Saving tropical forests: Value their carbon and improve farming technology

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Improved crop productivity alone can't save tropical forests from agricultural encroachment as the world warms and population grows. Emissions policies must place a value on carbon in forests as well, this study shows.

(PhysOrg.com) -- In a warming 21st century, tropical forests will be at risk from a variety of threats, especially the conversion to cropland to sustain a growing population. A new report this week in the *Proceedings of the National Academy of Sciences Early Edition* shows that crop productivity improvements and carbon emission limits together could prevent widespread tropical deforestation over the next 100 years -- but if relying on either one alone, the world is at risk of losing many of its tropical forests.

"We're often concerned with agriculture encroaching on forests," said research scientist Allison Thomson of the Department of Energy's Pacific Northwest National Laboratory. "This study shows that encroachment can be managed to a certain extent by increasing crop productivity -- boosting the amount of food or energy that can be produced on a given piece of land."

But the study clearly shows that improving crop productivity alone will not prevent tropical deforestation. Also needed is some form of economic incentive to store carbon in forests, for example, a plan to limit all carbon emissions -- from burning fossil fuels, biofuels or whole forests to make way for crops or other land uses -- through economic methods such as a carbon tax or cap-and-trade program. Combined with farming improvements, this tactic not only preserves tropical forests but increases their extent.

"Our model considers many different ways to limit carbon dioxide in the atmosphere to 526 parts-per-million," said Thomson, a member of the Joint Global Change Research Institute. "Limiting emissions from land use change is a lower cost option that can also be implemented immediately. In the near term, we can limit emissions by protecting forests, buying society additional time to make needed long-term changes in how we produce and consume energy."

Economics At Work

Thomson and colleagues at JGCRI, the University of Maryland and the University of New Hampshire, Durham examined future scenarios in a computer model called the Global Change Assessment Model, or GCAM. GCAM knits a comprehensive picture of how the next century may evolve, incorporating agriculture, economics, energy use, technology, land use, climate, ecosystem and other factors.

The researchers used the model to simulate a future that limits greenhouse gas emissions so that carbon dioxide in the atmosphere reaches a concentration of about 520 ppm -- a target that would require cuts in emissions of about half. The model calculates an economic cost for emissions that meets that limit in a way that optimizes costs across all activities that emit greenhouse gases.

"This is not a projection of what will happen," said Thomson. "The model tells us, 'this is the most cost effective way to reach this target,' given the requirements we feed it. The model can't give us a prediction, but it can provide insights into what pressures will bear on land use in response to economic and other forces."

The researchers also simulated a future in which the international political community makes no effort to limit carbon emissions. In that "business-as-usual" case, the atmosphere reaches 520 ppm carbon dioxide in about 2050, about twice as fast as with the selected carbon limit, and reaches almost 800 ppm by the end of the 21st century. Other simulations examined different rates at which crop productivity might improve.

To examine tropical lands in detail, the team applied a computational method called downscaling to the results from GCAM's regional models. The technique takes a region's land-use changes -- for example, where forests have been cut down for crops or where dormant cropland has grown into pasture -- and maps them more precisely. It breaks the region into smaller grids and determines how much and what type of the land use changes the grid cells could hold. Dividing up the land use changes in this way provides more information about the possible landscape, much like shrinking the size of pixels improves the resolution of a digital image.

The results provide new insights into how agriculture and land use might change over time in response to the economic pressure to limit emissions.

Forests, Energy, Food

Much of the public discussion about reducing carbon emissions revolves around reducing the use of fossil fuels. But this study showed that improving crop productivity is also important, Thomson said. Without farming improvements, the model projected loss of tropical forests, even when there is a high economic cost for those carbon dioxide emissions.

On the other hand, improvements in crop productivity in a world that emits carbon freely -- and lacks the associated economic incentive to preserve forests -- also failed to prevent widespread tropical deforestation.

Twenty-first century tropical forests fared well only when both crop productivity improved and limits to carbon emissions provided an extra economic inventive to keep land forested. The assumptions that went into that simulation were that farming technology continues to improve at the same rate as the last 50 years, and that carbon emission reductions included the full range of options -- everything from electric vehicles to capturing carbon from fossil fuel emissions and developing bio-based fuels.

The model showed that under those conditions, tropical deforestation not only stopped but reversed, particularly in Africa and South America.

"Viewed spatially, it's clear that carbon pricing and agriculture improvements are potential keys to saving sensitive tropical forest areas in this future scenario," said UMD geographer George Hurtt, a co-author of the study.

Second, production of bio-based fuels not only went up, but the producers used more waste from crops, forests and cities, in addition to crops grown specifically for energy.

Third, food became more affordable than it currently is. Although carbon emissions limits caused the cost of producing food to rise, incomes also went up. The model showed the percentage of income spent on food actually dropped.

"A key point of this study is the importance of counting the forest carbon in mitigation strategies," said Thomson. "Our previous work has shown that's important, but the contribution of agricultural technology as a climate mitigation strategy -- in terms of how much it can contribute to reducing carbon emissions from land use change -- is new. That hasn't been demonstrated before."

More information: Allison M. Thomson, Katherine V. Calvin, Louise P. Chini, George Hurtt, James A. Edmonds, Ben Bond-Lamberty, Steve Frolking, Marshall A. Wise, and Anthony C. Janetos, Climate mitigation and the future of tropical landscapes, Proc Natl Acad Sci U S A,

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