Hydrology and Earth System Sciences
An Interactive Open Access Journal of the European Geosciences Union

Hydrol. Earth Syst. Sci., 7, 467-483, 2003
www.hydrol-earth-syst-sci.net/7/467/2003/

Future recovery of acidified lakes in southern Norway predicted by the MAGIC model

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Abstract. The acidification model MAGIC was used to predict recovery of small lakes in southernmost Norway to future reduction of acid deposition. A set of 60 small headwater lakes was sampled annually from either 1986 (35 lakes) or 1995 (25 lakes). Future acid deposition was assumed to follow implementation of current agreed legislation, including the Gothenburg protocol. Three scenarios of future N retention were used. Calibration of the sites to the observed time trends (1990–1999) as well as to one point in time considerably increased the robustness of the predictions. The modelled decline in SO_4^* concentrations in the lakes over the period 1986–2001 matched the observed decline closely. This strongly suggests that soil processes such as SO_4 adsorption/desorption and S reduction/oxidation do not delay the response of runoff by more than a few years. The slope of time trends in ANC over the period of observations was less steep than that observed, perhaps because the entire soil column does not interact actively with the soilwater that emerges as runoff. The lakes showed widely differing time trends in NO_3 concentrations over the period 1986–2000. The observed trends were not simulated by any of the three N scenarios. A model based on the C/N ratio in soil was insufficient to account for N retention and leaching at these sites. The large differences in modelled NO_3, however, produced only minor differences in ANC between the three scenarios. In the year 2050, the difference was only about 5 μeq l^{-1}. Future climate change entailing warming and increased precipitation could also increase NO_3 loss to surface waters. SO_4^* concentrations in the lakes were predicted to decrease in parallel with the future decreases in S deposition. Fully 80% of the expected decline to year 2025, however, had already occurred by the year 2000. Similarly, ANC concentrations were predicted to increase in the future, but again about 67% of the expected change has already occurred over the past 20 years. The recovery of ANC was predicted to be incomplete. Even after the CLE scenario (for future acid deposition) is implemented, the chemical conditions in about one-third of the lakes were predicted to be insufficient to support trout populations in the future. Thus, additional measures will be required if these lakes are to be restored.

Keywords: acid deposition, lakes, model, Norway, recovery

Final Revised Paper (PDF, 1302 KB)

Citation: Wright, R. F. and Cosby, B. J.: Future recovery of acidified lakes in southern Norway predicted by the MAGIC model, Hydrol. Earth Syst. Sci., 7, 467-483, 2003. Bibtex EndNote Reference Manager