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Timing the carbon cycle: how far does the soil erosion benefit stretch ?

Z. Wang (1), G. Govers (1), K. Van Oost (2), and R. Merckx (1)

(1) K.U.Leuven, Earth and Environmental Sciences, 3001 Heverlee, Belgium (gerard.govers@ees.kuleuven.be), (2) Université Catholique de Louvain, Earth and Life Institure, Pl. Louis Pasteur 3, 1348 Louvain-la-Neuve, Belgium

Several papers have now convincingly shown that, on the short term, the intensification of soil erosion due to human activities does not lead to a massive emission of soil organic carbon. Rather, agricultural soil erosion may be responsible for a relatively small carbon sink. This conclusion is mainly based on the fact that a large fraction of the eroded carbon is dynamically replaced by additional soil carbon uptake at eroding sites and the behaviour of the carbon stores created by deposition. Over decadal time periods a large amount of the deposited carbon is indeed retained within the soil reservoir, thereby leading to net extra carbon storage.
It is still unclear, however, how stable such stores are over longer time spans. We therefore sampled both active and historical colluvial depositional stores in different landscape settings in the Loess Belt of central Belgium. We determined the total amount of carbon stored as well as the variation in its stable isotope composition and a limited number of samples were subjected to incubation runs. The age of the deposits was determined as accurately as possible by measuring total phosphorous as well as 137Cs analysis as well as by interpreting historical maps and aerial photographs.
We used our data to calibrate and validate a simple soil carbon model using two carbon pools only. While the values of the calibration parameters that we obtained for our different sites varied, the results with respect to the lifespan of a soil carbon store created by deposition were consistent. Model simulations show that, under realistic conditions, depositional carbon stores reach equilibrium after 300-1500 years, depending on the deposition rate. At this stage, 20 to 50 % of the deposited soil organic carbon is still present in the colluvium.
When accounting for the effects of soil erosion on the global carbon cycle it is therefore important to consider the dynamics of depositional stores over longer time spans. Our analysis shows that the significant carbon losses from these stores must be accounted for when considering long-term effects of agricultural soil erosion on the global carbon cycle.