



Long-Term Changes in Sulphur Concentrations in Scots Pine (*Pinus sylvestris* L.) Needles in the Area around Pulp and Paper Mills at Kemi, Northern Finland

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Received December 03, 2009; Accepted January 05, 2010

Abstract: During the period 1980 - 2008, gaseous sulphur emissions at Kemi, Northern Finland, fell considerably from 4502 tonnes per year to 485 tonnes per year. Furthermore, during the period 1992-2008, particulate matter emissions into the air decreased from 2044 tonnes per year to 124 tonnes per year. The decrease in gaseous sulphur and particle emissions is due to the fact that the industrial plants (i.e. pulp and paper mills, chromium mine, municipal district heating plants and port operations) have upgraded their processes. In this study we compared the sulphur concentrations in Scots pine (*Pinus sylvestris* L.) needles collected in 2009 at Kemi to those collected in 1999, 1989 and 1979. In 1979, the sulphur concentration in current-year (C) needles at Kemi varied between 804 – 1430 mg/kg (d.w.) and in previous-year (C+1) needles between 810-1420 mg/kg (d.w.). In 2009, the needle sulphur concentrations at Kemi varied between 740-1350 mg/kg (d.w.) and 770-1070 mg/kg (d.w.), respectively. This study also presents the most recent results for sulphur concentrations in Scots pine (*Pinus sylvestris* L.) C+1 needles sampled in bioindicator surveys carried out between 2005 and 2007 in those parts of Finland where pulp and paper mills operate. The sulphur concentrations in the C+1 needles at Kemi in 2009 were in good agreement with the values of 729 - 1068 mg/kg (d.w.) observed at Kemijärvi (Northern Finland) in 2005, and with the values of 842 - 1249 mg/kg (d.w.) observed at Pietarsaari (Western Finland) in 2007, as well as with the values of 898-1172 mg/kg (d.w.) observed at the Suupohja (Western Finland) in 2007, which are areas with operational pulp and paper mills.

Key Words: Emissions, Finland, *Pinus sylvestris*, paper mill, pulp mill, Scots Pine, sulphur.

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