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Influence of long-term land use (arable and forest) and soil mineralogy on organic carbon stocks as well as composition and stability of soil organic matter

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The function of soils to sequester organic carbon (OC) and their related potential to mitigate the greenhouse effect is strongly affected by land use and soil mineralogy. This study is aimed to clarify long-term impacts of arable and forest land use as well as soil mineralogy on topsoil soil organic carbon (SOC) stocks as well as soil organic matter (SOM) composition and stability. Topsoil samples were taken from deciduous forest and adjacent arable sites (within Germany) that are continuously used for more than 100 years. The soils are different in genesis (Albic and Haplic Luvisol (AL, HL), Colluvic and Haplic Regosol (CR, HR), Haplic and Vertic Cambisol (HC, VC), Haplic Stagnosol (HSt)). First, particulate and water soluble organic matter were separated from the topsoil samples (Ap and Ah horizons). From the remaining solid extraction residues the Na-pyrophosphate soluble organic matter fractions (OM(PY)) were extracted, analysed for its OC content (OC(PY)) and characterized by FTIR spectroscopy and 14C analyses.

The SOC stocks calculated for 0-40 cm depth are in general larger for the forest as compared to the adjacent arable soils (except VC). The largest difference between forest and arable topsoils was detected for the HR site (5.9 kg m-2) and seemed to be caused by a two times larger stock of exchangeable Ca of the forest topsoil. For the arable topsoils multiple regression analyses indicate a strong influence of clay, oxalate soluble Al and pyrophosphate soluble Mg on the content of OC(PY) weighted with its C=O content. Such relation is not found for the forest topsoils. Further, a positive relation between 14C values of OM(PY) and the following independent variables: (i) specific mineral surface area, (ii) relative C=O group content in OM(PY) and (iii) soil pH is found for the arable topsoils (pH 6.7 - 7.5) suggesting an increase in OM(PY) stability with increasing interactions between OM(PY) and soil mineral surfaces via cation bridging. A similar relation is found for the forest topsoils ($pH < 5$) if the specific mineral surface area is excluded from the multiple regression. This finding and the higher OC(PY) content of the forest topsoils suggest that in these soils the OM(PY) components are mainly cross-linked by cations and did not interact with mineral surfaces. We assume cross-linking to be less effective for OM stabilization as compared to cation bridging with mineral surfaces since 14C data indicate the OM(PY) from the forest topsoils to be less stable than that from arable topsoils.