Causality in the diversity-abundance relationship across the main World’s forest biomes: insights for nature-based mitigation solutions

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Increasing evidence now exists for a tight connection between tree diversity and carbon storage capacity. As part of the Paris Agreement (COP21), forests play a critical and prominent role to reach the ambitious goal of net-zero emissions in the second half of this century. Besides reducing emissions from deforestation and forest degradation (also known as REDD), maintaining and enriching tree assemblages could thus help mitigating climate change via increased abundance and more efficient resource use.

However, recent evidence questions this widespread idea of positive diversity effects on forest carbon storage. Specifically, tree diversity may not always be a causal mechanism but rather a consequence of tree abundance and productivity (following the 'more individuals hypothesis'). To test these contrasting hypotheses, this contribution analyses the most plausible causal pathways and their stability along global climatic gradients in the diversity-abundance relationship across the World’s main forest biomes, using a dataset comprising more than 2,500 forest plots and 83,800 trees sampled in pristine forest landscapes in all continents (except Antarctica).

We demonstrate that causal relations can be reconciled along global climate gradients, with diversity effects prevailing in the most productive environments, and abundance effects becoming dominant towards the most limiting conditions. These findings have major implications on climate change mitigation strategies aimed at carbon sequestration: we find that future nature-based mitigation solutions focused on fostering biodiversity will only be cost-effective in productive forest landscapes. In less productive environments, by contrast, mitigation measures should promote the abundance of locally adapted functional strategies. Conservation of species diversity in equatorial and tropical areas is thus a priority, not only to preserve the inherent value of biodiversity but also to achieve the global goals on atmospheric decarbonization. In less productive lands on Earth, the conservation of abundance through productivity should be posed, next to diversity, as a major element in environmental policies and land management.
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