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Nitrogen balance along a boreal forest fire chronosequence

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Fire is a major natural disturbance factor in boreal forests, and the frequency of forest fires is predicted to increase due to climate change in boreal regions. Because boreal forests comprise 30% of the global forest area, increases in the annual area burned may have significant implications for global carbon and nitrogen (N) cycles. The productivity of boreal forests is limited by low N availability. Fires cause N loss from ecosystems through oxidation and volatilization of N stored in biomass and soil. N balance may be poorly buffered against forest fires especially in sub-arctic ecosystems where atmospheric N deposition is low. Although forest fires alter N dynamics, there are little quantitative data available on N pools and fluxes through post-fire succession in sub-arctic boreal forests.

We studied changes in N pools and fluxes, and the overall N balance across a 155-year forest fire chronosequence in sub-arctic Scots pine (Pinus sylvestris) forests in Värriö Strict Nature Reserve situated in Finnish Lapland (67°46′ N, 29°35′ E). Soil was the largest N pool in all forest age classes and comprised 69–82% of the total ecosystem N pool. The total ecosystem N pool varied from 622 kg ha-1 in the recently burned forest to 960 kg ha-1 in the 155-year-old forest. The forests were N sinks in all age classes the annual N accumulation rate being 2.28 kg ha-1 yr-1 which was distributed almost equally between soil and biomass. The observed changes in ecosystem N pools were consistent with the computed N balance 2.10 kg ha-1 yr-1 over the 155-year post-fire period (Balance= (atmospheric deposition + N fixation) - (leaching + N2O emissions)).

The results indicated that N deposition is an important component of the N balance and the N outputs are small (13% of the inputs) in the studied ecosystems. N2O fluxes were negligible ($\leq$ 0.01 kg ha-1 yr-1) compared to the other N fluxes. The biological N fixation increased with succession and constituted 9% of the total N input during the 155-year period in the forests. Also the number and intensity of microbial genes involved in N cycling differed between recently burned and mature forest.