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Scenarios for in-lake Nitrogen concentrations in 11 Danish lakes using intensive monitoring data and an integrated hydrological and Nitrogen model

Jørgen Windolf, Rikke Bjerring, Gitte Blicher-Mathiesen, Christen Børgesen, Anker Højbjerg, Dennis Trolle, and Henrtik Tornbjerg

Aarhus, Institute of Bioscience, Silkeborg, Denmark (jwn@dmu.dk)

Abstract

Since 1990 nitrogen (N) and phosphorus (P) loads, and in-lake nutrient concentrations in Danish lakes included in the National Monitoring Program have been markedly reduced (Bjerring et al., 2013). Typically, in shallow Danish lakes with mean annual hydraulic retention <1 year, nitrogen concentrations in the inlet and outlets have been reduced by 45-50%. Reductions in the P load are of the same magnitude. Both fresh- and marine waters, however, still remain of poor ecological quality.

Nitrogen load has been reduced particularly due to more environmentally sound farming practices, including reduced N surplus on agricultural areas within the lake catchments. These reductions have mainly been achieved by general national measures common for all farmed land (through caps on N application rates, and also the use of catch crops), resulting in reduced N leaching from fields to groundwater, tile drains and streams, that are discharging to the lakes. A marked amount of N is reduced in groundwater before reaching surface waters although this reduction is relatively variable due to variations in hydrological pathways and reductions capacity in the groundwater aquifers. Especially variations in oxic and reduced groundwater depth distribution are governing variations in the N retention in ground waters. The lakes themselves also retain a considerable amount of N, before the outlet discharge eventually reach marine waters (mean retention: 37%; or 250 kg N / (yr • ha lake area).

Future environmental management strategy in Denmark is generally foreseen to allow increased farming intensity in some areas, and thus more N input and N leaching from grown fields. At the same time, more restrictive measures aiming at a further reduction in N loads to Danish near coastal waters is foreseen in areas where retention in ground waters and in surface waters is low.

To be able to quantify the effects of the expected changes in farming practices on Danish lakes, we used a combination of models and measurements. A seasonal empirical model linking N input and monthly N concentrations in Danish lakes (Windolf et al., 1996) was validated using recent monitoring data from the lakes in this study. Scenarios were then run using this model including a 30% change in N leaching from agricultural areas. These scenarios included estimation of changes in N concentrations in water leaching through the root zones, N retention in the up-stream catchments, and the resulting N concentrations in the lakes. The implications of changed N concentrations for the ecological quality of the lakes are discussed.

References:

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