



The capacity of peatland buffer areas to retain inorganic nitrogen

Anu Vikman, Sakari Sarkkola, Hannu Nousiainen, Annu Kaila, and Mika Nieminen

Finnish Forest Research Institute, Vantaa Research Center, Box 18, FIN-01301 Vantaa, Finland, anu.vikman@metla.fi

Natural and restored peatland buffer areas have proven to be effective constructions in reducing element transport such as nitrogen (N), phosphorus (P) and suspended solids from forested catchments (Nieminen et al. 2005, Väänänen et al. 2008). In this study, nitrogen retention capacities of six peatland buffer areas were studied by adding ammonium nitrate ($\text{NH}_4\text{NO}_3\text{-N}$) solution into the inflow waters once (one area) or twice (five areas). The first addition was made in 2003, 2004 or 2005 and the second in 2008 and the duration of each addition event lasted for four days. The buffer areas were either undrained mires or drained peatlands rewetted 4-7 years before the present study and they covered an area of 0.1 - 4.9% of the catchment area upstream.

Samples of the inflow and outflow waters were collected between 2002 and 2009, before and after the two additions. Samples of soil water, vegetation, peat and N_2O were collected during 2007-2009. The emissions of N_2O were measured using the closed chamber technique six to seven times before the N addition in 2008 and eight to nine times after it. The sampling was introduced from eight sampling plots at each buffer area. The biomass of above-ground and below-ground parts of plants was harvested from each of the study sites at peak standing crop in August of 2007 and 2008; before and after the second N addition. The samples were collected from 17-20 plots that were placed systematically to cover each buffer area as a grid. The below-ground parts of biomass were collected simultaneously with the above-ground biomass from the same plots. Peat monoliths ($3 \times 4 \times 15$ cm) down to a depth of 15 cm were sampled and divided into two layers of 7.5 cm thickness.

Except for the first N addition in one area, the three largest buffer areas (relative size higher than 1%) retained the added inorganic N almost completely; their retention efficiencies during the year of addition were higher than 93% for both $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$. Two of the three smallest buffers (relative size lower than 0.25%) were still able to reduce inorganic N from the through-flow waters effectively, as their retention capacities for inorganic nitrogen varied between 58 and 89%. However, one small buffer area had a retention capacity of less than 20%. The factors contributing to efficient N retention were hydrological load during N addition, relative size of the buffer area, and the length of the buffer area, i.e. the distance between the inflow and outflow points. The buffer areas appeared to be efficient and long-term sinks for inorganic nitrogen, because the release of N during the 2-4 years after N addition was minor.

The N_2O emissions correlated significantly with the water table level and the concentrations of $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$ in the soil water. Thus, in buffer areas with a high water table level the concentrations of $\text{NO}_3\text{-N}$ in the soil water and the emissions of N_2O increased soon after the N addition had started. The total N loss as N_2O was also larger than in areas where the water table level was lower and the concentrations of $\text{NO}_3\text{-N}$ in the soil water remained low. Compared with the high amount of N applied in the buffer areas, the loss of N as N_2O was low from all buffer areas.

The N content in the vegetation increased by about 6-43 kg ($9\text{-}67 \text{ kg ha}^{-1}$) at four of the five buffer areas, while a decrease in N content of about -2 kg was observed at one buffer area. The proportional retention in the vegetation was about 11-83% of the added N, except for the one buffer area. We suggest that a significant proportion of the N added has also been retained in microbial biomass and in the peat matrix.

References

- Nieminen, M., E. Ahti, H. Nousiainen, S. Joensuu & M. Vuollekoski, 2005. Capacity of riparian buffer zones to reduce sediment concentrations in discharge from peatlands drained for forestry. *Silva Fennica* 39: 331-339.
- Väänänen, R., M. Nieminen, M. Vuollekoski, H. Nousiainen, T. Sallantausta, E-S. Tuittila & H. Ilvesniemi, 2008.

Retention of phosphorus in peatland buffer zones at six forested catchments in southern Finland. *Silva Fennica* 42: 211-231.