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Soil function modelling based on soil property maps produced by digital soil mapping from geophysical data

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The iSOIL project aims at reliable mapping of soil properties and soil functions with various methods including geophysical, spectroscopic and monitoring techniques. The general procedure has three steps: (i) geophysical monitoring, (ii) generation of digital soil maps and (iii) process modelling.
The focus of this work concentrates on the turnover conditions for soil organic matter (SOM) because many soil functions in a direct or indirect way depend on SOM and SOM depletion is amongst the worst soil threats.
The applied CANDY model (Franko et al. 1995) was developed to describe dynamics of soil organic matter and mineral nitrogen as well as soil water and temperature. The model requires a complete set of soil physical parameters for the rooted soil profile but it may use pedotransfer functions in order to fill gaps in the input data basing on data about soil texture and SOC:

• Bulk density (BD)= F(Clay, SOC)
• Particle density (PD)= F(Clay, SOC)
• Pore volume (PV)= F(BD, PD)
• Texture interpolation after Nemes et al. (1999)
• Field capacity (FC)= F(Particles<= 20μm)
• Permanent wilting point (PWP)= F(Clay)
• Saturated conductivity (ks)= F(Clay, sand (USDA7))
• Long term stabilized SOC after Kuka (2005)= F(PV,FC,PWP)

The modelling procedure for selected soil functions will be described for the example of the field site Lany with a total area of 21 ha which is located in the central part of the Czech Republic (50°08'N, 13°52'E). It represents arable land with (rape, spring barley, winter wheat and corn) on Haplic Cambisol with an average annual temperature of 7.8 °C and 450 mm of annual precipitation.
Digital soil mapping based on Support Vector Machines regressions (Viscarra-Rossel and Behrens, 2010) between measured soil properties and data from geophysical measurements of electrical conductivity and gamma spectrometry with mobile sensor platforms provided data about clay, silt and sand as well as SOC and N content for three soil layers (0-10 cm, 10-30 cm, and 30-70 cm). For the construction of the soil profile we enlarged the last soil layer up to 150 cm.

The Biological Active Time (BAT) calculated by CANDY is a very efficient indicator to address SOM turnover conditions. BAT describes the time required for a given turnover result under optimal conditions and can be used to compare the effect of different soil properties and/or climate elements.
Beside the BAT values we also used the model to calculate changes of SOM storage and indicators of the water balance. The results gave some hints to potential hot spots where local adaptations of agricultural management would be required to further improve soil functions.

We analyzed the influence of different resolutions on process modelling comparing 5, 15, and 50 m grid sizes and will discuss what resolution of the input data could be recommended for environmental assessment and management decisions.