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

Hydrol. Earth Syst. Sci., 7, 494-509, 2003
www.hydrol-earth-syst-sci.net/7/494/2003/

Modelling reversibility of Central European mountain lakes from acidification: Part I - the Bohemian forest

V. Majer[1], B. J. Cosby[2], J. Kopácek[3], and J. Veselý[1]
[1]Czech Geological Survey, Geologická 6, 152 00 Praha 5, Czech Republic
[2]Department of Environmental Sciences, University of Virginia, Charlottesville, VA 22903, USA
[3]Hydrobiological Institute, AS CR, and Faculty of Biological Sciences, USB, An Sádkách 7, 370 05 Ceské Budjovice, Czech Republic

Abstract. A dynamic, process-based acidification model, MAGIC7, has been applied to three small, strongly acidified lakes in the Bohemian Forest, the Czech Republic. The model was calibrated for a set of experimental records on lake water composition over the 1984–2000 period, and produced hindcast concentrations that compared well, even with older (40-year) irregular determinations of nitrate, chloride and pH. Water and soil chemistry forecasts up to 2050 were based on reductions in S and N emissions presupposed by the Gothenburg Protocol. Modelled sulphate and chloride concentrations were predicted to decrease to the levels at the beginning of the 20th century by 2050. The lake water carbonate buffering system is predicted to be re-established in only two lakes (Cerné and Plešné), with current soil base saturations of 12-15%. Concentrations of ionic aluminium species decreased sharply, from 110 μeq l^{-1} in the mid-1980s to the current ~40 μeq l^{-1}, and were predicted to decrease below 10 μeq l^{-1} in the 2020s. Diatom-inferred pH in pre-industrial times was substantially lower than modelled pH. It is suggested that the diatom pH, based almost entirely on non-planktonic species, is biased by inwash of diatoms from more acidic tributaries into the sediment of these small lakes. Generally significant results can be summarised as follows: (1) Simulated sulphate levels agree well with observations during acidification progress and retreat only for values of soil SO_4^{2-} adsorption capacity three to six times (20 to 40 μeq kg^{-1}) higher than those found experimentally. This implies a further mechanism of S retention and release in addition to physical sulphate adsorption to Fe and Al oxides of soils. (2) The catchments' ability to retain deposited N appeared to decline after ~1950 but this was not connected with a sufficient change in the C:N ratio of the soils. Agreement between modelled and observed concentrations of nitrate was therefore achieved by empirical restriction of N retention in the soils. Based on their current ability to retain N, the catchments will remain N-saturated and could, temporarily, produce more inorganic N than they receive due to additional nitrate production from soil N-organic pools. This situation has occurred already in the Cerné Lake catchment. (3) Differences in responses of individual lakes can be attributed to different land usages over the past several centuries as well as to differences in geology and primary production.

Keywords: MAGIC, atmospheric deposition, N retention, diatom-inferred

pH, sulphate, nitrate, base cations, aluminium, Czech Republic

Final Revised Paper (PDF, 799 KB)

Citation: Majer, V., Cosby, B. J., Kopácek, J., and Veselý, J.: Modelling reversibility of Central European mountain lakes from acidification: Part I - the Bohemian forest, Hydrol. Earth Syst. Sci., 7, 494-509, 2003. Bibtex EndNote Reference Manager