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Tradeoffs Associated with Land-use Options to Mitigate Climate Change

David Kicklighter (1,2), Yongxia Cai (2), John Reilly (2), Jerry Melillo (1,2), Angelo Gurgel (2,3), Sergey Paltsev (2), Timothy Cronin (2), Andrei Sokolov (2), and Adam Schlosser (2)

(1) The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA, United States (dkicklighter@mbl.edu), (2) Joint Program on the Science and Policy of Global Change, Massachusetts Institute of Technology, Cambridge, MA, United States, (3) Department of Economics, University of Sao Paulo, Ribeirao Preto, Brazil

Land can be used in several ways to mitigate climate change. Forest areas can be preserved or expanded to accumulate carbon. Or, land area can be devoted to the production of biofuels while simultaneously promoting net carbon storage. Using an integrated global system model, we explore the roles that these two land-use options can play in a global mitigation strategy to stabilize Earth's average temperature within 2°C of the pre-industrial level. We show that an ambitious global energy-only climate policy that includes biofuels would likely not achieve the 2°C target, while pricing of land carbon storage combined with biofuels (energy+land policy) gets the world much closer to this target. While some regions continue to clear land for food and biofuels production with the energy+land policy, globally this REDD-like policy results in land becoming a large net carbon sink of about 96 Pg C (carbon) over the 21st century. Most of this carbon sink occurs in Latin America (30%), Canada (17%), Africa (15%) and Australia/New Zealand (12%). In contrast, land becomes either a small net carbon sink (+5 Pg C) with an energy-only policy or a large net source (-34 Pg C) with no climate policy (no policy) over the same period. The small carbon sink with an energy-only policy occurs because the large gains in net carbon storage in some regions like Latin America (+22 Pg C) more than compensate for the large losses in carbon from other areas like Africa (-21.6 Pg C). With no policy, losses of carbon primarily from forest clearing in Africa (-48.9 Pg C) overwhelm the gain of carbon in other areas such as Canada (+12 Pg C), Latin America (+11.0 Pg C) and Australia/New Zealand (+11.0 Pg C). A significant tradeoff with the integrated energy+land policy approach is that prices for conventional land-intensive products rise substantially compared to the energy-only policy and no policy approaches where land-use emissions are not priced. For wealthier regions, the share of income spent on food continues to fall even with higher prices. For the poorest regions, however, higher food prices could lead to a rising share of income spent on food even considering substantial income growth. In all three policies, land biodiversity is also likely to be affected. With no policy or an energy-only policy, biodiversity-rich tropical forests across the globe will be cleared, with the tropical forests of Africa being especially vulnerable. In addition, with an energy-only policy or an energy+land policy, the production of biomass for advanced biofuel programs will result in the widespread transformation of tropical woodland and savannas, also biodiversity hot spots, to intensively managed areas. These tradeoffs suggest that any policy to reduce greenhouse gases is likely to put significant pressure on land resources in the future.