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Coupling of land use change, soil erosion and carbon dynamic on the Chinese Loess Plateau

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Land use change can significant impact on carbon dynamics by directly changing the carbon stock on soil and biomass and by controlling the magnitude of soil erosion which indirectly influences the erosion-induced carbon sink or sources. Whether land use change causes a net carbon sink or source to the atmosphere, an integrated analysis that considers both the direct effects of land use changes on vertical fluxes as well as its effects on the erosion-induced carbon sink is therefore necessary.

The Chinese Loess Plateau (CLP) is an ideal case for an integrated assessment of the influence of land use change on OC dynamic, given that CLP has experienced significant land use change during last two decades and is the most eroded regions in the world which potentially target the relative higher magnitude of erosion-induced carbon sink. Therefore, the objectives of this study are to carry out an integrated analysis of the influence of land use change and soil erosion on regional carbon dynamics during 1990-2010.

Our results indicated that CLP experienced two inverse tendencies of land use change and carbon dynamics between 1990 and 2010. During 1990 to 2000, a net decrease of vegetation cover land (grass and woodland) has happened on the CLP which induced a carbon loss by 4.85 Tg C yr^{-1} on soil and biomass, which was mainly due to the cutting of native forest and the conversion of grassland to arable land. While, based on the assumes that 50% of the mobilised carbon is finally buried and that full replacement takes place at the erosion sites, the erosion-induced sink would compensate about 55% of the carbon loss due to land use change. Thus, between 1990 and 2000 the CLP was a net carbon source to atmosphere. Due to the implementation of the Grain for Green Project, permanent vegetation cover land has gradually increased between 2000 and 2010. The net rise of vegetation cover land resulted in an annual carbon sink of soil and biomass by 1.67 Tg C yr^{-1}. Meanwhile, soil conservation measures (terrace) and land use change constrained the strength of erosion-induced carbon sink. The total amount of carbon mobilised declined to ca. 5.00 Tg C yr^{-1} and the erosion-induced carbon sink was ca. 2.50 Tg C yr^{-1} (based on the same assumes of carbon replacement rate and carbon burial efficiency). Therefore, CLP was a carbon sinks during 2000-2010. Again, changes in land-atmosphere carbon fluxes due to land use change were far more important than changes due to erosion reduction.

There are large uncertainties in our estimations, especially because the extent of land use change due to the Grain for Green Project remains uncertain. Meanwhile, the magnitude of the erosion-induced carbon sink is also uncertain, and estimates need to be further refined and constrained by more accurate data and the use of more explicit models. Nevertheless, our current understanding allows us to clearly identify the direction of change in carbon fluxes brought about by the combined effects of land use change and erosion reduction.