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Functional soil organic carbon pools for major soil units and land uses in southern Germany

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Soil management, especially the type and intensity of land use, affect the carbon cycle to a high extent as they modify carbon sequestration in a specific soil. Thus man is intervening in the natural carbon cycle on a global scale. In our study, the amount of active, intermediate and passive SOC pools was determined for major soil types and land uses of Bavaria in southern Germany. Our SOC inventory revealed only slightly lower total SOC stocks in cropland soils compared to forest soils, when both top- and subsoils were considered.
In cropland and grassland soils around 90% of total SOC stocks can be assigned to the intermediate and passive SOC pool. High SOC stocks in grassland soils are partly related to a higher degree of soil aggregation compared to cropland soils. The contribution of intermediate SOC in cropland soils was similar to that in grassland soils due to an increased proportion of SOM associated with silt and clay particles. The cultivation-induced loss of SOC due to aggregate disruption is at least partly compensated by increased formation of organo-mineral associations as a result of tillage that continuously promotes the contact of crop residues with reactive mineral surfaces. Contrary, forest soils were characterized by distinctly lower proportions of intermediate and passive SOC and a high amount of active SOC in form of litter and particulate organic matter which accounted for almost 40% of total SOC stocks.
The determination of the current SOC content of silt and clay fractions for major soil units and land uses allowed an estimation of the C saturation deficit corresponding to the long-term C sequestration potential. The results showed that cropland soils have a low level of C saturation of around 50% and could store considerable amounts of additional SOC. A relatively high C sequestration potential was also determined for grassland soils. In contrast, forest soils had a low C sequestration potential as they were almost C saturated.
The high potential of agricultural soils for C sequestration warrants to optimize SOM management of cultivated soils. One has to bear in mind that besides the stable C sequestration in the fine fraction, a significant additional amount of labile SOC will also be sequestered as a result of improved agricultural management. At the same time there are benefits associated with C sequestration beyond CO_2 mitigation because increased SOM is associated with improved soil fertility, soil structure, water holding capacity and thus a sustained productivity.