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Forest Condition Monitoring in Finland – National report

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Soil percolation water quality during 1996–2010 on Level II plots in Finland

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Summary

The slightly decreasing temporal trend in pH values of soil percolation water found in most plots is caused by natural soil acidification taking place in time with tree stand ageing. No general trend corresponding to the observed decrease in SO_4-S deposition could be seen in soil percolation water SO_4-S concentrations, except on pine plots in Sevettijärvi (nr. 1), Kivalo (nr. 6) and Tammela (nr. 13). The NH_4-N and NO_3-N concentrations were generally very low, with the exception of spruce plots in Tammela (nr. 12), Punkaharju (nr. 17) and Uusikaarlepyy (nr. 23), where NH_4-N was relatively high, and in Juupajoki. (nr. 11), Uusikaarlepyy (nr. 23) and Punkaharju (birch, nr. 33), where NO_3-N concentrations were elevated. On Juupajoki plot the NO_3-N concentrations started to increase after stand thinning carried out in 2006. The high NH_4- and NO_3-N concentrations on plot nr. 23 are most probably due to the local emission caused by nearby fur farming. Uusikaarlepyy plot is located on an acid sulphate soil with low pH and high SO_4-S concentrations in soil water.

Percolation water collectors were located under the soil organic layer ca. five centimetres below the soil surface at Level II plots located in Norway spruce, Scots pine and two birch stands. Samples have been collected during the snow free periods at 4-week-intervals and analyzed for pH, NH_4-N, NO_3-N, and SO_4-S. Mean annual values were calculated as an average of all the measurements of the year in question.

Background

Soil solution is the matrix mediating between the solid soil and the tree roots, since roots access nutrients, as well as toxic compounds, in the soil through the soil solution. The chemical composition of percolation water sampled with zero-tension lysimeters provides also information on the passage of ions and compounds down the soil profile. Therefore, soil solution chemistry is a valuable indicator of soil-mediated effects of stress factors on both forests and the surrounding water ecosystems. The chemical composition of the soil solution is governed by a range of biogeochemical processes that comprise the input of atmospheric deposition into the soil, chemical interactions between the soil solid and liquid phases and the soil gas phase, and soil biological processes.

This report presents the results of monitoring carried out on percolation water quality during 1996–2010 on Level II plots located in Norway spruce, Scots pine and two birch stands.

Results and discussion

No dramatic changes or strong trends can be observed in pH values of percolation water during the monitoring period (Fig. 1, interactive map, below). However, a weak decreasing trend is found on most of the plots. This decrease is related to natural acidification taking place in time with tree stand ageing. The NH_4-N and NO_3-N concentrations were generally very low, which is in agreement with the relatively low N deposition in Finland. The only exceptions were plots nr. 12 and 17 (Tammela and Punkaharju spruce plots), where NH_4- was relatively high, and plots nr. 11 (Juupajoki spruce) and nr. 33 (Punkaharju birch), where NO_3-N concentrations were elevated. On plot nr. 11 the NO_3-N concentrations apparently increased after thinning carried out on site in 2006. In addition, the NH_4- and NO_3-N concentrations on plot nr. 23 (Uusikaarlepyy spruce) were exceptionally high, most probably due to the local emission caused by near by fur farm, which was also reflected as elevated NH_4- and NO_3-N deposition in throughfall (Lindroos et al. 2012).

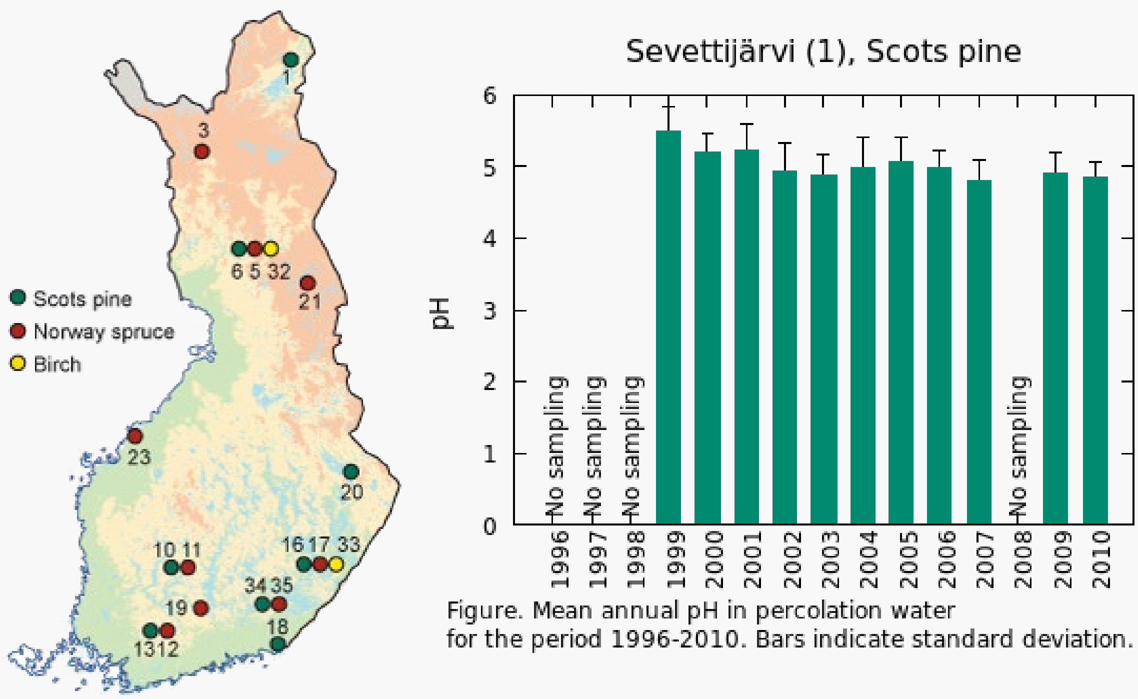

Figure 1. Please click the plot location on the map (left) and choose the variable to be shown in the graph (right).

Plot nr. 23 in Uusikaarlepyy is located on an acid sulphate soil, which explains the extremely high SO_4-S concentrations measured at the site. The observed decrease in SO_4-S deposition during the monitoring period (Lindroos et al. 2012) could not be seen as a corresponding decrease in percolation water SO_4-S concentrations. However, there was a decreasing trend in SO_4-S concentrations at three pine plots, Sevettijärvi, Kivalo and Tammela (nrs. 1, 6 and 13, respectively). Average values of the annual means were calculated for the eight plots with the longest monitoring periods (Table 1). The NH_4-N and NO_3-N concentrations, as well as the SO_4-S concentrations, were lowest at the northernmost Kivalo sites, but no other systematic differences between the locations or tree species can be observed.

Material and methods

Percolation water collectors were located under the soil organic layer ca. 5 centimetres below the soil surface. Samples have been collected during the snow free periods at 4-week-intervals and analyzed for pH, NH_4-N, NO_3-N, and SO_4-S. Mean annual values were calculated as an average of all the measurements of the year in question.

The sample collection and analysis methods are described in the sub-manual of the ICP Forests Programme (Manual on methods... 2010/11).

References

Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. 2010/11. Part XI: Soil solution collection and analysis. ICP Forests, Hamburg. 30 p. Available at: www.icp-forests.org/manual.htm.

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Table 1. Average pH and average concentrations of NH_4-N, NO_3-N, and SO_4-S for the period 1998–2010 on 4 spruce plots and 4 pine plots of the ICP Forests Level II programme. Standard deviation is given in parenthesis.

Nr.	Spruce plot	pH	NH_4-N mg L^{-1}	NO_3-N mg L^{-1}	SO_4-S mg L^{-1}	Nr.	Pine plot	pH	NH_4-N mg L^{-1}	NO_3-N mg L^{-1}	SO_4-S mg L^{-1}
5	Kivalo	4.1 (0.16)	0.22 (0.10)	0.02 (0.06)	0.37 (0.22)	6	Kivalo	4.1 (0.27)	0.24 (0.08)	0.02 (0.02)	0.43 (0.33)
11	Juupajoki	4.5 (0.29)	0.31 (0.13)	0.13 (0.08)	0.92 (0.42)	10	Juupajoki	4.3 (0.20)	0.15 (0.04)	0.10 (0.03)	0.65 (0.14)
17	Punkaharju	4.1 (0.19)	0.57 (0.11)	0.06 (0.08)	4.05 (1.21)	16	Punkaharju	4.5 (0.38)	0.30 (0.16)	0.04 (0.04)	0.97 (0.38)
12	Tammela	4.1 (0.21)	0.34 (0.40)	0.03 (0.01)	2.00 (0.46)	13	Tammela	4.5 (0.29)	0.54 (0.36)	0.12 (0.02)	2.30 (0.66)