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## Interactions between land use change and carbon cycle feedbacks

Analysis of direct, quasi-direct, and indirect impacts of land use and land cover change (LULCC) on the terrestrial carbon budget to year 2300

### The Science

Using an Earth system model (ESM), we explored the role of human land use and land cover change (LULCC) in modifying the terrestrial carbon budget in simulations forced by the Representative Concentration Pathway 8.5 (RCP8.5), extended to year 2300. We accounted for the direct and quasi-direct LULCC CO<sub>2</sub> emissions, as well as the influence of LULCC on reducing natural carbon sinks in the future.

### The Impact

The conversion of land (e.g., from forest to croplands via deforestation) resulted in a model-estimated, cumulative carbon loss of 490 Pg C between 1850 and 2300, larger than the 230 Pg C loss caused by climate change over the same interval. About 40% of the carbon loss associated with LULCC arose from direct human modification of the land surface; the remaining 60% was an indirect consequence of the loss of potential natural carbon sinks. Most anthropogenic carbon uptake in the model occurred from the influence of rising atmospheric CO<sub>2</sub> on photosynthesis in trees, and thus, model-projected carbon feedbacks were especially sensitive to deforestation.

### Summary

Human land use and land cover change (LULCC) contributes to anthropogenic climate change, accounting for approximately 10–15% of the atmospheric increase in CO<sub>2</sub> concentrations and for about 40% of the total radiative forcing including other heat-trapping gases. In addition to the effects of deforestation and harvesting on CO<sub>2</sub> emissions, LULCC also changes the surface albedo and biophysical properties of the land surface, increases emissions of methane and nitrous oxide, and alters aerosol emissions. For the first time, we used simulations from a full-complexity ESM to isolate the influence of LULCC on the evolution of the land carbon flux in simulations that extended from 1850 to 2300. Using a business-as-usual scenario, our simulations accounted for effects of LULCC and interactions with the climate system. Because of the multi-century carbon cycle legacy of current land use decisions, a globally averaged amplification factor of 2.6 was found to be required to apply to 2015 land use carbon losses to adjust for indirect effects. This estimate was 30% higher when considering the carbon cycle evolution after 2100. Since terrestrial uptake of anthropogenic carbon in the model occurred from the influence of rising atmospheric CO<sub>2</sub> on photosynthesis in trees, we found that model-projected carbon feedbacks were especially sensitive to deforestation.

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**Publications**

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