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Tillage erosion as an important driver of soil organic carbon (SOC) dynamics long before agricultural mechanisation

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Tillage erosion is known to be a major soil degradation process that is mainly associated with increasingly mechanised agriculture since the early 1950s. However, especially soil truncation on convex hilltops and slope shoulders can be already identified on historical aerial photos of our study region in Northeast Germany from the 1950s.

The aim of the study is to better understand the effect of mechanised and especially long-term non-mechanised soil redistribution processes on soil organic carbon (SOC) dynamics over the past 1000 years since the beginning of widespread soil cultivation in our study region and their contribution to the question of soil being a carbon (C) sink or source.

Therefore, a modified version of the spatially explicit soil redistribution and C turnover model SPEROS-C was applied on a large-scale catchment (approx. 200 km²) to simulate lateral soil and SOC redistribution, SOC turnover and erosion-induced vertical mixing within the profile (spatial and vertical resolution 5 m x 5 m and 0.1 m soil depth increments, respectively). The uncertainty of the modelling approach was estimated by varying the input variables according to different realisations of the development of agricultural management over the past 1000 years. The results were validated with an erosion classification derived from Sentinel-2 data and UAV based estimation of topsoil SOC. The lowest SOC stocks were found on hilltops, which points at tillage erosion as the major driver of soil degradation.

Our results show that the beginning influence of tillage erosion on catchment wide vertical SOC fluxes can be traced back to around 500 years ago. This clearly indicates that non-mechanised tillage erosion from the early stage of cultivation affected the SOC patterns in the study area and hence impacts todays C cycling.