The cost of ignoring nature: Insights from soil, pollination, and conservation scenarios

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Executive summary

By 2050, biodiversity loss could cut global crop yields by up to 37% in the Global South and 9% in Europe, due to soil degradation and pollinator decline, intensified by climate extremes. This report from BiROFin illustrates how these effects could lower global GDP by 1.2% and cause sharp regional shocks, including a 12.6% GDP drop and nearly double food prices in Sub-Saharan Africa.

Simple, nature-based measures, such as agroforestry, organic manure, reduced cultivation, and flower margins, can recover biodiversity, boost productivity and are cost-effective in many countries. Large-scale conservation efforts (e.g., protecting half of Earth's land) would safeguard biodiversity with only a 0.4% global GDP loss, although regional food prices could rise. Acting now on biodiversity is an investment in economic stability.

Key insights:

1. **Yields under threat:** Crop productivity could drop by 9-37% worldwide due to degraded soils and pollinator loss.

2. **Economic fallout:** While global GDP might fall modestly (-1,2%), regions like sub-Saharan Africa could lose 12.6% of GDP and face 95% higher food prices.

3. **Nature pays off:** Simple, farm level actions, such as organic manure, reduced cultivation, flower margins and agroforestry, are both cost-effective and productivity boosting.

4. **Trade-offs matter:** Protecting half of Earth's land could safeguard biodiversity but raise food costs where conservation is most intense.

5. **Act early:** local nature based measures are cheaper and fairer than crisis-driven global responses later on.

Access the full report: https://edepot.wur.nl/703497

This summary is structured as follows:

1. Key first-year insights, which guide practitioners in the financial sector, government, and private organisations engaged in environmental and nature-related issues.
2. Importance of understanding the assumptions, data gaps, and model limitations underpinning these results.
3. Implications of biodiversity risks for the financial sector, emphasising both strategic imperatives and opportunities.
4. Next steps, focusing on expanding impact and integrating insights into decision-making.

1 First-year insights: Biodiversity loss, risks, costs, and opportunities ahead

BiROFin findings illustrate how biodiversity-loss-induced declines in soil quality and pollinator loss threaten global crop productivity and have broader macroeconomic repercussions across domestic and international economies. It also shows how these threats can increase when the effects of climate-change-induced extreme climate events on soil quality and pollination resilience are taken into account. Further study evaluates the costs and benefits of abatement measures in Brazil, France, Germany, Italy, the Netherlands, Spain, the United Kingdom, and the United States. A final analysis examines the macroeconomic implications of a global conservation policy that would protect half of the Earth.

1. Climate-driven biodiversity loss threatens Global South crop yields

By 2050, biodiversity loss is projected to reduce crop productivity, especially in the Global South, during extreme climate events (Figure 1). The BiROFin project developed four scenarios to assess the impact of pollination and soil quality loss on crop productivity by 2050. The scenarios consider both the presence and absence of climate-change-induced extreme events. Without climate change, biodiversity-related soil degradation could lower productivity by up to 4.6% and pollination loss by up to 0.5% by 2050. When climate change is included, these impacts worsen substantially. For example:

- In countries such as the UK, Ireland, and the Netherlands, productivity is expected to decline by as much as 10%.
- **In parts of sub-Saharan Africa (i.e. Cameroon, Ghana, the Ivory Coast, and Nigeria), soil quality loss could reach 37%, revealing a sharp disparity in vulnerability and economic exposure.**

Pollination loss during climate extremes could reduce yields by up to 4.7% in Colombia and under 1% in Europe.

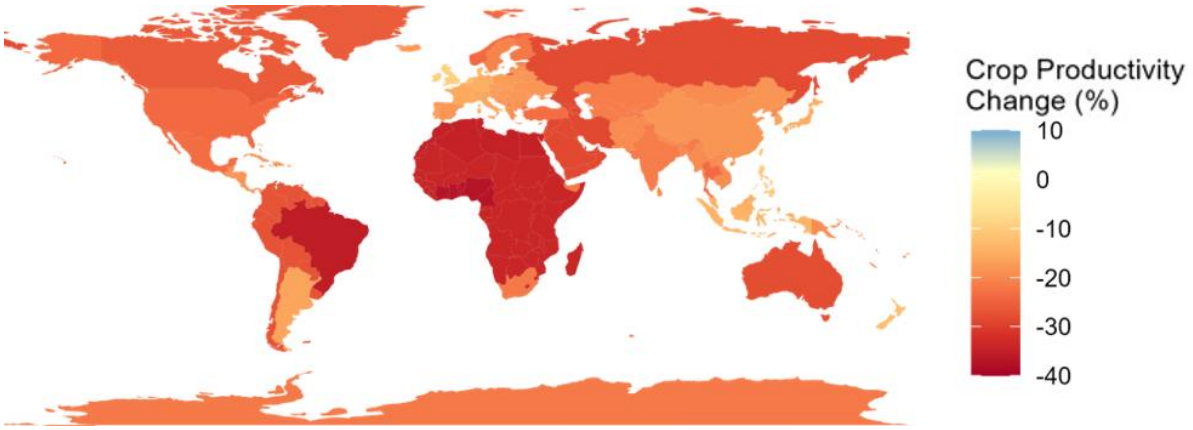

Figure 1 *Projected change in crop productivity due to biodiversity-loss-induced soil-quality loss by 2050, base year 2019, considering climate-change-induced extreme climate events based on IPCC's SSP2-RCP 4.5*

Note*: The above map shows the crop productivity that is projected to be lost by 2050, in addition to what has been lost until 2019. See Online Appendix- Biodiversity and Climate Change Impact for the approach used to derive these results.*

Source*: BiROFin project.*

2. Disproportionate economic impacts of biodiversity loss

By 2050, the projected loss of soil quality and pollination due to biodiversity decline is expected to have a *relatively modest aggregate effect on global GDP*, *but that masks significant regional disparities* (Figure 2). Global agricultural production may decline by up to 5.1%, triggering significant shifts in regional trade and consumption. For example, India may see a 9.8% drop in agricultural production, while European agricultural exports are projected to rise by 15%, reflecting shifting trade dynamics and comparative advantages due to varying levels of soil quality and pollination loss projections between regions in our scenarios. Other sectors face smaller indirect effects, with agrifood manufacturing and services, which are highly dependent on agriculture, adversely affected by up to -2.1% and -1.4%, respectively. ***Although the global GDP is projected to decline by up to 1.2% due to a joint pollination and soil quality loss scenario, considering also the extreme climate events, the economic consequences are highly unequal*, with Sub-Saharan Africa projected to experience a *severe contraction of up to -12.6%*.** The same joint scenario can increase agricultural consumer goods prices by up to 50% worldwide, by 110% in Sub-Saharan Africa, *further amplifying food security concerns*, with global calorie intake potentially reduced by 6%.

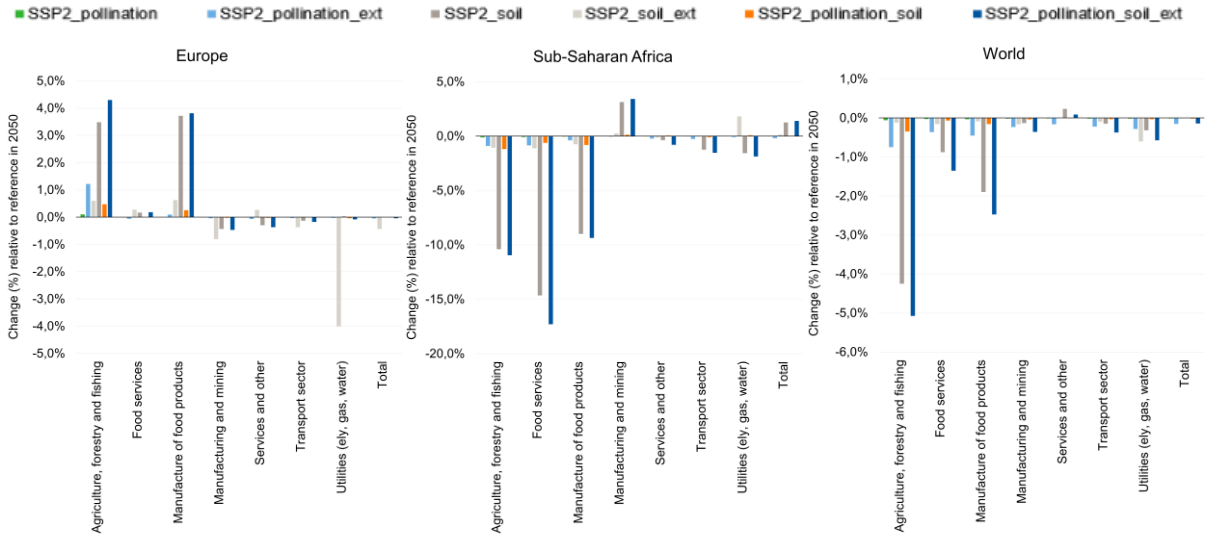

Figure 2 *Projected change in sectoral production volumes in 2050 due to pollination and soil quality loss induced by biodiversity loss and climate change, compared to the reference scenario (SSP2_pollination: Pollination loss scenario without extreme climate events; SSP2_pollination_ext: Pollination loss scenario with extreme climate events; SSP2_soil: Soil quality loss scenario without extreme climate events; SSP2_soil_ext: Soil quality loss scenario with extreme climate events; SSP2_pollination_soil: Combined soil and pollination scenario without extreme climate events ; SSP2_pollination_soil_ext: Combined soil and pollination scenario with extreme climate events)*

Note*: The figure illustrates the average projected impact of soil quality and pollination loss scenarios on the annual production volume across various sectors. This impact is estimated as the percentage difference between the projected production volumes under different pollination and soil quality scenarios and the projected volumes under reference scenario levels for the year 2050. These estimates are derived from the MAGNET model. See Online Appendix MAGNET CGE Documentation for further details about the methodology used.*

Source*: BiROFin project.*

3. Economic feasibility of abatement measures: opportunities and barriers to large-scale implementation

An assessment of six nature-based farm-level measures in eight countries shows that some strategies offer clear and promising global macroeconomic returns, while others remain economically less viable under current conditions (Figure 3). BiROFin identified six measures by selecting from a long list of nature-based measures applied at farm level. Selected measures can be widely adopted to restore biodiversity in eight countries, specifically address pollination and soil quality services loss, and also improve crop productivity. Country level implementation costs of these six measures vary significantly by country, ranging from USD 36 per hectare for flower margins in the Netherlands to USD 764 per hectare for diversified crop rotations in the United States. **By 2050, several measure–country combinations—including organic manure in parts of Europe, agroforestry in Southern and Western Europe, flower margins in the Netherlands, and reduced tillage in Brazil—are projected to generate net global macroeconomic benefits**. These options demonstrate both scalability and economic potential, with the capacity to be applied to as much as 125 million hectares of land. In contrast, diversified crop rotations and cover crops, although broadly applicable, remain less cost-effective at the macro level, which limits their widespread adoption under current economic conditions, unless supported by policy that reduces or shares implementation costs and rewards broader benefits such as improved soil health and enhanced biodiversity through pollination.

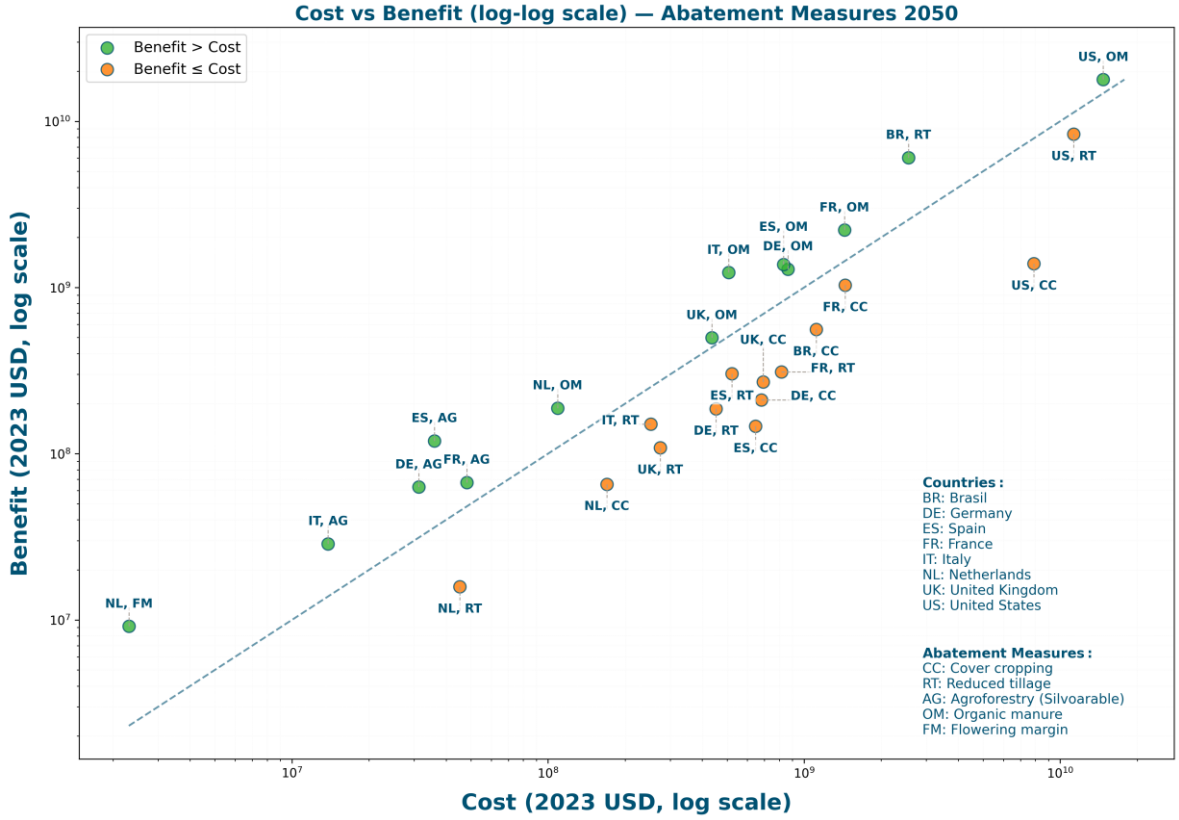

Figure 3 Macroeconomic costs vs global macroeconomic benefits of the selected Abatement Measures by 2050

Note: *Each label follows the format "country code, measure code" (e.g., NL, CC = Netherlands, Cover Cropping). Values are expressed in thousands of USD (2023). Axes use a logarithmic scale, with tick labels showing actual monetary values (e.g., 10^5 = 100,000). Cost estimates are based on per-hectare implementation costs, expected adoption rates, and the area of suitable land in each country. Benefits reflect avoided GDP loss from restored crop productivity by 2050, using results from the MAGNET model under pollination and soil quality loss scenario during extreme climate events. Other potential benefits—such as carbon credits or ecosystem services—are not included. The analysis is conducted under three scenarios (optimistic, pessimistic, and middle), which differ in assumptions about future cost trends and adoption rates. The figure presents results for the middle scenario. The 45-degree reference line indicates breakeven points where estimated benefits equal costs. These estimates are derived by using the approach explained in Online Appendix: Abatement Measures.*

Source: BiROFin project.

4. Balancing global gains and regional risks: economic implications of the Half-Earth land conservation scenario

The implementation of a Half-Earth protection scenario[1] where half of the global land, particularly biodiversity hotspots, is set aside from agricultural and urban expansion in line with Target 3 of the Kunming-Montreal Global Biodiversity Framework (ratified December 2022).[2] This would result in a relatively modest global GDP decline of 0.4% by 2050, equivalent to approximately USD 650 million. This global economic impact is minor compared to the projected economic damages from continued biodiversity and ecosystem services loss presented above. This highlights the potential long-term benefits of large-scale conservation. However, the policy would lead to a 10.8% global reduction in agricultural land use, driving up land and food prices, with disproportionate impacts on regions such as Sub-Saharan Africa, the Middle East, North Africa, and Latin America (Figure 4). When compared to the BAU, **agricultural output is projected to decline significantly in Sub-Saharan Africa (5.4%) and India (8.4%) under this scenario due to reduced land availability and rising production costs, while Europe may benefit competitively through increasing exports to severely affected regions.** Global agricultural prices are expected to be affected by a rise of 15%, with Sub-Saharan Africa experiencing a sharp 33% increase due to the protection of biodiversity hotspots, raising concerns about regional food security. While the global economic impact remains limited, the uneven distribution of conservation by the design of the scenario and resulting costs highlights the need for country conservation strategies that are evenly distributed between countries or targeted global policy measures to mitigate the adverse effects of these policies in regions that bear the costs and ensure an inclusive transition toward large-scale conservation.

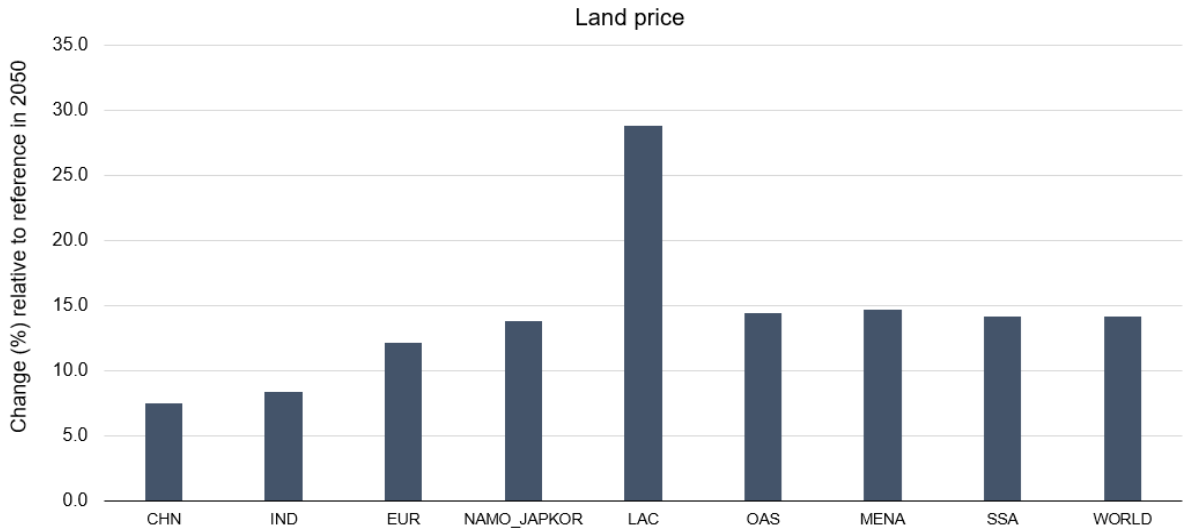

Figure 4 *Projected change in land prices in 2050 by regions due to Half-Earth Scenario*

Note*: The figures illustrate the average projected impact of the Half-Earth Scenario on land prices across various regions. This impact is estimated as the percentage difference between the projected levels of land prices under the Half-Earth scenario and the projected levels under the reference scenario for the year 2050. China (CHN), European countries (EUR), India (IND), Latin American Countries (LAC), Middle East and North Africa (MENA), North America, Oceania, Japan, and Korea (NAMO_JAPKOR). Other Asian Countries (OAS), Sub-Saharan Africa (SSA). Please see Online Appendix: Half Earth Scenario for further details on the method.*

Source*: BiROFin project.*

[1] This scenario is received from the study by Kok et al. (2020, 2023).

[2] Target 3 aims to protect 30% of the Earth's most crucial biodiversity hotspots, representing a step toward the broader goal of 50% protection. Improvement in land productivity is not an explicit assumption; however, higher land productivity is expected through higher land prices, which in turn lead to intensification through increased capital, labour and fertiliser inputs.

2 Understanding the caveats: assumptions, gaps, and model limitations

The findings are subject to noteworthy methodological uncertainties. The estimated impacts—particularly crop productivity losses under extreme climate scenarios—should be considered upper-bound estimates, as they assume simultaneous extreme climate events across all countries. **Economic impact estimates rely on scenario parameters that link biodiversity, soil quality, and pollination, based on expert judgment, reflecting current scientific understanding but inevitably introducing uncertainty**. The analysis does not account for feedback effects of economic activity on biodiversity, nor **does it include potential amplifying factors such as long-term financial capital losses or irreversible tipping points where soil and pollination services collapse, which can substantially increase the economic impact of pollination and soil quality loss.** Additionally, the effect of soil quality and pollination of loss on other ecosystems and the future policy interventions to curb biodiversity loss are not factored in. **Cost-benefit estimates for abatement measures are indicative rather than precise**, relying on cost extrapolation across countries, equal monetary benefit assumptions, and scenario-based adoption rates of practices, all of which introduce known limitations to the accuracy of the projections.

Nonetheless, given the unprecedented and evolving nature of climate-biodiversity interactions, it is more prudent to be roughly right than precisely wrong. This analysis applies the best available scientific knowledge to construct a plausible, integrated narrative of risks and opportunities in an expanding global risk landscape. While uncertainties remain, the findings provide a valuable foundation to create awareness and provide insights on accelerated ecological and economic change.

3 Navigating biodiversity risks: strategic imperatives and opportunities for the financial sector

Two major biodiversity-related risk scenarios—ecosystem service loss (pollination and soil quality) and a global conservation policy protecting 50% of Earth's land—pose limited direct threats to the European financial sector, as most assets are concentrated in high-income regions with minimal GDP impact from the losses and policy. However, significant **indirect risks** may arise from **emerging markets**, where biodiversity loss could drive food insecurity, social unrest, migration, and economic instability. These developments may lead to **increased non-performing loans**, weakened credit repayment, and pressure on sovereign bonds, particularly in countries that are dependent on agriculture and food imports. Interconnected global trade further amplifies the **risk of contagion**, potentially raising food prices and inflation in vulnerable economies. Despite these risks, the financial sector could seize strategic investment opportunities, including green finance for biodiversity-abatement measures (e.g., agroforestry, organic manure, reduced tillage) and impact investing in food security and agri-tech innovation. Commodity traders and some niche sectors may benefit from **altered export dynamics**. Financial institutions can also use abatement measures to guide client engagement and transition planning. Overall, integrating biodiversity and nature-loss scenarios into financial risk frameworks is not only essential but also required. However, any conclusions must take into account the uncertainties and regional variability in outcomes.

4 Next Steps: expanding impact and integrating insights

The BiROFin project will continue over the next two and a half years, building on the lessons learnt in the first project phase and responding to the evolving needs of our consortium partners. Following the strong interest from both public and private stakeholders, the research will now expand to include the economic implications of water-related ecosystem services, as well as targeted refinements to the existing models to better capture regional and sector-specific dynamics. These next steps aim to address key knowledge gaps identified in year one, particularly the need for more integrated insights into how the loss of nature, climate risks, and ecosystem service degradation interact within economic systems. Furthermore, analysing the abatement measure for the most vulnerable regions. As one of our private sector partners stated: *"There is a clear need to translate these complex risks into tangible decision-making tools — we are eager to help shape that process."*

Bridging science, policy, and finance to tackle the risk of biodiversity loss in a changing landscape

Launched in 2024, BiROFin is a pioneering public-private partnership that aims to quantify the macroeconomic impacts of biodiversity loss and identify opportunities for mitigation. Through advanced modelling, it integrates science-based climate, biodiversity, and financial scenarios to deliver detailed monetary estimates across sectoral, national, regional, and global levels. **Wageningen University and Research (WUR)** plays a key role by combining ecological and economic data and creating a unique dataset that evaluates the cost-effectiveness of biodiversity abatement and restoration strategies. By linking changes in ecosystem services, driven by biodiversity loss and extreme climate events, to economic impacts, BiROFin addresses a significant gap in current risk assessment frameworks. The project collaborates closely with the **Foundation for Sustainable Development** and leading private-sector stakeholders, including **ING, Allianz Group, APG, Commerzbank, and Ortec Finance**, ensuring that the outputs are both scientifically robust and practically relevant for financial decision-making. In 2025, we welcome our two new partners: **KfW and Sail Investments.**

This project receives financial support from the Top Sector Agri & Food, specifically from the Knowledge and Innovation Agenda for Agriculture, Water, and Food 2024-2027 (KIA). Within the Top Sector, businesses, knowledge institutions, and the government work together on innovations for safe and healthy food for 9 billion people in a resilient world.

Contact Information

Updates on research progress, upcoming publications, and stakeholder engagement opportunities will be shared through external workshops and public channels. Interested parties are invited to stay connected via our project website or by contacting the research team directly.

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2025-130-2