Simulation and comparison of forest carbon sequestration in the United States and China in recent decades

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Terrestrial ecosystems sequester roughly 30% of anthropogenic carbon emissions globally. While climate change is believed to drive ecosystem carbon cycles, land use and land cover (LULC) changes are becoming increasingly recognized as dominant drivers as well. The United States and China are the top two CO_2 emitting countries in the world. On the other hand, the two countries both have tremendous land extent and thus enormous potential to sequester carbon. In this study, we focused on quantifying and comparing the climate effect and the LULC change effect on forest carbon sequestration in the two countries.

The process-based Integrated Biosphere Simulator (IBIS) was used to simulate the effects of atmospheric CO_2 fertilization, nitrogen deposition, climate change, fire disturbance, logging, and deforestation/reforestation on ecosystem carbon changes. Output variables included carbon stocks, such as live and dead biomass, and carbon fluxes, such as fire carbon combustion, logging removal, net ecosystem productivity (NPP) and net biome productivity (NBP).

A comprehensive environmental input spatial dataset (1-km to 10-km resolution) was developed and used in IBIS, which included land cover change information derived from the Landsat data archive (1973 -2010), wildland fire scar and burn severity information (1984-2010), forest canopy percentage and live biomass (∼2000), spatially heterogeneous atmospheric CO_2 concentration and nitrogen deposition (2003-2009), and newly available climate and soil variables. In addition, forest field inventory data were used to calibrate the IBIS model.

Initial comparison of results indicate that although the two countries have significant differences in forest land area, forest age structure, biomass stock level, and disturbance type, the overall annual carbon sequestration rates are comparable.