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Does coniferous forest lead to a larger export of Hg to aquatic systems? A Holocene vegetation study of the northern Black Forest (Germany)

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Forest vegetation plays a key role for the cycling of mercury (Hg) in terrestrial ecosystems and litterfall has been indicated to be the major transport vector of atmospheric Hg to forest soils. Soil organic matter (OM) is the dominant carrier of Hg from forest catchment soil to lake sediments. Hence, it is important to understand how changes in forest vegetation affect Hg in soil and its biogeochemical cycling in lake systems. Here, we were particularly interested if coniferous forest led to a larger export of Hg to aquatic systems than deciduous forest. We investigated trace elements and tree pollen in sediment records from two cirque lakes (Schurmsee and Glaswaldsee) located in the northern Black Forest (Southern Germany) to evaluate whether long-term shifts in forest vegetation induced by climate or land-use influenced Hg accumulation in lakes. In addition, we collected OM by means of sediment traps to evaluate present day Hg content and OM quality. The radiocarbon-dated sediment cores show a well-defined Holocene vegetation history based on pollen-analyses. The forest vegetation during the Mesolithic, e.g. at the Schurmsee was dominated by Corylus avellana (hazel) until ∼8500 years BP. Hazel was replaced by Quercus robur (oak), which was replaced at ∼5300 years BP by a mixed forest of Abies alba (fir) and Fagus sylvatica (beech). When oak replaced hazel at Schurmsee, a sharp increase in Hg concentration from 43 ng g-1 to 116 ng g-1 and an increase in Hg:C ratio was observed. Mercury concentrations increased to 193 ng g-1 directly after the appearance of fir and beech, although there was no substantial increase in Hg accumulation rates, indicating that the increased Hg concentrations were caused by decreasing input of OM through litterfall in the coniferous forest. At ∼2700 years BP Hg concentrations and accumulation rates started to increase simultaneously in both lakes. This indicates an additional non-forest driven input of Hg, which might be due to first human activities in that area during the Late Bronze Age. In 2016, Hg concentrations in the OM obtained from the sediment traps reached 568 ng g-1 to 699 ng g -1. This signifies Hg accumulation rates of 14 to 16 μg m-2 during the collecting period of only 120 days. In comparison to the upper 2 cm sediment layer (∼25 years BP) we estimated an annual Hg accumulation rate of ∼35 μg m-2 y-1 at the Schurmsee, which is twofold higher than at pre-industrial time, when the local forest vegetation was comparable with present day. Our results contradict earlier studies suggesting an inevitable higher release of Hg from coniferous than deciduous forests. Soil erosion e.g. after deforestation, emissions from mining and other human activities seem to trigger changes on mercury accumulation stronger than considering changes in the forest vegetation alone.

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