An Overview of Nature-Related Risks and Potential Policy Actions for Ministries of Finance:

Bending The Curve of Nature Loss

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A product of the Helsinki Principle 5 Workstream

June 2022

The Coalition of Finance Ministers for Climate Action

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This report benefited from contributions from the following member countries: Chile, Finland, France, Germany, Indonesia, Italy, Luxembourg, the United Kingdom, and the United States.

The report benefited from the contributions from the following experts: Katie Kedward (University College London); Thomas Viegas (Bank of England); Charlotte Gardes-Landolfini and William Oman (International Monetary Fund); Jose Medeiros De Morais, Grzegorz Pezsko, Stefanie Onder, Boris Ton Van Zanten (World Bank); Miika Korja, Puroila Samuli, and Outi Haanperä (Sitra); Katia Karousakis, Clare Delpeuch, and Will Symes (Organization for Economic Cooperation and Development (OECD)), and Mariana Bellot and Marco Arlaud (UNDP BIOFIN).

Benjamin Holzman provided graphic design and Bruce Ross-Larson, Joe Caponio, and S.A. Braithwaite provided editing.

This work received support from the World Bank Global Program on Sustainability (GPS) Trust Fund.

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This work is a product of the Coalition of Finance Ministers for Climate Action ("the Coalition") and was prepared at the request of the Coalition under the Helsinki Principle 5 Workstream on "mobilizing private finance for climate action." The views, findings, interpretations, and conclusions expressed are, however, those of the authors and do not necessarily reflect those of the Coalition, its Members, or the affiliations of the authors.

Website: www.financeministersforclimate.org

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Suggested citation:

Power, Samantha; Nepomuk Dunz, and Olga Gavryliuk. 2022. *An Overview of Nature-Related Risks and Potential Policy Actions for Ministries of Finance: Bending the Curve of Nature Loss.* Coalition of Finance Ministers for Climate Action, Washington, D.C. © Coalition of Finance Ministers for Climate Action.

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Acronyms and Abbreviations

BES	biodiversity and ecosystem services
BIOFIN	Biodiversity Finance Initiative
CAT	common asset trust
CBA	cost-benefit analysis
CBD	Convention on Biological Diversity
CCLI	Commonwealth Climate and Law Initiative
CISL	University of Cambridge Institute for Sustainability Leadership
COP15	Fifteenth meeting of the Conference of the Parties
DNB	Dutch Central Bank
eDNA	environmental DNA
EMDE	emerging market and developing economies
ENCORE	Exploring Natural Capital Opportunities, Risks and Exposure
ESG	environmental, social, and governance
EU	European Union
FAO	Food and Agriculture Organization (of the United Nations)
FONAFIFO	National Fund for Forest Finance
G7	Group of Seven
G20	Group of Twenty
GDP	gross domestic product
GFN	Global Footprint Network
GHG	greenhouse gas
GNH Index	Gross National Happiness Index
GPFN	Government Pension Fund of Norway
HM Treasury	Her Majesty's Treasury
IAM	integrated assessment modeling
IBAT	Integrated Biodiversity Assessment Tool
ICMA	International Capital Market Association
IFC	International Finance Corporation
IFRS	International Financial Reporting Standards
IIASA	International Institute for Applied Systems Analysis
IMF	International Monetary Fund
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ISSB	International Sustainability Standards Board
ITF	Impact Taskforce
IUCN	International Union for Conservation of Nature
KPI	key performance indicator
MBI	Multidimensional Biodiversity Index
MoF	Ministry of Finance
MDB	multilateral development banks
NBSAP	National Biodiversity Strategies and Action Plans

NCA	natural capital accounting
NDC	Nationally Determined Contribution
NFIP	National Flood Insurance Program
NFRD	Non-Financial Reporting Directive
NGFS	Network for Greening the Financial System
OECD	Organization for Economic Co-operation and Development
PES	payments for ecosystem services
PPP	public-private partnership
SBTN	Science-Based Targets for Nature
SDGs	Sustainable Development Goals
SEEA	System of Environmental and Economic Accounts
SLB	sustainability-linked bond
SOE	State-owned enterprises
SSPs	Share-Socioeconomic Pathways
STAR	Species Threat Abatement and Recovery
TCFD	Task Force on Climate-related Financial Disclosures
TNFD	Taskforce for Nature-based Financial Disclosures
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WAVES	Wealth Accounting and the Valuation of Ecosystem Services
WEF	World Economic Forum

All dollar amounts are US dollars unless otherwise indicated.

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Foreword

The Coalition of Finance Ministers for Climate Action is a group of 72 Ministries of Finance (MoFs) that has been working since 2019 to support Members' efforts to mainstream climate change into economic, fiscal, and financial policies. Knowledge exchange, research, and preparation of policy-relevant reports are key ways in which the Coalition adds value to its Members. One of the priorities for the Coalition is to improve Members' understanding of climate- and nature-related risks, as well as opportunities that will arise with the transition to net zero, nature-positive economies. Nature loss and climate change are interrelated and neither crisis can be successfully resolved unless both are tackled together. As the understanding of the impacts of climate change become clearer, concern about nature loss among MoFs is growing. Hence, following the publication of the 2021 Coalition report on climate-related risks, the Coalition deemed it crucial to produce a report on nature-related risks. This report has been prepared by the Helsinki Principle 5 workstream, however it covers considerations relevant to all Helsinki Principles.

The gap between humanity's demands on nature and nature's ability to supply is widening and threatens continued provision of the critical ecosystem services that underpin key economic sectors. Awareness of the resulting nature-related risks among policymakers, real sector companies, financial institutions, and citizens has increased precipitously over the past several years. Simultaneously, the Parties to the Convention on Biological Diversity (CBD) are taking steps to reach an agreement on a post-2020 global biodiversity framework (to be decided at COP15). Finance is central to the negotiations and will be critical to ensuring effective implementation of the framework. For the first time, a range of financial institutions are highly engaged in supporting Parties to reach an ambitious framework. Nature is also playing a more prominent role than ever in the United Nations Framework Convention on Climate Change (UNFCCC) negotiations. For all these reasons, it is a critical time for Coalition Members to deepen their understanding of nature-related risks, how these risks are likely to transmit, and steps they can take to manage them.

This report focuses on economic and financial risks of nature loss, particularly those with fiscal implications. A range of potential policy options is presented, which could help MoFs manage nature-related risks. While the roles and responsibilities of MoFs differ across countries, they all control levers that can make a significant contribution to reducing nature loss and the resulting risks. At the same time, many of the policy recommendations in the report can be most effectively implemented through a coordinated approach with other relevant ministries and possibly with supervisor, regulator, or central bank counterparts. The Coalition will explore opportunities to collaborate with the Central Banks and Supervisors' Network for Greening the Financial System (NGFS) on this topic. This report is being published in time to ensure that Members are well placed to participate in policy discussions ahead of the CBD COP15 and UNFCCC COP27.

This report is an important step to help Coalition Members better understand nature-related risks and possible fiscal implications, as well as to initiate a discussion about policy challenges and how to best address them. The Coalition is very grateful to the authors, Members, Institutional Partners, and experts who contributed to this report.

Pekka Morén (Ministry of Finance, Finland) and Masyita Crystallin (Ministry of Finance, Indonesia),

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KEY MESSAGES

- The global economy is embedded in nature as it is profoundly dependent—and has a profound impact—on nature, placing nature loss squarely in the realm of economic decision makers.
- The widespread degradation of nature results from an array of indirect socioeconomic drivers of change that are threatening the provision of critical ecosystem services that economic sectors rely on, and countries need for future prosperity.
- Nature loss could have severe economic and financial impacts because environmental degradation follows a nonlinear pattern – it can compound and result in catastrophic ecological losses. This is exacerbated by the fact that few human-made substitutes for ecosystem services exist, in contrast to the case of low-carbon alternatives to fossil fuels.
- The materialization of nature-related risks for the economy and financial sector can have detrimental implications for governments, and MoFs in particular.
- Nature-related risks are not inevitable, but can be reduced by altering the economy and the financial sector's impact on nature, where MoFs have a pivotal role.
- Climate change and nature loss are deeply interconnected and mutually reinforcing.
- A government-led nature- or climate-only approach is likely to be fiscally inefficient, socially, and environmentally ineffective, and not sufficient to reach national or global climate and nature-related targets.
- Based on the findings of the report, MoFs are encouraged to:
    - Enhance their understanding of nature-related risks and promote awareness across government.
    - Take steps to integrate nature-related criteria into their strategies and decision-making, building on climate integration efforts.
    - Coordinate nature-related risk management with relevant ministries, as well as with their regulator, supervisor, and central bank counterparts.
- MoFs can manage nature-related risk using the following policy levers (this will vary by country):
    - Developing and applying valuation, metrics, and decision support tools (e.g., through implementing or supporting natural capital accounting (NCA), developing alternatives to gross domestic product (GDP), and developing nature loss scenarios).
    - Supporting economic policy reform to align incentives with sustainable practices (e.g., through assessing and raising awareness of the nature-related risks associated with harmful subsidies, offering recommendations on phasing out of these subsidies, and supporting the integration of the value of nature in decision-making through implementing environmental taxes, tradable permits, and payments for ecosystem services programs).
    - Integrating nature-related risks and opportunities into the key sectors exerting the greatest pressure on nature (e.g., through nature-smart planning and integrated landscape and seascape management, and investment in nature-based solutions).
    - Mobilizing finance for nature[a] (both through greening finance and financing green) through the identification of nature-aligned investments; an integrated climate-nature financial sector policy framework or strategy; sovereign and corporate nature-related disclosure; national nature investment plans; investment in global public goods; subnational access to bond markets; blended finance; innovative financial instruments; and incubators or accelerators.

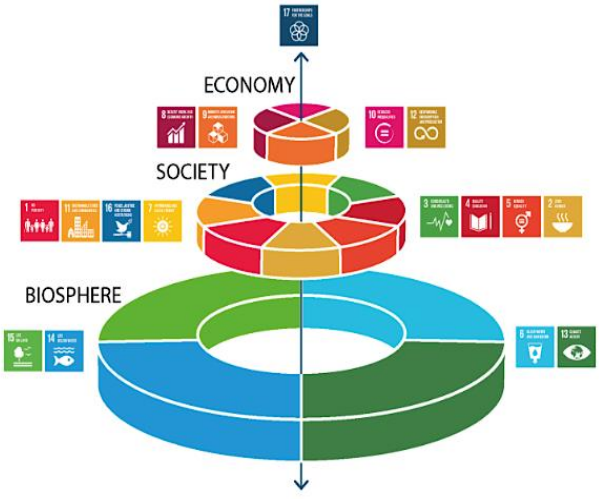
Executive Summary

Governments, and Ministries of Finance (MoFs) in particular, manage critical levers for nature conservation, restoration, and sustainable use and have high risk exposure to nature loss. MoFs are the central government entity tasked with designing and executing core government economic and financial functions.[1] This report provides an initial overview of how nature-related risks could affect the work and responsibilities of MoFs and focuses on economic and financial risks of nature loss, particularly those with potential fiscal implications. It summarizes global ongoing efforts to address nature-related risks, then provides a general overview of different nature-related risks and the transmission channels of fiscal and contingent liability risks they could trigger for MoFs. The report concludes by identifying policy actions MoFs could take to mitigate and manage these risks.

Interlinkages between nature and the global economy

The global economy is embedded in nature[b] as it is profoundly dependent—and has a profound impact—on nature (figure ES1)**.** Over the past 70 years, the world has observed a previously unseen level of economic development, fueled in part by abundant natural capital and a stable climate. However, rising incomes and consumption, as well as an increasing population and life expectancy, have made humans a significant force in the dynamics of the Earth's systems.[2] Despite rapid technological advances, development is still limited by the biosphere's ability to replenish, recover, and maintain balance.[3] The growing understanding of these interlinkages marks a shift from the conventional view of the economy as separate from the biosphere.[4]

Figure ES1. Nature is the foundation of economic activity



Source: Stockholm Resilience Centre, Stockholm University; WEF 2020.

[a] As part of an integrated approach to mobilizing private finance for sustainable development more broadly.

[b] This report uses the terms "nature" and "biodiversity and ecosystem services" to refer to the ensemble of living organisms and the functions of the biosphere.

The gap between humanity's demands on nature and its ability to supply is widening, threatening continued provision of the critical ecosystem services that underpin key economic sectors. Approximately 1.7 Earths are required to maintain the world's current living standards with current economic systems,[5] and this overshoot has been widening in recent decades, degrading natural ecosystems. Already, 14 of the 18 assessed categories of ecosystem services have declined since 1970.[6] Yet, these services, which include pollination, regulation of freshwater quality, soil productivity, and regulation of pollution and detrimental organisms, sustain economic activity in critical ways. With more than half of the world's GDP generated in sectors that depend highly ($13 trillion) or moderately ($31 trillion) on such ecosystem services, their decline has a substantial bearing on future economic performance.

Climate change and nature loss are deeply interconnected and mutually reinforcing.[7] The loss and degradation of nature releases carbon and reduces its sequestration, while climate change is one of the five direct drivers of biodiversity loss.[8] Additionally, healthy ecosystems are critical to climate change adaptation. Therefore, global climate- and nature-related targets can only be achieved if both crises are tackled in tandem.[9]

The widespread degradation of nature results from an array of indirect socioeconomic drivers of change that have accelerated in recent decades. The five direct drivers of nature loss—land and sea use change, direct exploitation, climate change, pollution, and invasion of alien species—are underpinned by societal values and behaviors such as unsustainable production and consumption patterns, human population dynamics, trade, technological innovations, and governance challenges. Varying degrees of market and governance failures as well as valuation challenges contribute to these phenomena. Market failures, such as the presence of public goods,[c] common access resources, externalities, and information asymmetries,[10] foster unsustainable use and degradation of nature. Additionally, many natural assets and their ecosystem services are intangible, incommensurable, and characterized by positive externalities since their benefits are often greater than the sum of their parts.[11] Market-based tools for managing resource allocation may be ineffective in this context.[d] Therefore, a more holistic approach may be required to assess nature's value.[e] Together these factors result in insufficient levels of investment in these public goods and in nature loss beyond a level that is socially optimal and within ecological boundaries.[12] Moreover, "collective moral hazard" among real sector companies and financial institutions also contributes to nature loss and associated risks.[f]

The global response needs to be comprehensive and bring about systemic change. Addressing the biodiversity crisis requires both more funding for conservation, restoration, and sustainable use of nature, and a concerted effort to reduce the drivers of nature loss. The draft post-2020 global biodiversity

[c] Many ecosystems provide services that have global, as well as local, benefits (e.g., the Amazon rainforest), yet most of the funding for conservation and restoration is generated locally—even in countries with high rates of poverty and indebtedness. Freeriding is one resulting problem.

[d] Valuation approaches such as those used in PES schemes and cost-benefit analysis (CBA) rely on measurable and attributable benefits and costs aiming to find a "true" value of an ecosystem. This approach is at odds, however, with the characteristics of ecosystems being interconnected, incommensurable, and intangible. This does not suggest that monetary values for ecosystems should not be discussed, but that at least equal attention would need to be paid to the valuation process as to the valuation result itself.

[e] The Dasgupta Review identifies six sources of value: human existence, human health, amenity, use, existence, and intrinsic value. Some believe the intrinsic value to be infinite.

[f] According to Stern and Stiglitz (2021), when there are large and correlated societal losses, there is a high probability that such losses will be socialized, even as the profits associated with the actions leading to the losses are privatized. Real sector companies may pursue unsustainable production practices and financial institutions may take on excessive nature-related risk as a result.

framework, which is expected to be adopted at the fifteenth meeting of the Conference of the Parties (COP15) to the Convention on Biological Diversity (CBD) in 2022, calls for urgent action to transform the economic, social, and financial models so that the trends that have exacerbated nature loss stabilize by 2030 and allow for the recovery of natural ecosystems in the following 20 years, with net improvements by 2050. To achieve these goals, it will be necessary to consider future risks associated with nature loss and systematically account for its value in decisions at all levels and across all sectors.[13] Coordinated implementation of the Paris Agreement and the post-2020 global biodiversity framework will also be required, taking advantage of the synergies and managing the trade-offs between them.[g]

Nature-related risk: types, exposure, and transmission channels

Types of nature-related risk for the economy and the financial sector

The economy's relationship with nature is twofold, where economic and financial risks can emerge from impacts and dependencies on biodiversity and ecosystem services. This poses nature-related *physical* and *transition risk*, which are material for sectors of the real economy and indirectly for the financial sector, given the current and expected trends of nature loss. MoFs could be significantly affected by both forms of risk given their pivotal role in economic and fiscal policy making and the implicit and explicit contingent liability risks that could be triggered as these risks materialize. Nature-related *physical* risk stems from the degradation and loss of biodiversity and ecosystem services, causing acute or chronic impacts. The *transition* to a nature-positive economy could expose the real and financial sectors to potential disruptions and shocks. Transition risk consists of sudden changes in policy, technology, and consumer preferences in response to nature loss and can have a substantial impact on the economic, financial, reputational, and legal position of firms and their financial institutions with large impacts on biodiversity and ecosystems. More details in figure ES2.

Figure ES2. Types of nature-related risk

Physical Risk	Stems from the degradation and loss of natural capital and the disruption of the ecosystem services it provides
Transition Risk	Stems from changes in economic policy, regulation, technological advancement, and shifting consumer preferences as well as reputational damage and litigation as a result of activities that are harmful to biodiversity

Potential transmission mechanisms of nature-related risks

Climate and nature-related risks share common characteristics and are interdependent, despite differences in their materialization and assessment. Multiple sectors and firms that have a high exposure

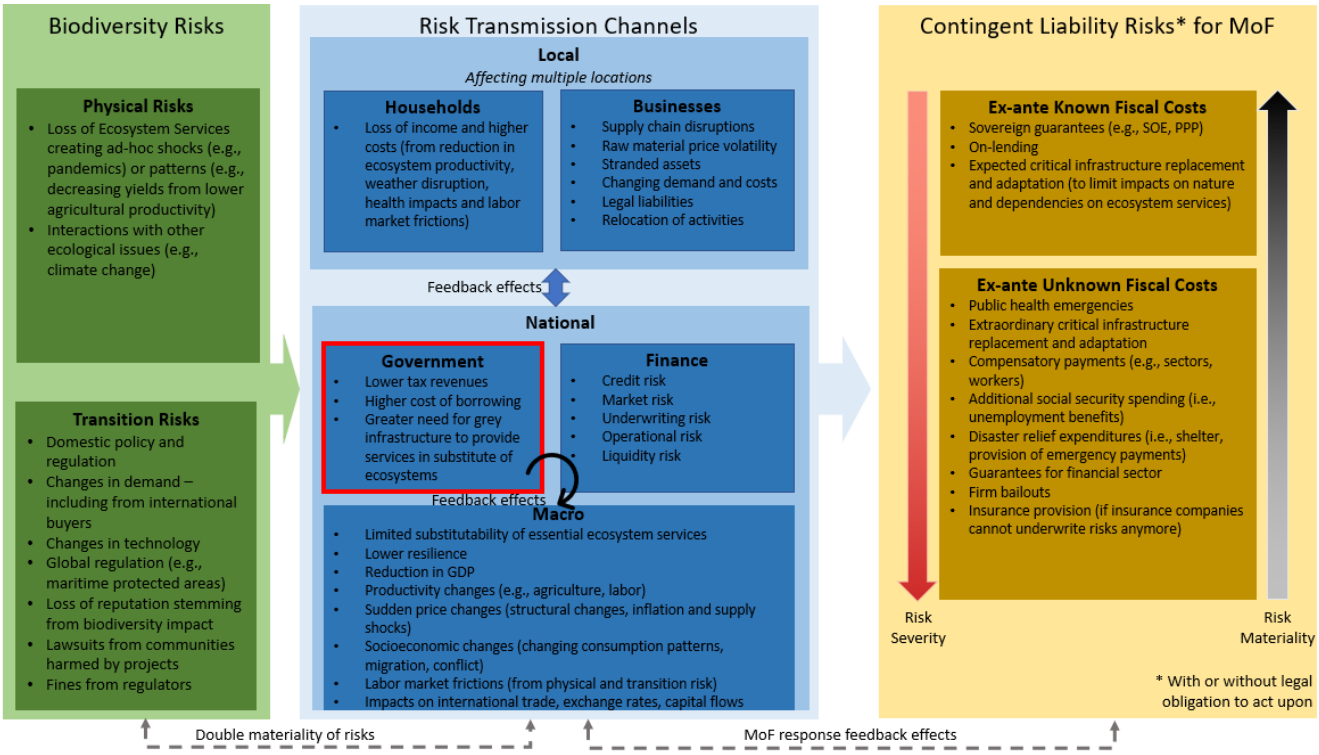
[g] In a way that is also aligned with achieving the Sustainable Development Goals (SDGs).

to climate-related risks also have significant exposure to nature-related risks (e.g., the mining, oil and gas, and agriculture sectors). The more severe nature- and climate-related risks become, the more the interactions between these risks become material. However, there are also important differences between nature-related and climate-related risks as nature-related risks tend to be more localized, risk assessment is more complex, and the lack of data is more of a challenge (see box 2 in the main report for details).

Nature-related risks could materialize on a local or national level and negatively affect different sectors of the economy (figure ES3). At the same time, nature-related risks and materialization differ among countries depending on their biophysical, economic, fiscal, and financial characteristics. For firms, households, the financial sector, the government, and the macroeconomy, different risk transmission channels interact and induce reinforcing feedback effects. While the evidence base for nature-related risk transmission is not as developed as for climate-related risk transmission, emerging research suggests that nature-related impacts could be substantial.[14] The report provides examples of where nature-related risks have materialized or are materializing and shows how these potentially severe impacts may affect governments and MoFs in particular.

Nature-related risks can transmit to governments, particularly to MoFs, through a variety of channels including lower tax revenues, higher borrowing costs, damage to public infrastructure, more stringent requirements for new infrastructure, increased disaster risk payouts, increased welfare payments, a more acute need to invest in ecosystem restoration, reduced economic growth, inflationary pressures, balance of payment imbalances, and greater political instability or conflict, among others—all with direct fiscal implications. Nature-related risks could also trigger financial instability and a wide range of contingent liabilities for MoFs, with known and unknown fiscal costs.

Figure ES3. Nature-related risk framework



Loss of resilience and limited substitutability of natural capital as matter of economic and financial stability

Nature loss could have severe economic and financial impacts because environmental degradation follows a nonlinear pattern – it can compound and result in catastrophic ecological losses. This is exacerbated by the fact that few human-made substitutes for ecosystem services exist, in contrast to the case of low-carbon alternatives to fossil fuels. Substitution for irreversibly lost or degraded ecosystem services is likely to face limits if nature loss continues at its current pace. Cascading impacts for the economy and financial sector could emerge since ecosystem services are substantial inputs in economic production for multiple sectors.[15] There is a risk of a far-reaching ecosystem collapse if certain tipping points are crossed, and compounding losses of ecosystem services across multiple regions—a phenomenon already occurring—could result in the loss of ecosystem resilience and systemic reductions in economic and financial resilience. This means that economic actors cannot diversify away from nature-related risks, which has significant implications for MoFs.

Managing nature-related risks: Endogeneity, synergies, tradeoffs, and opportunities

Nature-related risks are not inevitable but can be reduced by altering the economy and the financial sector's impact on nature. Whether and to what extent nature-related risks for MoFs will materialize

depends on actions to reduce the impact of economic activity on nature[h] and invest in ecosystem health. Structural economic changes to more sustainable production and consumption practices, accompanied by large-scale ecosystem restoration and connection, are required to address the ongoing crisis.[16] MoFs can use their policy, regulation, planning, and budgeting levers to drive structural economic reform that bends the curve of nature loss by reducing economic drivers. This is a key area where MoFs' responsibility to manage nature-related risks differs considerably from central banks and supervisors, who do not have substantial control over the drivers of nature loss. Additionally, MoFs have a role to play in ensuring a smooth economic transition to a nature-positive economy, including to limit the economy's impact and direct dependency on nature (limiting nature-related transition risk).

In order to ensure nature loss does not compromise conditions required for continued human flourishing over the long term, governments and MoFs need to apply strategic policies and a whole-of-economy approach to smooth intra- and inter-generational trade-offs. Some benefits from nature-positive action might only materialize over time while in the short-term, political costs and financial costs accrue (e.g., phasing out subsidies could increase food prices). It is important for governments and MoFs to be aware of, and strategically manage, such trade-offs. Furthermore, there is a need for global cooperation on governance and financial support to conserve and restore global public good ecosystems like rainforests and the oceans, as all countries depend on them.

The nature and climate agendas are complementary, with synergies that can be tapped to foster green, resilient, and inclusive development. At the same time, there is a need to manage trade-offs between nature and climate action. A government-led nature- or climate-only approach is likely to be fiscally inefficient, socially, and environmentally ineffective, and not sufficient to reach national or global climate and nature-related targets. As nature loss and climate change are interrelated, neither crisis can be successfully resolved unless both are tackled together.[17] Policy action to conserve, restore, and sustainably use ecosystems helps stem biodiversity loss and drive climate change mitigation and adaptation.

The combination of limited government budgets and the high impacts and dependencies of real sector companies and financial institutions on nature requires stronger private sector involvement in nature-related risk management to reduce the impact of business activity on nature. Global crises such as the COVID-19 pandemic triggered mounting sovereign debt levels and increased debt distress, especially for emerging market and developing economies (EMDE).[18] At the same time, countries' sustainable development is threatened by the challenges of containing global temperature increases and promoting healthy ecosystems. Given these constraints, scarce public financial resources need to be spent effectively. MoFs can take steps to create an enabling environment that better allows for the commercial viability of nature-positive activities. Such action could mobilize private sector finance by encouraging investors to green their financial portfolios and to finance nature-positive investments, thus reducing the likelihood of growing nature-related risks.[19]

[h] For instance, by reforming subsidies that support nature-depleting business practices, MoFs have a strong lever for reducing impact on biodiversity and ecosystem services.

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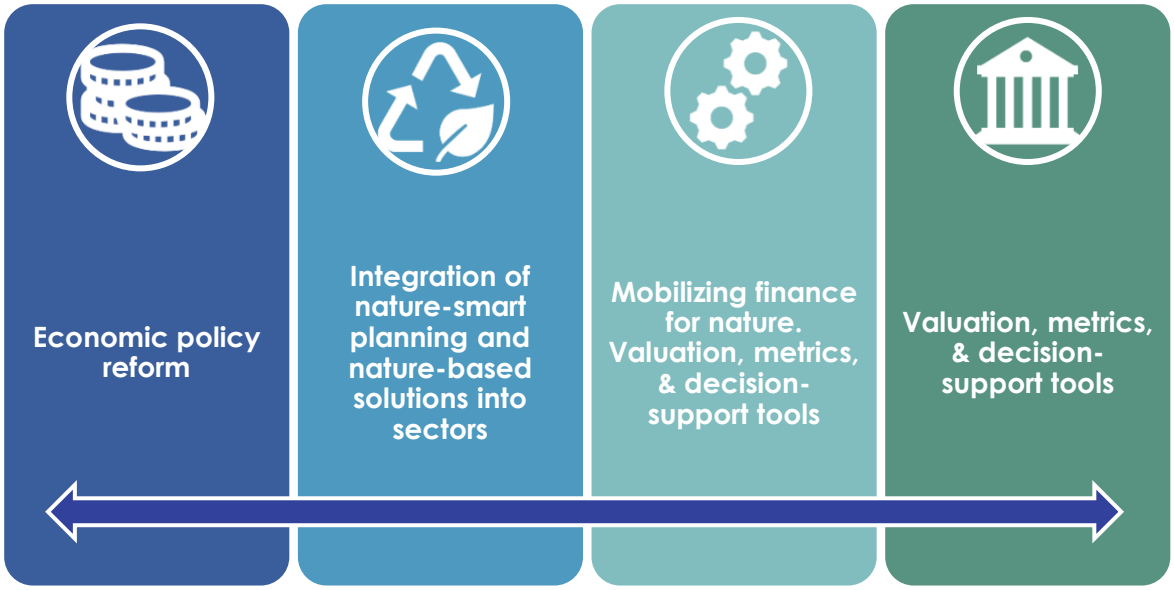
Potential policy actions for ministries of finance

Figure ES4. Policy action areas for Ministries of Finance



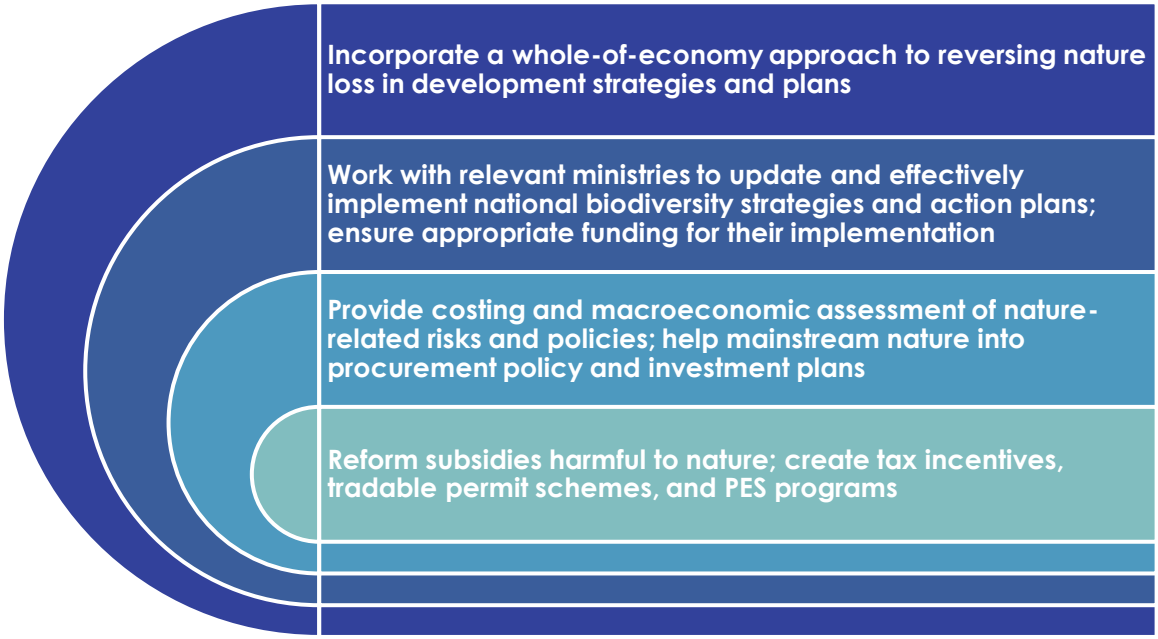
There ia a range of policy actions MoFs could pursue to mitigate and manage nature-related risks, making use of synergies and avoiding trade-offs with climate action. These actions range from economic policy reform to integration of nature-smart planning and nature-based solutions into sectors, to the development and application of valuation, metrics, and decision support tools, to measures for mobilizing finance for nature (figure ES4.). Clear policy signals from MoFs underpin domestic policy efforts to promote nature-smart[i] practices in key sectors that rely on, or have a high impact on, nature and to improve assessment and management of nature-related risks in the financial sector.[j] Managing systemic and endogenous risks calls for "market-shaping" interventions, where governments influence the directionality of activities facilitated by the financial system.[20] As countries' governance frameworks differ, as do the roles and responsibilities of the MoF, not all approaches discussed will be applicable in all countries. However, it is important that in all countries, MoFs coordinate with relevant ministries on this agenda, as well as with the regulator, supervisor, and the central bank.

[i] Nature-smart, in the context of this report, refers to approaches to policy, investments, and practices that include biodiversity and ecosystem service considerations from the perspectives of mitigating risks arising from the loss of nature and harnessing the economic and social benefits and opportunities that ecosystem services provide.

[j] The World Economic Forum estimates that together with climate change, three socioeconomic systems—food, land use, and ocean use; infrastructure and the built environment; and energy and extractives—endanger 80 percent of threatened or near-threatened species (WEF 2020).

Reforming economic policy

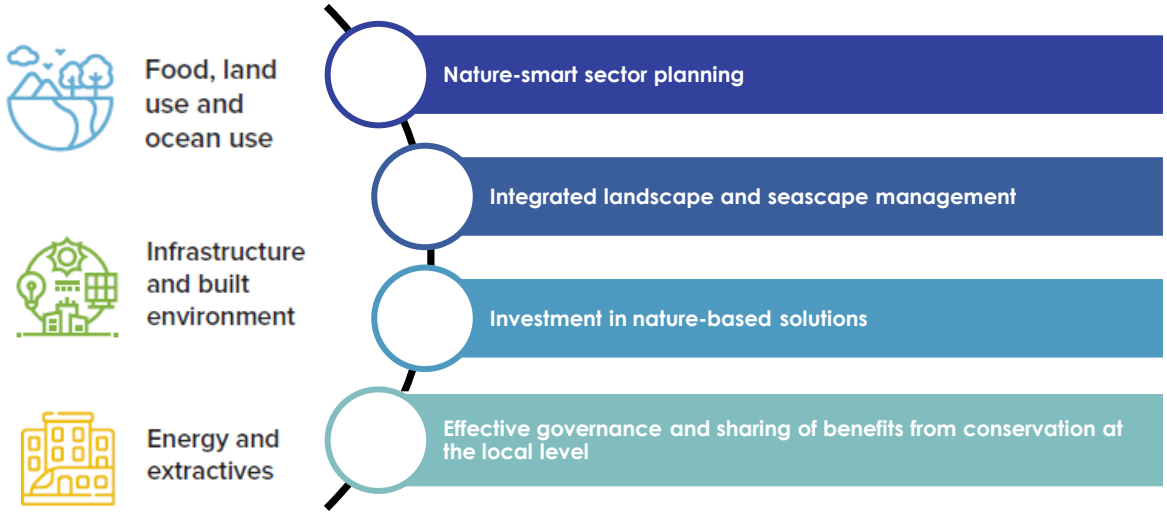
Figure ES5. Key economic policy reform actions for Ministries of Finance



Development strategies and national plans need to articulate a whole-of-economy approach to addressing the drivers of nature loss.[21] While MoFs are typically not the primary agency overseeing National Biodiversity Strategies and Action Plans (NBSAPs) and Nationally Determined Contributions (NDCs) at the country level, their involvement in the development and implementation of these policy instruments alongside ministries of environment is vital to ensure a whole-of-economy response and adequate (sufficient and predictable) financing. Furthermore, governments should integrate nature considerations, along with climate change considerations, in their economic policy and planning.[22] Another key action area for MoFs is to address market and governance failures that facilitate unsustainable production and consumption practices. Environmental fiscal reform presents an opportunity to not only align economic activity with sustainable development goals, but also to generate growth. Measures to ensure an inclusive and equitable transition, and thus to address political economy challenges between and within countries, are key to the success of such reform initiatives. MoFs can support environmental fiscal reform through assessing and raising awareness of the nature-related risks associated with harmful subsidies, offering recommendations on phasing out of these subsidies, and supporting the integration of the value of nature in decision-making through environmental taxes measures, tradable permits, and payments for ecosystem services programs, and circular economy solutions.

Integrating nature-smart planning and nature-based solutions into systems

Figure ES6. Key actions for Ministries of Finance to support better integration of nature-related risks and opportunities into sectors driving nature loss



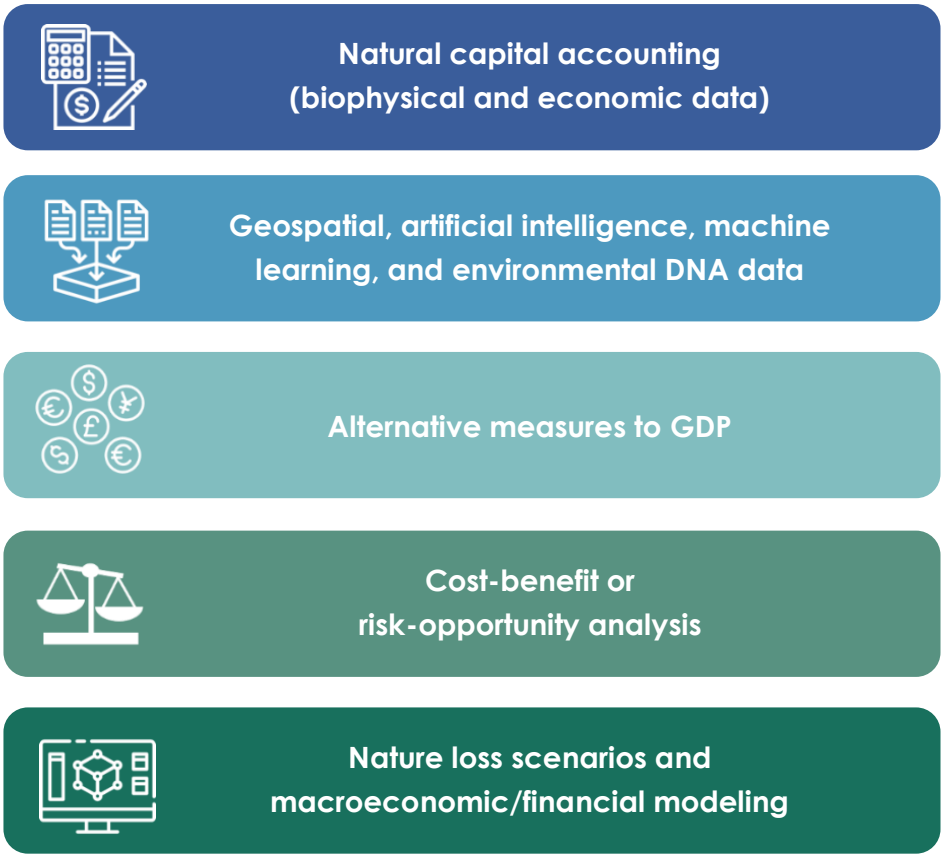
Source: Adapted from World Bank (2021c).

MoFs can promote better integration of nature-smart planning and practices in systems with the greatest environmental footprint (figure ES6). MoFs can help ensure adequate financing for policy implementation and investment plans and remove barriers to public and private investment in nature-based solutions or more sustainable business practices.

In addition to nature-smart economic incentives, MoFs have a role to play in nature-smart spatial planning in sectors with the greatest environmental footprint. Integrated landscape and seascape approaches are essential, given the need to increase the scale of conservation and restoration efforts outside core protected areas. To reach such a target, countries will also need to complement conservation measures with investments in sustainable management of productive landscapes and seascapes. MoFs can also support the uptake of NBSAPs by integrating nature into strategic sector planning and investments.

Valuation, metrics, and decision support tools

Figure ES7. Key actions for Ministries of Finance to support the development and implementation of valuation, metrics, and decision support tools



MoFs (together with other relevant ministries and agencies) can support the implementation of NCA practices and ensure this information is integrated into national accounts so that it is considered in budgeting, policy, and planning alongside other economic information to ensure effective 'asset management' of all forms of a nation's capital.[23] Implementing or supporting the development of NCA can provide MoFs with a more complete view of their country's public assets and support strategic management that maximizes nature's contribution to sustainable economic growth while balancing tradeoffs between competing land or sea use. Governments can ensure that national data are accessible to the public and in a usable format. Spatial NCA data that can be disaggregated is crucial to enabling use of this data by the private sector and sub-national governments in their decision-making. Governments may find cost-benefit or risk-opportunity analysis[24] a useful complement to NCA as they may provide a more holistic view of potential trade-offs and risks that the NCA may omit.

MoFs can use evolving geospatial, artificial intelligence, machine learning, and environmental DNA technology to improve monitoring of the health of their countries' natural capital and provide this information in a format that can inform decision-making in the private sector. Additionally, MoFs might

consider using alternative measures to GDP to drive policy making and planning, as many environmentally destructive activities[k] contribute positively to GDP, which can create perverse incentives.

Macroeconomic and financial modeling could give MoFs information on the fiscal implications of nature loss and enable evaluation of potential tradeoffs and complementarities of different nature-related policy instruments. Research on nature-related research is progressing, and methodologies are being developed to assess economic impacts from nature loss.[25] A growing number of central banks are conducting nature risk exposure assessments, and financial institutions can use an integrated risk and opportunity framework to structure their nature-positive transition strategy.[26] However, nature dynamics are complex, nonlinear, at times unpredictable, and frequently irreversible,[27] and the characteristics of nature and biodiversity dynamics and the prevailing data gaps[28] still pose modeling challenges that require further research.[29] MoFs can help develop a comprehensive set of severe, but plausible, nature loss scenarios. Scenario and transmission channels can then feed into models to assess the macroeconomic and financial impact of nature loss.

Mobilizing finance for nature

Managing nature-related risks will require a mix of public and private investment, as well as improved risk management practices in the public and private sectors, to reduce the impact of economic activity on nature. MoFs can pursue a dual approach to mobilizing finance for nature:[l] "greening finance"[m] and "financing green."[n,30]

GREENING FINANCE

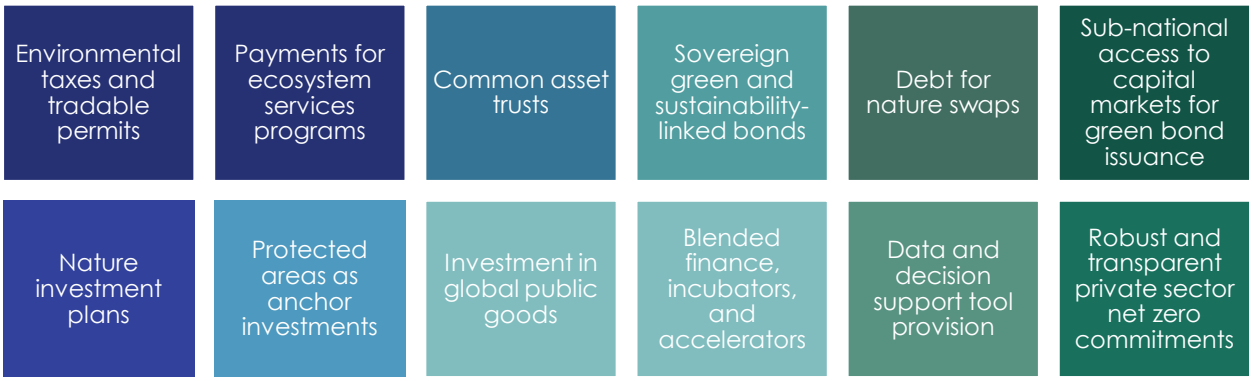
Figure ES8. Key actions for Ministries of Finance to green their financial sectors to manage nature-related risks

[k] Including activities that cause significant local or global environmental damages such as mining or the burning of fossil fuels, the cleanup of water pollution, or disposal of waste as the consequence of unsustainable production and consumption practices.
[l] As part of an integrated approach to mobilizing private finance for sustainable development more broadly.
[m] Greening Finance is directing financial flows away from projects with negative impacts on biodiversity and ecosystems to projects that mitigate negative impact and/or pursue positive environmental impacts as co-benefits.
[n] Financing green is increasing financial flows to projects that contribute—or intend to contribute—to the conservation, sustainable use, and restoration of biodiversity and ecosystems and their services to people.

Targeted policy, regulation, and guidance can ensure systematic integration of nature risk and opportunities in financial decisions and align financial flows with the forthcoming targets of the post-2020 global biodiversity framework. Working with central banks, financial regulators, and supervisors, MoFs can take action in areas identified in figure ES8.[31,o] MoFs should coordinate with their colleagues in environment and other relevant ministries to ensure that all measures are based on the best available science. MoFs can also help encourage market-based measures, such as real-sector corporate and financial institution commitments, to become "nature positive" and promote corporate commitments to only purchase commodities that meet rigorous environmental standards and certification.

FINANCING GREEN

Figure ES9. Key actions for Ministries of Finance to mobilize investment in nature



As many ecosystems have the characteristics of public goods, governments (and MoFs in particular) have a key role to play in funding their conservation, restoration, and sustainable use. MoFs are also critical in the development and implementation of incentives that contribute to the alignment of economic activity and financial flows with nature-related goals and the resulting nature-related risk reduction. A range of approaches MoFs can take to achieve these aims are listed in figure ES9. Those tools range from environmental taxes and tradable permits to PES programs, to debt for nature swaps, to national nature investment plans, to better empowering multilateral development banks to invest in these global public goods,[32] to providing blended finance, data, and decision support tools for private sector actors.

While this menu of potential policy actions is extensive, what is most important is that MoFs immediately start improving their understanding of the natural capital assets they are managing, the nature-related risks to which they are exposed, and the potential to align incentives with nature-related goals in the near term. Such improved understanding can clarify how governments should prioritize and sequence the various policy actions necessary to bend the curve of nature loss and mitigate the manifestation of nature-related risks in their respective countries. The Coalition may wish to pursue further research to advance understanding and promote decision support tools in one or more of these areas. Further research could also provide Coalition Members with more information on the prioritization, sequencing, and optimization of the policy actions laid out in this report.

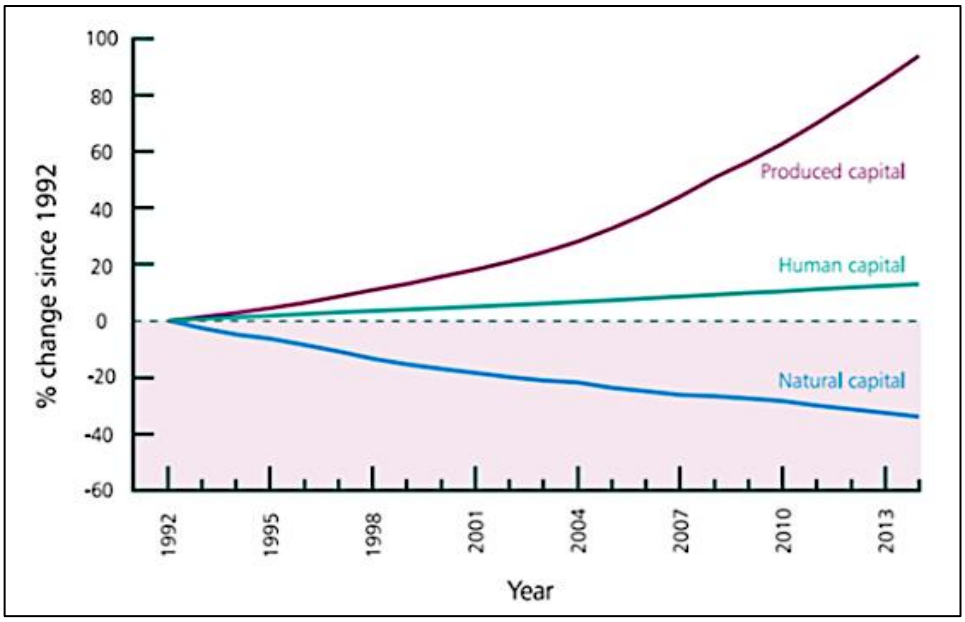
[o] The World Bank's *Toolkits for Policymakers to Green the Financial System* has toolkits covering several of these action areas (World Bank 2021d).

1. Introduction

1.1 Interlinkages between nature and the economy

The global economy is embedded in nature[p] as it is profoundly dependent—and has a profound impact—on nature. Over the past 70 years, the world has observed a previously unseen level of economic development, fueled in part by abundant natural capital and a stable climate (figure 1). However, rising incomes and consumption and an increasing population and life expectancy have made humans a significant force in the dynamics of the Earth's systems.[33] Despite rapid technological progress, development is still ultimately bound by the limits of the biosphere's[q] ability to replenish, recover, and maintain balance.[34] The growing understanding of these interlinkages marks a shift from the conventional view of the economy as separate from the biosphere (figure 2a).[35]

Figure 1. Global wealth per capita, 1992–2014



Source: Dasgupta 2021.

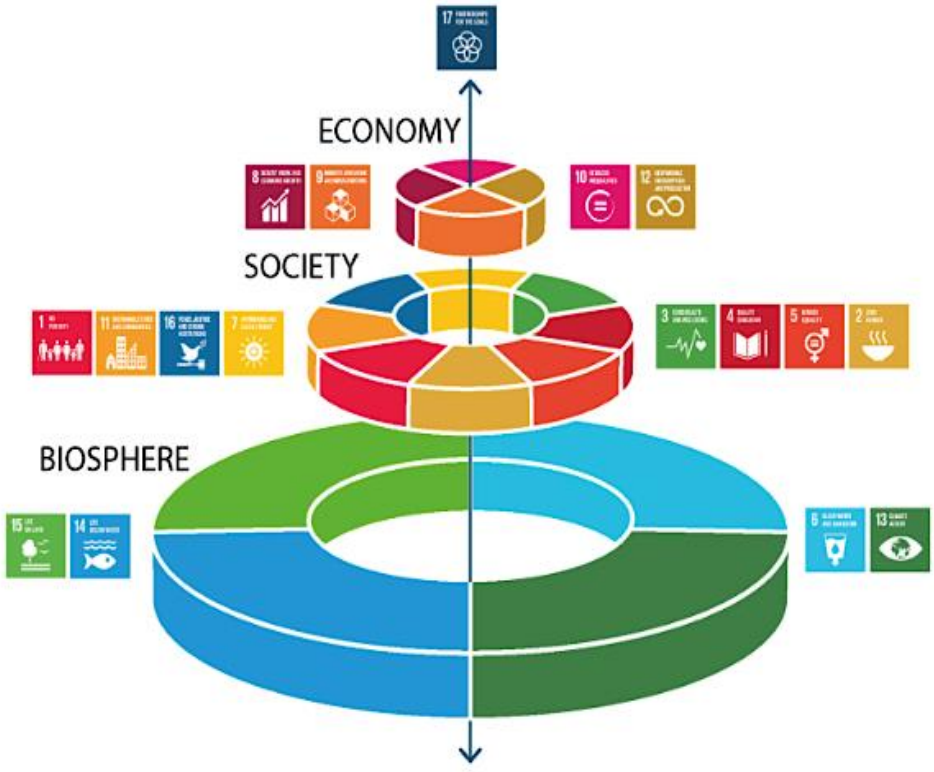
[p] This report uses the terms "nature" and "biodiversity and ecosystem services" to refer to the ensemble of living organisms and the functions of the biosphere.

[q] "The biosphere refers to the sum of all the ecosystems of the world. It is both the collection of organisms living on the Earth and the space that they occupy on part of the Earth's crust (the lithosphere), in the oceans (the hydrosphere), and in the atmosphere. The biosphere is all the planet's ecosystems." Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Glossary. In this report, the terms "nature" and "biosphere" are used interchangeably.

Conservative estimates suggest that more than half of global value added is highly or moderately dependent on nature's services.[36] The benefits that people derive from natural capital, measured as flows of goods and services, are called *ecosystem services*. They range from the provision of food, fresh water, and raw materials, regulation of climate and hazards, removal of pollution, soil formation, to the creation of a basis for personal enjoyment. These services in turn underpin economic activity in tangible, measurable ways, which can be illustrated by looking at sector dependencies. It is estimated that $44 trillion of global value added—corresponding to more than half of the world's gross domestic product (GDP)—is generated in sectors that depend highly ($13 trillion) or moderately ($31 trillion) on ecosystem services (figure 2b).[r] Other assessments also suggest that 55 percent of global GDP ($42 trillion) is dependent on high-functioning biodiversity and ecosystem services.[37] Take agriculture: 75 percent of food crops rely, at least in part, on animal pollination, and an estimated $235 billion to $577 billion of annual crop output is directly attributable to animal pollination.[s]

Figure 2. Nature is the foundation of economic activity

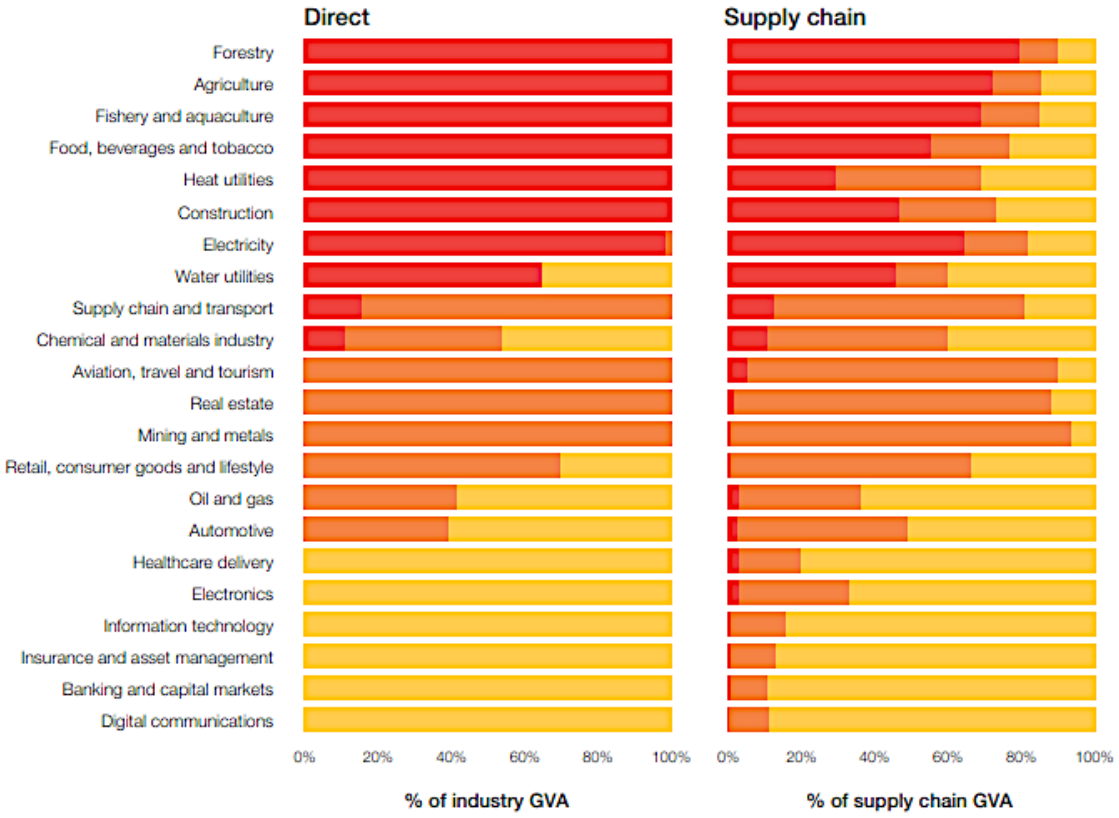
a. Contributions of the biosphere to sustainable development



[r] The World Economic Forum and Price Waterhouse Coopers (WEF 2020) analyzed the nature dependency of 163 sectors and their supply chains across a range of ecosystem services. Sectors such as agriculture, fisheries, food and beverages, heat and water utilities, construction, and electricity depend highly on nature.

[s] These studies aim to assess the multiple ways that the economy depends on nature (NGFS 2022a). They should not be interpreted as estimating the value of activities that could exist without functioning ecosystems, as the scientific answer would be "none." Economies and societies are embedded in nature, and life could not exist without it (Dasgupta 2021).

b. Percentage of direct and supply chain gross value added with high, medium, and low nature dependence



Source: Stockholm Resilience Centre, Stockholm University; WEF 2020.

The rapid global loss of biodiversity threatens continued provision of the critical ecosystem services that underpin economies. Already, 14 of the 18 assessed categories of ecosystem services, particularly regulating services, have declined since 1970.[38] They include pollination; regulation of freshwater quality; formation, protection, and decontamination of soils; and regulation of detrimental organisms. The decline of these services coincides with widespread reduction in the extent of natural ecosystems and the biodiversity they harbor:

- About 75 percent of the Earth's ice-free land surface and 66 percent of its marine environment have been significantly altered, as of 2019[39] and at least 20 percent of land surface is now degraded.[40]
- The average global abundance of mammals, birds, fish, reptiles, and amphibians declined by 68 percent from 1970 to 2016, with South America seeing a 94 percent decline.[41]
- Nearly 1 million animal and plant species (of 8 million recorded species) are now threatened with extinction; extinction rates are at least tens to hundreds of times higher than they averaged over the past 10 million years.[42]

Humanity's demands far exceed nature's ability to supply, and this gap is widening.[43] Economic activity has a profound impact on the environment through the extraction of nature's goods and services and disposal of waste, becoming the dominant influence on the Earth's climate and the biosphere.[t] Estimates show that 1.75 Earths are required to maintain the world's current living standards[u] with current economic systems on an annual basis,[44] and this overshoot has been widening in recent decades (box 1).[45] Of the nine planetary boundaries analyzed—including climate change, ocean acidification, biochemical flows (nitrogen and phosphorus), land system change, freshwater use, biosphere integrity, novel entities, stratospheric ozone depletion, and atmospheric aerosol loading—four have already been crossed.[46] Given the interlinkages between the economy and the biosphere, these biophysical trends have a bearing on future economic performance.

Socioeconomic impacts can be particularly severe if ecosystems collapse. Continued environmental degradation can push an ecosystem to a tipping point beyond which it will shift to a new state or collapse, leading to an abrupt decline in ecosystem services. Recent World Bank analysis demonstrates that the collapse of just three ecosystem services—wild pollination, provision of food from marine fisheries, and timber from native forests—could cost 2.3 percent of global GDP ($2.7 trillion) annually by 2030 relative to the baseline, with severe adverse consequences for some of the poorest countries. In the partial ecosystem collapse scenario analyzed, relative impacts are most pronounced in low-income and lower middle-income countries, where drops in 2030 GDP may reach 10 percent (Johnson et al. 2021; see also box 2, section 2).

Box 1. The Economics of Biodiversity: The Dasgupta Review

The Dasgupta Review (2021) states that global demand over the long run must equal the biosphere's ability to supply resources and services to provide life on Earth. An overshoot of demand runs down the capacity of the biosphere to sustain supply over time. As such an overshoot cannot be maintained indefinitely as our life support system would be threatened. To illustrate this insight mathematically, the Dasgupta Review emphasizes the impact equation, which states that for long-term sustainability, the global ecological footprint $\frac{Ny}{\alpha}$ needs to equal the regenerative rate of the biosphere *G(S)*, with *N* being human population, *y* economic activity per capita, and α the efficiency of humans in transforming resources and services from the biosphere to economic throughput and how much the waste the biosphere produced from that economic throughput transforms the biosphere:

$$\frac{Ny}{\alpha_X} + \frac{Ny}{\alpha_Z} \equiv \frac{Ny}{\alpha} = G(S)$$

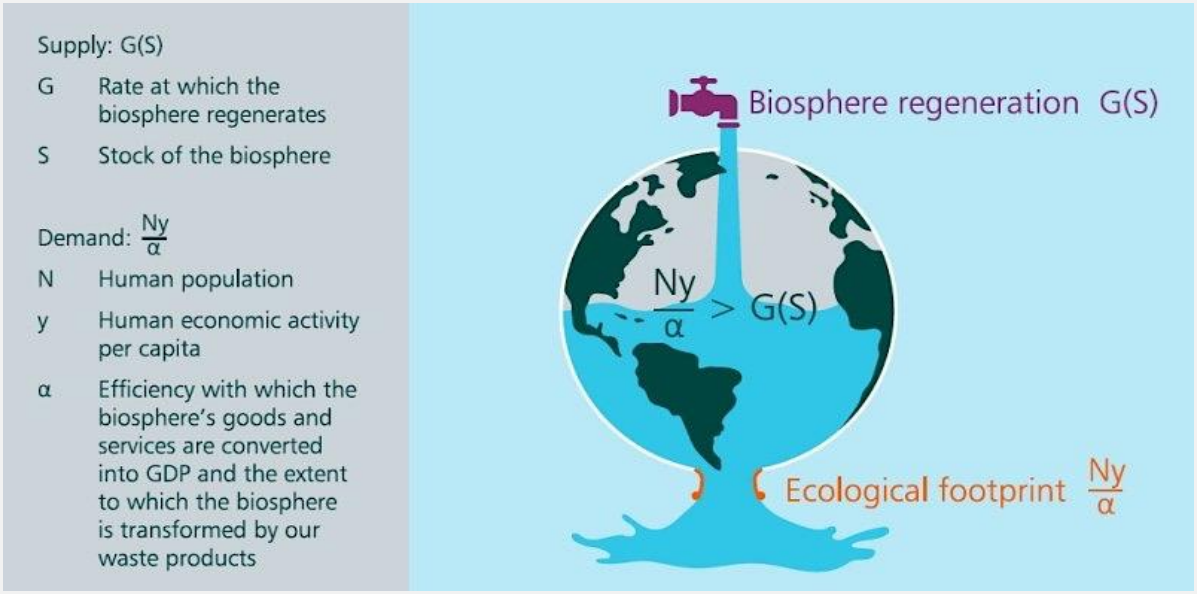
[t] The past century has been dubbed "the age of the Anthropocene," denoting a geological era during which human activity has become the dominant influence on climate and the environment (Steffen et al. 2018).

[u] There are substantial differences amongst countries. While 5.1 earths would be required if everyone lived like a US resident, 0.8 earths would be required if everyone lived like a resident of India, for instance. Substantial differences also apply within countries, often correlating with income or wealth levels.

Currently, the world is in a state of overshoot, where the global impact on the biosphere, the global ecological footprint, is far larger than the regenerative rate of the biosphere ($\frac{Ny}{\alpha} > G(S)$).[1] Box 1 figure 1 conceptualizes this imbalance of ecological footprint and biosphere regeneration as a bathtub, where water outflows exceed water inflows, thus leading to substantial water loss over time.

Based on the impact equation, the Dasgupta Review then formulates four potential action points for transforming the impact inequality into an impact equality. First, per capita global consumption could be addressed—by reducing *y*. Second, *N* could be targeted by lowering the future global population from its current level. Third, the efficiency of human use of the biosphere for resources and services—the extent to which our waste transforms the biosphere—α could be improved. Finally, the biosphere's regeneration rate $'(S)$ could be increased through more ambitious conservation and restoration efforts.

Box 1 Figure 1. Impact inequality



Source: Dasgupta 2021.
Note: According to the Global Footprint Network (GFN) current human impact on the biosphere would require 1.75 Earths to ensure a regeneration rate of the biosphere that would sustain this impact indefinitely. However, human ecological footprint per capita varies significantly by country, with countries in Sub-Sahara Africa, Latin America and South-East Asia having far smaller footprints than countries in Europe, North America, and East Asia (GFN 2021).

Climate change and nature loss are deeply interconnected and reinforce each other.[47] Terrestrial and marine ecosystems are carbon sinks, sequestering 56 percent of gross annual anthropogenic greenhouse gas (GHG) emissions.[48] The loss and degradation of nature releases carbon and reduces its sequestration. This is illustrated by deforestation, the second largest source of anthropogenic carbon dioxide emissions;[49] as well as agriculture, forestry, and other land use change, which are responsible for roughly a quarter of anthropogenic GHG emissions.[50] Parts of the Amazon rainforest now emit more carbon dioxide than they

absorb because of deforestation and climate change.[51] Conversely, climate change is one of the five direct drivers of biodiversity loss, along with land use change, overexploitation, pollution, and invasive species.[52] Global climate- and nature-related targets can only be achieved if both crises are tackled in tandem. For example, natural climate solutions have the potential to contribute up to 37 percent of emissions reductions necessary to reach the Paris Agreement goal.[53]

Under the most optimistic climate change scenarios (1.5°C to 2°C),[v] biodiversity and ecosystem functions will be severely affected, even if other drivers are addressed.[w] These negative impacts of climate change are already showing in the oceans, for example, where coral reefs are dying[x] and fish-migration patterns and fish-stock biomass are changing.[y] Close climate–biosphere interlinkages mean that the two crises reinforce each other, amplifying the risk of reaching planetary tipping points. These include the collapse of ice sheets and disappearance of coral reefs,[54] which could trigger positive feedback effects in the Earth's systems (such as a self-reinforcing global warming) and result in nonlinear and potentially irreversible environmental, social, and economic dynamics.[55]

The deterioration of ecosystems is the outcome of valuation challenges and market and governance failures. The unprecedented pressures from the five direct drivers of nature loss result from an array of underlying causes or indirect drivers of change such as socioeconomic and demographic trends, which influence production and consumption patterns, technological innovation, and governance approaches. These cause nature loss beyond a level that is socially optimal and within ecological boundaries. It also limits investment flows to ensure ecosystem maintenance and the continuing provision of ecosystem services. The following challenges are of particular relevance to MoFs:

- ***Valuation challenges.*** The Dasgupta Review identifies six sources of biodiversity's value: human existence value, human health value, amenity value (source of enjoyment), use value (through enabling the provision of ecosystem services), existence value (e.g., the existence of the Silverback Gorilla), and intrinsic value.[56] Economists usually focus their valuation efforts on just two of these sources—amenity and use value—from which they derive "accounting prices" for natural capital assets (like ecosystem services or a specific species). Human existence value and human health value are difficult or impossible to calculate. Additionally, there is a widespread, long-held belief (documented by indigenous peoples, philosophers, academics, and citizens of countries around the world) that nature has intrinsic value—value in its own right, independent of human uses.[z] With these values excluded, accounting prices capture just a fraction of nature's value, based on market

[v] The latest report of the Intergovernmental Panel on Climate Change has concluded that global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas (GHG) emissions—compatible with the very low and low GHG emissions scenarios (SSP1-1.9 or SSP1-2.6 respectively)—occur in the coming decades (IPCC 2021).

[w] Even in a 1.5°C to 2°C global warming scenario, most terrestrial species ranges are projected to shrink profoundly. Species distribution, phenology, population dynamics, and, ultimately, ecosystem functioning are all likely to be adversely affected.

[x] Already, the roughly 1.0°C rise in global temperatures is having widespread impacts on species and ecosystem. For example, ocean heatwaves have led to mass coral bleaching and loss of half of the shallow-water corals on Australia's Great Barrier Reef (Lenton 2013).

[y] A World Bank study on the effects of climate change on African fisheries estimated that, even under the most optimistic climate change scenario, the maximum catch potential will decrease by 30 percent or more as soon as 2050 in many tropical West African countries, resulting in severe economic impacts on often-impoverished communities that are among the most vulnerable (World Bank 2019).

[z] This long-documented view is reflected in recent academic literature and environmental public policies that highlight multiple dimensions (such as environmental science, social science, standard economic theory) on which nature can be described and valued (Maître d'hôtel and Pelegrin 2012, European Council 2021, Rea and Munns 2017, Svartzman et al. 2021).

values,[aa] revealed preferences, or stated preferences, which involve a range of assumptions.[57] Developing accounting prices for certain ecosystem services can be more challenging than for others as they are intangible, incommensurable, and characterized primarily by positive externalities.[58] The challenge can be most pressing for nonmaterial or cultural services (such as nature-based recreation, inspiration, and aesthetic appreciation) and regulating services (such as disease control or pollination). Because market-based tools may face challenges in this context,[bb] these ecosystem services often struggle to attract private finance for conservation or restoration.[59] Additionally, challenges associated with developing a comprehensive measure of the value of nature[cc] to be used in policy-making processes also often result in low public investment in these public goods.[60] The lack of agreement on the discount factor to be used in determining the value of these assets adds a layer of complexity.[61] Some economists have made the case that equitable access to wealth created by nature, on both the inter- and intra-generational levels, is crucial to sustainability, and that future generations must have access to continued flows of vital ecosystem services.[62]

- ***Market failures and lack of environmental markets and economic incentives.*** Market failures such as the presence of public goods (carbon sequestration by natural forests),[dd] common access resources (fisheries), externalities (water pollution), and information asymmetries (lack of information about environmental footprint of products and services)[63] enable unsustainable use and degradation of nature. While private property rights are effective at allocating rival and excludable goods and services, they are not effective at doing so for non-rival, non-excludable goods.[64] Economic incentives, including taxes, fees, charges, tradeable permit schemes, and payments for ecosystem services (PES) programs all have a role to play in addressing these market failures. However, implementation and the ambition of these instruments is still quite limited.[65]
- ***Other factors that limit policy responses to these market failures.*** The tragedy of the horizon, capacity constraints (and associated institutional failures), short- and long-term trade-offs and political economy considerations are some of the factors that limit policy responses to market failures.[66] Examples of political economy challenges include concerns about potential effects of environmental policies on the competitiveness of critical sectors; distributional implications (effects of such policies on the incomes of different socioeconomic groups); and the influence of vested interests or the political and social acceptability of reform, which can act as a salient barrier to decisive policy action. Aggregate GDP as the measure of economic success could have limitations as it cannot account for the value of natural capital for sustainable development. This could lead to misguided prioritization of short-term and unsustainable production practices, while undermining more long-term-oriented sustainable natural resource management.

[aa] Direct market value or cost-based methods

[bb] Valuation approaches such as those used in PES schemes and cost-benefit analysis (CBA) rely on measurable and attributable benefits and costs aiming to find a 'true' value of an ecosystem. This approach is at odds, however, with the characteristics of ecosystems being interconnected, incommensurable, and intangible. This does not suggest that monetary values for ecosystems should not be discussed, but that at least equal attention would need to be paid to the valuation process as to the valuation result itself.

[cc] Some believe the intrinsic value to be infinite.

[dd] Many ecosystems provide services that have global, as well as local, benefits (e.g., the Amazon), yet most of the funding for conservation and restoration is generated locally—even in countries with high rates of poverty and indebtedness. Freeriding is one resulting problem.

- ***Collective moral hazard.*** According to Stern and Stiglitz (2021), when there are large and correlated societal losses, there is a high probability that such losses will be socialized, even as the profits associated with the actions leading to the losses are privatized. Nature loss and the financial losses associated with the transmission of nature-related risks are likely to be large and correlated, particularly as nature loss and climate change accelerate and exacerbate each other. Companies and financial institutions know that the societal consequences of the government not engaging in a bailout are greater than those associated with the bailout. As a result, the anticipation of such bailouts leads to "collective moral hazard,"[67] manifesting as unsustainable production practices by companies and excessive risk taking by financial institutions.

Governments, and MoFs in particular, manage critical levers for conservation of nature, and have high risk exposure to nature loss. MoFs are the central government entity tasked with designing and executing core government financial functions.[68] Their responsibilities include policy development (such as economic, and fiscal policy and target setting), regulation (supervision of specific economic sectors and financial institutions), and transaction execution (processing budgetary payments). MoF fiscal space could become limited if nature and biodiversity loss affect the economy, leading to greater expenditure to replace ecosystem services, lower tax revenues and dividends from state-owned enterprises and reduced exports due to changes in production capacity, as well as potentially higher debt servicing costs.[69] Moreover, MoFs could be required to step in to support businesses, households, and financial institutions if contingent liability risks are triggered in extreme circumstances of nature loss. The timing and degree of such losses are, however, difficult to predict.

This report provides an initial overview of how nature-related risks could affect the work and responsibilities of MoFs. Nature loss contributes to a range of risks, including social and political risks. This report, however, focuses on economic and financial risks of nature loss, particularly those with fiscal implications. It summarizes global ongoing efforts to address nature-related risks, then provides a general overview of different nature-related risks and the transmission channels of fiscal and contingent liability risks they could trigger for MoFs. The report concludes by identifying policy actions MoFs could take to mitigate and manage these risks.

1.2 The global response to nature loss

The growing awareness of nature-related risks and urgency to act has generated political momentum and engaged financial and corporate leaders. According to the Global Risks Report 2022, environmental risks are perceived to be among the top five critical global long-term threats and are potentially the most damaging risks to people and the planet, with climate action failure, extreme weather, and biodiversity loss as the top three most severe risks.[70] The 2021 G7 Summit acknowledged the "unprecedented and interdependent crises of climate change and biodiversity loss pose an existential threat to people, prosperity, security, and nature," and committed the G7 to "reversing biodiversity loss,"[71] also reflected in the program of the German G7 presidency.[72,73] At the 2021 One Planet Summit, a coalition of over 50 countries also committed to the goal of conserving "30 percent of land and sea areas, with at least 10 percent under strict protection" by 2030. The United Kingdom is also making biodiversity a key priority and commissioned the recently published report "The Economics of Biodiversity: The Dasgupta Review." A follow-up report including policy recommendations, "Biodiversity, Natural Capital, and the Economy," was published by the OECD.[74] Furthermore, COP26 of the United Nations Framework Convention on Climate

Change (UNFCCC) produced commitments by countries to counter biodiversity and nature loss. For instance, 141 countries signed the Glasgow Leaders' Declaration on Forests and Land Use, a commitment to halt and reverse forest loss and land degradation by 2030.[75] The Glasgow Climate Pact also recognized the critical role of conserving and restoring nature and the ways in which biodiversity and climate change are interlinked.[76]

There is growing consensus that the global response needs to be comprehensive and bring about systemic change. The most recent assessment of progress on the 2011–20 Aichi Biodiversity Targets[ee] shows that none of the 20 targets has been fully achieved, and only six have been partially achieved.[ff] The draft post-2020 global biodiversity framework, which is expected to be adopted at the fifteenth meeting of the Conference of the Parties (COP15) to the Convention on Biological Diversity (CBD) in 2022,[gg] calls for urgent, transformative action to address biodiversity loss. COP15 is expected to set out an ambitious plan to implement broad-based action to transform society's relationship with nature, to ensure that the trends that have exacerbated biodiversity loss stabilize by 2030, and to allow for the recovery of ecosystems in the following 20 years, with net improvements by 2050.[77]

Achieving the transformations needed requires considering future risks associated with biodiversity loss and systematically accounting for its value in decisions at all levels and across all sectors.[78] It also means coordinated implementation of the Paris Agreement and the post-2020 global biodiversity framework, taking advantage of the synergies, and managing the trade-offs between them. Adequate financial resources required to implement the post-2020 global biodiversity framework are estimated on the order of $700 billion per year by 2030,[79] building on earlier assessments of the financing gap.[80] A large portion of this financing gap could be filled by repurposing public subsidies that are harmful to nature. The draft of the framework (Target 14) goes even further, proposing that all activities and financial flows are aligned with the goals of the post-2020 global biodiversity framework (still being negotiated at the time of writing). International support to countries that host and manage key biodiversity areas is one of the key areas of discussion.

[ee] The Aichi Biodiversity Targets, are an integral part of the CBD Strategic Plan 2011–2020, adopted by 194 countries a decade ago. They are organized under five strategic goals and comprise aspirations for achievement at the global vision of the Convention of Biological Diversity: "by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people."

[ff] Targets related to terrestrial and marine protected area expansion, to 15 percent and 7.5 percent respectively, are among those showing most progress. However, virtually no progress has been made in addressing the broader drivers of nature loss—land use change, direct exploitation, pollution, climate change, and invasive species, and the underlying economic market, policy, and institutional failures that are facilitating unsustainable practices (CBD Secretariat 2020).

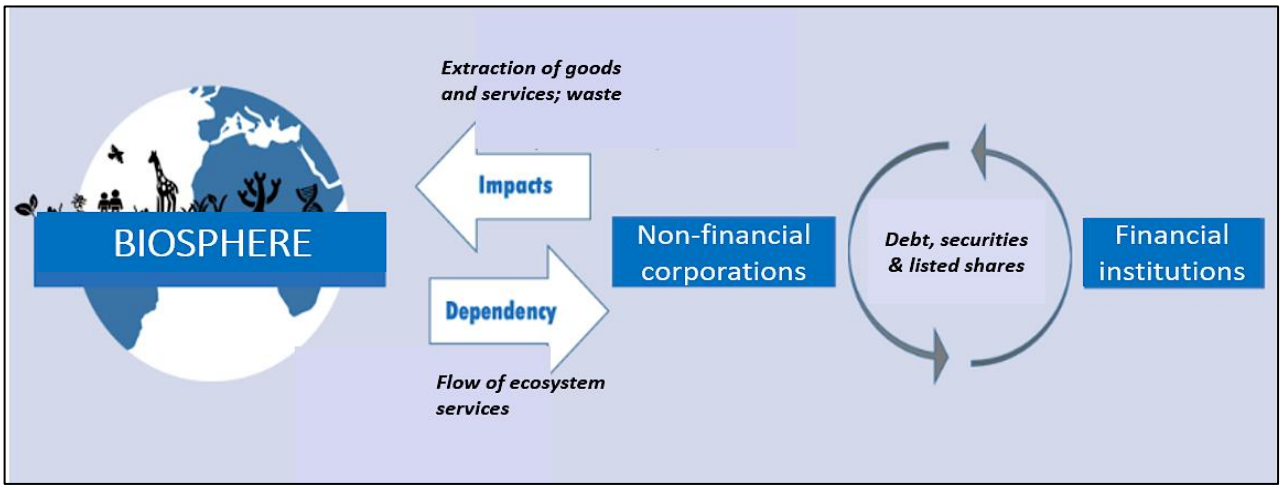
[gg] At the time of publishing, further postponement was being discussed, but a date had not been announced.

2. Nature-Related Risk: Types, Exposures, and Transmission Channels

2.1 Types of nature-related risk for the economy and financial sector

The economy's relationship with nature is twofold, where economic and financial risks can emerge from impacts and dependencies on biodiversity and ecosystem services. The economy depends strongly on a healthy biosphere and the ecosystem services it provides.[81] At the same time, a large set of unsustainable economic activities harms nature, putting the stability of Earth systems and continued provision of critical ecosystem services at risk.[82] This double materiality[hh] of being dependent on nature, while also negatively affecting nature, poses nature-related *physical* and *transition risks*, which are material for sectors of the real economy and indirectly for the financial sector given the current and expected trends of nature loss (figure 4).[83] MoFs could be strongly affected through both forms of materiality given their pivotal role in economic and fiscal policy making and the implicit and explicit contingent liability risks that could be triggered as these risks materialize.

Figure 3. Dependencies and impacts of the economy on nature



Source: Adapted from Svartzman et al. 2021.
Note: Similar logic could be applied to households.

[hh] Double materiality is a two-dimensional perspective on materiality adopted by the Non-Financial Reporting Directive (NFRD) of the European Commission in the context of climate change. The reference to the company's "development, performance [and] position" indicates financial materiality, in the broad sense of affecting the value of the company. Nature-related information should be reported if it is necessary for an understanding of the development, performance, and position of the company. This perspective is typically of most interest to investors." The reference to "impact of [the company's] activities" indicates environmental and social materiality. Nature-related information should be reported if it is necessary for an understanding of the external impacts of the company. This perspective is typically of most interest to citizens, consumers, employees, business partners, communities, and civil society organizations. However, an increasing number of investors also need to know about the impacts of investee companies on nature in order to better understand and measure the impacts of their investment portfolios (European Commission 2020, World Bank 2020).

Figure 4. Types of nature-related risk

Physical Risk	Stems from the degradation and loss of natural capital and the disruption of the ecosystem services it provides
Transition Risk	Stems from changes in economic policy, regulation, technological advancement, and shifting consumer preferences as well as reputational damage and litigation as a result of activities that are harmful to biodiversity

Nature-related *physical* risk stems from the degradation and loss of biodiversity and ecosystem services. As with depreciation of produced capital, declining quantity and quality of natural capital reduces its ability to provide services. Continuing degradation of the environment through unsustainable economic activity reduces the extent of ecosystems and the biodiversity they harbor as it outpaces nature's ability to regenerate. This, in turn, affects their stability and functionality, and makes them less productive. If unaddressed, degradation can push an ecosystem to a tipping point beyond which it will shift to a new state or collapse, leading to a large-scale, abrupt decline in ecosystem services.[84] Multiple sectors of the economy depend directly or indirectly on ecosystem services, so their activity is affected by any disruption of these ecosystem services for which substitution is costly or limited.[85] As such, the loss of ecosystem services can affect states, cities, real sector companies, financial institutions, farmers, and households. Quantitative estimates of these risks are presented in box 5 and throughout this section.

The *transition* to a nature-positive economy could expose the real and financial sectors to potential disruptions and shocks. Economic activities that are driving environmental degradation are likely to be affected. Transition risks can arise through different channels, including sudden changes in policy, regulation, technological advances, and consumer preferences aimed at reducing biodiversity loss and degradation of natural ecosystems (box 2). The risks from changes in consumer preferences can materialize either directly, through reduced consumer demand for products with high environmental impacts, or indirectly, through other market actors such as financial institutions demanding action from companies to reduce their biodiversity impacts. For instance, in 2019, the $1 trillion Government Pension Fund of Norway (GPFN) revealed that since 2012, the fund had divested from 33 palm oil companies over deforestation risks.[86]

Another form of transition risk is liability risk that could emerge for companies and states through litigation or legal avenues outside courtrooms, such as regulatory fines and enforcement. A recent report by the Commonwealth Climate and Law Initiative (CCLI) distinguishes between the narrower litigation risk and the broader liability risk.[87] The companies deemed responsible for a loss or injury associated with biodiversity loss may be required to pay compensation to the affected parties.

Box 2: Nature- vs. climate change-related risks

Climate and nature-related risks share common characteristics and are interdependent. Multiple sectors and firms that have a high exposure to climate-related risks are also strongly exposed to nature-related risks (e.g., in the mining, oil and gas, and agriculture sectors). The more severe nature- and climate-related risks become, the more the interactions between these risks are material. There are important differences, however, in the way nature-related risks can materialize and be assessed, as compared to climate-related risks.

- ***More localized risks.*** Compared with climate-related risks, biodiversity and ecosystem health and functionality are highly dependent on local factors, and ecosystem degradation has more immediate local economic and financial effects. A metric ton of CO_2 equivalent emitted in one landscape has the same effect on climate change regardless of location. The associated negative externalities are predominantly global. The direct cost to the emitter is determined by the jurisdiction it operates in—whether it has a carbon price levied on this activity and how high it is. In contrast, nutrient runoff from excessive use of fertilizers in an agricultural landscape into surrounding water bodies can cause eutrophication and decimate biodiversity (killing aquatic species), creating a health hazard for local communities and livestock. The associated negative externalities are predominantly local, translating into direct risks and costs for local communities and businesses. Notwithstanding this, as with climate change, degradation and loss of biodiversity and ecosystems can compound across landscapes and biomes, also causing degradation of the biosphere at the global level. For example, species loss can reduce the functional diversity across entire floras, leading to lower ecosystem functioning and reduced overall resilience and resistance of biosphere to future global changes, particularly if pre-adapted species disappear. The rapid decline of pollinators is another example, whereby intensive agricultural practices, monocultures and use of pesticides have led to large-scale losses, fragmentation and degradation of pollinator habitats across landscapes and bioregions. Along with climate change, pests, and diseases resulting from reduced resistance of pollinator colonies and from globalization, these drivers are decimating populations of bees and other pollinators at an alarming rate worldwide.[88]
- ***Complexity of risk assessment.*** Measuring biodiversity and ecosystem health and the progress of a company or country toward operating in harmony with nature is more multidimensional than measuring greenhouse gas emissions and their contribution to global warming. First, ecosystems are highly complex and dynamic systems, and there still is considerable uncertainty over their responses to human pressures. The scenarios that describe alternative futures of nature and society are not as advanced as those developed for climate futures.[a] From the point of view of managing nature-related risks, this reduces the confidence associated with the efficacy of conservation measures, the quantification of vulnerabilities, and the tradeoffs and synergies across different investment and policy decisions. Second, there is no single high-level metric to assess the footprint of economic activity, such as metric tons of CO_2 equivalent for nature, or a global goal equivalent to keeping warming well below 2°C and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. To capture this multidimensionality, the first draft of the post-2020 global biodiversity framework has multiple targets spanning genetic diversity, extinction rates, and the area, connectivity, and integrity of natural ecosystems.[b]
- ***Lack of data.*** Data to measure a company's, portfolio's, or country's dependency and impact on biodiversity and ecosystem services are still lacking in many cases yet are essential to inform both public and private sector decision-making if nature risk is to be taken into account. Tools such as

ENCORE can map sector-based direct impacts and dependencies on ecosystem services,[3] but data on the complex relationship between companies and biodiversity through operations and supply chains is limited.[c] ENCORE offers global averages, while ecosystem service dependencies and the state of the natural assets differ by country and require geographical context to refine the assessment. Still, publicly available biodiversity and ecosystem services-related data that could complement tools providing global averages currently face limitations in its accuracy, granularity, temporal consistency, spatial resolution, and data interdependencies.[5] Moreover, there are neither clear taxonomies to distinguish between nature-friendly investments and those that damage nature, nor widely accepted risk assessment and reporting frameworks. Promising approaches to close the data gap include the framework being developed by the Taskforce on Nature-Related Financial Disclosures (box 8) and innovative and interdisciplinary data collection and estimation methodologies.

Sources: Pörtner et al. 2021; O'Neill et al. 2014; Kim et al. 2018; CBD Secretariat 2021; Nature Capital Finance Alliance 2021; Patteron et al. 2022.
Note:
a. The Share-Socioeconomic Pathways (SSPs) have been developed by the integrated assessment modeling (IAM) community to define pathways that describe plausible alternative trends in the evolution of society and ecosystems over a century timescale, in the absence of climate change and climate policies. The application and refinement of the SSPs in the context of natural ecosystems is currently less developed compared to the extended applications in the climate sphere but is currently evolving.
b. Goal A in the first draft of the post-2020 global biodiversity framework states that "The integrity of all ecosystems is enhanced, with an increase of at least 15 percent in the area, connectivity and integrity of natural ecosystems, supporting healthy and resilient populations of all species, the rate of extinctions has been reduced at least tenfold, and the risk of species extinctions across all taxonomic and functional groups, is halved, and genetic diversity of wild and domesticated species is safeguarded, with at least 90 percent of genetic diversity within all species maintained." Goals B, C, and D pertain to benefit-sharing, valuation of nature's services, and resource mobilization.
c. Some promising attempts exist, however, such as the Trase tool that provides insights into the deforestation risk within soft commodity supply chains.

2.2 Potential transmission mechanisms of nature-related risks

For firms, households, sectors, and the macroeconomy, different risk transmission channels interact and induce reinforcing feedback effects (figure 5). While the evidence base for nature-related risk transmission is not as developed as for climate-related risk transmission, emerging research suggests that nature-related impacts could be substantial.[89] Nature-related risks are multidimensional, and there is still considerable uncertainty about how ecosystems will respond to continuing human pressure. While there is consensus that mounting local impacts could eventually become national and global risks, the timing, exact transmission channels, and wider implications are still unclear. These characteristics of nature-related risks (compared with climate-related risks) make it difficult to draw conclusions about how they will materialize, especially for the broader economy, but there are examples of where nature-related risks have materialized, or are materializing, suggesting that impacts could be severe. This report presents some of those examples to show the possibilities of how they may affect governments and MoFs in particular.

Nature-related physical risk might play out as an acute shock, such as the COVID-19 pandemic, or as a slower moving chronic impact, such as a decrease in agricultural yields. Both are the result of the loss of biodiversity and degradation of ecosystem services. Physical risks could affect business operations, affecting firms' profitability and ability to repay lenders. This could result in market and credit risk for financial

institutions. For instance, the Cambridge Institute for Sustainable Leadership (CISL) and Robeco[90] recently estimated the equity value at risk for listed companies in the food supply chain that were exposed to suppliers farming degraded land. The case study looks at companies' exposure to crop yield reductions resulting from extreme weather events. It found that small, packaged food company valuations fell by an average of 45 percent after an extreme weather event if their suppliers were farming degraded land. The study also found a market value decline of 13 percent for farmers operating on degraded land, while farmers working on healthy soils saw an increase of market value by 6 percent (mainly because of their ability to capture crop price rises following the weather event). [91]

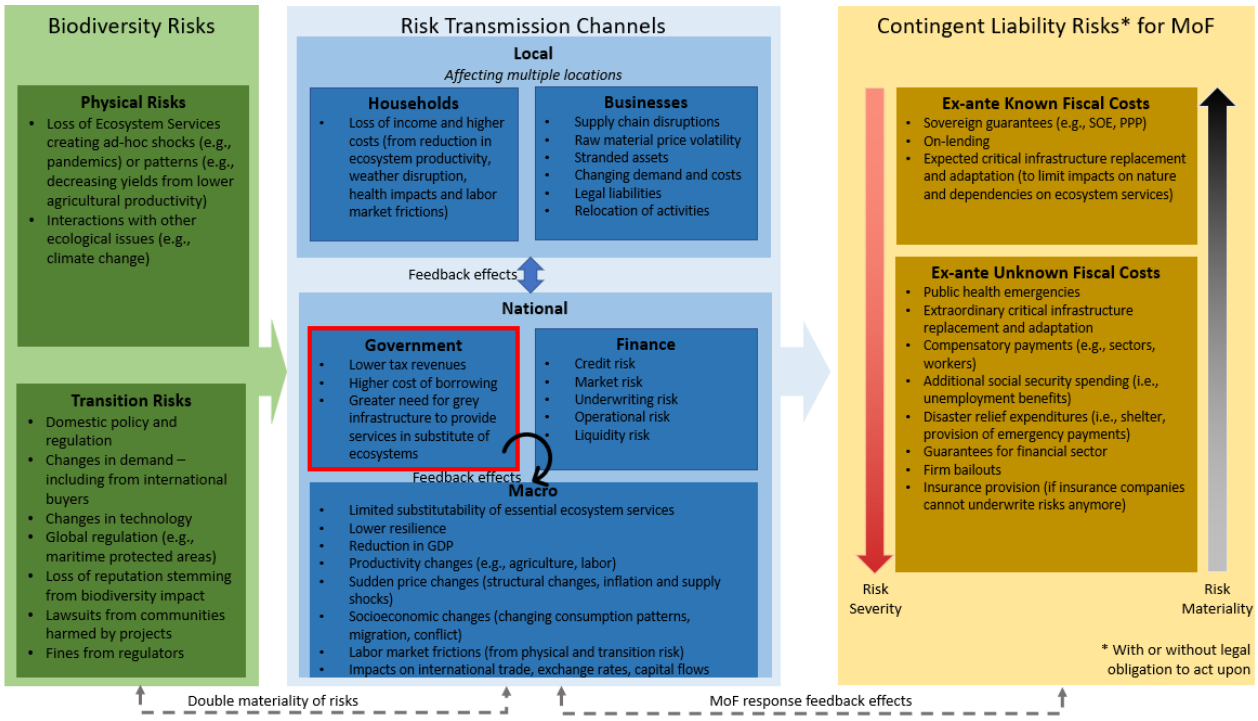
Nature-related transition risk might play out as an increase in the size of protected areas or strengthened regulation on the import or production of commodities.[ii] The expansion of protected areas, while essential for nature recovery, could reduce the availability of productive land and exploitable resources. This could be aggravated by a decrease in arable land resulting from climate change.[92] Strengthened regulation on the import or production of commodities is another potential transmission channel. France, for instance, adopted a national strategy which aims to end deforestation caused by importing unsustainable forest and agricultural products by 2030.[93] Such regulation, if implemented suddenly and in an uncoordinated way, could cause transition risk, both for exporters of key commodities and importers that depend on those commodities for production.

Risks could materialize on a local or national level and affect different sectors of the economy. Firms and households might be directly impacted from localized physical and transition risk materialization. The interaction of multiple local risks may lead to reinforcing feedback effects, potentially creating nation-wide impacts, affecting the government, financial sector, and eventually creating detrimental macroeconomic impacts. For instance, the price of productive land due to lower supply and the cost of production inputs may increase in response to the deterioration of ecosystem services. For example, it is estimated that already about one third of US nitrogen fertilizer use in maize agriculture is needed to compensate for long-term loss of soil fertility through erosion and organic matter loss, leading to half a billion-dollar extra costs for fertilizer supply per year.[94] These direct impacts of nature-related physical risks could increase firms' cost of doing business and lower their profitability. As a result, indirect impacts in downstream sectors in the economy could emerge from higher costs of raw materials. It is possible that such direct and indirect impacts could affect entire supply chains and eventually become macro-critical.

Reinforcing feedback effects might trigger contingent liabilities of ex-ante known and unknown fiscal costs for MoFs. Contingent liabilities are obligations that materialize only when a certain event in the future occurs. Contingent liability risks could become gradually or abruptly more severe with ongoing biodiversity loss, depending on the country context (red "risk severity" arrow). However, the materiality of these risks, with potentially high ex-ante unknown fiscal costs for MoFs, depends on the interplay of nature-related risk transmission channels, the degree of unfavorable reinforcing feedback loops, and biodiversity policies (grey "risk materiality" arrow).

[ii] Other sources of transition risk include changes in domestic and international demand, changes in technology, global regulation, loss of reputation, lawsuits, and fines from regulators.

Figure 5. Nature-related risk framework



Source: World Bank.

Potential impacts of nature loss on households and businesses

About 80 percent of the global population living below the poverty line resides in rural areas and is highly dependent on biodiversity and ecosystem services for their livelihoods.[95] Multiple examples of linkages between biodiversity and livelihoods exist, particularly in the context of forest and coastal ecosystems. One third of humanity (or 2.6 billion people) relies on wood and other traditional fuels, while between 3.5 billion to 5.8 billion use non-timber forest products for own use of to support livelihoods.; evidence also suggests that forests and other tree-based systems support poor people.[96] An estimated 1.2 billion jobs in sectors such as farming, fisheries, forestry, and tourism depend on the effective management and sustainability of healthy ecosystems.[97] Coastal ecosystems are known to be an important physical buffer and safety net, making vulnerable communities more resilient to natural and economic shocks.[98]

Loss of ecosystem services can affect households directly in several ways, with reduced agricultural productivity or collapse of fisheries as key transmission channels. Smallholders, subsistence farmers and fishers, and low-income rural households tend to be highly dependent on ecosystem services and thus vulnerable to fluctuations in their provision. For example, degraded productive land and the reduced quantity, quality, or predictability of potable water supply can lead to loss of livelihoods and plunge households into poverty. Converging drought and land degradation are already contributing to decreases in agricultural yields in many places—demonstrating the effects of compounding climate and nature-related risks. The recent United Nations Convention to Combat Desertification (UNCCD) Global Land Outlook report

conservatively estimates at least 20 percent[jj] of the global land surface is now degraded, with food systems being the major driver.[99] In Ethiopia, land degradation has been a major cause of the country's low and declining natural resource and agricultural productivity, persistent food insecurity, and poverty.[100] Driven primarily by deforestation and poor cropland and livestock management, land degradation has lowered crop yields, leading to food insecurity and higher poverty rates among rural communities. The estimated annual cost of land degradation associated with land use and cover change in Ethiopia was about $4.3 billion in 2016. The costs of action to rehabilitate lands degraded during 2001–2009 through land use and cover change were about $54 billion over a 30-year horizon. But if nothing were done, the resulting losses could equal almost $228 billion.[101]

Households in middle and high-income countries, too, are vulnerable to the economic effects of nature-related risks. Exposure through food prices provides a key example. During the summer of 2021, 95 percent of the western United States experienced a drought with nearly two thirds experiencing extreme or exceptional drought.[102] These conditions, combined with existing unsustainable levels of water consumption and degraded land in many Western states, resulted in decreased agricultural yields across the region.[103] In response to the drought, California water regulators implemented water restrictions for thousands of Central Valley farmers, who produce food consumed across the United States and abroad.[104,kk] An estimated 395,000 acres of land was idled because of the 2021 drought in the state.[ll,105] California crop revenue losses and increased pumping costs were estimated at $1.1 billion, with roughly 8,700 full- and part-time jobs lost.[106] The US Consumer Price Index for food increased by 3.9 percent in 2021[107] and was one of the drivers of inflationary pressures in the United States.[108] Globally, the Food and Agriculture Organization (FAO) food price index rose 28 percent in 2021.[109] While this increase partially resulted from a surge in post-pandemic demand and supply chain issues, the effects of lack of resilience to extreme weather events resulting from land degradation and lack of water access also played a role.[110] Such negative impacts from nature loss could be amplified when compounding with other sources of risk such as war and conflict. For example, as a result of the invasion of Ukraine—a major exporter of wheat, maize, sunflower seed oil, and other staples—global food prices have reached new record highs.[111] By the end of March 2022, 53 new policy interventions affecting food trade had been imposed—of which 31 restricted exports as governments scramble to contain surging food prices and ensure sufficient domestic supplies.[112] The FAO food price index rose 34 percent from March 2021 to March 2022.[113]

The loss of ecosystem services can have a significant impact on businesses in many economic sectors. Industries either highly dependent ($13 trillion) or moderately dependent ($31 trillion) on nature and its services generate an estimated $44 trillion of global value added, corresponding to more than half the world's GDP.[mm] Among the highly dependent are construction, agriculture, and food and beverages. They rely both on the direct extraction of resources from forests or oceans, and on supporting ecosystem services such as soil productivity, clean water, stable climate, and animal pollination. For example, pollination supports 75 percent of global food crop types, including fruits and vegetables, and some of the most important cash crops such as coffee, cocoa, and almonds. The annual market value of crops dependent on

[jj] With estimates ranging up to 40 percent from the studies cited in the report.
[kk] California's agricultural sector is valued at $50 billion (Escriva-Bou. A et. al 2022).
[ll] Over and above land already fallowed for other reasons.
[mm] The WEF has analyzed the nature dependency of 163 sectors and their supply chains across a range of ecosystem services, which include, inter alia, bioremediation, climate regulation, disease control, fibers and other materials, filtration, flood and storm protection, mass stabilization and erosion control, genetic materials, soil quality, and pollination (WEF 2020).
It should be noted, however, that every industry is dependent on nature to some degree.

animal pollination ranges from $235 billion to $577 billion.[114] Another example is tourism, which in 2019, before the pandemic, generated one in 10 jobs worldwide.[115] Natural landscapes and biodiversity are what makes many tourism destinations attractive. Coral reefs alone provide $36 billion a year in economic value through tourism, generated directly through on-reef activities such as diving and wildlife watching and tourism in reef-related areas, which attract visitors with their ocean views, beaches, and local seafood.[116]

Box 3: Spillover effects from economic activities with high nature-related risk

Impacts on nature from the risky actions of one company have the potential to create widespread multisectoral impacts and long-term, even permanent, damage to ecosystems, which may have indirect financial and economic costs for households and the government.

The 2010 BP oil spill in the Gulf of Mexico was the largest oil spill in the history of marine drilling operations. Approximately 5 million barrels of oil flowed into the Gulf over 87 days, affecting biodiversity and water quality along over 1,000 miles of coastline. The economy on the Gulf Coast was severely impaired, particularly in offshore drilling, fishing, and tourism. The disaster is estimated to cost BP $79 billion by 2032.

While BP ultimately sold its US arm and stopped operating in the country, other oil and gas companies felt the systemic effects of the incident as a moratorium on deep-water offshore drilling was put in place while new regulations were developed. In addition, compliance with the new regulation created a substantial new cost for the industry. Ten years later, every fish tested in the continental shelf of the Gulf of Mexico was found to have some trace of oil in it. Fish could also become re-contaminated from two large remaining reservoirs of oil from the BP spill—one on the bottom of the deep ocean and the other in the Louisiana marsh system. Furthermore, the region experienced some permanent loss of salt marshes. The impacts on the fishing and tourism sectors are expected to continue into the future. The resulting damage to the wetlands is also estimated to indirectly affect the communities that rely on wetlands for disaster risk resilience through greater vulnerability to storms. A loss of disaster risk resilience services provided by wetlands could thus indirectly result in increased payouts in disaster assistance and federal flood insurance from the government in the case of a disaster.[a] Hurricane Ida, which hit the Gulf Coast in September 2021 is estimated to have caused between $27–40 billion in damages.

Sources: U.S. Environmental Protection Agency n.d.; Ward 2018; Baker and Broder 2010; Pulster et al. 2020; Schleifstein 2020; Silliman et al. 2012; Barron et al. 2020; Congressional Budget Office 2017; Business Wire 2021.
Note:
a. The US National Flood Insurance Program (NFIP) is projected to run a deficit of approximately $1.4 billion per year under current conditions, with the expected annual cost of $5.7 billion exceeding the $4.3 billion in expected premiums. That shortfall stems largely from two sources: policies embedded in the NFIP and expected flood damages.

A reduction in the availability of production inputs resulting from the loss of ecosystem services or environmental regulation can lead to supply chain challenges and increasing costs for businesses. One example of such an effect is demonstrated in a case study conducted jointly by the University of Cambridge Institute for Sustainability Leadership and HSBC assessing the effect of the curtailment of water on the credit ratings of heavy industry companies in a water-stressed East Asian country. In a high water stress scenario, most of the companies in the sample were subject to an internal rating downgrade of at least one notch, with cases of multiple-notch downgrades also occurring. The credit risk of a significant share of companies in the sample moved from investment grade to speculative grade.[117]

Currently, however, companies' understanding of the nature-related impact of the activities in their supply chains is limited, as are their commitments to mitigate these impacts. A recent study found that one third of the 350 companies with the greatest exposure to deforestation through soy, beef, leather, timber palm oil, and pulp and paper do not have a commitment to remove deforestation from their supply chains. Almost two thirds of the 150 financial institutions that provide most finance to those companies do not have a deforestation policy, including the world's three largest asset managers. The study warns that companies will be ill-prepared for changing regulations.[118] Furthermore, companies that do not change their business models might face reputational hits.

Reputational damage represents a significant transition risk for businesses whose operations or supply chains have a large impact on nature. With growing consumer awareness and concern about the impact businesses are having on the environment,[119] the use of social media and continued loss of ecosystems and species, businesses with large environmental footprints are facing growing reputational risks.[120] Civil society organizations have facilitated campaigns to pressure companies to end destructive practices, which have resulted in protests, boycotts, and damage to brands. Greenpeace led a provocative campaign against Nestlé in 2010 based on evidence from its report, "Caught Red-Handed."[121] In the campaign, Greenpeace drew attention to Nestlé's contribution to deforestation and loss of orangutan habitat in Indonesia through its palm oil procurement. The campaign sparked protests and boycotts in multiple countries. In response, Nestlé undertook a detailed review of its supply chain, severed contracts with the palm oil producer identified in the Greenpeace report, and made a commitment to using 100 percent deforestation free palm oil by 2020.[122] According to company reports, as of March 2020, 30 percent of Nestlé's palm oil was still from sources that were not traced.

Potential impacts of nature loss on the financial sector

Since the financial sector finances companies that rely on ecosystem services and may facilitate the degradation of nature, financial institutions have an indirect (but significant) exposure to nature-related risks. Real economy impacts and sudden asset revaluations for nature-related risks could translate into risks for the financial sector, potentially compromising financial stability. Lower firm revenues and profits and lower household incomes could increase the probability of default and loss, given default. Along with the revaluation of collateral and creditworthiness (private, corporate, and sovereign), credit risk could increase. Rapid repricing and fire sales of debt, equity, and commodities could pose market risk. The deep uncertainty associated with the impacts of nature loss could increase the underwriting risk of insurance and financial products. Physical risks could pose operational risks to businesses depending directly on ecosystem services. Moreover, liquidity risks could materialize, if depositors and investors withdraw funds because of fears related to solvency or sudden nature-related risk expenses.

Academics, practitioners, and central banks have started to look at the financial system's exposure to nature-related risk.[123] More than 70 percent of corporate bonds held by the European Central Bank may be associated with high or very high negative impacts on nature.[124] The Dutch Central Bank (DNB) found that Dutch financial institutions worldwide have €510 billion in exposure to companies with high or very high dependency on one or more ecosystem services.[125] Moreover, 42 percent of the market value of securities held by French financial institutions stems from issuers (nonfinancial corporations) that are highly or very highly dependent on at least one ecosystem service.[126] At the same time, the accumulated terrestrial footprint of the French financial system corresponds to the loss of a natural area as large as 24 percent of metropolitan France. Of Brazilian banks' corporate loan portfolios, 45 percent are in sectors highly or very

highly dependent on at least one ecosystem service, and 15 percent of loans are granted to firms that operate in currently or to-be-protected areas in Brazil.[127] Of all commercial lending from Malaysian banks, 54 percent could now be exposed to financial risk due to risks arising from changes in the country's natural environment.[128] Future changes in policy, technology, and consumer preferences responding to nature loss could also expose about 87 percent of commercial lending from Malaysian banks.

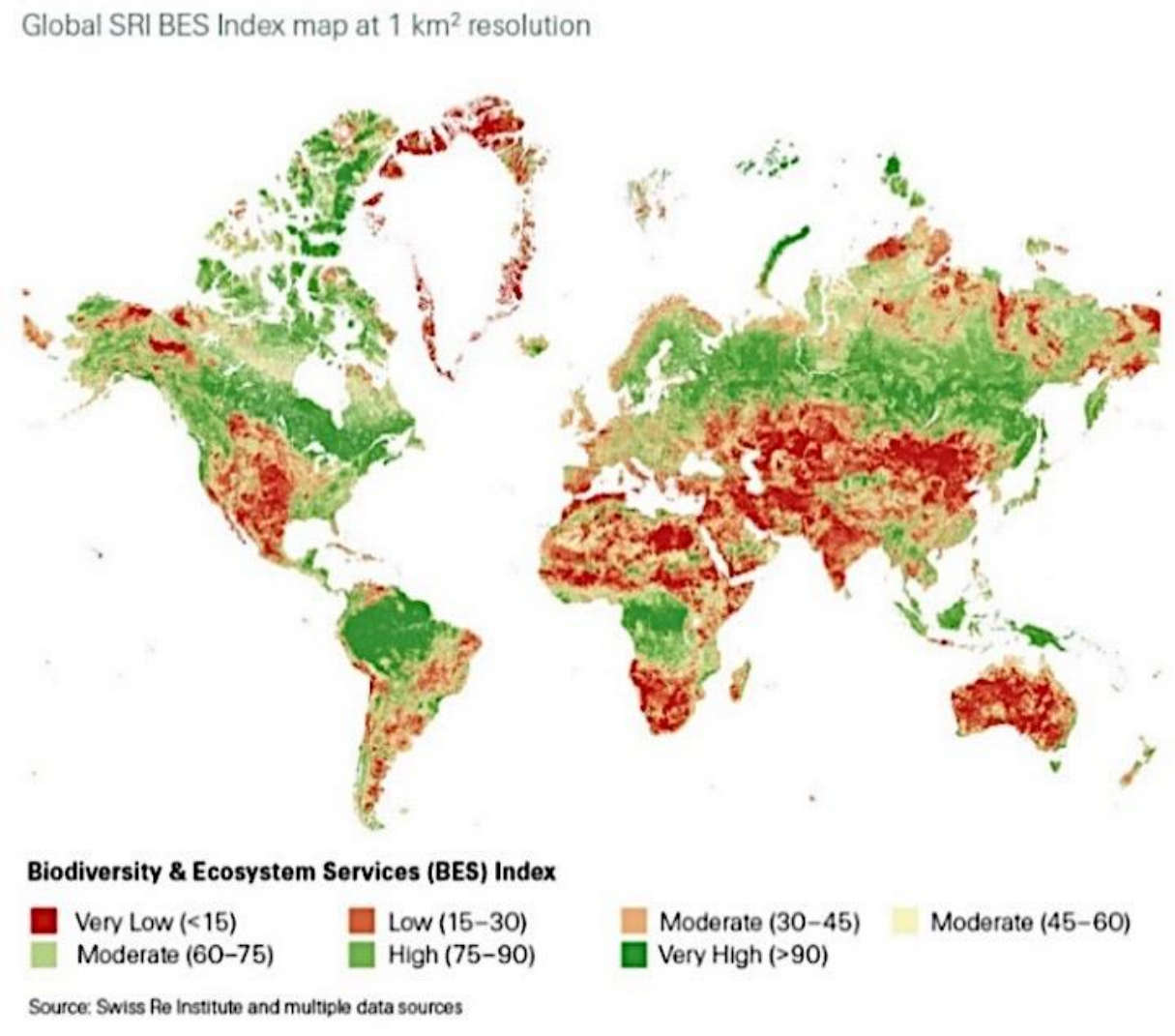
Other studies further emphasize the significant impact of banks' portfolios on biodiversity and ecosystem services, which could leave them susceptible to both physical and transition risk. A study by Portfolio Earth found that the world's largest banks in 2019 invested more than $2.6 trillion in sectors that are primary drivers of biodiversity loss.[129] Furthermore, a 2021 study estimates that the value of the potential damage to nature from lending activities by public development banks[nn] worldwide is around $800 billion annually, or seven cents for every dollar invested.[130]

Box 4: The Swiss Re Institute Biodiversity and Ecosystem Services Index

To better understand how nature-related risks will affect the insurance sector, the world's largest reinsurer, the Swiss Re Institute, developed a Biodiversity and Ecosystem Services Index, published in 2020.[a] The index assesses which economic sectors are most reliant on nature and evaluates the exposure each country has to the decline of biodiversity and ecosystem services based on the sectoral makeup of their economy. The index was designed to be used in decision-making in underwriting and asset management, to ensure that premiums adequately take nature-related risks into account. The Swiss Re Institute also expects this information to inform the development of nature-based insurance solutions, which could allow governments to use risk-transfer mechanisms to directly protect ecosystems, as the Quintana Roo government has.[2] The index shows that developing countries with highly agriculture-dependent economies, such as Kenya and Nigeria, are particularly susceptible to shocks from disruption to a range of ecosystem services (box 4 figure 1), and 39 countries have ecosystems in a fragile state on more than a third of their land.[3] This index might help governments to better understand their nature-related risk exposure.

[nn] Including both national and multilateral development banks.

Box 4 Figure 1. Swiss Re Biodiversity and Ecosystem Services Index



Sources: Swiss Re Institute 2020; The Nature Conservancy 2020.
Note: In the areas depicting a "very low" Swiss Re Institute Biodiversity and Ecosystem Services (BES) Index value, biodiversity and ecosystem services are particularly fragile. According to the Swiss Re Institute, some of these fragile areas include densely populated and economically important regions.
a. The index assesses share of fragile ecosystems, share of intact ecosystems, and GDP dependence on ecosystems to assess a country's nature-related risk.

Deforestation is one of the key categories of nature-related risk on which the financial sector has focused in the past decade. Deforestation contributes significantly to both nature- and climate-related risks, and the financial sector has facilitated deforestation, most notably through its financing of unsustainable

agriculture practices.[oo] Financing such deforestation practices could expose financial institutions to nature-related risk that could be transmitted through regulation, reduced market access, and loss of customers in the near term. Furthermore, supply chain disruptions and increased production costs in the longer term could affect firms' profitability, posing credit and market risk for the financial sector.[131] Through the negative impacts on nature of their portfolio investments, financial institutions contribute to systemic risks that could affect returns across their portfolios, particularly for large institutional investors.[132]

Financial institutions are beginning to take voluntary action to the risks associated with nature loss. For instance, the Financial Sector Commitment on Eliminating Agricultural Commodity-Driven Deforestation initiative,[133] with $8.7 trillion assets under management, recently committed to reduce deforestation through their capital allocation and engagement levers. Furthermore, the Finance for Biodiversity Pledge and Nature Action 100 initiatives acknowledge the significant and systematic consequences of biodiversity loss for the global economy, posing a financial risk. They also emphasize the emerging opportunities of a realignment of economic activities and public and private financial flows toward nature-positive pathways, which could deliver $10 trillion in annual business opportunities and 395 million jobs by 2030.[134]

Central banks and supervisors increasingly view nature-related risks relevant to their mandates. The recent NGFS report "Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability" provides a set of recommendations for financial regulators and supervisors.[135] Those recommendations include (i) recognizing biodiversity loss as a potential source of economic and financial risk; (ii) building skill and capacity to assess and address those risks; (iii) exploring options for supervisory actions on managing biodiversity-related risks and minimizing negative impacts on ecosystems; and (iv) helping build the necessary financial architecture for mobilizing investment for a biodiversity-positive economy. In support of this action, the NGFS also decided to launch a new task force on nature-related risks.[136]

Macroeconomic and systemic impacts of ecosystem services loss

The deterioration or loss of ecosystem services across multiple locations around the world could lead to knock-on effects for other ecosystem services.[137] Cascading impacts for the economy and financial sector could emerge since ecosystem services are substantial inputs in economic production for multiple sectors.[138] The loss or degradation of ecosystem services could create supply constraints and induce sudden price changes, which could trickle down through supply chains (box 5). For example, a reduction in pollination may lead to lower productivity (lower agricultural yields) in the geographic areas affected, higher production costs, and price increases for certain agricultural products. It may also trigger a shift in production to other geographic areas, reducing domestic exports and economic growth.[139] However, the impacts could be even further reaching with knock-on effects in other high- and low-income countries.[140] Even if the pollination loss occurs in smaller, low-income countries, high-income countries, such as the United Kingdom, Japan, or Germany, could face large economic consequences caused by global food price changes.[141]

[oo] The French financial sector could serve as a case in point. According to a report by Global Witness (2020), the French financial sector backed five of the six most harmful agribusiness companies investigated between 2013 and 2019. Those companies have been directly or indirectly involved in deforestation in the world's largest tropical rainforests in the Brazilian Amazon and the Congo Basin. This supported amounted to almost €2 billion, making France the second largest EU contributor of funds to these companies.

There is a risk of a far-reaching ecosystem collapse if certain tipping points are crossed. The collapse of the Amazon rainforest because of persistent deforestation and climate change (box 6)[142] would affect local and even global precipitation patterns and thus affect other ecosystem services and sectors such as rainfed agriculture in the entire Amazon basin and far beyond.[143] The Aral Sea is a historic example where an expansion of irrigation in the 1960s caused the lake level to fall by 23m, the lake area to shrink by 74 percent, volume to decrease by 90 percent, and salinity to grow from 10 to more than 100g/l.[144] This led to severe negative ecological changes, including decimation of native fish, species, initiation of dust storms, degradation of deltaic biotic communities and localized climatic changes, having severe economic and health-related implications for the local population. The American Dust Bowl, which eroded entire sections of the United States' Great Plains in the 1930s, is another example of long-run economic implications from an environmental catastrophe. The Dust Bowl was driven by human land degradation and human-induced vegetation reductions.[145] The socioeconomic consequences were substantial, as the Dust Bowl is estimated to have immediately, substantially, and persistently reduced agricultural land values and revenues in more eroded counties, with long-run economic adjustment predominantly occurring through large relative population declines in more-eroded counties.[146]

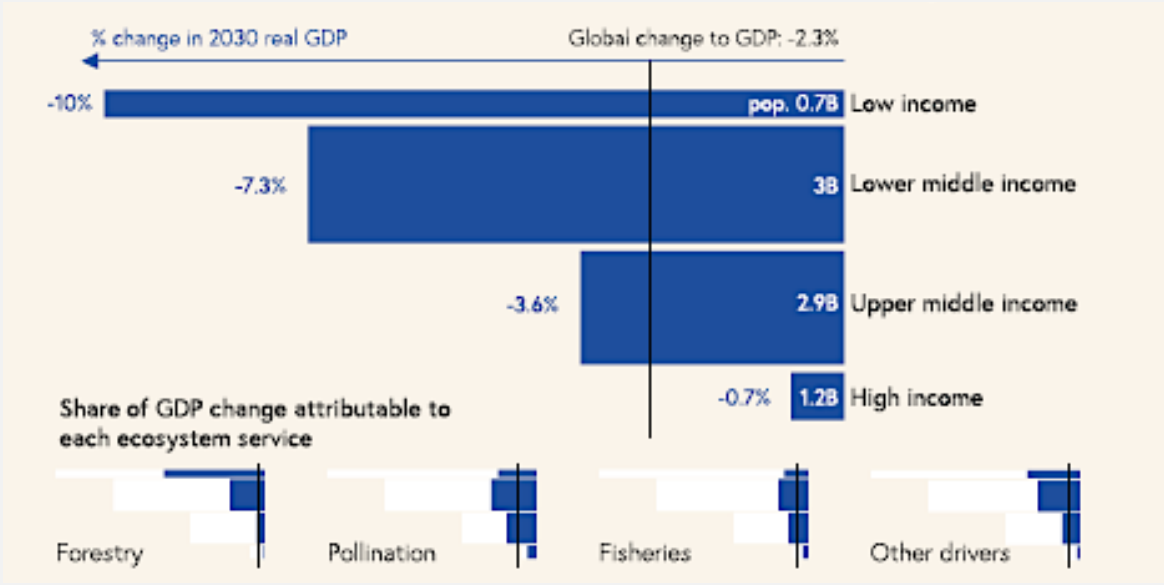
With multiple ecosystem services affected irreversibly at various locations, cascading effects across multiple sectors of the economy and the financial sector could emerge, with macroeconomic impacts. In addition, land use, land use change, and forestry contribute to greenhouse gas emissions, and to further systemic impacts and feedback loops—leading to further nature loss.[147] The loss of disease control ecosystem services provides another example of a potential global, systemic, economic, and financial impact of nature loss. Zoonotic diseases, such as COVID-19, are thought to exemplify how local risks likely linked to the degradation of nature can become transboundary and spread to the entire world.[148]

Box 5: The decline of biodiversity and ecosystem services is a development issue

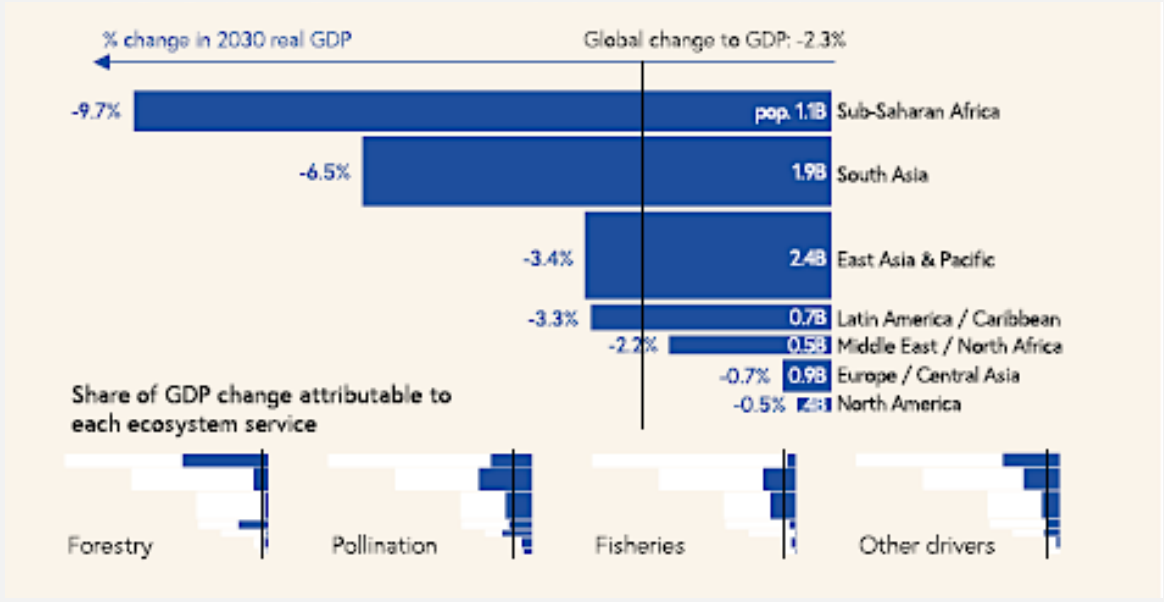
The decline of ecosystem services results in GDP losses, as demonstrated in a global ecosystem–economy model that the World Bank developed in collaboration with the University of Minnesota and Purdue University.[1] The model integrates selected ecosystem services in a general equilibrium model. In one of the scenarios analyzed, three services collapse, namely, wild pollination, food provision from marine fisheries, and timber from native forests. The model shows a corresponding drop of $2.7 trillion (–2.3 percent) in global real GDP annually by 2030 from the baseline scenario.[a]

The global aggregate conceals a larger contraction of GDP in lower-income countries, which account for nearly half of the world's population. The economic impacts are most pronounced in low-income and lower middle-income countries, where drops in 2030 real GDP could respectively reach 10 percent (–$81 billion) and 7.3 percent (–$734 billion) (box 5 figure 1a). At the regional level, Sub-Saharan Africa would experience the greatest relative contraction of real GDP: 9.7 percent annually by 2030 (–$358 billion), followed by South Asia that could see a 6.5 percent (–$320 billion) contraction of real GDP annually (box 5 figure 1b). These findings underscore the strong reliance of economies on nature, particularly in low-income countries.

Box 5 Figure 1a. Change in 2030 real GDP under the partial ecosystem collapse scenario compared with the no-tipping-point scenario by income group



Box 5 Figure 1b. Change in 2030 real GDP under the partial ecosystem collapse scenario compared with the no-tipping-point scenario by geographic region



Source: Johnson et al. 2021.
Note: The bars are proportional to the population in 2030.

Potential impacts of nature loss on governments

The loss of ecosystem services could represent substantial nature-related risk to governments. Wetlands, for example, provide extensive ecosystem services, notably disaster risk resilience. Yet, their global expanse is still declining,[149] with an estimated 54 percent to 57 percent, and possibly as much as 87 percent, of global wetlands lost as a result of land use change for agricultural, urban, and industrial expansion.[150] The flood protection benefits of mangroves alone are estimated to exceed $65 billion a year globally.[151] If mangroves are lost, 15 million more people could experience flooding annually (under current climate conditions). More than 45 20-kilometer coastal stretches of coastline, particularly those near cities, receive over $250 million annually in flood protection benefits from mangroves. When these disaster risk resilience services are degraded or collapse, governments are exposed, with direct and indirect fiscal implications for the government.

At the same time, ill-designed policies to conserve and restore nature could lead to transition risk, representing additional costs for the government. Even it is too early to have an academic assessment of underlying drivers and causes, the Sri Lankan campaign "Vistas of Prosperity and Splendor" and following ban of chemical fertilizers could serve as a example.[152] Within one single season chemical fertilizers were banned in Sri Lanka in April 2021, instead of gradually introducing the policy over several years, allowing farmers, organizer fertilizer suppliers, and financiers to adapt. After widespread protests in December 2021 the ban was rolled back, however, the damage was already done. Domestic rice production is expected to suffer a 30 percent reduction as a result and the country moved from exporting to importing the staple crop.[153] Meanwhile, domestic rice prices are expected to increase around 30 percent.[154] The ban also devastated the nation's tea crop, its primary export and source of foreign exchange.[155] These impacts added to an already challenging economic situation in the country, with exchange reserves at a record low and inflation soaring.[156] The ongoing global geopolitical situation pushing food prices to record levels globally[157] added to the difficulty of the national situation. The Sri Lankan government relied on credit lines from friendly neighbors to import rice, defaulted on its debt, and requested emergency financial help from the International Monetary Fund (IMF) and the World Bank.[158]

Nature-related risks can be transmitted to governments through a variety of channels, either directly or indirectly via household, firms, and financials sector impacts. They could lead to direct and indirect fiscal implications, thereby also being of particular relevance for MoFs. Beyond direct implications, nature-related risks could also trigger a wide range of contingent liabilities for MoFs with known and unknown fiscal costs (see figure 5). Contingent liabilities are generally considered obligations that become material only in a certain future state.[159] They can be split into explicit and implicit contingent liabilities. The explicit contingent liabilities represent obligations fixed by law or contract, implicit contingent liabilities involve moral obligations or public responsibilities not determined by legal contracts.[160] All of those direct and indirect impacts, as well as contingent liabilities for the MoF, imply substantial fiscal costs for the government if they materialize:

- Lower tax revenue associated with reduced household income and reduced profits to firms and financial institutions.
- Damage to public infrastructure, increased requirements for new infrastructure, increased disaster risk payouts, and increased welfare payments.
- More need for welfare payments associated with unemployment from the sectoral impacts of nature loss.

- Increased need to invest in ecosystem restoration to counter consequences of nature loss and prevent further loss via feedback loops.[pp]
- State-owned enterprises (SOEs) could be strongly exposed to both physical and transition risk. Decreasing profitability of SOEs may materialize for governments via lower or more volatile dividends.
- SOEs could call on government guarantees as they face pressure from nature-related physical and transition risks. This could also hold for private companies, in which the state might have financial exposure due COVID-19 emergency action.
- Inflationary pressures due to increased commodity and food prices, supply chain disruptions, or higher costs of manufacturing ecosystem-dependent goods.
- Slower economic growth from political instability or conflict induced by surging food and commodity prices.[qq]
- Lower export volumes and higher import needs affecting current account balances and exchange rates, while international capital flows could be shifted.
- Increased sovereign credit risk from nature loss, potentially resulting in higher interest payments on sovereign debt and debt sustainability concerns from a downgrade in a country's credit rating associated with nature loss and sectoral, macroeconomic, trade, or political stability.[161]

Given the complexity and uncertainty that characterize nature-related risks, the conditions for their materialization, as well as the fiscal costs and the required government response, are unclear and would require forward-looking scenario analysis (see below).[162] Multiple but unknown potential knock-on effects from deteriorating ecosystem services could require compensatory or emergency payments for households and firms that exceed expectations and allocated funds.[163] This leaves MoFs with high exposure to the costs to nature-related risks since they could be forced to step in to support households, businesses, and financial institutions in extreme circumstances, posing contingent liabilities with unknown fiscal costs for MoFs.

[pp] As was described in the Ethiopia case.

[qq] Most notably, the interaction between climate change and nature loss could contribute to drought and increasing food prices. There is evidence that drought was a contributing factor to the conflict in Syria that eventually led to a civil war in the country (Kelley et al. 2015).

2.3 Loss of resilience and limited substitutability of natural capital: A matter of economic and financial stability

How severe and persistent economic and financial impacts are depends on the extent to which natural capital can be replaced by human-made capital—on whether weak or strong environmental sustainability applies.[164] Weak environmental sustainability means full substitutability between natural and other types of capital to improve welfare. Strong environmental sustainability means that each type of capital provides a unique contribution to welfare as environmental characteristics—including irreversibility, incomparability, and deep uncertainty—pose binding constraints on substitutability of natural capital with human-made capital.[165]

Substitution for lost or degraded ecosystem services is likely to face limitations if nature loss continues at the current pace. Traditional solutions for substituting ecosystem services by acquiring new land, developing new technology, or substituting goods dependent on ecosystem services with imports from another region face their limits or tend to be costly with ongoing nature loss. If multiple regions face dramatic loss in ecosystem services, with continued nature loss and worsening climate change, it would be more difficult to shift production to other regions to make up for losses in the provision of ecosystem services in specific locations (box 6). Technology could indeed be important in addressing the challenges associated with deteriorating ecosystem services by lowering the intensity of ecosystem inputs in production, or even providing alternatives as inputs. Furthermore, technology could create more transparency into the impact of economic activities on nature, possibly improving risk management practices and regulation. Even though technological solutions could partially compensate for nature's services, they are unlikely, however, to be sufficient without structural economic changes.[rr] Increasing imports could be viable (albeit a short-term) solution for a country losing critical ecosystem services, with implications for its exchange rate, current account, tax revenue, and employment.

Reduced resilience in nature across multiple locations around the world could, however, reduce resilience for the global economy and financial system—with potential systemic socioeconomic impacts. While nature loss tends to materialize as local impacts, direct and indirect drivers globally could compound.[166] Compounding losses of ecosystem services across multiple regions—a phenomenon taking place at present (IPBES 2019)—could mean the loss of ecosystem resilience, and more systemic loss of economic and financial resilience. This means that economic actors cannot diversify away from nature-related risks, which has significant implications for MoFs.

[rr] This is feature seems to be more pronounced for nature-related risks than for climate-related risks where more no- or low-carbon alternatives exist. Especially in the energy sector, low-carbon technologies could eventually replace high-carbon energy technologies.

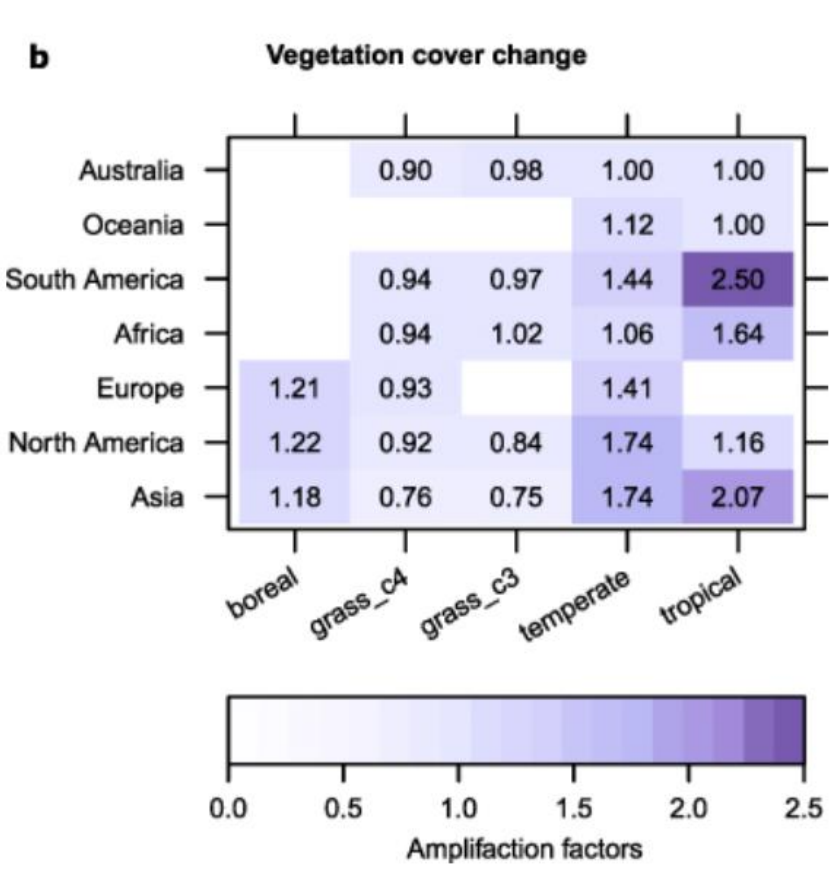
Box 6: The risk of ecosystem collapse

Climate change is not the only source of significant, nonlinear, and potentially irreversible environmental risks facing the global economy. Passing ecological thresholds can trigger abrupt, nonlinear systemic change in the health of entire ecosystems. If goods and services are drawn from an ecosystem in excess of its regenerative rate, it will eventually collapse or undergo a "regime shift," but the state of the ecosystem when it will collapse is not known. Ecosystem productivity declines at an accelerated rate as environmental degradation increases.

The decline of one ecosystem service usually does not occur in isolation. Ecosystem services are interconnected (e.g., erosion control and crop yields).[a] Further, multiple ecosystem services often depend on the same underlying natural asset (e.g., soil quality and water flow maintenance depend on intact habitats such as forests).[a] This means that a collapse of an ecosystem usually implies the decline or disappearance of multiple ecosystem services, which carries potential amplification effects.

The uncertainty and nonlinearity of such irreversibility is demonstrated by changes in the Amazon. Recent analyses of the impacts of continued deforestation in the Amazon suggest that loss of 20 to 25 percent of the remaining biome could trigger its dieback. Ongoing deforestation and degradation also reduces the biome's carbon storage and sequestration potential, reducing greenhouse gas mitigation and increasing systemic risks related to climate change for all countries. Indeed, the Earth system impact of deforesting the Amazon rainforest could amplify the impact of local vegetation cover change by as much as 2.5 times (box 6 figure 1).

Box 6 Figure 1. Vegetation cover change and its Earth system amplification impact



The high potential financial and nonfinancial cost of inaction calls for novel approaches to assessing these risks and for a precautionary approach in managing them. A recent report of the Bank for International Settlements points out that both climate change and nature loss could be behind the next systemic financial crisis or Green Swan. Yet, traditional macroeconomic models and risk assessment techniques used by financial institutions and supervisors, central banks and ministries of finance do not adequately account for such systemic risks because they rely on historic data or assume strong substitutability of human-made and natural capital.

Sources: Lade et al. 2021; Lenton 2013; Dasgupta 2021; Johnson et al. 2021; Lovejoy and Nobre 2019; Lapola et al. 2018; Bolton et al. 2020; Svartzman et al. 2021
Note: Amplification factors capture the extent to which carbon emissions and vegetation cover change are amplified by Earth system interactions into impacts across the Earth system. An amplification factor of 1 means the Earth system interactions modeled here lead to no net amplification of environmental pressures; more than 1 means net amplification; less than 1 means Earth system interactions partially mitigate environmental pressures.

2.4 Managing nature-related risks: Endogeneity, synergies, tradeoffs, and opportunities

Nature-related risks are not inevitable and can be reduced by altering the economy and the financial sector's impact on nature. Whether and to what extent nature-related risks for MoFs will materialize depends on actions to reduce the impact of economic activities on nature[ss] and invest in ecosystem health (bending the curve of nature loss). Such actions include conservation, restoration, and sustainable use of nature (limiting nature-related physical risk). This is a key area where MoFs' responsibility to manage nature-related risks differs substantially from central banks and supervisors, who do not have substantial control over the drivers of nature loss. Additionally, MoFs have a role to play in ensuring a smooth economic transition to a nature-positive economy, including to limit the economy's impact and direct dependency on nature (limiting nature-related transition risk). There may be opportunities to exploit synergies with central banks and supervisors on this (within institutions' respective mandates).

Nature-related risks and materialization differ for countries, depending on biophysical, economic, fiscal, and financial characteristics. The type and extent of ecosystems a country has, as well as their sensitivity man-made pressures and natural shocks (climate and non-climate related), and the degree to which they are connected to ecosystems in other jurisdictions, and how well those ecosystems are managed, all shape a country's exposure to nature-related risks. Furthermore, the structure of the economy (e.g., the degree of dependency of firms on ecosystem services, including via cross-border trade), the financial sector depth (e.g., a deeper and more diversified financial sector might absorb a certain degree of nature-related risks), and a country's fiscal space are important factors that influence the materialization of nature-related risk. Large agricultural commodity-producing countries may face larger (direct) impacts than countries with mostly knowledge-based economies. Likewise, a country with greater fiscal space might better support or compensate monetary losses incurred by households as a result of nature loss.

Every country has a significant degree of control over the materialization of nature-related physical and transition risks, however capacity and resources to address those risks could be constrained. Multiple

[ss] For instance, by reforming subsidies that support nature-depleting business practices, MoFs have a strong lever for reducing impact on biodiversity and ecosystem services.

ecosystems that are critical for global environmental stability and that need urgent protection are located in emerging market and developing economies (EMDE) (e.g., tropical rainforests) or are not under the jurisdiction of any one country (e.g., the oceans), while all countries—including advanced economies—are heavily dependent on their ecosystem services (e.g., climate regulation, evapotranspiration, biodiversity provision, disease regulation). Advanced economies' production and consumption activities are often significant contributors to the deterioration of those ecosystems. This demonstrates the need for global cooperation on governance and financial support for the conservation and restoration of global public good ecosystems like rainforests and the oceans, as all countries depend on them. Countries can also take steps to assess the nature-related impacts of their trade policies.

In order to ensure nature loss doesn't compromise conditions required for continued human flourishing over the long-term, governments and MoFs need to apply strategic policies to smooth intra- and inter-generational trade-offs. Some benefits from nature-positive action might only materialize over time while in the short-term, political costs (e.g., phasing out subsidies could increase food prices) and financial costs accrue. It is important for governments and MoFs to be aware of, and strategically manage, such trade-offs. A whole-of-government approach, including carefully designed fiscal, social, financial, and regulatory nature-related policies, could be taken to reduce short-term costs, while also ensuring that such costs are shared in a just and equitable way.

The nature and climate agendas are largely complementary, with synergies that can be tapped to foster green, resilient, and inclusive development. Nature loss and climate change are interrelated; neither crisis can be successfully resolved unless both are tackled together.[167] An integrated approach is required that could serve as an active risk management strategy. Nature-based solutions—such as investments in restoration of forests or conservation of mangroves to maintain biodiversity and ecosystem services—play an important role in climate change mitigation and adaptation and can help countries reach the targets of the Paris Agreement cost-effectively.[168] Similarly, strategies and investments in land and sea-based climate change mitigation and adaptation can channel funding into activities that could also generate significant improvements in biodiversity and ecosystem services, thus reducing risks stemming from their deterioration. A government-led nature- or climate-only approach is likely to be fiscally inefficient, socially, and environmentally ineffective, and not sufficient to reach national or global climate and nature-related targets.

An integrated climate-nature policy agenda has domestic and international political economy benefits. For example, articulating the full environmental and economic benefits of policy reforms can substantially boost domestic support.[169] The urgency of integrated action is also increasing as both the climate and nature loss crises worsen. For example, observational data from long-term monitoring show that the carbon sink capacity of the remaining undisturbed African and Amazonian tropical rainforest is declining (box 6).[170] Policy action to conserve, restore, and sustainably use ecosystems helps to stem biodiversity loss and drive climate change mitigation and adaptation.

There are also some tradeoffs between nature and climate action. Infrastructure development and material consumption generally have significant impacts on nature. The climate transition requires building new infrastructure, retrofitting old infrastructure, and replacing old inefficient cars and appliances with new more efficient electric alternatives. This will require increased mining of iron ore for steel and rare earth minerals for batteries and electrification. According to the ENCORE database, mining has a "very high" materiality rating in the category of impact on terrestrial ecosystems.[171] Some wind farms have been shown to have a negative impact on migratory birds.[172] Large-scale, intensive bioenergy crop production

approaches are often detrimental to biodiversity and ecosystem services. Negative effects may be on adjacent land or freshwater or marine ecosystems through fertilizer and pesticide use or by increasing agricultural water withdrawals.[173] Yet, such approaches may represent 45 percent of commitments to reforestation under the Bonn Challenge.[174] Biofuels may also compete with food for land area, which could drive agriculture into natural ecosystems.[175] Carbon credit projects, too, may have perverse incentives to deliver significant carbon sequestration outcomes that lead to negative biodiversity and ecosystem services outcomes. Climate strategies should integrate safeguards to minimize the impact of related actions on nature and nature-related risks.

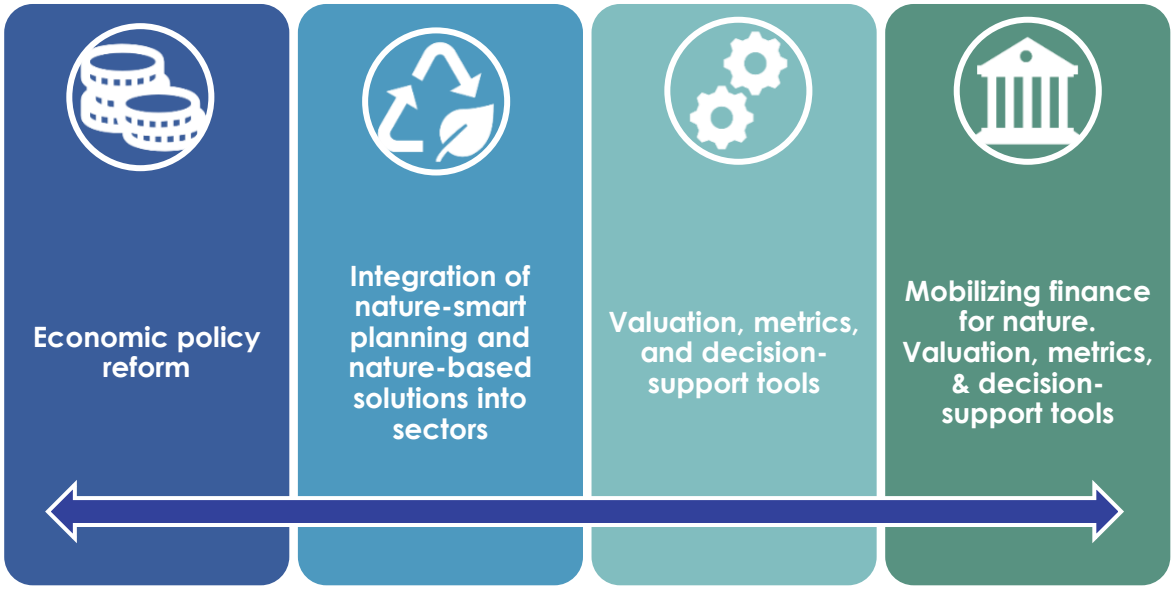
With limited government budgets, it is critically important for governments to ensure their strategies leverage synergies between the nature and climate agendas. Global crises such as COVID-19 led to mounting sovereign debt levels and are causing increased debt distress, especially for EMDEs.[176] At the same time, containing global temperature increases and ensuring healthy ecosystems are necessary for countries' sustainable development. Given those constraints, scarce public financial resources need to be spent effectively. Nature-based solutions, for example, are often more cost effective (especially when integrated with "grey" solutions) than purely grey solutions for mitigating growing climate impacts.[177] They can also be a cost-effective climate mitigation solution.[178] Another lever for MoFs with tight budget constraints is to carefully phase out nature-harming public incentives and subsidies. For example, for the fossil fuel and agriculture sectors, these amount to about $800 billion a year.[179]

The combination of limited government budgets and the high impact and dependency of real sector companies and financial institutions on nature requires stronger private sector involvement in nature-related risk management to reduce the impact of business activity on nature. MoFs can incentivize financial institutions to engage in risk management through implementing policy and regulation that make nature-harming activities less financially attractive. Furthermore, MoFs can create an enabling environment (e.g., supporting the alignment of financial instruments with international principles and standards, setting harmonized disclosure standards) that brings more nature-positive activities into the category of viable investments. Such action could mobilize private sector finance by encouraging investors to green their financial portfolios and finance nature-positive investments, thus reducing the likelihood of nature-related risks to emerge.[180]

The next section will discuss the range of policy actions that MoFs could pursue to mitigate and manage nature-related risks, making use of synergies, and avoiding trade-offs with climate action. We note that roles and responsibilities of MoFs differ by country and not all the approaches suggested are available to all MoFs.

3. Potential Policy Actions for Ministries of Finance

Figure 6. Policy action areas for Ministries of Finance



MoFs play a pivotal role in mitigating and managing nature-related risks. They can use their policy, regulation, planning, and budgeting levers to drive structural economic reform that bends the curve of nature loss by reducing its economic drivers.[tt] Structural economic changes to more sustainable production and consumption practices, accompanied by large-scale ecosystem restoration and connection, are required to address the ongoing crisis.[181] This means adopting a whole-of-economy approach to tackling the drivers of nature loss and accounting for the value of ecosystem services, as well as the future risks associated with their loss, in decisions at all levels in all sectors. MoFs are critical to this effort as they are at the center of economic and fiscal policy making and often oversee the supervision and regulation of banks and other financial institutions.[182] As countries' governance frameworks differ, as do the roles and responsibilities of the MoF, not all approaches discussed will be applicable in all countries. However, it is important that in all countries, MoFs coordinate with relevant ministries on this agenda, as well as with the regulator, supervisor, and the central bank.

[tt] "Bending the curve" refers to reversing the downward-sloping trend in biodiversity indices observed since the 1970s—the declining species abundance over time. This trend is expected to continue unless ambitious and integrated action is taken. Traditional biodiversity conservation interventions such as protected areas and species conservation planning remain crucial, but it is critical that the major drivers of biodiversity loss and ecosystem change are addressed. Bold conservation measures will conflict with other societal demands from land unless a shift toward sustainable food and material production and consumption simultaneously takes place (Mace et al. 2018, IPBES 2019, Leclere et al. 2020).

Efforts must focus on three socioeconomic systems—food, land use, and ocean use; infrastructure and the built environment; and energy and extractives—which drive most of the biodiversity and ecosystem services loss. These systems are not only directly driving nature loss globally, but also stand to lose the most from it. Given that they endanger 80 percent of threatened or near-threatened species, they also hold the key to many of the solutions needed to address the biodiversity and ecosystem services crisis.[183] As the backbone of the global economy, they account for one third of global GDP and two thirds of all jobs.[184] Their output is critical to satisfying the needs and demand of a growing global population. Their approaches to planning, investing, and producing therefore matter not only for the environment, but also for achieving development goals.[185]

Clear policy signals from MoFs underpin domestic policy efforts to promote nature-smart[uu] practices in these sectors that rely on, or have a high impact on, nature and to improve assessment and management of nature-related risks in the financial sector.[vv] Managing systemic and endogenous risks[ww] calls for "market-shaping" interventions, where governments influence the directionality of activities facilitated by the financial system.[186] This is relevant for ongoing COVID-19 economic recovery efforts.[xx] Potential actions for MoFs to manage nature-related risks span four policy response areas that could set economies on more sustainable pathways (figure6. These areas draw on the 2021 World Bank report, "Unlocking Nature-Smart Development: An Approach Paper on Biodiversity and Ecosystem Services."

[uu] Nature-smart, in the context of this report, refers to approaches to policy, investments, and practices that include biodiversity and ecosystem service considerations from the perspectives of mitigating risks arising from the loss of nature and harnessing the economic and social benefits and opportunities that ecosystem services provide.

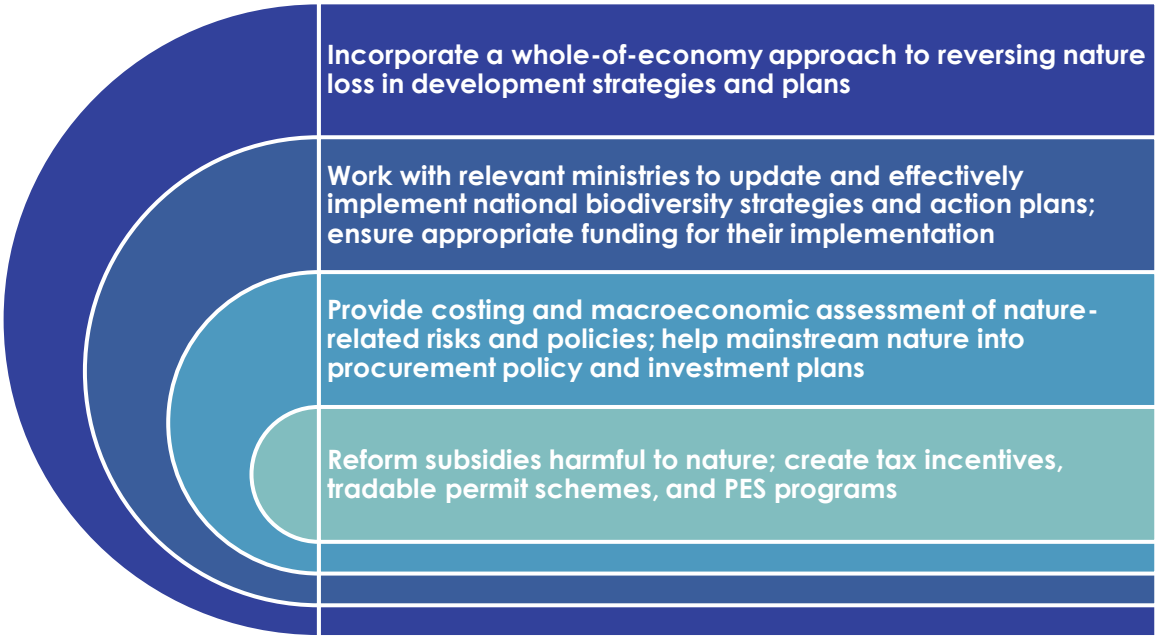
[vv] The World Economic Forum estimates that that together with climate change, three socioeconomic systems—food, land use, and ocean use; infrastructure and the built environment; and energy and extractives—endanger 80 percent of threatened or near-threatened species (WEF 2020).

[ww] Nature-related financial risks may emerge endogenously from within the financial system because financial actors can facilitate environmentally harmful corporate behaviors. Examples of investments and practices that may exacerbate the depletion of nature include investments in agricultural land. Empirical analysis has shown foreign direct investments in agriculture in Latin America and Southeast Asia to have driven cropland expansion linked to deforestation. Failure to achieve capital reallocation away from activities harmful to nature threatens to lock in future environmental impacts (Kedward et al. 2020, Ceddia 2020, Davis et al. 2015, Steinweg et al. 2018).

[xx] A recent analysis of 25 major fiscal recovery programs implemented in response to the COVID-19 pandemic has also shown that these programs are more "brown" than "green" and are likely not doing enough to decouple economic growth from fossil fuel use and natural capital degradation (Hepburn et al. 2020).

3.1 Reforming economic policy

Figure 7. Key economic policy reform actions for Ministries of Finance



As nature loss threatens sustainable development and economic prosperity, countries should integrate nature considerations, along with climate change considerations, in their economic policy and planning (figure 7). Environmental policy and commitments often remain siloed from national development policies and economic strategies, and their implementation is often led by a single ministry with minimal support from other parts of the government, despite the systemic risks and the multisectoral drivers of nature loss. Different layers of responsibility across national and subnational government agencies for land ownership and management of ecosystem services also impede effective action to tackle such issues as pervasive deforestation. Addressing such governance failures could substantially improve implementation and enforcement of nature-smart policies.

Development strategies and national plans need to articulate a whole-of-economy approach to addressing the drivers of nature loss.[187] The National Biodiversity Strategies and Action Plans (NBSAPs),[yy] which will be updated following the adoption of the ambitious post-2020 global biodiversity framework, and the Nationally Determined Contributions (NDCs) under the Paris Agreement offer an opportunity to lay out national strategies, plans, or programs for conservation and sustainable use of nature across different economic sectors. Few countries currently report on NDC alignment with biodiversity targets, despite the extensive synergies and some potential tradeoffs between nature-related and climate change interventions. There is also scope for greater inclusion of nature-dependent sector transitions in NDCs.

[yy] NBSAPs are national strategies, plans, or programs for conservation and sustainable use of biodiversity and ecosystem services, are the primary implementation mechanism for the Convention of Biological Diversity.

While MoFs are typically not the primary agency overseeing NBSAPs and NDCs at the country level, their involvement in the development and implementation of these policy instruments alongside ministries of environment is vital to ensure a whole-of-economy response and adequate (sufficient and predictable) financing. Moreover, the involvement of MoFs can foster better understanding of the links between biodiversity and ecosystem services and economic objectives and foster an enabling environment. MoFs can provide reliable costing and macroeconomic assessments of nature and climate change-related interventions and their feasibility within macro-fiscal constraints. MoFs can also facilitate mainstreaming of NBSAPs and NDCs into procurement policy, investment plans, and fiscal policy.

Another key action area for MoFs is addressing market and governance failures that facilitate unsustainable production and consumption practices. Markets generally do not capture the economic value of ecosystem services that accrues to the broader economy.[188] These services also tend to be free and accessible to all, and traceability gaps and information asymmetries make it difficult for consumers to make informed decisions about products and services and for actors pursuing sustainable practices to communicate their value. Although not all ecosystem services can be priced, there is scope for bringing the economic value of many ecosystem services into markets and thus aligning the social and private benefits of decisions affecting natural ecosystems.

Fiscal instruments, such as environmental taxes, and subsidies that MoFs administer, can incentivize a change in practices (both on the demand and supply side), by raising the cost of doing business as usual (in line with the "polluter pays" principle) or lowering the cost of the transition to more sustainable practices and making sustainable products more competitive for consumers. Other potential incentives include charges, tradeable permits,[zz] bans and quotas, PES programs, and ecological fiscal transfers. Tradable permit schemes (also referred to as cap-and-trade programs) can help governments limit pollution or resource use in line with the biological limits of an ecosystem and can mobilize private funding for conservation and restoration activities.[189] For example, in Chile, an amendment to the Fisheries Law in 2013 required the auction of 15 percent of the total allowable catch of fisheries. Revenues from such auctions could also be earmarked for conservation and restoration activities.[190] Ecological fiscal transfers allow intergovernmental budget transfers and revenue-sharing schemes to be harnessed to combine welfare and environmental objectives. While in many countries, the power to carry out environmental fiscal reform lies with parliaments, MoFs can play a role in laying out potential options and the fiscal and economic benefits of such reform.

Environmental fiscal reform presents an opportunity to not only align economic activity with sustainable development goals, but also generate growth. Governments spend at least $800 billion annually on support to agricultural producers, including through subsidies, and fossil fuels, which is potentially harmful to biodiversity, spending five to six times more than is spent globally for biodiversity conservation and its sustainable use.[191] Other global estimates suggest that some support to agricultural producers is biased toward measures that are inefficient, unequally distributed, and harmful for human health and the environment.[192] If the total cost is considered—the subsidy amount plus the associated negative externalities—global subsidies for energy, agriculture, water, and fisheries are conservatively estimated at $4 trillion to $6 trillion annually, or approximately 5 percent to 7 percent of global GDP.[193] Reform of such subsidies and other economic support is one of the key levers at the disposal of economic decisionmakers

[zz] Tradeable permits set a limit on total amount of a natural resource that can be exploited, and then allocate individual (tradeable) permits to users. The allocation of these permits can be grandfathered—allocated to existing users of the resource free of charge—or auctioned. Source: OECD 2021a.

for correcting the market and policy failures that facilitate nature loss and economic inefficiencies.[aaa] Similarly, introduction of well-designed environmental taxes (such as a tax on pollution or resource withdrawals) increases the price of a good or activity to reflect the cost of the environmental harm that it imposes on others, or at least moves the market price in that direction. The cost of the harm to others, which was external to markets, is then at least partially internalized into market prices. Empirical studies suggests that such economic instruments are underutilized; and where they exist, they tend to be too low. Nature-relevant tax revenues amount to only 0.9 percent of the revenue generated from all environmentally relevant taxes in OECD countries, which accounts for just 5.1 percent of total tax revenue.[194] Conversely, tax incentives such as property tax exemptions for conservation easements can promote environmental "goods."[195] Not all MoFs are empowered to carry out environmental fiscal reform, however, all MoFs can support this effort through assessing and raising awareness across government of the nature-related risks associated with harmful subsidies, offering recommendations on phasing out of these subsidies, and supporting the integration of the value of nature in decision-making.

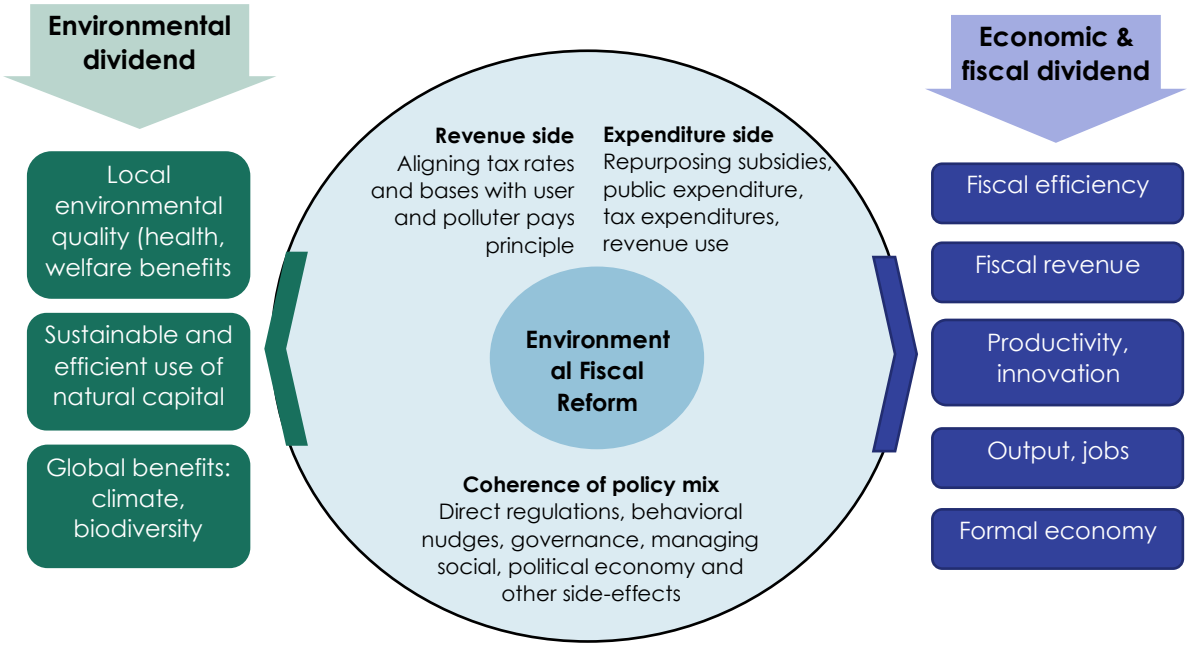
A first-of-its kind global integrated ecosystem–economy modeling exercise illustrates the potential "win-win" effect of nature-smart policies both on the global economy and biodiversity between now and 2030.[196] Combinations of policies, such as decoupling subsidies to farmers, global and local forest carbon payment schemes and public investment in research and development,[bbb] can avoid up to 50 percent of natural land conversion and increase global real GDP in 2030 by $50 billion to $150 billion. The environmental and economic and fiscal dividend can be even broader if interventions extend beyond biodiversity and ecosystem services, representing opportunities for a wide range of "win-win" policy interventions for MoFs (figure 8).

Still, measures to ensure an inclusive and equitable transition, and thus address political economy challenges between and within countries, are key to the success of such reform initiatives. Integrated ecosystem-economic modeling[197] found that none of the policy reform scenarios analyzed resulted in improved conditions for landowners and laborers in most countries. Moreover, despite net global GDP gains, a small number of countries in the policy scenarios analyzed experienced a decline in real income, thus requiring compensation, which could be achieved, for example, through ecological fiscal transfers from the Global North to the Global South. This scenario illustrates possible concerns of developing countries, whose action is critical to conserve globally significant ecosystems and curtail the global decline in biodiversity, but which may experience trade-offs. With regard to political economy within countries, empirical evidence reveals that concerns over potential impacts on competitiveness or distributional effects and the influence of vested interests or the political and social acceptability of reform may undermine efforts to implement environmental fiscal reform. There is scarce empirical evidence suggesting that environmental regulation reduces competitiveness and social equity outcomes, if it is implemented as an integrated policy solution, in a targeted and non-distorting way.[198]

[aaa] Environmental fiscal reform can address inefficiencies by reforming or repurposing incentives that favor environmentally unsustainable investments and production practices that overexploit and degrade natural capital. Reform may start with reforming environmentally harmful subsidies and shift the tax burden from economic goods, such as income and labor, to health and environmental bads. This redirects capital flows to modern, the green assets, aligns incentives between environmental, economic, and fiscal policies, and lower burdens on the poor—making the green transition just, inclusive, and socially acceptable.

[bbb] The policies analyzed (individually and in combination) are (i) the provision of decoupled support to farmers (by substituting agricultural subsidies linked to production with lump sum transfers to landowners); (ii) the establishment of domestic forest carbon payment schemes (compensating to landowners via increases in land subsidies); (iii) the establishment of a global forest carbon payment scheme (via a global pool approach); (iv) increase in public spending on agricultural R&D (Johnson et al (2021)).

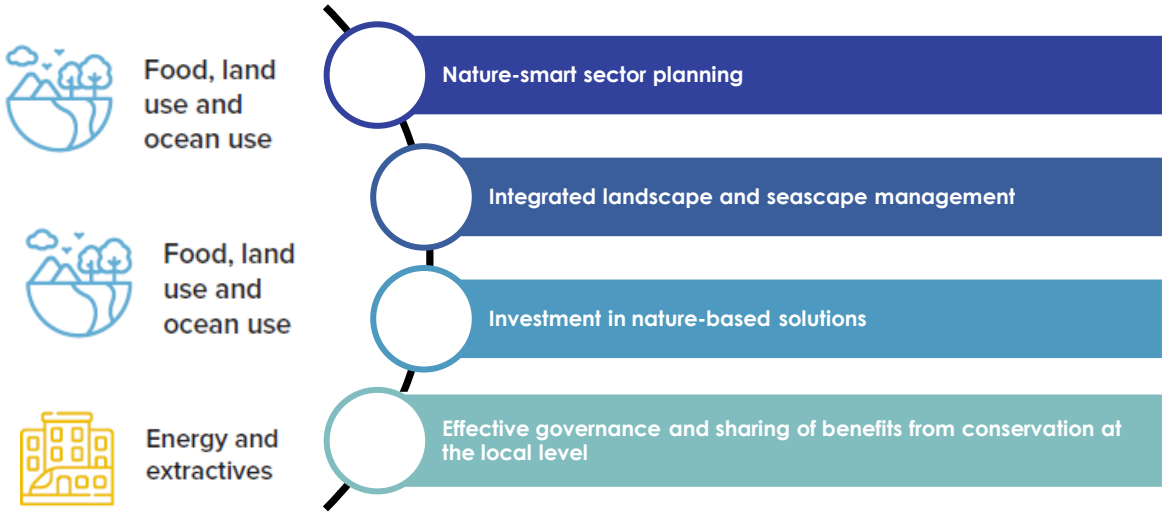
Figure 8. Environmental fiscal reform and its potential double dividend



Source: World Bank.
Note: "Direct regulations" refers to bans, technology standards, performance standards and other 'command-and-control' policies, which are legally binding instruments that directly prescribe the type or environmental performance of technologies, fuels or equipment that can be used by economic actors. "Behavioral budges," a term popularized by Thaler and Sunstein (2008), refers to softer policies that trigger behavioral change in groups and individuals through positive reinforcement.

3.2 Integrating nature-smart planning and nature-based solutions

Figure 9. Key actions for Ministries of Finance to support for better integration of nature-related risks and opportunities into sectors driving nature loss



Source: Adapted from World Bank (2021c).

Nature-smart planning and integrated landscape management approaches

In addition to nature-smart economic incentives, MoFs play a role in nature-smart[ccc] spatial planning in sectors with the greatest environmental footprint (figure 9). Nature-smart planning is used to balance economic, social, and environmental tradeoffs by developing a long-term vision and framework for different actors that consider multiple scales, competing demands, and resource-allocation decisions.[199] Such actions cannot be implemented by ministries of environment alone. Their effectiveness hinges on broad engagement from the central government, the private sector, subnational agencies, and communities on the ground and thus need to be incorporated into upstream sector strategies, planning, and investments. With infrastructure, for example, national and subnational infrastructure planning and investments need to be informed by spatially explicit biodiversity and ecosystem services data and by economic analysis to highlight the tradeoffs in land use decisions and reduce the loss of critical ecosystem services. Once the sector practices that are incompatible with any trajectory towards reversing rapid nature loss are identified, upstream planning can be used to reduce their negative footprint. Strong participation from MoFs can greatly accelerate sector transitions. MoFs can help ensure adequate financing for their implementation and remove barriers to investment in nature-based solutions or more sustainable business practices, an area in which sustainable investment taxonomies (or other approaches to identifying nature-aligned

[ccc] "Nature-smart" in this context refers to fully incorporating nature-related risks and opportunities into planning decisions.

investments) may play a critical role (more about this in section 3.4). This could be complemented with sector-specific sustainability standards,[ddd] and expanded technical and financial assistance for their implementation. Circular economy analysis, policies, or roadmaps can also play a role in such planning.[200]

A key challenge moving forward is to scale up conservation and restoration efforts outside the core protected areas. Area-based conservation remains the foundation for protecting biodiversity and maintaining ecosystem services.[201] The proportion of the planet's ecosystems under protection increased over the last decade to about 15 percent of terrestrial and 7.5 percent of marine areas designated as protected as of August 2020.[eee] But a far greater area under protection is needed to address biodiversity and ecosystem services loss.[202] Echoing this, one of the proposed goals of the draft post-2020 global biodiversity framework is to expand measures to "at least 30 percent of land and sea areas, with at least 10 percent under strict protection" by 2030.[203] More than 90 countries have committed to this goal so far.[204] While expanding protected areas is crucial, governments need to ensure sufficient funding for monitoring and management.[205] While administrative boundaries (national and subnational) play a role in conservation and restoration planning, it is important that governments also take a bioregional approach to such planning to ensure an efficient and effective implementation.[fff]

To reach such a target, countries will also need to scale up investments in sustainable management of productive landscapes and seascapes. Ministries of finance could support their uptake by the private sector is to encourage integration of nature into strategic sector planning and investments, including in identification of priority areas for conservation and restoration.[ggg] Several countries have piloted such approaches, including Seychelles, which developed a national coastal management plan in 2019. The plan identifies priority areas for coral reef management and rehabilitation.[206] Such integrated planning approaches in turn pave the way for investment in nature-based solutions that harness ecosystem services. In Seychelles, the government identified a portfolio of potential investments in coastal protection infrastructure such as coral reef and dune restoration, and creation of "blue barriers"[hhh], and accompanying monitoring and capacity building for implementation from 2019 to 2024.[207]

Effective local governance and benefit sharing

Mainstreaming nature into system practices hinges on its ability to generate local development benefits and share them equitably. Where local development benefits are insufficient, local conservation incentives—such as ecological compensation mechanisms, payment for ecosystem services—are needed to encourage sustainable practices.

[ddd] Alignment across international standards could help to avoid fragmentation.

[eee] The advances were made in accordance with CBD Aichi Target 11, which sought to protect at least 17 percent of terrestrial and inland water and 10 percent of coastal and marine areas by 2020 through protected areas and other area-based conservation measures (CBD Secretariat 2020).

[fff] One Earth presents a novel biogeographical framework called *Bioregions 2020*, which builds upon 844 terrestrial ecoregion divisions (Dinerstein et al. 2017) to delineate 185 discrete bioregions organized within the world's major biogeographical realms (One Earth 2020).

[ggg] Some countries may not yet have the data needed to conduct analysis needed to identify priorities. If this is the case, data collection must be a first step.

[hhh] Reef structures enhanced with coral restoration—can simultaneously provide coastal resilience, support the recovery of corals and marine biodiversity, and contribute to tourism and regenerate fish stocks (Jongman et al. 2021)

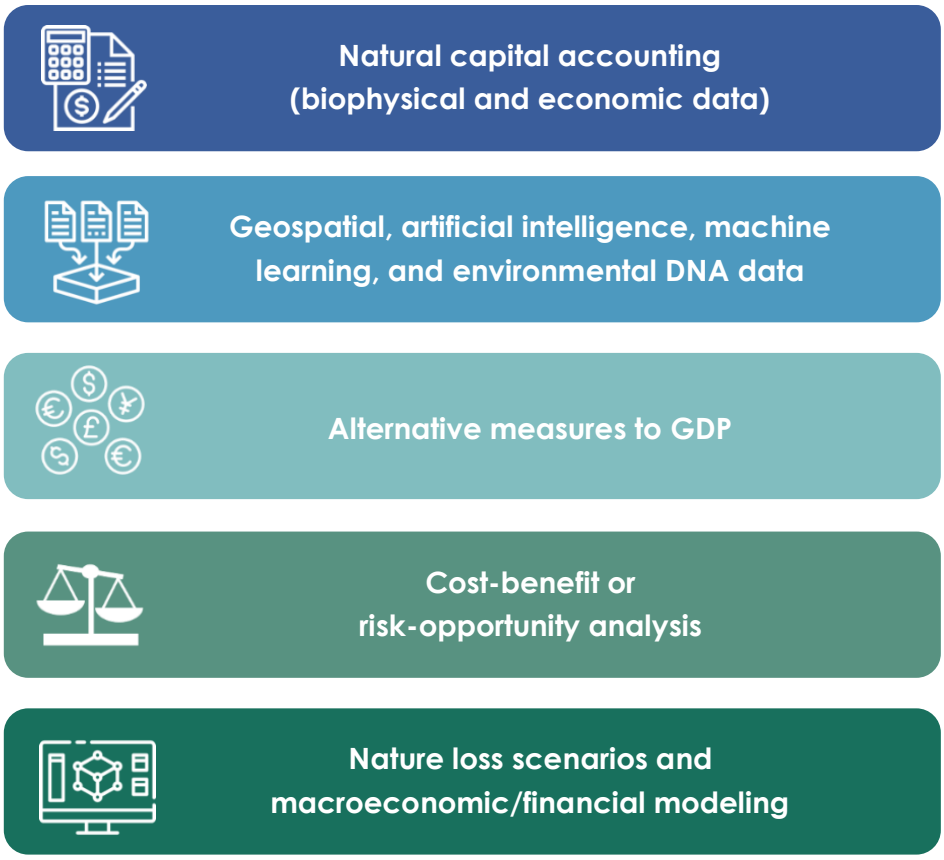
MoFs have a role in establishing and financing area-based conservation and strengthening local income multipliers of conservation. For protected areas and their buffer zones, as well as mixed landscapes combining conservation and productive land uses, this requires increasing public investment in management, and introducing fiscal incentives (such as repurposing subsidies), regulation and enforcement (a functioning cadaster), and removing financial barriers (providing a dedicated credit lines) for sustainable practices in sectors such as agriculture that operate in the vicinity of protected areas or are part of a mixed landscape. If the areas under conservation attract visitors, there are often opportunities to support the relevant line ministries in growing and diversifying the sustainable tourism business, improving concession policies, and supporting the diversification of tourism offerings.

Local communities can be assisted to participate in the tourism economy through entrepreneurship training, skill development, credit services, and logistics. Local procurement can strengthen linkages in local economies, prevent leakage and increase multipliers.[208] Developing functioning markets for environmental services is also critical for protected areas and other area-based conservation. Mitigating banking and biodiversity offsets also have the potential to direct private finance toward investment opportunities that would otherwise remain underfinanced. But the application of such mechanisms needs to become more systematic while adhering to the risk mitigation hierarchy.[iii] MoFs can facilitate the creation of markets for environmental services and other market-based instruments, while ensuring they do not become subject to greenwashing.

[iii] The mitigation hierarchy is a tool that guides users toward limiting the negative impacts on biodiversity from development projects. It consists of four sequential steps that must be taken throughout the project's life cycle to limit any negative impact on biodiversity: (i) anticipate and avoid risks and impacts; (ii) where avoidance is not possible, minimize or reduce risks and impacts to acceptable levels; (iii) once risks and impacts have been minimized or reduced, mitigate; and (iv) where significant residual impacts remain, compensate for or offset them, where technically and financially feasible. (World Bank 2016). This means that biodiversity offsets should be used as a last resort when other options to minimize impacts have been exhausted.

3.3 Valuation, metrics, and decision support tools

Figure 10. Key actions for Ministries of Finance to support the development and implementation of valuation, metrics, and decision support tools



Valuation

MoFs (together with other relevant Ministries and agencies) can support the implementation of national and subnational natural capital accounting (NCA) practices and ensure this information is integrated into national accounts so that it is considered in budgeting, policy, and planning alongside other economic information to ensure effective 'asset management' of all forms of a nation's capital.[209] Implementing or supporting the development of NCA, using the United Nations System of Environmental and Economic Accounts (SEEA) framework,[jjj] can provide MoFs with a more complete view of their country's public assets and support strategic management that maximizes nature's contribution to sustainable economic growth, while balancing tradeoffs between ecotourism, agriculture, subsistence livelihoods, and other ecosystem services, like flood protection and groundwater recharge. NCA can enable MoFs to mainstream natural

[jjj] SEEA was officially adopted by the UN Statistical Commission in March 2021. At least 90 countries have implemented the SEEA (UN SEEA 2022).

capital into development planning (Wealth Accounting and the Valuation of Ecosystem Services (WAVES) Partnership), national accounts (as the United Kingdom has done[210]), and the regulatory process (as the United States has committed to do[211]). For the ocean economy, natural capital accounts can draw attention to conservation, restoration, or sustainable use investment opportunities that might not otherwise be apparent. Governments can ensure that national data are accessible to the public and in a usable format, particularly for subnational governments and the private sector to consider in their planning, operations, and decision-making, but also for citizens who play a crucial role in ensuring good environmental quality in their communities. MoFs, statistics offices, ministries of environment, and central banks might jointly develop a national data hub that provides NCA data in a usable format for financial institutions who need to use this information to better understand and manage their nature-related risk exposure and risk management opportunities. Spatial NCA data that can be disaggregated is crucial to enabling such application. MoFs can also encourage the uptake of subnational and corporate NCA and offer training and access to tools to entities interested in using national NCA data or developing their own accounts.

While NCA data can support more efficient and effective policy and planning, governments should interpret this information in context and not pursue action that compromises the function of the extremely complex relations, processes, and biodiversity that underpins these ecosystem services. Both biophysical and economic NCA data offer simplified measures of complex and dynamic systems that science is continuously learning new information about.[kkk] Economic data, in particular, should be calculated and used carefully. As discussed in the introduction, accounting prices for natural capital can only capture a very limited portion of the value of nature.[lll] Developing economic valuations of ecosystem services requires a range of assumptions to estimate market value,[mmm] revealed value, or stated preferences for services.[212] Granular data, local knowledge, and welfare estimates can complement NCA data to provide governments a more holistic view of the health and value of ecosystem services to better inform management.[nnn] Governments may find cost-benefit or risk-opportunity analysis[213] a useful complement to NCA as they may provide a more holistic view of potential trade-offs and risks that the NCA may omit. It is important that governments engage with and include indigenous peoples and local communities in decision-making related to ecosystem management and consider that these groups' use and understanding of nature may conflict with a data-heavy approach. This is critical, as these groups are often very effective stewards of ecosystems and should have a central role in decision-making related to the ecosystems they depend on.[ooo]

MoFs might consider using alternative measures to GDP to drive policy making and planning, as many environmentally destructive activities contribute positively to GDP,[ppp] and its use can create perverse incentives. Alternatives include Bhutan's Gross National Happiness (GNH) Index,[qqq] OECD's Better Life

[kkk] *Seeing Like a State* details the potential consequences of states simplifying 'aspects of an otherwise far more complex and unwieldy reality' in order to achieve utilitarian goals (Scott 1998).

[lll] The Dasgupta Review identifies six sources of biodiversity's value: human existence value, human health value, amenity value (source of enjoyment), use value (through enabling the provision of ecosystem services), existence value (the existence of the Silverback Gorilla), and intrinsic value. Economists generally focus on amenity value and use value.

[mmm] Using direct market value or cost-based methods.

[nnn] Including knowledge from indigenous peoples and local communities.

[ooo] A recently published study found that rates of native vegetation loss between 2005 and 2012 were 17 times lower in Indigenous territories than in unprotected areas of the Brazilian Amazon (Alves-Pinto et. al. 2022).

[ppp] Including activities that cause significant local or global environmental damages such as mining or the burning of fossil fuels, the cleanup of water pollution, or disposal of waste as the consequence of unsustainable production and consumption practices.

[qqq] Bhutan started to measure factors including psychological health, living standards, community vitality as well as environmental and cultural resilience and this index is used in policymaking.

Index,[rrr] IUCN's Gross Ecosystem Product,[sss] the Genuine Progress Indicator,[ttt] the Sustainable Development Index,[uuu] and Italy's Equitable and Sustainable Well-Being Indicators.[vvv] New Zealand's Well Being Budget also offers an example of how setting different metrics for a government budget can drive environmental sustainability in public spending.[www] The UN is currently developing a narrative and recommendations for a set of metrics to measure progress beyond GDP to be presented at the "Summit for the Future" in September 2023.

Governments, including their MoFs, can take steps to implement new measures of biodiversity that balance both the ecological and social value dimensions. By identifying synergies and tradeoffs for sustainable development, the new Multidimensional Biodiversity Index (MBI) is designed to be a policy-relevant indicator that could be considered alongside GDP.[214] To identify priority landscapes for investment, MoFs can also use the International Union for Conservation of Nature (IUCN) Species Threat Abatement and Recovery Metric (STAR), which measures the contribution of investments to reducing species extinction risk.

Metrics

Technology is advancing that provides data on nature, particularly through measuring biodiversity and ecosystem health. Geospatial, artificial intelligence, and machine learning technology are all being used to better track the impact of economic activity on biodiversity and ecosystem health. With improving satellite technology and falling costs, images of life on Earth are of a higher resolution, more frequently available, more accessible, and less expensive than ever. Environmental DNA (eDNA) technology is also becoming less expensive and more accessible,[xxx] and eDNA analysis can be used to complement traditional survey methods. This makes it particularly useful for aquatic species or species living near bodies of water. Among its multiple potential applications are improving the understanding ecological conditions across a landscape, confirming the presence of rare species, or demonstrating the effectiveness of conservation measures.[yyy] MoFs can use this technology to improve monitoring of the health of their countries' natural capital, and provide this information in a format that enables decision-making in the private sector. This biophysical

[rrr] The BLI compares well-being across countries, based on 11 topics the OECD has identified as essential in the areas of material living conditions and quality of life.

[sss] Gross Ecosystem Product (GEP) provides specific indicators to measure the total economic value of all ecosystem products and services. GEP is the total value of final ecosystem goods and services supplied to human well-being in a region annually and can be measured in terms of biophysical value and monetary value.

[ttt] The GPI takes into account more than 20 aspects of citizens' economic lives that GDP ignores, including estimates of the economic contribution of numerous social and environmental factors. It also differentiates between economic transactions that add to well-being and those that diminish it. The GPI then integrates these factors into a composite measure so that the benefits of economic activity can be weighed against the costs.

[uuu] The SDI measures the ecological efficiency of human development, recognizing that development must be achieved within planetary boundaries. It was created to update the Human Development Index for the ecological realities of the Anthropocene.

[vvv] 152 indicators cover the following domains: health; education and training; work and life balance; economic well-being; safety; environment; innovation, research, and creativity; and quality of services (Italian Institute of National Statistics. 2021).

[www] All new spending must advance one of five government priorities: improving mental health, reducing child poverty, addressing the inequalities faced by indigenous Maori and Pacific Island people, thriving in a digital age, and transitioning to a low-emission, sustainable economy.

[xxx] eDNA is organismal DNA that can be found in the environment that originates from cellular material shed by organisms (skin, excrement, and so on) into aquatic or terrestrial environments that can be sampled and monitored using new molecular methods (U.S. Geological Survey n.d.b).

[yyy] A global group of eDNA experts recently published a *Practical Guide to DNA-based Methods for Biodiversity Assessment* (Bruce et al. 2021).

information can be used on its own, or to inform the development of economic or welfare data on natural capital. MoFs and central banks might together develop training for financial institutions to leverage such metrics to boost their capacity to assess and manage nature-related risks.

Decision support tools

Macroeconomic and financial modeling could give MoFs information on the fiscal implications of nature loss and enable evaluation of potential tradeoffs and complementarities of different nature-related policy instruments. Academic nature-related research is progressing, and methodologies are being developed to assess economic impacts from nature loss.[215] More central banks are conducting nature risk exposure assessments as financial institutions can use an integrated risk and opportunity framework to structure their nature-positive transition strategy.[216]

The characteristics of nature and biodiversity dynamics and the prevailing data gaps[217] still pose modeling challenges that require further research.[218] Nature dynamics are complex, nonlinear, at times unpredictable, and frequently irreversible.[219] This poses challenges to the current generation of methodologies and tools, and more generally to the quantification of nature-related risks. Notwithstanding the need for a precautionary policy approach to managing these risks,[220] the following non-exhaustive list of avenues for further research could overcome some of the data and modeling challenges:

- There is a need for comprehensive sets of severe, but plausible, nature loss scenarios. Such scenarios are country or region specific and would need to take biophysical interactions, such as climate change and ecosystem services loss, into consideration.[zzz] A potential avenue in this direction could be a "nexus approach," which can cover interlinkages of water-, energy-, and land-related issues.[221]
- A better understanding is needed of how adverse nature scenarios might impact the economy and financial sector, considering cascading and potential amplification effects. In this regard, the multidimensionality of ecosystems makes it difficult to aggregate them under a commensurable common unit of measurement, posing questions of suitable entry points for macroeconomic models.[222]
- Scenario and transmission channels should feed into models to assess the macroeconomic and financial impact of nature loss. Models might need to be adapted to account for the limited ability to substitute essential services provided by nature with human-made capital. Such developments would allow a better assessment of nature-related risks for MoFs to inform effective policy design.

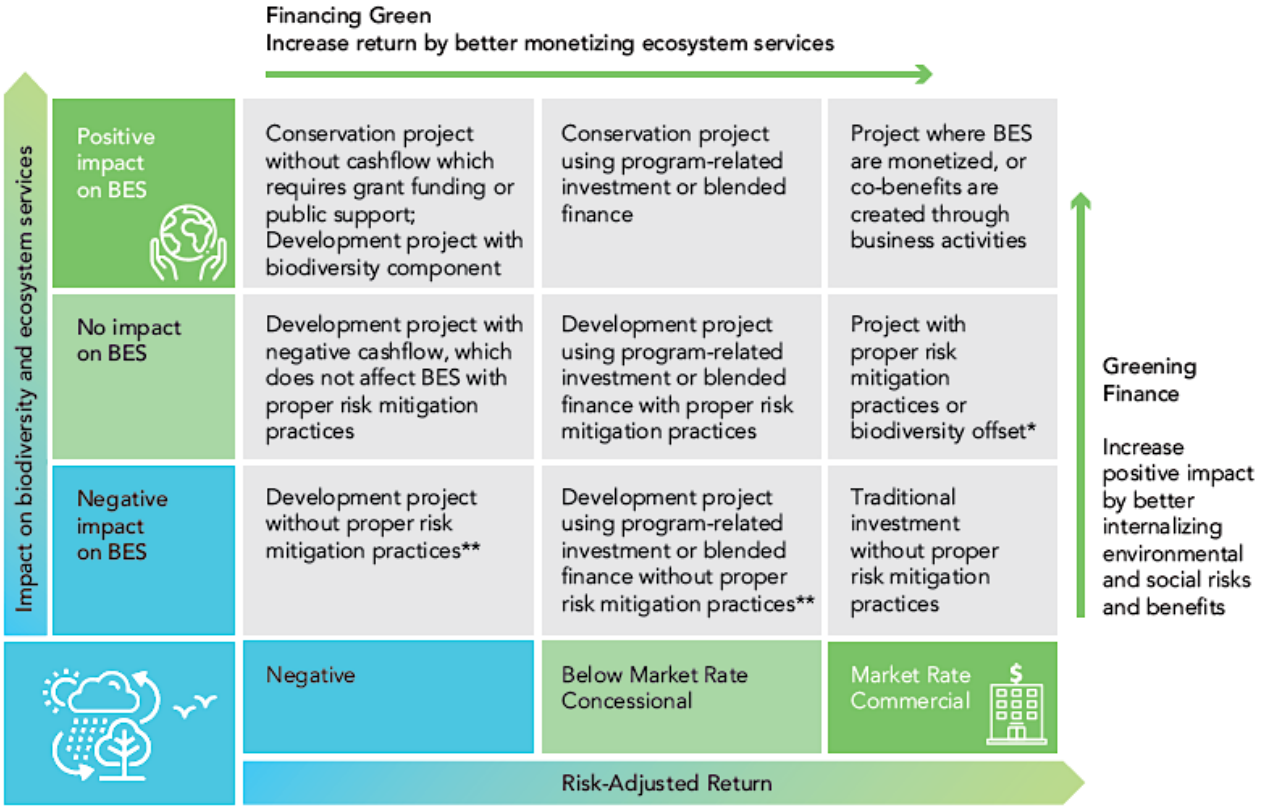
3.4 Mobilizing finance for nature

Managing nature-related risks will require a mix of public and private investment, as well as improved risk management practices in the public and private sectors, to reduce the impact of economic activity on

[zzz] In its statement on nature-related financial risks, the NGFS stated its intention to develop such scenarios that could be used to assess financial sector risk.

nature. MoFs can pursue a dual approach to mobilizing finance for nature:[aaaa] "greening finance"[bbbb] and "financing green"[cccc] (figure 10).[223,dddd]

Figure 61. The two dimensions of mobilizing private sector finance for Biodiversity and Ecosystem Services



Source: World Bank 2020.
Note: The figure assumes that projects comply with national environmental regulations. Standards refer to International Finance Corporation (IFC) performance standards or other widely accepted market standards.

[aaaa] As part of an integrated approach to mobilizing private finance for sustainable development more broadly.
[bbbb] Greening Finance refers to directing financial flows away from projects with negative impacts on biodiversity and ecosystems to projects that mitigate negative impact and/or pursue positive environmental impacts as co-benefits.
[cccc] Financing green refers to increasing financial flows to projects that contribute—or intend to contribute—to the conservation, sustainable use, and restoration of biodiversity and ecosystems and their services to people.
[dddd] Italy is currently developing a Sustainable Finance Action Plan, which is pursuing a dual approach entailing both "greening finance" and "financing green."

Greening Finance

Figure 12. Key actions for Ministries of Finance to green their financial sectors to manage nature-related risks

Source: World Bank.

Targeted policy, regulation, and guidance can ensure systematic integration of nature risk and opportunities in financial decisions and align financial flows with the forthcoming targets of the Post-2020 Global Biodiversity Framework. Working with central banks, financial regulators, and supervisors, MoFs can take action in the following areas:[224,eeee]

- Identify nature-aligned investments through developing and implementing sustainable investment taxonomies, labels, principles, or other approaches informed by science.[225] These approaches should identify activities that are harmful to nature and should not be financed (possibly with a plan to phase them out over time) and activities that are aligned with nature-related goals (as in the EU Taxonomy).[226] These frameworks should be aligned with international standards, principles, and best practices. Interoperability and usability should be prioritized. Approaches to identify nature-aligned investments can promote the standardization of nature-related metrics for reporting and enable the aggregation of projects.[227,ffff]
- Develop an integrated climate-nature financial sector policy framework[gggg] or strategy, such as a sustainable finance roadmap, that includes the implementation of precautionary policy that identifies exceptionally harmful business activities contributing to high levels of nature-related risk (such as deforestation) and directs relevant authorities to phase out financing of these activities. The strategy can redirect the economy to reduce the drivers of nature loss over time.
- Implement relevant financial regulation, supervision, and risk assessment measures to ensure that macro-financial stability monitoring and stress testing include nature-related risks, and that nature-

[eeee] The World Bank's *Toolkits for Policymakers to Green the Financial System* has toolkits covering several of these action areas (World Bank 2021d).
[ffff] Taxonomies can also serve as an overall sustainable finance strategy.
[gggg] That also considers broader social goals.

related criteria are incorporated into risk assessments of financial institutions and the financial sector more broadly.[hhhh]

- Report on sovereign climate and nature-related risks and opportunities to and how the government is managing them to sovereign lenders.[iiii,228]
- Promote or require nature-related information disclosure in financial markets (box 8) and inclusion of nature-related criteria in corporate accounting.[jjjj]
- Promote or require financial institutions publish nature transition alignment plans and report on progress towards achieving key milestones.
- Promote long-term investing that takes a more holistic view of risk, possibly through adjusting fiduciary duty policy and regulation.
- Participate in international networks[kkkk] to facilitate knowledge exchange and standardization or interoperability of new approaches to green the financial markets.

MoFs vary in their responsibilities, so the measures taken in these areas will vary accordingly. MoFs should coordinate with their colleagues in environment and other relevant ministries to ensure that all measures are based on the best available science. MoFs can also help to encourage market-based measures such as real-sector corporate and financial institution commitments to become "nature positive" and corporate commitments to only purchase commodities that meet environmental rigorous standards and certification. The Science-Based Targets for Nature (SBTN) aim to guide companies to align their business practices with ecosystem capacities.[229] The Taskforce for Nature-based Financial Disclosures (TNFD) will also recommend how firms should address nature-related risks in their governance, strategy, risk management, and metrics and targets. The ENCORE tool can assess financial sector exposure to the range of ecosystem services (through dependency and impact).

MoFs should implement these policies and regulations while also considering the political economy of the financial sector. As many financial institutions act globally, and they often coordinate their political advocacy (including through industry bodies), there is potential for the industry to influence policymakers and regulators in many jurisdictions to prevent or water down the implementation of the recommended actions if they are seen as curbing profits. With awareness of the potential influence of the financial sector over policy and regulation globally, MoFs could address such political economy issues by developing clear communication and capacity building strategies alongside the implementation of policies, to prepare the financial sector and build support among stakeholders. While such policies will reduce financial stability risk, which financial institutions should be seeking to manage,[llll] it is the role of MoFs to take policy and regulatory

[hhhh] While central banks in the Netherlands, France, Brazil, and Malaysia have conducted nature risk exposure assessments, none have done a risk analysis or have developed scenarios to do so. This step would thus require the assistance of further decision support tools (World Bank 2022a).

[iiii] This reporting can also help governments identify opportunities to issue green-labeled bonds or sustainability-linked bonds.

[jjjj] The Partnership for Biodiversity Accounting Financials (PBAF) has developed a PBAF standard that enables financial institutions to assess and disclose impact and dependencies on biodiversity of loans and investments.

[kkkk] Such as the Coalition of Finance Ministers for Climate Action, the Sustainable Banking Network, the G20 Sustainable Finance Study Group, and the International Platform on Sustainable Finance

[llll] But are not always incentivized to do so because of moral hazard, tragedy of the horizon and other issues (see the 2007-2008 financial crisis).

action to address both financial stability risk and broader economic and fiscal risk associated with nature loss. Policy and regulation to address the latter is likely to face more opposition than for the former.

Box 7: Nature-related disclosure developments

Following the global push for companies to disclose their climate-related risks and opportunities, momentum recently has been building behind the nature disclosure agenda. As the Task Force on Climate-related Financial Disclosures (TCFD) four pillars framework has become the most used framework globally for corporations and other organizations' disclosure on climate criteria, a Taskforce on Nature-related Financial Disclosures (TNFD) was formally launched in June 2021 with the mandate to build a similar framework for nature. The mission of TNFD is "to develop and deliver a risk management and disclosure framework for organizations to report and act on evolving nature-related risks, which aims to support a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes." The G7 finance ministers have endorsed the TNFD, and the G20 Sustainable Finance Roadmap encouraged TNFD to further understanding of nature-related metrics.

The TNFD will go through five phases of work from 2021 to 2023: build, test, consult, disseminate, and uptake, stating, "The TNFD will not create a new disclosure standard, but rather establish and promote the adoption of an integrated risk management and disclosure framework that aggregates the best tools and materials." A beta version of the framework was released in March 2022 and is currently being piloted. Meanwhile, a range of stakeholders are providing feedback. TNFD has committed to working closely with standard-setting and disclosure mechanism bodies and will promote global consistency in nature-related reporting. It aspires to ensure its framework and the TCFD's are comprehensive in their coverage of climate and nature-related financial risks, and complementary in their usability and adoption by market participants. The International Financial Reporting Standards (IFRS) Foundation's International Sustainability Standards Board (ISSB) has recently developed prototype climate and sustainability disclosure standards that ISSB hopes will be adopted as baseline standards globally. ISSB has stated that it may later develop nature-related disclosure standards and could look to the TNFD framework.

In late 2021 and early 2022, the United Nations Development Program's (UNDP) BIOFIN program conducted a study of five emerging economies to assess their readiness for nature-related disclosures. The study looked at the readiness of the policy and regulatory environment of institutions. In their responses, several countries noted the need to better determine the level of nature-related risk exposure in various sectors within the specific country context to convince financial institutions of the importance of assessing and disclosing these risks. Countries also shared the need to raise capacity of regulators to be able to define relevant risks in the national context, to understand and adopt disclosure standards, to work with business associations to set targets, and to support the design of systems for tracking disclosing nature-related risks and impacts throughout value chains. These countries noted their interest in receiving support for these activities.[230]

The most explicit biodiversity disclosure requirements to date have been imposed by France. Article 173-VI of France's "Energy Transition and Green Growth" law, which went into effect in January 2016, required investors to disclose how they factor environmental, social, and governance (ESG) criteria and carbon-related aspects into their investment policies. The French Parliament decided in November 2019 to go further, notably by setting up new disclosure requirements with an explicit focus on biodiversity. Based on the new Energy-Climate Law, an implementing decree published in May 2021 proposed a two-step approach. As of January 1, 2022, financial institutions (including financial institutions in their investment management capacity) will have to publish their strategy for alignment with international biodiversity conservation targets (set for 2030 and every five years thereafter), with quantified targets, and associated methodological details (notably on supply chains, primary

pressures and impacts, and the use of a biodiversity footprint indicator). From January 1, 2023, this will be complemented by the disclosure of information on the integration of ESG criteria into risk management, including physical, transition, and liability risks related to biodiversity. If the financial institution does not publish these elements, the decree requires that it discloses a continuous improvement plan (including improvements to the current strategy and the corresponding tangible actions to improve the current situation, any strategic and operational changes that have been introduced as a result of implementing corrective actions; and a timetable for implementation).

The decree makes a clear distinction between the risks from the impacts caused by the investment strategy and the main risks from the biodiversity dependencies of the assets and activities in which the entity has invested, therefore applying the double materiality principle. Each risk identified requires the indication of the supply chain parameter used and of whether the risk is specific to the industry or geographic area of the underlying asset. This prompted French investors to pursue the development of better data on nature-related impacts and dependencies.[231]

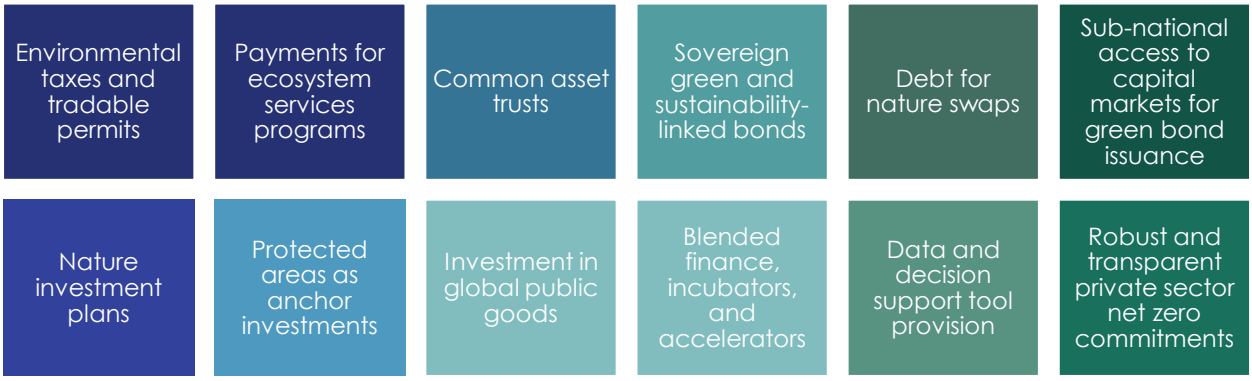
Other European governments are following suit, including the UK government, which has pledged in its Green Finance Strategy, published in 2019, to "work with international partners to catalyze market-led action on enhancing nature-related financial disclosures." The Dutch central bank June 2020 report on the risks to the financial sector arising from biodiversity loss calls for the development of a biodiversity risk disclosure framework. The EU Taxonomy of Environmentally Sustainable Activities also creates pressure for disclosure. "Conservation and restoration of biodiversity and ecosystems" and "sustainable use and protection of water and marine resources" are categories of the taxonomy. All investments under the taxonomy are required to "do no harm" under its six categories of environmental objectives.

The Impact Taskforce, organized by the UK presidency of the G7 group of countries, included in its recommendations that global standards for sustainability reporting be extended to enable governments to require mandatory corporate accounting of their positive and negative social and environmental impacts on all stakeholders.

Sources: Mirova 2020; HM Treasury 2019; van Toor et al. 2020; European Commission 2020; ITF Impact Taskforce 2021.

Financing Green

Figure 13. Key actions for Ministries of Finance to mobilize investment in nature



Source: World Bank.

Public

As many ecosystems have the characteristics of public goods, governments (and MoFs in particular) have a key role in funding their conservation, restoration, and sustainable use. The challenge for governments is to identify which ecosystems should be prioritized and how to mobilize the funding needed. Identification can be done through cost-benefit analysis (CBA) or risk-opportunity analysis, particularly to assess environmental, social, and economic benefits, using a range of tools.[232] Once priority ecosystems have been identified, MoFs will need to determine the lowest-cost way to fund or finance necessary activities. They must also assess how public funding can be used to mobilize private investment in nature. Figure 14 provides an overview of key actions that MoFs might take to finance green activities.

MoFs have a key role to play in the development and implementation of incentives that contribute to the alignment of economic activity and financial flows with nature conservation and restoration goals and the resulting nature-related risk reduction. Environmental taxes, fees, charges, tradeable permit schemes and other fiscal instruments will play an important role in driving this alignment and funding conservation, restoration, and sustainable use over the long-term. These instruments are covered in more detail in section 3.1.

MoFs can also support other relevant ministries in the development and implementation of national PES programs to help shift incentives and fund conservation and restoration activities. Costa Rica's PES for forests program provides a successful example. From 1950 to 1987, Costa Rica had one of the highest deforestation rates in the world (dropping from 72 percent to 21 percent cover).[233] In 1996, Costa Rica instituted a landmark Forest Law, which banned land use change, and created a PES program.[234] These measures helped increase forest cover to 52 percent by 2018.[235] The National Fund for Forest Finance (FONAFIFO) pays private landowners for conservation and restoration activities with funding from a fossil fuel and a water tax.[236,mmmm] Governments can develop and implement national PES programs that involve cost sharing with subnational governments or private corporations, as Mexico has done in its Fondos Concurrentes Program.[237] MoFs can also support and enable the valuation and value capture of disaster risk resilience ecosystem services to mobilize subnational or private investment in service provision.

In addition to developing national PES programs, MoFs can leverage global PES markets, such as the voluntary carbon market and the forthcoming voluntary biodiversity credits market,[nnnn] to help fund public conservation and restoration activities. For example, a large mangrove restoration project can enable the government to sell carbon credits to partially fund the project, as the Indonesian government is planning to do as part of its Mangroves for Coastal Resilience project.[238] The Bahamas has also recently stated its intention to sell blue carbon credits on the voluntary carbon market. While the inventory of its ocean-based assets is still ongoing, the Prime Minister has said the country can produce at least $300 million worth of blue carbon credits.[239]

In order to ensure continued flows of vital ecosystem services across generations, MoFs may lead the development and implementation of common asset trusts (CATs).[240] One structure for CATs proposed by Costanza et al. (2021) relies on the Public Trust Doctrine[oooo] and abides by a generalized version of Elinore

[mmmm] FONAFIFO has a clear mandate to sustain and enhance forests in Costa Rica.

[nnnn] A standard for tradable biodiversity credits is being developed by Plan Vivo and is set to be published in 2022. https://www.opwall.com/biodiversity-credits/

[oooo] It holds that certain natural resources should be held in trust as assets for public use. The Public Trust Doctrine has been used in many countries to protect ecosystems or species (Costanza et al 2021).

Ostrom's eight core design principles for sustainable commons management.[pppp] CATs use a combination of private and community property rights to address issues associated with managing non-rival, non-excludable goods. Under a CAT, the users of a resource for private gain compensate the broader society (through the CAT) for the right to do so. The CAT governance structure requires that it abide by ecological limits to ensure that future generations also have access to the resources. A cap, auction, and dividend scheme could be used, in which revenue is equally distributed across all members of a jurisdiction or reinvested in the health of the ecosystem.[241] CATs could facilitate more effective public-private partnership (PPP) and PES schemes that mobilize private investment in ecosystem conservation and restoration.[242] Examples of similar structures include the National Trust for Places of Historic Interest and Natural Beauty (England, Wales, Scotland, and Ireland) and the Costa Rican PES program described above also operates similarly to a CAT. It receives payments from activities that harm and utilize the asset (carbon emissions and water use) and rewards private parties that protect or restore the asset via payments for designated activities.[243] While the Costa Rican PES scheme is currently limited to forests on private land, the government is considering expanding the scheme to include all terrestrial and marine ecosystems and more directly envisioning the system as a National Common Asset Trust.[244] An alternative or complement to CATs involves granting ecosystems legal rights. This approach is being used in some jurisdictions, in part in response to issues related to inter-generational equity (ecosystems have been granted legal personhood in New Zealand and India and Ecuador's constitution now grants nature the "right of integral respect").

There are multiple new and innovative approaches for governments to potentially raise lower-cost capital to invest in nature and broader sustainability activities. There is a range of instruments with the potential to reduce the perceived credit risk of government debt and increase demand from sustainability investors. Green and sustainability-labeled bonds are being used more frequently to fund nature-related investment activities or transition activities that reduce the impact of economic activity on nature. France's sovereign green bond allocates funding for nature conservation and restoration. In 2020, 7 percent of sovereign green expenditure, or €463 million, was directed into activities relating to protecting biodiversity,[245] and some countries have realized a "greenium" for such labeled bonds.[246] Sustainability-linked bonds (SLBs) have rapidly gained in popularity in the private sector. The interest rate on a sustainability-linked bond is tied to a country achieving an agreed-upon key performance indicator (KPI), and Chile recently became the first country to issue a sovereign SLB tied to meeting its emissions reduction targets.[247] A range of climate and nature-related KPIs could be used for sovereign SLBs.[248] Building on the "Sustainability-Linked Bond Principles" set forth by the International Capital Market Association (ICMA), the report provides initial guidance on a framework for assessing the suitability of KPIs.[qqqq] If countries achieve their KPIs, they can realize below-market financing that reduces investor risk. Donors may even support the interest rate reduction an emerging market or developing country receives if it meets its KPIs.

Debt for nature swaps are another way for governments to reduce their debt burden and free up capital to invest in nature. While the first debt for nature swap was conducted in 1987, the approach has recently had a resurgence, with both the Seychelles and Belize restructuring some of their sovereign debt in

[pppp] Elinore Ostrom's eight core design principles for sustainable commons management: (1) shared identity and purpose; (2) equitable distribution of contributions and benefits; (3) fair and inclusive decision-making; (4) monitoring agreed behaviors; (5) graduated responses; (6) fast and fair conflict resolution; (7) authority to self-govern; and (8) collaborative relations with other groups and spatial scales.

[qqqq] The metrics include whether a potential indicator is sufficiently robust, properly interpreted, aligned with the country context and credibly ambitious.

exchange for ambitious conservation pledges. Both deals involved innovative elements like a conservation trust, which includes a blue economy investment fund in the Seychelles,[249] and the layering of a sovereign first-ever debt service catastrophe parametric insurance policy in Belize.[250] Thus far, significant debt distress has been required for such negotiations to yield substantial debt forgiveness.

As many nature-related projects lend themselves to local financing, MoFs may wish to assess subnational access to bond markets and subnational capacity to issue green or sustainability-labeled bonds. Several US states and cities have issued environmental performance bonds, with the interest rate linked to the environmental performance of the environmental infrastructure.[251] Similarly, the Australian state of Queensland is exploring a mangrove bond.[252] MoFs can address policy and institutional barriers to subnational actors accessing bond markets and facilitate capacity building for subnational governments to structure and report on these instruments.[253]

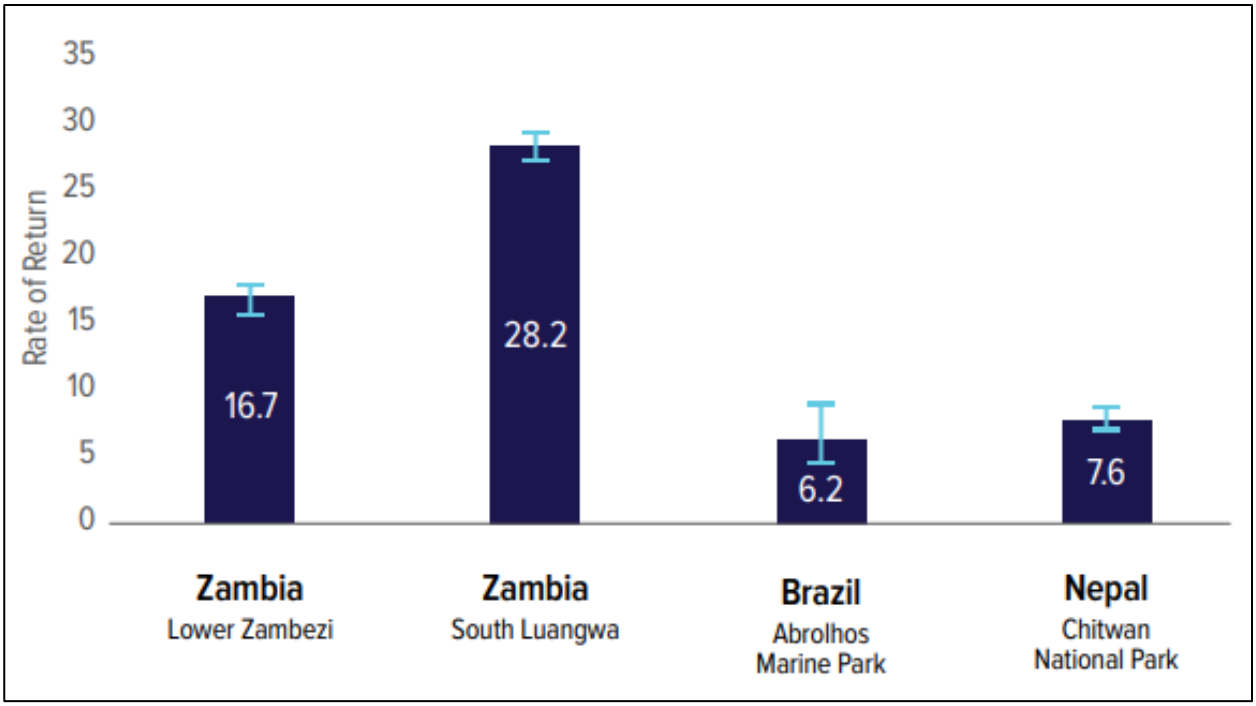
MoFs can take the lead on developing nature investment plans that identify conservation, restoration, and sustainable use projects funded by the government or the private sector and that will require blended finance.[rrrr] MoFs can set up targeted funds to provide grants to small businesses investing in nature and natural capital business incubator or accelerator programs, possibly through a national green bank or development bank. They can also mandate that these public banks invest a certain amount of their public funding in mobilizing private investment in nature-related activities.

A public anchor investment in a landscape or seascape as a protected area generates other investment opportunities for the private sector.[254] Examples of such investments include a national park that can attract tourists, promoting the emergence of tourism-related businesses around the park; a marine protected area that allows fish stocks to recover, improving fish catch in the surrounding areas; or a protected forest that provides water provision services to sustainable farms downstream.

Figure 7 shows the annual estimated rate of return from tourism on government spending for a given protected area in three countries. The return on investment was obtained by dividing total economic impact of protected area-associated tourism by the sum of wage and non-wage expenditures on the park by governments.

[rrrr] This division will be based on returns a given project is expected to generate, as well as social and environmental conditions on the ground. The UN BIOFIN Program provides the best example of a national nature investment plan.

Figure 74. Annual estimated return from tourism to the economy for government spending on protected areas (2018/19)



Source: World Bank 2021b.
Note: Error bars represent 95 percent confidence intervals.

Managing loss and degradation of the world's global public goods—like the rainforests and oceans—is critical to managing systemic nature and climate-related risk. MoFs, particularly from donor countries, can consider better empowering multilateral development banks to invest in these global public goods, as was recommended by the G20 High Level Independent Panel on Financing the Global Commons for Pandemic Preparedness and Response.[255] The panel recommended doing this by adjusting the mandates of multilateral development banks (MDB) and providing them with resources for the new function. Developing countries and emerging markets may struggle to fund global public good ecosystems at the levels necessary to continue to supply the rest of the world with the ecosystem services on which they depend. MoFs, especially from donor countries, thus play an important role here. They can work with trade and environment ministries to assess the impact of the country's economy on these global public goods and identify opportunities to reduce this impact. The United States President recently called for the evaluation of options from various US government agencies, including the Treasury Department, for a whole-of-government approach to combat international deforestation that includes an analysis of the feasibility of limiting or removing specific commodities grown on lands deforested either illegally or after 2020 from agricultural supply chains.[256]

Private

Financial institutions are becoming more aware of opportunities to invest in projects contributing to conservation, restoration, and sustainable use of nature. Financial institutions are investing in developing project pipeline and innovating to create new financial instruments. They are developing their own nature business incubator and accelerator programs[257] and are making pledges for the levels of investment they expect to make in these assets.[258] Governments can support this activity by providing blended finance and better biophysical and economic data on natural capital, particularly geospatial data that can be disaggregated, by encouraging or mandating disclosure (see box 7) and through NCA and the provision of CBA and modeling tools and analysis. Financial institutions' net zero commitments also encourage greater investment in natural capital businesses and projects, and MoFs have a role in increasing the impact and transparency of these commitments.[259]

Conclusion and Recommendations

Nature-related risks can transmit to governments through a variety of channels including lower tax revenues, higher borrowing costs, damage to public infrastructure, more stringent requirements for new infrastructure, increased disaster risk and welfare payments, a more acute need to invest in ecosystem restoration, reduced economic growth, and greater political instability or conflict among others—all with direct fiscal implications. Nature-related risks could also trigger financial instability and a wide range of contingent liabilities for MoFs, with known and unknown fiscal costs.

While this menu of potential policy actions in this report is extensive, what is most important is that MoFs immediately start improving their understanding of the nature-related risks to which they are exposed, the natural capital assets they are managing, and the potential nature-related opportunities they could pursue in the near and medium term. Such improved understanding can clarify how governments should prioritize and sequence various policy actions necessary to bend the curve of nature loss and mitigate the manifestation of nature-related risks in their respective countries. MoFs can take steps to integrate nature-related criteria into their strategies and decision making, building on climate integration efforts. They can also coordinate nature-related risk management with relevant ministries, as well as with the regulator, supervisor, and the central bank.

The need for action to bend the curve of nature loss is urgent. The monetary cost that citizens worldwide would need to pay to stop biodiversity and ecosystem services loss may be twice as high if policy makers delay global action by as little as 10 years, rather than acting immediately.[260] Biodiversity and species are being lost at an accelerating pace, and any delay makes it more difficult to restore nature, jeopardizing the economic and political feasibility of mitigating measures. It is recommended that MoFs pursue action at the climate-nature nexus, addressing the climate and biodiversity crises simultaneously.

MoFs can manage nature-related risk using the following policy levers (this will vary by country):

- Developing and applying valuation, metrics, and decision support tools (e.g., through implementing or supporting the development of natural capital accounting (NCA), developing alternatives to gross domestic product (GDP), and developing nature loss scenarios).
- Supporting economic policy reform to align incentives with sustainable practices (e.g., through assessing and raising awareness of the nature-related risks associated with harmful subsidies, offering recommendations on phasing out of these subsidies, and supporting the integration of the value of nature in decision-making through environmental taxes measures, tradable permits, and payments for ecosystem services programs, and circular economy solutions).
- Integrating nature-related risks and opportunities into the key sectors exerting the greatest pressure on nature (e.g., through nature-smart planning and integrated landscape and seascape management, and investment in nature-based solutions).
- Mobilizing finance for nature[ssss] (both through greening finance and financing green) through the identification of nature-aligned investments; an integrated climate-nature financial sector policy framework or strategy; sovereign and corporate nature-related disclosure; national nature investment

[ssss] As part of an integrated approach to mobilizing private finance for sustainable development more broadly.

plans; investment in global public goods; subnational access to bond markets; blended finance; innovative financial instruments; and incubators or accelerators.

Coalition Members recognize that MoFs have a critical role to play in raising awareness about the potential risks of nature loss to economies. Based on the findings of this report, the Coalition is better placed to consider the climate change and nature loss crises simultaneously and to support Members in designing policies. In this context, the Coalition could consider taking the following steps:

- Organize events to enable sharing of best practices for nature-related risk management among Members;
- Host dialogues with key stakeholders to provide Members with new ideas, relevant information, and applicable guidance;
- Contribute to advancing the design of decision support tools – as prioritized by Members;
- Initiate further research on specific recommendations in the report to support Members in prioritization, sequencing, and optimization of policy actions.

The Coalition of Finance Ministers for Climate Action

Glossary

Biodiversity is the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems (Convention on Biological Diversity).

Biodiversity loss, also referred to as 'nature loss' in this report, is the reduction of any aspect of biological diversity (i.e., diversity at the genetic, species, and ecosystem levels) that is lost in a particular area through death (including extinction), destruction, or manual removal; it can refer to many scales, from global extinctions to population extinctions, resulting in decreased total diversity at the same scale (IPBES).

Biosphere is the sum of all the ecosystems of the world. It is both the collection of organisms living on the Earth and the space that they occupy on part of the Earth's crust (the lithosphere), in the oceans (the hydrosphere), and in the atmosphere. The biosphere is all the planet's ecosystems (IPBES).

Blended finance is the use of catalytic capital from public or philanthropic sources to increase private sector investment in sustainable development. (Convergence) More specifically, it is the use of concessional donor funds to mitigate specific investment risks and help rebalance risk-reward profiles of pioneering, high-impact investments so that they have the potential to become commercially viable over time (International Finance Corporation).

Carbon sequestration is the long-term storage of carbon in plants, soils, geologic formations, and the ocean. Carbon sequestration occurs both naturally and as a result of anthropogenic activities and typically refers to the storage of carbon that has the immediate potential to become carbon dioxide gas (IPBES).

Double materiality is a two-dimensional perspective on materiality (see below) where the economy's relationship with nature is twofold: it is dependent on, and also has negative impacts on, nature. Economic and financial risks can emerge from impacts and dependencies on biodiversity and ecosystem services.

Drivers of change, in the context of IPBES and this report, are all the factors that, directly or indirectly, cause changes in nature, anthropogenic assets, nature's contributions to people, and a good quality of life. Drivers have direct physical (mechanical, chemical, noise, light, etc.) and behavior-affecting impacts on nature. They include, inter alia, climate change, pollution, different types of land or sea use change, invasive alien species and zoonoses, and overexploitation of resources. Indirect drivers are drivers that operate diffusely by altering and influencing direct drivers, as well as other indirect drivers. They do not impact nature directly. Rather, they do it by affecting the level, direction, or rate of direct drivers. Global indirect drivers include economic, demographic, governance, technological, and cultural ones (adapted from IPBES).

Ecosystem is a dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit (IPBES).

Ecosystem services (also referred to as nature's contributions to people) are the benefits people obtain from nature (Millennium Ecosystem Assessment). Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems and which may include food, freshwater, timbers, fibers, and medicinal plants; (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes and which may include surface water purification, carbon storage and sequestration, climate regulation, and protection from natural hazards; (iii) cultural services, which are the nonmaterial benefits people obtain from ecosystems and which may include natural areas that are sacred sites and areas of importance for recreations and aesthetic enjoyment; and (iv) supporting services, which are the natural processes that maintain the other services and which may include soil formation, nutrient cycling, and primary production (World Bank)**.**

Financing green is increasing financial flows to projects that contribute—or intend to contribute—to the conservation, sustainable use, and restoration of biodiversity and ecosystems and their services to people (World Bank).

Greening finance is directing financial flows away from projects with negative impacts on biodiversity and ecosystems to projects that mitigate negative impact and/or pursue positive environmental impacts as co-benefits (World Bank).

Intrinsic value of nature is nature's value in its own right, independent of human uses.

Land use is the human use of a specific area for a certain purpose (such as residential, agricultural, recreational, industrial, etc.), influenced by, but not synonymous with, land cover. Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover (IPBES).

Materiality, in the context of this report, refers to the significance of a matter in relation to its impact on the economy or the financial sector. An assessment of materiality may require consideration of both quantitative and qualitative factors.

National Biodiversity Strategy and Action Plans (NBSAPs) are policy documents, developed and adopted by Parties to the Convention on Biological Diversity, in line with the requirements of the Aichi Biodiversity Target 17 (Convention on Biological Diversity).

Natural capital is the world's stocks of natural assets which include geology, soil, air, water, and all living things. From it, humans derive a wide range of ecosystem services, which make human life possible (Convention on Biological Diversity).

Natural Capital Accounts (NCA) are sets of unbiased data for material natural resources, such as forests, energy and water. NCA follow an international standard approved by the United Nations Statistical Commission, called the System for Environmental-Economic Accounts (SEEA) (World Bank).

Nature, in the context of this report, refers to the natural world, with an emphasis on biodiversity. Within the context of science, it includes categories such as biodiversity, ecosystems, ecosystem functioning, evolution, the biosphere, humankind's shared evolutionary heritage, and biocultural diversity. Other components of nature, such as deep aquifers, mineral and fossil reserves, and wind, solar, geothermal and

wave power, are not the focus of the report. Nature contributes to societies through the provision of contributions to people (adapted from IPBES).

Nature-based solutions (NBS) are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits (UNEP).

Real economy/sector is the part of the economy that produces goods and services, rather than the part that consists of financial institutions and services.

Taxonomy refers to a classification system for investments, particularly as they relate to a government's environmental goals (scientific taxonomies are not discussed in this paper).

Tipping point is a set of conditions of an ecological or social system where further perturbation will cause rapid change and prevent the system from returning to its former state (IPBES).

Nature-related risks, in the context of this report, are economic and financial risks associated with nature loss (both physical and transition risks), particularly those with fiscal implications.

Physical risks stem from the degradation and loss of natural capital and the disruption of the ecosystem services it provides.

Transition risks stem from changes in economic policy, regulation, technological advancement, and shifting consumer preferences as well as reputational damage and litigation as a result of activities that are harmful to biodiversity.

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