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Prediction of soil organic carbon concentration and soil bulk density of mineral soils for soil organic carbon stock estimation

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Soil monitoring networks provide a powerful base for estimating and predicting nation's soil status in many aspects. The datasets of soil monitoring are often hierarchically structured demanding sophisticated data analyzing methods. The National Soil Monitoring of Estonia was based on a hierarchical data sampling scheme as each of the monitoring site was divided into four transects with 10 sampling points on each transect. We hypothesized that the hierarchical structure in Estonian Soil Monitoring network data requires a multi-level mixed model approach to achieve good prediction accuracy of soil properties. We used this database to predict soil bulk density and soil organic carbon concentration of mineral soils in arable land using different statistical methods: median approach, linear regression and mixed model; additionally, random forests for SOC concentration. We compared the prediction results and selected the model with the best prediction accuracy to estimate soil organic carbon stock. The mixed model approach achieved the best prediction accuracy in both soil organic carbon (RMSE 0.22%) and bulk density (RMSE 0.09 g cm-3) prediction. Other considered methods under- or overestimated higher and lower values of soil parameters. Thus, using these predictions we calculated the soil organic carbon stock of mineral arable soils and applied the model to a specific case of Tartu County in Estonia. Average estimated SOC stock of Tartu County is 54.8 t C ha-1 and total topsoil SOC stock 1.8 Tg in humus horizon.