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# Land rehabilitation, erosion and C sequestration in soils of the Chinese Loess Plateau

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Once the cradle of Chinese civilization, the Chinese loess plateau is now one of the most degraded ecosystems in the world and a wide range of ecological rehabilitation programs have been implemented since the 1950s that aim at facilitating synergies between soil conservation, food production and socio-economic welfare. More recently, the scope of vegetation restoration programs has been extended to include sequestration of C by soils and the reconversion of 4.8 million ha of cropland to forest and grassland has re-sequestered a substantial amount of C in soils between 2000 and 2008. Although this appears to represent a significant win-win, these estimates are associated with considerable uncertainty both due to the extrapolation and, significantly, because of the assumptions made about the pre-restoration state.

Here, we argue that a full assessment of the C sequestration benefit of land rehabilitation programs requires quantification not only of the C uptake in vegetation and plants under the new land use regime (as has been undertaken), but also of the soil atmosphere C exchange associated with the elevated erosion rates that typify the pre-restoration state. We present the results of an intensive measurement campaign to characterize the erosional control on vertical carbon fluxes from degraded land, typical of the pre-restoration state. We report year-round soil respiration (in the absence of vegetation) measurements with high temporal resolution along an erosion gradient on cultivated sloping land in the Chinese Loess Plateau. At 14 sites along an eroding cultivated slope, we quantified the temporal dynamics of soil $CO_2$ fluxes using an Automated Soil $CO_2$ Flux System. This resulted in 13296 respiration measurements between April 2007 and September 2008. We investigate the factors controlling in-situ soil respiration, including soil temperature, moisture, soil erosion and SOC stock and quality. Soil and, by inference, C erosion and deposition since 1954 were quantified for 53 soil profiles using the artificial fallout radionuclide 137Cs. Our results indicate that the existing approaches ignore the erosion-induced reduction of in-situ soil $CO_2$ emission from agriculturally eroding sites, and may therefore significantly overestimate the potential of reforestation in enhancing carbon sequestration. When the elimination of the erosion-induced sink term is accounted for, and for a range of protection levels of buried SOC in the fluvial system, we estimate that the C sequestration potential of re-vegetation may be overestimated by 25% to 50% for a period of c. 100 years.