Influence of nitrogen deposition to mountain forests: N-addition with ^{15}N labelling in a paired-catchment experiment

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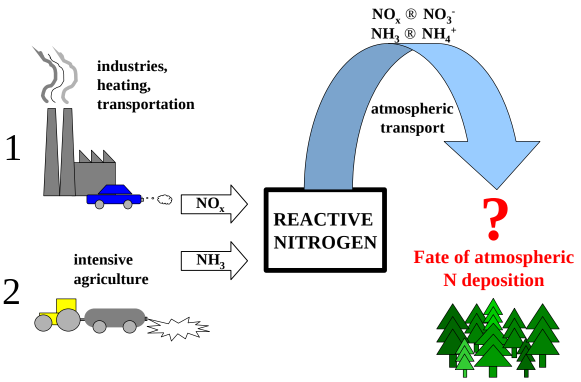
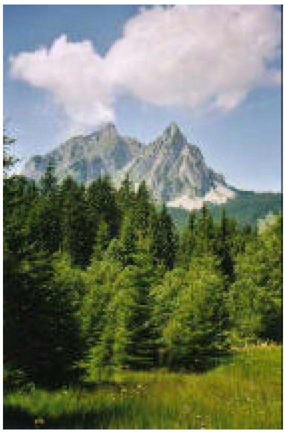
Introduction

In the last decades, human activities strongly altered the global nitrogen cycle.
Two main types of anthropogenic activities release reactive nitrogen to the atmosphere:



The increasing input of reactive nitrogen particularly affects mountain ecosystems. It can induce eutrophication of previously N-limited systems and finally cause nitrogen saturation.
To assess these effects, flow and fate of inorganic nitrogen are followed by a ^{15}N tracer in a paired-catchments experiment with N-addition.

Research site



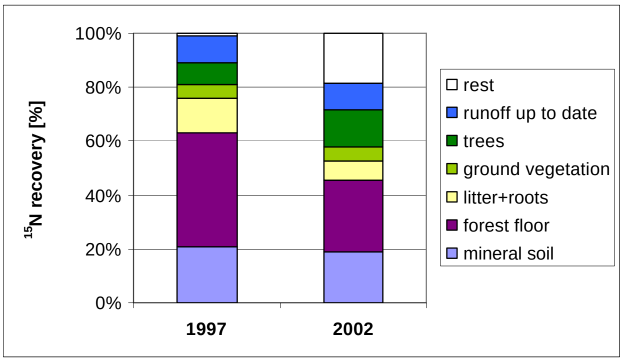
Alptal:
- Prealps of Central Switzerland
- *Picea abies* forest, 1200 m a.s.l.
- cool and wet climate (6°C, 2300 mm/year)
- bulk deposition of NO_3^- + NH_4^+ of 12 kg ha^{-1} year^{-1}
- umbric Gleysol with raw or muck humus over Flysch
- low permeability, water table close to surface and preferential water flow paths

Materials and methods

- N-addition experiment simulates a deposition increase of 27 kg N ha^{-1} year^{-1}
- N-addition as NH_4NO_3 in rain water applied by sprinklers to a paired-catchment, (addition and control, 1500 m^2)
- N-addition from 1995 - 2003
  - 1994-1995 calibration year
  - 1995-1996 $^{15}NH_4{}^{15}NO_3$ tracer application
  - 1997 and 2002 N-pool sampling
  - sampled pools: trees, ground vegetation, litter, soil, soil microbial biomass, roots and water runoff

Results

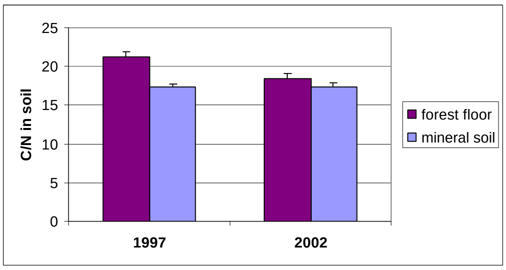
^{15}N-tracer recovery



1997:
- the largest sink for ^{15}N is the soil, mainly the forest floor
- 10 % of the added ^{15}N goes directly as NO_3^- into runoff

2002:
- the largest sink is still the soil, ^{15}N in forest floor decreases due to mineralization and tree uptake
- ^{15}N in litter and roots decreases as well
- a rest amount was no longer recovered

Change of C/N ratio



1997:
- the forest floor has a higher C/N ratio

2002:
- the C/N ratio of the forest floor decreases over time, due to the continuous N-addition and it's strong N retention (already observed with ^{15}N)

Conclusion

- ^{15}N tracer is a good tool to show the fate of N
- a large ^{15}N sink is the soil, 10% leaves the system directly by preferential flow. A part of the stored ^{15}N in the soil is still available for tree uptake
- a higher N deposition alters the C/N ratio in the soil and has an influence on other pools
- the whole nitrogen cycle is very slow and effects can only be seen after several years

Link: IRISALP Project http://www.wsl.ch/forest/wus/irisalp/iris-de.htm