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Effects of land use change and monsoon variability on atmosphere-ecosystem exchange in high alpine grasslands on the Tibetan Plateau

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Motivation

- How does interaction of grazing and fencing, as range land management, influence the water balance, soil productivity and C sequestration, carbon and energy fluxes on the Tibetan Plateau (TP)?
- What happens to *Kobresia pygmaea,* the most abundant species on the TP covering 450.000 km², without the traditional grazing habits of nomads?
- What happens to soil organic carbon which is stored in high altitude soils under different grazing intensities?

Experiments

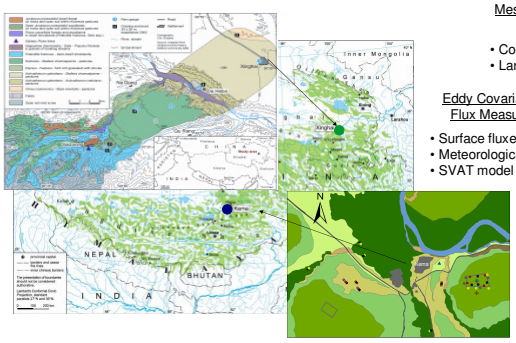
Multidiscipline experiments on the response of *Kobresia pygmaea* pastures to land use changes

Xinghai 2009 (7 year grazing exclosure)

- Investigation of grazing impact on vegetation structure, soil properties, C stock and CO_2 fluxes along a transects of exclosures.
- Studies on sequestration and fate of C from root exudates in soil.

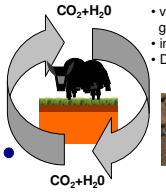
Kema 2010 (1 year grazing exclosure)

- Analysis of the C and water cycles on a wide range of temporal and spatial scales.
- Evaluation of grazing effects on vegetation dynamics, CO_2 fluxes and C and N turnover.



Mesoscale Atmospheric Modeling
- Convective events
- Land use change

Eddy Covariance (EC) Flux Measurements
- Surface fluxes, CO_2 H_2O
- Meteorological data
- SVAT model



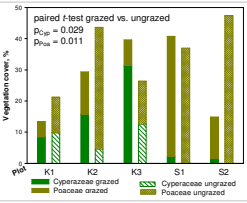
^{13}C ^{15}N labeling chamber Measurements
- Soil respiration
- Assimilation
- Carbon pools
- Partitioning of C fluxes

Vegetation monitoring
- Biomass
- Nutrient availability
- vegetative and generative reproduction
- impact of different herbivores
- Degeneration / Regeneration

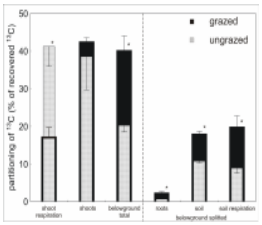
Lysimeter and Infiltration measurements
- Water availability
- Evapotranspiration
- Evapotranspiration modeling
- Dew fall

Results

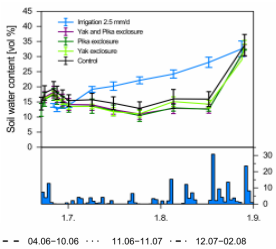
- Grazing exclosures in Xinghai resulted in a dominance of Poaceae over *Kobresia* (Cyperaceae) with significant lower root mass ($p = 0.02$) leading to smaller Soil Organic Carbon (SOC) stocks (Xinghai)

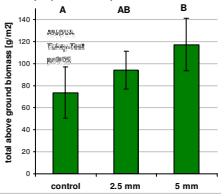


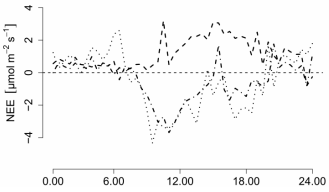
- Grazing exclusion effects partitioning pattern of assimilated C:
  - Below ground C allocation was reduced
  - C losses by shoot respiration were increased
  - C input into soil was reduced (Xinghai)

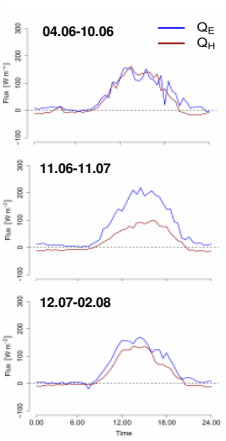


- Availability of water had a strong effect on soil water content, latent heat flux (Q_E) and net ecosystem exchange (NEE). Artificial irrigation additional to natural occurring precipitation showed a significant raise in biomass growth and soil water content, (40 mm rain in July vs. app. 160 mm, strong rain after 15.08.) (Kema)

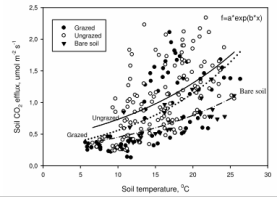




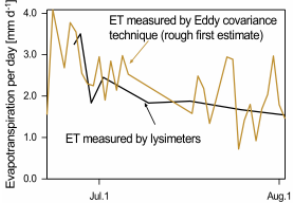




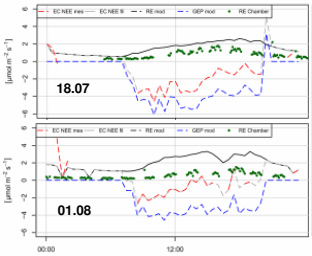
- Soil respiration chamber measurements show 50% smaller efflux on bare soil and seem to depend strongly on soil temperature, which is altered fast due to changing radiation. (Kema)



- Rough estimates of evapotranspiration from EC and lysimeters compare well, but statistics could not be calculated since EC data need to be gapfilled. (Kema)



- Combining ^{13}C pulse labeling with NEE measurements by the EC on July 1st was used to estimate the C flux into different ecosystem compartments. The Gross Ecosystem Photosynthesis (GEP) on the day of labeling was 3.07 g C m^{-2} d^{-1} the table shows the calculated fluxes as revealed by the partitioning of assimilates. Comparison of the modeled Respiration RE with the chamber RE show great differences. Which questions the accuracy of the model results based on Michaelis-Menton and Lloyd-Taylor functions. (Kema) (Method: See Poster by M.Riederer)



	depth [cm]	% of recovered ^{13}C	Total C flux [g C $m^{-2}d^{-1}$]
Shoots		9.1±2.2	0.28
White roots	0-5	9.2±1.5	0.28
	5-15	0.8±0.2	0.02
Woody roots	0-5	13.8±1.7	0.42
	5-15	5.3±1.2	0.16
Soil Organic Carbon	0-5	3.4±0.7	0.1
	5-15	2.1±0.6	0.06
CO_2 efflux (RE)		36.8±1.4	1.13
Missing ^{13}C		19.5	0.6

Conclusion and Outlook

The experiment in Xinghai showed that the excluded grazing caused a change in plant community structure, which had a great influence on soil carbon and nitrogen stocks. The ^{13}C labeling experiments combined with the evaluation of C stocks showed reduced C input into soil inside the *Kobressia pygmaea* grazing exclosures. That may lead to reduced SOC stocks over a longer time period when the traditional grazing is reduced in this ecosystem. This might prove true also for Kema, since the pulse labeling indicated that most of the C is stored in belowground biomass. Due to the dry conditions during the Kema experiment and the short time the grazing exclosures were established no differences in biomass growth or NEE could be seen on the different treatments. Nevertheless the dry conditions in 2010 showed that the response of the pastures are driven by water availability. Further experiments will be conducted in Kema to investigate long term dynamics. To integrate the data on the different time and spatial scales more effort will be put into modeling of the relevant quantities.

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