THREE YEARS OF INCREASED NITROGEN DEPOSITION DO NOT AFFECT THE VEGETATION OF A MONTANE ECOSYSTEM

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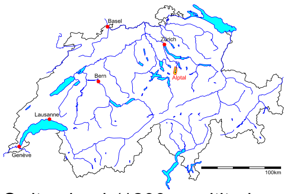
NITREX

NITROGEN SATURATION EXPERIMENTS

Introduction

Natural alpine ecosystems tend to have a rather tight nitrogen cycle. This is because both the supply and demand of mineral nitrogen are limited by climate and soil conditions prevailing at higher altitudes. The relative impact of nitrogen deposition is therefore potentially stronger there than at lower altitudes.

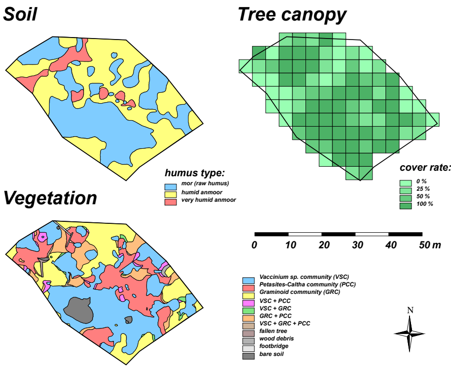
N critical loads are exceeded in large parts of Swiss forests. Tree health, biodiversity and water quality (nitrate) may be detrimentally affected.



A simulation of a higher deposition rate is being conducted as a paired-catchment experiment in a spruce forest at Alptal, central Switzerland (1200 m altitude, gleysols over flysch, 2300 mm annual precipitation, 12 kg/ha/year bulk inorganic N deposition).

Soil and vegetation

The vegetation and the humus types of the gley-sols are closely linked to the micro-topography and therefore to the water regime of the site.

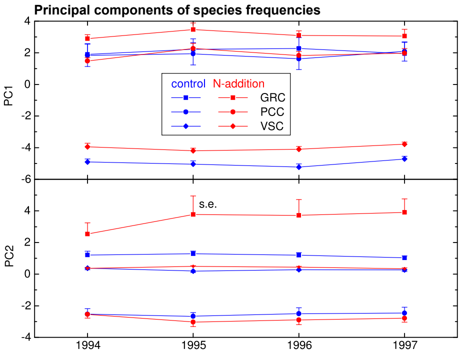


The trees, along with *Vaccinium* shrubs, grow on acidified mounds. They are up to 250 year old. Their canopy has a low density (430 stems/ha, BA = 41 m²/ha). The nutrient richer, wet depressions carry a graminoid community (in canopy gaps) or a *Caltha* and *Petasites* community (in the shade).

Ground vegetation

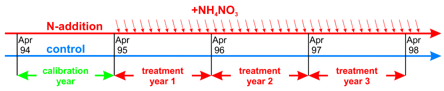
Species were counted 3 times per vegetation period on 9 permanent quadrats (50 x 50 cm) per plot. An analysis of principal components of frequencies was performed. The first component was found to be linked to soil conditions and the second to light. There was a clear discrimination between three plant communities but so far no response to the addition of nitrogen.

Principal components of species frequencies

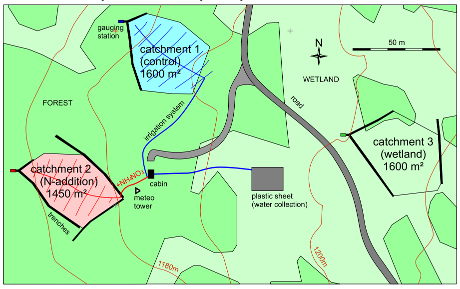


Nitrogen addition

Two forested catchments (≈1500 m²) have been delimited. NH_4NO_3 dissolved in rain water is applied by sprinklers to catchment #2 at 30 kgN/ha/year. Catchment #1 is the control and receives only unchanged rain water. The addition experiment started after one year of calibration and included 1400 ‰ $\delta^{15}N$ during one year.



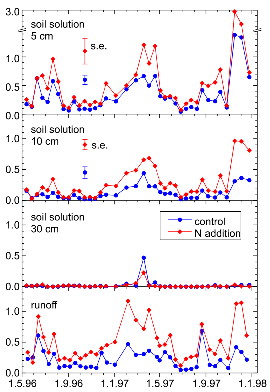
NITREX experimental setup at Alptal



Nitrate dynamics

During the calibration year both catchments were very similar. The N treatment induced a sharp increase in the nitrate concentrations of the runoff but did not drastically change their pattern (nitrate peaks at low runoff or with snowmelt). In the soil solution, nitrate was not enriched below 10 cm.

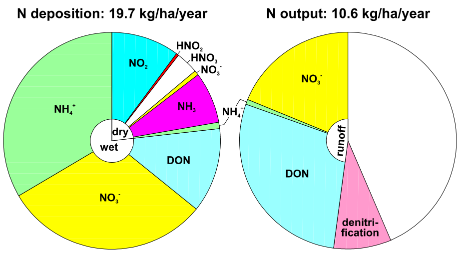
Nitrate-N concentrations in soil solution and runoff



These dynamics can be explained by denitrification and preferential flow through soil macropores. Nitrate from rain or snowmelt is poorly retained in the soil and the observed leaching is not proof of a real ecosystem N saturation.

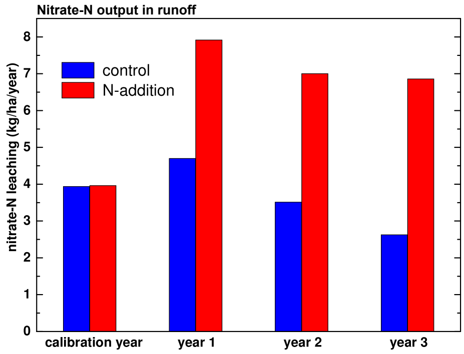
Nitrogen budget

The control catchment retains 9 kg N/ha/year.



3 years of N addition doubled the nitrate output.

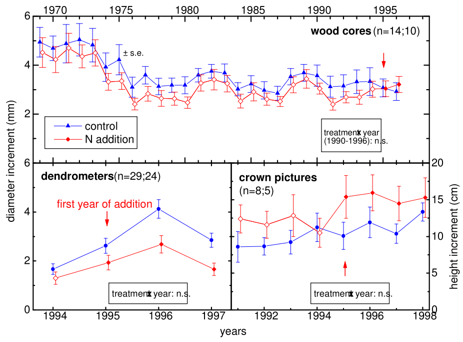
Nitrate-N output in runoff



Tree growth

Diameter increment of the spruce trees was assessed using wood cores and dendrometers. Height growth was measured with annual photo-graphs of tree crowns. None of these methods showed any significant effect of the N addition, even if initial diameter or height were taken as covariates. A slight positive N effect suggested by core measurements is not supported by the (more precise) dendrometer readings.

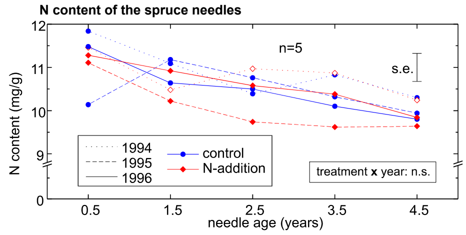
Diameter and height growth of the spruce trees



Foliage

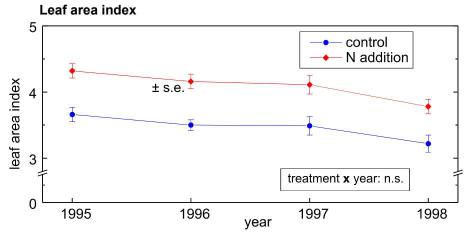
Analyses of spruce needles showed slight deficiences in both N and P. Thus far, the addition of N did not increase the needle N contents.

N content of the spruce needles



The leaf area index (Li-Cor LAI 2000) varied between years and plots but no interaction (i.e. no treatment effect) could be seen.

Leaf area index



Conclusions

The lack of response to nitrogen in the vegetation of Alptal can be explained by the following scheme: