Biosphere is source, not sink, for carbon dioxide emissions, study shows

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Converting forests into croplands and pastures reduces carbon storage, say scientists who studied the impacts of human-induced change on terrestrial ecosystems. The study results have important implications for predicting carbon dioxide levels, and will help provide a more complete understanding of Earth's carbon cycle.

In its most recent report, the Intergovernmental Panel on Climate Change found that Earth's biosphere was acting as a sink for carbon dioxide. By storing carbon dioxide, plant growth – especially that of trees – could help reduce the effects of global warming, and could be part of meeting the targets and timetables of the Kyoto Protocol.

Using a more advanced version of the Integrated Assessment Model, Atul Jain, a professor of atmospheric sciences at the University of Illinois at Urbana-Champaign, and graduate student Xiaojuan Yang report that the biosphere might now be acting as a source, not as a sink. Rather than storing carbon dioxide, the biosphere may have recently begun driving atmospheric levels higher.

"We studied different land cover changes for cropland data sets in combination with pasturelands," Jain said. "Our model-estimated results for net uptake of carbon dioxide by the biosphere suggest that greater account for pastureland processes may result in significantly lesser estimated uptake of carbon dioxide."

Furthermore, continued clearing of forests at the same pace will

accelerate the rate of increase of carbon dioxide in the atmosphere, Jain said. Carbon dioxide absorbed by trees can be released quickly through slash and burn practices, or slowly through conversion into products such as lumber and paper or through the gradual decay of woody material. Regardless of rate, the carbon locked in trees will ultimately be returned to the atmosphere when trees are removed.

Human activities have significantly altered the vegetation cover in nearly every part of the globe. While the rate of change has stabilized in developed countries, deforestation abounds in many developing countries. Particularly hard hit are the regions of South and Southeast Asia, tropical Africa and Latin America.

“Land-use changes can alter regional and global climate through changes in the biophysical characteristics of Earth’s surface and changes in the global carbon cycle,” Jain said. “Whether the biosphere is a source or sink in a given geographic area depends on such factors as temperature, precipitation, soil properties and types of vegetation cover.”

Using the Integrated Science Assessment Model developed at Illinois and the United Nations Food and Agriculture Organization data, Jain and Yang examined the effects of human-induced land use emissions on terrestrial carbon storage between the years 1765 and 1990. They found that not only do changes in land use significantly alter carbon storage, but also enhance decomposition in soils as a result of global warming, particularly at high latitudes. Consequently, the terrestrial biosphere is losing its capacity to store carbon, resulting in concentrations of atmospheric carbon rising at an increasing rate.

“The Kyoto Protocol allows a country to apply the carbon stored in its forests and other ecosystems toward its budgeted reduction in carbon dioxide and other greenhouse gases,” Jain said. “By providing a geographically explicit distribution of net sources and sinks, this study

will help us more accurately determine how much carbon is being stored or released in different regions."

Jain and Yang report their findings in a paper accepted for publication in the journal Global Biogeochemical Cycles and posted on the journal's Web site. The U.S. Department of Energy funded the study.

Source: University of Illinois at Urbana-Champaign