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Soil organic carbon stocks in southeast Germany as affected by land use, soil type and sampling depth

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Precise estimations of soil organic carbon (SOC) stocks are of decided importance for the detection of carbon sequestration or emission potential induced by land use changes. For Germany, a comprehensive, land use–specific SOC data set has not yet been compiled. We evaluated a unique data set of 1460 soil profiles in southeast Germany in order to calculate representative SOC stocks to a depth of 1 m for the main land use types.
The results showed that grassland soils stored the highest amount of SOC, with a median value of 11.8 kg m-2, whereas considerably lower stocks of 9.8 and 9.0 kg m-2 were found for forest and cropland soils, respectively. However, the differences between extensively used land (grassland, forest) and cropland were much lower compared with results from other studies in central European countries. The depth distribution of SOC showed that despite low SOC concentrations in A horizons of cropland soils, their stocks were not considerably lower compared with other land uses. This was due to a deepening of the topsoil compared with grassland soils. Higher grassland SOC stocks were caused by an accumulation of SOC in the B horizon which was attributable to a high proportion of C-rich Gleysols within grassland soils.
The incorporation of subsoil SOC stocks revealed that land use may not be the main controlling factor for SOC storage and highlighted the importance of pedogenetic properties, particularly in grassland soils. We recommend that pedogenetic soil information should be included in SOC stock estimations as well as in carbon sequestration studies. Our results further indicate that SOC depletion in cropland soils due to cultivation is probably often overestimated because tillage-induced deepening of the topsoil was ignored by studies with fixed depths. The application of modelled parameters in SOC inventories is generally questioned, because SOC stocks, calculated with pedotransfer functions, were systematically biased, particularly for forest soils. Therefore, we propose that in future SOC inventories, soils should be sampled down to the parent material and completely analyzed by horizon instead of depth increments in order to increase the accuracy of SOC stock estimations and to elucidate pedogenetic effects on SOC storage. A land use–specific and soil type–specific quantification of functional SOC pools with different turnover times would make it possible to estimate the future development of SOC stocks under a changing climate.