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Setting-up and application of spatial data for SOC stocks modelling in topsoils of agricultural soils of Slovakia in 1970 – 2006 period

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Soil organic carbon (SOC) content is one of the most important soil parameters which influence many soil processes. The C cycle, including SOC dynamics, can be considered one of the most sensitive biological cycles subject to climate changes and human driven land use change. Promising method for estimation of SOC stock changes is simulation modelling. RothC model is one of the models widely used in small as well as large scale SOC dynamics studies.

We applied RothC model in Slovakia to estimate temporal and spatial changes in topsoil SOC stocks of agricultural soils in 1970-2006 period. Crucial point of the national-level SOC stock modelling was preparation of appropriate data on climate, soil, and organic carbon inputs to the soil attributed to spatial simulation units (SimU).

Source of weather and climate national-level data was the observation network of Slovak Institute of Hydrometeorology, soil data were received from the national soil profile database and agricultural land use database maintained by Soil Science and Conservation Institute, Bratislava and source of soil management data represents NUTS4 level agricultural statistic data on crop harvesting areas, crop yields and manure application rates. All these sources made basis for characterization of the SimUs by information on climate, soil and land use.

Each SimU was designed so that it represented one cell of 10 km resolution regular grid covering agricultural land of Slovakia.

Total area of agricultural land and cropland and/or grassland land cover class area portion was calculated for each SimU. Area portion dominant land cover class was assigned to each SimU.

Total number of 70 point measurements of daily mean temperature (°C), potential evapotranspiration (mm), and rainfall (mm) daily were interpolated to the 10 km spatial resolution grid using interpolation algorithm based on weather station similarity to unknown interpolated location (proximity and altitude).

Mean values of initial SOC stock (t/ha) and clay content (%) in 0 – 20 cm topsoil layer were calculated for each SimU using soil profile data. Prior to calculations soil profiles were stratified and selected according to land cover (cropland/grassland), topsoil SOC content and topsoil texture.

Regarding available agricultural statistics and agricultural land use changes after political changes at Slovakia in early 1990-ies land use data were interpreted separately for the 1970 – 1994 and 1995 – 2006 periods. Crop harvesting areas were analyzed to get regionally representative crop shares for estimation of organic carbon inputs from crop residues. Published data and default RothC model settings were used for estimation of SimU-related monthly carbon inputs to soil (t/ha). Manure consumption statistic served the source for analyze of regionally specific rates of manure application (t/ha). Published data were used to estimate SimU-related monthly application rate of manure (t/ha) separately for cropland and grassland.

SOC stock (t/ha) dynamics in the 1970 – 2006 modelling was done for those SimUs having area portion of agricultural land more than 25%. It was done for 271 SimUs representing cropland and 96 SimUs representing grasslands.

Total estimated national-level SOC stock shows almost 4 times higher values for cropland compared to grassland due to high area portion of cropland from total agricultural land of Slovakia. For Slovak agricultural land the highest SOC stock is characteristic for arable land of endofluvic and haplic chernozem situated on southwest of Slovakia and low SOC stock is typical for Flysh area of northeast Slovakia. Based on simulation results we also found out that in general, initial SOC stock increased slightly in starting modelling period 1970-1994 and then slightly decreased in second modelling period 1995-2006 probably due to decreased organic inputs into soil.