Forest SOC monitoring in Estonia – challenges and needs for the future

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NorForSoil: Integrating Soil Monitoring in Nordic Forests – data harmonization, future designs and studies to examine soil function at different scales; 8.-9.2.2023 kick-off in Ås, Norway
Forest SOC monitoring is conducted by Estonian Environment Agency

- Part of the state monitoring program (Forest monitoring sub-program)
- Estonian forest monitoring is part of the Pan-European *ICP Forests* program
- Soil monitoring
  - Level II sites: 1996 and 2009
  - Additional forest litter plots: 2017
- All three surveys followed the ICP methodology

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C stocks in forest soils

- The highest SOC stocks were accumulated in Sapric (56.9 kg/m²) and Fibric Histosols (45.7 kg/m²).
- In Histic Podzols and Histic Gleysols, the SOC stocks were 19.1 and 18.1 kg/m², accordingly.
- SOC stock in mineral soils is varied between 5.5 (Umbrisols) and 14.6 (Gleysols) kg/m².
- The majority (80-98%) of organic carbon of mineral and peaty soils are deposited in a 40 cm superficial layer.

Modelling SOC changes in forest soils

- Implementing Yasso model for forest mineral soils
  - Yasso07 model overestimated C stocks in Estonian forest soils
  - Additional measurements of C fluxes have been conducted for model parametrization and validation

Further Yasso model implementation based on Estonian data is in process in cooperation Allan Sims from Estonian University of Life Sciences

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Estonian Soil Map

- Estonian large scale (1:10 000 soil map) is based on surveys conducted in 1958–1989
- Digitalized and available at: https://geoportaal.maaamet.ee/eng/Spatial-Data/Estonian-Soil-Map-p316.html
- Area of histosols needs updating, partly mineralized
- Monitoring reports and data are available on web page of Estonian environmental monitoring system
  https://kese.envir.ee/kese/welcome.action

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Kmoch et al 2021 EstSoil-EH: a high-resolution eco-hydrological modelling parameters dataset for Estonia
https://doi.org/10.5194/essd-13-83-2021

NorForSoil: Integrating Soil Monitoring in Nordic Forests – data harmonization, future designs and studies to examine soil function at different scales; 8.-9.2.2023 kick-off in Ås, Norway
Israfilbayov, Y. 2023 Soil organic carbon prediction with machine learning (MSc thesis, supervisor A. Kmoch)
Some specific publications

• Kõlli et al 2004. **Organic carbon pools in Estonian forest soils.** Baltic Forestry 10, 19-26

• Noreika et al. 2019 **Forest biomass, soil and biodiversity relationships originate from biogeographic affinity and direct ecological effects,** [https://doi.org/10.1111/oik.06693](https://doi.org/10.1111/oik.06693)
  In this study they disentangle the indirect effects of the species pool and direct ecological effects on the complex relationships among wood volume, soil conditions and diversities of different plant and fungal groups in 100 old-growth forest sites (10 × 10 m)


• Kriiska, K 2019. **Variation in annual carbon fluxes affecting the soil organic carbon pool and the dynamics of decomposition in hemiboreal coniferous forests.** PhD thesis [https://dspace.ut.ee/handle/10062/64800](https://dspace.ut.ee/handle/10062/64800)
  Additional measurements (soil respiration, fine root biomass and production, decomposition...) at ICP sites

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Challenges and needs for the future

• Data analyses (joint campaigns between the institutions)
• Missing metadata: better ways to characterize the environmental variables - when and where the soil sample was taken, the history of forest management, etc.
• New ideas which spatially distributed (and ideally continuous) covariates can serve as predictors (e.g., remotely-sensed spectral indicators, topographical variables etc.)
• Next-generation monitoring, sensing, sampling protocols
• Harmonization of sampling protocols
• Using data sampled in different ways, at different depths, by following different methodologies...