EXPERIMENTAL ACIDIFICATION OF ALPINE CATCHMENTS AT SOGNDAL, NORWAY: RESULTS AFTER 8 YEARS

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Abstract. Manipulations with whole catchments were initiated in Norway in 1983 (RAIN project Reversing Acidification In Norway) to obtain direct experimental evidence relating to the reversibility of soil and water acidification, rate of change, and the relative roles of sulfur and nitrogen. We present here results for soil and runoff chemistry during 8 years of acid addition at Sogndal, a pristine acid-sensitive site in central Norway characterized by gneissic bedrock, thin and patchy soils, and alpine vegetation. Catchment SOG2 receives 100 meq m$^{-2}$ yr$^{-1}$ H$_2$SO$_4$, catchment SOG4 receives a 1:1 mixture of H$_2$SO$_4$ and HNO$_3$, while catchments SOG1 and SOG3 serve as untreated controls. Acid is applied to the snowpack in April and in 5 portions of 11 mm of pH 3.2 acidified lakewater during the snowfree period.

The 8-years of acid addition have caused major changes in runoff chemistry. Concentrations of sulfate and base cations have increased while acid neutralizing capacity (ANC) has decreased. Henriksen's F-factor (change in concentration of non-marine Ca + Mg divided by change in concentration of non-marine SO$_4$) is about 0.35, but is expected to decrease as soil acidification proceeds. Runoff is acidic, aluminum-rich, and toxic to fish and other aquatic organisms. Repeated soil sampling indicates no dramatic trends related to treatment. Year-to-year variations are large, and mask changes expected. The input-output budgets indicate that over the 8-yr period Ca has been depleted by about 5% of the total soil pool of exchangeable Ca. The observed trends are consistent with response predicted by MAGIC, a process-oriented model of soil and water acidification. The gradual increase in nitrate flux from catchment SOG4 may be the first indication of 'nitrogen saturation' induced simply by increasing nitrogen deposition.

1. Introduction

Acid deposition and the acidification of terrestrial and aquatic ecosystems ranks as one of Norway's greatest environmental concerns. Acidification has affected fish populations in freshwaters in > 36 000 km$^2$ of southern Norway (Henriksen et al., 1989). Most of the acidification is attributed to long-range transported sulfur compounds, although in recent years nitrogen has played an increasingly important role (Henriksen et al., 1988). Efforts to solve the acidification problem focus largely on achieving reductions in emissions of sulfur and nitrogen oxides on a regional
Fig. 1. Location of the experimental catchments at Sogndal (RAIN project). Areas within the pH 4.7 isoline receive precipitation with a yearly-weighted average pH below 4.7.

scale. Such measures tacitly assume that acidification of soils and waters is reversible, and that if acid deposition decreases, acidified waters will recover.

To obtain direct experimental evidence relating to the reversibility of soil and water acidification, rate of change, and the relative roles of sulfur and nitrogen,