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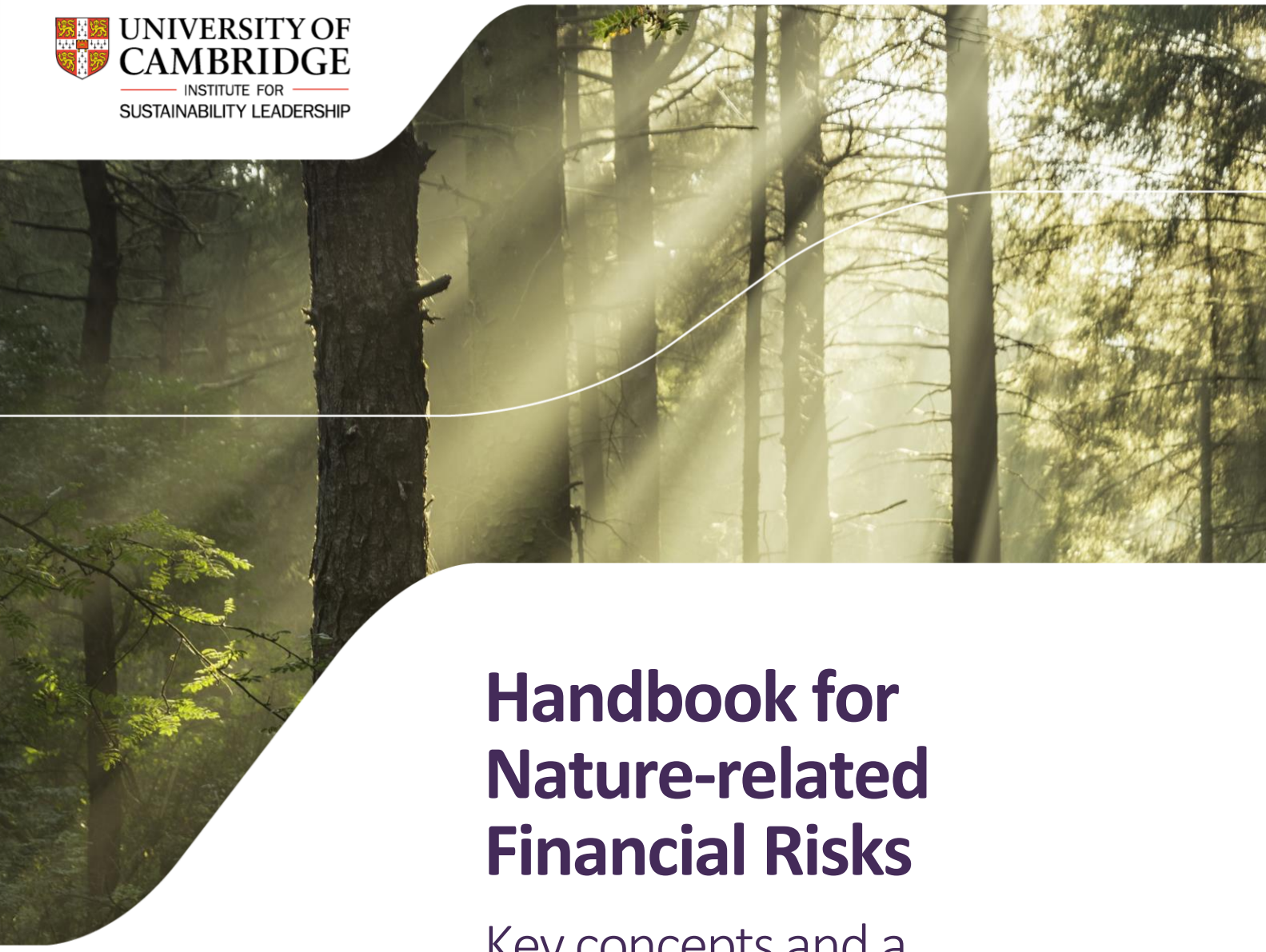
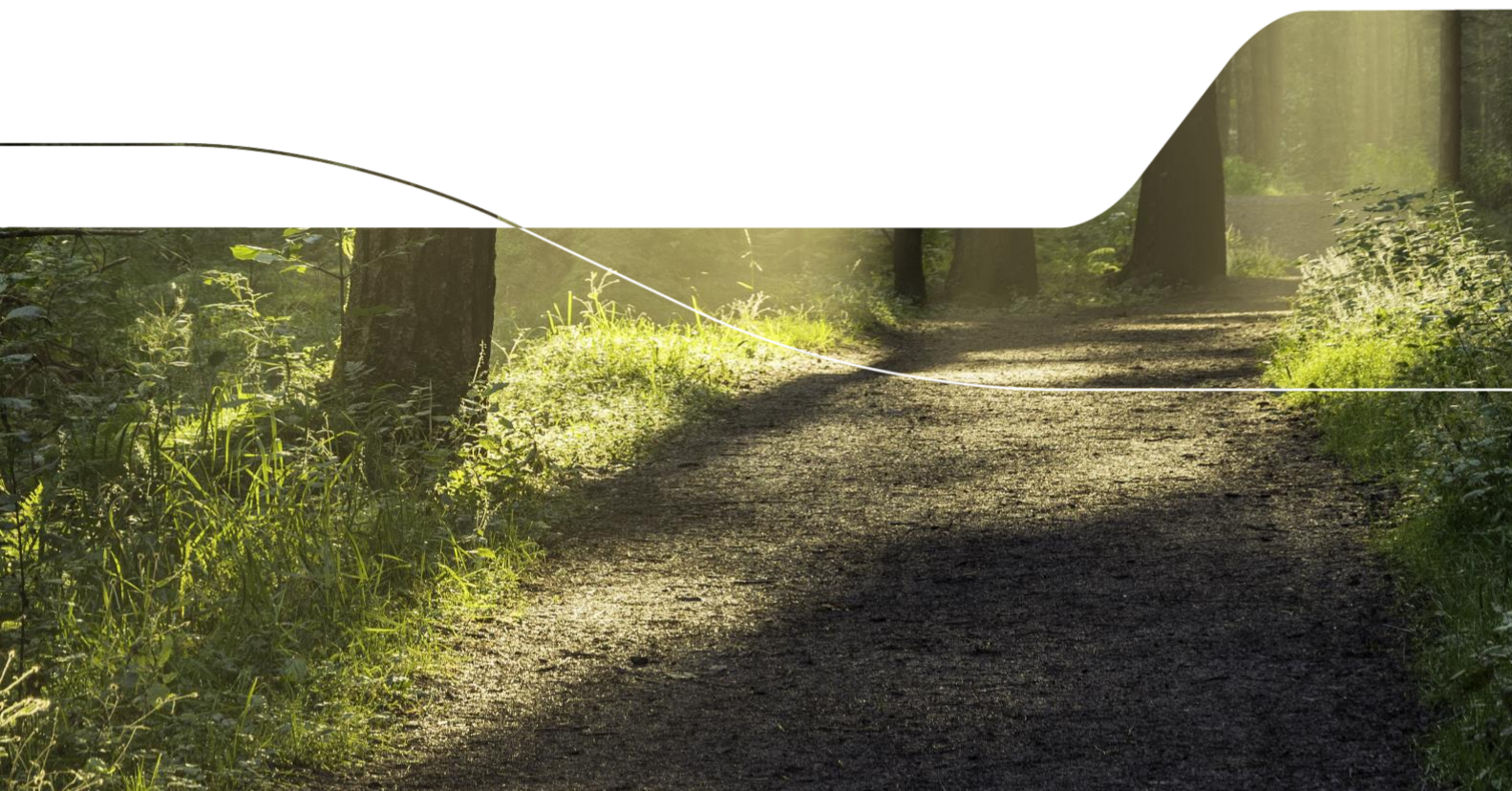


Handbook for Nature-related Financial Risks

Key concepts and a framework for identification



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Authors

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Contents

Executive Summary

Our economy depends on the services that nature provides. Yet despite these services being worth more than USD $100 trillion per year, nature is in decline.[1] Twenty-three per cent of land is now degraded and ocean 'dead zones' span an area greater in size than the United Kingdom.[2]

As nature declines, businesses, households and financial institutions are put at risk. To translate our trillions of dollars of dependence on nature into identification of specific risks posed by nature loss to financial institutions, the Cambridge Institute for Sustainability Leadership (CISL) has created this handbook and a framework for the identification of nature-related financial risks.

This handbook builds on the Dasgupta Review of the economics of biodiversity, enabling financial institutions to begin embedding nature into mainstream financial models, risk frameworks and portfolio strategies. It was co-created by banks, asset managers, CISL's Centre for Sustainable Finance and academics from the University of Cambridge conservation cluster.[i] During 2021, this group will use it to identify and assess specific nature-related financial risks.[ii]

To make this handbook immediately useful to practitioners we:

1. Define key concepts
2. Detail transmission channels that make nature loss a financial risk
3. Outline a framework that banks and asset managers can use to identify nature-related financial risks

The main audience for this handbook are financial practitioners with limited prior knowledge of biodiversity loss, land degradation or how the decline of nature can put their institution at financial risk. The intent is that it serves as a reference guide for individuals to engage with these subjects further and to use the framework presented to start identifying nature-related financial risks.

Much attention has been devoted to the interaction between climate change and nature loss. While climate change is a substantial driver of nature loss and subsequent nature-related financial risks, others, such as water pollution, also cause considerable financial risks. By understanding and measuring nature-related financial risks, in addition to climate risk, financial institutions move a step closer to understanding how to manage these risks in their portfolio. Through that act of management, the value of nature can be recognised and a transition to a nature-positive economy catalysed.

Note for readers: throughout this handbook hyperlinks are provided for key terms. By clicking these, the reader can find the place in the document where the term is defined.

[i] Cambridge, UK is home to the largest cluster of conservation organisations in the world.

[ii] This handbook represents the latest output from the CISL programme of work on nature-related financial risks, which began with a review of the financial materiality of biodiversity loss and land degradation.

How nature loss is a risk to financial institutions

Human activity is driving the decline of nature. The financial risks of biodiversity loss and land degradation begin with human activity that drives nature loss.[iii]

As nature declines:

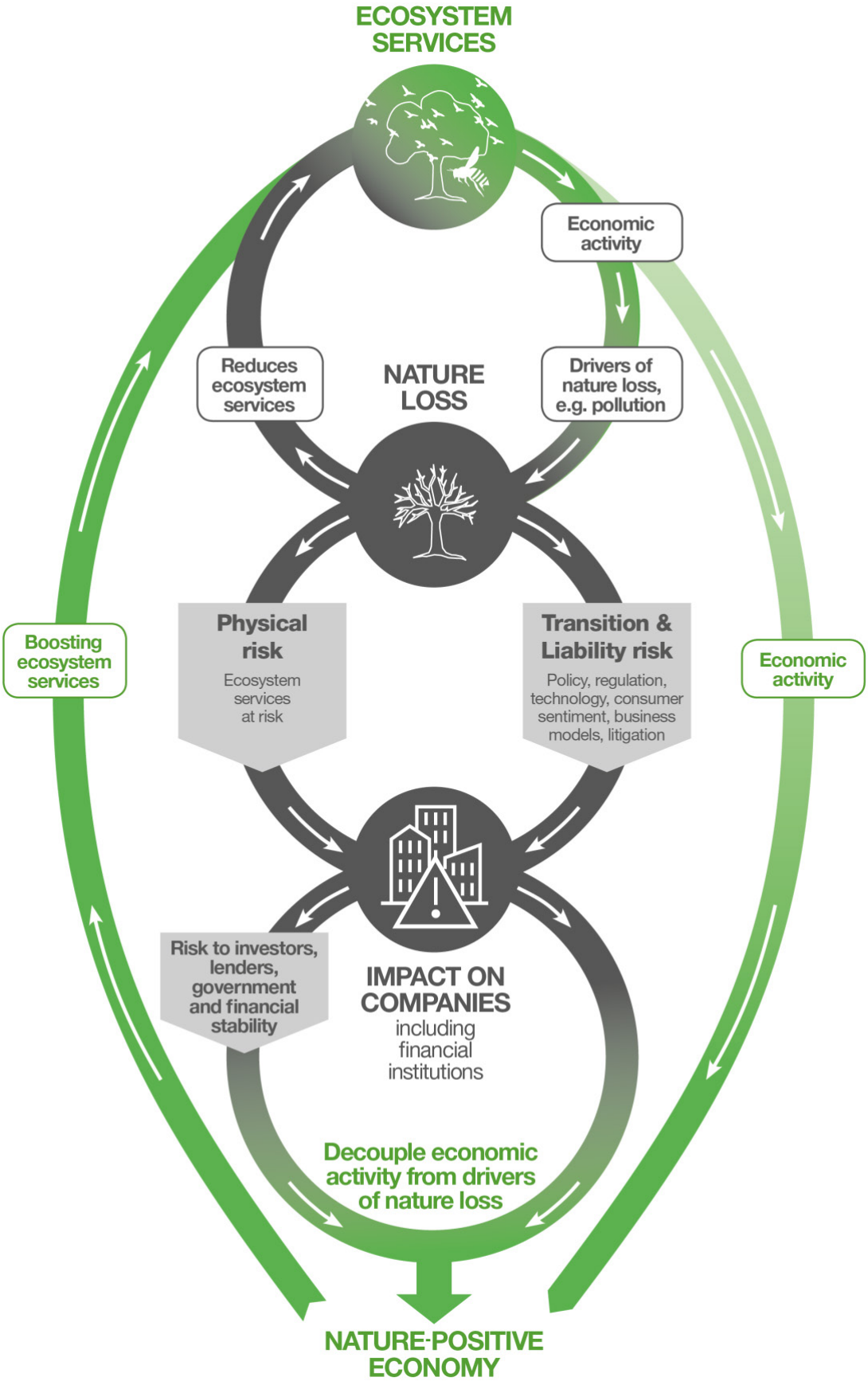
1. Natural capital is damaged and put at risk;
2. This reduces nature's capacity to provide ecosystem services, either temporarily or permanently, on which companies depend;
3. These companies are recipients of finance and investment, sources of tax revenue and key links in supply chains. Their vulnerability to an ecosystem service decline is therefore a vulnerability to investors, lenders, insurers, governments, connected companies and, by extension, a source for potential financial instability. These are physical risks.

Parallel to physical risks, transition and liability risks emerge, such as policies to protect nature. Despite their positive impact on nature, such policies can cause economic harm to some companies and, in turn, those financial institutions (FIs) connected to them.

Physical, transition and liability risks can drive a reorientation of portfolios and economic activity. As a result, financial flows could be redirected to boost the ecosystem services that provide benefits to people and drive a transition to a nature-positive economy, as shown in the below Figure 1.

[iii] The financial materiality of biodiversity loss and land degradation was covered earlier in our CISL programme of work on nature-related financial risks.

Figure 1: Connections between economic activity, nature and financial risk



Box 1: Definitions of sources of nature-related financial risks and a nature-positive economy

***Physical risks**:*	Much of global economic enterprise depends on the good functioning of natural systems, such as stability of climate and generation of raw materials. Physical risks arise when these natural systems are compromised, due to the impact of climatic (i.e. extremes of weather) or geologic (i.e. seismic) events or widespread changes in ecosystem equilibria, such as soil quality or marine ecology.[3] Physical risks can be event-driven or longer-term in nature.[4] It is the damage to ecosystem equilibria and resulting ecosystem service degradation that is our focus. For example, deforestation could reduce local rainfall, raising operating costs for numerous sectors.
Transition risks:	Regulatory or market efforts to address environmental harm can negatively impact companies and lead to stranded assets – representing 'transition risks'.[5] These can include abrupt or disorderly introduction of public policies, technological changes, shifts in consumer or investor sentiment and disruptive business model innovation.[6] As such they "relate to [a] process of adjustment"[7] towards a nature-positive economy. For example, anti-deforestation legislation increases due diligence costs for buyers of soft commodities that could be connected to deforestation.
Liability risks:	The risk associated with emerging legal cases related to nature loss, which could arise if parties that suffer loss or damage from the effects of environmental change seek compensation from those they hold responsible.[8] These losses or damages can include "potential pay-outs, fines, legal and administrative costs, insurance costs, financing costs, and reputational costs."[9] Fines for oil spills are a prominent example.
Nature-positive economy:	An economy in which public and private sector actors through choice and incentive take action at scale to reduce and remove the drivers and pressures fuelling the degradation of nature, actively improving the state of nature (natural capital) and the ecosystem services it provides.[10]

There are five direct drivers of nature loss:

- Climate change, where a change in climate destabilises ecosystems
- Invasive species, where animals or plants have been moved to places where they damage existing ecosystems, e.g. Japanese knotweed
- Land use change, such as cutting down a forest to make way for agriculture
- Overexploitation of natural resources, where a resource is used up faster than it can be replaced, e.g. overfishing
- Pollution of air, land or water

Land degradation refers to how a combination of these drivers can negatively impact land-based ecosystems.

Box 2: Definitions of nature loss and the benefits nature provides

Natural capital: Stock of renewable and non-renewable resources (e.g. plants, animals, soils, minerals, ecosystems) that combine to yield a flow of benefits to people, referred to as ecosystem services.[11]

Ecosystem services: Benefits that people obtain from natural capital, such as air and water purification services, crop pollination and the breaking down of waste. Biodiversity underpins the flow of benefits. Ecosystem services are also known as 'nature's contributions to people'.[12]

Biodiversity: The variety of life on earth – from flatworms to forests. Biodiversity is a characteristic of healthy natural capital assets. It underpins nature's capacity to generate flows of ecosystem services, such as how birds and animals pollinate our crops, worms are essential to soil fertility and intact forests prevent the spread of diseases.[13] The resilience of nature is directly related to the health and status of biodiversity.

Nature loss: Decline of natural capital, ecosystem services and biodiversity.

The relationship between biodiversity, natural capital, ecosystem services and their benefits to society is shown in the below diagram from the *Capitals Coalition*.

Box 3: Direct drivers of nature loss[iv]

Climate change:	Change in climate attributed directly or indirectly to human activity.[14] When climate conditions are destabilized, ecosystem services are disrupted and biodiversity is lost. For example, 50 per cent of the corals in the Great Barrier Reef have died since the 1990s.[15]
Invasive species:	Species whose introduction by humans threatens biodiversity. The species will not be native and is described as invasive if it expands into and modifies the ecosystem.[16] For example, European starlings are estimated to cause USD 1 billion of damage per year to US agriculture.[17]
Land use change:	Change in the use or management of land by humans.[18] This may lead to a change in the quality or extent of natural habitat, which has knock-on effects for ecosystem services. For example, the conversion of natural forests to agriculture threatens local water supply: in the Amazon area, one-third of the rainfall is created by natural processes in the forest itself – rainfall that would be lost if the forest became degraded.[19]
Overexploitation of natural resources:	Using natural resources or harvesting species from the wild at rates faster than then they can recover. One example of overexploitation is overfishing; between the 1950s and 1990s the amount of fish caught in the wild quadrupled, putting major pressure on marine ecosystems.[20]
Pollution:	Introduction of materials into the environment that harm nature.[21] Pollution can be of air, water and/or land. One example is how air pollution impacts cognitive performance and human health, significantly reducing both the supply and productivity of labour.[22]

Why nature loss is a financial risk

Nature loss becomes a financial risk when physical, transition and liability risk manifest, causing negative impacts upon:

1. Companies and governments, to which FIs are exposed via loans, debt and/or equity holdings and/or revenues from financial services;
2. Financial markets, including commodity and money markets, to which FIs have exposure through investments or financial services (e.g. derivatives).
3. The operations or property of FIs, e.g. a lack of green space in cities can lead to fast water runoff causing flash flooding that damages FI property.[23]

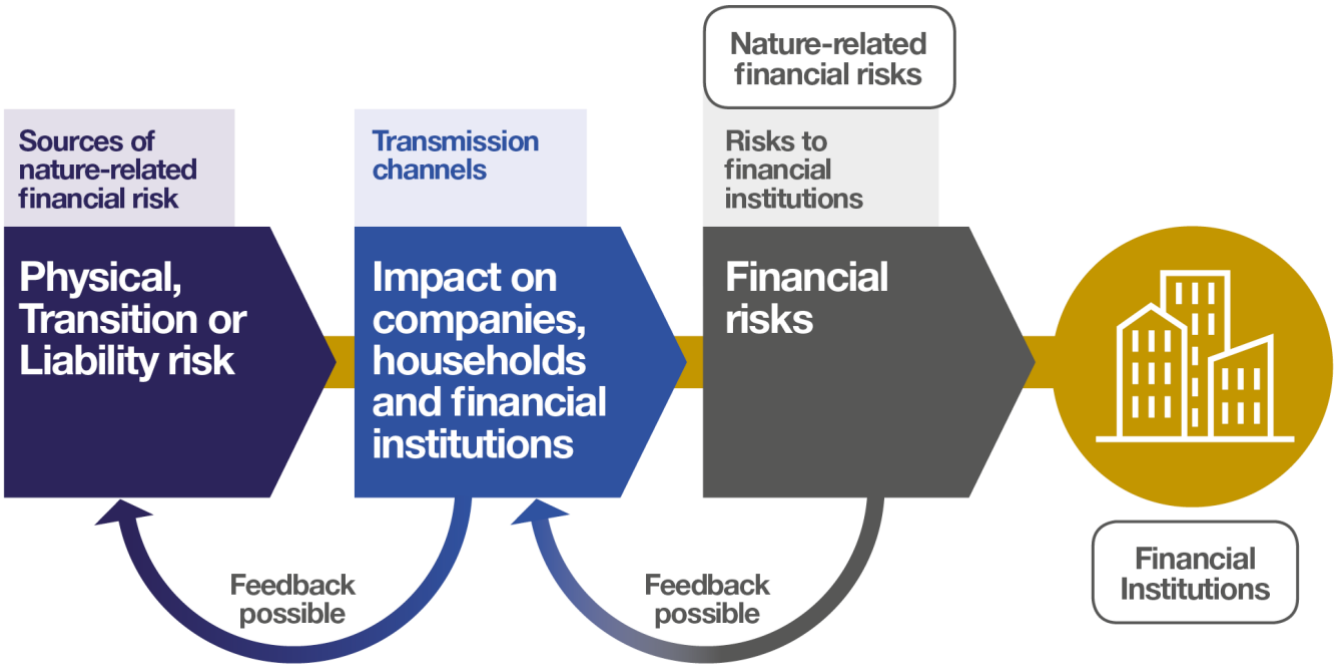
These exposures lead to credit, market, liquidity and business risks – referred to as 'Financial risks' in the below Figure 2.[v]

[iv] These Direct Drivers align with those of IPBES detailed here.
[v] Underwriting risks are out of scope for this handbook.

Transmission channels for nature-related financial risks

The links between sources of nature-related financial risks and the financial system are called ***transmission channels***, a concept used to analyse how the real and financial economy are connected.[24]

Figure 2: Transmission of nature-related risks to financial institutions



Types of transmission channel

De Nederlandsche Bank (DNB) identifies six types of economic impact that can be caused by nature-related financial risks and then transmitted into the financial system.[25] These are detailed in Figure 3. To provide colour to the DNB categories, micro- and macro-economic impacts highlighted by the Network for Greening the Financial System (NGFS)[vi] are also detailed.[26]

[vi] The NGFS is a membership group of central banks and financial supervisors from around the world aimed at strengthening the response to environmental risks, such as nature loss. As of December 14th 2020, the NGFS consists of 83 members and 13 observers.

Figure 3: Transmission channels: from sources of nature-related financial risk to financial risk

------- Transmission channels ------>				
Source of nature-related financial risks	**Micro** (from NGFS)[27]		**Categories** (from DNB)[28]	**Financial risks**
	Businesses (including FIs)	- Property damage and business disruption - Stranded assets and new capital expenditure due to transition - Changing demand and changing costs - Legal liability (from failure to mitigate or adapt)	Disruption of activities/value chains	
	Households	- Loss of income (from weather disruption and health impacts, labour market frictions) - Property damage or restrictions increasing costs and affecting valuations	Raw materiality price volatility Pricing externalities	
	Macro (from NGFS)[29]			
	Aggregate impacts on macroeconomy	- Capital depreciation and increased investment - Price shifts (from structural changes, supply shocks) - Productivity changes (from severe heat, diversion of investment to mitigation and adaptation, higher risk aversion) - Labour market frictions - Socio-economic changes (from changing consumption patterns, migration, conflict) - Other impacts on international trade, government revenues, fiscal space, output, interest rates and exchange rates	Stranded assets Adjustment/ relocation of activities Capital destruction	

The six categories of transmission channel are defined below. They are economic impacts that can be acute and/or chronic:

- Acute impacts are event-driven, with consequences that are sudden and often large, then recede until the event happens again.
- Chronic impacts gradually worsen, with consequences that are not anticipated to recede or revert to their prior state.

1. **Disruption of activities or the value chain** (acute)

   Disruption could be due to:

   - Business interruption
   - Changing costs
   - Changing demand
   - Labour market frictions, which for a business would mean an increase in the amount of time to hire suitable workers or the likelihood of losing those workers
   - Litigation, resulting in losses or damages
   - Productivity changes, e.g. severe heat, pandemic impacting workers
   - Property damage

   These would add costs to doing business in the short-term e.g. transport route diverted temporarily awaiting a landslide road clearance, potentially drawing on working capital and access to debt. Without access to either, the solvency of the business may be threatened, increasing the probability of default. The increased demand for liquidity may also increase refinancing risk.

2. **Raw materiality price volatility** (acute and chronic)

   Refers to fluctuating commodity prices caused by disruptions at the beginning of supply chains, or systemic changes in the supply chain. For example, poor harvests due to extreme weather can cause price volatility, especially if stocks are low, as they were with grain in 2006.[30]

   Commodity price risk is material: "commodity price swings are the second-largest driver of earnings uncertainty at publicly-traded companies."[31] It is also especially relevant to banks offering hedging and trade finance products.

3. **Pricing externalities** (chronic)

   Pricing externalities means accounting for the economic, social and/or environmental impacts arising from the activities of an entity.[32] Companies and their stakeholders (investors and customers) often do not bear the cost of these impacts. Recognition of these impacts is set to increase, via initiatives such as the upcoming Taskforce for Nature-related Financial Disclosures, and any subsequent regulatory changes may mean business is charged for 'externalities', leading to additional costs of doing business.[vii] Taxes on nitrogen fertiliser to reduce water pollution are one example.[33]

   Although pricing externalities may generate an increase in short-term costs if the price is absorbed by the company, an increasing number of business leaders now view it as wise to take account of externalities to future-proof the organization, reducing the risk of sudden unexpected cost increases and driving operational efficiencies.[34] For example, Colgate-Palmolive devised an internal price for water as much as 2.5 times higher than the purchase price by accounting for services currently provided by ecosystems (externalities), which in turn helped drive lower water usage in production processes.[35]

[vii] By supporting the disclosure of impacts and dependence on nature, the Taskforce for Nature-related Financial Disclosures could help catalyse the creation of a vault of information about the relationship of a company to nature. Equipped with such information, governments are able to better identify categories of negative impact, who is associated with them and who or how to charge for them.

4. **Stranded assets** (acute and chronic)

   Assets that "suffer from unanticipated or premature write-offs, downward revaluations or are converted to liabilities [as a result of] a range of environment-related risks."[36] For example, recent impairments in the oil and gas industry have been attributed to weakening demand linked to emerging transition risks. A demand scenario consistent with Paris Climate Goals weakens the outlook for oil and gas prices and was specifically cited by Repsol for the EUR 4.8 billion impairment charge it took in 2019.[37]

   Work on stranded assets has typically focused on fossil fuel industries, but the issue has much wider scope.

5. **Adjustment or relocation of activities** (chronic)

   In this transmission channel, as opposed to a temporary disruption, the consequences on business operations are more long-term. Drivers of a decision to more permanently adjust or relocate activities can include:

   - Changing costs / price shifts
   - Changing demand
   - Labour market frictions, where the inability to hire or retain appropriate workers forces adjustment
   - Litigation, where the business model or operations shift indefinitely as a result of liability risk manifesting
   - Productivity changes
   - Property damage, such as from an increase in the regularity or severity of extreme weather events

   Adjustment or relocation of activities would involve capital expenditures in order to adapt, e.g. international trade flows changing due to new anti-deforestation regulations. Higher capital expenditures increase the financial risks associated with the business in the short- to medium-term.

6. **Capital destruction** (acute)

   Capital destruction, simply defined, happens when a physical risk manifests and damages assets, e.g. if a landslide damages a railway.

The final step: from transmission channel to financial institutions

Each transmission channel identified can lead to the impairment of assets or collateral and/or lower corporate profitability.[38] These impairments or impacts on profitability, actual or anticipated, establish a connection to financial institutions and create financial risks.

Feedback is possible: transmission channels can flow in both directions

As awareness of the 'nature-related financial risks' improves, feedback is possible, first to the economy and then to the environment. In other words, transmission channels can flow in both directions: from the real to the financial economy and from the financial economy back to the real economy. For example:

- If the credit rating of a sector exposed to nature-related risk is lowered, then this may promote behaviour in the real economy that further damages nature. In the case of agriculture clients, a lower rating and higher interest rates could deter investment in equipment that improves the productivity of degraded land, in turn increasing the likelihood that more land is deforested to meet growing food demand.[viii]

[viii] It is critical that techniques to improve degraded land productivity do not simply reduce prices and thus enable greater consumption of agricultural products, per Jevons paradox.

Framework for identifying nature-related financial risks

Equipped with knowledge about the physical, transition and liability risks related to nature loss, and the transmission channels that connect these risks with the financial world, it is possible to create a framework for identifying nature-related financial risks. Shown below, this framework begins with sources of nature-related financial risks (column A) and concludes with the financial risks (column D). The transmission channels in between can be found in column C and mirror those described in the above Figure 3.

When risks manifest as a result of nature loss, they can do so as a result of the decline of ecosystem services or because of a response to that nature loss. Ten categories of ecosystem service decline and responses to nature loss are specified (column B). These categories are defined in full by the next chapter, as are the financial risks specified by column D.

Figure 4: Framework for identifying nature-related financial risks

1. Select a sector **AGRICULTURE**

2. Choose a type of risk	3. Choose the ways the risk can manifest	4. Use knowledge of (a) the risk manifestation and (b) the sector value chain to provide examples under the 'impact on companies' headings	5. Given the impact on clients or investments, what could be the financial risk under each category? (For business risk, what is the risk to the operations or business lines of the financial institution)
A Type of risk	**B** Risk manifests as a result of…	**C** Examples of impact on companies	**D** Examples of resultant financial risk
Physical risk Ecosystem services at risk due to land use change, either in agricultural systems or due to other industries changing the landscape, the provision of water and/or the stability of soils, such as…	**Water security** degrading… Deforestation disrupts local climate regulation and water supply **Food and other goods** provision degrading… Less genetic diversity of crops increases vulnerability to pests	**Stranded Assets** Lower rainfall and increased vulnerability to pests threatens crop yields, reducing land value and compromising business viability	**Credit:** Value of assets and collateral decline significantly if yields worsen chronically. Increases the probability of default and decreases recovery rate, therefore reducing the creditworthiness of the client **Business:** If local rainfall cycle disrupted, this would impact the health of the entire industry in a region, reducing revenues available from clients in the value chain that in turn causes certain staff or service lines to become redundant **Liquidity:** Depth of regional commodities markets impacted if a biodiversity tipping point, such as rainfall cycle disruptions, causes output to fall dramatically
Transition risk In response to land degradation, such as…	**Policy and Regulation** License to use land temporarily revoked as the result of new pollution regulation Introduction of biodiversity targets, e.g. organic farming requirements	**Disruption of activities or value chain** Temporary halt of activity results in cash burn **Adjustment or relocation of activities** Switching to organic farming methods could mean additional up-front cost, placing strain on short term profitability. Importantly, the less future-proofed the business, the higher and more shocking the cost to change will be	**Credit:** Working capital allowance may not be great enough for short term cash needs, affecting the overall creditworthiness of the client **Market:** Risk to investments in pesticide value chain from ban on neonicotinoid insecticides **Business:** Additional due diligence required by financial institutions to ensure that clients adhere to biodiversity targets **Liquidity:** Increased cost of debt refinancing if license to operate temporarily withdrawn
Liability risk	**Litigation**	**Disruption of activities or value chain** Damages awarded to repair environmental damage, such as fertiliser run off impacting ground water supply	**Business:** Fine for financing a client that causes environmental damage

AGRICULTURE

Using the framework

During usability testing of the framework, financial institutions recommended applying it to one sector at a time, though the framework could also be applied to a specific geography (e.g. country/region). This meant that the framework functioned as detailed above.

During 2021, CISL and financial institutions will use the framework to identify and assess specific nature-related financial risks. As progress is made, the framework may evolve to ensure accessibility and usefulness.

First- and second-order effects and systemic risks

Identifying nature-related risks for the agriculture sector provides a good example of ***first-order effects***, where the manifestation of the risks have a direct impact on a company.[39]

However, whilst it is "easy to draw a direct link between a risk and its impact on [a] business"[40] it will be more difficult to identify ***second-order effects***. These effects have a "wider impact, beyond the first order effects, that influence another element in [the] industry or value chain, and thereby change the economic balance of [the] industry."[41] For example, a tax on imports should directly reduce demand for the affected goods, impacting the companies that produce them – a first order effect; yet this lower demand for imported goods could also impact associated sectors e.g. retail, logistics etc – a second order effect.

Lastly there is ***contagion risk***, which can originate in the financial or real economy and is a systemic risk that financial difficulties at one or more financial institutions spill over to the financial system as a whole.[42] One example is how the sub-prime mortgage crisis catalysed the global financial crisis of 2008-2009.

Risk cascades

> *In wild periods of alarm, one failure makes many, and the best way to prevent the derivative failures is to arrest the primary failure which causes them.*
>
> — Walter Bagehot, Lombard Street

The chain of economic effects, from first- to second-order through to contagion, are a risk cascade such as Bagehot describes that can result in ***systemic risks*** to the economy as a whole. His words allow us to conclude this section with a reference to where we began in Figure 1: namely; that economic activity causes nature loss – the 'primary failure' – that causes a cascade of reactions and economic impacts to which investors and lenders are exposed.

Definitions of risk types in the framework

Physical risks

Physical risks can arise when ecosystem equilibria are damaged, causing ecosystem services on which the economy depends to degrade (full definition).

Ecosystem services: definitions and examples of what drives their decline

The ecosystem services that are degraded by economic activity, causing financial risk, are divided into five categories. This is a simplification of a classification by the Swiss Re Institute, noting that others exist (see Appendix A). The purpose of creating five clear, simple categories is so the financial community can begin to identify and distinguish between the sources of nature-related financial risks.

Table 1: Ecosystem service categories

Five categories	Swiss Re Institute
- Air quality and local climate *E.g. the regulation of temperature, humidity and pollutants*	- Air quality and local climate
- Water security *E.g. the availability of freshwater*	- Water security - Water quality
- Food and other goods provision *E.g. pollination enabling agricultural output*	- Food provision - Timber provision - Pollination - Soil fertility
- Habitat intactness *E.g. intact habitats reduce risk of disease*	- Habitat intactness
- Hazard regulation *E.g. mangroves that protect coastlines*	- Erosion control - Coastal protection

1. Air quality and local climate[ix]

Definition

The regulation of air quality and local climate.

Within the local climate, "vegetation can modify temperatures, humidity, and wind speeds… at local and micro-levels."[43] For example, a lack of trees in urban areas increases the urban heat island effect, increasing air conditioning costs.[44]

For air quality, a range of organisms and natural structures (e.g. peat or forests) filter and absorb pollutants that could "directly affect human health or infrastructure."[45] Again, a lack of trees in urban areas reduces air quality.[46]

In passive house design, buildings are extremely airtight. This makes the conditions inside the building more stable and predictable. Predictability means temperature can be controlled without wasting energy (versus high energy consumption if the building leaks). A stable environment means less costly building management. Climate stability and good air quality provide the same predictable operational environment from which all companies can benefit.

Consequences of air quality and local climate degrading

Examples of the consequences of air climate and local climate degrading, by driver, include:

Land use change

- One-third of water falling in Amazon comes from its own trees (trees take up rainwater and give it back to the atmosphere, where it turns again to rain). If the forest is degraded, this climate control collapses and the Amazon forest itself risks turning into a savannah, with substantial consequences for agriculture and water supplies across South America and into North America. [47]

Pollution

- Lower air quality due to particulate pollution reduces working productivity.[48]

Example of how this could manifest as a financial risk

Sovereign debt risk could increase if revenues from industries reliant on predictable rainfall, such as agricultural export-based economies, are impacted.

2. Water security

Definition

The availability and quality of freshwater.

From beverage manufacturers, to utilities and consumer goods companies, the availability of clean water is the lifeblood of the business.

[ix] Global climate stability is critical for the health of all five of the services identified in Table 2.

Consequences of a decline of water security

Examples of the consequences of a decline in water security, by driver, include:

Land use change

- Deforestation can negatively affect water security as forests regulate water flows through wet and dry seasons. This increases resilience of land to drought and consistency of water supply, safeguarding drinking water and food supply. 20 million people in Mexico City get their drinking water from mountain forests.[49]

Pollution

- Agricultural runoff, such as fertilisers, can pollute freshwater, raising water treatment costs and posing risks to public health.[50] This type of pollution is particularly relevant when it occurs in mountain areas, since these provide 60-80 per cent of freshwater supply.[51]

Example of how this could manifest as a financial risk

Reduced availability of water directly impacts the cost base of industries such as utilities and agriculture, increasing operational expenditures and cost of living. This could lead to additional credit or market risk associated with the companies impacted, especially if significant investment is needed to adjust operations.

3. Food and other goods provision

Definition

The provision of food and other goods, including materials and energy.[52]

This ecosystem service grows or otherwise creates soft and hard commodities, from which tangible economic goods are derived.

Consequences of a decline of food and others good provision

Examples of the consequences of a decline in food and other goods provision, by driver, include:

Invasive species

- Introduction of foreign species disturbs fish hatcheries, e.g. Asian carp in the US Great Lakes consume what native fish would have, crowding out native species and undermining an industry worth USD $7 billion.[53]

Land use change

- Removing mangroves removes habitats critical to the productivity of nearshore fisheries.[54]
- Land management practices that compact soil, worsen water flow regulation and degrade soil carbon ultimately reduce crop yields.[55]
- Reducing the genetic diversity of plant species farmed on land, such as rice, wheat and maize, can reduce crop yields because there is less resilience to pests.[56]

Overexploitation of natural resources

- Fishery mismanagement reduces wild catch by up to $83 billion each year.[57]

Pollution

- Pesticide pollution can cause near-shore fishery collapse.[58]

Example of how this could manifest as a financial risk

Lower volumes from agricultural, forestry or fishery industries in certain locations could reduce the demand for associated services in the value chain, such as pulp and paper processing, increasing the credit and market risk of these companies.

4. Habitat intactness

Definition

Habitat intactness refers to the maintenance of conditions necessary for habitat dependent species and ecosystem health. One way a habitat ceases to be intact is if connectivity is removed and species are marooned in small pockets. For example, having a decent-sized block of connected forest to maintain the forest ecosystem.

Consequences of a loss of habitat intactness

Examples of the consequences of a loss of habitat intactness, by driver, include:

Climate change

- Twenty-five per cent of all marine species depend on healthy coral reefs.[59] Changes in our climate are warming oceans, killing the coral habitats. Current rates of warming are compounding other pressures, such as overfishing, to the extent that 90 per cent of reefs are threatened with extinction by 2030.[60]

Land use change

- Greater reliance on pesticides: pest control is weakened when land management does not sufficiently acknowledge the value of habitat connectivity.[61]
- Loss of nursery habitats that support the provision other services, such as food; for example, eelgrass beds provide a valuable refuge, foraging, and spawning habitat for many commercially and recreationally fished species.[62]

Examples of how this could manifest as a financial risk

Less habitat intactness can concentrate species and increase the number of interfaces between those species and humans. This increases the chance of zoonotic disease – where pathogens transmit from animals to humans – such as Covid-19.[63, x]

Furthermore, the loss of species due to the loss of habitat intactness is irreversible, with such extinction representing the loss of genetic material that may have held yet to be understood medicinal or other future value.

[x] There is clear overlap here with the other category of Hazard Regulation.

5. Hazard regulation

Definition

Regulation of the impact of floods, fires, landslides, droughts, wind, storms, hurricanes, seawater intrusion, tidal waves, heat waves, tsunamis, high noise levels and organisms detrimental to humans.[64]

Much of the value of hazard regulation is only fully realized when it is lost. Reduced hazard regulation can create a need for costly expenditures such as sea defences and tidal barriers, as well as emergency government action such as mandatory evacuations and travel bans.

Consequences of a decline in hazard regulation

Examples of the consequences of a decline in hazard regulation, by driver, include:

Land use change

- If soils are allowed to erode due to how the land is managed, flood risk can increase.[65]
- Mangroves weaken wave energy, providing storm surge protection. If land use is changed, and mangroves degraded, then flood damage costs could increase by $65 billion annually.[66]

Invasive Species

Invasive species undermine the ability of an ecosystem to regulate organisms that can cause damage to the economy, for example:

- Invasive plants can severely damage lakefront property values by interfering with waterfront recreation opportunities. In Vermont, this has negatively impacted property values by 16 per cent.[67]
- Invasive mollusc populations can negatively impact hydropower electricity production, increasing the cost base of utilities.[68]

Example of how this could manifest as a financial risk

If the impact of hazards is not regulated, then infrastructure and real estate are put at greater risk of flood, storm, etc. and capital destruction can occur. That capital destruction poses credit risk where assets are offered as security, and market risk as balance sheets are impacted.[xi]

Measuring the health of ecosystem services

What constitutes ecosystem health will vary by geography and context. What is more, the quality and availability of data and tools to measure that health varies.

Examples of tools include the CISL Biodiversity Impact Metric, a risk-screening tool for those sourcing goods in agricultural supply chains, the Integrated Biodiversity Assessment Tool, which contains data

[xi] It also poses underwriting risk for the insurance industry, which is out of scope for this handbook.

about threatened species, protected habitats and key global biodiversity sites, and the WBSCD Guide to Corporate Ecosystem Valuation.[xii]

Yet this is an ongoing field of research and where gaps exist, methods continue to emerge. For example:

- Trase Finance is mapping the link between deforestation, finance and trade.
- The Science Based Targets Network (SBTN) is working on creating targets for nature, which will create a harmonised set of metrics for assessing and measuring nature loss caused by companies.[69] The aim is for these targets to be developed by 2022.

Transition risks

Transition risks arise from efforts to address environmental change (full definition). These efforts tend to manifest as changes to regulation and policy, technology, consumer or investor sentiment and business model innovation. As a rule, the more disorderly or abruptly these changes manifest the greater the transition risk.

Policy and regulation

Policy refers to government legislation passed, whereas regulation can come from a semi-autonomous regulatory body, including financial regulation.

Examples of public policy and regulation that are a source of nature-related transition risk include:

- Nitrogen reduction policies:

  In order to meet nitrogen pollution reduction rules, licensing of new construction projects was halted in the Netherlands in 2019. The extent to which any resultant cost for transitioning nitrogen producing activities falls on public or private companies will influence the extent of the financial risk.[70]

- Organic farming requirements:

  The EU Biodiversity Strategy targets at least 25 per cent of agricultural land to be farmed organically by 2030.[71] This could impact revenues of some fertiliser companies, posing risks to creditors and investors.

- Extension of the 'polluter pays' principle:

  The Alpine Convention, which includes the polluter pays principle, places an environmental damage burden on business.[72] The extension of the principle increases the liability risk facing business and, by extension, their creditors or investors.

- Stricter 'no biodiversity net loss' legislation, e.g. wetland mitigation banking in the US.[73]

[xii] Other examples are covered in an earlier CISL publication on the *Financial Materiality of Biodiversity and Land Degradation*.

Stricter regulation can increase the cost of doing business for some. Those without shadow pricing, where the value of ecosystem services is accounted for, will see increased liabilities that could increase refinancing and credit risk.

- Requirement for property developments to factor in open space or a net biodiversity gain for new developments.[74]

  Those firms without the pedigree and institutional expertise to deliver will put their investors at greater market risk, should such requirements be introduced.

Technology

Technological improvements or innovations that support the transition to a nature-positive economy can have a significant impact on certain companies. For example, the development of leather and protein alternatives as a substitute to deforestation-associated agricultural goods. To the extent that new technology displaces old systems and disrupts some parts of the existing economic system, winners and losers emerge. There are financial risks of being exposed to the latter.

The timing of technology development and deployment, however, is a key uncertainty in assessing technology risk.[75]

Business model innovation

New ways to organise and run a company can improve the profitability or balance sheet of that company, without the use of new technology. For example, by organising and managing the production of agricultural products at a 'landscape'[xiii] level, a number of ecosystem services benefits can accrue to farmers, such as improved water quality.[76]

As with technology risk, if business model innovation displaces old systems and disrupts some parts of the existing economic system, then winners and losers emerge, with greater financial risks attached to the latter.

Consumer or investment sentiment

Changing consumer sentiment toward certain products or investor sentiment toward certain assets can impact demand for both:[77]

- Investors are sensitive to environmental disasters. For example, of a sample of 64 explosions in chemical plants and refineries between 1990-2005 petrochemical firms lost 1.3 per cent of their market value in the two days following an explosion; furthermore, the greater the extent of chemical pollution from the event, the greater the size of the loss.[78]
- Consumer demand for sustainability labels has led to unlabelled products losing market share to ethical products. Between 2013 and 2018, 90 per cent of the fastest growing consumer goods products in the US, by sales, were marketed as sustainable.[79]

[xiii] A landscape is a fixed geographic area containing many producers. If managed according to the agreed upon standards a landscape can become what IDH calls a 'verified sourcing area'.

Liability risks

Liability risks can impact companies or financial institutions and manifest as:

- Pay-outs and fines.
- Legal or administrative costs during litigation, for legal counsel and the associated back-office work for the defence and, if ordered, for the claimant.
- Insurance costs, for liability insurance products that may adjust their terms as nature-related liability risks become more visible.
- Reputational costs, where consumer or investor sentiment is impacted by litigation.[80]

Examples include:

- Revocation of licences to develop land if the government deems the environmental and social impact assessment inadequate, see the Bear Creek vs Peru case.[81]
- Fines if a company cultivates land connected to illegal deforestation.[82]
- Penalties relating to ballast water regulations that cover the introduction of alien species.[83]
- Fines for deliberate ocean dumping or oil spills.[84]

These liabilities increase the credit and market risk associated with a company.

Liability risk is different to 'policy and regulation' transition risk. The latter is about the emergence of new policy or regulation that, for example, requires an adaptation of business operations; whilst the former is based on regulation that is in place and represents the risk that there is a failure in, to give one example, company operating procedures.

Nature-related financial risks

Nature-related physical, transition and liability risks pose financial risks to financial institutions. The transmission channels have been described above. They can manifest as credit, market, liquidity and business risks, as defined below.[xiv]

Credit risk

Definition: Credit risk is "comprised of issuer and counterparty risk. Issuer risk is the possibility that an issuer/borrower is not able to fulfil its obligations due to its default. Counterparty risk comprises the risk that a counterparty defaults and is not able to fulfil its obligations."[85]

Examples:

- Deforestation and land conversion for agriculture reduces flood control, which increases counterparty risk by putting assets of clients at greater flood risk.[86]
- Mangroves safeguard property values by offering wind protection; the wind protection value of mangroves during storms in reducing house damage amounted to approximately US$177 per hectare.[87] This is of value where property is used as counterparty risk collateral.

[xiv] Underwriting risks are out of scope for this handbook.

- Rating of European Chemical companies could be negatively impacted by EU proposal to reduce fertiliser use by greater than 20 per cent by 2030. This could pose a material risk to sales for those with significant European end market exposures.
- If land is managed appropriately, it can can help prevent wildfires, protecting property values (collateral) in the case of a counterparty default.[88]

Market risk

Definition: the "risk of losses in on- and off-balance-sheet positions arising from movements in [financial] market prices."[89]

Examples:

- Uncertainty over the potential impact of an emerging zoonotic disease, such as Covid-19, can cause significant market losses.
- Accidents with negative environmental effects can result in negative stock market reactions. Following the Deepwater Horizon explosion in the Gulf of Mexico in 2010, the abnormal return for BP was -2.62 per cent, with an abnormal return of -3.38 per cent for Transocean, the owner of the drilling rig.[90] Other examples exist,[91] such as how potash mining accidents negatively impact the miner's market value in the days that follow an accident.[92]
- Breaking environmental regulations can limit access to capital markets. For example, the China Securities Regulatory Commission has blocked companies from carrying out an initial public offering if they have broken environmental protection laws.[93]
- Almost USD $600 billion of annual crop values are at risk due to pollinator losses.[94] Insect pollinators underpin agricultural yields, with 84 per cent of commercial grown crops insect pollinated.[95] Stressed pollinator populations pose a significant equity and debt market value risk to the agriculture sector, but could also trigger second order effects that impact other industries. For example, if food prices significantly increase because of lower agricultural yields then the percentage of household spending on non-essentials, such as consumer technologies, could decrease, putting equity and debt market values of firms in those value chains at risk.

Liquidity risk

Definition: the risk that an institution "will not be able to meet efficiently both expected and unexpected current and future cash flow and collateral needs without affecting either daily operations or the financial condition of the firm."[96]

Examples:

- Soft commodity market volatility can be caused by difficult to predict harvest volumes. For example, in the first five months of 2018 cocoa prices increased by more than 50 per cent, mainly because the 2017/2018 harvest was not anticipated to be as strong as 2016/2017.[97] If a biodiversity tipping point, such as rainfall cycle disruptions in the Amazon, cause agricultural output to fall dramatically this could significantly reduce liquidity in soft commodity markets, putting trading positions at risk.[98]
- Pressure to liquidate assets due to a biodiversity tipping point emerging may undermine the financial condition of FIs, potentially triggering wider systemic risks.

- Cost of debt refinancing if client's licence to operate is temporarily withdrawn due to environmental damage or non-compliance with environmental regulations.

Business risk

Definition: Those risks that a financial institution's operations, plans or business model face as a result of a change in circumstances. [99] This can include the reputational risk to revenues of being connected, as a financier or investor, with biodiversity loss.

Examples:

- Dams and irrigation, which are examples of land use change, have increased the prevalence of malaria and encephalitis, potentially impacting employee sickness rates and labour productivity.[100]
- Being connected to major negative environmental events, such as oil spills or deforestation, may lead to action by creditors or investors such as the withdrawal of deposits or deterioration of share value.[101]
- Policy or regulatory changes to protect nature, such as the Lacey Act, which since 2008 has banned US imports of illegally sourced lumber and timber products, create an additional risk exposure and operational overhead for FIs that could impact the commercial viability of some business lines.
- Financial institutions without sufficient ESG policies, including on nature loss, risk investor action.

Next steps

The Dasgupta Review of the economics of biodiversity focuses on completely rewiring mainstream economic and financial models. This handbook aims to advance that rewiring process. By defining key concepts and putting forward a framework for identifying nature-related sources of financial risk, we aim to enable financial institutions to begin to embed nature in their operations, risk frameworks and portfolio strategies. Once embedded, and the logic of financial decision making rewired, much needed private capital can be mobilised toward nature-based solutions and a transition to a nature-positive economy catalysed.

During 2021, CISL's Centre for Sustainable Finance will continue their collaboration with academics and members of the Banking Environment Initiative and Investment Leadership Group, applying the framework to assess specific instances of nature-related financial risk (creating use cases).

Assessing these risks brings the financial materiality of nature loss into sharp focus, making a compelling business case for financial institutions to engage with risk mitigation strategies that protect and restore nature, whilst creating opportunities to design new investment, hedging and insurance products that drive change in the real economy for a nature-positive future.

Call to action

We call on the financial community to use this handbook to start identifying nature-related financial risks. The sooner we begin the journey to embedding nature into financial decision making, the sooner we rewire our economy to protect and restore our natural world.

Appendix A

Table 2: How the five categories of ecosystem services match up with other classifications[xv]

Five categories	Swiss Re Institute	ENCORE	IPBES
- Air quality and local climate	- Air quality and local climate	- Ventilation - Climate regulation - Filtration	- Regulation of air quality - Regulation of climate
- Food and other goods provision	- Food provision - Timber provision - Pollination - Soil fertility	- Fibres and other materials - Soil quality - Genetic materials	- Pollination and dispersal of seeds - Regulation of ocean acidification - Formation, protection and decontamination of soils - Energy - Food and feed - Materials and assistance - Medicinal, biochemical and genetic resources
- Habitat intactness	- Habitat intactness	- Maintain nursery habitats - Genetic materials	- Habitat creation and maintenance - Learning and inspiration - Physical and psychological experiences - Supporting identities - Maintenance of options
- Hazard regulation	- Erosion control - Coastal protection	- Buffering and attenuation of mass flows - Mass stabilisation and erosion control - Flood and storm protection - Disease control - Mediation of sensory impacts	- Regulation of hazards and extreme events - Formation, protection and decontamination of soils - Regulation of organisms detrimental to humans
- Water security	- Water security - Water quality	- Ground water - Surface water - Water quality - Filtration - Water flow maintenance - Bio-remediation	- Regulation of freshwater quantity, location and timing - Regulation of freshwater and coastal water quality

[xv] The groupings of the services specified by the Swiss Re Institute, ENCORE and IPBES are intended to be indicative only.

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