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Upscaling of annual mean and dynamics of water table depth in German organic soils

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Water table depth is the key parameter controlling the fluxes of CO_2, CH_4 and N_2O from organic soils (peatlands and other organic soils). Therefore, a good estimation of the spatial distribution of water table depth is crucial in any upscaling approach for these greenhouse gases (GHGs). It is further the prerequisite to assess the effects of re-wetting measures. There are attempts to obtain maps of water table depth at large scales (e.g. national or continental) by using process-based hydrological model concepts. However, major problem of the process-based approach is the representation of the water management (ditches, tile drains, pumping and weir management), which is at the best known spatially just for the ditch patterns. Thus, this approach is hardly applicable to the diversely-drained and -used organic soils in central Europe.

Here, we present an alternative, data-driven approach for upscaling annual mean and dynamics of water table depth in organic soils. Groundwater level data of a unique dataset from about 60 peatlands, 1100 dipwells and around 8000 annual data sets, is the basis of this approach. Time series were used to calculate long-term annual means, average annual amplitudes and ponding durations. In case of continuous observations, shape parameters of the annual frequency distribution of water table depths were calculated. For each well, numerous site characteristics were collected as possible explanatory variables. This collection was restricted to nationally-available data. For each dipwell, land use is taken from official land use maps (German database ATKIS), and the soil type from the national geological map (1:200.000). In case of reliable site information, maps were corrected accordingly. Additionally, from these maps, topological indicators such as the ditch distance and density, the distance to the edge of the peatland and the peatland area within different buffers were calculated. Meteorological data (precipitation, potential evapotranspiration and climatic water balance) was extracted from gridded data (1x1 km) from the German Weather Service. Topographic indices were calculated using the national digital elevation model. Further, protection status (nature reserves, Natura2000, etc.) and peatland type was collected for each well.

We use two data-driven models (fuzzy-logic and boosted regression trees) to analyze the influence of the site characteristics on the various water table depth target variables (mean, amplitude, etc.). First results using the fuzzy-logic approach show that a land use/vegetation and protection status categorization of the data combined with separate fuzzy models for each category can explain substantial parts of the variance seen in the data set. Variables with strong explaining power were meteorological (summer precipitation and/or climatic water balance) and topological parameters of the ditch network and the peatland body. Uncertainty of the models is evaluated using cross-validation. Models are applied with nationally-available data to generate maps of statistical measures of water table depth for the German organic soils.