Tropical forest soils capture carbon under elevated nitrogen deposition

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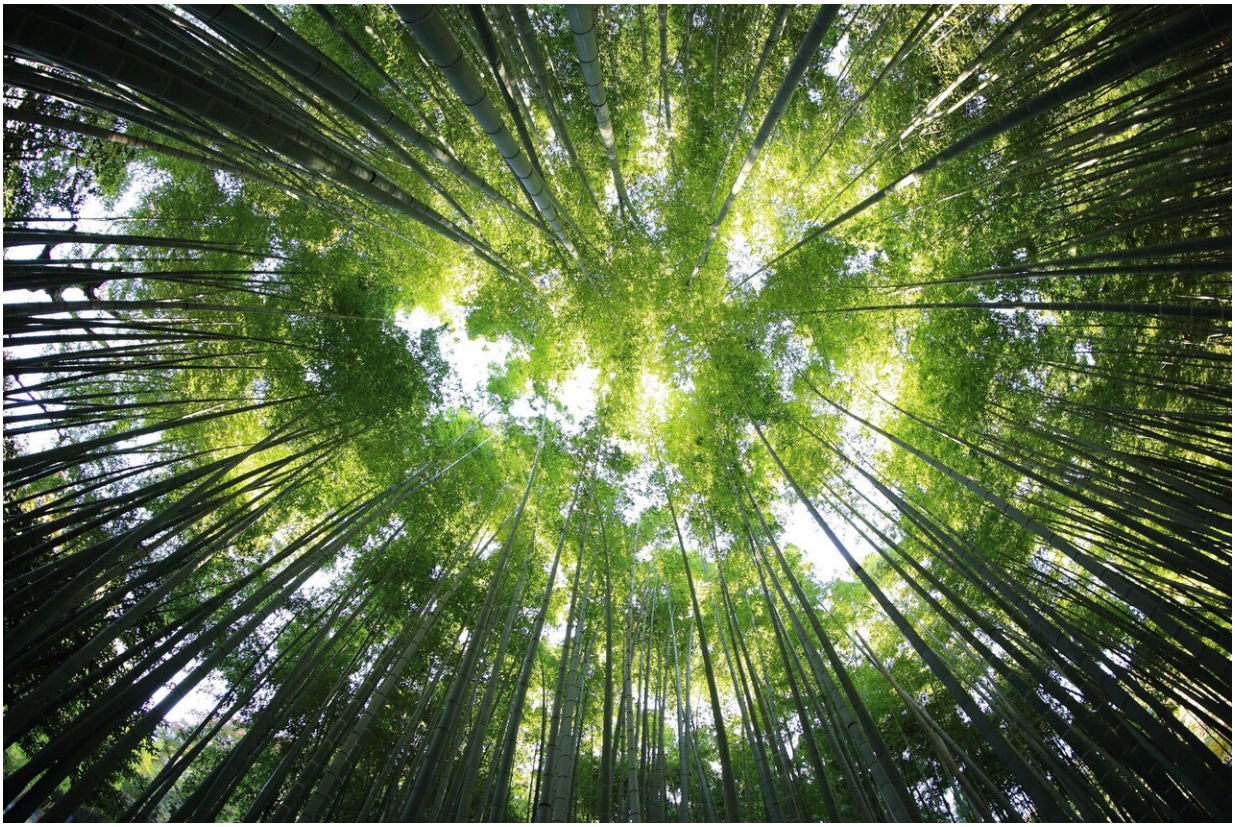

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In a new study, Dr. Lu Xiankai and his colleagues from the South China Botanical Garden (SCBG) of the Chinese Academy of Sciences (CAS) found that tropical forests can capture carbon dioxide (CO_2) into soils

and thus reduce emitted CO_2. But how exactly do tropical forest soils capture atmospheric CO_2?

Current knowledge of forest soil carbon sequestration mainly focuses on temperate and boreal forests, where most ecosystems are nitrogen-limited, and an increase in nitrogen supply can enhance net primary productivity (NPP) and subsequent soil carbon sequestration.

Traditionally, many scientists thought that nitrogen-rich tropical forests are unlikely to increase belowground soil carbon storage under greater nitrogen supply due to a lack of stimulation of NPP. However, this assumption has not been fully verified under field conditions, and belowground ecosystems have always been neglected by scientists.

Dr. Lu and his colleagues initiated more than a decade of continuous nitrogen addition experiments in a nitrogen-rich tropical forest ecosystem and quantitatively demonstrated that excessive nitrogen deposition significantly increased soil carbon storage by 7-21%.

According to the researchers, soil carbon sequestration efficiency was estimated to be 9 kg of carbon per unit of added nitrogen, which is comparable to temperate forest ecosystems. Interestingly, soil nitrogen retention was significantly and positively correlated with carbon sequestration.

Combining these field experiments with other global data, they concluded that nitrogen deposition stimulates soil carbon sequestration, which is prevalent throughout nitrogen-limited and nitrogen-rich ecosystems, however the underlying mechanisms of these two ecosystems are different.

In nitrogen-limited ecosystems, nitrogen deposition stimulates soil carbon sequestration of organic carbon by increasing aboveground plant

litter inputs to forest soils and reducing CO_2 emissions from soils. In nitrogen-rich forests, however, the subsequent decreases in CO_2 emissions and dissolved organic carbon leaching from soils are the two major drivers of carbon sequestration.

The researchers showed that organic matter interacting with soil minerals plays the dominant role in regulating the stabilization of soil carbon stocks for the two ecosystems.

"This study for the first time proves that excess nitrogen deposition can promote soil organic carbon accumulation in nitrogen-rich tropical forests," said Dr. Lu, the first author of the study and principal investigator of the Nitrogen Biogeochemistry Lab at SCBG. "We have highlighted that these mechanisms can be incorporated into state-of-the-art Earth models, improving prediction of terrestrial carbon cycles under global change scenarios."

"Our findings, however, do not imply that we encourage loosening limits on nitrogen emissions into the atmosphere, in view of their adverse impacts on the environment and human health," said Lu.

More information: Xiankai Lu et al, Nitrogen deposition accelerates soil carbon sequestration in tropical forests, *Proceedings of the National Academy of Sciences* (2021). DOI: 10.1073/pnas.2020790118

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