EGU25-14971, updated on 18 May 2025
https://doi.org/10.5194/egusphere-egu25-14971
EGU General Assembly 2025

Challenges and enablers of co-achieving ambitious global climate and biodiversity targets

Yazhen Wu[1,2], Stefan Frank[1], Kazuaki Tsuchiya[3], David Leclère[1], Oliver Fricko[1], Shinichiro Fujimori[1,4], Mykola Gusti[1], Tomoko Hasegawa[5], Andrey Lessa Derci Augustynczik[1], Tamás Krisztin[1], Sibylle Rouet-Pollakis[1], Michael Wögerer[1], Hans van Meijl[2,6], Willem-Jan van Zeist[6], Akiko Hirata[7], Volker Krey[1], Haruka Ohashi[7], Kiyoshi Takahashi[3], Keywan Riahi[1], and Petr Havlík[1]

[1]International Institute for Applied Systems Analysis, Biodiversity and Natural Resources (BNR), Laxenburg, Austria (wu.yazhen@outlook.com)

[2]Wageningen University, Wageningen, the Netherlands

[3]National Institute for Environmental Studies (NIES), Tsukuba, Japan

[4]Kyoto University, Kyoto, Japan

[5]Ritsumeikan University, Kyoto, Japan

[6]Wageningen Economic Research, The Hague, the Netherlands

[7]Forestry and Forest Products Research Institute (FFPRI), Tsukuba, Japan

Background: The need to address the dual challenges of climate change and biodiversity loss is pressing and requires collective efforts in both land-use and energy sectors. However, the interactive impacts between mitigation and biodiversity conservation measures, especially the indirect impacts through the energy-land nexus, have not been comprehensively investigated. The question arises as to whether and what levels of synergies or trade-offs exist between mitigation and biodiversity targets, and what are the implications on energy system decarbonization pathways and corresponding mitigation costs.

Methodology: By applying and comparing two modelling frameworks that link integrated assessment models (AIM, MESSAGEix-GLOBIOM) and biodiversity models (Figure 1), we explore the system-wide synergies and trade-offs between the ambitious climate and biodiversity targets included in the Paris Agreement and Kunming-Montreal Global Biodiversity Framework (KMGBF). Four forward-looking policy scenarios with different mitigation and biodiversity conservation ambitions are simulated for the period 2010-2070 to quantify the land-use dynamics, greenhouse gas emissions, biodiversity indicators, as well as energy transformation pathways under different policy targets. Additional sensitivity analysis and decomposition analysis allow us to explore the implications of alternative mitigation pathways on the key findings, and to disentangle the effects of individual policy measures within the mitigation and biodiversity portfolios.

Results: Scenario results show that despite biodiversity synergies from stringent mitigation measures for the 1.5°C target, area-based biodiversity conservation measures are not enough to revert the declining trends of biodiversity. Biodiversity losses can be halted or decelerated with combined mitigation and biodiversity efforts, but until 2070 global biodiversity cannot restore its

2010 levels. On the other hand, due to the energy-land nexus, deploying biodiversity conservation measures can double the carbon price in line with the 1.5°C target and increase global gross domestic product loss by 0.7% by 2070. However, the availability of alternative negative emission technologies and increased pasture production efficiency can act as enablers to reduce the additional costs to achieve 1.5°C-mitigation induced by the biodiversity target. Besides, the large land demand for co-achieving stringent mitigation and biodiversity targets can increase the global average price of agricultural products by 35-53% in 2070 and reduce food consumption. Avoiding the potential negative implications on food security would entail substantial food system transformation efforts. Our results indicate that the challenges of co-achieving the 1.5°C and KMGBF targets can be amplified via cross-sectoral impacts on the energy system and be greater than previously thought. This calls for more careful policy design to simultaneously address the two targets while limiting the trade-offs with food security or the economic feasibility of decarbonization.

Figure 1. Overview of research design