Carbon fluxes of *Kobresia pygmaea* pastures on the Tibetan Plateau

Effects of rangeland management and degradation

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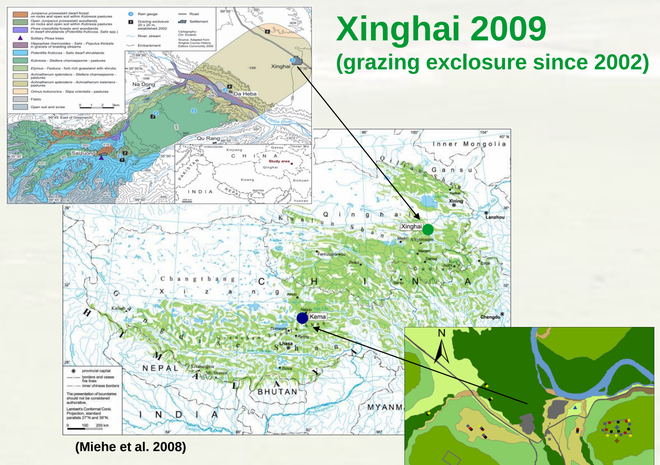
Motivation

- *Kobresia pygmaea* is, with a cover of 450.000 km², the most abundant species on the Tibetan Plateau (TP)
- What happens to this ecosystem without traditional grazing habits?
- How does interaction of grazing and fencing, as rangeland management, influence soil productivity and C sequestration, carbon and energy fluxes on the TP?
- What happens to soil organic carbon which is stored in high altitude soils under different grazing intensities?
- How are Carbon fluxes influenced by degradation?

Study sites

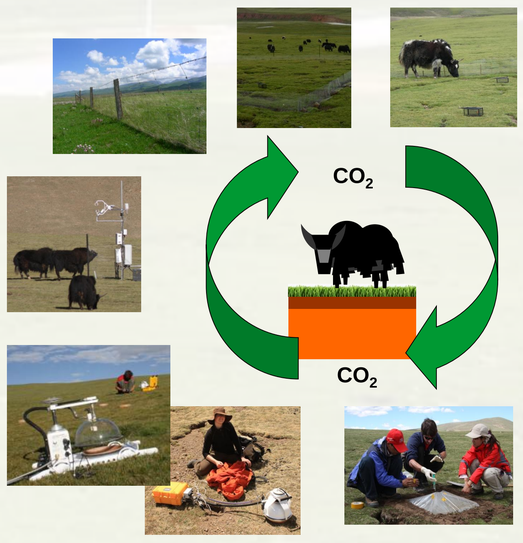


Xinghai 2009
(grazing exclosure since 2002)

(Miehe et al. 2008)

Kema 2010 + 2012
(grazing exclosure since 2009)

Experiments



Vegetation monitoring ●●

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

Eddy Covariance (EC) ● Flux Measurements

- Surface fluxes, CO_2 H_2O
- Meteorological data
- SVAT model

^{13}C labeling ●● chamber Measurements ●

- Soil respiration
- Assimilation
- Carbon pools
- Partitioning of C fluxes

Long-term grazing effects in Xinghai

- Grazing exclosures 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 (Fig. 1).

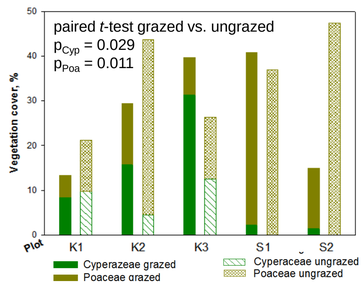


Fig. 1: Vegetation composition change due to grazing exclosure of yak and sheep

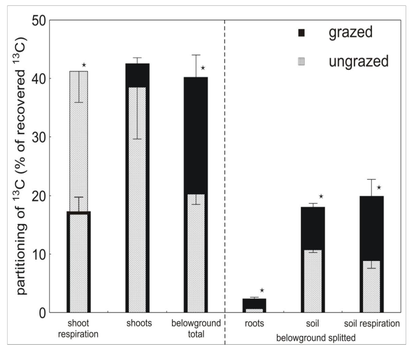


Fig.2: Carbon partitioning pattern of grazed and ungrazed pasture (no yak and sheep) (Hafner et al. 2012)

- Grazing exclusion effects partitioning pattern of assimilated C (Fig. 2):
  - Below ground C allocation was reduce
  - C losses by shoot respiration were increased
  - C input into soil was reduced

Fate of Carbon in *Kobresia pygmaea* pastures

- ^{13}C labeling revealed that the greatest amount of C is moved into the turf layer (Fig. 5).
- Combining relative ^{13}C pulse labeling results with mean Carbon uptake observed by the eddy-covariance method (EC) for July enabled us to estimate the absolute C fluxes into different ecosystem compartments (Fig. 6)
- EC data made it also possible to observe the flux conditions during the chase period of the ^{13}C tracer (Fig. 7).

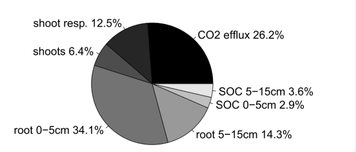


Fig.5: Distribution of recovered ^{13}C 23 days after labeling

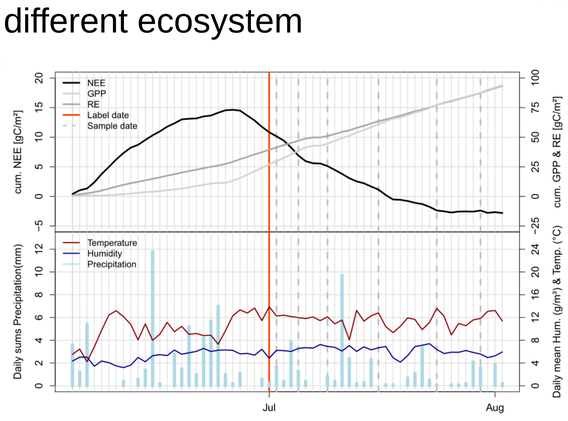


Fig.7: C Fluxes observed with EC, weather conditions during the experiment , the labeling event and sampling dates

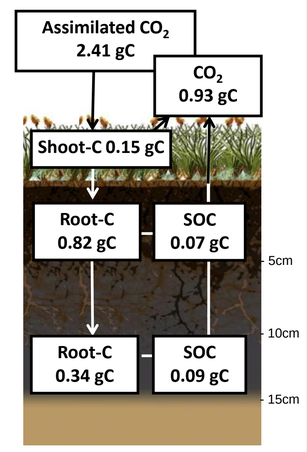


Fig.6: Absolute mean daily C fluxes for July

Short- term grazing effects in KEMA

- No obvious differences between grazing treatments visible in vegetation structure within one season.
- NEE and below ground C stocks from all treatments are very similar, small differences can be explained by heterogeneity in vegetation cover.

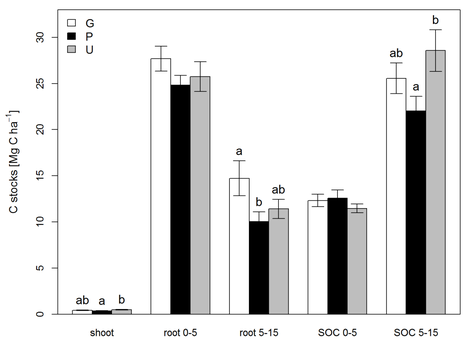


Fig. 3: C stocks from grazed plots (G) and plot with no yak (P) and with no grazing at all (U)

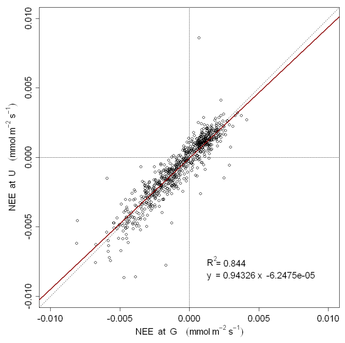


Fig. 4: Comparison of NEE measurements by EC on a plot with (G) and without yak grazing (U)

C fluxes of different surface types within the pastures

- Chamber measurements revealed great differences in CO_2 flux partitioning according to the vegetation cover.
- The influence of rain events and the vapor pressure deficit on the C fluxes showed a great water limitation of the ecosystem.
- The results also showed that reference data for direct comparison of different surface types are needed due to changing weather conditions. Unfortunately up to now still missing.

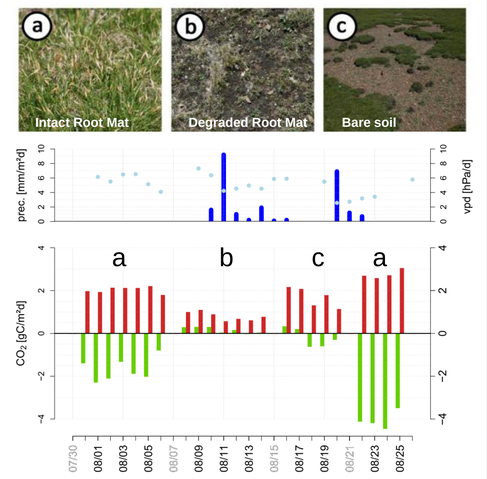


Fig.8: Surface types found *in Kobresia pygmaea* pasture and corresponding C fluxes measured with a LiCOR 8100 Chamber system (LiCOR Bioscience Inc)., precipitation and vapor pressure deficit

Conclusion

- Long-term grazing exclosure effects vegetation composition, C Stocks and C partitioning and therefore the quality of the pasture.
- Large belowground fluxes into the turf layer indicate that the pastures have a great potential of C storage which is highly sensitive.
- Loss of the turf layer due to vegetation changes or degradation would decrease this potential.
- The ecosystem is highly water limited and therefore strongly influenced by changes in monsoon dynamics.

Outlook

- C fluxes will be also modeled with SVAT Models to obtain data for the quantification of the degradation effect on C fluxes.
- These models will be validated by eddy covariance measurements.
- The effect of the water limitation will be further investigated with a precipitation manipulation experiment.

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