

Regional and depth distribution of carbon in Finnish upland forest soils

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Carbon reservoirs on forestry land in Finland

Kauppi, Posch, Hänninen, Henttonen, Ihalainen, Lappalainen, Starr, & Tamminen 1997. Carbon reservoirs in peatlands and forests in the boreal regions of Finland. *Silva Fennica* 31(1).

	Tg	%
Tree biomass	618	10
Upland forest soils (70 cm)	1040	16
Peat	4800	74
Total	6459	100

Aim

Describe depth distribution of carbon amounts in Finnish upland forest soils

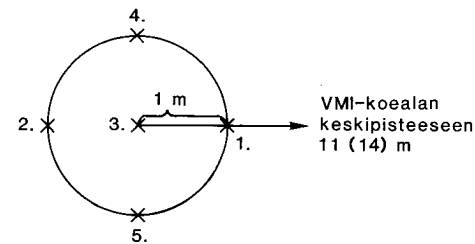
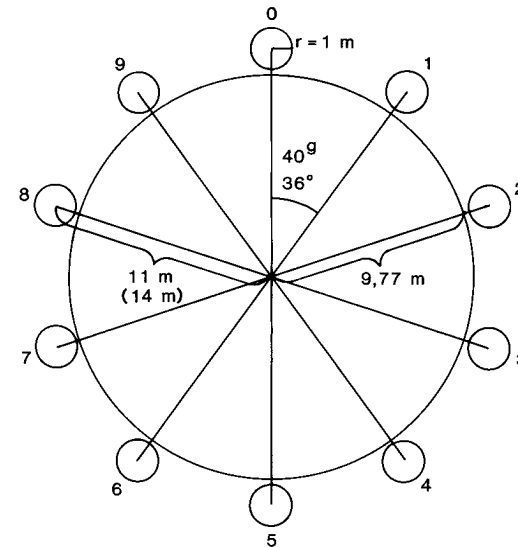
Describe regional amounts of carbon throughout Finland:

- organic and 0-20 cm mineral soil layer

Describe relationships between soil carbon and site and soil variables

Material

Material was collected from 488 permanent plots of the 8th national forest inventory in 1986-95 .



Soil sampling

Organic layer was sampled with a cylinder of 58 mm diameter by taking 10 to 30 subsamples depending on the thickness of the organic layer.

Mineral soil was sampled by digging pits down to 70 cm and taking samples from the layers 0-5, 5-20, 20-40 and 60-70 cm.

For mineral soil layers bulk density of analysed under 2 mm fraction was estimated by using regression equations (Tamminen and Starr 1994).

Proportion of stone volume was estimated for mineral soil according to the stoniness of the layer 0-30 cm (Viro 1952).

Analysis of carbon

Organic samples were ground in a mill with a 2 mm bottom sieve and mineral soil samples were sieved to retain under 2 mm fraction.

Total carbon concentration was analysed by Leco CHN analyser for all organic and for 259 mineral soil samples.

C concentration for the rest of mineral soil samples (1500) were calculated from Loss-on-ignition measurements:

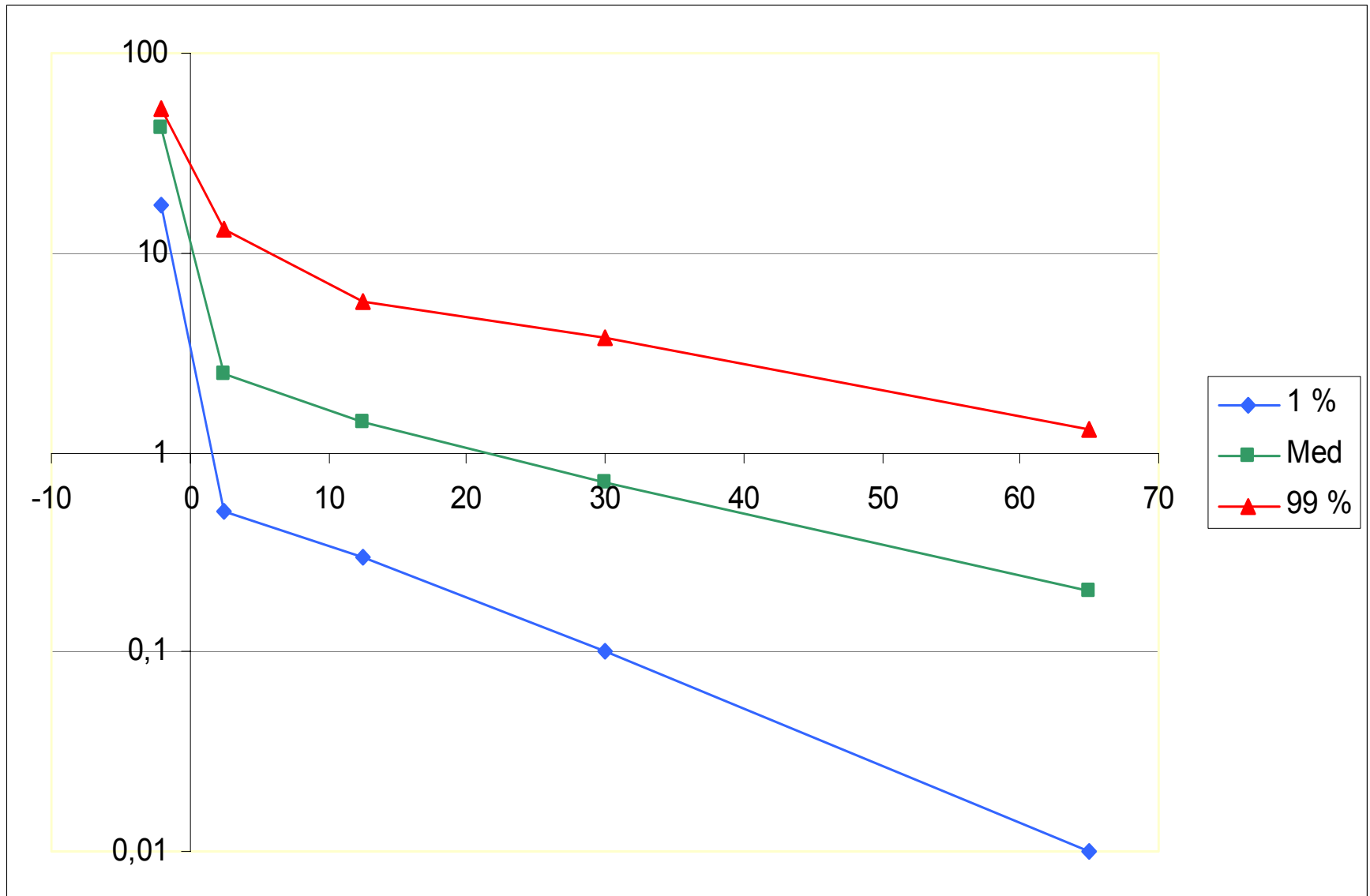
$$C=f(\text{Loi, sampling depth}); R^2=0.98$$

Sampling error

Sampling error for C concentrations was, on average, for organic layer <5% and for mineral soil layer 0-5 cm 5-15% and for layers 5-20 and 20-40 cm 10-30%.

Sampling errors for amounts were higher due to variation in organic layer thickness and due to variation in rock fragments content in the mineral soil.

Depth profile of soil carbon concentration



Amount of carbon (Mg/ha) by soil layer

	Median	Min-Max
Organic layer	18	0 - 101
Mineral soil 0-20 cm	21	2 - 94
Mineral soil 20-40 cm	10	0 - 78

Carbon amount in organic layer and 0-20 cm mineral soil layer almost similar.

Carbon amount in 20-40 cm mineral soil layer half of that in 0-20 cm layer.

Factors affecting on soil carbon

Relationships of soil carbon with site and soil variables were studied by regression analysis, independent variables being:

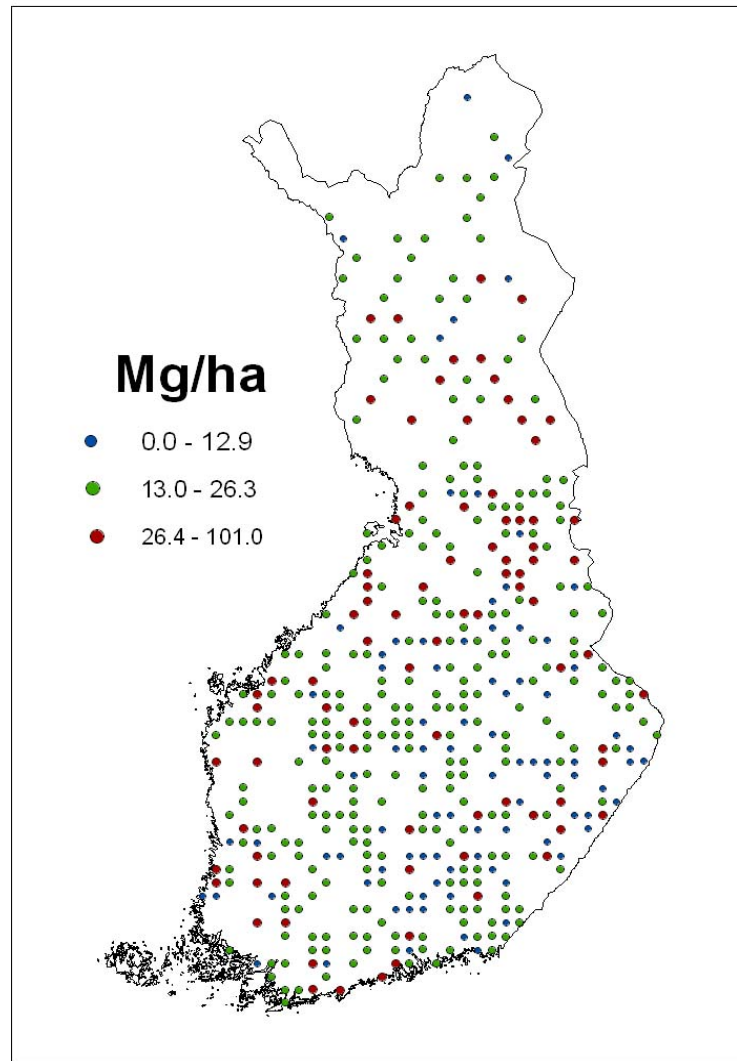
latitude, effective temperature sum, site fertility (forest site type), actual tree species and stand age, paludification stage, proportion of stones, texture of mineral soil.

Factors affecting on amount of carbon (Mg/ha) in organic layer

$$y=\ln(C+1); R^2=0.32; n=441$$

<u>Variable</u>	<u>Std regr. coeff.</u>
Clay%	-0.13
Most fertile site type(0/1)	-0.13
Least fertile site type(0/1)	-0.20
Sphagnum coverage	+0.44
Age of tree stand	+0.24

Geographical distribution of amount of carbon (Mg/ha) in the organic layer

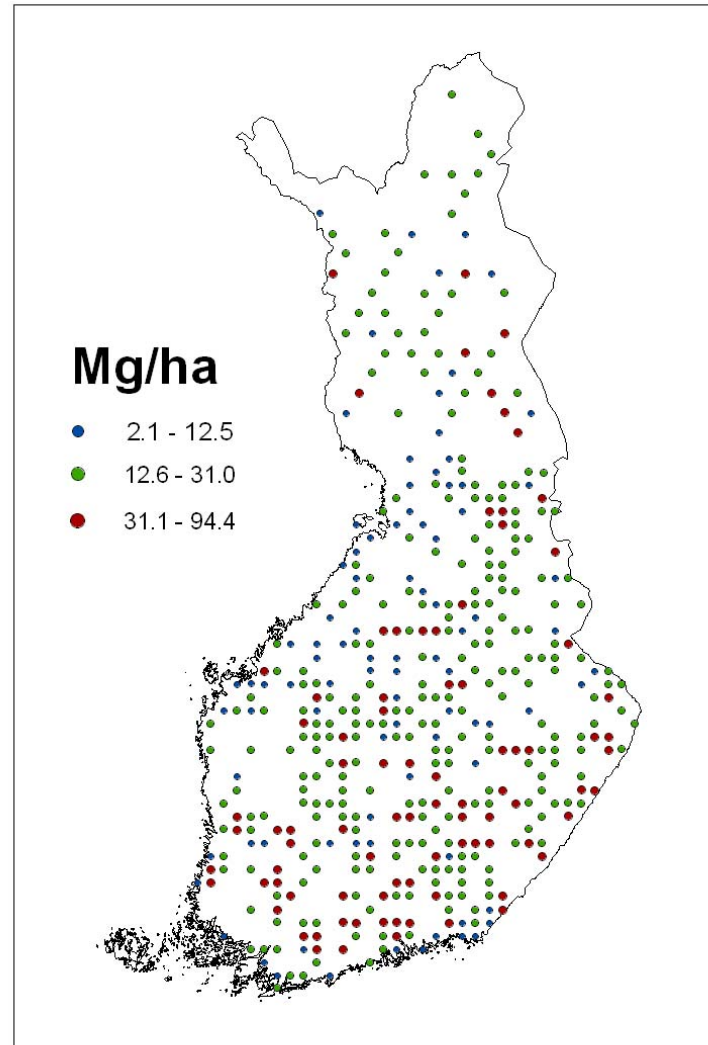


Factors affecting on amount of carbon (Mg/ha) in 0-20 cm mineral soil layer

$$y=\ln(C+1); R^2=0.70; n=441$$

<u>Variable</u>	<u>Std regr. coeff.</u>
Temperature sum, dd	+0.37
Elevation, m	+0.27
Stoniness%	-0.66
Fines%(<63 μm)	+0.34
Most fertile site types(0/1)	+0.12

Geographical distribution of amount of carbon (Mg/ha) in the 0-20 cm layer



Influence of temperature and moisture on soil organic matter (SOM) in Europe

Source. Jones, Robert J.A., Hiederer R, Rusco, E., Loveland P.J. and Montanarella, L. 2004.
THE MAP OF ORGANIC CARBON IN TOPSOILS IN EUROPE: VERSION 1.2 - SEPTEMBER
2003 Explanation of: Special Publication Ispra 2004 No.72 S.P.I.04.72.

Peatlands

Peatlands are particularly common in northern and eastern Finland. Peatland map is based on the 9th national forest inventory data.

Proportion of Histosols, i.e. soils having over 40 cm peat layer was highest in:

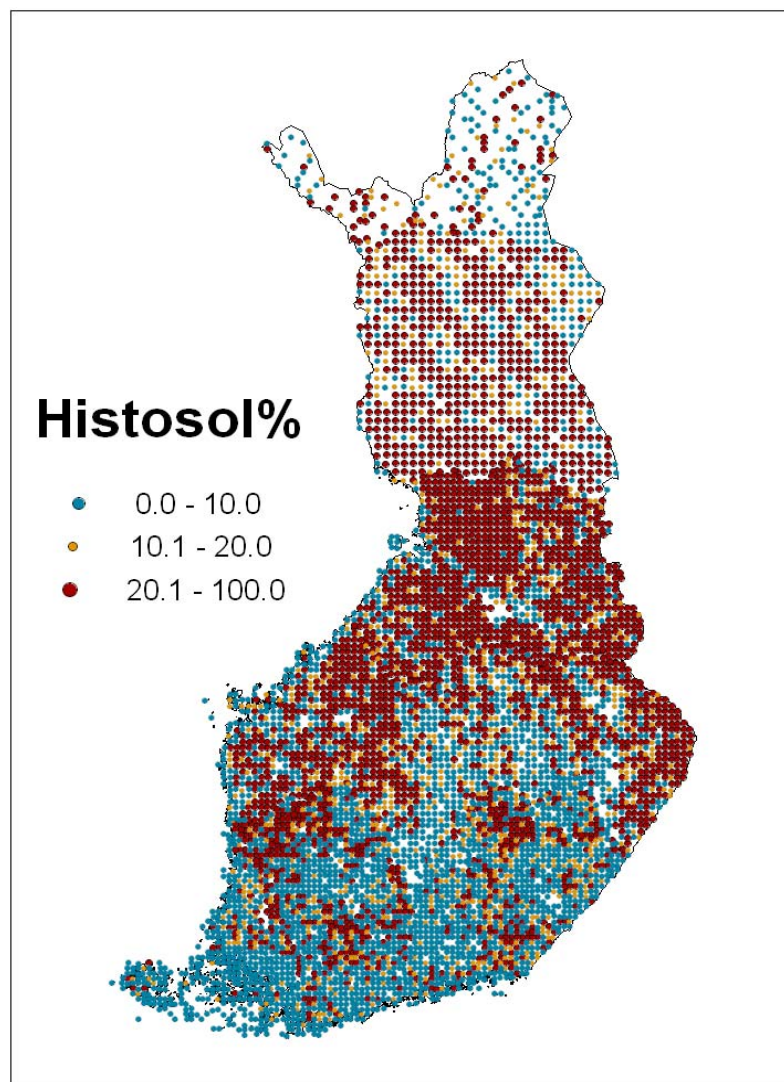
Northern Ostrobothnia, 38 %

Kainuu and Southern Ostrobothnia, 34 %

Northern Carelia, 28 %

Lapland, 26 %

Proportion of Histosols



Conclusions

Sampling errors in estimating amounts of soil carbon are rather high due to heterogeneity of soil properties.

Upland soils have stored huge amounts of carbon during about 10 000 years after the last ice age.

Carbon is concentrated on the top of mineral soil, i.e. in the organic layer (forest floor) and in the surface layers of the mineral soil.

Amount of carbon in the organic layer is connected most to paludification, i.e. peat formation due to wet soil conditions, and to stand age.

Amount of carbon in mineral soil is correlated best to stoniness or soil shallowness due to bedrock, to temperature sum or latitude and to proportion of fine fractions.

Soil carbon seems to have on upland forest sites a more superficial distribution in the northern compared to southern Finland.