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Present and potential nitrogen outputs from Norwegian soft water lakes – an assessment made by applying the steady-state First-order Acidity Balance (FAB) model

Ø. Kaste[1], A. Henriksen[2], and M. Posch[3]
[1]Norwegian Institute for Water Research, Southern Branch, Televeien 3, N-4879 Grimstad, Norway
[2]Norwegian Institute for Water Research, P.O. Box 173 Kjelsås, N-0411 Oslo, Norway
[3]National Institute for Public Health and the Environment (RIVM), P.O. Box 1, NL-3720 BA Bilthoven, The Netherlands
Email for corresponding author: oeyvind.kaste@niva.no

Abstract. The steady-state First-order Acidity Balance (FAB) model for calculating critical loads of sulphur (S) and nitrogen (N) is applied to 609 Norwegian soft-water lakes to assess the future nitrate (NO_3^-) leaching potential under present (1992-96) S and N deposition. The lakes were separated into five groups receiving increasing levels of N deposition (<25, 25-49, 50-74, 75-99 and 100-125 meq $m^{-2}yr^{-1}$). Using long-term sustainable N sink rates presently recommended for FAB model applications, N immobilisation, net N uptake in forests, denitrification and in-lake N retention were estimated for each group of lakes. Altogether, the long-term N sinks constituted 9.9 ± 3.2 to 40.5 ± 11.4 meq $m^{-2}yr^{-1}$ in the lowest and highest N deposition categories, respectively. At most sites, the current N deposition exceeds the amount of N retained by long-term sustainable N sinks plus the NO_3^- loss via the lake outlets. This excess N, which is currently retained within the catchments may, according to the FAB model, leach as acidifying NO_3^- in the future. If these predictions are fulfilled, NO_3^- leaching at sites in the various N deposition categories will increase dramatically from present (1995) mean levels of 1-20 meq $m^{-2}yr^{-1}$, to mean levels of 7-70 meq $m^{-2}yr^{-1}$ at future steady state. To illustrate the significance of such an increase in NO_3^- leaching, the mean Acid Neutralising Capacity (ANC) at sites in the highest N deposition category may decrease from -18 ± 15 µeq L^{-1} at present, to -40 ± 20 µeq L^{-1}. Under present S and N deposition levels, the FAB model predicts that 46% of the Norwegian lakes may experience exceedances of critical loads for acidifying deposition. In comparison, the Steady-State Water Chemistry model (SSWC), which considers only the present N leaching level, estimates critical load exceedances in 37% of the lakes under the same deposition level. Thus far, there are great uncertainties regarding both the time scales and the extent of future N leaching, and it is largely unknown whether the FAB model predictions will ever be fulfilled. Hence, long-term monitoring and further studies on N immobilisation processes under varying N deposition levels and ecosystem types seem necessary to make better predictions of future NO_3^- leaching.

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