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Seasonal changes in streamwater concentration and pathways of phosphorus in a forested catchment under a temperate climate

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In forest ecosystems phosphorus (P) is regarded to be among the most limiting nutrients. Therefore, P is cycled in an almost closed system, so that losses of P are minimal. Litterfall and leaf decomposition are key processes that control nutrient dynamics between forest and river systems and can cause losses of P. It is important to understand the dynamics and seasonal variations of P because P input-output balances can have an effect on sustainability of forest ecosystems.

A forested headwater catchment (230 ha) has been monitored for different fractions of dissolved (<0.45 μm) P concentration in the river and in soil- and groundwater from January 2011 until December 2013. The P measurements consisted of dissolved reactive P with colorimetry and total dissolved P with ICP-OES. Base flow samples were taken twice a week and when discharge events occurred, samples were taken flow proportional with an ISCO sampler. Leaf decomposition was measured in a column test under different fluxes of water to assess P fluxes out of the decomposition of the litter layer.

The yearly flux of P out of the catchment was on average 0.2 kg P.ha-1.y-1. There was a clear difference in total P concentration between summer and winter in the river water. In winter, the concentrations were low (<0.2 mg P/l), even when a rainfall event occurred. In summer, concentrations of total P rose up to 0.6 mg P/l in the base flow. In the peak flow they lowered due to dilution effects. The rise in P concentration in the base flow in summer could only be attributed to in-river processes, because no hydrologic pathway of P reaching the river could explain this particular rise in concentration. Concentrations of P remained low in groundwater (0.035 $\pm$ 0.039 mg P/l) and soil water (0.021 $\pm$ 0.14 mg P/l) during the 3 years of measurements. A hypothesis is that the breakdown of leaf litter aided by temperature driven microbial activity can be accounted for this rise and can deliver up to half of the flux of P out of a forested catchment connected to a river system.