Forest Condition Monitoring in Finland – National report

Photo: Metla/Erkki Oksanen

Sulphur and nitrogen deposition in bulk deposition and stand throughfall on intensive monitoring plots in Finland

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Summary

The sulphur (S) and nitrogen (N) deposition in the open area (bulk deposition) and in stand throughfall on eight Norway spruce and eight Scots pine Level II plots during 1996–2010 are presented in this report. In addition, these results for four more recently established plots are presented (two birch plots in 2006–2010, and a pine and a spruce plot in 2009-2010). Mean SO_4-S deposition in throughfall, as well as NH_4-N and NO_3-N in bulk deposition were clearly higher in southern than in northern Finland during 1996–2010. Sulphur deposition has decreased during the monitoring period; especially during the first years of monitoring and in southern Finland. In general, there was no corresponding decrease in the deposition of inorganic nitrogen compounds.

Background

Sulphur and nitrogen deposition on the forests and forest floor have been considered to be one of the most important parameters in the assessment of forest condition in relation to different stress factors. S and N compounds in the atmosphere and deposition may affect forests in several ways, including direct effects on vegetation or via soil acidification and eutrophication. An important question to be answered by using the deposition data is also how strong reductions in the S emissions are reflected in the condition and biogeochemistry of forest ecosystems, and are the similar kind of reductions needed also for N emissions. Deposition and availability of nitrogen in the forest ecosystems are also linked to carbon cycling and therefore, they are of interest in climate change studies. For example, the S and N deposition results are used in the evaluations of soil and soil solution acidification and buffering status. The effect of acidifying S and N deposition on the soil solution acidification status has earlier been evaluated for the period 2001–2004 by Derome et al. (2007).

Results and discussion

The annual S and N deposition values were in general higher in the southern part of Finland than in the north (Figs. 1–6). Stand throughfall deposition (TF) was generally higher than bulk deposition in the open area (BD) for SO_4-S indicating wash-off of dry deposition. The BD values for NH_4-N and NO_3-N were generally higher than those in TF indicating retention of inorganic N compounds already in the tree canopies. On the Uusikaarlepyy plot (nr. 23), located on the west coast of Finland, local NH_3 emissions were reflected in deposition: the TF values for NH_4-N and NO_3-N were in many cases relatively high compared to the values in BD.

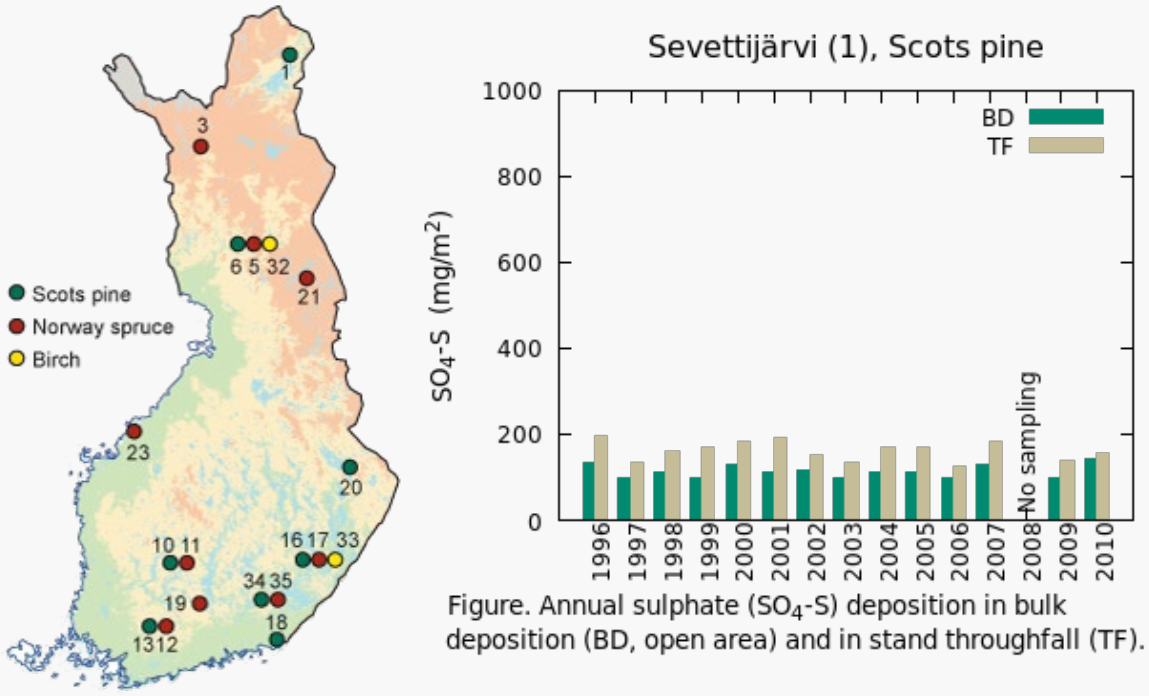

Figure 7. Please click the plot location on the map (left) and choose the variable to be shown in the graph (right).

The lowest annual SO_4-S deposition load in the open (BD) was recorded on the Oulanka (nr. 21) and Pallasjärvi (nr. 3) plots in northern Finland, 72 mg m^{-2} in 2009, and the highest load on the Miehikkälä plot (nr. 18) in southern Finland, 519 mg m^{-2} in 1996. The lowest SO_4-S deposition in TF was recorded on the birch plot at Kivalo (nr. 32, North Finland), 73 mg m^{-2} in 2009, and the highest value on the spruce plot in Tammela (nr. 12, South Finland), 956 mg m^{-2} in 1996. The lowest NH_4-N deposition in BD occurred at Kivalo (North Finland), 17 mg m^{-2} in 1997, while the corresponding highest deposition load was recorded at Miehikkälä (nr. 18, South Finland), 229 mg m^{-2} in 1996. The lowest NO_3-N deposition in BD occurred at Sevettijärvi (nr. 1, North Finland), 32 mg m^{-2} in 2002 and 2009, while the corresponding highest deposition load was recorded at Tammela (nrs. 12 and 13; South Finland), 290 mg m^{-2} in 2008 (Fig. 7, interactive map, above). Sulphur deposition in BD and TF were the highest during the first years of the monitoring (monitoring started in 1996), and this was especially the case on the plots in southern Finland (Lindroos et al. 2006). This decrease is in accordance with the results for the whole European monitoring network (The Condition of...2005). On the other hand, there was no corresponding decrease in the deposition of NH_4-N and NO_3-N.

Material and methods

Since 1996–1999, deposition on the forests (bulk deposition in the open area, BD) and on the forest floor (stand throughfall, TF) have been monitored on the intensive monitoring plots, including eight Norway spruce and eight Scots pine stands. In addition, two new Silver birch plots (nrs. 32 and 33) were established in 2005 and one pine (nr. 34) and one spruce plot (nr. 35) in 2009. The BD and TF samples were collected in general at 4-week intervals

during the winter, and at 2-week intervals during the snow-free period. However, in some of the years, the sample collection was performed at 4-week intervals throughout the year.

There were 20 systematically located bulk deposition collectors (ø = 20 cm, h = 0.4 m) within the stand (TF) during the snow-free period, and 6–10 snow collectors (ø = 36 cm, h = 1.8 m) during the wintertime depending on the structure of the stand. The number of snow collectors in each stand was based on a pre-study using 20 snow collectors located systematically on each plot. From this 20-collector network, 6–10 collectors were selected for sampling such that the mean deposition value was approximately the same as the result obtained with the 20 collectors. The number of collectors in the open area was three (bulk deposition) and two (snow collectors). The samples were pretreated and analysed according to the sub-manual of the ICP Forests Programme (Manual on methods... 2006).

References

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Lindroos, A-J., Derome, J., Derome, K. & Lindgren, M. 2006. Trends in sulphate deposition on the forests and forest floor and defoliation degree in 16 intensively studied forest stands in Finland during 1996–2003. Boreal Environment Research 11(6): 451–461. (pdf)

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Figures 1–6:

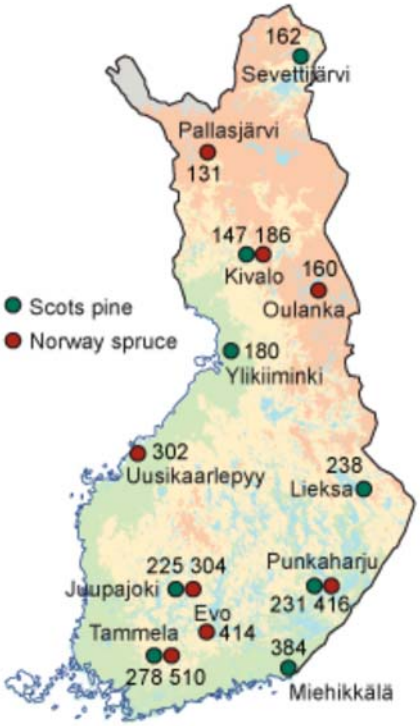

Figure 1. Mean SO_4-S deposition (mg m^{-2} yr^{-1}) in stand throughfall for the period 1996–2010.

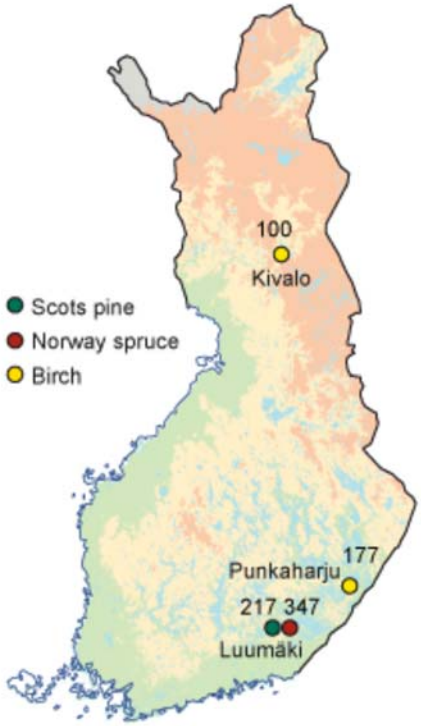

Figure 2. Mean SO_4-S deposition (mg m^{-2} yr^{-1}) in stand throughfall for the period 2006–2010 (Punkaharju, Kivalo) and 2009-2010 (Luumäki).

Figure 3. Mean NH_4-N deposition (mg m^{-2} $yr^{-1)}$ in bulk deposition for the period 1996–2010.

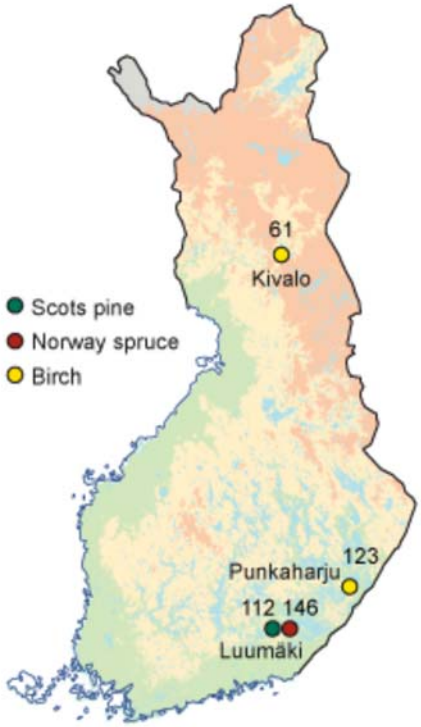

Figure 4. Mean NH_4-N deposition (mg m^{-2} yr^{-1}) in bulk deposition for the period 2006–2010 (Punkaharju, Kivalo) and 2009–2010 (Luumäki).

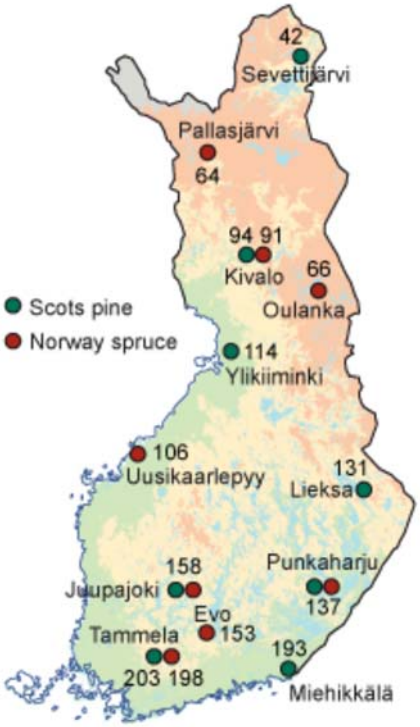

Figure 5. Mean NO_3-N deposition (mg m^{-2} yr^{-1}) in bulk deposition for the period 1996–2010.

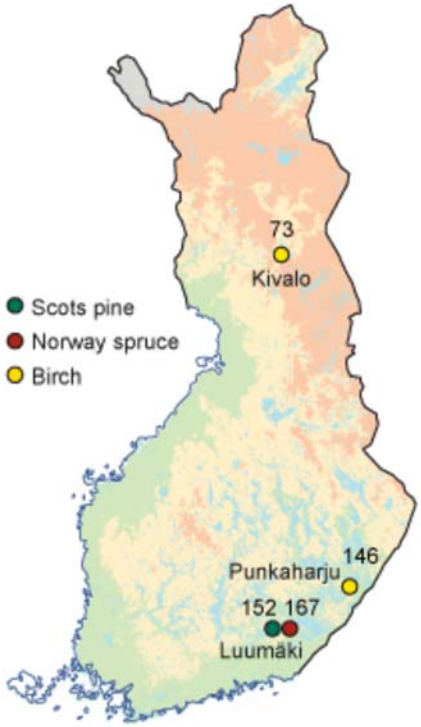

Figure 6. Mean NO_3-N deposition (mg m^{-2} yr^{-1}) in bulk deposition for the period 2006–2010 (Punkaharju, Kivalo) and 2009–2010 (Luumäki).

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