Impact of climate change on N-cycle and greenhouse gas fluxes in alpine grassland ecosystems: An *in situ* climate change experiment

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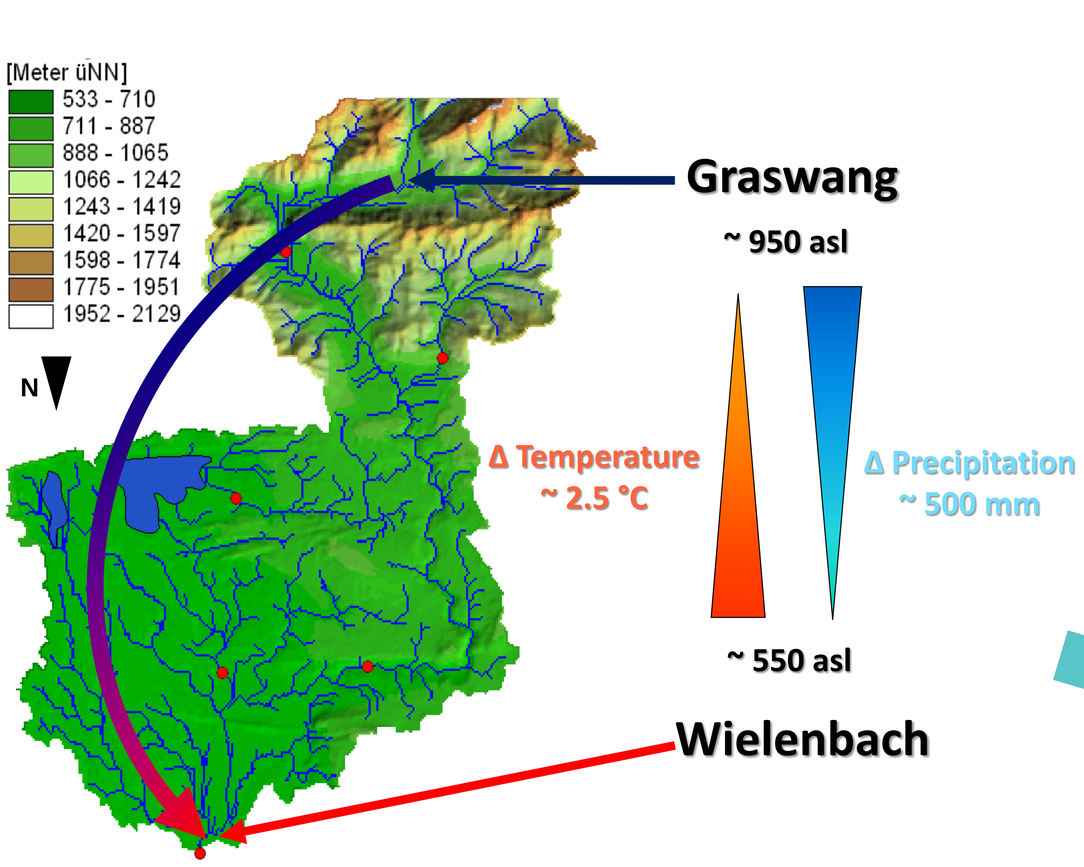
Abstract

This project investigates the short term impact of climate change (increasing temperature, decreasing precipitation) and extreme events (drought, heavy precipitation) on nitrogen storage and cycling as well as the total greenhouse gas balance of alpine grasslands. The major goal of the project is in particular the identification of climate-change-sensitive C and N turnover processes and –pools in alpine grasslands. Detailed process studies will allow to judge the response of the central N and C processes in soil (microbial nitrogen turnover, plant nitrogen uptake and nitrogen losses along hydrological pathways, greenhouse gas exchange between soil and atmosphere, net CO_2 ecosystem exchange, carbon and nitrogen storage in the system and composition/quality of soil organic matter) to the predicted climate change. The study sites are grasslands located in the Ammer catchment area (*TERENO*-Climate-Feedback-Station „Ammer“, *TERrestrial ENvironmental Observatories*) along an altitudinal gradient and consequently along a natural temperature gradient (+ 2.5 C mean annual temperature) and precipitation gradient (- 500 mm mean annual precipitation). These natural gradients will be used to simulate the biosphere-hydrosphere-atmosphere-exchange processes under climate change. The results of this subproject are vitally important for mitigating climate change effects on ecosystem stability and –productivity. Furthermore, the obtained data will be used for the further improvement and validation of process oriented models simulating the changes in carbon and nitrogen storage and biosphere-atmosphere-exchange of trace gases in alpine grasslands under changing climatic conditions.

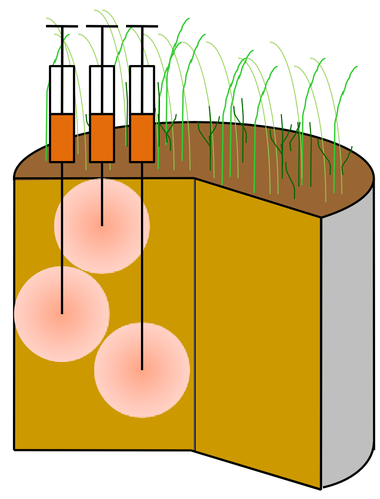
Intact grassland plant soil systems

Transplanting along a natural temperature and precipitation gradient to simulate Climate Change



Using ^{15}N-Isotope-Tracer and Pool-Dilution-Technique

Injected ^{15}N and ^{13}C:
$^{15}NH_4^+$
$^{15}NO_3^-$
^{15}N-^{13}C-Glycine



Tracing ^{15}N and ^{13}C in:
Above and below ground plant biomass
DON
Microbial C and N
NH_4^+, NO_3^-

Simultaneous determination of plant N uptake and microbial N turnover in intact plant soil systems under simulated Climate Change

Project objectives

1. Short term ^{15}N dynamics
   - Measuring processes of gross N turnover
   - Seasonal variability
     Comparing the gross N fluxes in spring, summer and autumn between control and transfer side
   - Extreme climatic events
     Simulate drought and heavy precipitation and compare with systems without treatment (on control and transfer side)

2. Longer term ^{15}N dynamics

   Recovery rate of ^{15}N applied in different pools:
   - Plants
   - Microbial biomass
   - Soil organic matter
   - Stable N pools

   Who wins the competition for nitrogen in these grasslands on the long-term: plants or microbes, or will there be increased N loss?

3. C and N losses
   - Measuring greenhouse gas exchange (CO_2, N_2O, CH_4), every 2 weeks
   - Measuring nitrogen losses in leachate (DON, NO_3^-, NH_4^+), event driven
   - Comparing the transfer site with the control side

How is the nitrogen-cycle and greenhouse gas budget in alpine grassland soil affected by climate change?

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