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1 Long-term trends in stream nitrate concentrations and losses across watersheds undergoing recovery from acidification in the Czech Republic

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Stream nitrogen (N) export and nitrate (NO_3^-) concentration were measured at 14 forested watersheds (GEOMON network) in the Czech Republic between 1994 and 2005. In the last several decades, emissions of sulfur (S) and N compounds have decreased throughout much of Europe. In the Czech Republic, atmospheric deposition of S has decreased substantially since the beginning of 1990s, whereas N deposition remains largely unchanged at most sites. The mean dissolved inorganic nitrogen (DIN) stream water export ranged from 0.2 to 12.2 kg ha^{-1} yr^{-1} at the GEOMON sites. Despite decades of elevated N deposition, 44-98% of DIN inputs to these watersheds were retained or denitrified, and many watersheds showed seasonal variation in nitrate concentrations. Dissolved organic N export was quantified in one year only, and ranged from 0.05 to 3.5 kg ha^{-1} yr^{-1}.

Spatial variability in DIN export among watersheds was best explained by spatial variability in average acidic deposition, in particular S deposition (R^2 = 0.81, $p<0.001$);

DIN input and forest floor carbon:nitrogen (C/N) also provided significant explanatory power. DIN export was strongly influenced by the forest floor C/N ratio and depth of the forest floor soils (R^2= 0.72, $p<0.001$). The only variable that predicted variations in forest floor C/N (R^2= 0.32, $p < 0.05$) among watersheds was S deposition. Forest floor depth was also related to deposition variables, with S deposition providing the most explanatory power (R^2 = 0.50, $p < 0.01$). Variation in forest floor depth was also associated with climatic factors (precipitation and temperature).

Temporal variability in DIN export was primarily associated with changes in acidic deposition over time; S deposition explained 41% of variability in DIN exports among all watersheds and years. Extensive acidification of forested watersheds was associated with the extraordinarily high S inputs to much of the Czech Republic during earlier decades. We hypothesize that recovery from acidification has led to improved tree health as well as enhanced microbial activity in the forest floor. As these watersheds move into a new regime with dramatically lower sulfur inputs, we expect continued declines in nitrate output.