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The effects of afforestation on Fe mobilization in soils and potential for leaking into surface waters

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Increasing surface water concentrations of Fe and DOC (browning), have been reported around the northern hemisphere in the last couple of decades. This increase has far-reaching ecological and societal implications, as it alters the light climate in water and decreases the quality of drinking water. One of the hypothesis behind the increase has been that afforestation and a dominance of coniferous forest have increased the availability of Fe and DOC for transport from soils into surface waters. The accumulation of organic soil layers in coniferous forests increases acidity and the amounts of organic acids in soils and may thus enhance weathering, solubility and mobilization of Fe as the forest ages. In this study we examined the effects of afforestation and growth of Norway spruce on the mobilization and potential leakage of Fe and DOC from soils to surface waters. To represent the effects of ageing forest we used plots with spruce stands of different ages (35, 61, 90 years) and unforested control plots in their immediate proximity, in Tönnersjöheden experimental forest (Sweden). Soil water collected in lysimeters (installed below the organic horizon and in the mineral soil) and analyzed for Fe, Fe speciation, using X-ray absorption spectroscopy (XAS), as well as DOC, metals, major anions and cations. Soil samples were analyzed for Fe speciation and crystallinity at different depths. Results from the soil water analysis show that more Fe was mobile in older spruce forest stands with higher DOC concentrations and lower pH. Covariation of Fe and DOC concentrations in soil waters, indicate the dependence of Fe on DOC to solubilize and stay in solution. Preliminary results from our XAS analysis also indelicate a considerable amount of Fe(II) in soil water that is likely stabilized from oxidation by organic complexation. Surprisingly Fe extracted from the organic (O) soil horizon showed the highest crystallinity and crystallinity did not vary much between soils of different stand ages. The results of this study indicate that afforestation promotes Fe and DOC availability for export into surface waters as well as strengthens the notion that the effects of afforestation are not immediate, but take time as soils develop slowly. As afforestation and dominance of coniferous forest continues in many parts of the northern hemisphere, we can expect further increase of Fe and DOC in surface waters.