

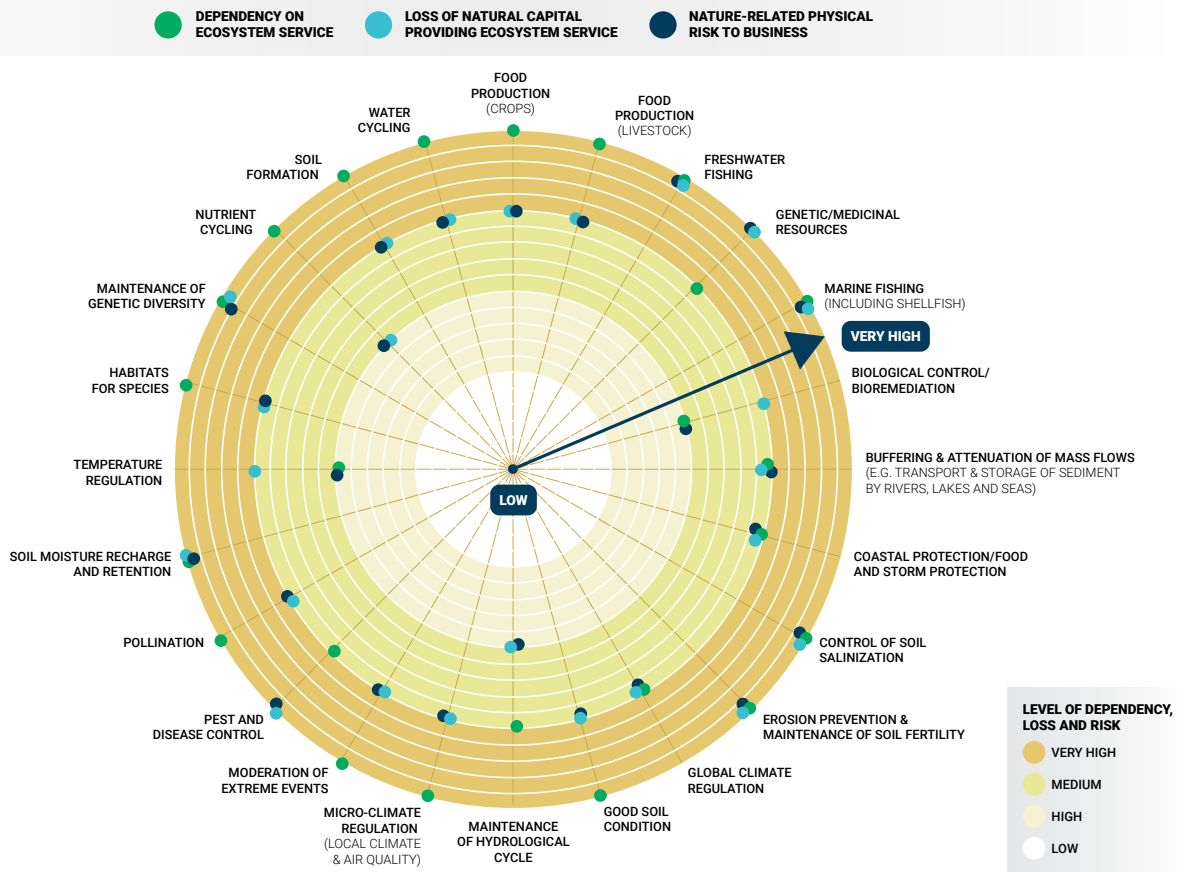


Agriculture, fishery and livestock

Agriculture, fishery and livestock businesses are very highly or highly dependent on several ecosystem services, most prominently the ones derived from water, land and species. While a net global assessment of the economic value these businesses generate from nature is not available, one estimate¹⁶² places the global annual market value of animal-pollinated crops at up to US\$577 billion, the first sale valuation of fisheries and aquaculture at US\$362 billion per year, and the global annual value of seagrass nutrient cycling (e.g. the economic enhancement of commercial fish by seagrass) at US\$1.9 trillion. A study by the Economics of Ecosystems and Biodiversity¹⁶³ found that a well-managed reef in the Indian and Pacific Oceans can provide between 5 and 15 tonnes of seafood per square kilometre each year, demonstrating the important role of coral reef habitats. Another study,¹⁶⁴ looking specifically at pest management ecosystem services (e.g. animals and birds feeding on potentially harmful pests), values the natural pest control in agricultural settings between US\$54 billion and US\$1 trillion. A study by WWF¹⁶⁵ shows that around 6,000 terrestrial plant species are domesticated today, of which nine account for two thirds of crop production.

Figure 27 **Dependency level of agriculture, fishery and livestock business sector on nature, and business risk as a result of nature loss**

AGRICULTURE, FISHERY & LIVESTOCK



Source: Author

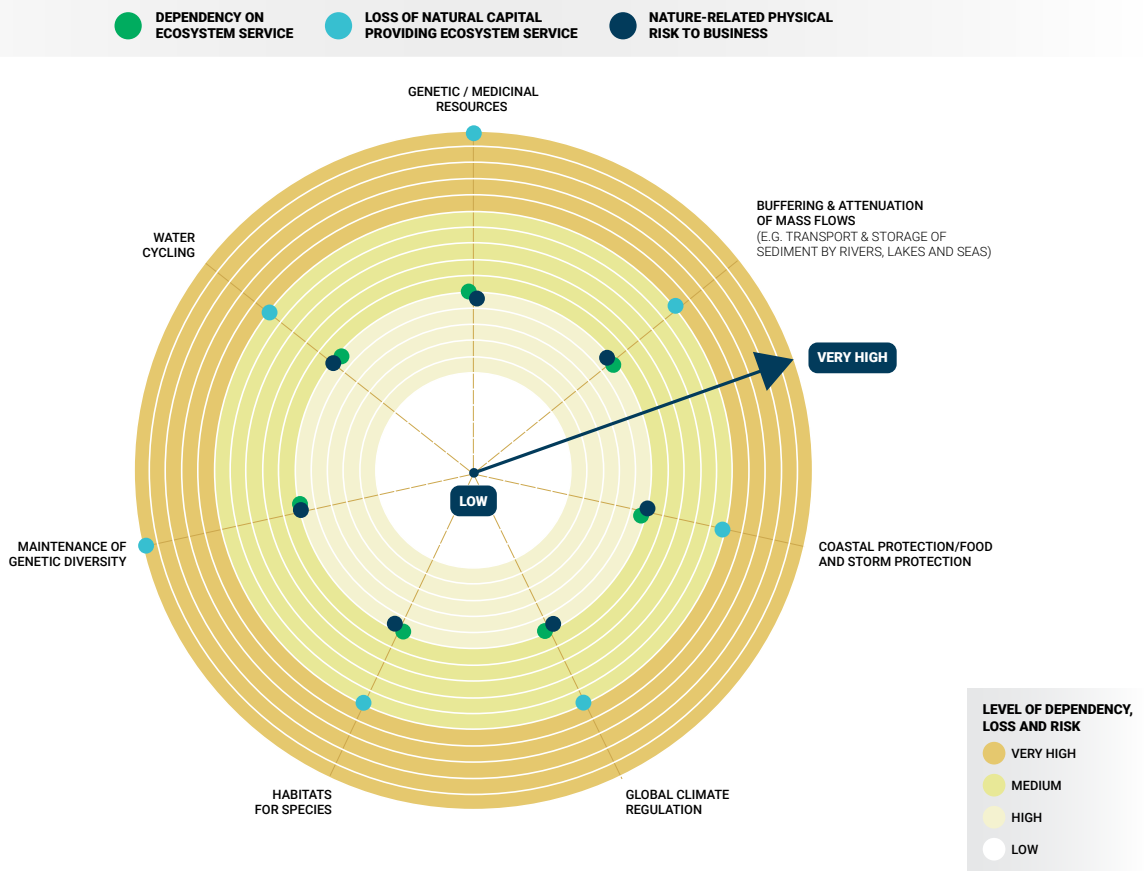
The physical risks to agriculture, fishery and livestock businesses are mostly very high and high because of their very high or high level of dependency on ecosystem services and the current very high or high global level of nature loss that has deteriorated the ecosystem services on which these businesses depend.

Apparel (clothing, footwear, etc.) and textiles

The apparel and textile sector is only moderately dependent on most ecosystem services. The provision of groundwater and freshwater is the only case where the dependence is very high, because textile production (including cotton farming) uses around 93 billion cubic metres of water annually, which represents 4 percent of global freshwater withdrawals.¹⁶⁶ Similarly, an estimated 342 million barrels of oil, a non-renewable natural resource, are used every year by the textile industry to produce plastic-based fibres.¹⁶⁷

Figure 28 **Dependency level of apparel and textile business sector on nature, and business risk as a result of nature loss**

APPAREL (CLOTHING, FOOTWEAR, ETC.) & TEXTILES



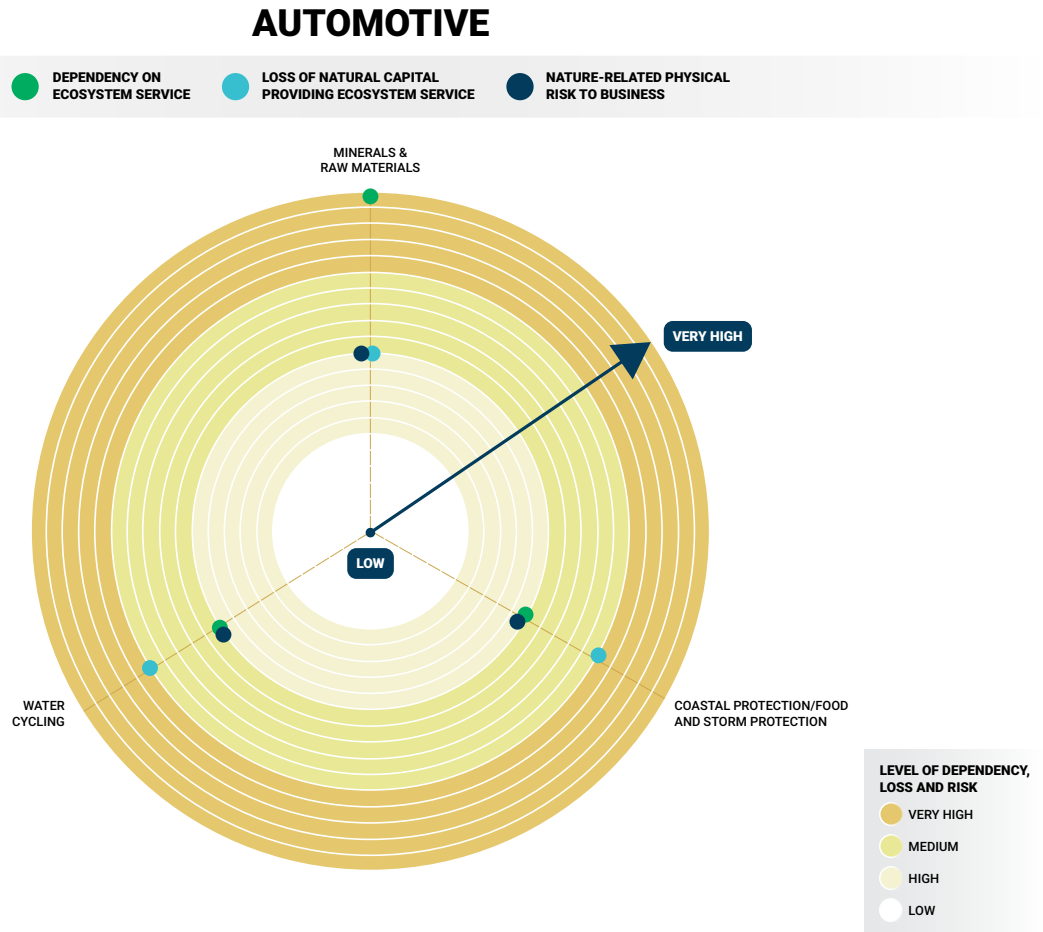
Source: Author

The level of physical risk to the business is low because of the low level of depletion of water resources at the global level. However, at the regional or sub-regional level, many parts of the world have already reached very high levels of freshwater and groundwater loss (see Figure 5), which should be a concern for apparel and textile companies operating in those regions.

Automotive

The automotive sector is below moderately dependent on most ecosystem services. The provision of minerals and raw materials is the only case where the dependence is very high. A study by Nissan¹⁶⁸ shows that automobiles are highly dependent on mineral resources, and metals account for approximately 80 percent by weight of the materials used to build a vehicle.

Figure 29 **Dependency level of automotive business sector on nature, and business risk as a result of nature loss**



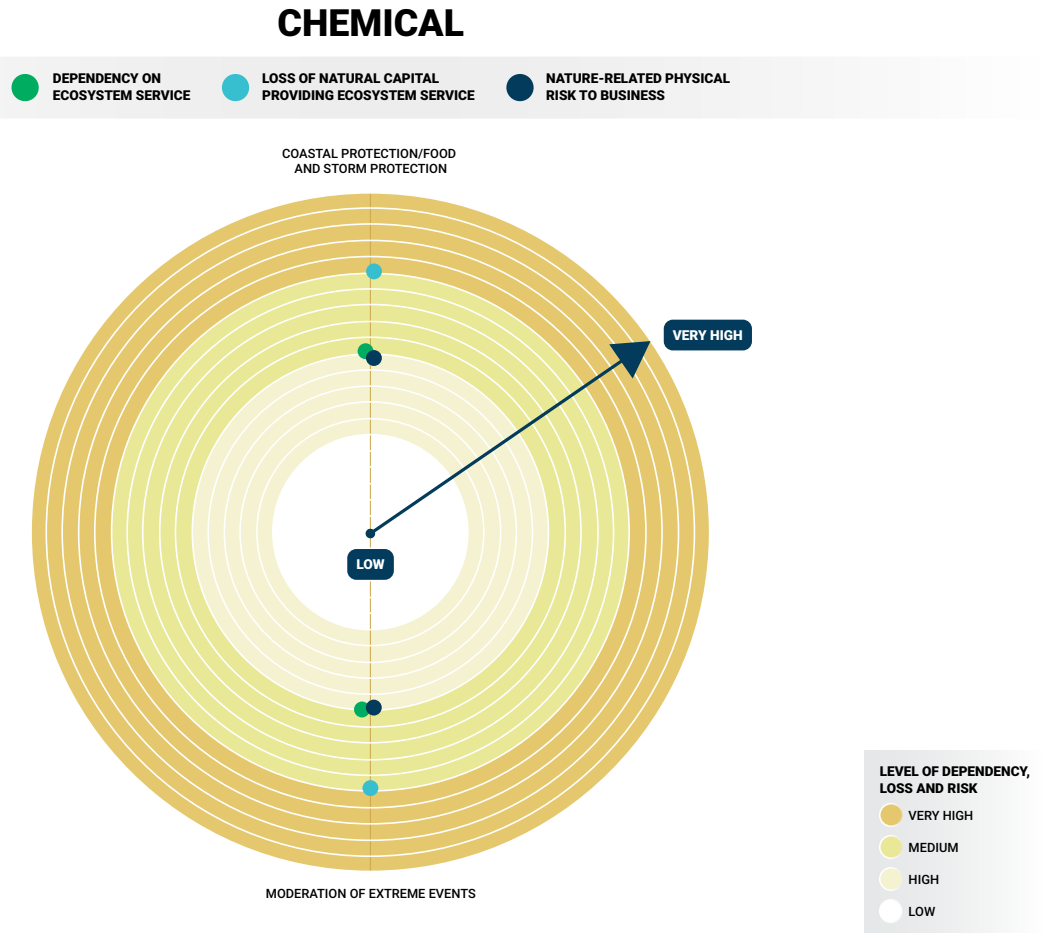
Source: Author

The level of physical risk to the business is medium because of the less significant depletion of minerals and raw materials at the global level. Although metals and minerals are overexploited in certain parts of the world, a study published in *Nature*¹⁶⁹ suggests that a direct reserve depletion is not a source of risk in metal and mineral supply over the coming decades.

Chemical (excluding pharmaceuticals)

The chemical business sector is below moderately dependent on most ecosystem services. The provision of ground and surface water, mainly used for process functioning, cooling, cleaning and transport, is the only case where the dependence is very high. The manufacturing phase is also moderately dependent on protection against floods, storms and extreme events, especially for sites that are located in flood-prone areas.

Figure 30 **Dependency level of chemical business sector on nature, and business risk as a result of nature loss**



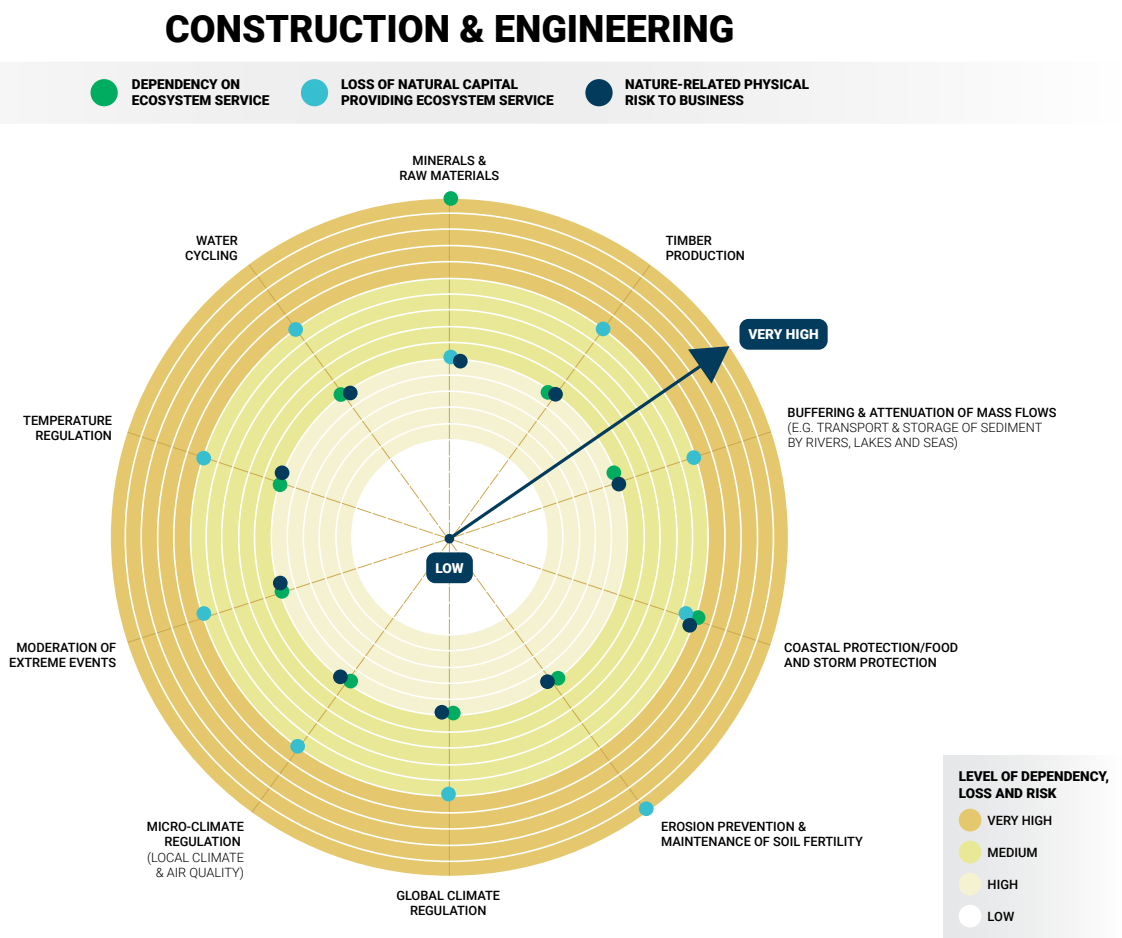
Source: Author

Despite a very high dependency on ground and surface water, the physical risk to the business is low because of the low level of depletion of ground and surface water at the global level.

Construction and engineering

The construction and engineering sector, consisting mainly of buildings construction and heavy and civil engineering construction, is moderately dependent on several ecosystem services, most prominently the provision of ground and surface water, timber production, erosion control, climate regulation, hydrological cycle and moderation of extreme events. The dependency is very high for minerals and raw materials, and high for flood and storm protection. In terms of raw materials, the global construction industry is the largest consumer of sand, whose extraction has increased by more than 300 percent over the last 30 years.¹⁷⁰ Since desert sand is too round for the cement to adhere, much of this sand is extracted from the oceans. Other raw materials heavily used in this industry are clay, limestone, stone, gravel, wood, iron, aluminum and copper, among others. In Europe, housing alone accounts for 30–50 percent of the use of these materials.¹⁷¹

Figure 31 Dependency level of construction and engineering business sector on nature, and business risk as a result of nature loss



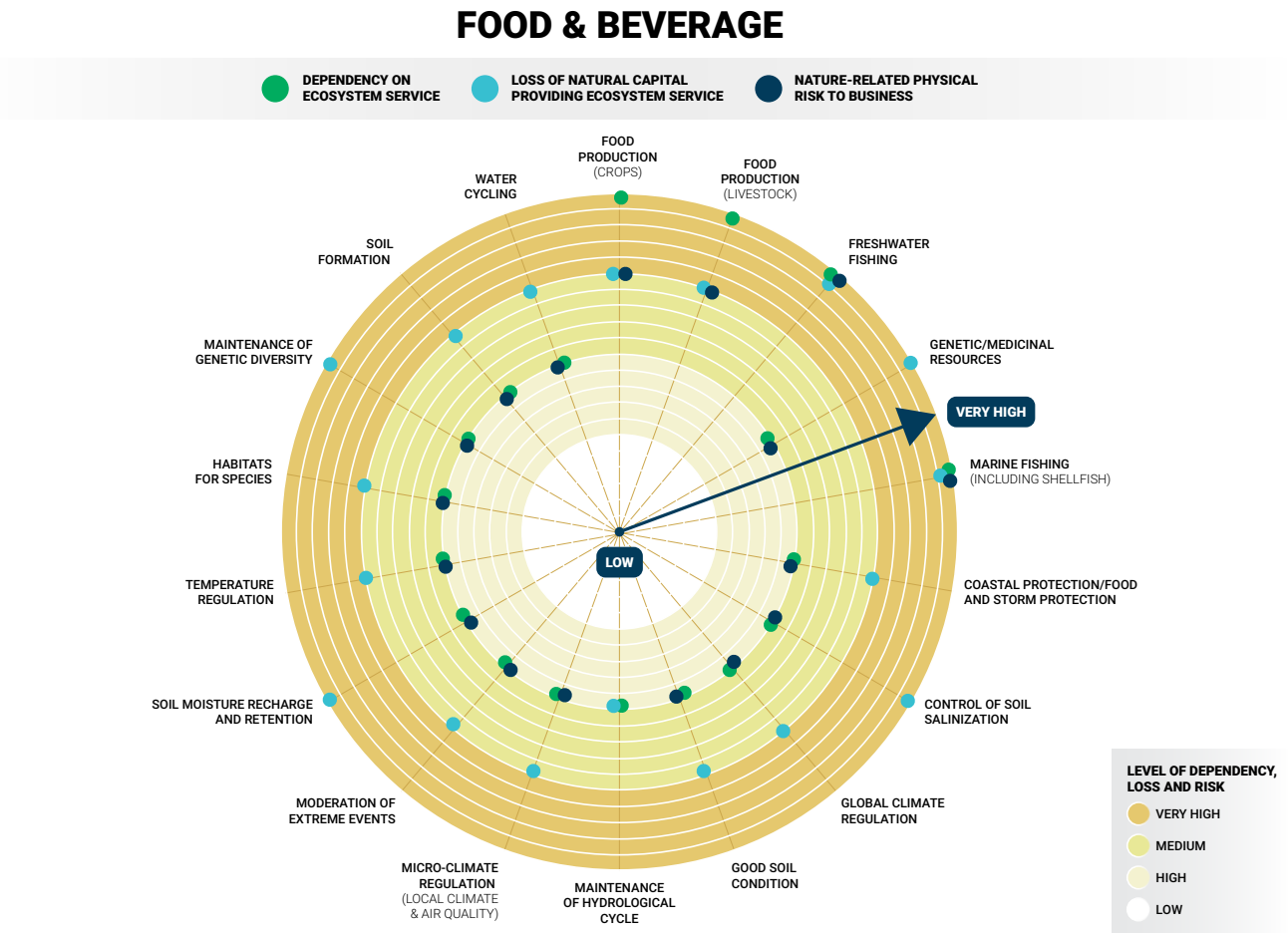
Source: Author

The physical risk to the business is moderate except in coastal areas where the risk is high because of the high level of coastal area deterioration on a global level.

Food and beverage

The food and beverage business sector is distinct from the agriculture, fishery and livestock sector covered in this report with some overlaps. The former is involved in the processing of raw food materials while the latter is involved in primary food production. The food and beverage sector is very highly or highly dependent on some ecosystem services, predominantly the provisioning of food production, and ground and surface water. A study by WWF¹⁷² shows that humans use over 1,160 wild plant species, and at least 2,111 insect, 1,600 bird, 1,110 mammal, 140 reptile and 230 amphibian species as food. The same study shows that around 60 species of edible fungi are commercially cultivated by the food and beverage sector.

Figure 32 Dependency level of food and beverage business sector on nature, and business risk as a result of nature loss



Source: Author

The physical risks to this business sector are similar to those for the agricultural sector because of the heavy reliance on agricultural products.

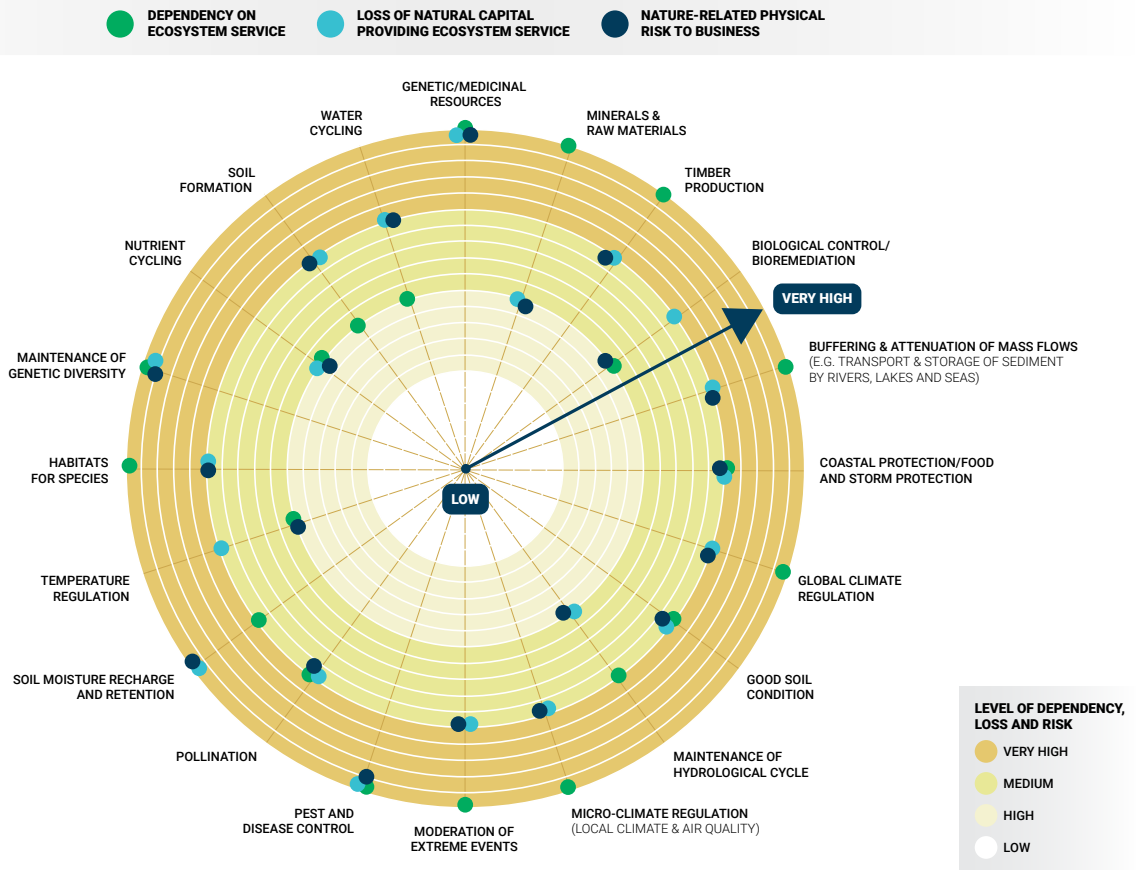
Manufacturing (e.g. metals, paper, timber)

Primary metals, fabricated metal products, plastics, rubber, and electrical and electronics components

The manufacturing of primary metals and electrical and electronics components is very highly or highly dependent on most ecosystem services, in particular on minerals and raw materials but also protection services for the manufacturing sites. Since the supply chains involved in this industry are globalized, it is important to examine nature dependencies at the supplier level as these dependencies are often indirect. For example, for subsectors such as rubber, ecosystem services such as good soil condition, soil moisture retention, nutrient cycling and soil formation are important because these services enhance soil macrofaunal activities, the distribution and protection of organic matter and the neutralization of soil pH¹⁷³ – all essential for the primary supply of rubber to the industry.

Figure 33 Dependency level of manufacturing business sector (excluding paper, pulp and timber) on nature, and business risk as a result of nature loss

MANUFACTURING (METALS & OTHERS)



Source: Author

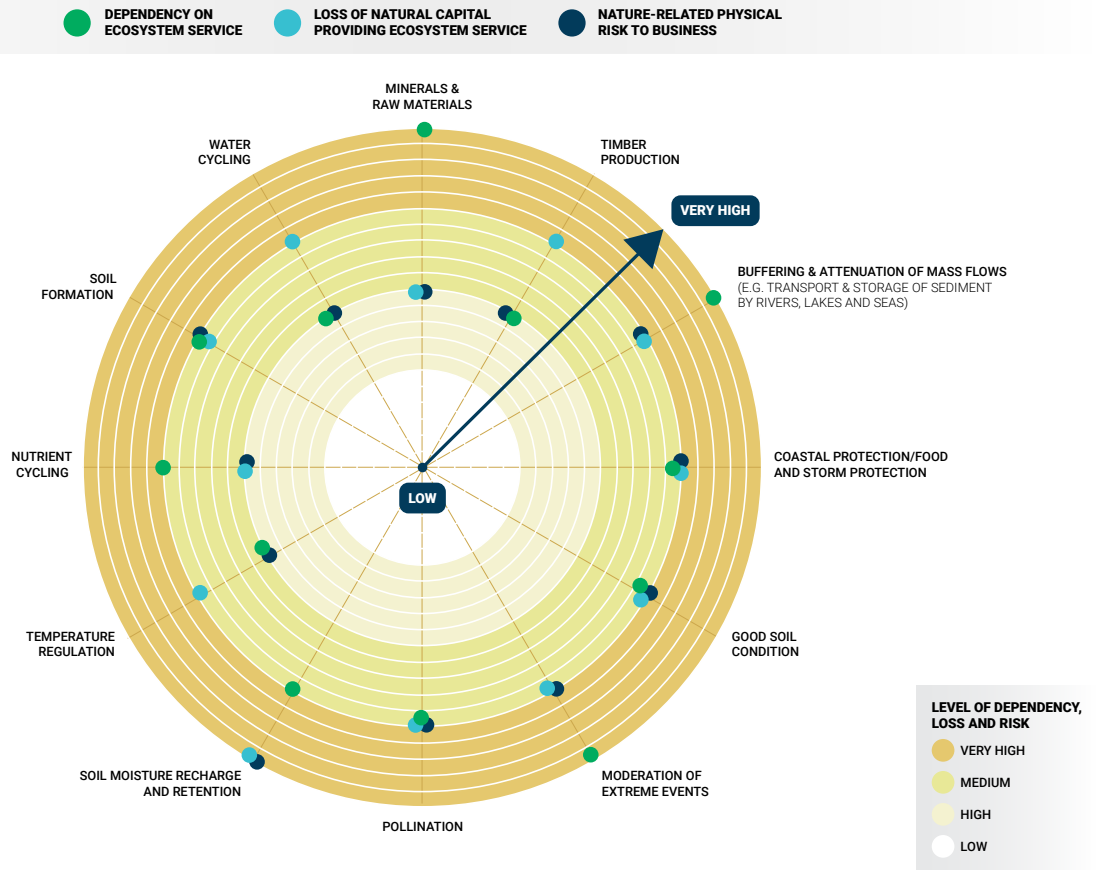
The physical risk to this sector is fairly high because of the already high level of loss of natural capital providing many of the ecosystem services on which the sector is highly dependent. In the figure above, no immediate physical risk has been identified corresponding to freshwater use because of the availability of freshwater on a global scale. However, as this industry is very water-intensive (e.g. it takes more than 30 litres of water to make a single computer chip), a regional and subregional assessment of water availability should be conducted to get a geographically disaggregated landscape of physical risks. For example, in Taiwan (Province of China), where multiple water reservoirs have dropped below 20 percent because of repeated drought events, the semiconductor industry, which uses 10 percent of the island's water,¹⁷⁴ faces risks of disruption to its chipmaking capacity.

Paper, pulp and timber (including furniture and related products)

The paper, pulp and timber manufacturing business is very highly dependent on most ecosystem services. The forest products contributing to the global timber, pulp and paper industry accounted for a total of US\$390 billion in global exports in 2019.¹⁷⁵

Figure 34 **Dependency level of paper, pulp and timber manufacturing business sector on nature, and business risk as a result of nature loss**

MANUFACTURING (PAPER, PULP, TIMBER)



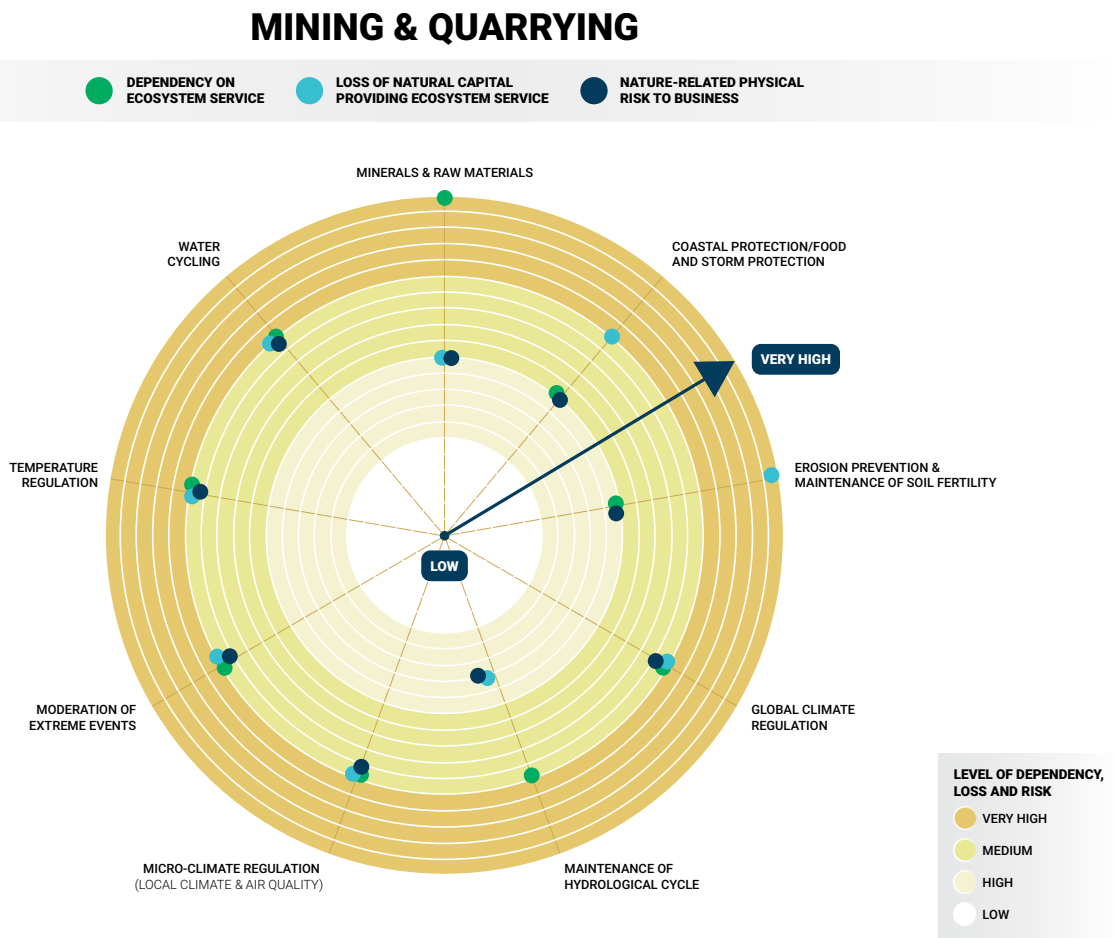
Source: Author

Since the level of loss of natural capital providing most ecosystem services is relatively high or medium, the physical risks to business are generally high.

Mining and quarrying

The mining and quarrying business sector is highly dependent on the provision of minerals and raw materials. In terms of total revenue generated by the top 40 mining and quarrying companies, the major commodities mined globally are copper (26 percent), iron ore (22 percent), coal (17 percent), gold (13 percent), aluminium (3 percent), platinum group metals (2 percent) and others, including phosphate, potash, silver and zinc (17 percent).¹⁷⁶ The raw materials used in the production of batteries, including lithium, nickel, cobalt, manganese and graphite represent less than 3 percent. As of 2020, the total market capitalization of the top 40 mining and quarrying companies was US\$1.46 trillion.¹⁷⁷ As metals and minerals are directly extracted from the Earth's crust, the industry's dependency on nature is direct and the highest among all business sectors. The regulating and supporting ecosystem services such as flood and storm protection, moderation of extreme events and climate regulation are also highly important for this business sector.

Figure 35 Dependency level of mining and quarrying business sector on nature, and business risk as a result of nature loss



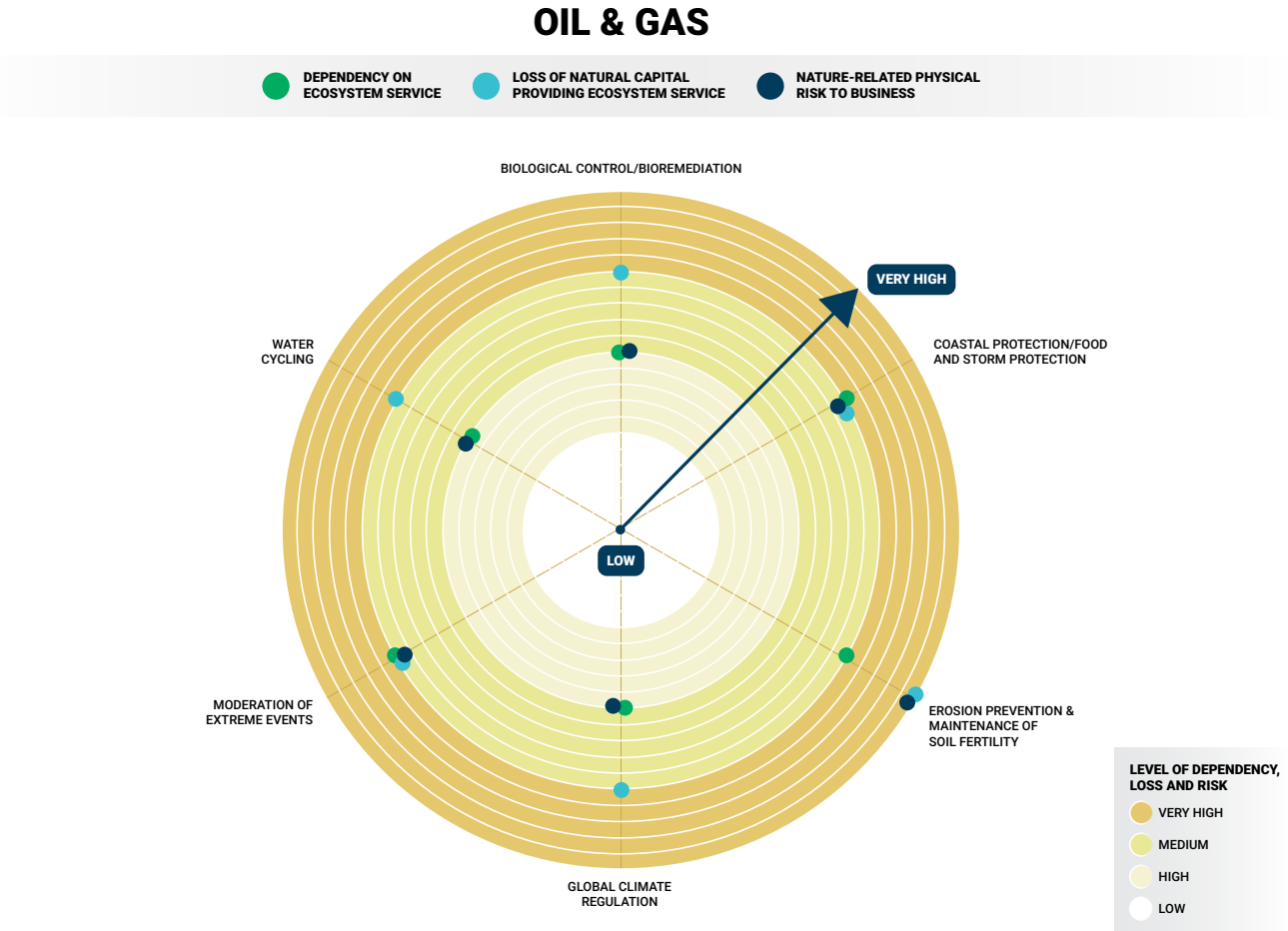
Source: Author

The relative physical risk of a direct reserve depletion of minerals and raw materials is not high according to a study published in *Nature*.¹⁷⁸ However, the overall physical risk to the sector is high because of the deterioration in supporting and regulating ecosystem services.

Oil and gas

The oil and gas business sector is moderately dependent on a limited number of ecosystem services as illustrated in the figure below. As oil and gas are directly extracted from the Earth’s crust, the industry’s dependency on nature is direct.

Figure 36 **Dependency level of oil and gas business sector on nature, and business risk as a result of nature loss**



Source: Author

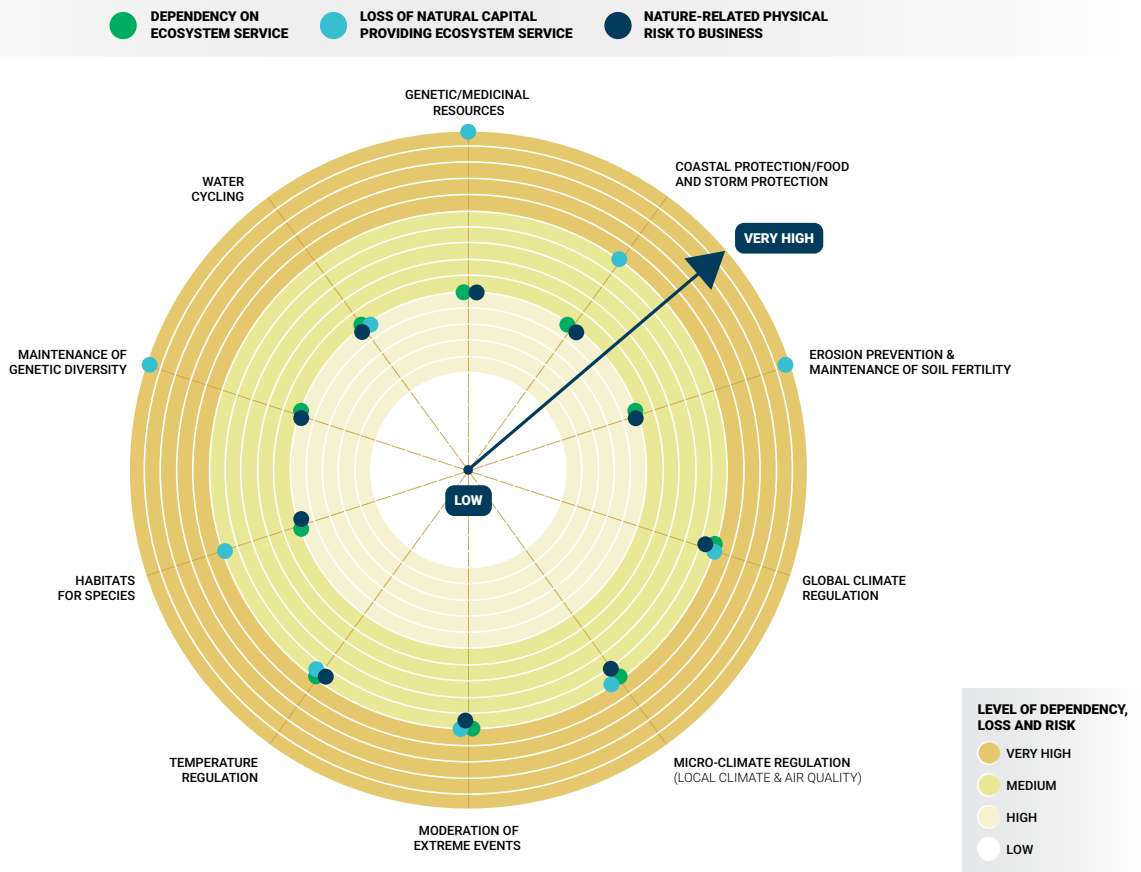
The overall physical risk to the sector is medium to high because of the deterioration in supporting and regulating ecosystem services.

Pharmaceutical, healthcare, life sciences and biotech

The pharmaceutical, healthcare, life sciences and biotechnology business sector is moderately dependent on a limited number of ecosystem services. According to an assessment by the OECD,¹⁷⁹ many drugs used today are derived directly from nature (e.g. digoxin from plant sources, exenatide from lizards, ziconotide from cone snails, penicillin from fungi, atorvastatin from a microbial natural product), which is only a fraction of the millions of plant, microbe and animal species on Earth that could be studied for their pharmacological potential. A US Environment Protection Agency analysis of the costs and benefits of its Clean Air Act between 1990 and 2020¹⁸⁰ shows that the benefits of cleaner air exceed costs, on average, by a factor of more than 30 to 1, leading to better health and productivity for American workers as well as savings on medical expenses for air pollution-related health problems. The same analysis estimates that the Clean Air Act Amendments will prevent over 230,000 early deaths in 2020, demonstrating the significant value of quality air to the global healthcare industry. A similar study¹⁸¹ on the magnitude and value of the effects of trees and forests on air quality and human health across the United States showed lower incidences of acute respiratory symptoms in areas with trees than in those without.

Figure 37 **Dependency level of pharmaceutical, healthcare and biotechnology business sector on nature, and business risk as a result of nature loss**

PHARMACEUTICAL, HEALTHCARE, LIFE SCIENCES AND BIOTECH



Source: Author

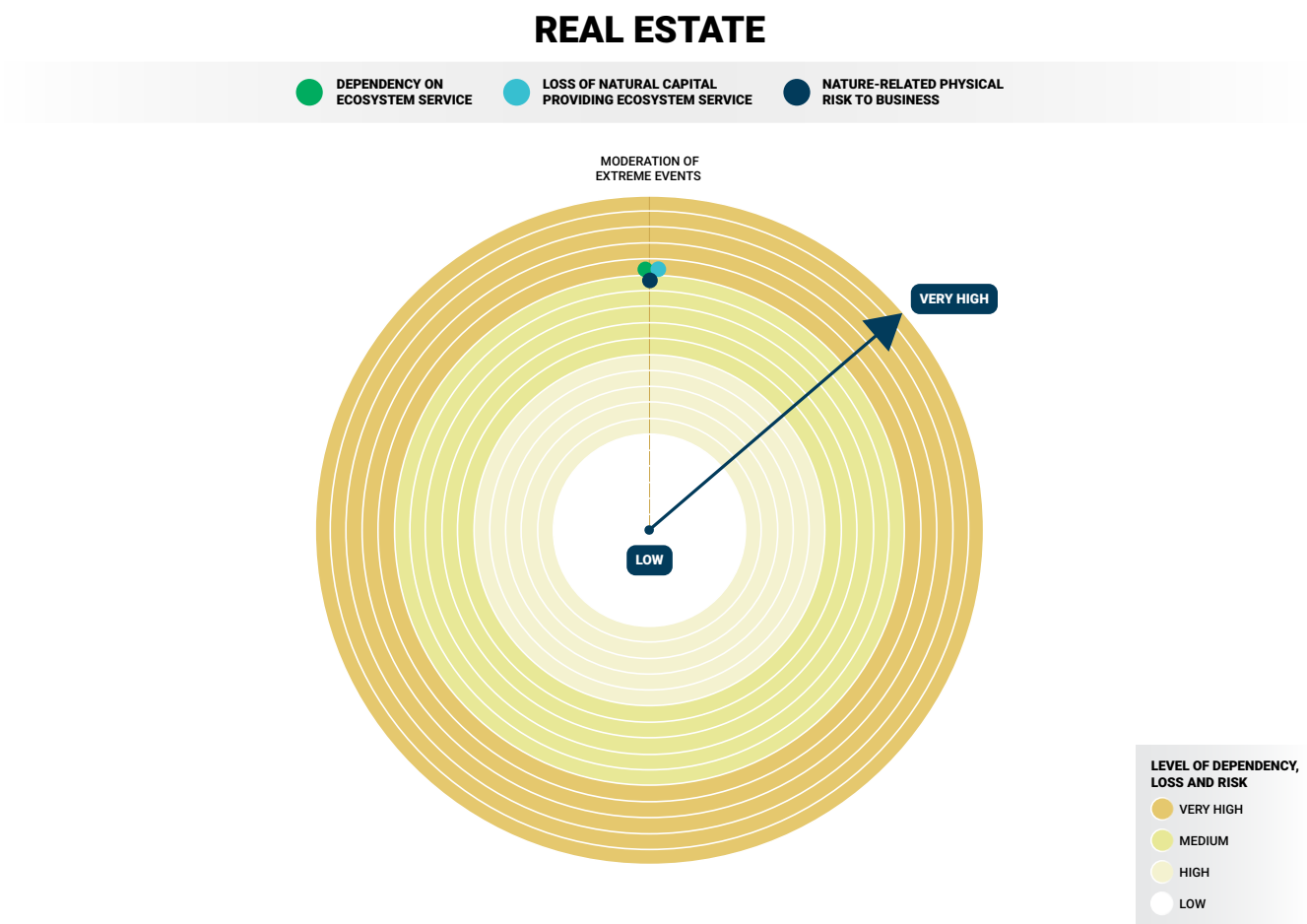
The physical risks to this sector because of nature loss are medium to high. The risks related to depletion of genetic resources are only moderate at this stage and could continue to remain so because of technological advancement in the production of synthetic genetic materials for drugs.

Real estate/home

When assessed separately from construction and engineering, the real estate business sector is relatively less dependent on most ecosystem services. The high dependency is only on the moderation of extreme events. By one estimate,¹⁸² coral reefs reduce wave energy by an average of 97 percent, protecting nearly 50 percent of the global population living in low exposed areas near reefs from the increased frequency of natural hazards caused by storms, flooding and rising sea levels. Another study on the flood reduction benefits of mangroves to people and property in critical global hotspots found that such functions could generate an annual value of US\$82 billion.¹⁸³

From a valuation perspective, a University of Washington study suggests that “homes that are adjacent to naturalistic parks and open spaces are valued at 8–20 percent higher than comparable properties, and the presence of larger trees in yards and as street trees can add from 3 percent to 15 percent to home values throughout neighborhoods”.¹⁸⁴

Figure 38 **Dependency level of real estate business sector on nature, and business risk as a result of nature loss**



Source: Author

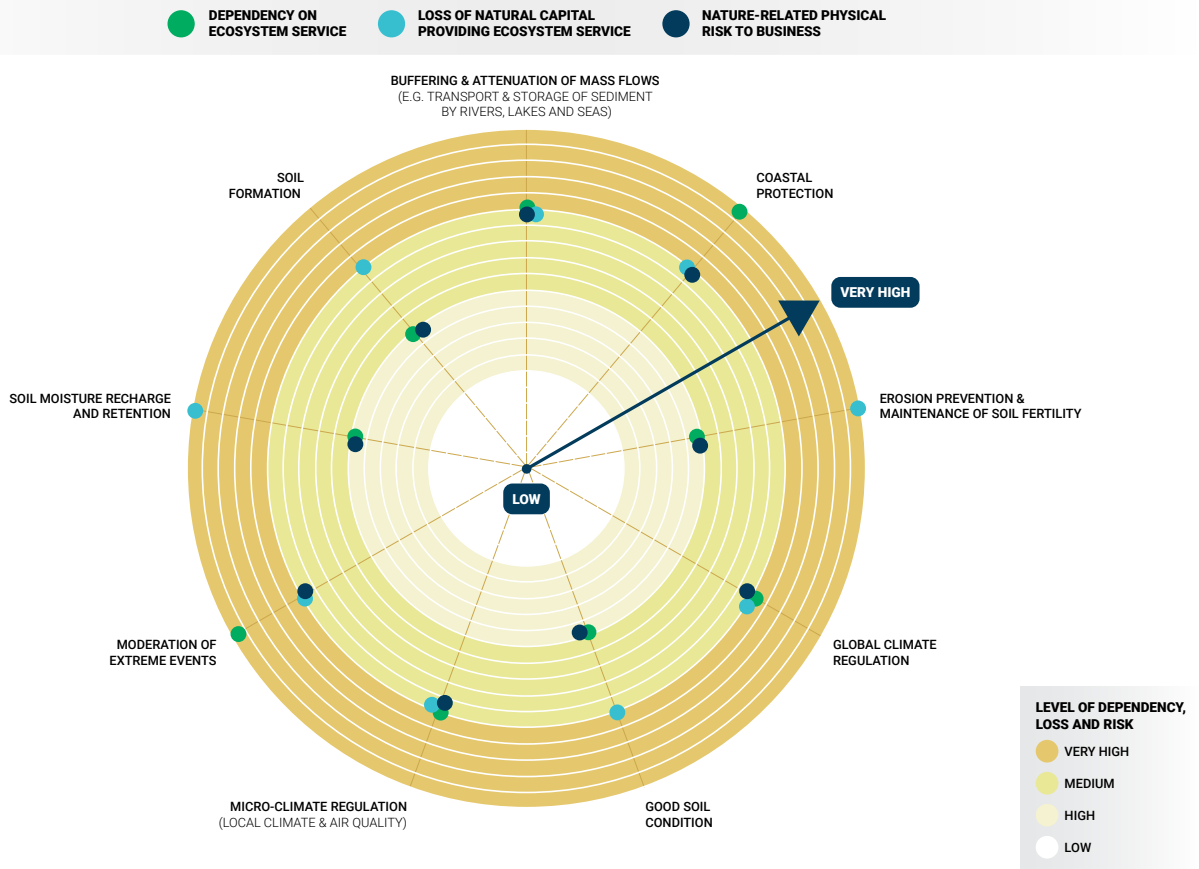
Over the last decade, extreme events such as flooding, storms, hurricanes and wildfires have become more frequent. On the other hand, natural defense systems such as mangroves are disappearing fast. Similarly, because of climate change and other human activities, forests are becoming thinner, less diverse and soil is becoming drier – increasing the intensity of wildfires. Hence, even though real estate’s overall dependency on nature is low, the fast-paced loss of regulating and supporting ecosystem services makes the overall physical risk to this business sector high.

Telecommunications, IT, media and entertainment

When assessing the dependence of the telecommunications, IT (including data processing, hosting and related services), media (including publishing) and entertainment (e.g. broadcasting, music and sports) sector, the key focus is on the underlying infrastructure such as transmission lines and cables, broadcasting towers and data servers. Since the production of these parts (e.g. chip manufacturing) is already covered by other business sectors in this report, we consider installation infrastructure (e.g. telecom towers with different components) for our dependency study. This infrastructure is moderately dependent on regulating and supporting ecosystem services, similar to real estate.

Figure 39 **Dependency level of telecommunications and information technology business sector on nature, and business risk as a result of nature loss**

TELECOMMUNICATIONS, IT, MEDIA & ENTERTAINMENT



Source: Author

Since the relative vulnerability of this business sector’s infrastructure (e.g. transmitters and cables) to natural or anthropogenic hazards such as landslides, floods and storms is high compared to real estate, the physical risks resulting from the loss of some ecosystem services is also high. However, the operational risk to business is relatively low because of the sector’s superior repair and recovery options (mobile network antennas, poles and towers).

Tourism, travel and hospitality

The tourism and travel business sector is very highly or highly dependent on a large number of ecosystem services. While a net global assessment of economic value generated by tourism and travel business from nature is not available, an assessment by McKinsey¹⁸⁵ found that tourism linked to protected areas was worth approximately US\$300 billion in revenues in 2019. An OECD study¹⁸⁶ estimated that global coral reef tourism has an annual value of US\$36 billion and that the recreational benefits of French forest ecosystems have an annual value of US\$10 billion. Another recent finding by the UK's Office for National Statistics¹⁸⁷ put nature's contribution to the British tourism and outdoor leisure business at US\$17 billion in 2019.

Figure 40 Dependency level of tourism business sector on nature, and business risk as a result of nature loss



Source: Author

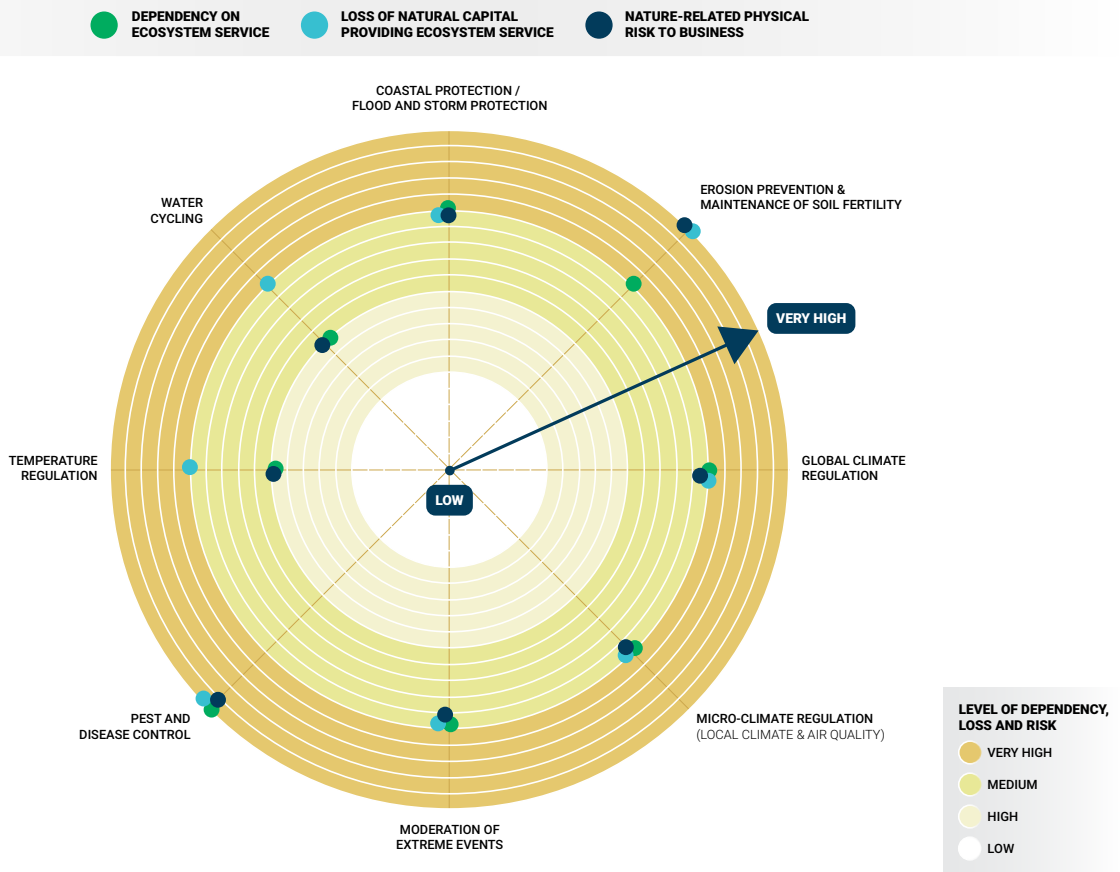
The physical risks to this business sector are high to very high because of the high dependence on ecosystem services as well as the high level of loss of natural capital providing these services. For example, nature's deteriorating capacity for bioremediation and detoxification of pollutants has resulted in more polluted lakes and rivers, and wasteland, which reduces the appeal for tourism. Similarly, habitat conservationists have argued that the increasing frequency of zoonotic diseases such as COVID-19 is a result of increasing encroachment into wild habitats and loss of natural habitat for species. A joint study by the World Tourism Organization (UNWTO) and the United Nations Conference on Trade and Development (UNCTAD) has estimated that as a result of COVID-19, the international tourism and its closely linked sectors suffered an estimated loss of US\$2.4 trillion in 2020.¹⁸⁸

Transportation and storage

The transportation (air, rail, water, truck, transit and ground passenger, and pipeline) and storage (including warehousing) business sector is highly or moderately dependent on regulating and supporting ecosystem services. For example, vegetation plays an important role in reducing the amount of sediment in runoff and storm water from reaching roadways and railways.

Figure 41 **Dependency level of transportation and storage business sector on nature, and business risk as a result of nature loss**

TRANSPORTATION & STORAGE



Source: Author

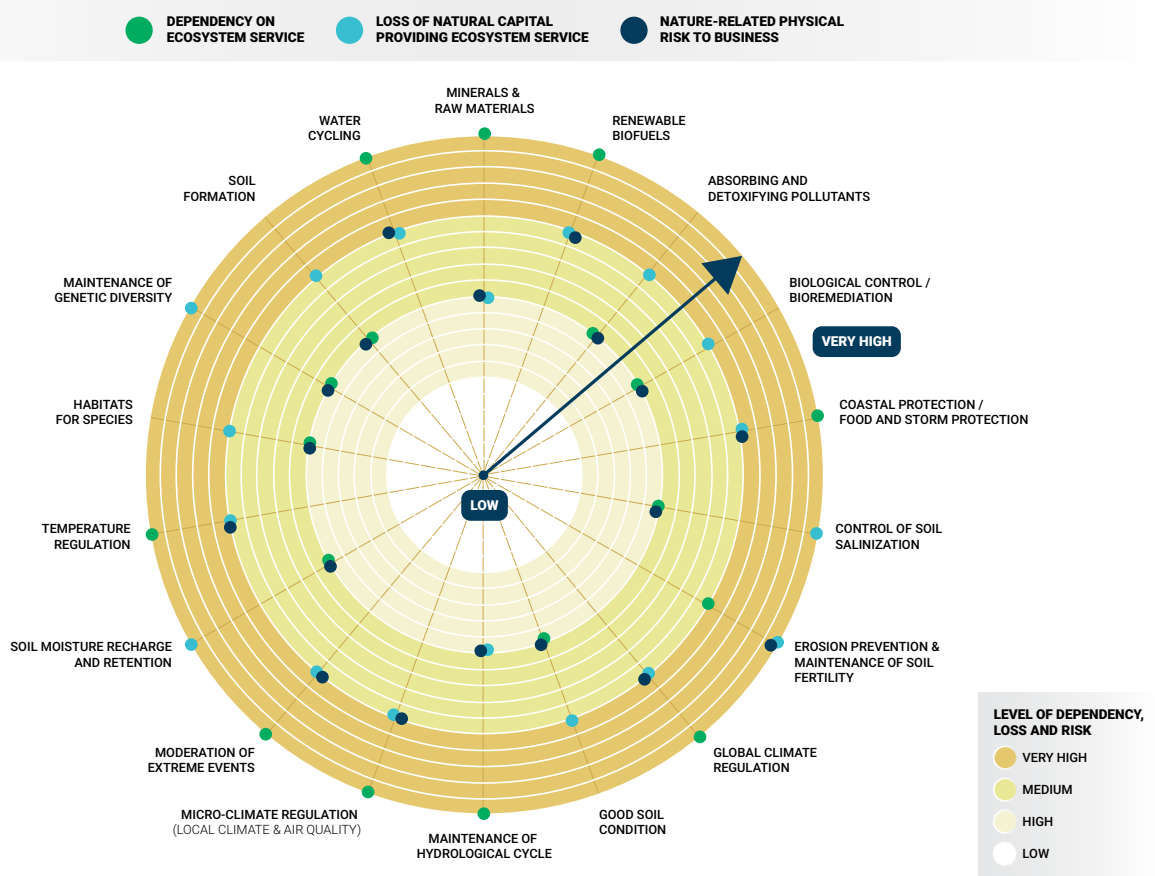
The physical risks of delays, disruptions, damage and failure across air, land-based and marine transportation systems are high because of the high to very high loss of natural capital providing ecosystem services such as erosion and flood control, and temperature regulation. For example, high temperatures can soften and expand roadways, creating potholes, particularly in high traffic areas.¹⁸⁹ Similarly, coastal storm surges could damage air transportation facilities such as airstrips. In areas with depleted vegetation cover, increased runoff from extreme precipitation events could cause silt and debris to build up, making shipping channels too shallow¹⁹⁰ and leading to weight restrictions for ships.

Utilities (electricity, energy, water)

The utilities business sector is very highly or moderately dependent on many ecosystem services. While a net global assessment of economic value generated by the utilities business from nature is not available, one could estimate the extent of benefits by examining individual ecosystem services. For example, the total flow of in-river nitrogen retention (in terms of water purification services) is valued at over US\$20 billion annually in Europe.¹⁹¹ An Ecorys study for the European Commission¹⁹² found that the water supply and sewerage sector, which is 100 percent dependent on freshwater and groundwater supplies, accounts for 0.3 percent of the total EU economy. Similarly, for hydropower plants, conservation and maintenance of upstream forests could increase water flow and reduce sedimentation.

Figure 42 Dependency level of utilities business sector on nature, and business risk as a result of nature loss

UTILITIES (ELECTRICITY, ENERGY, WATER)



Source: Author

Even though the physical risk of freshwater and groundwater loss at the global level is not high, the depletion of these resources has already reached an alarming level in many countries. This, in turn, poses a high risk for electricity utilities as well. According to UN Water,¹⁹³ 90 percent of the global power production consumes water – for raw material extraction, powering turbines and cooling thermal processes. In many countries, power plant cooling accounts for almost 50 percent of total freshwater withdrawals. As global energy demand is growing, physical risks arising from water stress will increase. Several regulating and supporting ecosystem services such as erosion and flood control are also rapidly deteriorating, which poses a medium to high risk to critical power and water infrastructure systems.

Annex VII

Methodology adopted for determining physical risks to economic sectors originating from nature loss

A re/insurance company insures or invests in companies in the real economy. To understand current nature-related physical risks to the re/insurance companies (D), it is first important to assess how companies in the real economy are dependent on nature (A), and what the current level of nature loss is (B).

A business sector's dependency on ecosystem services could be very high, high, medium, or low. In some cases, there is no dependency. The physical risk level related to each ecosystem service is derived by mapping these business dependencies to the current level of loss of natural capital providing the corresponding services. Although some authors think that higher dependency ultimately leads to higher risks¹⁹⁴ or at least higher *a priori* exposure to physical risks and vice versa, this may not always be the case, which is the reason this study also considers the current global loss as an additional variable in the equation. For example, a chemical plant operating in location X might be highly dependent on the provision of groundwater, but if there is no loss of groundwater level, the resulting physical risk for the plant could be negligible or low.

Since risk is a function of hazard, exposure, vulnerability and coping ability (see the formula and definitions below), the overall risk to a business sector is determined by assessing each of these individual variables.

For the purpose of this report, only a 'qualitative' assessment is conducted.

Potential dependency on ecosystem services (A)	Current global level of loss of natural capital stock providing these services (B)	Coping Ability (C)	Physical risk to business (D) ³⁶
Very high	Very high	Coping ability of each economic sector against a potential hazard resulting from loss of natural capital and deterioration of corresponding ecosystem services might be different, hence this variable is separately considered in sector-specific assessments in Annex VI.	Very high
Very high	High		High
Very high	Medium		Medium
Very high	Low		Low
High	Very high		Very high
High	High		High
High	Medium		Medium
High	Low		Low
Medium	Very high		Medium
Medium	High		Medium
Medium	Medium		Low
Medium	Low		Low
Low	Very high		Low
Low	High		Low
Low	Medium		Low
Low	Low		Low

³⁶ D is a function of A, B and C. C is considered directly in sector-specific assessments in Annex VI.

Risk = Hazard × Exposure × (Vulnerability ÷ Coping Capacity) → Also called “Resilience”

where,

Hazard: Nature-related physical or transition events, trends or impacts.

Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure or economic, social or cultural assets in places and settings that could be adversely affected.

Vulnerability: Susceptibility to damage, given a certain hazard event.

Coping Capacity: Capacity to cope with a hazard event.

Resilience: Capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values or a range of possible outcomes. Risk, therefore, depends not only on the magnitude and frequency of hazards but also the exposure and vulnerability to any given hazard. For example, “the risk from flooding to human and ecological systems is caused by the flood hazard (the frequency and/or magnitude of flood events), the exposure of the system affected (e.g. topography, or infrastructure in the area potentially affected by flooding) and the vulnerability of the system (e.g. design and maintenance of infrastructure, existence of early warning systems)”.¹⁹⁵

Source: Cardona et al., 2012¹⁹⁶



ENDNOTES



Endnotes

- ¹ World Economic Forum (WEF), 2021. *The Global Risks Report 2021*, 16th Edition.
- ² NGFS, 2020. *Overview of Environmental Risk Analysis by Financial Institutions*.
- ³ Alliance for Corporate Transparency Project, 2020. General results EUKI Research 2020.
- ⁴ Capitals Coalition and Cambridge Conservation Initiative, 2020. *Integrating biodiversity into natural capital assessments*.
- ⁵ Taskforce on Nature-related Financial Disclosures (TNFD).
- ⁶ NGFS, 2021. *NGFS and INSPIRE launch a joint research project on 'Biodiversity and Financial Stability'*.
- ⁷ Dasgupta, P., 2021. *The Economics of Biodiversity: The Dasgupta Review*.
- ⁸ Some other reports have also adopted a similar approach. See Ninety One and WWF, 2020. *Climate & Nature Sovereign Index: Introducing a framework for a clear assessment of environmental risk*.
- ⁹ World Commission on Environment and Development, 1987. *Our Common Future*.
- ¹⁰ International Federation of Accountants, 2021. *Enhancing Corporate Reporting: Sustainability Building Blocks*.
- ¹¹ Lee, C. F. and Baral, P., 2017. *Green Finance Opportunities in ASEAN*.
- ¹² European Banking Authority (EBA), 2021. *EBA Report on Management and Supervision of ESG Risks for Credit Institutions and Investment Firms*.
- ¹³ Ibid.
- ¹⁴ United Nations, 1992. *United Nations Framework Convention on Climate Change*.
- ¹⁵ IPCC, 2021. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.
- ¹⁶ Pendleton L., Donato D.C., Murray B.C., Crooks S., Jenkins W.A., Sifleet S. et al., 2012. Estimating Global "Blue Carbon" Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems. *PLoS ONE* 7(9): e43542.
- ¹⁷ Goodyer, J., 2021. *The Amazon rainforest now emits more carbon than it absorbs*.
- ¹⁸ Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Desertification Synthesis*. World Resources Institute, Washington, DC.
- ¹⁹ IPBES, 2019. *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. [Brondizio, E. S., Settele, J., Díaz, S., & Ngo, H.T. (eds.)]. IPBES secretariat, Bonn, Germany.
- ²⁰ World Economic Forum (WEF), 2020. *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*.
- ²¹ WWF, 2020. *Living Planet Report 2020 – Bending the curve of biodiversity loss*.
- ²² IPBES, 2019. *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. [Brondizio, E. S., Settele, J., Díaz, S., & Ngo, H.T. (eds.)]. IPBES secretariat, Bonn, Germany.
- ²³ Environmental Business Journal, 2020. Volume XXXIII, Numbers 7/8.
- ²⁴ 1 quadrillion = 1,000 trillion
- ²⁵ Rockström, J., Steffen, W., Noone, K. et al., 2009. A safe operating space for humanity. *Nature* 461, 472–475.
- ²⁶ Steffen, W. et al., 2015. Planetary boundaries: Guiding human development on a changing planet. *Science* 347: 736, 1259855.
- ²⁷ World Economic Forum (WEF), 2020. *New Nature Economy Report II: The Future Of Nature And Business*.
- ²⁸ Steffen, W. et al., 2015. Planetary boundaries: Guiding human development on a changing planet. *Science* 347: 736, 1259855.
- ²⁹ Swiss Re Institute, 2020. *Biodiversity and Ecosystem Services: A business case for re/insurance*.

- ³⁰ Ibid.
- ³¹ As per data from McKinsey Global Insurance Pools and author's own research.
- ³² Pereira, R., 2020. Where insurers are placing their money. *IPE Magazine*.
- ³³ Costanza, R. et al., 2014. Changes in the global value of ecosystem services. *Global Environmental Change*, Vol. 26, pp. 152–158.
- ³⁴ World Economic Forum (WEF), 2020. *New Nature Economy Report II: The Future Of Nature And Business*.
- ³⁵ Swiss Re Institute, 2020. *Biodiversity and Ecosystem Services: A business case for re/insurance*.
- ³⁶ Swiss Re Institute, 2020. *Biodiversity and Ecosystem Services: A business case for re/insurance*.
- ³⁷ World Economic Forum, 2020. *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*.
- ³⁸ World Economic Forum (WEF), 2020. *New Nature Economy Report II: The Future Of Nature And Business*.
- ³⁹ Natural Capital Finance Alliance, 2021. ENCORE Database.
- ⁴⁰ Watson, S.C.L. and Newton, A.C., 2018. Dependency of Businesses on Flows of Ecosystem Services: A Case Study from the County of Dorset, UK. *Sustainability*, 10, 1368.
- ⁴¹ Allianz Global Corporate & Specialty, 2018. *Measuring and Managing Environmental Exposure – A Business Sector Analysis of Natural Capital Risk*.
- ⁴² G7, 2020. *Nature Compact*.
- ⁴³ Ibid.
- ⁴⁴ United Nations, 2019. Resolution adopted by the General Assembly on 1 March 2019.
- ⁴⁵ Convention on Biological Diversity (CBD), 2020. *Zero draft of the post-2020 global biodiversity framework*.
- ⁴⁶ UNEP-WCMC and IUCN (2021) *Protected Planet Report 2020*.
- ⁴⁷ Cefic, 2013. *Biodiversity and Ecosystem services – What are they all about?*
- ⁴⁸ Caldecott, B., Howarth, N. and McSharry, P., 2013. *Stranded Assets in Agriculture: Protecting Value from Environment-Related Risks*.
- ⁴⁹ European Commission. *Biodiversity strategy for 2030*.
- ⁵⁰ Nielsen, 2018. *Global consumers seek companies that care about environmental issues*.
- ⁵¹ Briggs, F., 2019. Over 75% of UK grocery shoppers switch, avoid or boycott brands because of environmental policies, says Kantar. *Retail Times*.
- ⁵² McKinsey & Company, 2014. *Profits with purpose: How organizing for sustainability can benefit the bottom line*.
- ⁵³ CB Insights, 2020. *Our Meatless Future: How the \$2.7T Global Meat Market Gets Disrupted*.
- ⁵⁴ Barker, S., Mulholland, E. and Onifade, T., 2020. *The emergence of foreseeable biodiversity-related liability risks for financial institutions - A gathering storm?* Commonwealth Climate and Law Initiative.
- ⁵⁵ Ibid.
- ⁵⁶ Ibid.
- ⁵⁷ Ibid.
- ⁵⁸ Ibid.
- ⁵⁹ Stop Ecocide, n.d.
- ⁶⁰ Finance for Biodiversity Initiative, 2020. *Aligning Global Finance with Nature's Needs: A Framework for Systemic Change*.
- ⁶¹ Tam, C., 2020. *Should Nature be Given Legal Rights?*

- 62 Ibid.
- 63 CDP Worldwide, 2020. *Analysis of CA100+ Company Data for CDP Investor Signatories*.
- 64 ISIS Asset Management, 2004. *Is biodiversity a material risk for companies? An assessment of the exposure of FTSE sectors to biodiversity risk*.
- 65 World Economic Forum, 2010. *Biodiversity and business risk: A Global Risks Network briefing*.
- 66 NGFS and INSPIRE, 2021. *Biodiversity and financial stability: exploring the case for action*.
- 67 University of Cambridge Institute for Sustainability Leadership (CISL), 2021. *Handbook for nature-related financial risks: key concepts and a framework for identification*.
- 68 Coalition of Finance Ministers for Climate Action, 2021. *Climate-Related Risks for Ministries of Finance: An Overview*.
- 69 NGFS, 2020. *Guide for supervisors: Integrating climate-related and environmental risks into prudential supervision*.
- 70 Swiss Re Institute, 2020. *Biodiversity and Ecosystem Services: A business case for re/insurance*.
- 71 Johnson, J.A. et al., 2021. *The Economic Case for Nature : A Global Earth-Economy Model to Assess Development Policy Pathways*. World Bank, Washington, DC.
- 72 Johnson, J.A. et al., 2020. *Global Futures: modelling the global economic impacts of environmental change to support policy-making*. Technical Report.
- 73 Dasgupta, P., 2021. *The Economics of Biodiversity: The Dasgupta Review*.
- 74 Financial Times, 2021. *Worst drought in a century hits Brazil as it fights to overcome Covid*.
- 75 Johnson, J.A. et al., 2021. *The Economic Case for Nature : A Global Earth-Economy Model to Assess Development Policy Pathways*. World Bank, Washington, DC.
- 76 Ibid.
- 77 Bautzer, T. and Alves, A., 2015. *Insurers face \$600 million claim in Brazil dam burst, sources say*. Reuters.
- 78 Allianz, 2018. *Global Risk Dialogue – Analysis and Insight from the World of Corporate Risk and Insurance*.
- 79 Financial Times, 2021. *'Green bubble' warnings grow as money pours into renewable stocks*.
- 80 Chandellier, J. and Malacain, M., 2021. *Biodiversity and Re/insurance: An Ecosystem at Risk*. Muséum National d'Histoire Naturelle.
- 81 Planet Tracker and the Grantham Research Institute on Climate Change and the Environment have defined 'sovereign health' as the capacity of countries to issue debt and repay it in alignment with the UN's 2030 Sustainable Development Goals (SDGs). See Elwin, P., Robins, N., Willis, J. and Cozzolino, G., 2021. *Brazil: roadmap to a sustainable future - Nature-based challenges, opportunities and solutions*.
- 82 Elwin, P., Robins, N., Willis, J. and Cozzolino, G., 2021. *Brazil: roadmap to a sustainable future - Nature-based challenges, opportunities and solutions*.
- 83 Federal Reserve, 2021. *Climate Change and Financial Stability*.
- 84 Société Universitaire Européenne de Recherches Financières (SUERF), 2021. *Understanding the financial risks of nature loss: exploring policy options for financial authorities*.
- 85 PRé Sustainability, 2021. *ASN Bank Biodiversity Footprint - Biodiversity Footprint for Financial Institutions Impact Assessment 2014 – 2019*.
- 86 Portfolio Earth, 2021. *Bankrolling Extinction – The Banking Sector's Role in the Global Biodiversity Crisis*.
- 87 PRé Sustainability, 2021. *ASN Bank Biodiversity Footprint - Biodiversity Footprint for Financial Institutions Impact Assessment 2014 – 2019*.
- 88 ShareAction, 2021. *Insuring Disaster - A ranking of 70 of the world's largest insurers' approaches to responsible investment and underwriting*.
- 89 Planet Tracker. *Beached, not Stranded*.

- ⁹⁰ Ibid.
- ⁹¹ IUMI, 2020. *IUMI's 2020 analysis of the global marine insurance market*.
- ⁹² The Pew Charitable Trust, 2013. *FAQ: Illegal, Unreported, and Unregulated Fishing*.
- ⁹³ International Association of Insurance Supervisors (IAIS), 2021. *Application Paper on the Supervision of Climate-related Risks in the Insurance Sector*.
- ⁹⁴ Chandellier, J. and Malacain, M., 2021. *Biodiversity and Re/insurance: An Ecosystem at Risk*. Muséum National d'Histoire Naturelle.
- ⁹⁵ Ibid.
- ⁹⁶ CRO Forum, 2021. *Emerging Risks Initiative – Major Trends and Emerging Risk Radar*.
- ⁹⁷ Bassen, A., Busch, T., Lopatta, K., Evans, E. and Opoku, O., 2019. *Nature Risks Equal Financial Risks: A Systematic Literature Review*.
- ⁹⁸ Credit Suisse Group AG, 2021. *Unearthing investor action on biodiversity*.
- ⁹⁹ globalforestwatch.org
- ¹⁰⁰ fairs.org/about-fairr/about-us
- ¹⁰¹ iris.thegiin.org/metrics
- ¹⁰² Natural Capital Finance Alliance, 2021. ENCORE Database.
- ¹⁰³ ibat-alliance.org
- ¹⁰⁴ trase.earth
- ¹⁰⁵ Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector
- ¹⁰⁶ fsb-tcfd.org/supporters
- ¹⁰⁷ AM Best, 2020. *Special Report: Insurers and Reinsurers: Ignoring ESG Factors Poses Reputational Risk*.
- ¹⁰⁸ G7 Finance Ministers and Central Bank Governors Policy Paper (5 June 2021).
- ¹⁰⁹ G20 Finance Ministers and Central Bank Governors Communiqué (9–10 July 2021).
- ¹¹⁰ AXA Investment Managers, 2020. *Iceberg Data Lab and I Care & Consult selected to provide first of its kind biodiversity impact measurement tool for investors*.
- ¹¹¹ ShareAction, 2021. *Insuring Disaster - A ranking of 70 of the world's largest insurers' approaches to responsible investment and underwriting*.
- ¹¹² financeforbiodiversity.org/about-the-pledge
- ¹¹³ Swiss Re, 2020. Sustainable Business Risk Framework.
- ¹¹⁴ Achmea, 2021. Engagement Guidelines.
- ¹¹⁵ European Insurance and Occupational Pensions Authority (EIOPA), 2021. *Report on non-life underwriting and pricing in light of climate change*.
- ¹¹⁶ Beck, M.W. et al., 2020. *Reducing Caribbean Risk: Opportunities for Cost-Effective Mangrove Restoration and Insurance*. The Nature Conservancy.
- ¹¹⁷ The Nature Conservancy and Willis Towers Watson, 2021. *Wildfire Resilience Insurance: Quantifying the Risk Reduction of Ecological Forestry with Insurance*.
- ¹¹⁸ Controlled burning and removal of smaller trees and other vegetation in overgrown forests, i.e. ecological thinning.
- ¹¹⁹ Global Canopy, 2021. *The Little Book of Investing in Nature – A simple guide to financing life on Earth*.

- ¹²⁰ De Nederlandsche Bank (DNB), 2020. *Indebted to nature - Exploring biodiversity risks for the Dutch financial sector*.
- ¹²¹ Swartzman, R., Espagne, E., Gauthey, J., Hadji-Lazaro, P., Salin, M., Allen, T., Berger, J., Calas, J., Godin, A. and Vallier, A., 2021. *A "Silent Spring" for the Financial System? Exploring Biodiversity-Related Financial Risks in France*. Banque de France Working Paper #826.
- ¹²² De Nederlandsche Bank (DNB), 2020. *Indebted to nature - Exploring biodiversity risks for the Dutch financial sector*.
- ¹²³ ASX Corporate Governance Council, 2019. *Corporate Governance Principles and Recommendations - 4th Edition*.
- ¹²⁴ BaFin, 2020. *Guidance Notice on Dealing with Sustainability Risks*.
- ¹²⁵ California Department of Insurance, 2021. *Protecting Communities, Preserving Nature and Building Resiliency*.
- ¹²⁶ NGFS and INSPIRE, 2021. *Biodiversity and financial stability: exploring the case for action*.
- ¹²⁷ NGFS, 2020. *Guide for supervisors: Integrating climate-related and environmental risks into prudential supervision*.
- ¹²⁸ tnfd.info
- ¹²⁹ TNFD, 2021. *France's Article 29: biodiversity disclosure requirements sign of what's to come*.
- ¹³⁰ Dasgupta, P., 2021. *The Economics of Biodiversity: The Dasgupta Review*.
- ¹³¹ G7 2020 Nature Compact.
- ¹³² G20 Environment Ministers Communiqué (22 July 2021).
- ¹³³ DG Env, 2021. *Biodiversity: ground-breaking change to economic reporting accounting for nature's contribution to economy*.
- ¹³⁴ Ibid.
- ¹³⁵ Convention on Biological Diversity (CBD), 2020. *Zero draft of the post-2020 global biodiversity framework*.
- ¹³⁶ G20 Data Gaps Initiative.
- ¹³⁷ ngfs.net/en/about-us/governance/workstream-bridging-data-gaps
- ¹³⁸ futureofsustainabledata.com
- ¹³⁹ IAIS, 2021. *IAIS Comments on IFRS Foundation Constitution Amendments for ISSB Exposure Draft*.
- ¹⁴⁰ Natural Capital Finance Alliance, n.d. *What is Natural Capital and why is it important?*
- ¹⁴¹ IPBES, 2019. *IPBES Global Assessment on Biodiversity and Ecosystem Services. Glossary*.
- ¹⁴² Convention on Biological Diversity (CBD), 1992. Article 2. Use of Terms.
- ¹⁴³ Locke, H. et al., 2021. *A Nature-Positive World: The Global Goal for Nature*.
- ¹⁴⁴ IPBES, 2019. *IPBES Global Assessment on Biodiversity and Ecosystem Services. Glossary*.
- ¹⁴⁵ IPBES, n.d. *Ecosystem Services*.
- ¹⁴⁶ Global Canopy and Vivid Economics, 2020. *The Case for a Taskforce on Nature-related Financial Disclosures*.
- ¹⁴⁷ IPBES, 2019. *IPBES Global Assessment on Biodiversity and Ecosystem Services. Glossary*.
- ¹⁴⁸ Adapted from Watson, S.C.L. and Newton, A.C., 2018. *Dependency of Businesses on Flows of Ecosystem Services: A Case Study from the County of Dorset, UK*. *Sustainability*, 10, 1368.
- ¹⁴⁹ Based on a bilateral consultation with McKinsey & Company colleagues.
- ¹⁵⁰ McKinsey & Company, 2021. *Global Insurance Pools statistics and trends: An overview of life, P&C, and health insurance*. Read more [here](#) and [here](#)
- ¹⁵¹ Nearly US\$300 billion in global reinsurance premium, primarily providing reinsurance to P&C insurers.
- ¹⁵² Pereira, R., 2020. *Where insurers are placing their money*. *IPE Magazine*.

- ¹⁵³ EY, 2019. *2020 Global Insurance Outlook*.
- ¹⁵⁴ National Association of Insurance Commissioners (NAIC), 2020. *U.S. Property & Casualty and Title Insurance Industries – 2019 Full Year Results*.
- ¹⁵⁵ As per the US P&C insurance sector data of 2019. See Federal Insurance Office, US Department of the Treasury, 2020. *Annual Report on the Insurance Industry*.
- ¹⁵⁶ As per the US Life and Health insurance sector data of 2019. See Federal Insurance Office, US Department of the Treasury, 2020. *Annual Report on the Insurance Industry*.
- ¹⁵⁷ Ibid.
- ¹⁵⁸ Corporate bonds account for nearly 70 percent of the bond portfolios of each of the three insurance segments.
- ¹⁵⁹ S&P Global, 2019. *Global Reinsurance Highlights 2019*.
- ¹⁶⁰ International Association of Insurance Supervisors (IAIS), 2020. *The Global Insurance Market Report (GIMAR)*.
- ¹⁶¹ S&P Global, 2019. *U.S. Corporate Debt Market: The State of Play In 2019*.
- ¹⁶² OECD, 2019. *Biodiversity: Finance and the Economic and Business Case for Action, report prepared for the G7 Environment Ministers' Meeting, 5–6 May 2019*.
- ¹⁶³ Russi D. et al., 2013. *The Economics of Ecosystems and Biodiversity for Water and Wetlands*.
- ¹⁶⁴ Kreye, M.M., 2019. *Understanding the Value of Wildlife in Pennsylvania*.
- ¹⁶⁵ WWF, 2020. *Living Planet Report 2020 - Bending the curve of biodiversity loss*.
- ¹⁶⁶ MacArthur Foundation, 2017. *A new textiles economy: Redesigning fashion's future*.
- ¹⁶⁷ Ibid.
- ¹⁶⁸ Nissan, n.d. *Ecosystem Services and the Automotive Sector*.
- ¹⁶⁹ Jowitt, S.M., Mudd, G.M. and Thompson, J.F.H., 2020. Future availability of non-renewable metal resources and the influence of environmental, social, and governance conflicts on metal production. *Commun Earth Environ* 1, 13.
- ¹⁷⁰ TradeMachines, 2018. *Why the world is running out of sand*.
- ¹⁷¹ Ecorys, 2014. *Resource efficiency in the building sector*.
- ¹⁷² WWF, 2020. *Living Planet Report 2020 - Bending the curve of biodiversity loss*.
- ¹⁷³ Wongcharoen, A., 2010. *Biological activities of soils under rubber trees (Hevea brasiliensis) and interactions with trunk phloem necrosis*.
- ¹⁷⁴ Fortune, 2021. *Taiwan's drought is exposing just how much water chipmakers like TSMC use (and reuse)*.
- ¹⁷⁵ FAO, 2021. FAOSTAT: Forestry Production and Trade.
- ¹⁷⁶ PwC, 2021. *Mine 2021 – Great expectations, seizing tomorrow*.
- ¹⁷⁷ Ibid.
- ¹⁷⁸ Jowitt, S.M., Mudd, G.M. and Thompson, J.F.H., 2020. Future availability of non-renewable metal resources and the influence of environmental, social, and governance conflicts on metal production. *Commun Earth Environ* 1, 13.
- ¹⁷⁹ OECD, 2019. *Biodiversity: Finance and the Economic and Business Case for Action, report prepared for the G7 Environment Ministers' Meeting, 5–6 May 2019*.
- ¹⁸⁰ US EPA, 2011. *The Benefits and Costs of the Clean Air Act from 1990 to 2020*.
- ¹⁸¹ Nowak, D., Hirabayashi, S., Bodine, A. and Greenfield, E., 2014. *Tree and forest effects on air quality and human health in the United States*.
- ¹⁸² Ferrario, F., Beck, M., Storlazzi, C. et al. The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. *Nat Commun* 5, 3794.

- ¹⁸³ Beck, M.W. *et al.*, 2018. *The Global Value of Mangroves for Risk Reduction. Summary Report*.
- ¹⁸⁴ Wolf, K.L., 2010. Community Economics - A Literature Review. In: *Green Cities: Good Health*.
- ¹⁸⁵ McKinsey & Company, 2020. *Valuing nature conservation*.
- ¹⁸⁶ OECD, 2019. *Biodiversity: Finance and the Economic and Business Case for Action, report prepared for the G7 Environment Ministers' Meeting, 5–6 May 2019*.
- ¹⁸⁷ Office for National Statistics, 2021. *Tourism and outdoor leisure accounts, natural capital, UK: 2021*.
- ¹⁸⁸ United Nations Conference on Trade and Development (UNCTAD), 2021. *COVID-19 and Tourism – An Update: Assessing the economic consequences*.
- ¹⁸⁹ United States Environmental Protection Agency (US EPA), n.d. *Climate Impacts on Transportation*.
- ¹⁹⁰ Ibid.
- ¹⁹¹ Notte, A.L. *et al.*, 2017. Physical and monetary ecosystem service accounts for Europe: A case study for in-stream nitrogen retention. *Ecosystem Services*, Volume 23, Pages 18–29.
- ¹⁹² Spit, W. *et al.*, 2018. *The Economic Value of Water - Water as a Key Resource for Economic Growth in the EU*. Deliverable to Task A2 of the BLUE2 project "Study on EU integrated policy assessment for the freshwater and marine environment, on the economic benefits of EU water policy and on the costs of its non- implementation". Report to Directorate-General for the Environment of the European Commission.
- ¹⁹³ UN Water, n.d. *Facts and Figures*.
- ¹⁹⁴ Swiss Re Institute, 2020. *Biodiversity and Ecosystem Services: A business case for re/insurance*.
- ¹⁹⁵ Intergovernmental Panel on Climate Change (IPCC), 2020. *The concept of risk in the IPCC Sixth Assessment Report: a summary of cross-Working Group discussions*.
- ¹⁹⁶ Cardona, O.D. *et al.*, 2012. Determinants of risk: exposure and vulnerability. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 65–108.



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