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Vulnerability of SOC stocks and fractions to different land-use change types in Europe

C. Poeplau and A. Don

vTI, Braunschweig, Agricultural Climate Research, Braunschweig, Germany (christopher.poeplau@vti.bund.de)

Land use changes have a major impact on the balance of soil organic carbon (SOC). Converting grassland or forest to cropland leads to a decrease in SOC stocks, while afforestation and grassland establishment leads to an accumulation of soil carbon. However, the dimension of published SOC stock changes varies greatly, due to site specific differences but also due to methodological differences among the studies. Based on the assumption, that land use change affects only the topsoil, most studies used a maximum sampling depth of 30 cm. In our study we sampled 24 different paired plots with different land-use changes, covering the four major land use change types in hot spot regions of Europe with a sampling depth of 80 cm. The comprehensive sampling across different soils, climatic regions and land use change types gives way to an integrative analysis of qualitative and quantitative SOC stock changes. To assess quantitative changes we measured bulk density, stone content, inorganic carbon content, total carbon and total nitrogen content. To assess qualitative changes we measured different pools of SOC after using the fractionation method described by Zimmermann et al. (2007).

We found, that all land use change types except grassland to forest have a significant influence on topsoil carbon stocks (0-30 cm), while the subsoil dynamic (30-80 cm) was very site specific and often contrary to the topsoil SOC dynamics. Topsoil SOC losses after cropland establishment can be completely offset by subsoil SOC sequestration, which evidently shows that the assessment of carbon stocks should always be performed to a greater depth than 30 cm. The strongest changes occur in the labile SOC fraction (POM), while DOC and the mineral associated SOC fraction showed comparable change after land use changes as the total C stocks. Surprisingly, also the resistant SOC pool, which is often excluded from carbon cycling as inert organic matter (e.g. in the RothC model), showed similar changes and vulnerability to land use changes as total SOC. This might indicate that the role of chemical stabilization for the turnover of SOC is overestimated.