WORLD ECONOMIC FORUM

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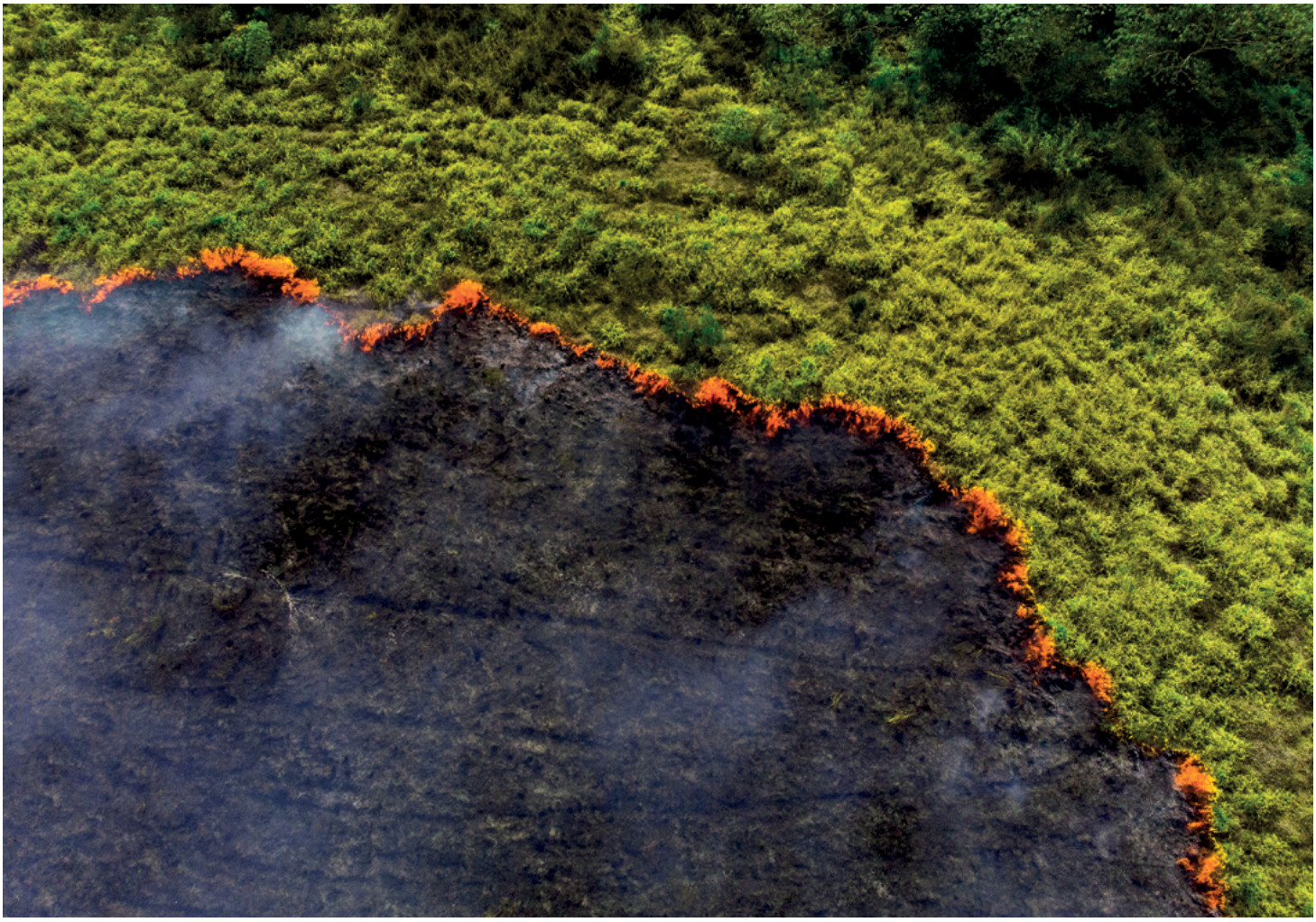
New Nature Economy series

Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy

In collaboration with PwC

January 2020



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Nature Risk Rising is published by the World Economic Forum in collaboration with PwC. It is the first in a series of reports from the New Nature Economy project.

About the New Nature Economy series

The series of New Nature Economy (NNE) reports is being developed under the umbrella of the Nature Action Agenda, a platform for committed actors to join up ideas and efforts in the run-up to the UN Convention on Biological Diversity COP15 – in Kunming, China, in October 2020 – and in support of the related Business for Nature agenda. The NNE reports aim to contribute to the Agenda's fact base, focusing on the business and economic case for action.

The series will span three reports that focus on the following priorities:

1. **Make the case for why the nature crisis is crucial to business and the economy**, including:

   – The scale and urgency of the nature crisis
   – The potential consequences for society if the crisis goes unchecked
   – The interests of business to make the crisis a critical consideration

2. **Identify a set of priority socioeconomic systems for transformation:**

   – Target areas in which individual and collective action from business and other actors (such as state-owned enterprises, investors and financial corporations) is urgent and indispensable
   – Ecosystems that are closer to irreversible tipping points, and hence have more global relevance if tipped, and in which the drivers of degradation are more deeply connected to economic and business activities. Actors in this space therefore have more value at stake and a greater ability to influence the transformation.

3. **Scope the market and investment opportunities for nature-based solutions to environmental challenges:**

   – Research solutions across the biodiversity, climate mitigation, climate resilience and ocean agendas
   – Assess their economic and nature-building potential
   – Identify areas and approaches that are most interesting for private-sector finance to engage in

About the World Economic Forum

The World Economic Forum, committed to improving the state of the world, is the International Organization for Public-Private Cooperation. The Forum engages the foremost business, political and other leaders of society to shape global, regional and industry agendas.

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Foreword

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> **How come the most intellectual creature to ever walk Earth is destroying its only home?**

Jane Goodall, writing in *The Guardian*, 3 November 2018

Since the start of the 20th century, human ingenuity and entrepreneurialism have delivered exponential economic growth.[1] In the last century, real global output grew 20-fold[2] and the further acceleration that took place after 1950[3] has delivered impressive improvements in human welfare. For example, child mortality rates have halved globally since 1990,[4] and average life expectancy has increased from 29 years in the pre-modern era to 73 years in 2019.[5,6] However, the pivotal role of natural capital assets and ecosystem services in ensuring this social and economic prosperity has gone largely unnoticed.

Our analysis detailed in this paper shows that in high-growth economies such as India and Indonesia, around a third of the GDP is generated in sectors that are highly dependent on nature. We also find that every industry sector has some degree of direct and indirect dependency on nature. Unsurprisingly, primary industries such as food and beverages; agriculture and fisheries; and construction exhibit the highest nature dependency. In addition, nature loss can also fuel socioeconomic instability, which in turn disrupts the markets in which business operates.

According to the World Economic Forum's 2020 *Global Risks Report*, biodiversity loss is one of the top five risks in terms of likelihood and impact in the next 10 years. Nature loss is a fat-tail risk like the 2008 asset-price bubble: It cannot be seen with a linear world view, but once triggered can have far greater than average implications. This has significant ramifications for businesses both in the short and long term and requires a reset of how businesses perceive, assess and mitigate nature risks. By investing in a more nature-positive way of doing business, we can mitigate significant economic and societal shocks in the coming future. To this end, there is a need for new mechanisms of public-private collaboration and non-traditional flows of finance to reverse nature loss and secure a net-zero emissions world by 2050. Fourth Industrial Revolution technologies also offer great opportunities to support this shift towards a net-zero, nature-positive world.

The World Economic Forum's New Nature Economy (NNE) report series aims to catalyse a public-private momentum in 2020 with a focus on the UN Convention on Biological Diversity (CBD) COP15 in Kunming, China, and the related Business for Nature mobilization. This report, the first of the NNE report series, begins by calling out the dependency and impact of business on nature and aims to ensure that biodiversity and nature-related risks are appropriately considered within the broader economic growth agenda.

As the world prepares for the 2020 "Super Year for Nature", with important international political milestone events on oceans, climate, Sustainable Development Goals and biodiversity, we hope that this report helps bring new perspectives and stakeholder engagement to bear in tackling the urgent nature crisis.

Executive summary

Although the world's 7.6 billion people represent only 0.01% of all living things by weight, humanity has already caused the loss of 83% of all wild mammals and half of all plants. The current rate of extinction is tens to hundreds of times higher than the average over the past 10 million years – and it is accelerating. Current production and consumption patterns, land use and urbanization, population dynamics, trade, industry and governance models underpin this loss, calling for a radical reset of humanity's relationship with nature.

Consequently, it is not surprising that the World Economic Forum's 2020 *Global Risks Report* (GRR), through its comprehensive risks perception survey, ranks biodiversity loss and ecosystem collapse as one of the top five risks in terms of likelihood and impact in the coming 10 years. Yet general confusion persists on *what* amount of nature loss has occurred, *why* it relates to human prosperity and *how* to confront its loss in a practical manner, especially in the business world.

Following on the heels of the 2020 GRR, this report provides a deep dive into how nature loss is material to businesses in all industry sectors and makes a clear argument for nature-related risks to be regularly identified, assessed and disclosed by business – as is now increasingly the case for climate change risks. This will help prevent risk mispricing and inaccurate capital buffers, as well as guiding action to mitigate and adapt business activities that degrade and destroy nature.

Human societies and economic activities rely on biodiversity in fundamental ways. Our research shows that $44 trillion of economic value generation – more than half of the world's total GDP – is moderately or highly dependent on nature and its services and is therefore exposed to nature loss. Together, the three largest sectors that are highly dependent on nature generate close to $8 trillion of gross value added (GVA): construction ($4 trillion); agriculture ($2.5 trillion); and food and beverages ($1.4 trillion). This is roughly twice the size of the German economy. While the risk to primary industries is straightforward to grasp, the consequences for secondary and tertiary industries can also be significant. For example, six industries – chemicals and materials; aviation, travel and tourism; real estate; mining and metals; supply chain and transport; retail, consumer goods and lifestyle – with less than 15% of their direct GVA highly dependent on nature, still have "hidden dependencies" through their supply chains. More than 50% of the GVA of their supply chains is highly or moderately dependent on nature.

Nature risks become material for businesses in the following three ways:

1. When businesses depend directly on nature for operations, supply chain performance, real estate asset values, physical security and business continuity

2. When the direct and indirect impacts of business activities on nature loss can trigger negative consequences, such as losing customers or entire markets, legal action and regulatory changes that affect financial performance

3. When nature loss causes disruption to society and the markets within which businesses operate, which can manifest as both physical and market risks

Given that efforts to mitigate the risks of climate change are significantly more mature than those of nature-related risks, this report draws lessons from the climate action agenda. The Task Force on Climate-related Financial Disclosures (TCFD) recommendations, for instance, are proving to be an important lever for enhancing corporate and investor climate action by embodying climate risk and opportunity into effective risk management, strategy and oversight. Learning from and drawing on this approach may be a crucial mechanism for managing nature-related risks and will ensure alignment with broader risk-management processes. To this end, this report suggests adapting a fit-for-purpose approach to incorporating nature-based risks into existing core enterprise risk-management processes, as is increasingly undertaken for climate change and broader environmental, social and governance (ESG) processes.

> "Never before have we had such an awareness of what we are doing to the planet, and never before have we had the power to do something about that."

Sir David Attenborough, at the World Economic Forum Annual Meeting in Davos-Klosters, 2019

1. The nature emergency

The ecological foundations underpinning our society and economy are at risk

Environmental costs of economic growth

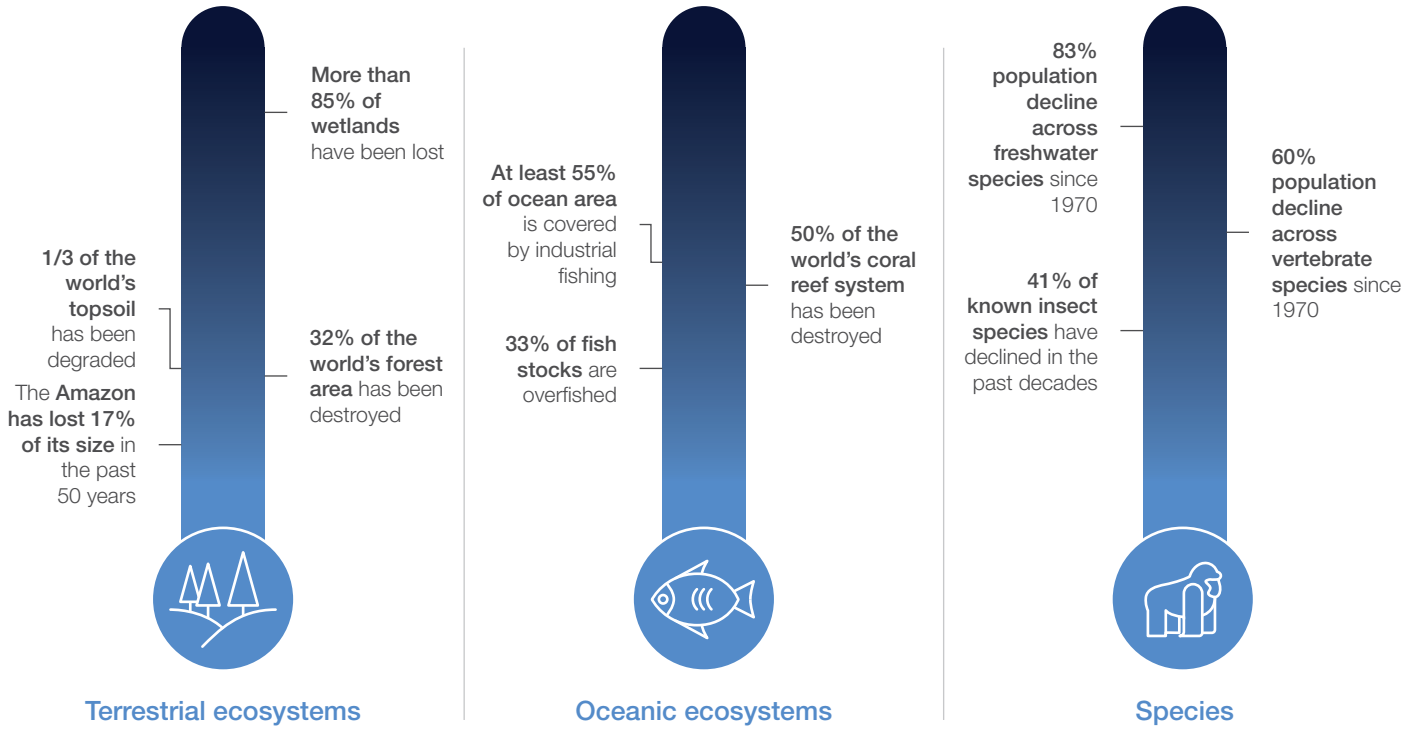
The pace of change over the past 50 years has been unprecedented in human history, with extraordinary increases in world economic output and life expectancy. The human population has doubled, the global economy has expanded four-fold and more than 1 billion people have been lifted out of extreme poverty.[7,8] Globally, we produce more food, energy and materials than ever before.[9] The improvements in human welfare and aggregate benefits from the accelerated economic growth over the past century have been impressive. The global middle class, currently 3.5 billion people, continues to grow by about 160 million people a year, 70% of whom are in China and India.[10]

However, this remarkable growth and prosperity has come at a heavy cost to the natural systems that underpin life on Earth – and which therefore underpin these economic achievements too (see Figure 1). Human activities have already severely altered 75% of land and 66% of marine environments.[11] Around 25% of assessed plant and animal species are threatened by human actions, with a million species facing extinction, many within decades.[12] Ecosystems have declined in size and condition by 47% globally compared to estimated baselines.[13]

Earth system science is showing us how climate change and nature loss are inextricably interlinked. The destruction of mangroves, peatlands and tropical forests for agriculture and other uses contributes to 13% of total human CO2 emissions and will continue to exacerbate the effects of climate change.[14] Their conversion to farmland and other uses releases carbon from vegetation and soils while undermining Earth's capacity to absorb and sequester greenhouse gases from the atmosphere. In a business-as-usual scenario, as global temperatures increase by 2°C compared to the pre-industrial growth era, one in 20 species will be threatened with extinction from this warming alone.[15] Additionally, more than 99% of coral reefs, which host more than a quarter of all marine fish species, will be lost.[16]

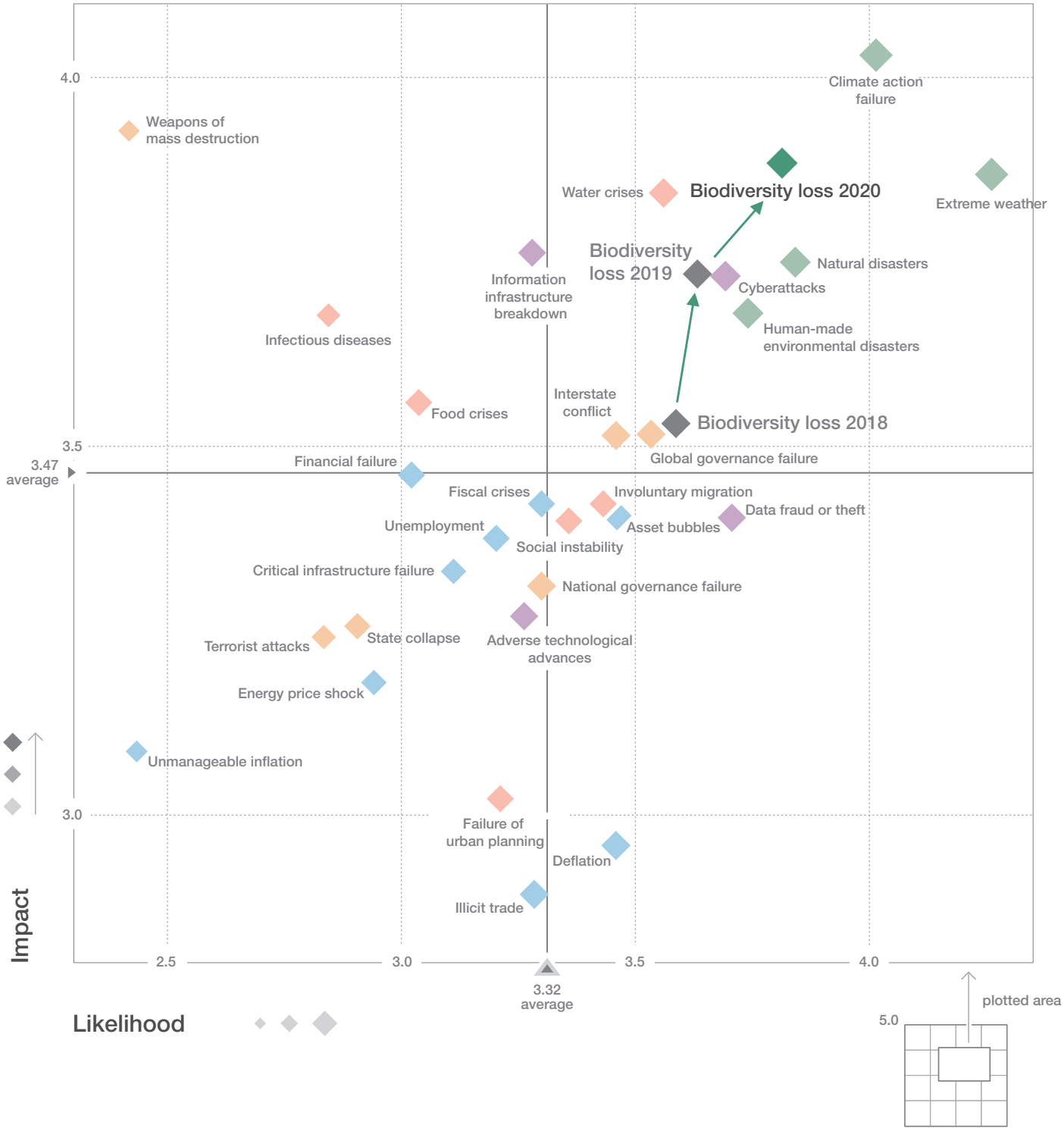
So it is unsurprising that the World Economic Forum's annual *Global Risks Report* (GRR) has, for the past five years, identified biodiversity loss and ecosystem collapse as a mid- to high-level global risk in terms of impact and likelihood (see Figure 2). In 2020, the GRR's comprehensive Global Risks Perception Survey, conducted across a global community of businesses, governments and civil society, displays a striking result. *For the first time,* the top five global risks come from a single category: the environment. This includes biodiversity loss as one of the top risks in the coming 10 years.

FIGURE 1:
Human activity is eroding the world's ecological foundations



Source: IPBES, 2019, "Global assessment report on biodiversity and ecosystem services"; Maria-Helena Semedo of the Food and Agriculture Organization (FAO) at World Soil Day 2014; The Economist, 2019, "On the brink – The Amazon is approaching an irreversible tipping point"; WWF, 2018, "Living planet report – 2018: Aiming higher"; F. Sánchez-Bayo and K.A.G. Wyckhuys, 2019, "Worldwide decline of the entomofauna: A review of its drivers", Biological Conservation.

FIGURE 2:
The Global Risks Landscape 2020 and the evolution of the biodiversity loss risk in the past three years



Source: World Economic Forum Global Risks Perception Survey 2019–2020

Note: Survey respondents were asked to assess the likelihood of the individual global risk on a scale of 1 to 5, with 1 representing a risk that is very unlikely to happen and 5 being a risk that is very likely to occur. They were also asked to assess the impact of each global risk on a scale of 1 to 5 (1: minimal impact, 2: minor impact, 3: moderate impact, 4: severe impact and 5: catastrophic impact).

Drivers of nature loss

Although the world's 7.6 billion people represent only 0.01% of all living things by weight, humans have already caused the loss of 83% of all wild mammals and half of all plants.[17] The current rate of extinction is tens to hundreds of times higher than the average over the past 10 million years – and it is accelerating.[18] The impacts on the planet by a single species, humans, are so profound that scientists have coined a new geological epoch: the Anthropocene, or the period when humans are the key driver of geological change on the planet.[19,20] We are breaching the planet's boundaries beyond the ability of natural systems to cope, which is increasing the risk of large-scale, irreversible environmental and societal changes.[21]

According to the latest report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) – the most comprehensive global biodiversity assessment to date – five direct drivers of change in nature have accounted for more than 90% of nature loss in the past 50 years (see Figure 3). Ultimately, these five drivers stem from a combination of current production and consumption patterns, population dynamics, trade, technological innovations and governance models.

FIGURE 3:
Five direct drivers of nature loss have accelerated since 1970

Driver of nature loss	Illustrative impact on nature
Land- and sea-use change	Half of all habitable land today is used for agriculture and livestock[22] In recent years, we have lost more than 3 million hectares annually of tropical primary forest, one of the most biodiverse ecosystems in the world[23] In the past 50 years, there has been a four-fold increase in the number of dead zones, i.e. areas in which levels of oxygen are too low to support most marine life; there are more than 400 dead zones worldwide, a combined area greater than that of the United Kingdom[24,25]
Climate change	Fires in boreal forests are now more extensive and destructive than in the past 10,000 years;[26] climate models predict that conditions making fires more frequent and severe will significantly increase[27] Coral reefs are projected to decline by a further 70% to 90% at 1.5°C of warming, with larger losses (>99%) at 2ºC[28]
Natural resource use and exploitation	93% of fish stocks today are fished at or beyond maximum sustainable levels[29] Since 1970, annual extraction of natural resources, including fossil fuels and biomass, has increased 3.4-fold[30]
Pollution	Globally, around 115 million tonnes of mineral nitrogen fertilizers are applied to croplands each year; a fifth of these nitrogen inputs accumulate in soils and biomass, while 35% enter the oceans[31]
Invasive alien species	There has been a 70% increase in non-native species, with adverse impacts on local ecosystems and biodiversity[32]

Non-linear risks of nature loss

> **Many have tended to assume that tipping points in the Earth system – such as the loss of the Amazon rainforest or the West Antarctic ice sheet – are of low probability and little understood. Yet evidence is mounting that these events could be more likely than was thought, have high impacts and are interconnected across different biophysical systems, potentially committing the world to long-term irreversible changes.**

Johan Rockström, Director – Potsdam Institute for Climate Impact Research

Scientists and researchers predict that if the current rates of nature destruction continue unabated, some biomes (e.g. tundra, grasslands, forests, deserts) may cross irreversible tipping points, with far-reaching economic and societal impacts. When exceeded, these tipping points can trigger catastrophic events – sometimes locally, sometimes (as with climate change) globally.[33] For example, large-scale forest loss in the Amazon not only affects the destroyed area, but can also alter regional weather patterns,[34] affecting regional water availability and agricultural productivity. Some 17% of forest cover in the Amazon has been lost since 1970.[35] If the rate of forest loss continues, and 20–25% of the forest is lost, scientists warn that the region will reach a tipping point and parts will change to non-forest ecosystems.[36] Models suggest that this would lead to increased duration of droughts in the region[37] and annual agricultural production losses of $422 million in Brazil alone.[38] Brazil is a significant global exporter of food, and a sharp decline in its agricultural output could increase the volatility of food prices around the world.

Accurately managing and mitigating such risks requires a fundamental shift in thinking about the value of nature, including accounting for natural capital and the costs of ecosystem degradation within economic development. New business models enabled by Fourth Industrial Revolution technologies have the potential to accelerate this shift towards a nature-positive development path and unlock nature's value while minimizing resource use. Examples include harnessing artificial intelligence (AI), satellite imagery and drones to automatically detect land-use changes or monitor and control invasive species and diseases in ecosystems. Likewise, circular economy models and new technologies can both optimize use of inputs and minimize waste and enable real-time tracking and monitoring of global agricultural and industrial supply chains. This century requires a reset of the relationship between humans and nature – in doing so, innovations of the 21st century need to responsibly deliver for both people and the planet.

The global economy is embedded in Earth's broader ecosystems and is dependent upon them.[39] As nature continues to deteriorate, businesses progressively run more risk. This risk is not only reputational and legal – as more consumers and governments become aware of and act on nature loss. It is also operational and financial – as direct inputs disappear and ecosystem services, on which businesses depend, stop functioning.

As nature declines, the prospects for business success and future prosperity dwindle. Conversely, the business opportunities that await those committed to restoring natural ecosystems could be considerable. Solutions to the issue of nature loss are complex, but unless we take transformative action urgently, the risks and impacts of such loss will only accelerate.

2. The hidden risks of nature loss for business

Nature loss creates significant risks for businesses and the wider economy

The 2019 Edelman Trust Barometer found that more than three-quarters (76%) of the population want chief executive officers to lead the way in delivering change rather than waiting for governments to impose it.[40]

Despite increasing levels of attention to the topic of nature loss over the past few years, there is still limited understanding of how nature loss affects business and what practical steps businesses can take towards addressing nature loss. One of the main reasons for this is that nature is often hidden or incorrectly priced in supply chains.

There are three ways in which the destruction of biodiversity and ecosystems creates risks for businesses:

1. **Dependency of business on nature:** when businesses depend directly on nature for operations, supply chain performance, real estate asset values, physical security and business continuity

2. **Fallout of business impacts on nature:** when the direct and indirect impacts of business activities on nature loss trigger negative consequences, such as losing customers or entire markets, costly legal action and adverse regulatory changes

3. **Impacts of nature loss on society:** when nature loss aggravates the disruption of the society in which businesses operate, which in turn can create physical and market risks

Risks emerging from dependency of business on nature

All businesses depend on natural capital assets and ecosystem services either directly or through their supply chains. Our research shows that $44 trillion of economic value generation – more than half of the world's total GDP – is moderately or highly dependent on nature and its services, and therefore exposed to risks from nature loss.[41] To estimate the extent to which the global economy depends on nature, we have assessed the reliance on natural capital assets of 163 economic sectors and examined them at an industry and regional level, based on the economic value creation of each industry. Our methodology is detailed in Appendix A.

Industry dependency on nature

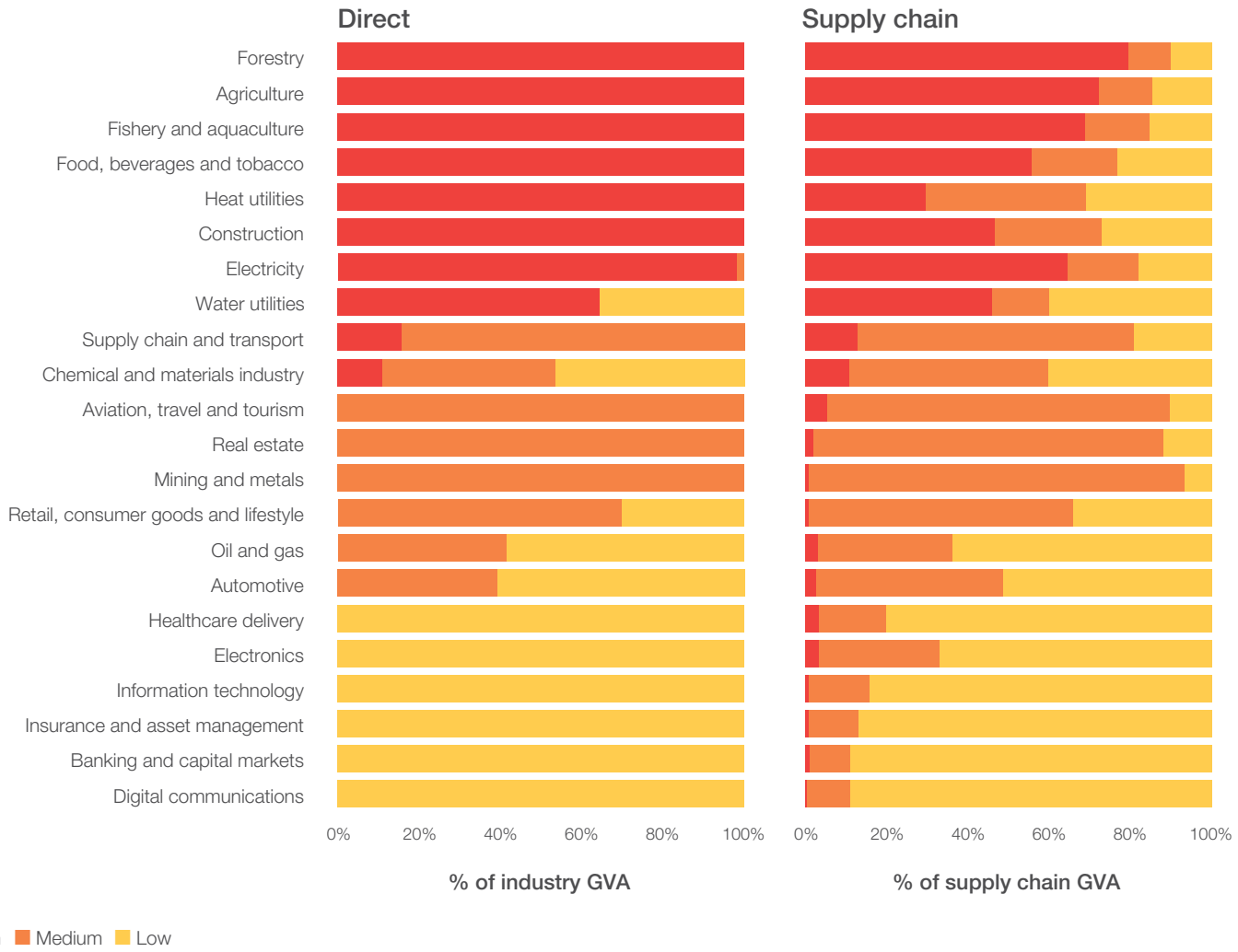
Industries that are highly dependent on nature generate 15% of global GDP ($13 trillion), while moderately dependent industries generate 37% ($31 trillion). Together, the three largest sectors that are highly dependent on nature **generate close to $8 trillion of gross value added (GVA[42])**. These are construction ($4 trillion), agriculture ($2.5 trillion) and food and beverages[43] ($1.4 trillion). This is roughly twice the size of the German economy. Such sectors rely on either the direct extraction of resources from forests and oceans or the provision of ecosystem services such as healthy soils, clean water, pollination and a stable climate. As nature loses its capacity to provide such services, these sectors could suffer significant losses.

For example, 60% of coffee varieties are in danger of extinction due to climate change, disease and deforestation.[44] If this were to happen, global coffee markets – a sector with retail sales of $83 billion in 2017[45] – would be significantly destabilized, affecting the livelihoods of many smallholder farmers.

Similarly, outbreaks of invasive pests and diseases are a common cause of nature loss that threatens the survival of commercially important crop species with low genetic diversity. More than half of the world's food comes from just three staples – rice, wheat and maize – which already suffer annual losses of up to 16% of total production (valued at $96 billion) due to invasive species.[46] Agricultural crop diversification can improve resilience to pest and disease outbreaks, as well as buffer crop production against the effects of greater climate change.[47] However, monocultures, induced mostly by economic incentives, are still the dominant form of industrial agriculture.[48,49]

Dependency on nature can vary considerably between different industries and sectors. While the risk to primary industries is straightforward to grasp, the consequences for secondary and tertiary industries can also be significant. For example, six industries – chemicals and materials; aviation, travel and tourism; real estate; mining and metals; supply chain and transport; retail, consumer goods and lifestyle – with less than 15% of their direct GVA highly dependent on nature still have "hidden dependencies" through their supply chains. More than 50% of the GVA of their supply chains is highly or moderately dependent on nature. Figure 4 illustrates in more detail the proportion of GVA exposed to nature loss in 22 global industries.

FIGURE 4:
Percentage of direct and supply chain GVA with high, medium and low nature dependency, by industry



Source: PwC

Spotlight

Coral reef and wetland destruction could cost insurance companies and tourism billions

Maintaining healthy coastlines is critical to providing protection from flooding and other extreme weather events. Destruction of coral reefs reduces such protection and puts at risk up to 300 million people living within coastal 100-year flood zones.[50] If global warming increases to 2°C, the world will lose 99% of all coral reefs.[51] This loss also creates economic risks for the tourism industry. Globally, coral reefs provide $36 billion a year in economic value through tourism, of which $19 billion is generated through "on-reef" tourism such as diving and wildlife watching, while the remainder is generated from tourism in reef-related areas, for instance, ocean views, beaches and local seafood.[52]

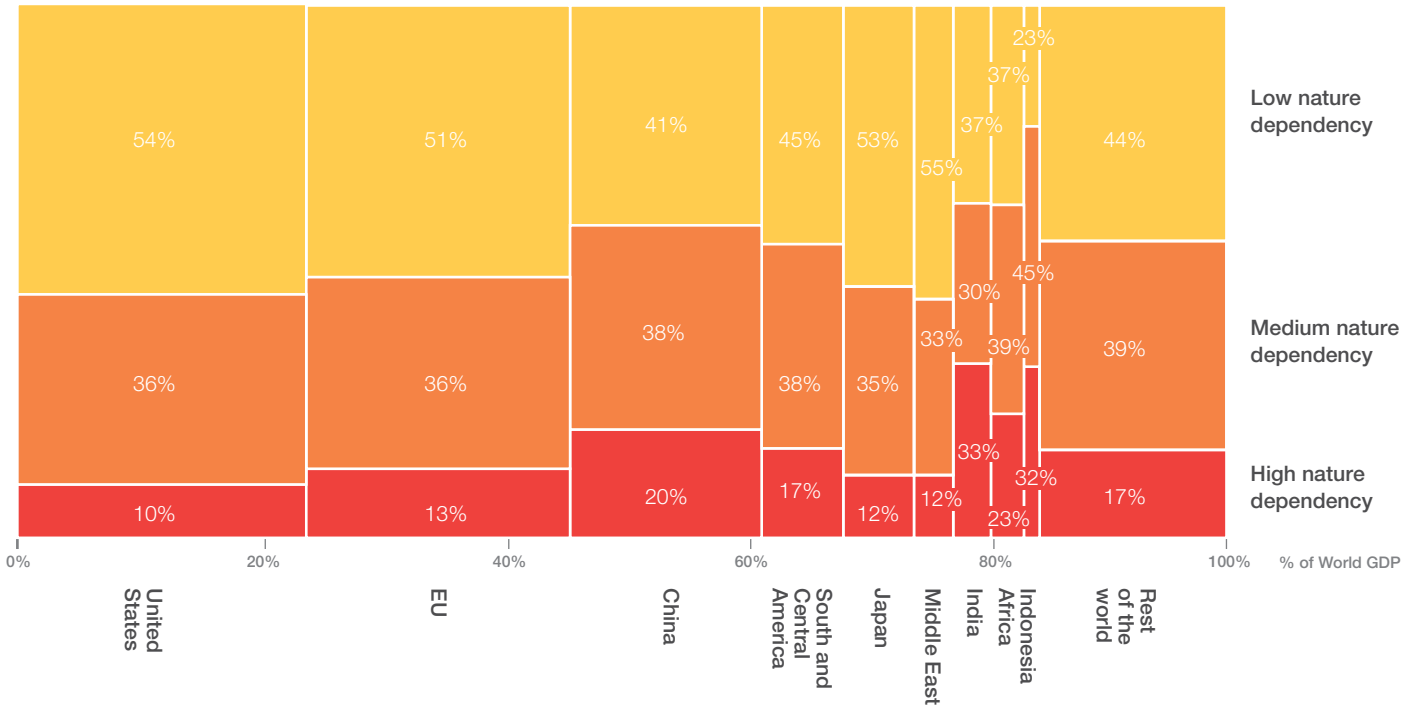
Wetland destruction is another critical risk, as these habitats provide significant ecosystem services, including water filtration and flood control.[53] During Hurricane Sandy, the strongest hurricane of the 2012 Atlantic season, wetlands were estimated to have saved more than $625 million in avoided flood damage.[54] Protecting coastal wetlands could save the insurance industry $52 billion a year through reduced losses from storm and flood damage.[55]

National and regional dependency on nature

Analysing industry-wide GVA through a national or regional lens provides additional perspectives on the dependency and impacts of businesses on nature (see Figure 5). We find that some of the fastest-growing economies in the world are particularly exposed to nature loss. For example, around one-third of the GDP of India (33%) and Indonesia (32%) is generated in sectors that are highly dependent on nature, while the African continent creates 23%[56] of its GDP in such sectors.

In terms of global exposure, larger economies have the highest absolute amounts of GDP in nature-dependent sectors: $2.7 trillion in **China,** $2.4 trillion in the **EU**, and $2.1 trillion in the **United States**. This means that even regions with relatively lower shares of their economies at high exposure to nature loss hold a substantial share of the global exposure and therefore cannot be complacent.

FIGURE 5:
Distribution of nature dependency classification by region



Source: PwC

Given their significant nature dependencies, it is critical that these economies with significant exposure to nature loss assess, prioritize and invest in nature. However, this is only part of the picture, as there are also potential missed opportunities from nature loss that may not be captured in current economic data or trends. There are many cases in which nature has inspired and enabled people to solve complex human challenges. For example, researchers from Harvard University studied the Namib desert beetle to develop a better way to condense and transport water droplets to fight droughts.[57] They did so by mimicking the way the beetle collects water droplets on the bumps of its shell while V-shaped spines guide droplets to the plant's body.

Risks emerging from fallout of business impacts on nature

In addition to dependency on nature, the negative impacts that businesses have on nature can create direct and indirect risks in the form of regulatory, legal, reputational and market risks, among others.

Regulatory and legal pressures

In October 2020, the 15th Conference of the Parties (COP) will gather 196 parties to the UN Convention on Biological Diversity, in Kunming, China, to negotiate the adoption of the post-2020 Global Biodiversity Framework, setting the course of action for a "Paris moment" for nature. The meeting will set new targets, encouraging increased government action on nature loss. A variety of new regulatory levers are anticipated, including strict rules on the commercial use of specific land areas, subsidy reforms, taxes and fines, science-based targets and trade directives. A few countries have already started this journey. Indonesia has introduced a moratorium on peatland conversion by restricting the issuing of new agricultural licences;[58] Costa Rica has redirected cattle subsidies towards paying farmers and landowners to provide ecosystem services such as carbon sequestration and watershed protection;[59] and France recently established a duty-of-care law that requires companies to include environmental assessments in their supply chains.[60] More countries are likely to follow, and this will increase the regulatory risk exposure for many businesses.

As regulation intensifies, the chance of businesses holding "stranded assets" increases. Companies holding nature-related stranded assets, such as land banks that can no longer be developed, might face premature write-offs, downward revaluations or conversions to liabilities.[61] The Tropical Forest Alliance (TFA), for example, has estimated that if over the next five to 10 years investors continue to invest in the production of deforestation-linked commodities, tens of billions of dollars in assets could be at risk of stranding.[62] Often, risks resulting in stranded assets are little understood, mispriced and overlooked. This means that the financial system is likely to be overexposed to such assets.[63] In addition to regulatory changes, stranded assets can also arise directly from longer-term environmental changes, such as climate change or nature loss.[64]

Public perception, reputation and investor pressure

Public opinion is shifting, especially among millennials and generation Z. We are seeing major consumer shifts on single-use plastics,[65] meat[66] and other ethical consumer considerations.

A typical company in the fashion and textile industry, for instance, can often be resource- and water-intensive, chemical-heavy and a significant generator of waste.[67] Consumers are becoming increasingly aware of the environmental damage caused by the industry and are demanding action. Companies that stay at the forefront of this shift in consumer consciousness and preferences stand to benefit. Prompted by the G7 summit in 2019, more than 50 companies and 250 brands have signed up to the G7 Fashion Pact, a commitment by the fashion industry to do more to stop global warming, restore biodiversity and protect the oceans.[68]

Another example of shifting consumer preference is seen in the meat industry, which is coming under increased scrutiny given the environmental damage it causes.[69] Beef consumption in the United States fell by 19% between 2005 and 2014[70] and Europe predicts that both its beef and pork meat consumption will decline by 2030.[71]

Consumers are not the only ones demanding more from businesses. Ratings agencies have started to include nature-related disclosures in their assessments, while institutional investors are demanding more accountability in terms of the environmental risks of business operations.[72] This means companies will incur higher costs of capital when engaging in nature-degrading practices.

In the soy supply chain, for example, 57 institutional investors with assets totalling $6.3 trillion have asked all soy trading companies to "demonstrate commitment to eliminating deforestation" by publicly disclosing their policies on this issue, including the origin of their soy and their stance on suppliers that fail to comply with no-deforestation standards.[73]

Spotlight

Tropical deforestation drives market and reputational risks in agriculture and biofuels

Tropical deforestation is a key source of nature risk for sectors that either have an impact or dependency on tropical forests.

An estimated 4.3 million hectares of humid tropical primary forest,[74] an area the size of Denmark, are lost each year – mainly due to agriculture, livestock and infrastructure expansion. The impact of deforestation activities can reach beyond agriculture sectors: The World Bank estimates that 2015's deforestation-fuelled fire crisis in Indonesia cost their economy $16 billion through disruption of economic activities and reduced GDP growth.[75]

Exposure to commodities linked to deforestation is another critical risk for businesses, with up to $941 billion of turnover in publicly listed companies dependent on the commodities most connected with forest loss (beef, soy, palm oil, pulp and paper). Deforestation risk can emerge as reputation risk, where shifts in public perception have led to business commitments to zero-deforestation sourcing (commitments that companies are struggling to meet); but it can also quickly manifest as market risk.

A good example is the palm oil sector. In 2016, the European Food Safety Authority raised concerns about three contaminants present in palm oil and fats.[76] The issue was quickly picked up by anti-palm oil campaigners in Italy. This resulted in Coop Italia – the largest Italian grocery chain with more than €12 billion of turnover – and Barilla – the world's leading pasta manufacturer with €3.4 billion in sales – phasing out some or all of the palm oil from their food product lines. While there are serious questions about the environmental benefits of these exclusions,[77] there is no doubt that they triggered market turbulence in the palm oil sector, with "palm oil-free" branding becoming the subject of a legal and trade dispute.[78]

Meanwhile, biofuel accounted for nearly half of Europe's palm oil consumption in 2015.[79] This, too, is coming under pressure as the European Union has revised its regulations around assessing the deforestation risks of biofuel in a way that would require palm oil to be phased out by 2030.[80] These regulatory and market movements pose significant risks to a sector that imports 3.5 million tonnes (€2.2 billion) of palm oil into the EU every year.[81]

Risks emerging from impacts of nature loss on society

Besides their contribution to economic activities, nature's assets and services – clean air, plentiful fresh water, fertile soils, a stable climate, to name a few – provide vital public goods on which human societies rely for their functioning. Consequently, the loss of nature can contribute to systemic geopolitical risk and, in some cases, destabilize the environments in which businesses operate.

Risks to global health

The degradation and loss of natural systems can affect health outcomes.[82] For example, the onset of infectious diseases has been connected to ecosystem disturbance such as the strong links between deforestation and outbreaks of animal-transmitted diseases like Ebola and the Zika virus.[83]

Nature loss can also exacerbate the effects of air pollution, a major threat to health that causes between 3.4 and 8.9 million deaths every year.[84] Urban trees provide substantial pollution reduction services – an estimate for the world's 10 megacities is $482 million per year[85] – while the destruction of vegetation in forest and brush fires is an increasingly frequent source of hazardous air pollution levels. The World Bank estimated that the haze from the 2015 forest fires in Indonesia caused $151 million of immediate health costs alone, with long-term costs still unquantified.[86]

Risks to global peace

The degradation of nature can – with climate change – contribute to water shortages, which in turn have long been a precursor to disputes and conflicts.[87] Droughts have been linked to climate change[88] and are exacerbated by nature-loss trends such as deforestation.[89] Geopolitically, drought events have increasingly been referenced as major components of increased violence,[90] including in sub-Saharan Africa,[91] internal security challenges in Kenya and Sudan and numerous coups in Mali.[92] A well-known example of this relationship is the drought that has been linked to the onset of the Syrian civil war.[93]

Risks to global trade

Large-scale loss of nature has the potential to affect trade relations between countries. The dramatic increase in forest fires in the Brazilian Amazon in 2019 is threatening to derail the EU-Mercosur trade agreement after 20 years of negotiations. The trade between the two blocs is worth €122 billion[94] and the deal is expected to generate significant new market opportunities through the reduction or elimination of tariffs and trade barriers. However, EU member states have voiced concern about the scale of forest fires, putting the deal in jeopardy. The Austrian parliament, citing environmental concerns among other things, has expressed its opposition to the deal, which would effectively torpedo any EU ratification.[95] Ireland and France have also stated that they will reject the deal unless Brazil meets its environmental commitments regarding the Amazon.[96]

Risks to economic development

Nature loss is particularly dire for the rural poor and their prospects of economic development. Rural communities are often directly and heavily dependent on nature for their food, shelter, income, fuel, health and way of life. They are more vulnerable to its loss since substitutes are often unavailable or too costly.[97] In India, for example, while forest ecosystems contribute only 7% to India's GDP, they contribute 57% of rural Indian communities' livelihoods.[98] Given that three-quarters of moderately and extremely poor people live in rural areas,[99] the loss of natural assets and ecosystem services has a profound effect on global poverty and development.

Risks to gender equality

Nature loss and climate change have a disproportionate impact on women and children, as women play a vital role in managing biological resources such as fuel, food and water.[100,101] As increased gender equality is a driver of economic growth,[102] the adverse impacts of nature loss on women have wider implications for economic development and can reduce market development opportunities for businesses.

Spotlight

Genetic material loss puts future growth in the pharmaceutical industry at risk

The sustainable growth of the pharmaceutical industry depends on the development of new drugs and treatments to drive future revenues.[103] No other sector spends as much on R&D as pharmaceuticals.[104] As much as 50% of prescription drugs are based on a molecule that occurs naturally in a plant,[105] while 70% of cancer drugs are natural or synthetic products inspired by nature.[106]

In the past 70 years, approximately 75% of approved anti-tumour pharmaceuticals have been non-synthetic, with 49% being wholly natural products or directly derived therefrom.[107] Species currently endangered by biodiversity loss include the South American cinchona tree, the source of the malaria drug quinine.[108]

The industry is particularly dependent on biodiverse tropical rainforests for new discoveries, with 25% of drugs used in modern medicine derived from rainforest plants.[109] As tropical forests face threats from felling and wildfires, pharmaceutical companies face losing a vast repository of undiscovered genetic materials that could lead to the next medical – and commercial – breakthrough. Only 15% of an estimated 300,000 plant species in the world have been evaluated to determine their pharmacological potential.[110] According to some estimates, we are already losing one potential major drug every two years.[111]

The field of venomics (scientific analysis of venom) also makes significant contributions to pharmaceuticals in a variety of areas including cancer, heart disease, diabetes and other health issues.[112] For example, Byetta is part of a new wave of drugs designed to lower blood glucose in patients with type 2 diabetes. Its key ingredient, exendin-4, is found in the saliva of the Gila monster, a large lizard species native to the south-western US and north-western Mexico.[113] This is just one example of how the loss of species yet to be studied can carry with it the loss of unmeasured potential for further discovery.

3. Managing nature-related risk

The previous two chapters established the materiality of nature-related risks to businesses and the economy. As the global community works towards transitioning to a nature-positive economy, an urgent reframing of the financial materiality of nature risks to businesses, financial institutions, asset owners, regulators and governments is required. It is important that these risks are regularly identified, assessed and disclosed by business – as is now routinely the case for climate risks. This will help prevent risk mispricing and inaccurate capital buffers to both short-term risk events and more chronic impacts.

Nature-related risks can be incorporated within existing ERM (enterprise risk management) and ESG (environmental, social and governance) processes, investment decision-making, and financial and non-financial reporting. Using a similar framework across environmental risk categories should enable more efficient and effective integration into business decision-making.

Many large businesses have already adopted the framework proposed by the G20-initiated Task Force on Climate-related Financial Disclosures (TCFD) for identifying, measuring and managing climate risks (see Figure 6). Although voluntary at this stage, more than 870 organizations – including companies with a combined market cap of more than $9.2 trillion and financial institutions responsible for assets of nearly $118 trillion – have signed up to support the TCFD's recommendations.[114] The TCFD framework could be used to manage nature risks by relying on the main aspects of the framework that make it particularly powerful:

1. **Financial materiality:** The TCFD moves beyond non-financial sustainability metrics and requires assessment and disclosure of potential financial impacts. In the case of nature, this could include, for example, the impact of land-use restrictions on asset value, or the costs and insurance premium increases arising due to settlements from pollution.

2. **Governance**: The TCFD recommends that disclosures are made in audited (e.g. public) annual financial filings under the laws of the jurisdictions in which they operate. This puts climate risk assessment and disclosure in the hands of the chief financial officer and chief risk officer and makes them subject to the rigorous governance processes that inform mainstream financial filings. The resulting increase in governance and board understanding is a significant step and would raise action on nature-related risks (alongside climate) to executive board level rather than leaving it to sustainability departments alone.

3. **Business-centric**: The TCFD framework was developed with input from a wide range of businesses and investors and is flexible enough to allow risks to be incorporated into companies' own ERM systems and other core business risk processes. The TCFD's recommendations are based on the broad themes of governance, strategy, risk management and metrics and targets (see Figure 6). These are well known to risk practitioners and corporate reporters, and commonly accepted as a way of managing and reporting on many types of risk.

FIGURE 6:
Core elements of recommended climate-related financial disclosures

Governance
The organization's governance around climate-related risks and opportunities

Strategy
The actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy and financial planning

Risk management
The processes used by the organization to identify, assess and manage climate-related risks

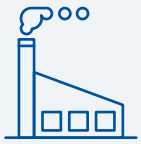
Metrics and targets
The metrics and targets used to assess and manage relevant climate-related risks and opportunities

Source: TCFD, 2017, "Recommendations of the Task Force on Climate-related Financial Disclosures", https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-2017-TCFD-Report-11052018.pdf (link as of 16th Dec 2019).

Aligning nature-related risk with existing risk categories

Nature-related risks can be assessed using categories that are broadly consistent with the climate risk categories as defined in the TCFD.[115] Figure 7 outlines the key categories of risk that businesses should consider, as well as high-level examples of how these different risk types can manifest.

FIGURE 7:
Categories of nature-related risks

Category of nature-related risk	How this risk materializes	Examples
 **Physical risks** Similar to climate change-related damage from storms, floods and other extreme events, nature-related damage such as habitat destruction, invasive species and habitat decline can also pose risks for business operations, assets and value chains.	**Commodity risks** Nature is a key contributor to a business's production processes.	More than three-quarters of the world's food crops rely at least partially on pollination by insects and other animals. Global crop production with an annual market value of between $235 billion and $577 billion is directly attributable to animal pollination and thus at risk from pollinator decline.[1]
	Supply chain performance risks Nature is critical to the performance of a business's supply chain.	Degradation of forest landscapes can threaten the availability and longer-term security of valuable commodities on which the €200 billion global cosmetics market[2] depends. For example, the supply of shea butter used in various cosmetics products is reliant on the shea tree, which currently is threatened by deforestation, parasites and pollinator loss[3,4] and is classified as vulnerable by the International Union for the Conservation of Nature (IUCN).[5] Argan oil, another key commodity for the cosmetics industry, is at risk from land degradation in Morocco, where the argan tree grows.[6]
	Damage and business continuity risk Nature provides the stable conditions (e.g. physical security against acute and chronic events) necessary for a business's operations and continuity.	Mangroves provide crucial protection to businesses and communities against coastal flooding and storm surges[7] in addition to biodiversity benefits and carbon sequestration.[8] Coastal communities with more extensive mangroves benefit from increased protection against tropical cyclones, reducing permanent losses to economic activity.[9] With an estimated 35% or more of their original cover lost,[10] mangroves' ability to continue providing these essential services is in jeopardy. If today's mangroves were lost, 18 million more people would be flooded every year (a 39% increase) and annual damages to property would increase by 16% ($82 billion).[11]
	Business value risk Nature enables the conditions necessary for maintaining the value of a business (e.g. nature loss can give rise to real estate asset repricing).	Japanese knotweed is a highly persistent, fast-spreading and treatment-resistant invasive species that affects many properties in Great Britain. The cost and difficulty of eradicating it – as well as its potential to spread to neighbouring properties and give rise to legal damages – has resulted in lower asset prices for affected properties;[12] it is estimated to cost Great Britain £165 million every year.[13] Similarly, an invasive forest pathogen called sudden oak death is projected to cost $7.5 million in tree treatment, removal and replacement costs and $135 million in losses to single-family residential property values in California between 2010 and 2020.[14]

Regulatory and legal risks	Increased policy and regulatory intervention in response to nature risks could cause some sectors of the economy to face big shifts in asset values (e.g. if they hold stranded assets due to legislation change) or higher costs of doing business for companies that generate negative impacts on nature (e.g. in response to subsidy removals or new taxes and fees). Laws, policies, regulations and court actions that may affect business operations include: – Standards/certifications – Moratoria/bans/fines on access – Taxes and fees – Subsidies – Tradable permits and resource quotas – Trade directives – Payment schemes – Emissions pricing – Changes in disclosure requirements – Changes in liability schemes	Nature losses caused by business operations may trigger regulatory interventions. For example, in 2018 Indonesia's president issued a three-year moratorium on clearing primary forests and peatlands for land-use activities such as palm oil plantations and logging,[15] and this was made permanent in 2019. The moratorium is forecast to reduce Indonesia's economic growth and negatively affect other macroeconomic indicators such as gross national expenditure (GNE) and welfare. Sumatra, Indonesia's largest palm oil-producing region, is expected to be worst affected, with a predicted -2% deviation from its baseline GDP by 2030.[16]
Market risks	Many companies are threatened by emerging products/services, technologies and business models aimed at counteracting nature risks, as well as from shifting supply and demand patterns, as consumers and the market react to nature risks.	Meat and fish alternatives, including synthetic proteins, will increasingly replace traditional meat products. The demand for cow products will decrease by 70% by 2030, and by 80–90% by 2035, with a total cost in excess of $100 billion to meat producers and their supply chains.[17]
Reputational risks	Shifts in public sentiment mean that companies face reputational risks by being held accountable by customers, clients and the wider public for natural capital decline/biodiversity loss or through facing litigation for such losses. This can result in lower brand value, loss of customer base and profits and/or further increases in insurance premiums (in the case of legal action).	Businesses are held to account by customers as social awareness of nature-related issues has increased. In 2010, Greenpeace launched a campaign against Nestlé's KitKat brand to raise awareness about the brand's sourcing of palm oil from deforested Indonesian rainforests. Nestlé's stock subsequently decreased by 4%.[18]

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Developing a risk-management approach for nature-related risk

The TCFD framework was designed to go beyond risk disclosure to provide a structure within which to embed climate risk and opportunity into effective risk management, corporate strategy and oversight. Nature-related risks and opportunities can be managed by building on the same core TCFD elements:

Governance and strategy: Businesses with significant exposure to nature's assets and services will want to ensure there is a clear governance structure in place to identify and manage the risks stemming from nature loss throughout the business. This includes defining a process for communicating upwards from business units to management (and the board) and specifying the frequency with which this needs to happen. Businesses also need to understand the implications and expected evolution of nature-based risks over the short, medium and long term, and actively use this understanding to inform their business planning and strategy.

Risk management: Underlying a clear governance structure and links to business strategy is a robust risk-management process to assess nature-based risks. The categories described in Figure 7 can serve as a framework for businesses to identify the nature-based risks to their operations and supply chains across the main categories – physical, regulatory and legal, market and reputational risks.

Metrics and targets: Businesses should consider developing metrics and targets for monitoring material nature-based risks and assessing progress against strategy. While key metrics will differ by sector, there is likely to be some overlap with climate-related metrics already being reported by a range of organizations.

Figure 8 provides guidance on the organizational basics for nature risk management, alongside a summary of what a mature approach could look like. Over time, organizations with material nature risks should expect to move towards a more mature approach to adequately respond to nature-related risks.

FIGURE 8:
A fit-for-purpose nature-based risk management approach

	The basics	Mature approach
Governance	– Identify management member responsible for nature-based risks; if possible, the same person should have responsibility for climate and nature – Integrate nature considerations into existing environmental risk management, for example, within ERM and/or ESG functions, and the corporate sustainability team – Educate key governance functions on interplay between nature and broader ESG risks	– Identify board and/or senior management level ownership of nature risk – Establish governance structure and process to identify, manage and report nature-based risks and opportunities both to the board and across the organization – Identify key board-level committee(s) for nature-based risks and process for informing these (including audit, risk and ESG committees) – Integrate performance on nature and climate into incentives for key leadership
Strategy	– Consider company ambition on nature and how the business wants to be positioned in the market – Describe any nature-related risks and opportunities the organization has identified over the short, medium and long term – Develop action plan to consider and mitigate key risks and opportunities	– Conduct forward-looking scenario planning for nature-related risks and impact on company growth strategy – Have clearly defined position and communications about nature, including link to climate – Identify and lead partnerships and initiatives in key markets or internationally
Risk management	– Conduct a high-level assessment of risks to identify hotspots and overall risk level, and any material risks, if present – Consider how to integrate material risks into ERM and risk processes, including linkages to climate risk management – Decide timeline for risk review	– Embed nature risks fully into enterprise risk management processes, alongside climate – Conduct detailed analysis of material risks and opportunities including, where possible, effects on impact statements and balance sheets – Have a good understanding of organizational resilience and action plan for nature risk and opportunity management
Metrics and targets	– Develop simple metrics to identify and track nature-related risks and opportunities to products and services, supply chain, and business continuity – Integrate nature considerations into targets set for broader environmental impact ambition	– Develop and describe the targets used by the organization to manage naturerelated risks and opportunities and your performance against these targets – Disclose key metrics and targets
	Lower risk sectors	**High risk sectors**

Source: PwC

4. Moving to action on nature-related risks

The accelerating negative impact of human activities on biodiversity and nature cannot be tackled without a proactive shift in the policies and practices that have driven much of the current growth model.

With this in mind, companies, investors and policy-makers have a vital role to play, working alongside civil society to bend the curve on nature loss by 2030. This report is the first of a series of New Nature Economy reports, prepared through the Nature Action Agenda, a platform that aims to encourage a movement of businesses, governments, civil society, academics, innovators and youth to disrupt business-as-usual approaches.

To uphold the principles of stakeholder capitalism as well as to remain profitable in a time of growing risks, this report attempts to highlight the materiality of nature-related risks for businesses. In the absence of the TCFD recommendations formally being extended to incorporate nature-risk considerations, we recommend that businesses and investors (particularly in high-risk sectors) extend and apply the principles of the framework to nature, alongside considering nature risks as part of ERM and ESG practices. In parallel, we also recommend that governments and regulators look at how to recognize the systemic risks posed by nature loss to the financial system through strategic and policy action, including consideration of extending climate risk disclosure to nature risk.

As the global momentum on safeguarding nature continues to strengthen, the next step is to identify the areas in which strategic transformation of current business models and production processes can contribute the most to halting and reversing nature loss, and the ways to finance this transformation. As the trend for greater transparency and accountability continues, costs are likely to rise for businesses that have not begun to include nature at the core of their enterprise operations. Businesses that ignore this trend will be left behind while those that have embraced this transformation will exploit new opportunities. In the food and land-use sector alone, a recent study suggests there is an annual business opportunity of $4.5 trillion by 2030 associated with transitions towards a nature-positive economy, including forest restoration, sustainable aquaculture, plant-based meat, precision and regenerative agriculture, and reducing food waste.[116]

To this end, the World Economic Forum's Nature Action Agenda platform will be releasing two subsequent reports, focusing on opportunities and finance. Provisionally entitled *Future of Nature and Business* and *Financing for Nature*, these reports will be released at milestone events in 2020, providing new thinking on business's impact and dependency on nature.

Appendix A: Approach to modelling nature dependency for countries and sectors

Direct nature dependency

We analysed the nature dependency of 163 sectors and their supply chains across a range of ecosystem services, building on work done by the UN Environment Programme World Conservation Monitoring Centre (UNEP WCMC)[117] and PwC for the Natural Capital Finance Alliance (NCFA).[118] Further information on the underlying methodology for identifying and rating sector dependencies on individual ecosystem services is available from the NCFA.[119,120] The full list of ecosystem services considered in the underlying analysis is as follows:

Ecosystem services	
Animal-based energy	Groundwater
Bio-remediation	Maintain nursery habitats
Buffering and attenuation of mass flows	Mass stabilization and erosion control
Climate regulation	Mediation of sensory impacts
Dilution by atmosphere and ecosystems	Pest control
Disease control	Pollination
Fibres and other materials	Soil quality
Filtration	Surface water
Flood and storm protection	Ventilation
Genetic materials	Water flow maintenance
	Water quality

Source: NCFA[121]

Dependency ratings consider a sector's reliance on ecosystem services at the production process level, for a range of factors, including: inputs to production, inputs to research and development, business operations, assimilation of waste and protection of assets. These ratings were based on desk research and consultation with industry experts, conducted as part of the work done by UNEP WCMC and PwC for NCFA. The rating process considered the degree of dependency on each ecosystem service of each relevant production process, the sensitivity of the production process to changes in the provision of the ecosystem service, and the sensitivity of financial performance to changes at the production process level.

Each sector was assigned an overall dependency rating – aggregated from multiple ecosystem service/production process dependencies – based with equal weight on three factors:

- The number of different individual dependencies identified
- The mean strength of those dependencies (rated from 1–5 in the underlying analysis)
- The maximum strength of any individual dependency

This approach was developed to provide some representation of the heterogeneity of types and strengths of ecosystem service dependency and should be understood as providing a relative and indicative assessment of sector-level nature dependency.

Consolidated dependency scores above 3.0 are considered "high", scores between 2.0 and 3.0 are considered "medium" and scores below 2.0 are considered "low". By aligning these sector-level dependency ratings to GVA data split by sector and country, the amount of direct GVA generated at each level of dependency can be estimated.

To determine nature dependency by *industry*, sectors were aggregated into overarching industry groups. These industries are based on the World Economic Forum Strategic Intelligence industries, with some additional sector groupings added where necessary. The industry GVA is calculated as the sum of GVA in all relevant sectors. The share of industry GVA in "high", "medium" or "low" dependency categories is then calculated based on the dependency scores of the sectors within that industry. Similarly, regional GVA is calculated as the sum of GVA in all relevant countries in the region. The share of regional GVA in "high", "medium" or "low" dependency categories is calculated based on the dependency scores of the sectors within that region, weighted by GVA.

Supply chain nature dependency

A global multiregional input-output model was used to analyse the commercial relationships between sectors in order to assess the level of nature dependency present in supply chains. For example, while the food-processing sector has limited direct dependencies on nature, it relies heavily on agricultural inputs, which are produced in sectors with typically high direct nature dependencies.

The GVA generated in the supply chain of each individual sector (the purchasing sector) was calculated using a multiregional input-output model with inputs based on the entire country-level intermediate demand from the sector in question. The sum of supply chain GVA is calculated as the sum of GVA created in all of the sectors that make up the purchasing sector's supply chain – in proportion to demand from the purchasing sector as a share of demand from all other sectors at each tier of the supply chain. The share of supply chain GVA in "high", "medium" and "low" dependency categories is calculated based on the dependency scores of the sectors within the supply chain, weighted by the GVA created in each. Sector-level supply chain GVA estimates were aggregated at industry level in the same way as for direct nature dependencies.

All GVA figures were adjusted to 2018 prices using standard World Bank GDP deflators. Where figures are expressed at regional or global scales, the industry-level GVA figures were aggregated and converted to estimates of GDP by adjusting for transfers (selected taxes), which are excluded from sector-level GVA figures.

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