Forest Condition Monitoring in Finland – National report

Kuva: Metla/Erkki Oksanen

Soil condition monitoring on Level II plots – parameters related to acidity and buffering status

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Summary

S deposition has decreased clearly during the monitoring period, but the acidifying deposition (S and N compounds) is still higher in southern than in northern Finland. At the same time, there is a strong climatic gradient from hemiboreal zone to northen boreal zone affecting many processes in the forest soils. Therefore it is difficult to make a difference between the effects of acid deposition and climatic factors on soil acidity status on the Level II plots in Finland. Base saturation of the topsoil has decreased during the monitoring period on many plots. According to pH values, the plot which is strongly acidified is located on acid sulphate soil. The lowest acidity of the organic and uppermost mineral soil layer as well as the highest base saturation was measured on the birch plot in southern Finland.

Background

Soil properties of the intensive monitoring plots (Level II) have been determined twice since the starting of the monitoring activities in Finland. The first round was associated with the establishment Level II monitoring network during 1995-1998. There have been slight changes in the monitoring network during the study years, so that the last Level II plots were established in 2006 (2 birch plots) and in 2009 (1 pine and 1 spruce plot). The second round of the soil condition monitoring took place for most of the plots as a part of the BIOSOIL project (see Tamminen et al., Level I in this publication).

The aim of this report is to present results of soil condition monitoring related to the acidity and buffering status of forest soil. The results are part of the BIOSOIL project for most of the plots. For 2 plots, the results are part of the EU Life+ project FutMon. The BIOSOIL data were collected in 2006 and FutMon data 2009.

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Results and discussion

Birch plots

The pH of the organic layer (humus) and upper part of the mineral soil was higher on the Punkaharju plot in eastern Finland compared to the Kivalo plot in northern Finland (Fig. 1). The pH values were the highest on the Punkaharju birch plot in the whole Level II plot network, i.e. also compared to the values on all the spruce and pine plots (see below).

Cation exchange capacity (CEC, Fig. 2) and base saturation (BS, Fig. 3) were higher on all the soil layers in Punkaharju than in Kivalo. BS was also generally higher on the Punkaharju birch plot compared to the spruce and pine plots (see below).

The concentration of exchangeable Al was higher in the organic layer in Kivalo than in Punkaharju but vice versa in the mineral soil layers (Fig. 4).

Pine plots

The clearest differences in the soil pH values of the pine plots were found in the deeper layers (Fig. 5). The pH values were the lowest in the soil layers 10–20 and 20–40 cm on the plots in southern Finland. The CEC values varied between the plots (Fig. 6), but the lowest BS values (Fig. 7) were also detected on two southernmost plots, Miehikkälä and Luumäki. The highest exchangeable Al concentrations in the organic and uppermost mineral soil layer were observed on the Juupajoki plot (Fig. 8).

Spruce plots

The pH values of the deeper soil layers 10–20 and 20–40 cm were higher on the plots in northern Finland (Pallas, Kivalo, Oulanka) compared to the other spruce plots in central and southern Finland (Fig. 9). The lowest pH values were measured on the Uusikaarlepyy plot throughout the soil profile reflecting the fact that this spruce stand is located on an acid sulphate soil (see also Nieminen et al., Soil percolation water quality in this publication). Variation in CEC and BS values among the plots is presented in Figs. 10 and 11. BS values in 2006 (Fig. 11) in the organic layer and upper mineral soil have decreased on most of the spruce plots since the establishment of the plots in 1995–1998 (Derome et al. 2001). The exchangeable Al concentrations were lower on the spruce plots located in northern Finland (Pallas, Kivalo, Oulanka) compared to the other spruce plots in central and southern Finland (Fig. 12).

Material and methods

Soil samples were taken from the Level II plots in 2006 as a part of the BIOSOIL project. In addition, the samples were taken from 2 plots in 2009 as a part of the establishment of these plots. The soil types and texture are presented in Table 1 (pdf). Samples were taken from the organic layer and from the mineral soil layers 0–5, 5–10, 10–20 and 20–40 cm. Three composite soil samples were taken from each plot. pH was measured in distilled water, and exchangeable cations were determined using BaCl 2 extraction followed by determination of elemental concentrations with inductively coupled plasma atomic emission spectrophotometer (ICP/AES). Exchangeable acidity (EA) was determined by titration of the extract with NaOH to pH 7.8. Cation exchange capacity (CEC) was calculated as a sum of exchangeable base cations (Ca, Mg, K, Na) and EA. Base saturation (BS) was calculated as a proportion (%) of exchangeable base cations out of CEC (Cools & De Vos 2010).

References

Cools, N. & De Vos, B. 2010. Sampling and analysis of soil. Manual Part X, 208 pp. In: Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests, UNECE, ICP Forests, Hamburg.

Derome, J., Lindroos, A-J., Lindgren, M. 2001. Soil acidity parameters and defoliation degree in six Norway spruce stands in Finland. Water, Air, and Soil Pollution: Focus 1: 169–186.

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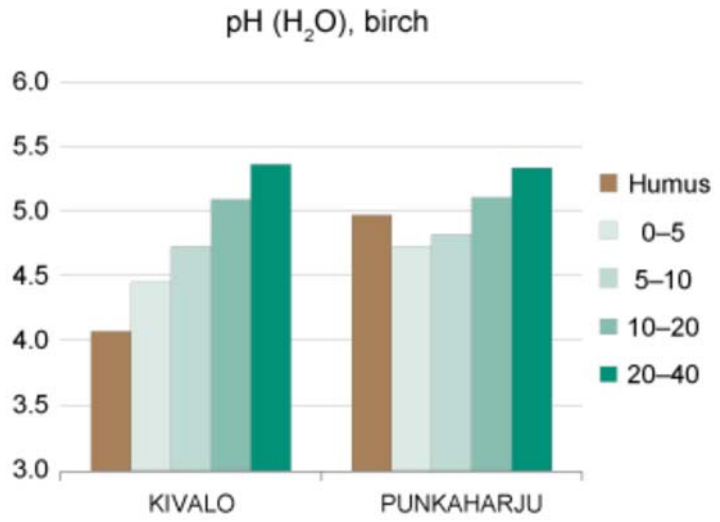
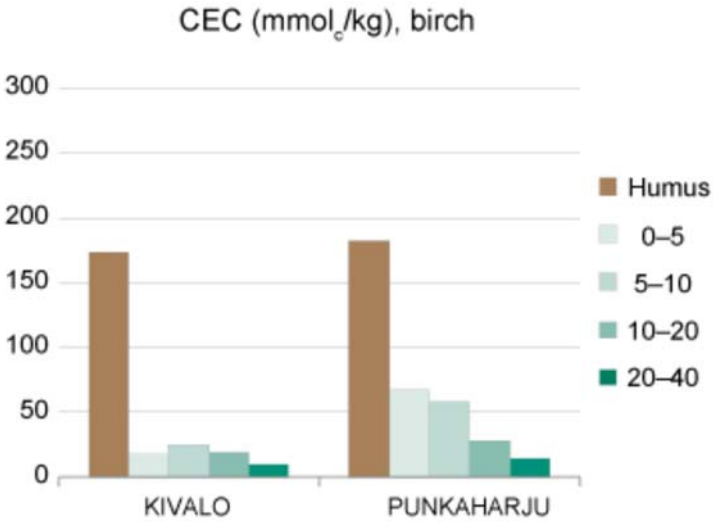
Figure 1



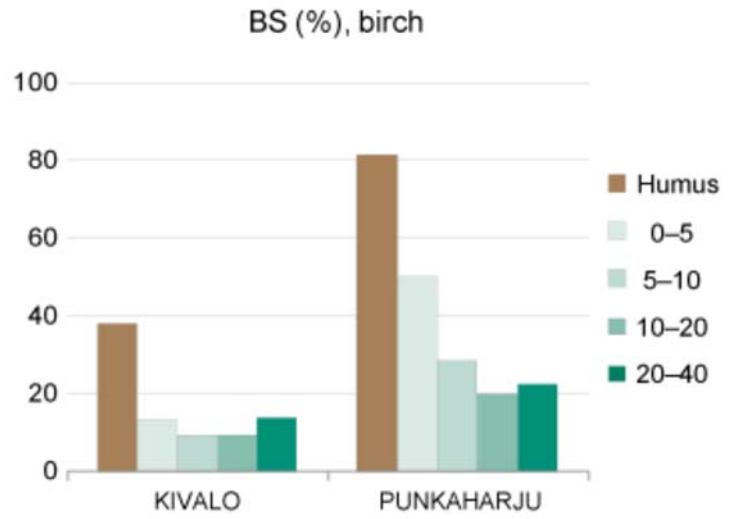
pH(H_2O) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II birch plots.

Figure 2



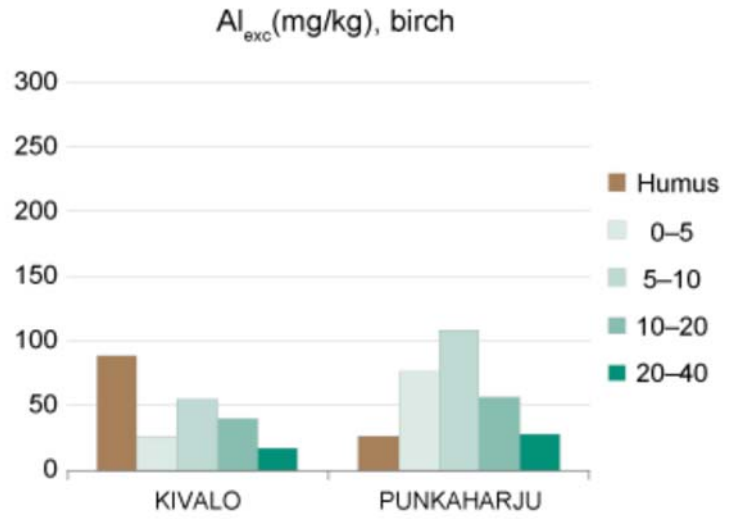
Cation exchange capacity (CEC) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II birch plots.

Figure 3



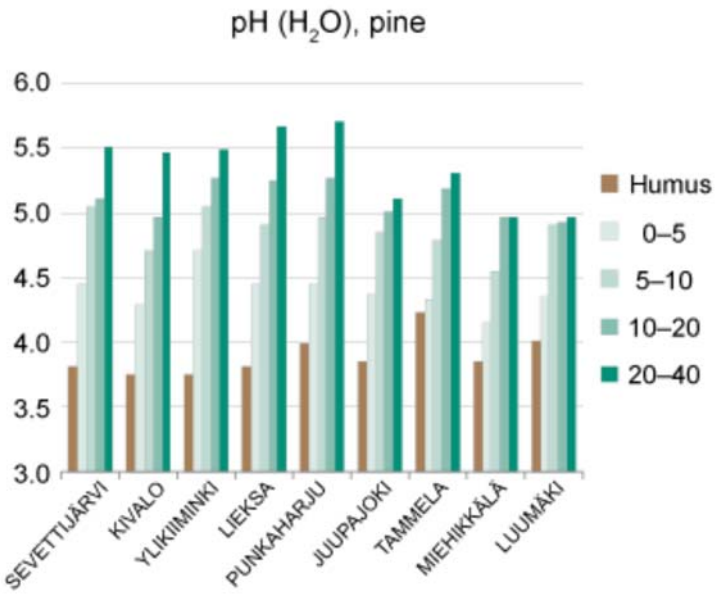
Base saturation (BS) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II birch plots.

Figure 4



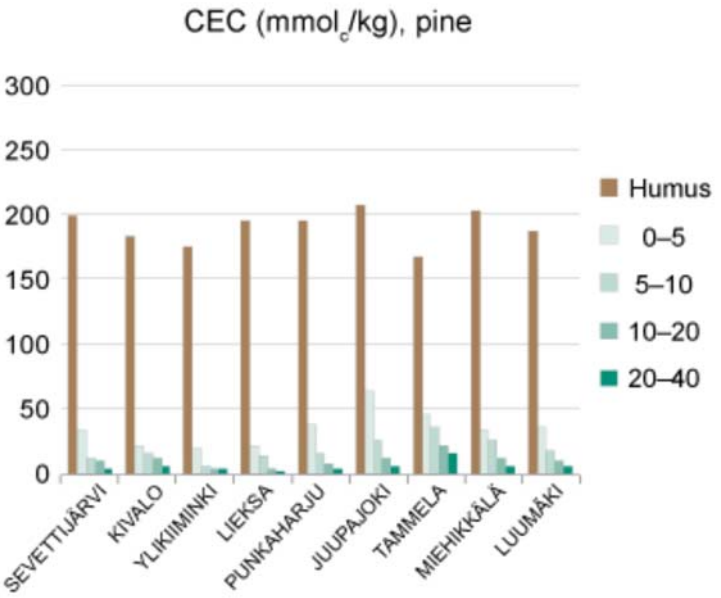
Concentration of exchangeable Al of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II birch plots.

Figure 5



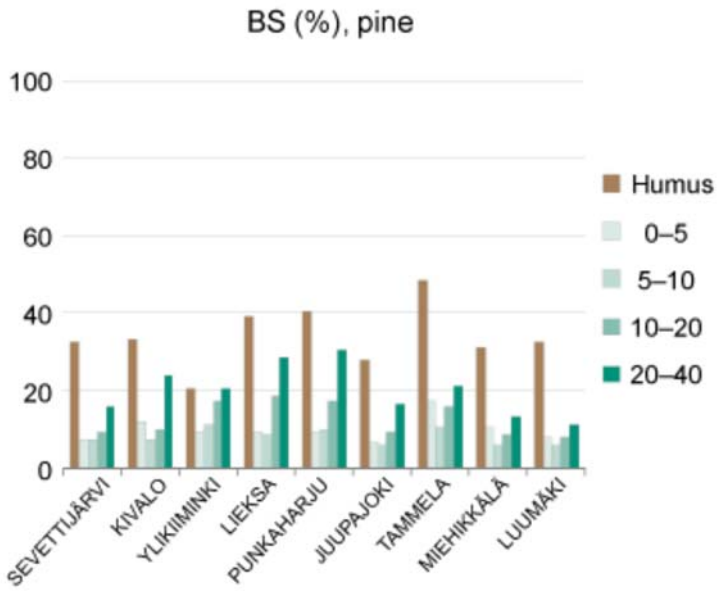
pH(H_2O) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II pine plots.

Figure 6



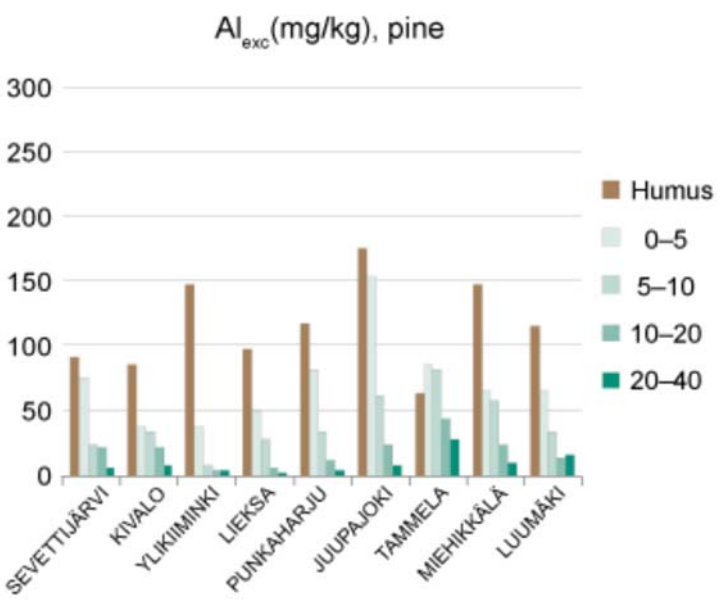
Cation exchange capacity (CEC) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II pine plots.

Figure 7



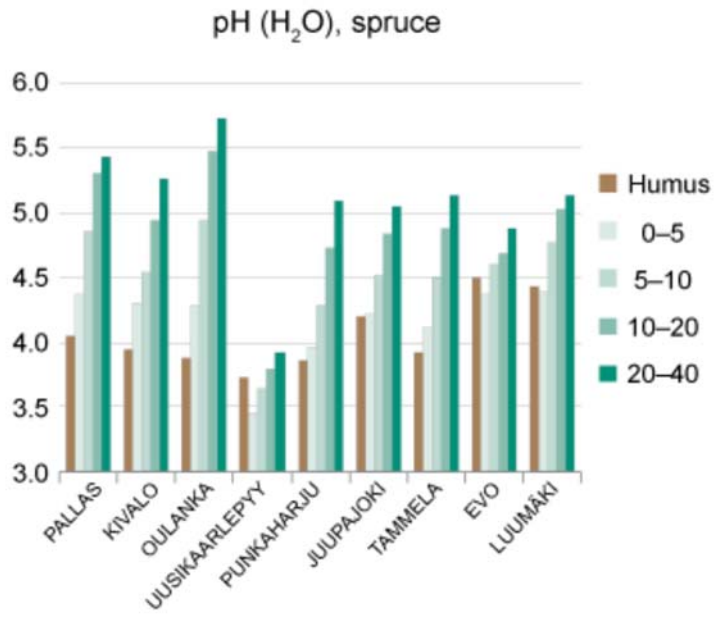
Base saturation (BS) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II pine plots.

Figure 8



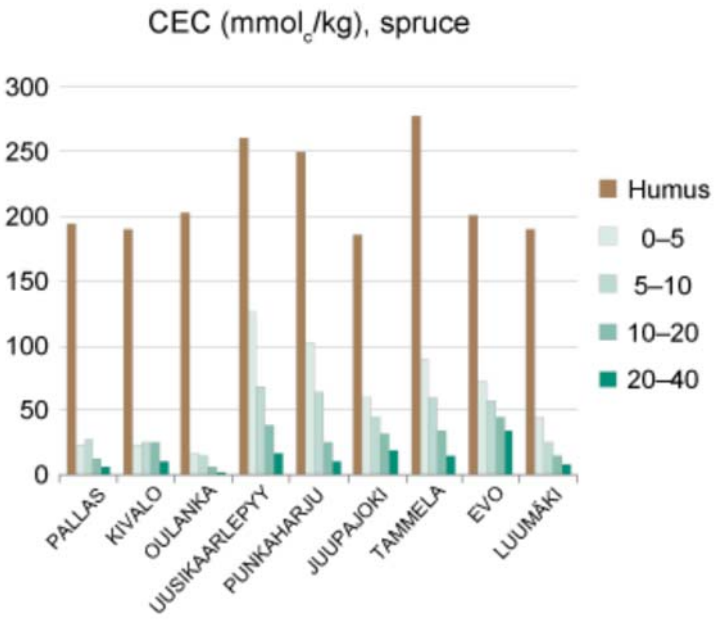
Concentration of exchangeable Al of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II pine plots.

Figure 9



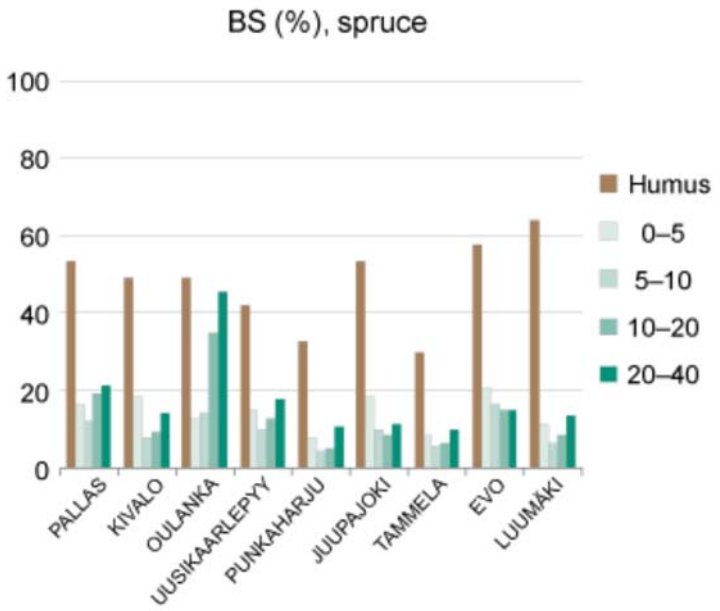
pH(H_2O) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II spruce plots.

Figure 10



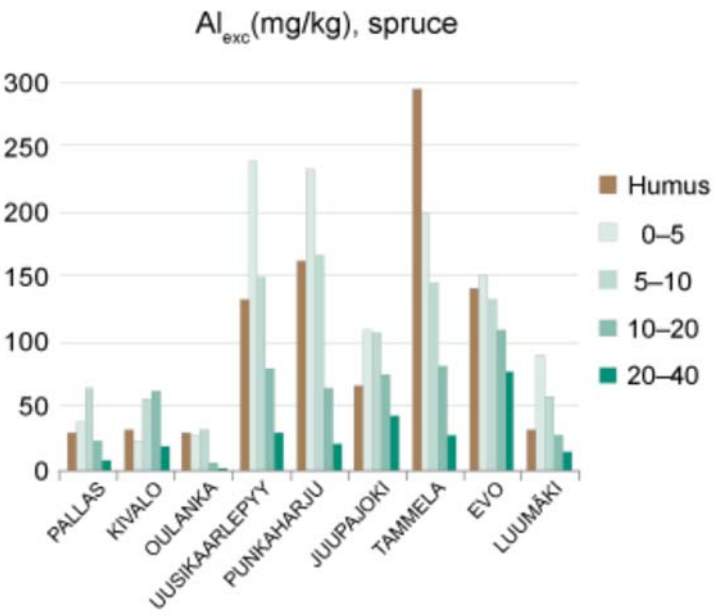
Cation exchange capacity (CEC) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II spruce plots.

Figure 11



Base saturation (BS) of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II spruce plots.

Figure 12



Concentration of exchangeable Al of the organic (humus) layer, and the mineral soil layers 0-5, 5-10, 10-20 and 20-40 cm on the Level II spruce plots.

Table 1. Soil types and material of the Level II plots.

Plot (nr)	Tree species	Soil type (WRB)*	Soil material
Kivalo (32)	Birch	Carbic Podzol	Till
Punkaharju (33)	Birch	Albic Arenosol	Till
Sevettijärvi (1)	Pine	Rustic Podzol	Sorted glaciofluvial
Kivalo (6)	Pine	Albic Arenosol	Sorted glaciofluvial
Ylikiiminki (9)	Pine	Albic Arenosol	Sorted glaciofluvial
Lieksa (20)	Pine	Albic Arenosol	Sorted glaciofluvial
Punkaharju (16)	Pine	Rustic Podzol	Sorted glaciofluvial
Juupajoki (10)	Pine	Albic Arenosol	Sorted glaciofluvial
Tammela (13)	Pine	Albic Arenosol	Sorted glaciofluvial
Miehikkälä (18)	Pine	Haplic Arenosol	Sorted glaciofluvial
Luumäki (34)	Pine	Haplic Arenosol	Sorted glaciofluvial
Pallas (3)	Spruce	Orsteinic Podzol	Till
Kivalo (5)	Spruce	Albic Arenosol	Till
Oulanka (21)	Spruce	Albic Arenosol	Till
Uusikaarlepyy (23)	Spruce	Endogleyic Regosol	Till
Punkaharju (17)	Spruce	Haplic Regosol	Till
Juupajoki (11)	Spruce	Haplic Arenosol	Till
Tammela (12)	Spruce	Haplic Arenosol	Till
Evo (19)	Spruce	Rustic Podzol	Till
Luumäki (35)	Spruce	Haplic Arenosol	Sorted glaciofluvial

*World Reference Base for Soil Resources (FAO)