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Unearthing the nature risk in financial portfolios

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- Ecosystem degradation affects the economy by lowering returns, reducing market value, and dampening GDP.
- Understanding how much companies depend on nature isn't enough to gauge financial risk. Financial institutions need to consider the likelihood and probability of impact as well.
- Financial institutions can better integrate nature risk into credit and underwriting models to mitigate losses and rebalance portfolios.

Unchecked nature loss could wipe out trillions in economic value—and your financial portfolio is probably more exposed than you realise. That's because thus far, few financial institutions have fully included biodiversity loss or the degradation of natural ecosystems in their risk assessments and portfolio decisions. Decision-makers increasingly understand that these factors are important, but they're not generally line items in credit models or underwriting.

New PwC modelling suggests that within the next 15 years, unchecked nature loss could erode 12–17% of GDP, 11–14% of overseas investments, and 12–18% of stock exchange market value (roughly US$11 trillion), according to our analysis of the economies of Australia, Canada, New Zealand, and Singapore. Of the 20 sectors we studied in each country, at least four sectors had more than 9% of their economic activity at risk from degradation of just a single **ecosystem service**. Similar analysis of financial portfolios can identify where risks are concentrated, where terms and conditions might be mispriced, and where clients can take steps to lower their risk.

Nature-related risks reach financial institutions in much the same way that other risks do: by **disrupting business performance** and economic activity. When, for example, forests, wetlands, prairies, and rivers lose the ability to provide fresh water, sustain crops, protect against floods, and filter air, **companies pay a price** in higher input costs, production downtime, or asset damage. Corporate earnings decline, default risks rise, and collateral values fall. Asset repricing follows. Underwriting pressure mounts as insured losses add up, a dynamic that spills over into bankability when assets become uninsurable. Meanwhile, risks emerge as firms relocate activity and adjust business models. Liquidity and refinancing pressures can develop where exposures are concentrated.

Forward-thinking institutions can respond by building nature risk into the way they measure and manage credit and underwriting risk. Many will also recognise nature risk as a reason to adapt their businesses and form new cross-sector partnerships. After all, rising nature risk means their clients will likely seek investment capital to pay for strategic and operational shifts, along with specialised new forms of risk capital. It's another instance of how financial institutions can innovate to create value as nature loss and other megatrends put **value in motion**.

The good news is that financial institutions already have a language and a process for identifying material risks and stress testing their portfolios. The approach used here mirrors that practice, extending it to ecological disruption so that nature-related value at risk (NVAR) can be quantified—and managed—at the country and sector level.

01

Impact on economies, sectors, and value chains

To manage nature risks, financial institutions must first locate them throughout their portfolios. PwC's analysis reveals sector-level patterns that are intuitive yet sobering. Threats to ground and surface water availability and water quality feature prominently in the NVAR profiles of manufacturing and wholesale/retail companies. Declines in soil quality and stability translate into erosion and landslides that affect construction, real estate, and agriculture. Loss of wetlands, mangrove forests, and other natural buffers against floods and storms leads to more severe, more frequent damage to buildings and infrastructure. Air quality degradation—amplified by wildfire smoke—reduces labour productivity across services and transport. Pests and pathogens hurt yields in agriculture and forestry.

Besides analysing sector-level patterns, financial institutions also need to understand where risks arise across the operations and value chains of the businesses they fund and insure. This necessity exists because distribution of risks varies greatly across countries, as illustrated by our analysis of four economies (using 2023 data):

- **Singapore**, for example, is particularly exposed to trade-transmitted shocks. The city state's heavy reliance on imports from **parts of Asia** where nature degradation is acute—especially China—poses a risk to domestic sectors such as manufacturing and wholesale/retail. In fact, it is the only economy we looked at with more value at risk from international supply-chain business activities (55%) than domestic business activity (45%).

- **New Zealand's** stock exchange illustrates how macro dependencies translate into market risk at the firm level. Approximately 16% of listed market value proved to be at risk, largely from risks to water-flow regulation. That value at risk is concentrated in construction and real estate companies. Construction companies account for the highest proportion, with 30% of the sector's GDP at risk from nature's reduced capacity to regulate the flow of rainfall. Real estate companies also face water-flow regulation risk from worsening retention of soil and sediment.

- **Canada's** profile includes around US$259 billion at risk, roughly 11% of its GDP. Much of that is in wholesale and retail trade and manufacturing (each containing $56 billion at risk), where ecosystem loss is creating more exposure to damage from storms and floods. The proportion of at-risk GDP is highest in fishing (26%) and forestry (25%) because ecosystem degradation reduces flood and storm protection and heightens chronic impacts from pests and pathogens. Those sectors also are highly exposed to shifting rainfall patterns and the effects of global climate change.

- **Australia's** picture features water- and soil-linked risks, with agriculture and mining the most prominent. Flooding, landslides, and wildfire-related air quality disruptions affect both infrastructure and productivity in these sectors. The country's mining sector has the highest value at risk. It's responsible for 15% of the country's total GDP, yet 22% of the value of mining activity is at risk.

02

Calculating nature risk in a financial portfolio

We've seen that financial institutions increasingly accept the idea that nature risk is a financial risk. Some also understand that companies are often **dependent on nature** and its services. But few go on to quantify how much economic and financial value is on the line. As a result, they tend to lack measures of nature risk they could use in business decisions.

To calculate those decision-relevant metrics, our analysis starts with a measure of how much business value at the economy level depends on nature. We then multiply that figure by the likelihood of a specific nature-related shock given the current state of ecosystem health, the potential impact of a shock on the economy, and capacity of the economy to respond in the event of a shock. The product represents the value at risk from nature loss for that economy, though the equation can easily be adapted for a portfolio of companies or an individual company.

The components of nature value at risk

PwC's approach adapts familiar risk concepts at the macroeconomic level, and is modelled after the Green Finance Institute's work with the University of Oxford and University of Reading on nature-related financial risks. It allows us to estimate the value at risk from biodiversity loss and nature degradation in macroeconomic scenarios. Those estimates can then be mapped against financial portfolios at banks and insurance companies to provide a rough idea about where risks are concentrated. It considers risk from three specific angles: exposure to risk, the likelihood of a nature-related shock, and the probability of such an event.

- **Exposure:** How dependent economies and sectors are on ecosystem services (e.g. water-flow regulation, soil quality, flood and storm protection, air quality, pollination, pest control). Our analysis includes both direct and

indirect supply-chain dependencies using a global multiregional input/output database to quantify indirect exposures.

- **Likelihood:** How degraded the state of nature is where business occurs and how vulnerable each country is (adaptation capacity). This includes country-level indicators of ecosystem integrity by service and a vulnerability index—provided by the Notre Dame Global Adaptation Initiative—that covers policy, infrastructure, and readiness to adapt.
- **Probability of loss:** We calibrated the likelihood of sector-specific loss over the next 25 years using decades of historical output volatility based on World Bank sector output data, allowing for severe-but-plausible shocks. We used the World Bank's indicators at roughly 1-in-20-year severities and acute shocks at 1-in-100-year severities, with a high-confidence value at risk level aligned to best practices of financial stress testing.

At a bank portfolio level, consider the impact of the decline in pollinators, such as bees, butterflies, and birds on Canadian companies that are directly dependent on agriculture—or indirectly via their supply chain. A bank would need to evaluate which of its clients is likely to be affected, by country and sector, and add up the value these companies generated. From there, bank managers can determine the potential loan book devaluation because of declining yields, margins, and the increased risk of defaults. The same calculation can be used to determine the value at risk due to other potential nature events.

Understanding nature-related value at risk

Nature-related value at risk accounts for the value generated by an economic sector, its risk exposure, the current state of nature, and the probability of loss. It can be calculated for any specific nature risk that could affect a sector of a region's economy.

Example calculation: Canadian agriculture and pollination

How much value do agriculture-dependent Canadian companies produce:	**$1,000**
What proportion of that value depends on pollination:	**80%**
What are the chances of a decline in pollination:	**34%**
What is the probability of loss (likelihood of impact):	**55%**

NVAR = $1000 × 0.8 × 0.34 × 0.55 = $150

Source: PwC analysis

03

Managing nature value at risk

Nature-related risk is manageable—provided it is measured across a portfolio and integrated into decision-making processes. Estimates of GDP value at risk by sector, combined with multi-regional input-output linkages, can help institutions bridge from macro scenarios to portfolio impacts. Ultimately, this analysis lets them manage nature risk at the level of individual loans and other financial products.
The following steps have helped financial firms we know to include nature risk in their thinking.

- **Identify hotspots:** Financial institutions can identify portfolio-specific hotspots by replacing GDP-by-sector weights in NVAR calculations with their own portfolio exposures by sector and country. Our analysis of Canada, for example, identifies NVAR hotspots across 11 sectors and 11 countries that supply Canadian companies (121 sector-country combinations). When a large Canadian pension fund screened for material nature-related risks across a handful of potential acquisitions, they identified which organizations carried the most nature risk, as well as why and where the risk was located. That enabled meaningful engagement with those organizations to understand what mitigation and management measures were in place.

Nature risk hotspots in the supply chain

Canadian companies that rely on the forestry sector have some of the highest levels of nature-related value at risk, whether their suppliers are in Canada or elsewhere.

NVAR as a percentage of GDP related to the country and sector, based on 1-in-100-year scenarios

	Agriculture	Business activities	Construction	Fishing	Forestry	Manufacturing	Mining and extraction	Real estate	Transport	Utilities	Wholesale and retail trade
Australia	21.88	12.95	23.10	22.08	24.28	11.14	22.43	10.78	14.26	11.41	12.06
Brazil	22.42	14.26	24.46	22.61	24.87	15.06	22.54	9.78	16.33	18.21	16.27
China	31.23	19.76	29.27	27.71	37.61	18.29	27.96	12.75	20.60	19.15	22.91
France	17.63	11.17	18.88	21.69	19.63	10.39	17.46	9.43	13.27	8.73	12.34
Germany	22.03	10.13	17.88	23.38	25.14	9.14	14.30	8.43	11.64	7.33	10.96
Portugal	27.81	17.15	21.07	28.85	31.74	11.55	21.07	13.56	14.33	12.52	14.30
Spain	20.64	15.09	19.81	23.88	23.30	10.76	19.77	12.40	12.76	11.06	12.68
Switzerland	16.43	10.72	18.08	16.43	18.08	9.50	18.06	10.81	11.43	11.61	12.11
United Kingdom	19.80	10.08	16.68	22.59	22.57	9.22	13.49	8.51	11.69	8.07	11.35
United States	20.26	13.79	21.92	20.83	24.50	11.98	18.72	8.77	13.85	9.47	12.21

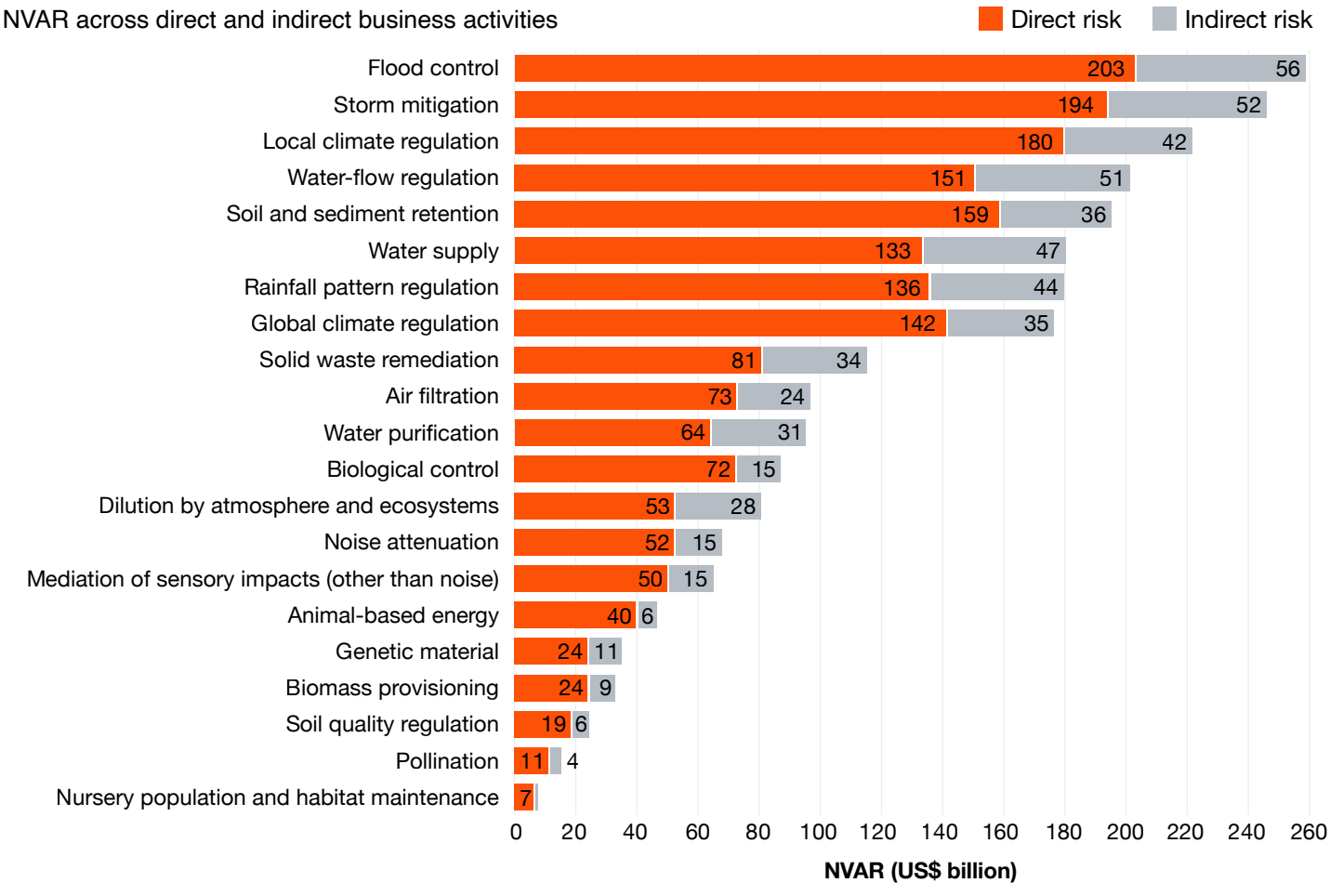
Source: PwC analysis

- **Integrate into stress testing:** Incorporating NVAR into stress testing enables better calibration of severe-but-plausible scenarios by distinguishing chronic productivity drags, such as soil productivity decline, from acute event losses, such as pest outbreaks or water contamination, and by accounting for supply-chain transmission. For example, our NVAR approach models acute sector- and country-specific shocks at 1-in-20-year severity and at 1-in-100-year severity for severe-but-plausible scenarios. Managers can then feed results into macro-credit models and capital planning or use them to screen potential acquisitions. Insurance companies might use the level of degradation of natural ecosystems and the likelihood and probability of impact to adjust their models of natural catastrophe risk.

- **Map direct and supply-chain risks:** Identifying where upstream ecosystem degradation (e.g. water-flow regulation in supplier regions) could impair borrowers' revenues and operations can help banks more accurately price their loan products. If an institution serves companies in myriad locations around the globe, it will want to start by focusing on either the companies or locations with the **greatest dependence on nature**—and identifying the ecosystems where NVAR is most critical to financial health. Typically, this involves quantifying high-level risks and focusing on the most critical value chains, suppliers, assets, and operations.

Ecosystem services driving value at risk

For Canada, large shares of economic value are at risk because of declines in nature's ability to provide flood control, storm mitigation, local climate regulation, and water-flow regulation.



Source: PwC analysis

- **Engage and differentiate:** Where risk concentration is the issue, financial institutions can rebalance their portfolios within sectors and geographies. For new loans and financial products, they can use probability-weighted pricing, covenants, and sustainability-linked features to offset risk and incentivise mitigation by clients. They can prioritise engagement where they can influence client practices around ecosystem and water management, biodiversity plans, and adaptation in key hotspots. And they can promote stability by encouraging business continuity and operational resilience plans. For banks, part of that process should include tracking the stance of insurers on high-hazard regions and asset classes and understanding how those shifts affect collateral quality and coverage. Among financial companies, insurers are often among the first to identify nature-linked hazards—and what becomes uninsurable can quickly become unbankable.

- **Don't overlook the opportunity:** Resilience is investable. Ecosystems that provide flood mitigation or coastal protection—wetlands, mangroves, coral reefs—can be restored to reduce exposure for insured property and financed assets. Nature-based lending structures and sustainability-linked features can help align borrower behaviour with risk mitigation, while policy alignment reduces transition risk. We already see banks opening new revenue streams through adaptation lending. Financing wetlands, floodplains, and marine restoration as natural infrastructure reduces physical-risk exposure in loan portfolios. Blended-finance structures and sovereign or corporate deals tie ecosystem health to improved credit performance. Insurers, too, are investing in resilience. Coastal nature-based solutions, such as reefs and mangroves, materially reduce expected storm and flood losses, creating a clear commercial opportunity to lower claims, structure new risk products, and monetise resilience through mechanisms like parametric cover and resilience credits.

Nature loss is already shaping financial risk. Executives can adapt proven stress-testing techniques to ecological realities, and by replacing macro proxies with their own exposures, financial institutions can surface hidden concentrations, price risk more accurately, and steer capital toward resilience before losses are realised.

04

Methodology

PwC's NVAR approach is modelled after the **Green Finance Institute's** work with the University of Oxford and University of Reading on nature-related financial risks. To quantify macroeconomic impacts, we constructed nature-related shocks using sectoral exposure metrics from their NVAR framework and empirical evidence from historical episodes where nature loss or ecosystem disruption has materially affected these economies (for example, major droughts, wildfires, fisheries collapses, and crop pest outbreaks). These shocks combine longer-run, chronic pressures on ecosystems with shorter-lived, acute events and are scaled to represent severe-but-still-plausible conditions, consistent with the scenario-development approach set out in the Green Finance Institute's work. We then fed these calibrated shocks into the global economic model (NiGEM) developed by the UK National Institute of Economic and Social Research (NIESR). That enabled us to trace how nature-related risks propagate through demand, trade, and prices, generating economy-wide estimates of nature value at risk.

The NiGEM model estimates how GDP and industries might be affected under plausible-yet-severe global and local environmental disruption. It is a leading global macro-econometric, comprising individual country blocks that are linked through trade, capital markets, and asset holdings, and is widely used for forecasting, scenario analysis, and stress-testing of macroeconomic events. NiGEM has been widely used by organisations such as the Network for Greening the Financial System and United Nations Environment Programme Finance Initiative for climate-related scenario analysis and environmentally extended macroeconomic impact modelling, providing a credible platform for tracing system-wide economic effects of nature-related shocks.

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