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Additional carbon sequestration of eroded agricultural soils is concealed by the return of crop residues

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Carbon (C) stored in soils represents the largest C pool of terrestrial ecosystems and consequently plays a crucial role in the global C cycle. So far, it is widely unclear to what extent different land uses and land use change influence soil C storage. This applies in particular to soil erosion, which is intensified as a result of arable farming in sloping terrain. Soil erosion by tillage, water and wind induces a small-scale pattern of soils that differ greatly in erosion status. However, there are no data about the consequences for the C sink or source potential of these sites up to now.

To investigate the influence of erosion state on the C source and sink potential, we calculated annual net ecosystem carbon balances (NECB) as a proxy for changes in soil organic carbon stocks. Measurements were conducted for winter wheat (Triticum aestivum) during two consecutive years from 2015 to 2016 at four sites at the “CarboZALF-D” experimental field, which is located within the hummocky ground moraine landscape of northeastern Germany, an area characterized by intense cropland use. The measurement sites represent the different soil erosion states: non-eroded Albic Luvisols (plateau), slightly eroded Calcic Luvisol (mid slope), extremely eroded Calcaric Regosols (steep back slope) and depositional Endogleyic Colluvic Regosols (closed depression).

Continuous hourly measurements of the net ecosystem CO_2 exchange (NEE) were conducted for four repetitive automatic flow-through non-steady-state closed chambers per measurement site. Flux separation into ecosystem respiration (Reco) and gross primary productivity (GPP) as well as gap filling was performed based on empirical temperature and PAR dependency models. Soil C stock changes were calculated as the balance of gap filled NEE, harvested NPPshoot, and the C input due to the return crop residues as well as initial mineral fertilization.

Disregarding the return of crop residues, calculated NECB varied from minor to modest C losses for the back slope, midslope and hilltop, respectively, to pronounced C losses for the depression. However, accounting for returned crop residues, all measurements sites acted as minor to modest C sinks irrespective of their particular soil erosion state. Hence, an additional soil C sequestration of the eroded measurement sites (back slope and mid slope) was concealed by the return of crop residues, which substantiates the significant influence of farming practices on C dynamics of agricultural landscapes.