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Future Trends of Carbon Uptake from Land-use Change

European researchers have recently investigated the possible changes in terrestrial carbon storage in Europe under projected climate and land-use changes. They conclude that the carbon uptake capacity of the biosphere is likely to be small compared to projected European fossil fuel emissions. The results might be useful when considering measures to maximise carbon storage in terrestrial ecosystems to meet the Kyoto targets and other climate mitigation policies.

The uptake of carbon by natural vegetation, forests, agricultural land and soils (also known as the 'terrestrial biosphere') is an important part of the carbon cycle. Terrestrial carbon uptake can lessen the increasing concentration of CO_2 in the atmosphere, thus reducing the impact of these emissions on the global climate system. Indeed, the terrestrial biosphere in Europe currently acts as a small carbon (C) sink, sequestering annually up to 12% of European fossil fuel emissions. However, the uptake rate and storage capacity of carbon in the terrestrial biosphere are influenced by different factors, such as temperature, precipitation, atmospheric CO_2 concentration, nitrogen fertilisation by air pollutants, the growth rate of plants, fires, storms, and land-use changes. Only a few studies have addressed the interaction between future transformations of landscape and climate changes on the global terrestrial C cycle.

As a part of the EU-funded ATEAM[1] project, European researchers have assessed the magnitude of the terrestrial carbon fluxes that can be caused by changes in land-use and climate in the 21st century in EU15, Norway and Switzerland (hereafter called EU*). This assessment is based on an advanced version of a global vegetation model that represents actual land-cover as well as land-use changes. The potential future greenhouse gas emissions and regional land-use changes are based on scenarios from the Intergovernmental Panel on Climate Change's Special Report on Emission Scenarios.

The researchers observed that the abandoning of agricultural areas and the subsequent increase in forest areas led to a net carbon uptake in Europe's terrestrial ecosystems under all the evaluated future path-ways of land-use changes between 1990 and 2100. The difference in the magnitude of the uptake between different scenarios is primarily influenced by the extent that farming has been abandoned. The authors estimated that the cumulative carbon uptake from the atmosphere into the biosphere between 1990 and 2100 resulting from land-use changes is equivalent to approximately 1.9%–2.9% of the EU* fossil fuel related CO_2 emissions.

Furthermore, the cumulative carbon sequestration for the same period associated with climate and atmospheric changes in CO_2 concentrations is equivalent to about 0.7%–3.8% of EU* fossil fuel related CO_2 emissions. The authors highlight, however, that the climate and atmospheric CO_2 concentration changes will lead to enhanced biospheric uptake rates before 2040, and a weakening of the uptake rate thereafter in all scenarios, thus turning the European terrestrial biosphere into a net C source for the climate change scenarios that exhibit the strongest warming.

Overall, the results of this study show that land use changes alone have a positive effect on carbon storage, while climate change can counter this effect. In spite of the uncertainties in the cumulative European terrestrial carbon uptake estimated between 1990 and 2100, these results suggest that the terrestrial carbon uptake -and its impacts on mitigating climate change- is likely to be small. These results provide new insights into the processes of carbon sequestration that might be useful in the future when considering a system for accounting for activities in agriculture and forestry that reduce emissions or increase removal of greenhouse gasses (so-called land use, land-use change, and forestry (LULUFC) sector) under the Kyoto Protocol.

[1]The project ATEAM "Advanced Terrestrial Ecosystem Analysis and Modelling" (http://www.pik-potsdam.de/ateam/) is supported by the European Commission under the 5th Framework Programme, theme "Energy, Environment and Sustainable Development".

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