

New study predicts future consequences of a global biofuels program

October 22 2009



MBL senior scientist Jerry Melillo and his colleagues have found that carbon emissions from land-use change caused by the displacement of food crops and pastures by a global biofuels program may be twice as much as emissions from lands directly devoted to biofuels production. Credit: Chris Neill, MBL

A report examining the impact of a global biofuels program on greenhouse gas emissions during the 21st century has found that carbon loss stemming from the displacement of food crops and pastures for biofuels crops may be twice as much as the CO₂ emissions from land dedicated to biofuels production. The study, led by Marine Biological Laboratory (MBL) senior scientist Jerry Melillo, also predicts that increased fertilizer use for biofuels production will cause nitrous oxide emissions (N₂O) to become more important than carbon losses, in terms of warming potential, by the end of the century.

Using a global modeling system that links economic and biogeochemistry data, Melillo, MBL research associate David Kicklighter, and their colleagues examined the effects of direct and indirect land-use on greenhouse gas emissions as the production of biofuels increases over this century. They report their findings in the October 22 issue of [Science Express](#).

Direct land-use emissions are generated from land committed solely to bioenergy production. Indirect land-use emissions occur when biofuels production on cropland or pasture displaces agricultural activity to another location, causing additional land-use changes and a net increase in carbon loss.

No major countries currently include [carbon emissions](#) from biofuel-related land-use changes in their carbon loss accounting and there is concern about the practicality of including such losses in a system designed to reduce fossil-fuel emissions. Moreover, methods to assess indirect land-use emissions are controversial. All quantitative analyses to date have either ignored indirect emissions altogether, considered those associated from crop displacement from a limited area, confused indirect emissions with direct or general land-use emissions, or developed estimates based on a static framework of today's economy.

Using a modeling system that integrates global land-use change driven by multiple demands for land and that includes dynamic greenhouse-gas accounting, Melillo and his colleagues factored in a full suite of variables, including the potential of net carbon uptake from enhanced land management, N₂O emissions from the increased use of fertilizer, environmental effects on carbon storage, and the economics of land conversion.

"Our analysis, which we think is the most comprehensive to date, shows that direct and indirect land-use changes associated with an aggressive

global biofuels program have the potential to release large quantities of greenhouse gases to the atmosphere," says Melillo.

Melillo and his colleagues simulated two global land-use scenarios in the study. In Case 1, natural areas are converted to meet increased demand for biofuels production land. In Case 2, there is less willingness to convert land and existing managed land is used more intensely. Both scenarios are linked to a global climate policy that would control greenhouse gas emissions from fossil fuel sources to stabilize CO₂ concentrations at 550 parts per million, a target often talked about in climate policy discussions. Under such a climate policy, fossil fuel use would become more expensive and the introduction of biofuels would accelerate, ultimately increasing the size of the biofuels industry and causing additional effects on land use, land prices, and food and forestry production and prices.

The model predicts that, in both scenarios, land devoted to biofuels will become greater than the total area currently devoted to crops by the end of the 21st century. Case 1 will result in more carbon loss than Case 2, especially at mid-century. In addition, indirect land use will be responsible for substantially greater carbon losses (up to twice as much) than direct land use.

"Large [greenhouse gas emissions](#) from these indirect land-use changes are unintended consequences of a global biofuels program; consequences that add to the climate-change problem rather than helping to solve it," says Melillo "As our analysis shows, these unintended consequences are largest when the clearing of forests is involved."

In their model, Melillo and his colleagues also simulated N₂O emissions from the additional fertilizer that will be required to grow [biofuel](#) crops in the future. They found that over the century, N₂O emissions will surpass CO₂ in terms of warming potential. By 2100, Melillo and his

team estimate that in both study scenarios, biofuels production will account for more than half of the total N₂O emissions from fertilizer. "Best practices for the use of nitrogen fertilizer, such as synchronizing fertilizer application with plant demand, can reduce N₂O emissions associated with biofuels production," the scientists say.

Source: Marine Biological Laboratory

Citation: New study predicts future consequences of a global biofuels program (2009, October 22) retrieved 5 August 2024 from

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