Nitrogen has key role in estimating CO2 emissions from land use change

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A new global-scale modeling study that takes into account nitrogen – a key nutrient for plants – estimates that carbon emissions from human activities on land were 40 percent higher in the 1990s than in studies that did not account for nitrogen.

Researchers at the University of Illinois at Urbana-Champaign and the University of Bristol Cabot Institute published their findings in the journal *Global Change Biology*. The findings will be a part of the upcoming Fifth Assessment Report from the Intergovernmental Panel on Climate Change.

"One nutrient can make a huge impact on the carbon cycle and net emissions of the greenhouse gas carbon dioxide," said study leader Atul Jain, a professor of atmospheric sciences at the U. of I. "We know that climate is changing, but the question is how much? To understand that, we have to understand interactive feedback processes – the interactions of climate with the land, but also interactions between nutrients within the land."

The carbon cycle is a balance of carbon emissions into the atmosphere and absorption by oceans and terrestrial ecosystems. Carbon is absorbed by plants during photosynthesis and by the oceans through sea-air gas exchange. On the other side of the cycle, carbon is released by burning fossil fuels and by changes in land use – deforestation to expand croplands, for example. While fossil fuel emissions are well-known, there are large uncertainties in estimated emissions from land use change.

"When humans disturb the land, the carbon stored in the plants and the soil goes back into the atmosphere," Jain said. "But when plants regrow, they absorb carbon through photosynthesis. Absorption or release of carbon can be enhanced or dampened depending on environmental conditions, such as climate and nutrient availability."

Nitrogen is an essential mineral nutrient for plants, which means that plants need it to grow and thrive. In nontropical regions especially, plant regrowth – and therefore carbon assimilation by plants – is limited by nitrogen availability.

"Most models used to estimate global land use change emissions to date do not have the capability to model this nitrogen limitation on plant regrowth following land use change," said Prasanth Meiyappan, a graduate student who is a co-author of the study. "This means, for example, they overestimate regrowth and they underestimate net emissions from the harvest-regrowth cycle in temperate forest plantations."

Jain's team, in collaboration with Joanna House, a researcher at the University of Bristol's Cabot Institute, concluded that by not accounting for nitrogen as a limiting nutrient for plant growth, other models might have underestimated the 1990s carbon emissions from land use change by 70 percent in nontropical regions and by 40 percent globally.

"This gross underestimation has great implications for international policy," House said. "If emissions from land-use change are higher than we thought, or the land sink (regrowth) is more limited, then future emissions cuts would have to be deeper to meet the same mitigation targets."

Next, the researchers are investigating the impacts of other nutrients, such as phosphorus, on the carbon cycle. They also are estimating the carbon stored in the soil, and how much is released or absorbed when the soil is perturbed.

"Soil has great potential to sequester carbon," Jain said. "The question is, how much that's being released is being sequestered in the soil? We have to understand how human behavior is changing our environment and interacting with our ecosystems."

More information: The paper, "CO2 emissions from land-use change affected more by nitrogen cycle, than by the choice of land-cover data," is available online at onlinelibrary.wiley.com/doi/10.1111/gcb.12207/full

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