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Spatial patterns of soil organic carbon stocks in Estonian arable soils

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Soil organic carbon (SOC) determines ecosystem functions, influencing soil fertility, soil physical, chemical and biological properties and crop productivity. Therefore the spatial pattern of SOC stocks and its appropriate management is important at various scales. Due to climate change and the contribution of carbon store in the soils, the national estimates of soil carbon stocks should be determined. Estonian soils have been well studied and mapped at a scale 1:10,000. Previous studies have estimated SOC stocks based on combinations of large groups of Estonian soils and the mean values of the soil profile database, but were not embedded into the geo-referenced databases. These studies have estimated SOC stocks of Estonian arable soils 122.3 Tg. Despite of available soil maps and databases, this information is still very poorly used for spatial soil modelling. The aim of current study is to assess and model spatial pattern of SOC stocks of arable soils on a pilot area Tartu County (area 3089 sq km). Estonian digital soil map and soil monitoring databases are providing a good opportunity to assess SOC stocks at various scales. The qualitative nature of the initial data from a soil map prohibits any straightforward use in modelling. Thus we have used several databases to construct models and linkages between soil properties that can be integrated into soil map. First step was to reorganize the soil map database (44,046 mapping units) so it can be used as an input to modelling. Arable areas were distinguished by a field layer of Agricultural Registers and Information Board, which provides precise information of current land use as it is the basis of paying CAP subsidies. The estimates of SOC content were found by using the arable land evaluation database of Tartu from the Estonian Land Board (comprising 950 sq km and 31,226 fields), where each soil type was assessed separately and average SOC content grouped by texture was derived. SOC content of epipedon varies in study area from 0.6 to 45%. Then we constructed a statistical mixed model for predicting bulk density (Db) of humus layer from multiple variables (SOC content, depth, moisture content, texture). Constructed model is not compatible for predicting Db values for peat soils, which was estimated through the degree of peat decomposition. For modelling Db we used a dataset compiled from soil samples collected from 1983–1994 under the framework of national monitoring of arable soils. The dataset consists of 90 different sites all over Estonia holding 17,294 unique Db values. SOC stocks were calculated (also the coarse soil fraction was subtracted from the total soil volume) and integrated to Estonian large scale soil map. Up-scaling from soil mapping units allowed assessing SOC stocks at the regional level. Also it formed a methodology and basis to develop nationwide spatial decision support system for SOC accounting and management.

The integration of precise soil map and soil models enables to give more accurate estimates of many soil properties including SOC. Thus our study provides the knowledge of how much carbon is stored in the arable soils, we can take better actions to control SOC fluxes and preventing climate change, e.g. using appropriate land management. Also it helps to construct an upgraded agricultural land use suitability models in which soil organic matter and environmental aspects are more deeply involved.