

The Financial Risks of Biodiversity Loss and Ecosystem Degradation

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Abstract:

The degradation of biodiversity and ecosystem services are manifesting itself as a severe risk. However, they are under recognised by the financial systems and economic stability studies. This paper highlights the risk of nature loss, climate change and financial risks in the purview of Economics and development. The paper mentions how natural capital underpins macroeconomic productivity, the impact of ecosystem disruption on financial institutions and the challenges in assessing nature-related risks. Key global frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD) and the Kunming-Montreal Global Biodiversity Framework are discussed for their role in recognising the importance of biodiversity and ecosystem services. The study underscores the urgent need to factor the nature related risk in addition to the traditional risk for risk management frameworks. Giving due weightage to nature-related financial risks is critical for achieving climate goals and preserving long-term economic resilience and global financial stability.

Keywords:

Biodiversity Loss, Ecosystem, Nature-related financial risk, Nature-based solutions (NbS), Taskforce on Nature-related Financial Disclosures (TNFD), Kunming-Montreal Global Biodiversity Framework, Physical risk, Transition risk, Taxonomy.

Introduction:

Nature is embedded in our studies on economies and livelihood. Over the past centuries, our economic activities are causing destruction and degradation of nature. The extent of destruction of nature have exceeded the planet's ability to provide ecosystem services, causing a degradation of nature at unprecedented rates as per United Nations Convention on Biological Diversity Report, 2025.

Nature based solutions aims to protect, manage and restore ecosystems that address societal and human challenges. Some nature based solutions are well suited to provide climate change mitigation and adaptation benefits.

After all, climate change is caused by excess human generated carbon-dioxide emissions and other greenhouse gases. Plants require carbon-dioxide for photosynthesis to produce chemical energy in the form of sugars and as building blocks for their structural tissues. The carbon is retained in plants

indefinitely however when the plant is burnt or decomposes, the carbon-dioxide is re-released into the atmosphere.

In terrestrial forest, microbes and fungi can absorb water and sequester carbon-dioxide in the soil.

Indeed, the entirety of our economy underpins in some way on Nature and the ecosystem services. These services are getting recognised by the private and public sector. Ecosystem are broadly defined as the benefit it provides to humans. The Millennium Ecosystem Assessment (MA) generated global interest and highlighted that the majority of the world's "24 ecosystem services" like provisioning of freshwater, air quality regulation are in decline.

Business, communities and governments rely on ecosystem services for both profits, health, safety and stability. For instance, an energy utility firm depends on fresh-water to cool its tower, floodwater regulation from forest that protect operating

machinery, wetlands that maintain river water quality.

The Natural Capital Protocol and the World Resources Institute Ecosystem Services Review offer methodologies to track organizational effects and dependencies on as well as value natural capital and ecosystem services.

In April 2021, the Network for Greening the Financial System (NGFS) launched a study group on “Bio-diversity and Financial Stability” and in Jun 2021, the taskforce on Nature Related Financial Disclosures (TNFD) was established with the widespread support from Financial Institutions, corporates, governments and civil society, including bodies like G7 and G20.

TNFD through its four pillars i.e. Governance, Strategy, Risk Management, Metrics and Targets provides recommendation and guidance which helps to channelize the global financial flows away from nature negative outcomes to nature positive outcomes. The mentioned four pillars are also consistent with the Task Force on Climate Related Financial Disclosures

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is an independent intergovernmental body which provides assessment on bio-diversity and nature to the governments. The service is similar to the Intergovernmental Panel on Climate Change which provides assessment on climate change.

The recommendation from both TNFD and IPBES are synonymously highlighting that the Mankind needs to solve both the climate and nature crisis or it will not solve either.

As a first work towards integrated assessment of climate and broader nature-related risk a conceptual framework on assessing nature-related risk was developed by NGFS. The Organisation for Economic Co-operation and Development framework on nature-related risk is also echoing the below points:

1. Potential Risk are identified and prioritised as per their likelihood and impact.
2. Potential Macro-economic effects of these risk are evaluated.
3. Potential impact on financial institutions are assessed.

The NGFS Risk Management framework consist of three phases:

1st Phase: Potential sources of risk are identified which are material from macro-prudential, micro-prudential point of view. The degradation of one or more ecosystem services can make the physical risk acute or chronic.

Existing and announced regional, national, global policies can be used as scenario to analyse transition risk. As an example NGFS has used the 2030 targets of Global Biodiversity Framework to halt the reverse of biodiversity.

2nd Phase; Central Banks through the exposures assess the economic effects: Physical and Transition risk will directly or indirectly affect both on macro and micro economic levels. Productivity, Investment, Socio-economic changes, trade and capital flows can be effected by physical and transition risk on a macro level. The risk assessment will need to consider the abilities of the various actors of the economies to adapt to shocks, either through geographical or technological substitution.

3rd Phase: Central Banks will consider to understand the sources of physical and transition risk to the exposures which is materialising as financial risk. The feedback loops to the real economy can come from an individual financial institutions and hence there is a merit to consider it. Any effect on nature affect the financial risk and hence both the economic and financial actors needs to be monitored and managed.

As a follow up to this framework, NGFS is looking at the practical steps like bridging data and modelling gaps to build scenarios and integrating nature related financial risk into the ongoing climate work. It urges central banks to identify, assess and act on material economic and financial risks stemming from dependencies and impacts on nature and their nexus on climate change.

Source:https://www.ngfs.net/system/files/import/ngfs/medias/documents/ngfs_conceptual-framework-on-nature-related-risks

Nature Loss and its Financial Relevance:

Nature refers to the natural world and it is made up of four realms: land, ocean, freshwater and atmosphere.

Natural capital refers to the stock of natural assets such as soil, air, water, forest and all living things that provides ecosystem services

Ecosystem provides the below services:

1. Supporting Services: Habitat, Nutrient Cycling, Soil Formation.
2. Provisioning Services: Freshwater, Timber, Food.
3. Regulating Services: Flood Regulation, Erosion Control, Water Purification.
4. Cultural Services: Recreational, Spiritual, Educational

The mentioned services of ecosystem directly impact industries that depend on ecosystem services and some of the examples are appended below:

1. Agriculture: Degradation of soil fertility and loss of pollinators threatens food security and which will inflate the cost. The annual market value of crop production which has a positive correlation with pollination was \$235-\$577 billion as per the assessment report on pollinators, Pollination and food Production published by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2017,

2. Pharmaceuticals: Impacts manufacture of existing drugs and Research for new drugs.

For instance, as per the recent report of National Research Centre on Camel(NRCC) antibodies derived from Camel derived antibodies are proving better than traditional antivenoms derived from horse immunoglobulin(IgG)

3. Insurance: Increased flooding and climate risk will increase premium which will impact the affordability.

As per the paper published by Henk Jan Verhagen on Financial Benefits of Mangroves for Surge Prone High-Value Areas, it is concluded that mangrove not only protect the coastal areas against flooding during cyclones however also cheaper than other means of protection.

4. Tourism: Degradation of natural landscapes reduces tourist appeal and revenue.

As per the Journal of Tourism Studies and Hospitality Research, the erratic snowfall and glacier retreat are one of the potential reason of winter tourism decline.

The sector wise economic valuation as per some global reports are appended below:

Table 1: Sectoral economic valuations

Sectors	Contributions	Estimated Value (Approximate)
Ecosystem Services	Global value of ecosystem Services contribute to agriculture, forestry, fisheries and tourism	USD 125 Trillion / Year (assuming that unit values and changes to biome areas) to USD 145 Trillion/Year (assuming only unit values changed)
Agriculture and Pollination	Crop production directly attributable to Animal pollinators.	Annual Market Value of USD 235 billion to USD 577 billion in 2015
Climate Resilience	Mangroves reduces storm and flood damages	USD 855 Billion worth of economic values saved by Mangroves globally as flood reduction benefits
Pharmaceuticals	Many medicines are derived from natural compounds such as marine life and trees.	Indirect Benefits is attributed to the Pharma Industries
Tourism	Forest safaris, national park, coral reef diving contributes to tourism	Billions of losses due to nature related risk like 68% of Australian tourism will be at major risk

Source: Compiled by the Authors

As per global reports and publication, degradation of natural capital is substantial which are tabulated below:

Table 2: Degradation of Natural Capital

SI	Particulars	Economic Valuation
1	Natural Resources and Services	Approximately USD 44 Trillion is dependent on nature related services
2	Collapse of certain ecosystem services such as fisheries or native	Approximately USD 2.7 Trillion annually by 2030 will be affected
3	Hidden Biodiversity Loss of current business practices	Approximately USD 10 trillion to USD 25 trillion annually and as per the same report approved by IPBES member states these cost will increase when Industries will continue to be apathetic.

Source: Compiled by the Authors

So, economy is intrinsically a part of nature which depends on the ecosystem services and the natural capital.

However, nature and economy value operates within different frameworks: economic value is generated through human and institutional arrangements, while nature is governed by scientific laws. Natural capital straddles the economy and its nonlinear feedback effects will bring frequent macro-economic shocks. The natural resources, climate change and economic growth are interconnected and the same is well documented (Cline 1992, Stern 2006)

The challenges posed by the environmental change were the focus of IMF Executive Board discussions as early as 2019 which is reflected in the minutes of a 1991 IMF Executive Board Seminar. The minutes emphasize the linkage between environmental concerns and macroeconomic and structural policies which have been identified in the study by the World Bank, OECD and other international and national institutions.

The below World Bank's estimates on GDP loss based on nature loss scenario:

The World Bank reports decline in ecosystem services as 14 of the 18 assessed categories shows declines since 1970. The trend is alarming for the economic prospects particularly to those that are heavily reliant on natural capital. Since now economic models do-not factor in the natural capital and hence the outlook may look like optimistic for economic prosperity. However, it is prudent to consider the risk to develop resilient and inclusive growth strategies.

To understand the macro-economic impact rising from bio-diversity loss, the World Bank develops a

global integrated economic model. The report uses combination of computable general equilibrium model with ecosystem services models to integrate economic and ecosystem services data. The ecosystem services like timber, pollination, fisheries and carbon are covered in these model. The model assess how GDP, returns on factor of production, economic welfare and returns of sectors like agriculture, fisheries will be affected due to the delta in the ecosystem services. The baseline scenario assumes that ecosystem remain unchanged and provide the same benefit which is used for comparing against scenarios where the ecosystem services declines due to degradation of environment.

In case no action is taken, it is estimated in these report that 46 million hectares of natural land could become cropland, forest plantation, pastureland by 2030 leading to drop in GDP up to USD 225 billion.

The baseline scenario is compared to the scenario where the three ecosystem services namely wild pollination, food from marine fisheries and timber from native forest collapsed. For which the model predicts there is a drop of USD 2.7 trillion (2.3%) in global GDP per annum in 2030 compared to the baseline scenario. The situation will impact low income and lower middle income countries where drops in 2030 GDP could reach to 10% compared with baseline scenario. Among the G20 nation, China would be most impacted with a projected loss of USD 943 billion in GDP by 2030. In China there could be a drop of 9% in non-extractive output like agriculture and fisheries. In India, there could be a projected loss of USD 193 billion by 2030 and decline in the agriculture, livestock, forestry production, fisheries sectors by 6%. In Indonesia, there could be a reduction of forestry productivity by 33% and a projected loss of USD 144 billion in GDP by 2030.

Scenarios of three ecosystem service collapse

Table 3: Economic Scenarios analysis

SI	Scenario	Methods
1	Collapse of Wild Pollination	The scenario focused on the crops that are dependent on the wild pollination in the event when there is a 90% reduction in wild pollination.
2	Collapse of Marine Fisheries	The model assumes Representative concentrated pathway 8.5 and worst case climate outcomes reported in uncertainty bounds and sensitivity analysis to stimulate the severe disruption in fish migration which will reduce the total catch biomass to impact economic model.
3	Massive conversation of tropical forest to savannah	The model assumes a hypothetical scenario where 88% less forest cover and lowering of forestry in the amazon basin which will impact the provision of timber from native forest in agro-ecological zones 5 and 6 by 90%

Source: Compiled by the Authors from World Bank

Classification of Nature Risk

The nature related risk can be broadly classified in the following ways:

1. Physical Risk: Disruption of economic activities stemming from ecosystem service degradation directly affecting business and financial institutions. (NGFS Nature Related Financial Risk, 2024)
2. Transition Risk: Misalignment of economic objective and policies aiming to save the degradation of nature. (TNFD Beta Framework v0.4)
3. Litigation Risk: Higher compliance cost due to materialisation of transition risk. (NGFS Nature Related Litigation Report, 2024)
4. Institutional Risk: It arises from regulation co-ordination affecting global financial stability. (Financial Stability Board's report on Stocktake on Nature-related Risks, 2024).

Direct Relationship of Nature and Climate Change

The inter-relationship between climate change and nature creates confusion and hence Taskforce on Nature-related Financial Disclosures published in its recommendation in September 2023 that climate change is one of the drivers of nature related risks, together with four other commonly accepted drivers such as land or freshwater or ocean use change, resource exploitation, pollution and invasive species.

Such linkages will make the changes in one element in the system drive changes in other parts of the

system and thus compel that effective policies on isolation will not move the needle.

Nature is also vulnerable to climate change as the difference between 1.5 degree to 2 degrees would lead to total loss of coral reefs as per the IPCC report 2018.

So, there is a vicious cycle which indicates a probable acceleration of natural and climate change risk for example the forest and soils observed 1.5-2.6 Gt of Carbon-dioxide in 2023 vis a vis 9.5 Gt in 2022 due to degrading health of forest and soil cover (Ke and others 2024). Despite these high correlations between Natural and Climate Change, both are largely addressed in isolation.

Commonalities of Nature Related Financial Risk with Climate Related Financial Risks

Most of the risk are emanating from Physical and Transition Risk as per NGFS 2023a; 2023b.

a Physical Risk is occurring from Natural Transformation (Ocean Acidification, degradation of forest health) and Natural Loss (Decline in Biodiversity and disruption of ecosystem services)

b Transition Risk occurs from misalignment of economic activities with new laws/regulations aimed to mitigate/adapt Natural Risk.

Like Climate Risk, Natural Risk also follow non-linear complexities, tipping points which can be from both domestic and global channels. Also, Transmission Risk can be due to policy level changes for both Natural and Climate Change which will alter macro-economic goals.

Differences of Nature Related Risk from Climate Related Risk:

a Risk emanating from Nature related risk can attain tipping point earlier like Amazon Rainforest dieback

b Quantification of Natural Risk is more daunting as the same is multidimensional unlike Greenhouse gases in Climate Change.

c Uncertainty in Natural Risk is higher and requires a deep understanding of local nature related patterns.

Cascading effects of Local Level Natural Event into Global Consequences:

The economic activity driven through market forces will be jeopardised by the nature at an unprecedented scale into global threats. The consequences are highlighted at different scientific forums with a warning that we are in a critical phase – either un-sustainable or irreversible collapse (IPBES 2019).

Nature loss events at a local place are amplified by globalisation, commodity market structure affects global supply chains and trade. For example, Dieback of Amazon Forest which is local event would have an impact of biodiversity loss and will accelerating climate change as the stockpile of greenhouse gases in the atmosphere will increase.

As stated, ecological shocks originated in one country has a ripple effect on the global markets by affecting exchange rates and sovereign debt ratings like in 2010-12, the droughts in China, Russia and Ukraine disrupted the supply chain of global wheat moving the prices northward and affecting the trade term. (Sternberg 2012, NFGS 2023a).

The efforts to calculate the impact of nature related risk on GDP are still in their nascent stage as most estimates cover only a subset of nature loss drivers and ecosystem services. The acceptances are increasing that estimates of macro-economic cost due to degradation of nature are conservative (NGFS 2023a). The models are not able to connect the dotted lines of ecosystem services and economy is the main reason of not able to estimate the degradation of Nature and its detrimental effect on economy.

Although the magnitude of various model effect is conservative, however it is uniform across all the forums that the relationship of Natural loss, Climate

Change and Economic Activity are directly proportional.

Few of the instances observed are advocating the severity of the Natural loss are appended below:

1. Mangroves and coastal wetlands act as adaptive factors against flooding and storm and the degradation leads to more destructive storm with knock-on effects on economic activity post storm.
- The cumulative growth rate declines of regions with average mangrove protection is 6.1 to 8.2 percent vis a vis 2.6 to 5.5 percent where the mangrove cover is well protected (Hochard, Hamilton and Barber 2019).
2. Bio-diversity loss such as natural pest control by bats – has led to higher use of insecticide which in turn attributing infant mortality (Frank 2024). As per IPBES 2020 the Bio-diversity loss has led to significant emerging diseases. Another example is in China, a decline of wild bees has forced farmers to hire people to go from flower to flower and hand-pollinate the flowers using tiny brushes. Thus in all the example cited above, it is evident that the bio-diversity loss will be shifted to the society as a cost.
3. Soil degradation has led to a collapse in forest which means it is affecting carbon sink role and thus will affect climate change adversely. Accelerated climate change will affect forest loss as Sea level rise is already contributing mangrove degradation (Ward et al 2016).
4. Nature degradation can also affect tourism industry as there is a dedicated global receipts that comes from Eco-tourism.
5. A shift in the timing and magnitude of the Indian Monsoon, changing seasonal rainfall that billions of people relying on for agriculture and allied activities which in turn drives the Country's food security.

Fiscal pressure will rise with revenue losses from Natural loss. Lower receipts from tourism and other factors which all are leading to lower growth. The same will amply as the result of natural degradation will move non-linearly and at that point the possibility of orderly transition risk is bleak. Also, as a society when we are investing for adapting with the natural and climate risk we need to be aware that the same can transfer the exposure from one

community to the other community thus leading to maladaptation. Some of the instances are appended below:

1. Insurance Policies can lead to reduce due diligence and encourage risk exposure by the buyer of insurance policy. Thus leading to abuse of the country's productive capital.
2. Intensive Irrigation facilities build to adapt droughts can lead to water scarcity.
3. Building Sea-walls or other coastal defence structures can sometimes lead to increased erosion and affect marine lives thus creating new vulnerabilities and negatively impacting ecosystems.
4. Planting trees is often seen as a way to address climate change however planting monoculture tree species can have negative consequences like affecting bio-diversity, increased vulnerability to pest and diseases and potential disruptions to local water cycles.

In addition to direct aid, governments can also implement regulations and financial incentives to encourage citizens to adapt to a changing scenario like regulations promoting water conservation for example would help communities at the time of decreased fresh-water availability.

Finally, Government bodies can also help the masses by disseminating technical information on the possible response to adapt to climate and Natural change which will help in better practice like helping a farmer figure out what farming practice needs to change in order to be better adapted to a drier climate.

There are solutions which can be deployed by using the natural resources for conserving, restoration and management of natural capital and some of them are enumerated below:

1. *Forest conservation and reforestation*: Forests absorb carbon dioxide from the atmosphere for photosynthesis. So, protecting existing forests and planting new trees can help sequester carbon, reduce emissions.
2. *Agroforestry*: Integration of trees into agricultural landscapes help sequester carbon-dioxide.
3. *Soil Carbon sequestration*: The large amount of carbon in the soil can be stored by agricultural

practices like conservation tillage, cover cropping and organic farming.

4. *Wetland Restoration*: Wetland such as marshes and swamps store carbon in the soil along with other benefits like improving water quality and reduce flood events.

Case Studies on Nature Based Solutions:

1. Combination of SDGs (13,14 and 15) targeted by Nature Based Solutions:

The case study is attempting to understand how protecting ecosystem like forest, grasslands, mangroves and wetlands (SDG 14, 15) can address human-caused climate change (SDGs 13).

Climate Change is caused by excessive carbon-dioxide and other greenhouse gases generated by human. Plants absorb carbon-dioxide to do photosynthesis to produce chemical energy in the form of sugars and building blocks for their structural tissues. The carbon is retained in the plant or the wooden product till it is decomposing or burn the carbon-dioxide is retained.

The microbes and fungi in the terrestrial forest absorb and sequester carbon-dioxide in the soil. Wetlands can retain and absorb flood waters which in protect the building and infrastructure. Mangrove attenuate storm surge and provide important habitats for fish and other marine life

For nature-based solutions to be viable, the World Wildlife Fund (WWF) stresses the below points to be included:

- Climate and increase ecosystem functionality be addressed
- Science-based approach
- Maintain Synergy
- Designed and implemented with the help of local stakeholders and indigenous people
- Measurable and Traceable

By reviewing the same, we can understand the vulnerability of some of the well-known nature based solutions:

- ✓ Planting one species of trees can fail unless it addresses the bio-diversity and ecosystem.

One species of tree will address carbon-dioxide perspective however it will not remain for decades and hence it will be burned or the nature based

solution will not exist if bio-diversity is not respected.

To ensure long term growth / existence of the nature based solution, we need to ensure biodiversity and ecosystem is respected as per the world wild life fund.

Source: World Wide Fund for Nature(wwf.panda.org) and GARP SCR Text Book, 2024

Macroeconomic Shocks, External Financing Constraints and Nature Degradation:

As per the relevant World Bank report 2024, many developing countries are facing a prolonged slowdown due to a series of shocks that impacts global economy. The same is hindering the developing countries efforts to address climate change, reduce poverty and contribute to food security as per IMF report 2024. Additionally, liquidity pressures, high debt service impacting vital investment and social spending including mitigation and adaptation to the natural and climate risk.

As per UNCTAD 2024, 54 developing nation spends 10 percentage of government revenues for debt servicing in 2023. Nowadays, many developing countries are issuing foreign debt for servicing existing debts against expected revenues from natural resources, exporting natural resources including bio-diversity extracts, over-exploitation of eco-tourism, indirect foreign takeover of natural resources through carbon credits or securitized “green” assets.

Foreign Exchange (Mainly in USD) requirement occurs due to “premature” deindustrialisation” and “re-primarization” in developing countries with significant trade related pressure on natural resources (Rodrik 2016; Alami and Dixon 2024). It almost becomes the specialisation of developing economies to export commodities. Advanced economies are becoming the net importers and developing economies are the net exporter of primary products (Malik et al 2024). Further, nature loss can be accelerated by new order of global trade. Large advanced countries like China are the top 10 net importers of deforestation and low income countries like Indonesia and Paraguay are the top 10 exporters of deforestation (Mittempergher, Vergez and Puydarrieux 2023). There is evidence that

developed economies are consumer of high levels of biodiversity based services by importing upto 40 percent of pollinator dependent crops from developing economies, incentivising cropland expansion at the cost of biodiversity (Silva et al 2021). Global impact on biodiversity is 25% due to consumption based international trade (Marques and others 2019).

The requirement of large foreign exchange meeting through nature degrading exports could lock countries into extracting growth models which will encourage nature-degrading investments. Given that many developing countries rely on natural capital for their exports (Dasgupta and Levin 2023), which will lead to surge in investment and lock infrastructure associated with nature loss inducing and carbon intensive activities. For example, growth in soy production and mining due to export and addressing balance of payment has lead to nature loss and deforestation in Argentina and Democratic Republic of Congo (Dempsey et al 2024).

Considerable efforts are being made in the global governance on nature and climate to take into account these linkages and domestic constraints linked with the international monetary and financial structure.

Similar to the climate related risk, Financial Institute contribute to the nature related risk mainly through Fund and Non-Fund based exposures in the companies that are exposed to Nature related risk. Although some companies are not directly exposed to physical risk, their impact on nature may increase risk incrementally to the economy and financial system. Thus along with physical risk, these companies will be exposed to transition risk due to enactment of legislation and regulation aimed at curbing or prohibiting certain activities which are detrimental to the nature which in summation will also affect the Financial Institution which has an exposure in those companies.

Debt Sustainability and Nature:

Nature loss and debt sustainability are linked and influenced by environmental, economic and social factors. As the economy of many developing economic countries are dependent on either carbon intensive or bio-diversity export activities, the surge in investment for augmenting the same will lead to unsustainable exploitation of natural resources

surpassing the nature's regeneration capability. So, the public finances of emerging economies are sensitive to natural capital loss which reduces their resilience towards environmental and climate induced risk. These risk are amplified by existing structural deficits and low debt carrying capacity.

As heavily commodity exporting economies are reach their nature tipping point, their potential output will significantly decrease. The same fate will be shared by economies heavily dependent on tourism receipt as over-exploitation will accelerate to reach the critical threshold where tourism receipt will decline.

The macro-economic impact of the natural loss will affect public finances and affect the debt servicing availability of the sovereign. The cost of mitigation and adaptation due to natural loss and climate risk will have additional fiscal deficit (Kraemer and Volz 2022),

Additionally, the transition to a nature-positive economy by the importing nation may demand sustainable supply chain regulation.

In such a scenario, investors will demand a risk premium on sovereign debts due to depleting natural capital and potential output growth or any sovereign downgrade will result into high borrowing cost.

So, natural loss is an important scale of a country's sovereign credit assessment (NGFS 2023a). Sovereign Credit Risk assessment should consider the impacts of nature loss and need for investment to reduce the reliance on natural capital. The nature financing gap should also include the debt servicing ability of the sovereign needed for transition to a nature positive economy (Dempsey et al 2024).

Transmission of Nature-related shocks into the Financial Sector

Similar to the climate related risk, Financial Institute contribute to the nature related risk mainly through Fund and Non-Fund based exposures in the companies that are exposed to Nature related risk. Although some companies are not directly exposed to physical risk however are exposed to transition risk due to enactment of legislation and regulation aimed at curbing or prohibiting certain activities which are detrimental to the nature.

The nature-related shocks could transmit to the financial sector in the following way:

1. Credit Risk: It is mainly driven by counterparty credit risk emanating from the fund and non-fund based exposures to the companies impacted by nature or any disruption in supply chain due to nature related risk.
2. Market Risk: Biodiversity loss or change in government policy may impact some sectors more which are not captured adequately by the market which will impact the equity and bond holdings of different financial institutions. For instance, the ECB-ESRB (2023) underlined that EU's proposal to reduce 20% use of fertilisers by 2030 could affect the profitability of chemical companies which will reflect in their shares.
3. Liquidity Risk: Financial Institution having higher exposure to nature related risk will have lack of funding or withdrawal of funding at certain times.
4. Underwriting Risk: Nature related risk would increase claims which will affect the insurance provisions (premiums and claims). For example: Brazilian Authorities noticed that summer droughts are persistence in the southern region of Brazil result in potential insurance payments exceeding USD 1 Billion in 2022. Other examples are crop insurance claims due to reduce soil fertility, increased marine and business interruption lead to more claims.
5. Operational Risk: Financial Institution may face operational risk due to disruption in facilities, suppliers, technologies and nature related litigation cost will entail both legal and reputational risk.

While Banks tend to be mainly exposed to credit risks, non-bank financial institute exposed to market risks, particularly in advanced economies.

The insurance companies will demand higher insurance cost due to underwriting losses in catastrophe. High insurance premium will reduce insurability which will either lead to reduce funding from commercial banks or credit cost of the bank. So, ultimately it will also pass to the government under the ambit of socio-economic development leading to more pressure to the already strained fiscal balance of the government particularly to the developing or under-developed countries.

The Task Force on Nature related Financial Disclosures (TNFD) identifies systematic risk as ecosystem-stability risk and financial stability risk where the collapse of ecosystem will drive physical and transition risk which will materialise into financial stability risk (TNFD 2023).

This may arise at the intersection of credit, market, liquidity and underwriting risks, with variation in expectations and risk aversion as the main transmission channels. Variation in expectation can be in the form of asset prices or profitability of sectors or firms or risk aversion.

Other changes are in the form of transition related cost due to nature or physical risk damaging the real estate or any other economic assets affecting Bank operations and legal liabilities. The devaluation or revaluation of assets driven by increased risk aversion and shifts in expectation could cascade into “nature Minsky moments”. All the events will end into a potential systematic financial crisis causing widespread value destruction including stranded assets and jobs.

The ability of the financial sector to bank the real economy could be hampered due to knock effects on real economy production including cross-sectoral and cross-border amplification. Positive correlation among the affected sector of the economy could weaken the financial system and ultimately trigger a protracted economic contraction.

Below are the instances where the nature related risk on the Financial Systems are clearly spelled out:

- Work of the Financial Stability Board (FSB), Swiss Financial Market Supervisory Authority (FINMA), Hong Kong Monetary Authority (HKMA) and Banco Central do Brasil (BCB) underlines cross border nature related risk materialisation through global disruptions and financial systems interconnectedness.
- The European Insurance and Occupational Pensions Authority (EIOPA) highlighted the insurance availability may be affected by global nature related shocks causing systematic impacts.
- The European Central Bank (2023b) published the impact of the euro area economy and banks on biodiversity by providing the estimates of financial exposure of euro area banks to climate and nature risk are much higher by considering

the physical and transition risk (like where firm have higher combination of GHG emissions and biodiversity loss either directly or via supply channels) as compared to baseline where non-financial companies are exposed to either climate or nature related risk in silos.

- De Nederlandsche Bank (DNB)’s TNFD pilot on two of the central bank’s reserve portfolio indicated that nature related risk are not diminished in a Paris-aligned mandate.

Physical Sources and Transition of Nature Related Risk:

1. Transition Risk:

Transition risk emanating from nature loss are gaining traction as global policy efforts to halt biodiversity loss intensifies. Transition Risk mainly comes from the misalignment between the economy and the market forces vis-a-vis the restraint on extraction of environmental resources to make the economic activities and human life sustainable.

The Kunming-Montreal Global Biodiversity Framework (GBF) marks itself as one of the credible proxy for potential targets aimed at addressing urgent bio-diversity concern by 2030.

The below targets from GBF will be discussed as how it will impact policy transmission channel:

- Target 18: Aims to phase out of subsidies that are harmful for bio-diversity:

The harmful subsidies are causing natural degradation and biodiversity loss which is threat to indigenous peoples and local communities. Harmful subsidies like subsidies for fossil fuels are driving fossil fuel consumption (UNEP 2023; Black and others 2023).

The subsidies are negatively impacting biodiversity in both directly and indirectly. Direct impacts are like land conversion to bio-fuel crops and indirect effects like climate change.

The GBF Target 18 challenges the fundamental policy as phasing out harmful subsidies would have structural economic impacts, particularly on extractive industries and agriculture given their reliance on subsidies. Additionally, if the Target 18 implemented then it would also require an important just transition given the socio-economic contexts of emerging market and developing countries like

subsidy phase-out of harmful fertiliser will have an impact on the country where the majority of the population depends on Agriculture.

As per UNDP and BIOFIN 2024, the subsidies are approximately to be at USD 640 Billion in Energy, USD 520 Billion in Agriculture, USD 350 Billion in Water, USD155 in forestry and USD50 Billion in Fisheries which are becoming counterproductive by under-pricing of natural resources leading to overconsumption and unsustainable use of the ecosystems. Subsidies are in the form of direct fiscal expenditure by the sovereign, tax breaks and price supports and their impacts varies considerably.

There will be an increase in the counterparty risk of the Banks which has an exposure to the sectors and people who are directly impacted due to the transition risk of the phasing out of subsidies.

- Target 3: Aims to conserve and manage at least 30 percent of land and water areas by 2030 is another source of transition risk:

This target is aimed to protect 17 percentage of terrestrial and 10 percentages of marine areas.

There are major political, economic and logistical challenges as it involves land rights, financing conservation efforts and need for international co-operation.

The establishment of protected areas and establishment of sustainable management practices in the bio-diversity rich and carbon-sink areas are a significant source of transition risk.

There are Bank exposures exposed to areas targeted for protection against GBF target 3 which means transition-related financial risks associated with conservation related areas.

There are also challenges in form of bridging data gaps to do the risk assessment of transition risk sources and some of them are appended below:

- I. Elasticity effects of harmful subsidies.
- II. Other ecologically aligned economic activities in biodiversity-sensitive areas.
- III. Impact of the transition in under-developed and developing countries.

Also, there are lack of third-party verification of the data used to do this kind of risk assessment. Unavailability of third party verified data on harmful

subsidies, geographical subindustry and company size breakdown and the other factors which impact nature requires further research.

Additionally, as per NGFS 2023a models and scenario-analysis must be improved to assess resilience to both nature shocks and policy and hence a granular understanding of transmission channels to the Banking system needs to be developed.

2. Physical Risk:

Physical risk is the tipping point beyond which nature irreversibly enters a degraded state. Tipping point is the minimum nature capital needed to stop irreversible collapse. It is important to identify the level of ecosystem degradation and which ones are more degraded. This can be done at the relevant scale say country which could be combined to identify sectors vulnerable to physical risk. The same understanding would help to assess the magnitude of shocks to the economy and prices particularly agricultural prices and spell financial stability risks, also the gradual deterioration in ecosystem services like pollination and soil erosion.

One of the recent example of tipping point is the Amazon rainforest system, which could soon reach its tipping point due to increased exposure to unprecedented stress from deforestation, extreme droughts, warming temperature and forest fires leading to large scale collapse.

Considering the limits imposed by Nature and Earth System, productivity can be defined as production efficiency subject to the preservation of the nature which is the basis for creation of economic value. So, it can be construed that increase in labour or capital productivity accompanied by loss in nature is false sense of productivity as it affects the basis of economic value creation.

If the resources extracted and the waste placed back in nature exceeds the nature regeneration limit and thus this path will make the productivity unsustainable.

However, to become unsustainable state the unsustainable production needs to be over time.

So, there can be three possible states of the world on the sustainability of production:

- Sustainable State: Production is at sustainable and hence the use of natural resources does not degrade the nature to a low level.
- Unsustainable State: Natural capital is depleted at unsustainable level at some periods to drive economic expansion. It means the natural capital is still above the tipping point with each period of unsustainable production
- Irreversible collapse State: Over-all production is at unsustainable level surely leads to a collapse.

Policy Intervention can be implemented only at Sustainable state and Unsustainable state to reverse environmental degradation. As, in the irreversible collapse state rendering natural recovery is not feasible because of the excessive deterioration of natural system.

However, defining tipping point is almost impossible to determine with certainty like a coastal coral reefs collapse would cascade to marine biodiversity loss and adverse effects for other ecosystems and human livelihood with a magnitude which is difficult to anticipate.

Also, to determine tipping point at the appropriate geographic scale requires multidisciplinary work however such work would require extensive and high quality data, sufficient financing and political support and then also the probability of uncertainty will remain high.

There is a paucity of third party verified data for which in sights needs to be understand from the private vendor data providers like MSCI regarding voluntary reporting on indicators relevant for physical risk.

As per the Carbon Disclosure Project (CDP) Global: Water Questionnaire just under 55 percent of companies included water-related issues into their long term business plans however there are no uniformity for measuring the effectiveness of nature related risk.

This warrants the importance of specific introduction on governance like board and management oversight, incentives to board members and management of nature-related risk and strategic planning for example nature related policies across key economic activities with time bound and

quantifiable targets and solution for the supply chain bottlenecks.

Case Studies on Physical and Transition Risk

1. Case Study on Real Estate:

PHYSICAL RISK

Real estate is static and hence they are vulnerable to get affected in physical related risk like wildfire and flood risk. As a warning sign a certain particular wild fire ravaged parts of Australia and California in 2019-20 which stops the local insurer to stop selling residential insurance.

Another example is coastal flooding risk in USA where the real estate faces both sea level rise risk and increased frequency of storms and hurricanes pricing into property markets and then indirectly to banks, insurers and wider financial systems. An analysis by Bernstein and associates in 2019 showed that properties exposed to sea level rise (SLR) sell at discount of 7% vis a vis unexposed properties matching key characteristics.

Keenan and Bradt highlighted that local lenders pass on more SLR risk to secondary market then large national banks indicating that local banks are having more access to softer information like SLR. Ouazad and Kahn mentions that the physical risk prompting mortgage originators in USA to increase the mortgage share just below the limits of mortgage eligible for securitisation by the government sponsored enterprises like Freddie Mac and Fannie Mae and hence passing on SLR risk to wider markets.

TRANSITION RISKS

Transition risk affects the real estate through the energy use of buildings. Electricity can be agent of transition risk if the source of energy is fossil fuel.

Many jurisdictions are updating building codes on the basis of higher energy efficiency standards and requiring the use of renewable energy. For example, UK's Minimum Energy Efficient Standards (MEES) highlights how building can cause transition risk. The UK system provides rating from A to G on the basis of energy efficiency. Under the MEES rule, the properties with rating of F and G could not be rented on new lease and for existing leases it was extended from 2023. Any non-compliance would bring fines.

This could be a transition risk for banks if landlord credit position deteriorates due to lost income or the market value of F and G properties falls.

As per Bank of England, energy efficiency rating is a predictor of credit risk on residential properties.

2. Case Study on Electricity Generations:

TRANSITION RISK:

Electric Utilities is one of the primary hit of transition risk like coal power plants can be affected directly from transition policy risk which are mandated to shut down in Germany in a phased manner by 2038 means many coal power plants will not complete its shelf life.

Coal power plants can also be affected from cost competitiveness of renewable energy. As per research firm BloombergNEF the cost of electricity from solar, offshore wind and onshore wind is reduced to USD 39, 78 and 44 per MWh as of 2020 from USD 347, USD 190 and USD 111 from 2009. So, the economic momentum is strong for renewable sector to replace fossil fuels even without policy interventions.

PHYSICAL RISK:

The climate change induced summer temperature and droughts in western US is a significant contributor of wildfires which is responsible for doubling the forest fires from 1984.

In 2018, in a dry and warm day, poorly maintained equipment of California based Pacific Gas and Electric (PG&E) ignited campfire which burnt 84 people and devastated the “Paradise” town. The firm was held responsible in court and had to declare which has been termed the “first climate change bankruptcy”

In January 2021, an extreme cold spell due to jet stream deviation lead to unseasonable drop in temperature in Texas which froze electricity infrastructure comprising of natural gas plants and nuclear plants to wind turbines which was not “winterised”. The same lead to blackouts in the state leading to death of several people due to freezing.

The incidents voted the importance of preparing for extremes in the future.

Case Studies on nature-related risk by Institution:

1. Analysis of World Bank of nature related risk in Brazil:

Brazil accounts for 15% to 20% of biological diversity and hence vulnerable to deforestation and climate change. As per the World Bank’s estimate Brazil’s GDP will be cumulatively lower by 20% from 2021 to 2030 under a partial ecosystem collapse scenario compared with business as usual scenario due to collapse of ecosystem services like wild pollination and marine fisheries food provision. The World Bank calculated the exposures of Brazilian Bank from their scope 3 emissions.

On physical risk, the study follows the laid down procedures of DNB (2020) by linking bank’s credit portfolio to economic sectors with their associated production process. It was found out that 46% of corporate credit was exposed to business process highly or very highly dependent on one or more ecosystem particularly which provides climate regulation, surface water and ground water. On the basis of historical sensitivity of Non-performing loans to GDP, it is estimated that under a low probability, high impact scenario there could be an uptick of nonperforming corporate loans by 900 basis points.

On transition risk, the study found that 15% of the Brazilian Bank’s loans are to firms which are operating under protective area and it can be increased to 38% if the priority areas included under protective area which may impact the Bank’s portfolio leading to halt in developing activities of the nation.

2. Analysis of ECB of nature related risk in euro areas:

Quantitative analysis was conducted to understand the physical and transition risks arising from the dependencies on ecosystem services and financing activities contribute to natural capital loss.

For Physical Risk, the ECB (2023a) observed that 75% of the corporate loans are vulnerable to ecosystem degradation in euro areas. In the scenario of current emissions pathways and biodiversity losses, the losses of euro-banks could be three times higher than the Paris aligned scenario. For Transition Risk, the ECB (2023b) The impact of the euro area economy and banks on biodiversity

quantified that the biodiversity impact in the euro area is equivalent to the loss of 60% European land area. It highlighted that surface water provision could be impacted by higher chances of drought which will cascade to the financial institution which has provided loans to the economy vulnerable to surface water provisions. Similarly, agriculture and electricity provision in the euro areas are exposed to transition risk from capping of GHG emissions

(climate change) and nitrogen use (policies to halt biodiversity loss).

The ECB concluded that exploratory analytical studies are creating the awareness of natural risk and also highlighted the need for future research to address the risk effectively.

Summary of other analytical work by financial authorities

Table 4: Economic analysis by financial institutions

SI	Paper	Jurisdiction	Important Details
1	DNB(2020)	Netherlands	<p>Physical Risk: 36% of the financial sector exposures are vulnerable to high or very high dependency on at least one ecosystem services.</p> <p>Transition Risk: Financing activities driven by equity investment of dutch financial system at a given point in time contributes around an estimated loss of 58,000 square km of pristine nature.</p>
2	Banque de France (2021)	France	<p>Physical Risk: 42% of the equity and debt investment held by French financial institution are to companies which are vulnerable to high or very high dependency on at least one ecosystem services.</p> <p>Transition Risk: French securities at a given point contributes to an estimated loss of 130,000 square km of pristine nature.</p>
3	World Bank (2023), Biodiversity and Finance: A Preliminary Assessment of Physical Risks for the Banking Sector in Emerging Markets	Emerging Markets	<p>Physical Risk: On a sample size of 20 emerging markets, it is observed that on a mean 55% of the Bank loan exposures are for a activities that are highly or very highly dependent on at least one ecosystem services.</p>

Source: Financial Stability Board Stocktake on Nature Related Task, 2024

Financial policies addressing Nature – Related Risk:

The conceptual understanding of depleting natural capital is bringing significant challenges and opportunities for the financial sector globally.

There are some global protocol or regulations which are limiting the nature degrading activities like Protocol on Environmental Protection to the Antarctic Treaty, United Nations negotiations on deep-seabed mining regulations, and other laws that prohibits illegal activities. A global change of this magnitude would draw cap exposure limits of financial system. However, many rules are not

implemented for economic activities. The critical role of financial sector policy to phase out harmful activities and for investment to transition to nature positive economy are likely:

1. Information to address pricing of nature related risk and development of impact financing for conservation and restoration.
2. Supervisory guidance for quantification and management of nature related risk.
3. Financial Governance to mitigate short term biases.

There are some jurisdictions where supervisory guidance exists, it covers nature related risk under the environmental risks, including climate (FSB

2024). There are global collaborative initiatives by the Financial Stability Board, Network of Central Banks and Financial Supervisors for Greening the Financial System (NGFS), Group of Seven (G7) and Organisation for Economic Cooperation and Development (OECD) seek to address nature-related risk. NGFS and OECD developed non-regulatory framework to assess bio-diversity related financial risks. In some case with the support of multilateral agencies like World Bank there are various regional and local initiatives across countries to identify, assess and address nature-related risk like considering nature-related risk as part of their broader frameworks.

In recent years, there has been a push for corporate disclosures on nature like TNFD encouraging financial and non-financial companies to assess, report, and act upon their nature-related dependencies, impacts, risks, and opportunities (FSB 2024). In April 2024, a project on disclosure of nature related risks and opportunities launched by International Sustainability Standards Board

Critical insight into the emerging discipline of nature-related financial risk management is provided by the 2025 Global Survey of Nature Risk Management at Financial Firms by GARP (Global Association of Risk Professionals). The report benchmarks the progress of firms in integrating nature risk into governance, strategy, risk frameworks, metrics, and disclosures by surveying 48 major financial institutions (banks, asset managers, and insurers managing over USD 50 trillion in assets and balance sheet holdings). It acknowledges that the firms are progress on integrating nature risk is evident, especially in governance and disclosure. However, nature-related significantly lag behind climate risk in institutional maturity and integration.

The survey observed uptick in board-level oversight (50%, in 2025 vis a vis 46% in 2024), increasing acceptance of scenario analysis (21% currently using and 52% planning to use in future), and proportion of firms assessing nature-related risks (42%, in 2025 from 25% in 2024). Notably, increasingly firms are now recognizing nature loss as a risk, though many remain in the early stages of formal integration. However, only 6% of firms have developed a risk appetite statement for nature, and

21% of the firms are currently leveraging metrics, targets or limits to manage nature-risk.

Data availability and modelling deficiencies remain the most cited challenges across all time horizons, with regulatory uncertainty and staff capacity also noted as significant barriers. While scenario analysis remains nascent, its intended expansion signals growing institutional recognition of nature-related systemic vulnerabilities, particularly in ecosystems with high biodiversity or water stress. Training and internal capacity-building are slowly improving, but most firms report teams of fewer than five staff dedicated to nature risk.

The GARP maturity model illustrates that the average across all firms has increased by 15% from the last 2024 Garp Survey. The report concludes by urging firms to leverage their experiences of establishing good climate risk management to build their nature-risk journey. In sum, while nature risk management is gaining traction, it remains in early development, necessitating focused attention to overcome barriers of regulatory uncertainty and availability of staff along with poor availability of data and novice models.

Some of the examples of supervisory guidance for financial institutions to manage nature related risk and overall environmental frameworks are appended below:

1. Brazil: The central bank has boosted its prudential regulations on environmental risks by implementing exclusion rules for concessional rural credit to protected areas and indigenous lands.
2. Hong Kong Special Administrative Region: From 2020, banks are required to manage environmental risks emanating from environmental degradation, biodiversity loss, and deforestation as part of common assessment.
3. European Union: The capital requirements directive and regulations for banks as per its amendments (EU Regulations 2024) implements ESG risks requiring disclosures, governance, and management of ESG risks which includes factors like environmental degradation of ecosystem and biodiversity loss.

Currently a few countries include nature related taxonomies however their incorporation is gaining traction including mega-biodiverse countries.

As per the data collected as on July 30, 2024 the status of taxonomies of some of the countries are appended below:

Table 5: Climatic taxonomies by various countries

Particulars	Taxonomy Adopted	Taxonomy under development	No Taxonomy under development
Biodiversity and ecosystem is fully or partially implemented	ASEAN, China, Columbia, Dominican Republic, Georgia, Egypt, EU, Korea, Kazakhstan, Mongolia, Russian Federation, Panama, Sri Lanka, Thailand, Singapore	Costa Rica, Latin America, and Caribbean Common Framework (co-ordinated by UNEP)	
Biodiversity and ecosystem is a broad objective and sometimes supported with “do no significant harm” criteria	Bangladesh, Ecuador, Indonesia, Malaysia, Mexico, Papua New Guinea, South Africa	Brazil, Chile, India, Kenya, Peru, Vietnam, Rwanda, Senegal	
Biodiversity and ecosystem protection as future objective		New Zealand, UAE, UK, Philippines	
Biodiversity and ecosystem not yet included		Australia, Argentina, Hong Kong SAR, Canada	Democratic Republic of Congo, US, Venezuela

Source: IMF Staff Climate Notes, based on taxonomy data collections for 44 jurisdictions and regions as on July 2024.

Over-view of Financial Instruments in the context of Global Biodiversity Framework:

Aligning capital flows from nature degrading to nature positive development or without affective bio-diversity. The end use of the capital flows needs to address nature specific purposes like protection, restoration and sustainable land management.

The dual requirement of stopping financing to harmful nature related activities while closing the financing gaps of nature underscore broadly the framework of Global Diversity Framework (GBF).

The framework underlines the shared vision of “living in harmony with nature” by 2050 with four main policy goals supported by 23 policy targets within 2030 to halt and reverse bio-diversity loss.

These targets provide guidelines for the financial sector to act like:

1. Target 14: Highlights the concepts of alignment to nature by advocating the needs to align financial flows with the goals and targets of the GBF.

2. Target 15: Financial Institutions and Business needs to reduce negative impacts and increase positive on biodiversity including reporting.
3. Target 16: Supply Chain transparency and certification program
4. Target 18: Rewards for nature positive choices like phasing out harmful subsidies by 2030.
5. Target 19: Mobilising USD 200 Billion annually from all sources.

As per UNEP 2023 report, the scale of negative financial flows from both public and private is approximately at USD 7 trillion annually out of which private’s share is USD 5 trillion per year. These flows are degrading nature and holding back flows for climate risk mitigation and adaptation.

The GBF estimates that meeting target 18 and target 19 requires around USD 700 Billion annually while other studies cited greater shortfall to the amount of USD I trillions by 2030 (Deutz and others 2020). So, the estimated amount are differing across different bodies and all shortfalls are in estimates given the uncertainties, methodologies and data gaps. However, all estimates are echoing the needs for redirecting finances from harmful activities.

There are a wide range of nature financing methods in recent years however the bottle neck is in the scaling up of nature finance. The bottleneck for scaling up nature finances are due to some of the reasons:

1. Lack of policy support for conservation, restoration, and sustainable use of nature. For example, prices and market behaviour for subsidies that are harmful for environment.
2. Lack of bankable projects due to small and localised nature, limited technical capacity, inconsistent project assessment.

3. Uncertainties on the integrity of market mechanism
4. Limited demand from industries
5. Lack of co-ordination of public and private market participants
6. Absence of standardised data and performance indicators.

The current policies and frameworks are skewed on risk which may be de-railing the financial innovations and market interest.

Some of the financial instrument for nature are appended below:

Table 6: Nature specific financial instruments

SI	Instrument	Description of the instrument	Challenges of the instrument
1	Use of proceed debt instruments (thematic debt)	<p>Issuer to invest the proceeds raised for pre-defined nature/biodiversity-oriented projects like ocean conservation, blue infrastructure, reforestation.</p> <p>The instrument's issuance framework includes environment metrics to track use of proceeds which ensures impact investing.</p> <p>Repayment takes place through project revenues or state budget, grants and donor capital (sovereign or multilateral development banks/ development finance institutions (DFI) debt.</p>	<p>Monitoring costs, due diligence and enforcement.</p> <p>These instrument face challenges in terms of lack of income generating projects at scale and technical skills in aggregating nature related projects, lack of corporate and sovereign issuers and slow development of reporting and financial sector policies on nature.</p>
2	Sustainability based debt instrument	<p>The objective of the instrument is to achieve nature related targets with a coupon price linked to the predetermined KPIs. In case of any negative trigger event that can increase the coupon price.</p> <p>Repayment takes place through project revenues and the issuer's general revenues.</p> <p>There are also sovereign sustainability linked bonds where the bond interest is tied up with meeting the sustainability targets of the issuing governments like Chile's issuance in March 2022 which is focused on reducing greenhouse gas emissions and increasing renewable energy sources.</p>	<p>These instruments may suffer from limited scalability considering the lack of nature transition planning (for both corporate and sovereign level).</p> <p>The coupon structure is rewarding for achieving the KPI however there should be a penalty mechanism for missing the KPIs (IMF 2022)</p>
3	Blended Finance	<p>Strategic use of concessional resources to mobilise financing from public and private financial institutions to achieve climate related impacts (NGFS 2023c)</p> <p>For example, MDBs or DFIs investing in a mezzanine investment or give a guarantee to de-risk private investors.</p>	<p>The complex instrument is difficult to replicate.</p> <p>Environment and financial credibility of the underlying instrument.</p>

		Credibility is enhanced through the selection of underlying assets and their certifications process	
4	Debt for nature swaps	<p>Instruments to promote specific investments and policy usually nature conservations oriented and some debt relief on a sovereign's external debt.</p> <p>There are many instances where the instrument have benefited from political risk guarantee provided by the US Development Finance Corporations due to its higher credit rating.</p> <p>Debt buyback involves replacement of a Eurobond for a portion of blue or green bond (with a discount) as their proceeds will be used for nature related investment</p>	<p>Small scale nature of financial arrangement and complex mechanism which are hard to replicate and scalable.</p> <p>Limited impact on fiscal space to date (Carbon brief 2024). Historically, DNS have not provided debt sustainability (Chamon et al 2022).</p> <p>Use of "tied aid" approaches favouring creditor country interests in use of freed-up resources.</p> <p>Debtor country must have strong sovereignty over its fiscal and natural resources (Paul and others 2023).</p> <p>Debtor Nations should not be vulnerable to global financial cycle which can achieve sustainability achieved by DNS (Standing 2023).</p>

Source: IMF Staff Climate Notes

Policy Initiatives:

Global Policies:

Scaling up nature finance needs existing financial instruments and their relevance across different contexts, income levels, and ecological and financial needs like developing an instruments to incorporate robust conservations rewards for sovereigns, quasi-sovereign and private sectors (Harstad and Storesletten 2023). Debt for Nature needs to be credible, impactful and scalable. Nature based financing strategies required in the context of the GBF, taxonomies, national biodiversity strategies and transitional plans. There is a need for building technical capacities, engaging indigenous peoples and local communities and robust monitoring mechanisms.

Scaling up of finance for nature requires comprehensive approach and one size fits approach to be avoided as the relative impact of the instruments are heterogeneous (International finance, domestic resource mobilisation, fund for

environment conservation and so on). Most bio-diverse countries are emerging countries with limited borrowing capacity and low credit rating/ Moreover, policies should address the nexus of climate change mitigations and adaption and nature conservation. For example: Forest conservation, restoration of coastal mangroves is critical and should be explored by policymakers and market participants working with communities and scientific experts.

Global Financial Sector policies:

Global collaborations are warranted for developing and ensuring access to reliable and comprehensive data on nature which is pre-requisite for scenario analysis, stress testing for effective risk management and to align financial flows with nature. The same may need standardisation of transition plans, taxonomies and disclosures and support physical and transition risk. Harmonisation and strengthening of nature related disclosures is dependent on the work of international standard setters including

International Sustainability Standards Boards (ISSB) and the International Organisation of Securities Commissions (IOSCO). The design and use of metrics on ecosystem state and vulnerability and interdependencies within species are required to solve the nexus between climate and nature. Geographical indicators, impacts on nature across sectors and supply chain traceability needs to be incorporated while drafting policies for nature positive development. National accounting and reporting will integrate biodiversity valuation and the same will be followed in emerging and developing countries which will be critical. Availability of credible data will be the baseline to monitor state of biodiversity due to investments which will build strategies and policies towards nature conserving financing. As per TNFD report 2023, substantial technological advancement is required for data generation and analysis to improve data credibility, collection, consistency.

Central Banks and supervisors are required to support the alignment of the financial sector with nature related goals and targets. Supervisory actions can facilitate constructive feedback loops among national biodiversity goals, nationally determined contributions, transition plans for nature of the various corporate including financial institute (IMF 2023, World Bank Group, OECD 2023). As an outcome of such initiatives it could shift in capital allocations from harmful to nature positive activities and projects while balancing risk in capital markets which will implement the Paris Agreement and the GBF.

To facilitate just transition involvement of local people, communities are required as they contribute meaningfully in the financial ecosystem.

Non-banking financial corporations (NBFCs) could also measure biodiversity that are increasingly used across industries. They also need to include nature related risk into their practices into the shareholder and client engagement, risk management and investment strategies.

The TNFD has recommended the four disclosures which are mirroring the TCFD recommendation so that the firm using TCFD recommendation can easily integrate the below TNFD recommendations:

1. Governance: Disclosing of organisation's governance of nature related risk.

2. Strategy: Disclosing of the material dependencies, impacts, risks, opportunities, on the organisation business models, strategies, financial planning due to nature related degradation.
3. Impact Management: Description of the processes to identify, assess, prioritise, monitor nature related risk and opportunities for the organisation.
4. Metrics and targets: Metrics and targets to assess and manage material dependencies, impacts, risks, opportunities due to nature related degradation.

The NGFS provides a list of options for central banks to develop nature-related scenarios.

At national level few authorities like the Netherland, Central bank (DNB) conducted scenario analysis in 2023 to explore the tail events scenario in response to nature degradation. The study concluded that although there is a limited impact of Dutch Financial Institutions however it may be due to underestimating the real economy and financial stability impact of the considered nature scenarios.

There is a general consensus among supervisory bodies and private bodies that more expertise is required and hence some authorities are conducting conferences to promote, share, stress on the importance of nature-related financial risk for central banks and the financial system. The Australian government is co-ordinating with the private sector and TNFD to build market readiness of nature related financial disclosures which includes pilot testing of the TNFD report with Australian Business and publish various reports on learnings to the broader public. In China, China Banking and Insurance Regulatory Commission promotes communication on green financial services among its major banks and People's Bank of China conducts pilot programs for green finance reforms and innovation to explore standard setting on financial support for bio-diversity conservation and new financial instrument for the purpose.

There are capacity building initiatives for supervisors like:

1. Sustainability Training Reference Guide (NGFS STaR Guide) and Sustainability Knowledge and Information Learning Library

- (SKILL) are created by ECB and BCB to encompass nature risk.
2. NGFS Task force on nature related risk provides a forum for authorities to share the work and learn from peers.
 3. World Bank supports global capacity building for nature related risk and also conducted series of seminars across Sub-Saharan Africa, East Asia, Pacific, Latin America and Caribbean on nature related risk.

Policy Initiatives in India:

The Government of India recognises the risk arising from environment and climate change. To address the same, GOI has announced a set of legislative, regulatory and administrative measures for preservation, conservation, and protection of the environment and prevention, control and abatement of pollution.

The Union Government has designated Ministry of Environment Forest and Climate Change (MoEFCC) as the nodal ministry to oversee the implementation of India's environment and forest policies and programmes including climate change. Various schemes are launched by the Ministry aiming at the preservation, conservation, and protection of the environment and prevention, control and abatement of pollution.

These schemes are at various phases of implementation and also include umbrella schemes on national coastal management programme, environmental knowledge and capacity building, environmental education, awareness, research and skill development, control of pollution, national mission for a green India, integrated development of wildlife habitat, conservation of natural resources and ecosystem.

The Impact of some of the schemes are tabulated below:

Table 7: Global schemes and policies

Serial No.	Schemes	Description
1	The National Clean Air Programme	The scheme is launched on 2019 which covers around 130 cities in 24 States and Union Territories. The objective of the scheme is to substantially improve air quality up to 40% reduction in particulate matter by 2025-26 from 2017-18. A portal named "Prana" is launched to update the air quality data in real time.
2	Regulatory framework for circular economy	It has been mandated under the scheme for the producer to get the end of life wastes recycled under extended responsibility regime. Extended Responsibility Regime (ERR) rules is applied for plastic waste, tyre waste, battery waste, used oil waste and e-waste with the objective to enhance the circularity in economy and also facilitate to manage the wastes in environmentally sound manner.
3	Mangrove Initiative for Shoreline Habitats and Tangible Incomes (MISHTI)	The scheme is launched on 5 th Jun 2024, to restore and promote mangroves as a unique, natural ecosystem which will preserve and enhance the sustainability of the coastal habitats. The objective of the MISHTI is to "restore mangrove forests" by encouraging mangrove restoration measures along the coast of India. Approximately, there are 22,561 Hectares of Degraded Mangroves which have been restored in 13 states/UTs. It is estimated that INR 17.96 cores is released for the restoration of 3,836 Hectares in 6 States/UTs.
4	National Afforestation and Eco-development Board (NAEB)	The Board is implementing Nagar Van Yojana which envisages to develop 600 Nagar Vans and 400 Nagar Vatikas in the country during the period ranging from 2020-21 to 2026-27 with an objective to significantly enhance the trees outside forests and green cover, enhancement of biodiversity and ecological benefits to

		the urban and peri-urban areas apart from improving quality of life of city dwellers.
5	Mission LiFE (Lifestyle for Environment)	It is a global initiative launched by India in October 2022 to foster sustainable lifestyle through mindfully deliberating consumption to protect the environment. The initiatives focus on seven core themes: conserving energy, saving water, reducing waste, managing e-waste, eliminating single-use plastics, promoting sustainable food systems, and adopting healthy lifestyles.
6	Eco-Mark Rules	The scheme was launched on 26 th September 2024 to encourage the demand for environmental friendly products aligning with the principles of LiFE. The scheme will promote lower energy consumption, resource efficiency and circular economy. The scheme ensures accurate labelling and prevent misleading information about products.
7	Ek Ped Maa ke Naam (#Plant4Mother)	The Honourable Prime Minister of India on “World Environment Day” 5 th June 2024 launched the campaign urging people to plant trees as mark of love and respect for one’s own Mother and for protecting and preserving Mother Earth. MoEFCC has reached out to Central Government Departments, Institutions and Organisations.

Source: Authors compiled from various sources

Protected Areas in the country have risen to 1022 from 745 in the year 2014. This protected areas accounts for 5.43% of the country’s total geographic area. The community reserves has increased from 43 in the year 2014 to approximately 220 which is a substantial increase in the establishment of Community Reserves.

Apart from the protected areas, India has also 57 Tiger Reserves notified under the Wild Life (Protection) Act,1972 for the conservation of Tigers and its habitat. There are many states which have also declared 33 elephant reserves to provide safer habitats to the elephants.

Since 2014, there are 59 wetlands which are added to the list of “Ramsar” sites making the total number of wetlands to 89 covering an area of 1.35 million ha. India boasts the largest “Ramsar” site network in Asia and third largest in World in terms of number of sites. Udaipur and Indore have been recently included in the same list.

As per All India Tiger Estimation 2022 report, the estimated tiger population in India is 3,862 which accounts for 70% of the wild tiger population of the world.

National Determined Contribution (NDC) guides the climate action for the nation, which aims to reach Net Zero by 2070. The 2008 National Action Plan on Climate Change outlines eight national missions. The missions comprise of solar energy, enhanced energy efficiency, sustainable habitat, water, sustaining Himalayan ecosystems, Green India, sustainable agriculture, human health and strategic knowledge for climate change. All these missions are implemented by their respective nodal Departments.

Some of the important development in Indian Financial system are highlighted in the address delivered by Shri M. Rajeshwar Rao, Deputy Governor, Reserve Bank of India - April 17, 2025 - at Credit Summit 2025 organized by the Bharat Climate Forum at New Delhi on how to build and develop a robust ecosystem for Green and Sustainable Finance in India.

1. Creating a National Level Taxonomy and an announcement of the same was made in the Budget Speech of 2024-25. Meanwhile RBI used the Sovereign Green Bonds (SGrB) framework on acceptance of Green Deposits in April 2023 which align with the SGrB Framework towards identification of green sectors.

2. Development of Robust assurance and verification functions on end use of Green and Sustainable Finance which would then operate as a key enabler for addressing Greenwashing.

3. Transparency in Climate Related Disclosures and Coherence among various sectors on disclosure aspects.

4. To bridge data gaps and provide standardized datasets to Regulated Entities (REs) on three aspects viz: Physical Risk Data, Transition Risk Data, Carbon Emission Data Factors, RBI announced the formation of Reserve Bank - Climate Risk Information System (RB-CRIS) in the Monetary Policy Statement of October-2024.

5. Importance of reforms within the DFIs to play a major role in channelizing the flow of credit for Green and Sustainable Finance in the middle of multi-polar worlds and the importance of representation from/credit flow to the global South.

6. To leverage the benefits of Technology and Innovation in the mitigation of climate change risk - The RBI included Sustainable Finance and Climate Risk mitigation a topic under the Theme Neutral - "On Tap " application facility under the Regulatory Sandbox.

The Speech concluded by recognizing the fact that India faces the dual challenge of fostering and sustaining economic development while addressing the climate change and dealing the same with collaborative and sensitive approach to address the various issues given the impact on the economies and the societies at large.

Conclusions

This paper is voting that biodiversity loss and ecosystem degradation will bring systemic economic and financial risks. Nature and climate risks are deeply connected which branches out in form of physical and transition risks. The current financial system is unable to provide due weightage to the value of natural capital. There are global bodies like TNFD and International bodies like GBF which decides biodiversity targets (e.g., GBF Targets 3 and 18) for providing guidance to address Nature related risk. However, institutional maturity in managing nature-related financial risk remains low compared with the climate risk.

The paper recognised that bridging data gaps, enhanced scenario analysis and taxonomies are critical to embed nature risk into board rooms of global financial house. The Paper advocates to consider micro and macro aspects of adaptation and mitigation strategies to avoid maladaptation. Addressing environmental sustainability and financial resilience will require coordinated action from governments, financial institutions, and multilateral agencies. The integration of nature into economic planning and risk frameworks is imperative for sustainable development by remaining vigilant of limitation of planetary boundaries.

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