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Working together for forest soils

Holistic management practices, modelling and monitoring for European forest soils





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Uncertainty and benchmarking for forest soils

Aleksi Lehtonen (LUKE)

Content

- Uncertainty in soil C change with forest lands
- Benchmarking data and models
- HoliSoils soil C model ensemble
- Peatlands



Uncertainty in soil C change on Forest land - examples



Contents lists available at SciVerse ScienceDirect

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ARTICLE

Uncertainty of upland soil carbon sink estimate for Finland¹

Aleksi Lehtonen and Juha Heikkinen

Propagating uncertainty for large regions

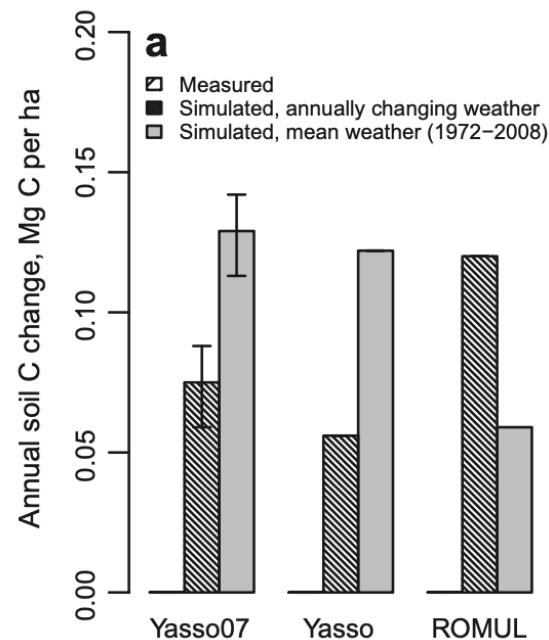
- Sampling error in NFI (forest inventory)
- Uncertainty in biomass & litter estimation
- Uncertainty in harvesting statistics
- Bayesian uncertainties of Yasso07 parameters

Table 1. Change in soil C ($\text{Mg C}\cdot\text{ha}^{-1}$) during the first Kyoto period, 2008–2012, and its uncertainty (presented according to IPCC guidelines as $2 \times$ standard error of the estimate), uncertainty after omitting

	Southern Finland		Northern Finland	
	$\text{Mg C}\cdot\text{ha}^{-1}$	%	$\text{Mg C}\cdot\text{ha}^{-1}$	%
Estimate	0.508		0.797	
Uncertainty, U	0.131	25.8	0.251	31.5

The Yasso07 soil carbon model – Testing against repeated soil carbon inventory

Miitta Rantakari^{a,c}, Aleksi Lehtonen^{a,*}, Tapio Linkosalo^a, Mikko Tuomi^b, Pekka Tamminen^a, Juha Heikkinen^a, Jari Liski^b, Raisa Mäkipää^a, Hannu Ilvesniemi^a, Risto Sievänen^a



Uncertainty in soil C change of organic layer in Forest land Southern Finland based on Yasso07 parameter uncertainty and sampling error of Biosoil (n=275 plots)

Uncertainty in soil C change on Forest land - examples

Biogeosciences, 8, 1279–1289, 2011
www.biogeosciences.net/8/1279/2011/
doi:10.5194/bg-8-1279-2011
© Author(s) 2011. CC Attribution 3.0 License.

Soil carbon stock increases in the organic layer of boreal middle-aged stands

M. Häkkinen, J. Heikkinen, and R. Mäkipää

Repeated sampling of fast growing forest stands from Biosoil grid.

- 4 samples from 10 locations per plot.
- 2nd sampling round +18 degrees

Result:

The increase was significant in 6 out of the 38 plots from which data were available.

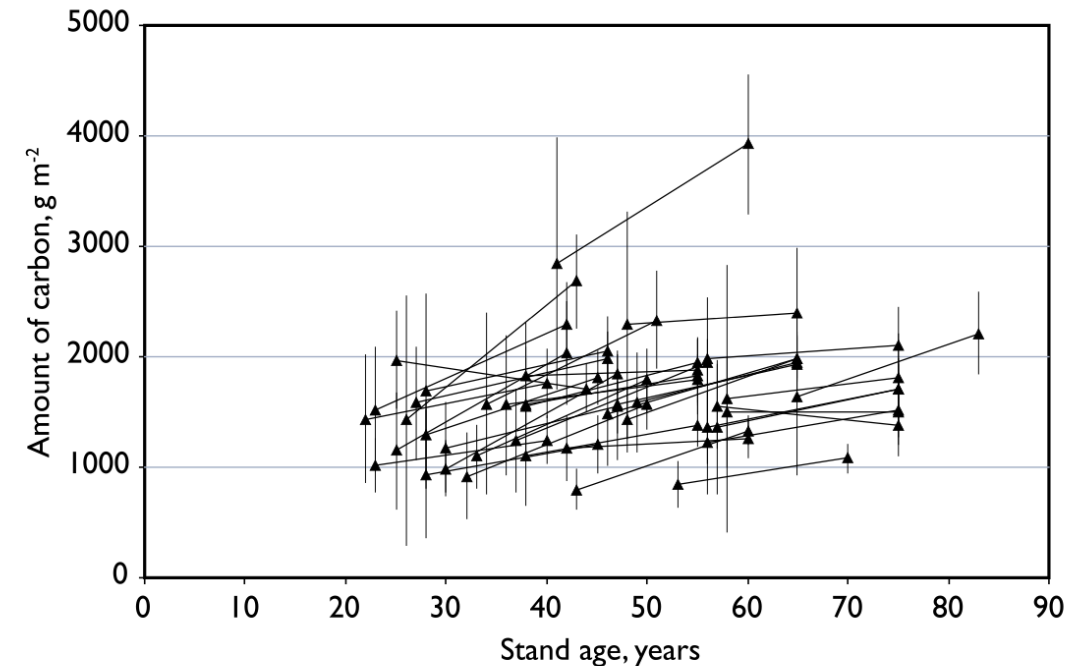
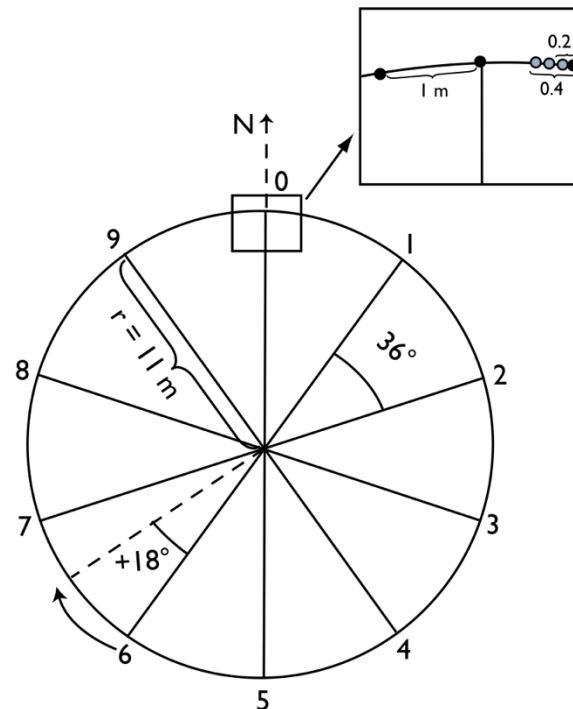
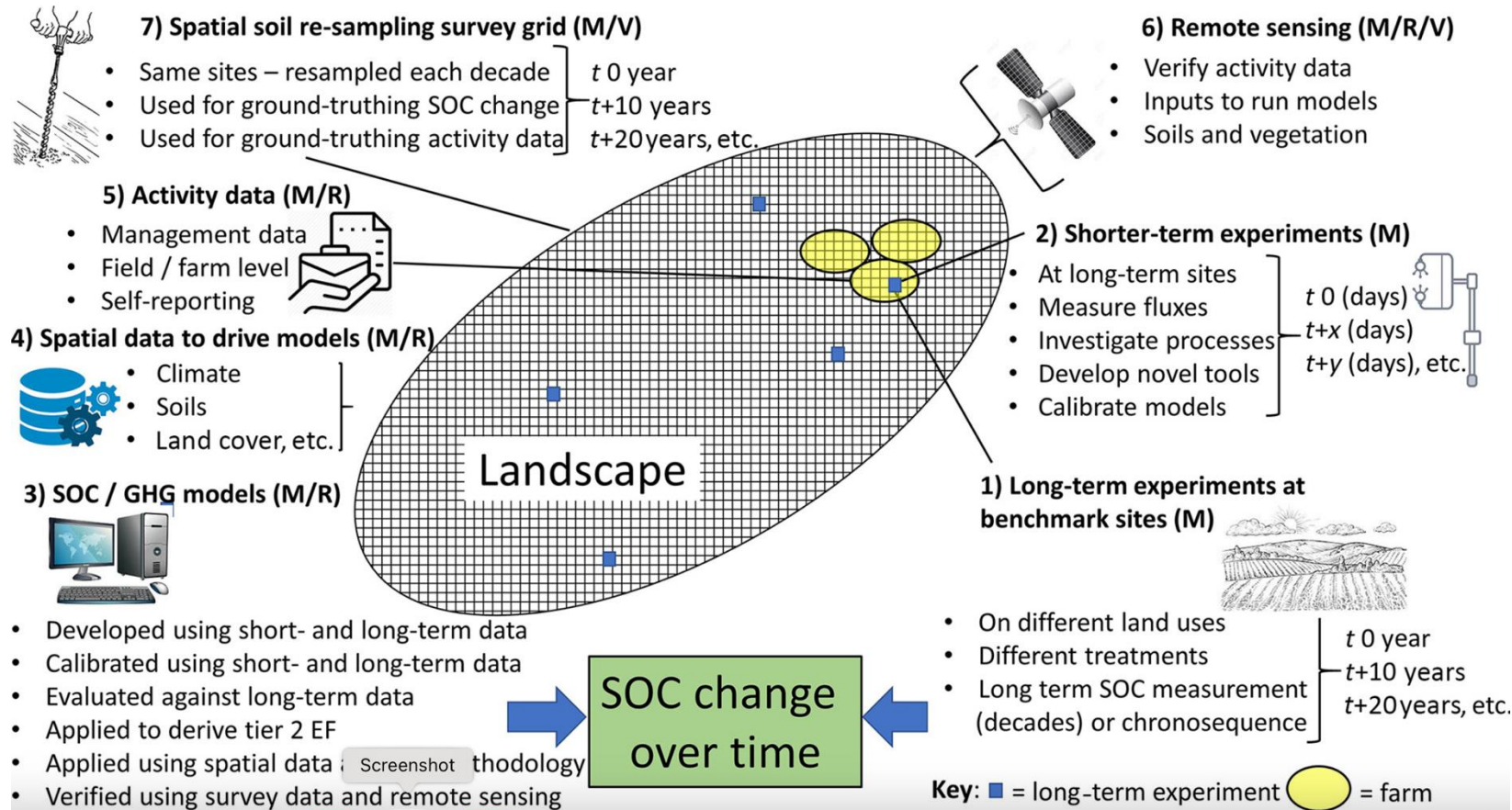


Fig. 4. The amount of carbon at the time of the first and the second sampling with 95 % confidence intervals, connected with a line which describes the magnitude of the change.

Uncertainty management in MRV



Carbon farming requires the use of multiple data streams.

And management of systematic and random error of those.

- Earth observations
- Field measurements
- Process-based models
- Machine learning

Benchmarking soil data that is used for Forests

Significantly higher C and N concentrations can be attributed to an insufficient separation of the organic layer from the mineral soil during the sampling conducted by LUCAS 2015

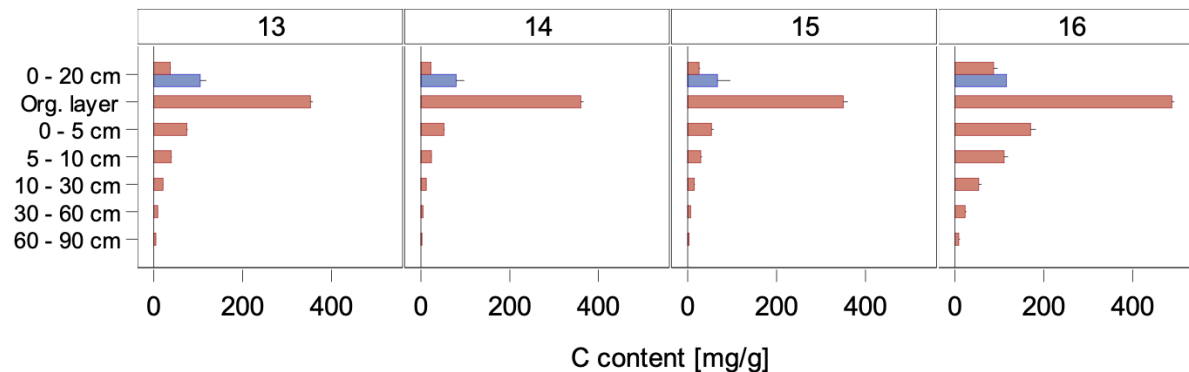


Figure 14: Depth distribution of the C concentrations for soil groups based on the soil inventories. Black bars = standard error, *Numbered soil groups see table 1

Comparison of the LUCAS 2015 inventory with the second National Forest Soil Inventory

Comparability and representativeness of two soil inventories conducted in Germany

Daniel Ziche, Erik Grüneberg, Winfried Riek, Nicole Wellbrock

Thünen Report 94

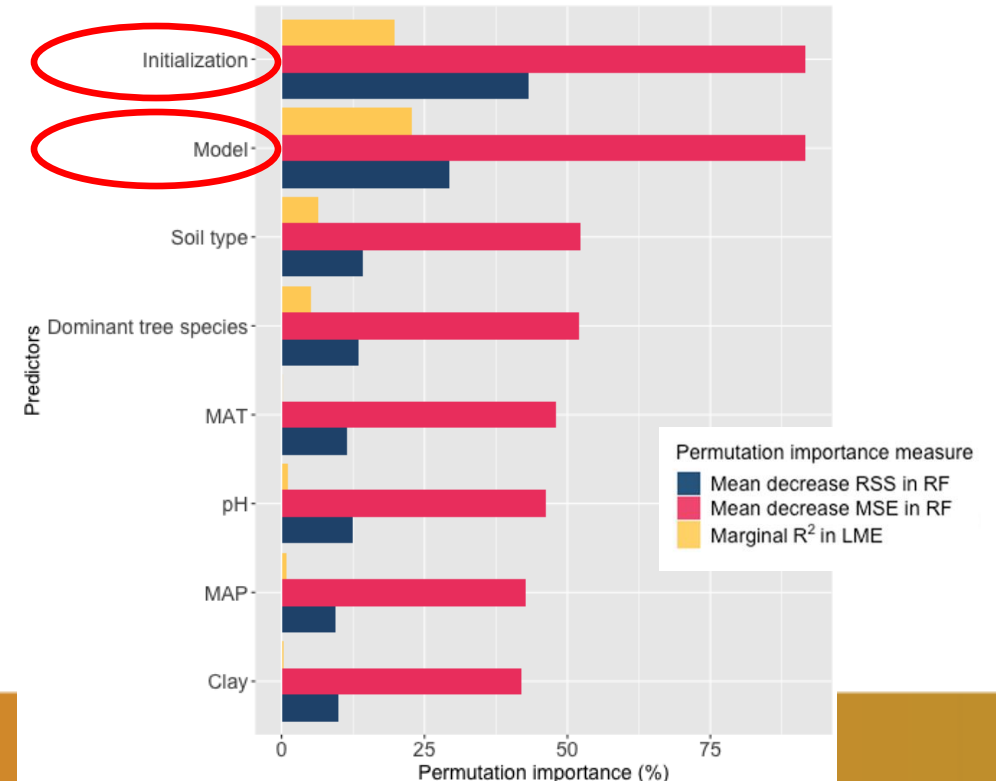
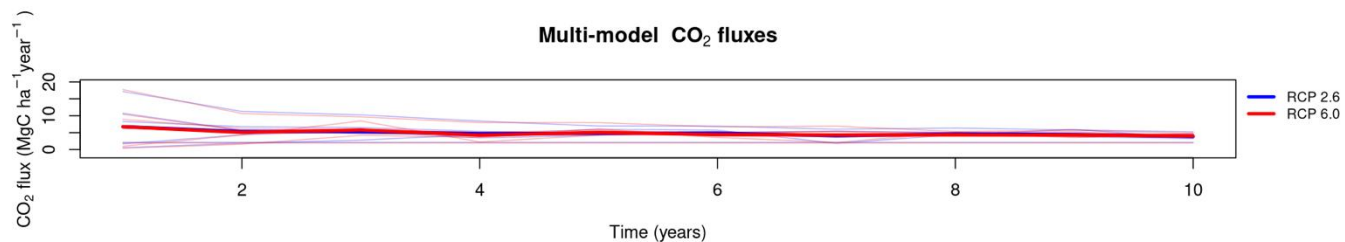
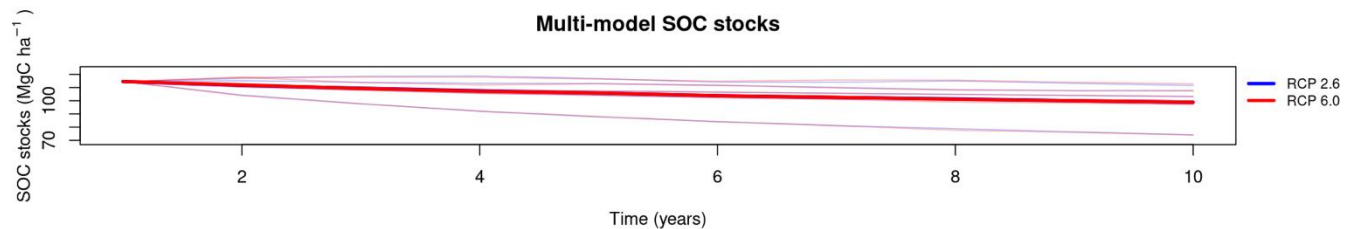
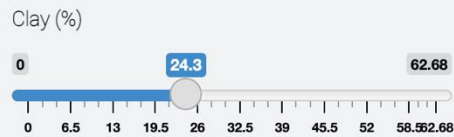
Benchmarking soil models – HoliSoils

Work done by Elisa Bruni & Bertrand Guenet CNRS France

Soil model ensemble hosted here:

<http://me4soc.geologie.ens.fr:3838/me4soc/v1/>

- Century (Parton et al., 1988)
- ICBM (Andrén and Kätterer, 1997)
- Roth-C (Coleman and Jenkinson, 1996)
- Yasso07 (Tuomi et al., 2009)
- Yasso20 (Viskari et al., 2022)
- SG (Hashimoto et al., 2011)



Benchmarking soil models – Initialisation

Extensification and afforestation of cultivated mineral soil for climate change mitigation in Finland

Boris Āupek^{a,*}, Aleksi Lehtonen^a, Raisa Mäkipää^a, Pirjo Peltonen-Sainio^a, Saija Huuskonen^a, Taru Palosuo^a, Jaakko Heikkinen^b, Kristiina Regina^b

Factors affecting the uncertainty of sinks and stocks of carbon in Finnish forests soils and vegetation

Mikko Peltoniemi^{a,*}, Taru Palosuo^b, Suvi Monni^c, Raisa Mäkipää^d

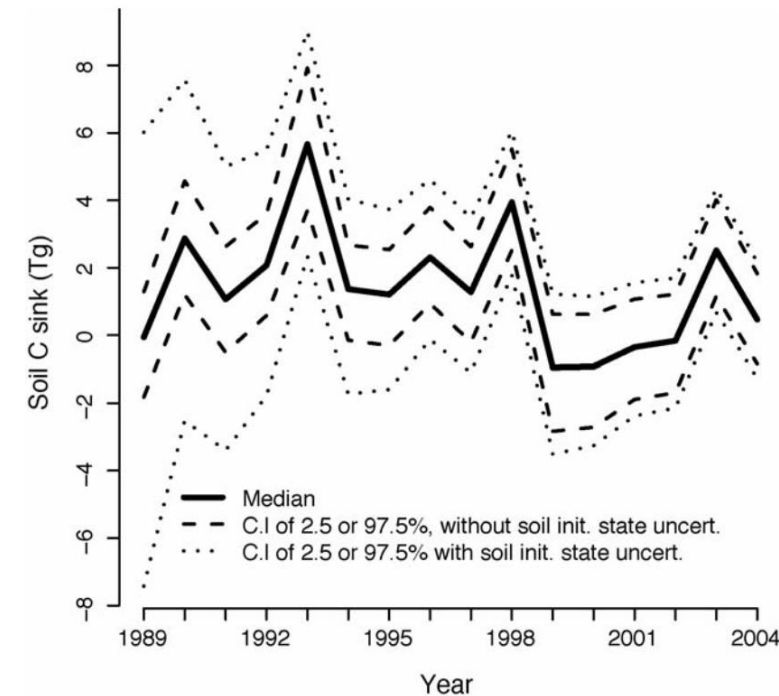
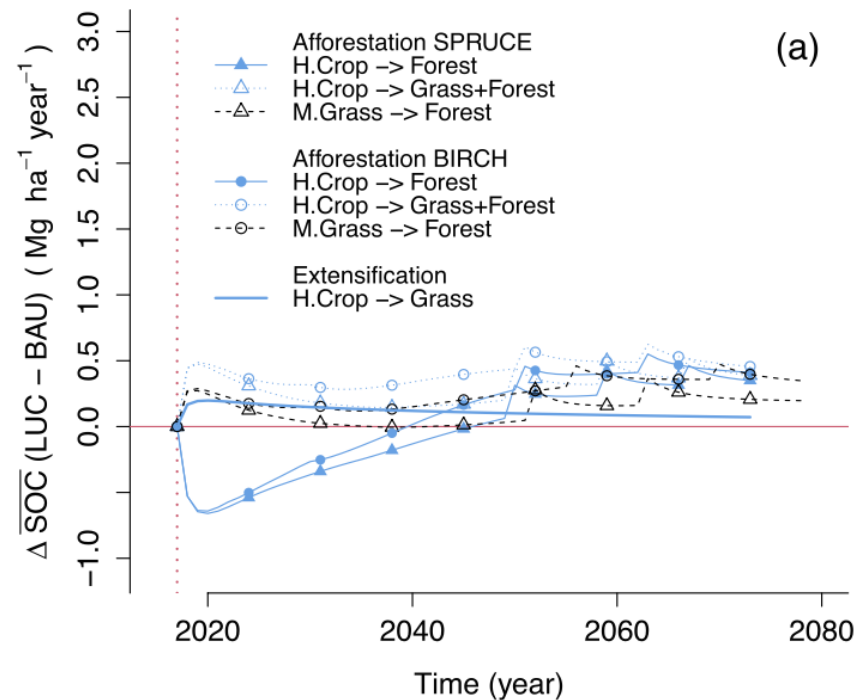
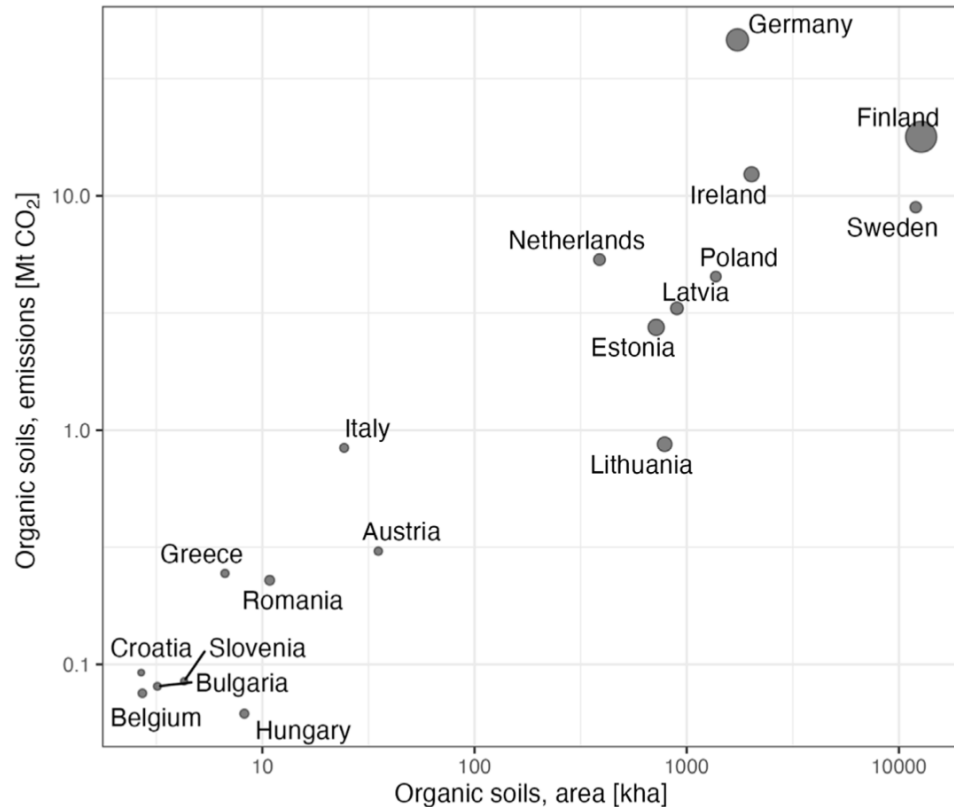


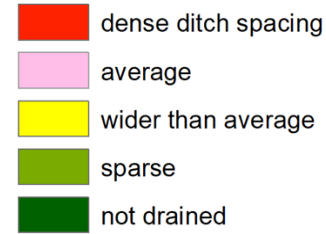
Fig. 4. Effect of initial state uncertainty on sinks from 1989 to 2004. The effect can be seen as differences between the confidence limits of the two simulations.

We need targeted policy interventions in the EU to save soil carbon

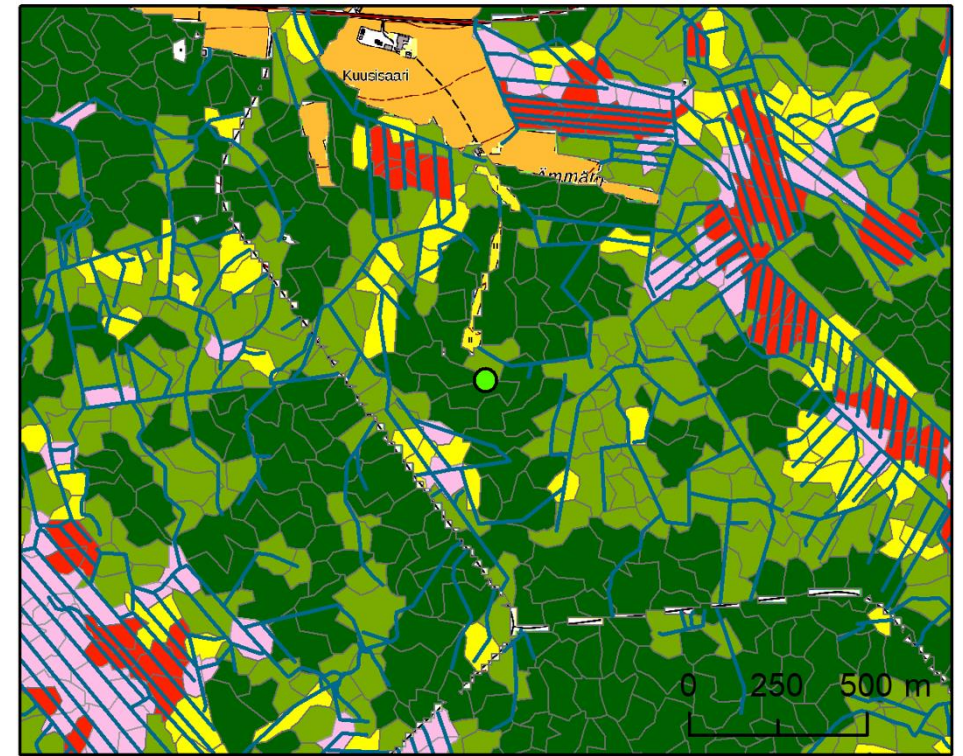
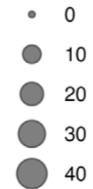
R. Mäkipää^{1*}, O. Bruun², A. Lehtonen¹, M. Peltoniemi¹ and K. Kulovesi²



HoliSoils peatland map for drained and undrained forests



Griscom et al. 2017



Activity data for peatlands is coming (HoliSoils, ALFAwetlands), but significant uncertainties with emission factors

FIGURE 1 Land areas of organic soils for forest land, cropland, grassland, and wetlands under UNFCCC reporting for 2021, based on the 2023 submissions of the countries that reported organic soils, y-axis for corresponding organic soils CO₂ emissions, while size of the circle indicates estimated emission reduction potential by [Griscom et al. \(2017\)](#) (peatland restoration and avoided peatland impacts).



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