TiP (DFG SPP 1372) Atmosphere - Ecology - Glaciology - Cluster

Does grazing exclusion help improving montane grassland on the Tibetan Plateau? – Joint Xinghai-experiment 2009 –

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Motivation and Goals

The Tibetan Plateau comprises one of the world's most extensive grazing ecosystems. The high-altitude soils store large amounts of carbon – corresponding to 2.5 % of the global soil organic carbon (SOC) stocks (Wang et al. 2001). Grazing is a key factor affecting plant community, productivity and soil element stocks. Given that grazing pressure increased since the 1950s' fencing is often considered a suitable tool for presumption on a fencing experiment along an altitude gradient comprising different plant communities. The study aimed in answering following questions:

Does grazing exclusion…

…improve plant species diversity and fodder quality?

…increase above and belowground biomass productivity?

…lead to higher SOC and Nitrogen (N) stocks?

…change the partitioning pattern of recently fixed C?

Study Site

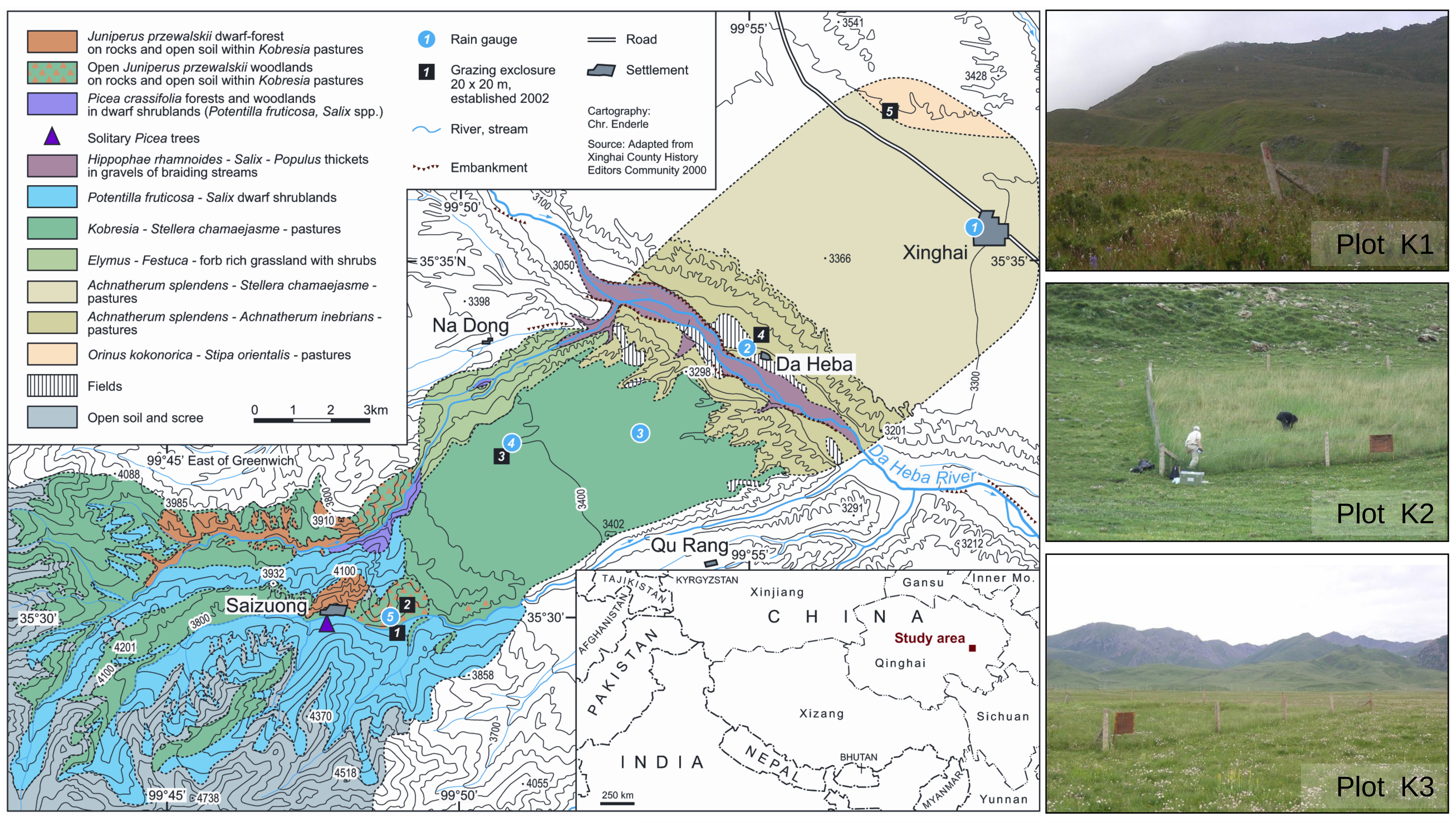


Fig 1: Location of plots, photographs of fences and surrounding area

Tab 1: Site characteristics of study plots

Plot No	Altitude [m a.s.l]	MAP [mm]	Vegetation Type	Grazing	Soil type
K1 (1)	3605	505	*Potentilla fruticosa-Salix* dwarf scrub-pasture	Yak, sheep, grazed year - round	
K2 (2)	3620	449	*Kobresia pygmaea-Stellera chamaejasme* pasture	Yak, sheep, grazed year - round	Kastanozem
K3 (3)	3420	404	*Kobresia pygmaea-Stellera chamaejasme* pasture	Yak winter pasture	Kastanozem
S1 (4)	3085	390	*Achnatherum splendens-Stipa* pasture	Yak, grazed year-round	Cambisol
S2 (5)	3332	375	*Stipa krylovii- Orinus kokonorica* pasture	sheep, goat, grazed year-round	Cambisol

Methods

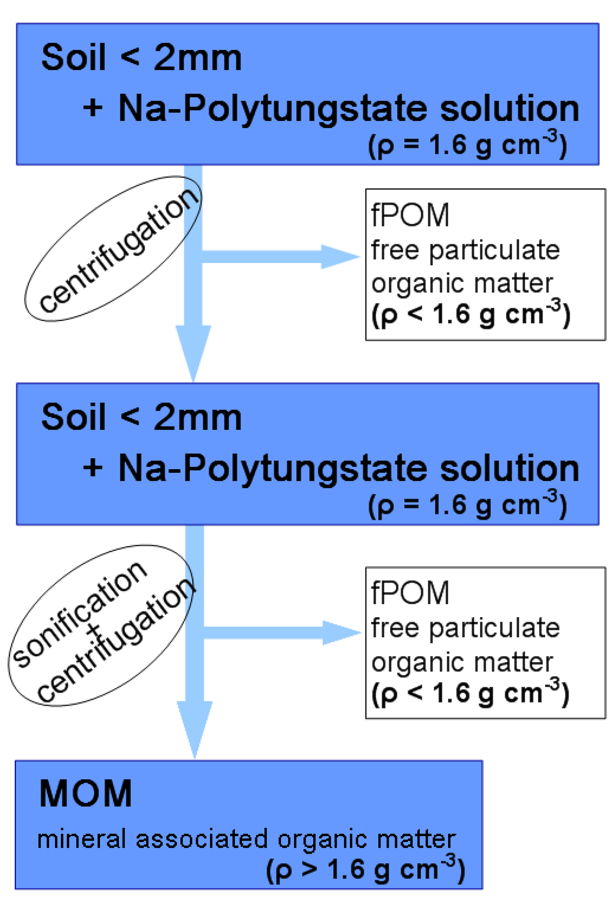


Fig 2: Density fractionation – procedure

Vegetation (plots K1-3, S1+2)

- Records of plant species composition and cover, biomass harvest in 0.25 m^2 subplots

Soil (plots K2+3, S1+2)

- three depth increments (0-5, 5-15, 15-35 cm), 5 cm inner diameter of corer
- Air-dried, total roots removed, sieved < 2mm
- Density fractionation (Fig 2)

Chemical analyses and calculation

- C and N determination (Vario EL III CNS, Elementar , Hanau)
- Inorganic carbon (IC) (Scheibler apparatus) OC_{soil} = Total C – IC
- stock calculation according to 'Equal mass approach'

Special analyses (plot K3 only)

- In situ $^{13}CO_2$ pulse labeling (July 29, 2009)
- Sampling of different pools (shoot, root, soil, soil respiration) in time intervalls 1, 5, 12, 18, 27 days after labeling
- Separation of living and dead roots

Results and Discussion

- Aboveground biomass increased; forage quality (= N content, grazed > ungrazed: p = 0.001) and plant species richness decreased (p = 0.001) under grazing exclusion (Fig 3)
- *Kobresia* (Cyperaceae) dominated outside but were overgrown by Poaceae inside the grazing exclosures (Fig 6)
- Root and soil parameters showed no significant responses to grazing exclusion (Fig 4 and 5)
- *Kobresia* and *Stipa* dominated sites differed significantly in all parameters
- Detailed investigations on plot K3 suggested a decrease of living root mass inside the fence (Fig 5)
- Roots made an important contribution to SOC in our investigation area, leading to smaller SOC stocks under *Stipa* dominated communities with significant lower root mass (p = 0.02)
- Grazing exclusion effects partitioning pattern of assimilated C (Fig 7):
- Below ground C allocation was reduced
- C losses by shoot respiration were increased
- C input into soil was reduced

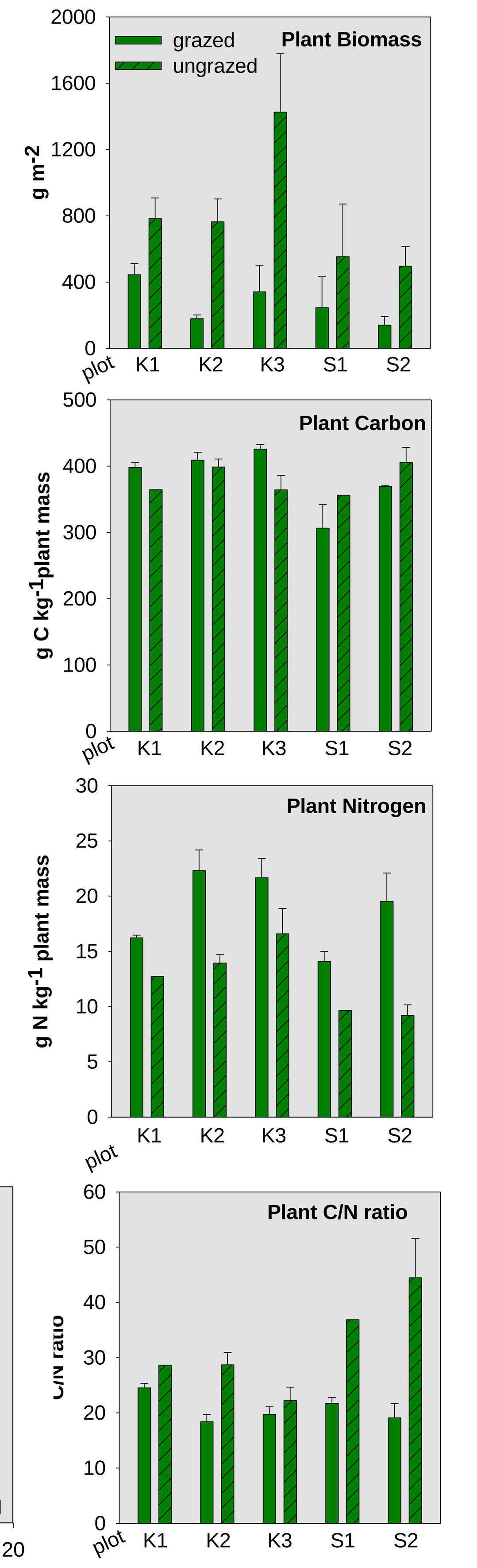


Fig 3: Grazing exclusion effects on above-ground biomass, C and N stocks and C/N ratio (mean and standard deviation, no stdev. = one measurement only)

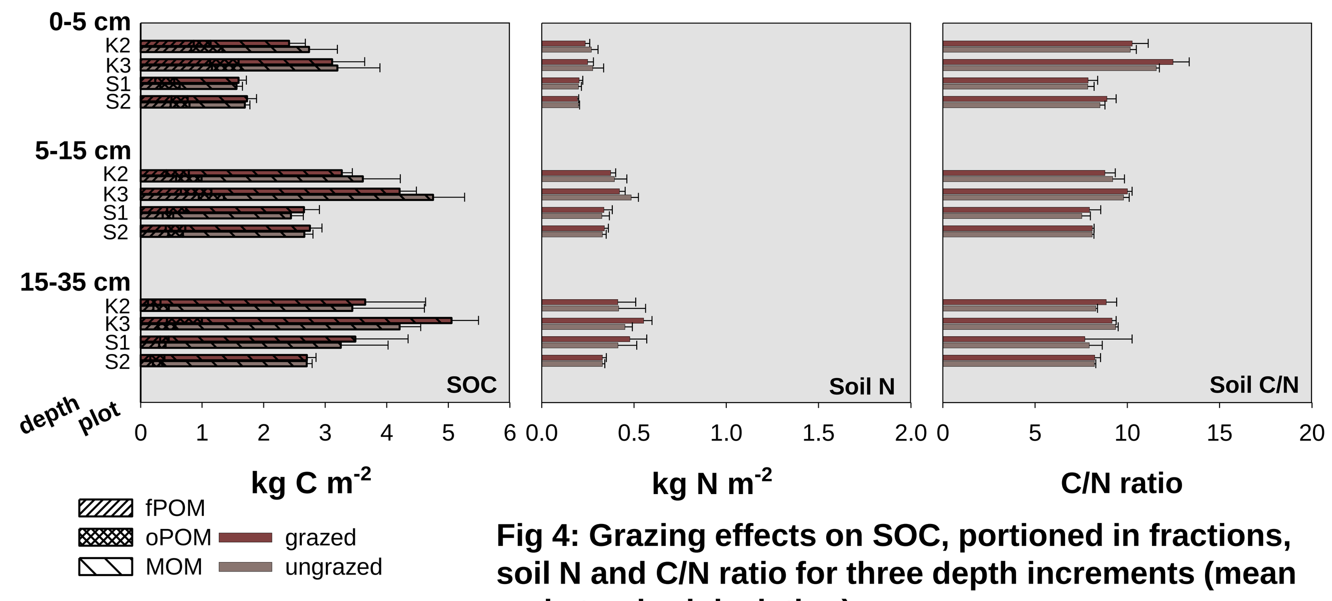


Fig 4: Grazing effects on SOC, portioned in fractions, soil N and C/N ratio for three depth increments (mean and standard deviation)

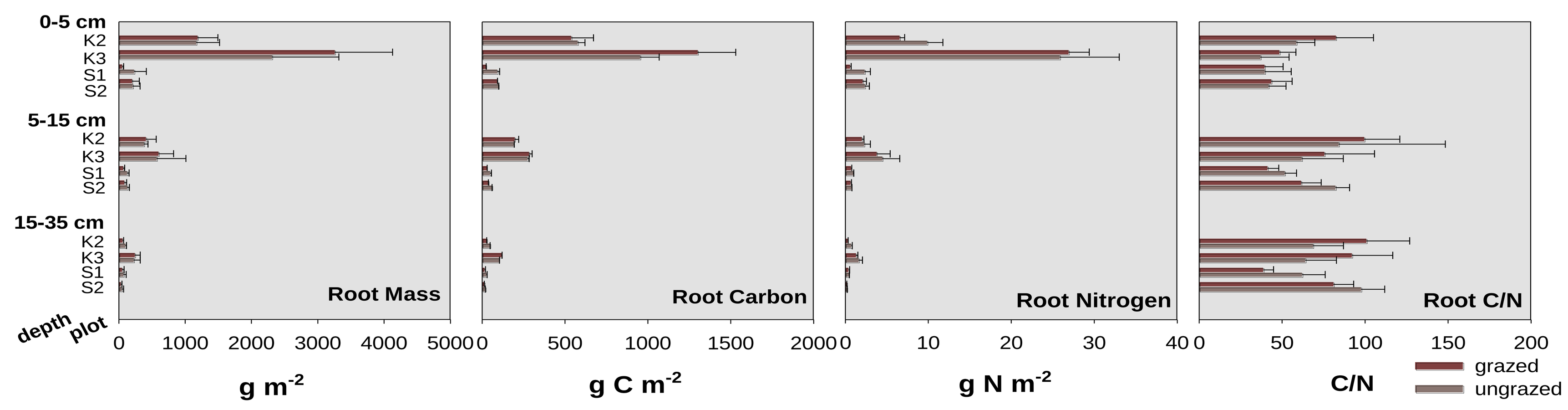
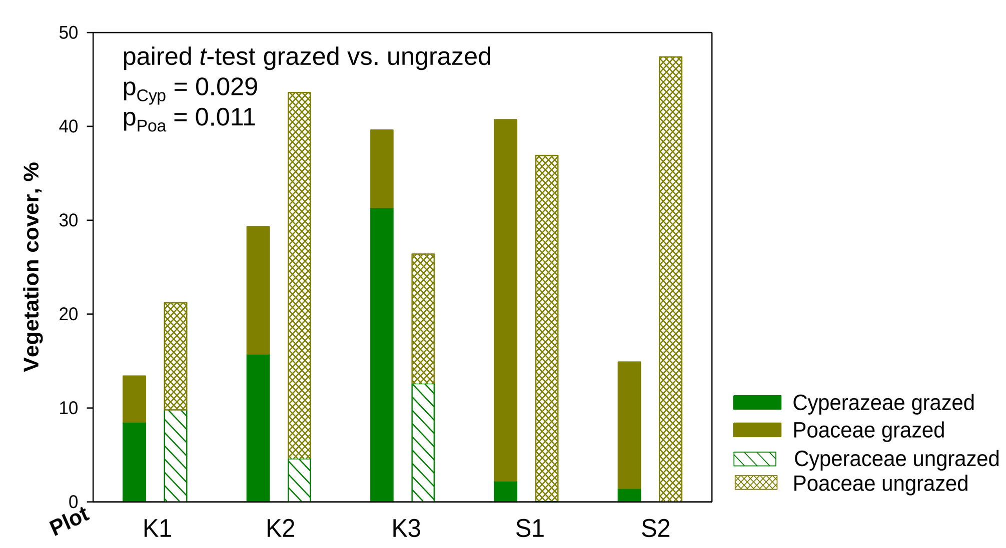


Fig 5: Grazing effects on root mass, root C and N stocks and C/N ratio (mean and standard deviation)



	K1	K2	K3	S1	S2	
Species no. per 0.25 m^{-2}	23	16	20	6	12	Grazed
	16	15	13	5	8	Ungrazed

Fig 6: Grazing effects on plant community composition and species number

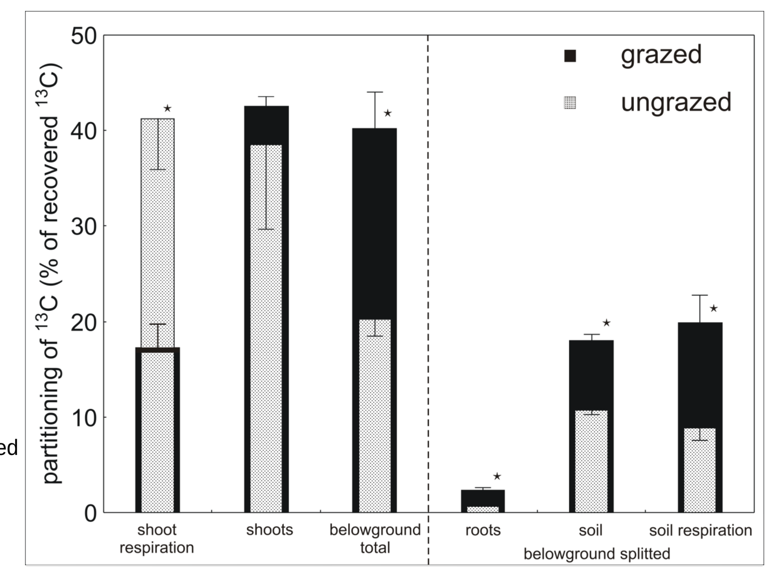


Fig 7: ^{13}C partitioning 27 days after assimilation

Conclusion

In our investigation soil carbon and nitrogen stocks and fodder quality were influenced much more by plant community structure than by grazing. After only seven years of grazing exclusion no tremendous changes in SOC parameters are expectable. However the results of the labeling experiment in a typical *Kobresia* pasture showed reduced C input into soil inside the grazing exclosures. Thus total grazing exclusion in traditional grazing ecosystems may lead to reduced SOC stocks over a longer time period. Especially for *Kobresia* dominated areas we cannot recommend fencing as a maintaining tool.

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Wang G, Qian J, Chang G, Lai Y (2002) Soil organic carbon pool of grassland soils on the Qinghai-Tibetan Plateau and ist global implication. The Science of the Total Environment 291:102-217