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Soil organic carbon storage in the forest-tundra ecotone zone in the North-Eastern Europe

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High latitude terrestrial ecosystems are considered key components in the global carbon (C) cycle [McGuire et al., 2009, Hugelius et al., 2010, in press]. Large stocks of soil organic carbon (SOC) have accumulated in Cryosols and Histosols, where permafrost affects to reduce decomposition rates. In a recent study based on the Northern Circumpolar Soil Carbon Database (3530 pedons, soil map mean polygon size 259 km2), Tarnocai et al. [2009] estimated soil organic carbon (SOC) stocks in the northern permafrost region to be 1024 Pg (Pg = g x 1015) for the upper three meters (with Histosols contributing 278 Pg and Cryosols 634 Pg).
This study describes detailed partitioning of soil organic carbon (SOC) for the forest-tundra ecotone zone in the border of the discontinuous and massive island permafrost terrain with MAGT -0.5° to -2.0° C, North-Eastern European Russia.
Soil cover of the study area is diverse and mosaic and form complexes of soils owing to a variety of microrelief, cryoturbation processes, snow cover distribution, etc. In peat plateau/thermokarst complexes, Cryic Folic Histosols with shallow permafrost tables are interspersed with Fibric Histosols (permafrost free fens) and Fibric Floatic Histosols (thermokarst lakes in-filling with vegetation). Permafrost-affected mineral soils (Cryosols) are usually formed on loamy wind-exposed surfaces under tundra dwarf-shrub vegetation where shallow snow cover preserves permafrost within the soil profile. In these sites, quite thick peaty layers (10-40 cm) also favours shallow permafrost occurrence (Histic Cryosols). Non-permafrost soils (Gleysols, Cambisols and Albeluvisols) are usually formed in sites under tall shrub vegetation where thicker snow cover in winter results in a warmer soil regime. Non-permafrost soils are developed under forest vegetation (Cambisols and Albeluvisols) and in floodplains (Fluvisols).
Georeferenced soil data from field observations were overlaid on Landsat images and a supervised classification procedure was carried out. As a result satellite images were coded to raster maps containing soil type information in pixel classes. The images were then homogenized prior to conversion to vector polygons. Resulting vector maps were processed as shape files in the software ArcGIS 9.1, where adjacent uniform polygons were merged and corrected and soil maps were compiled.
Mean SOC storage (kg C m-2) for each soil type (SOC only) was calculated as the arithmetic mean of C storage in the sites belonging to that class and was upscale to soil groups in the map.
Mean SOC storage for all four study areas combined is estimated to be 39.5 kg C m-2 (soil map and LCC upscaling respectively). Detailed GIS map of SOC storage can be used to model the potential effect of permafrost thaw on SOC stores.