Nitrate leaching and greenhouse gas fluxes after tree girdling in a long-term low-dose N addition experiment at Alptal, Switzerland

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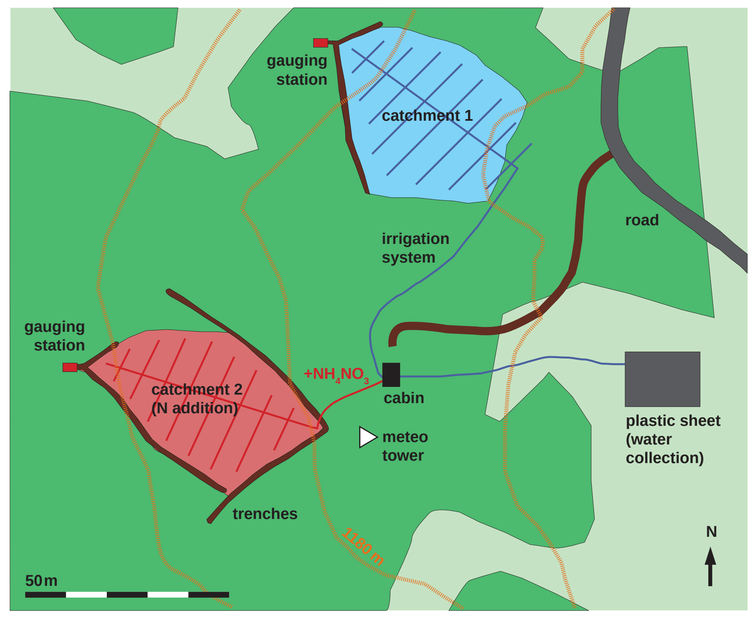
Experimental site Alptal

- Central Switzerland, 1200m a.s.l.
- Subalpine Norway spruce forest (*Picea abies*)
- Precipitation 2300 mm/a (30% as snow)
- Mean air temperature: 6°C
- Soil/parent rock: Gelysol/Flysch

Long-term low-dose N addition

- N addition with sprinklers during rain events
- Two small catchments (each 1500m^2):
  → Catchment 1: control, rainwater only (12 kg/ha/a N)
  → Catchment 2: NH_4NO_3 addition (+20-25 kg/ha/a N)
- After 15 years of N addition different N status of catchments



Experimental setup at the Alptal site

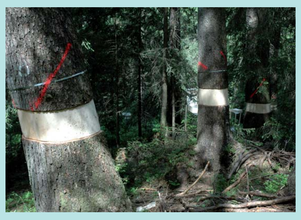
Questions

> How does nitrate leaching and greenhouse gas fluxes (CO_2, CH_4, N_2O) change after tree girdling?
> Is there an interaction with the N status?

Tree girdling

- Best possible simulation of a bark beetle infestation
- At breast height, bark and phloem were removed in a 30 cm strip around the trunk
- In June 2009, half of the trees per plot (15) were girdled
- Nine months after girdling, trees do not show any visible response to the treatment
- After girdling, root starch content of girdled trees clearly decreased

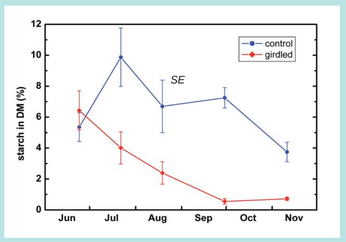
Forester removing bark and phloem



Girdled trees on chatchment 2

Root starch after girdling

- Coarse roots from 8 girdled trees and from 8 control trees were sampled (1.5 m from stem) approx. every 4 weeks (5 times) after girdling
- Samples were directly freeze-dried, then ground to powder using a laboratory disk mill
- 18% HCl was used to disolve total starch (Magel 1991)
- After staining with *Lugol's* solution, absorption was directly measured at 605 nm by spectrophotometer



Coarse root starch content in % of dry mass of girdled and control trees (n=8)

Nitrate leaching

- Natural lysimeter due to impermeable clay horizon (40-80cm depth)
- Trenches around the catchments lead water downhill to gauging station
- Runoff is measured using V-notch weirs
- Runoff proportional samples are bulked over one week
- NO_3-N leaching from control plot: ~3 kg/ha/a
- NO_3-N leaching from N addition plot: ~10 kg/ha/a

V-notch weir for runoff measurement

Installation for taking runoff proportional samples

Greenhouse gas fluxes

- Static chamber method is used to measure CO_2, CH_4 and N_2O fluxes from the soil
- Measurements approximately once per month by gas chromatography
- Replicated plot design, n=5 (6)
- CO_2 is additionally measured directly in the field by IRGA sensor
- Two years of measurements on the N treated plot showed increased emissions of nitrous oxide and a tendency to reduced soil respiration (CO_2)

Vaisala MI70 for soil respiration (CO_2) measurements

Gas samples (CO_2, CH_4, N_2O) are taken from static chambers by syringe

Further expected results

- Since starch reserves of girdled tress are very low (see above), we expect them dying this spring during shoot production
- Increased nitrate leaching as a result of less uptake by girdled trees
- Increased fluxes of CH_4 and N_2O due to more anoxic conditions (decreased water uptake)
- Decreased CO_2 emissions due to reduced root respiration

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Reference
Magel, E (1991): Qualitative and Quantitative Determination of Starch by a Colormetric Method, Starch 43,10, 384-387

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