Afforestation and reforestation have varying biodiversity impacts across and within biomes

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ASIA-PACIFIC INTEGRATED MODEL

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- Carbon dioxide removal (CDR) is essential for climate goals: Emissions reductions alone are insufficient to meet the UNFCCC and Paris Agreement temperature targets, making large-scale CDR, particularly through afforestation and reforestation (AR), a critical component of climate mitigation strategies.
- AR poses potential risks to biodiversity that require careful assessment: While afforestation contributes to climate mitigation, its biodiversity impacts vary by strategy and region, highlighting the need for regionally sensitive, equitable approaches to avoid further global biodiversity decline.
- Safeguarding biodiversity is vital for effective climate mitigation, as it supports ecosystem resilience and carbon regulation. AR strategies should be carefully designed to avoid unintended biodiversity loss and maximize their potential as a **nature-based solution for both climate and biodiversity goals.**
- Our approach highlights **how and where** AR strategies can be deployed to simultaneously achieve climate change mitigation and biodiversity conservation.

Grow Billion Trees

BONN CHALLENGE

What is the background?

Climate change mitigation measures

Afforestation and reforestation (AR)

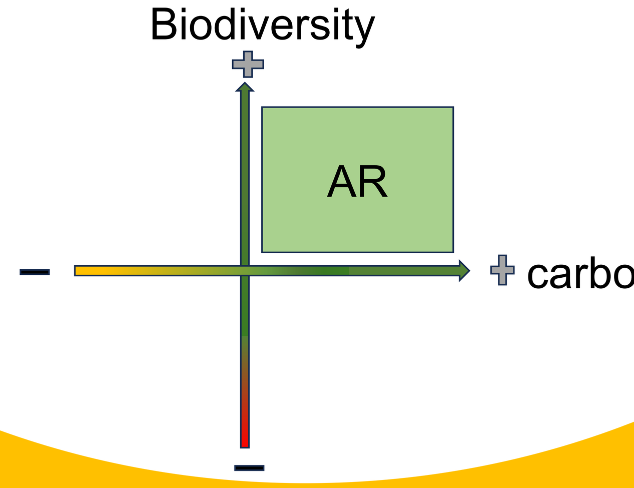
Biodiversity measures

ipbes

KUNMING-MONTREAL GLOBAL BIODIVERSITY FRAMEWORK

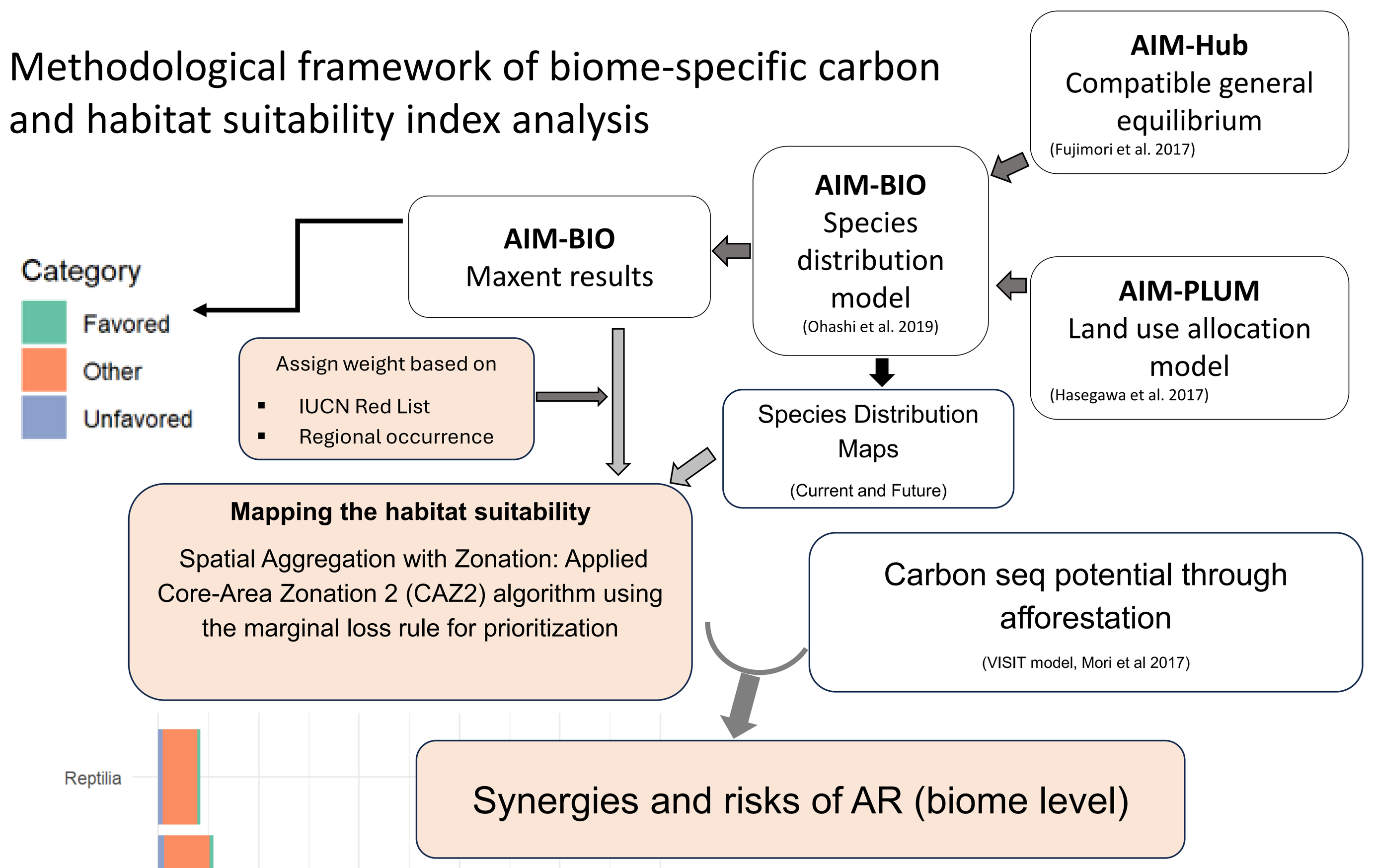
Research gap

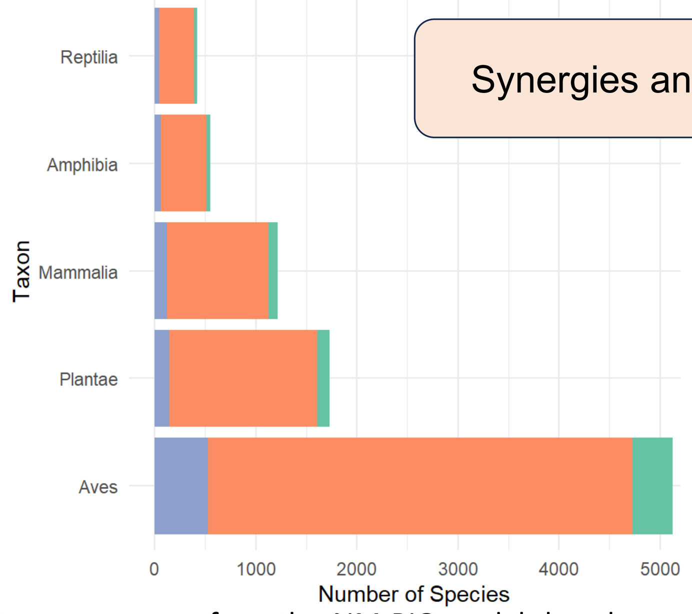
Given the ongoing expansion of AR, the scarcity of global-scale studies, and the risk of significant biodiversity loss, there is a pressing need for research that applies a spatial prioritization approach to identify areas that should be avoided for AR, particularly at a global level.



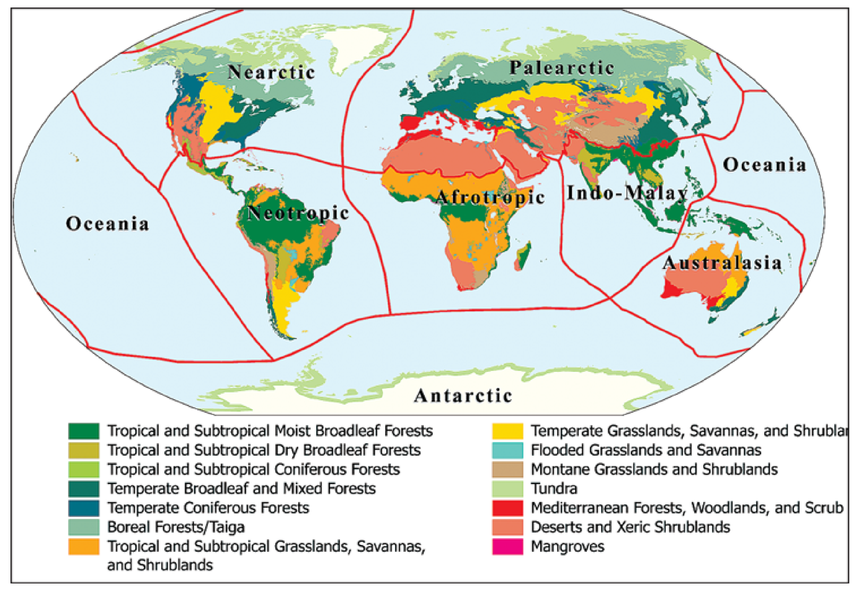
What did we do?

Methodological framework of biome-specific carbon and habitat suitability index analysis





Response curves from the AIM-BIO model show how 8,428 species across five taxonomic groups respond to forested land use, based on linear and quadratic Maxent terms.

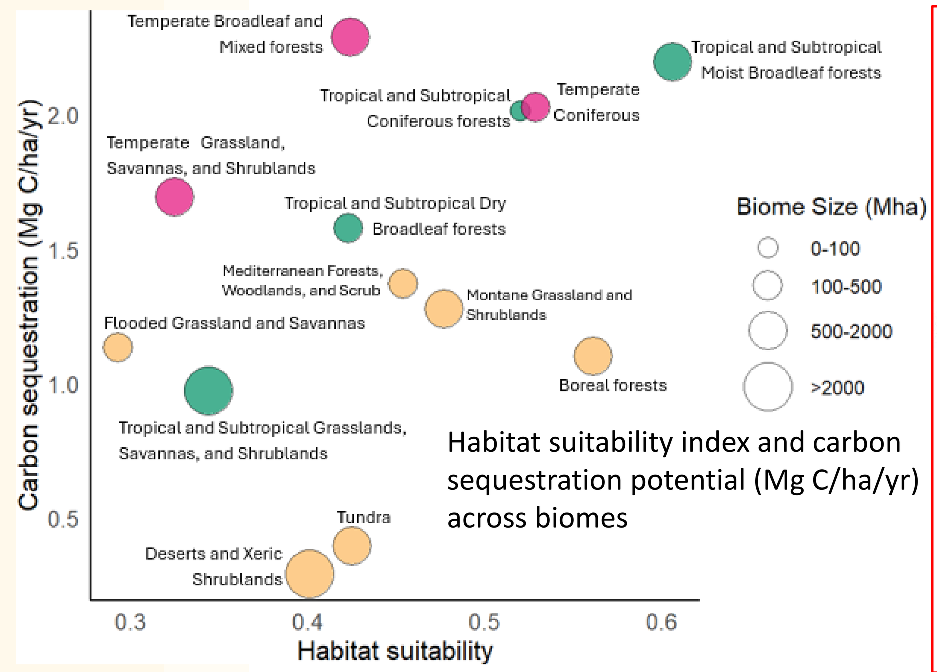


Terrestrial biomes (Olson et al, 2001)

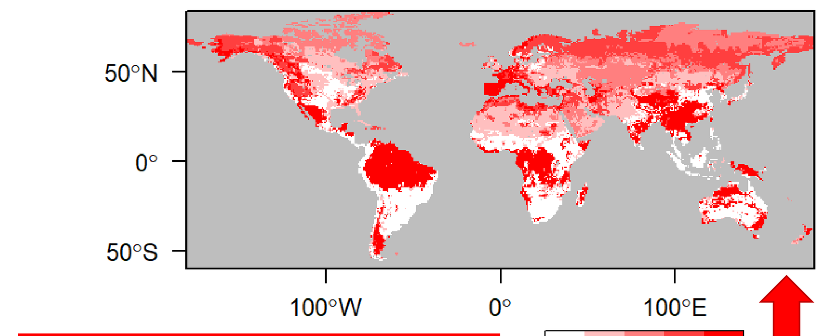
Negative habitat conversion effects 872 species

Positive habitat conversion effects 673 species

What did we find?



Habitat suitability index and carbon sequestration potential (Mg C/ha/yr) across biomes



Red- the most suitable areas for AR

White- the least suitable areas for AR

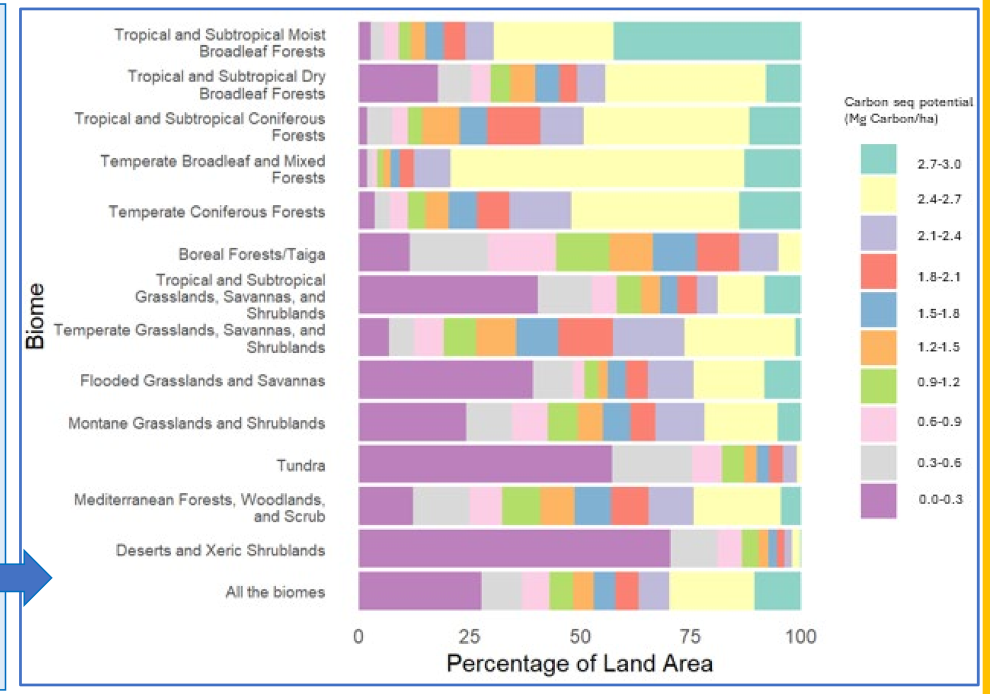
Zonation priorities for AR are aimed at maximizing the habitat suitability index (0-1 range) across major taxa, including Amphibia, Aves, Reptilia, Plantae, and Mammalia, for the future average (2010-2090)

Habitat suitability area share (%) across different biomes

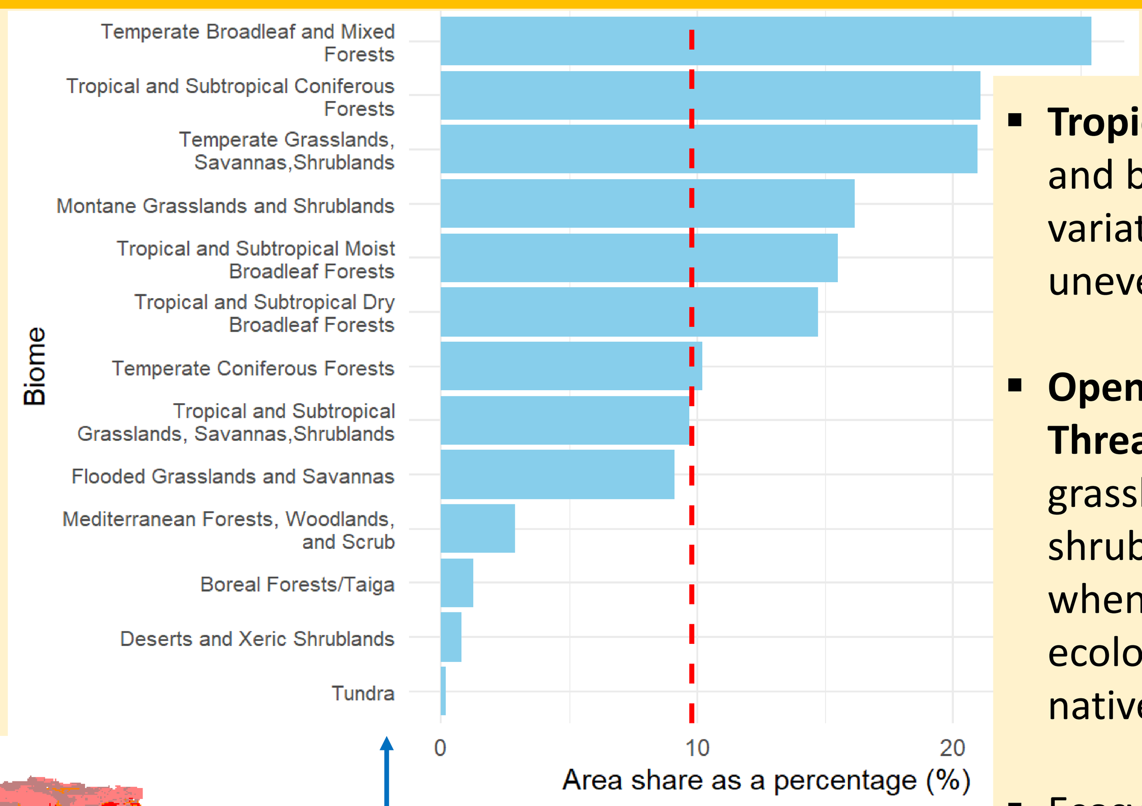
- **Tropical forests** have the highest habitat suitability for AR, with 65% of Tropical and Subtropical Moist Broadleaf Forests in the top suitability range (>0.8)
- **Non-forested tropical biomes** like grasslands and savannas show low suitability, with up to 50% of their area in the lowest range (<0.2)
- **Boreal forests and tundra** mostly fall in the intermediate suitability range (0.2–0.8), indicating limited but moderate potential for AR

Biome-Level Variation in Carbon Sequestration

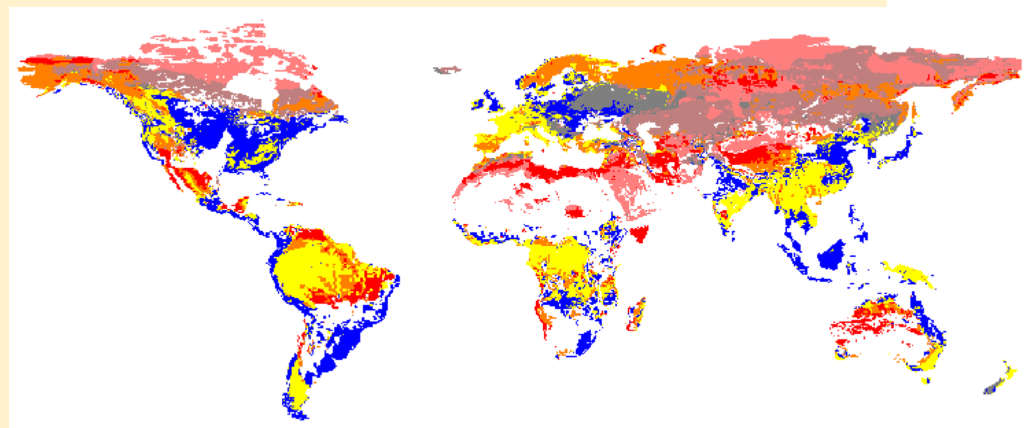
- Temperate and tropical broadleaf forests have the highest potential (>2.4 MgC/ha/yr)
- Deserts and tundra have very limited potential, with the majority of their area in the lowest range (<0.6 MgC/ha/yr)
- Boreal forests and temperate grasslands mainly fall within the intermediate range (0.6–2.4 MgC/ha/yr)

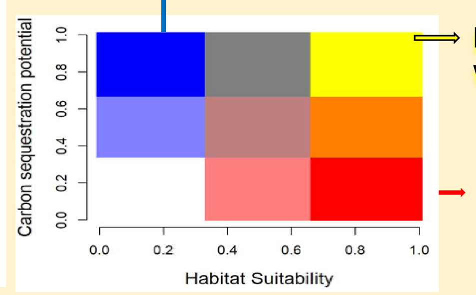


What is the conclusion?



Area share of each biome when selecting only the top 33% of carbon sequestration potential while excluding the bottom 33% of habitat suitability.





potential "win-win" regions

high habitat suitability index with low carbon yield

- **Tropical forests** offer high carbon and biodiversity potential, yet local variation within biomes can lead to uneven biodiversity outcomes.
- **Open Biomes Face the Greatest Threat-** Tropical and temperate grasslands, savannas, and shrublands are most vulnerable when AR prioritizes carbon over ecological integrity, risking loss of native biodiversity.
- Ecosystem restoration **beyond forest expansion** can better support both CDR and biodiversity.
- **Spatially explicit planning** is essential to balance carbon goals with ecological integrity and avoid trade-offs.

Funding source- This research was supported by the Environment Research and Technology Development Fund (JPMEERF20241001) of the Environmental Restoration and Conservation Agency, provided by the Ministry of the Environment, Japan.