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

Effect of grazing on C stocks and assimilate partitioning in Tibetan montane pasture revealed by $^{13}CO_2$ pulse labeling

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Introduction

Since the late 1950s governmental rangeland policies have changed the grazing management on the Tibetan Plateau (TP). Increasing grazing pressure and since the 1980s the privatization and fencing of pastures near villages lead to land degradation, whereas remote pastures recover from stronger overgrazing. To clarify the effect of changing grazing intensity on the carbon (C) cycle of the TP, we investigated differences in belowground C stocks, sources of CO_2 efflux from soil and C allocation using *in situ* $^{13}CO_2$ pulse labeling of 1) a montane *Kobresia* winter pasture, and 2) a 7-year old grazing exclosure plot, both on the TP in 3440 m a.s.l.

The aims of this study were (1) to determine the partitioning of recently fixed C among pools in the plant-soil system, (2) to evaluate differences in the partitioning pattern of recently fixed C assimilates between the grazed and ungrazed grassland, (3) to estimate the effect of grazing on C input into soil, and (4) to evaluate differences in SOC stocks after seven years of grazing exclosure.

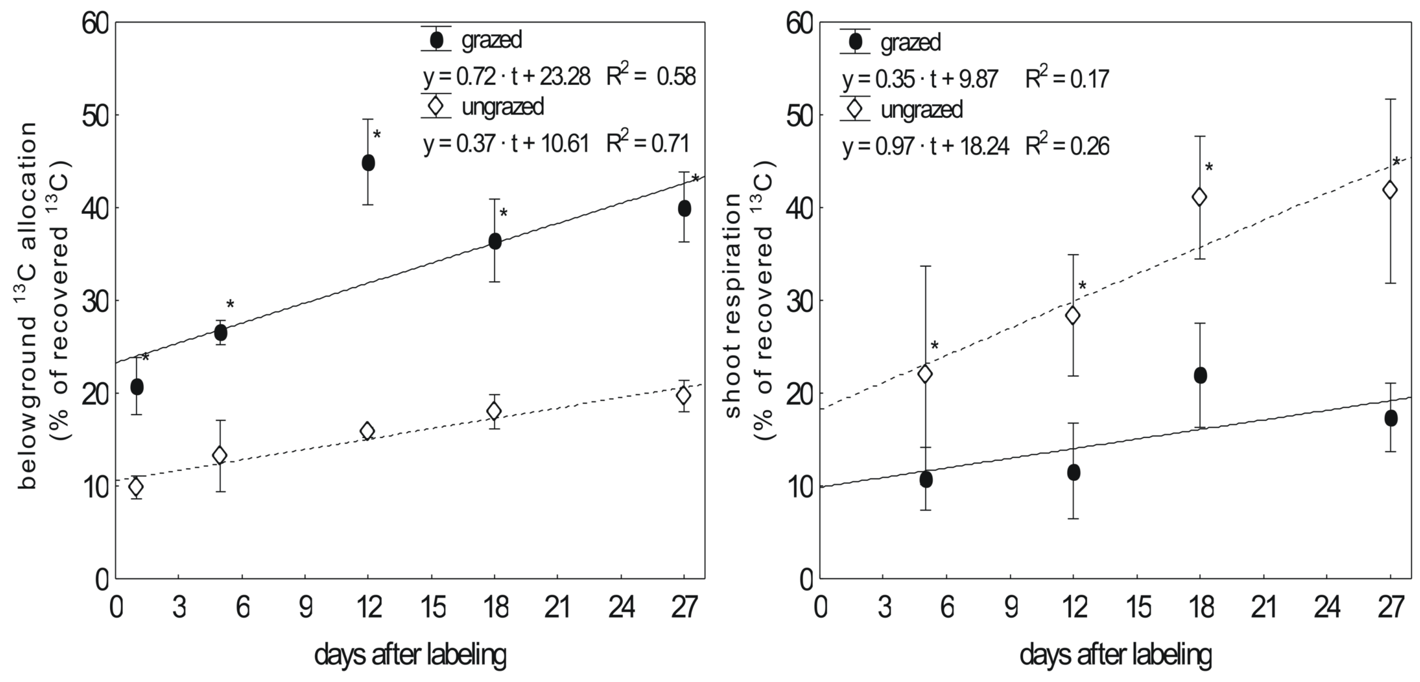
Conclusion

Seven years without grazing reduced SOC stocks in the upper 15cm due to:

1) lower C input into soil,
2) ongoing decomposition of the *Kobresia* turf,
3) reduction of root biomass leading to less C incorporation into stable soil C pools,
4) higher SOM-derived C in CO_2 efflux, since total CO_2 efflux does not differ between the treatments but the contribution of root-derived C to total CO_2 efflux was larger at the grazed site.

Summing up, the ^{13}C labeling experiments combined with the evaluation of C stocks demonstrated a negative effect of grazing exclosure on medium (living and dead roots) and long term (SOC) C storage in the upper 15 cm of the soil profile. Therefore, we conclude that the absence of grazing in remote areas leads to a decrease in C storage and that sustainable moderate grazing is a suitable tool to preserve the high ability of the montane pasture land to store C.

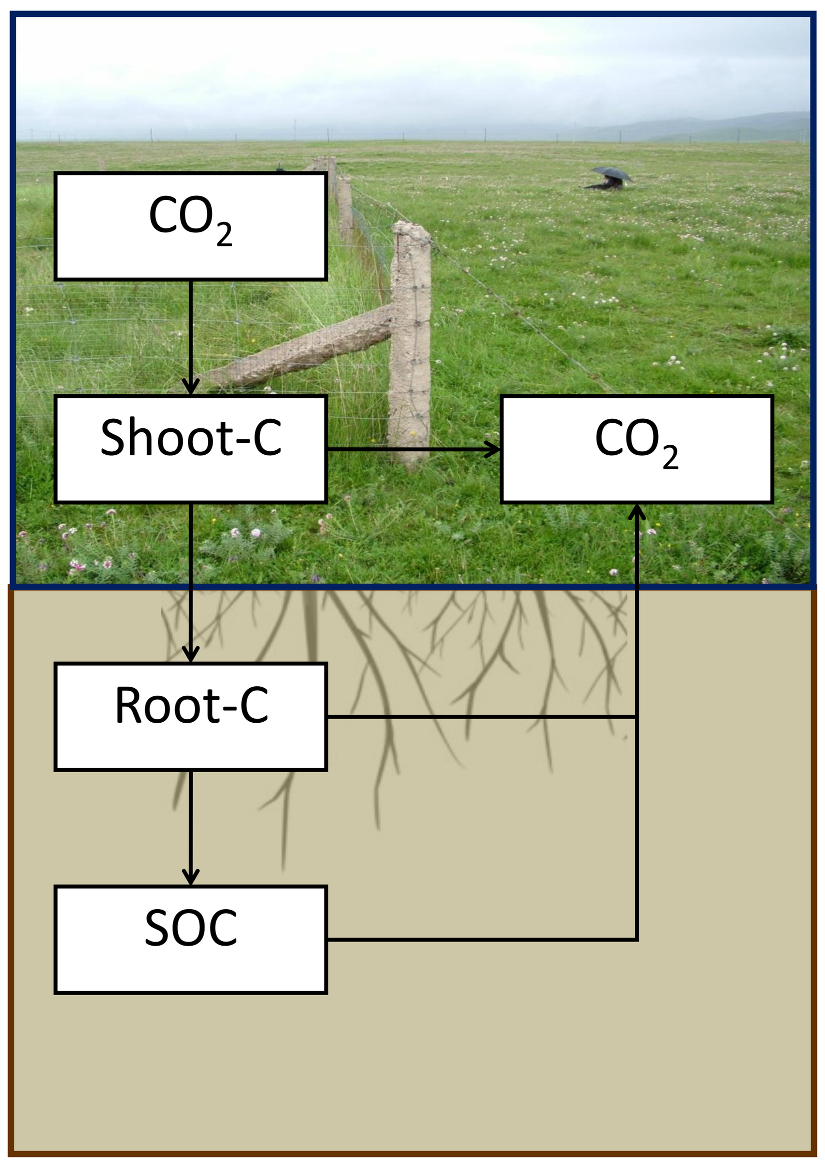
Results



* denotes significant differences at $p<0.05$ obtained by MWU test.

Fig 1: ^{13}C **losses by shoot respiration and** ^{13}C **allocation belowground**

- C losses by shoot respiration were lower but
- Belowground C allocation was higher at the grazed site:
  - C is needed as storage for regrowth after grazing
  - Increased C relocation to roots and rhizodeposition improves nutrient acquisition



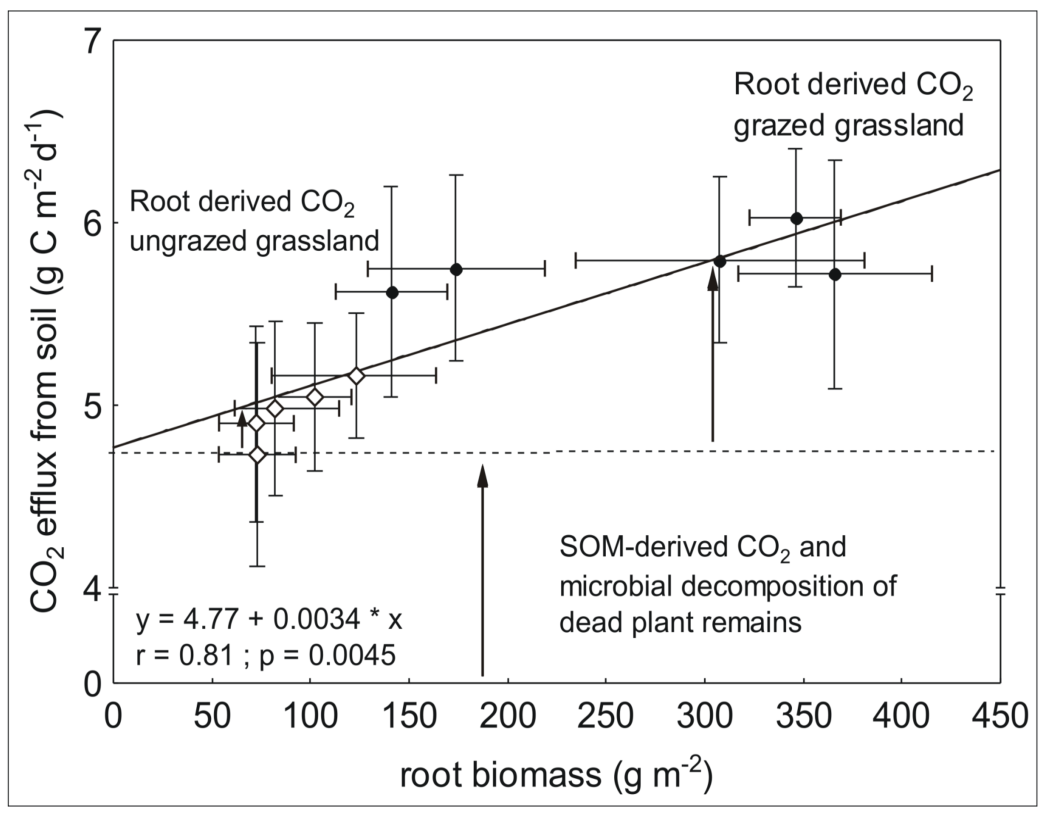


Fig 3: Portions of root- and SOM-derived CO_2 (n=5).

SOM-derived: 4.8 g CO_2-C $m^{-2}d^{-1}$

Root-derived: 0.9 g CO_2-C $m^{-2}d^{-1}$ (16% of total soil respiration)

0.3 g CO_2-C $m^{-2}d^{-1}$ (6% of total soil respiration)

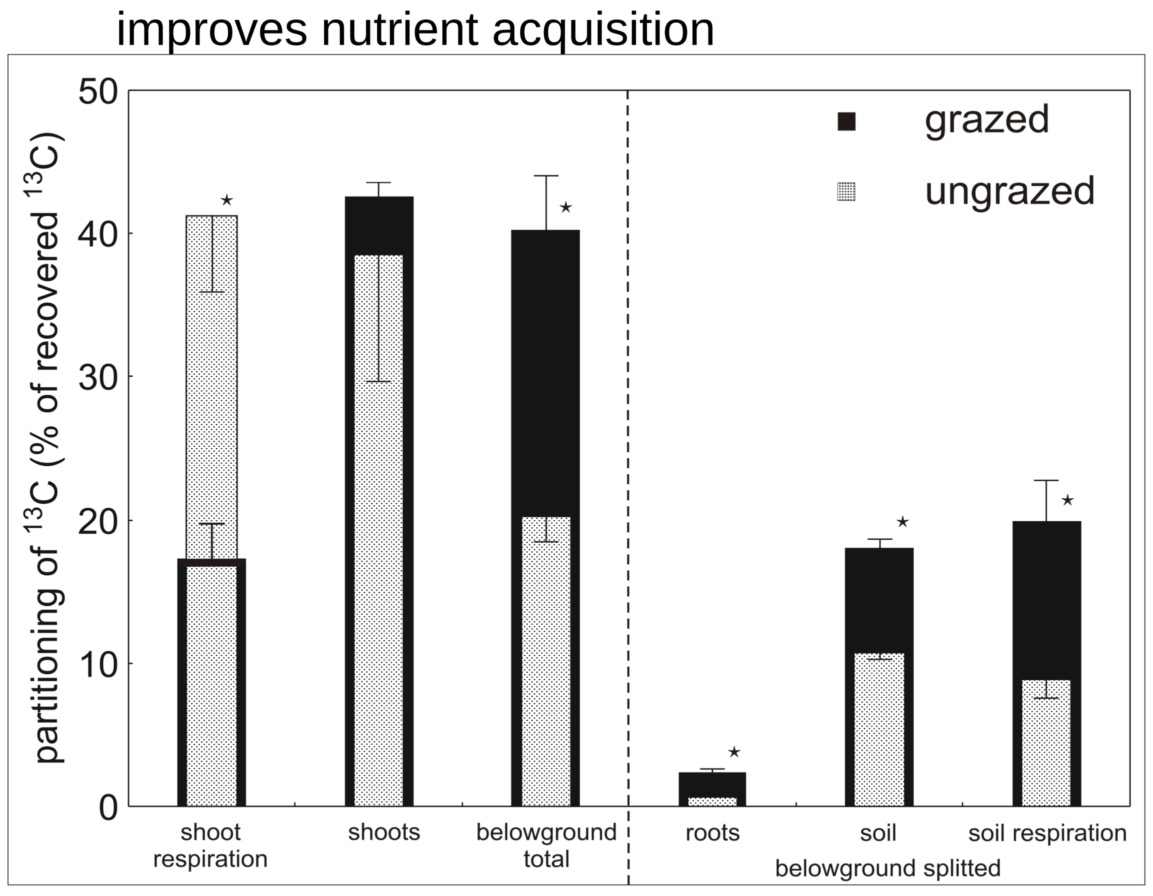


Fig.2: ^{13}C **partitioning 27 days after the assimilation.**

*denotes significant differences at $p<0.05$ (n=3) obtained by MWU test

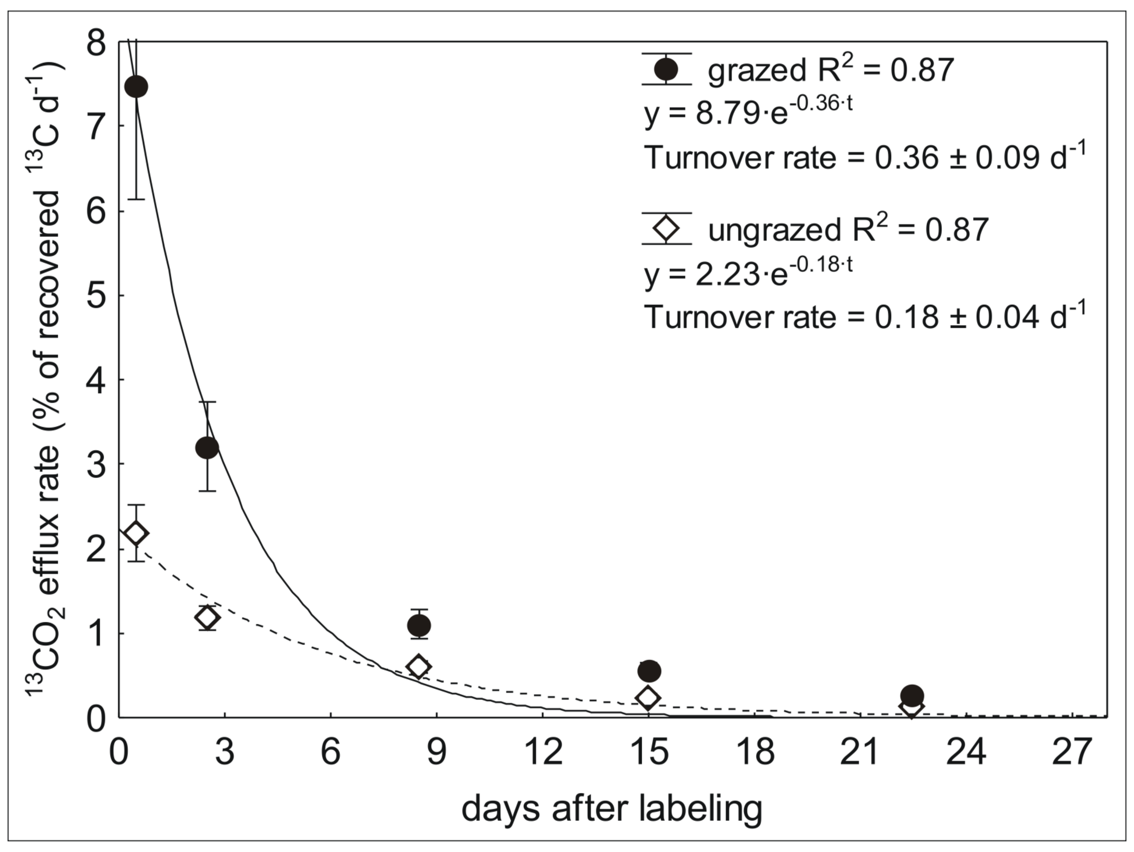


Fig 4: Turnover rate of C in rhizodeposits and root assimilates

- higher in the grazed case indicating that the contribution of assimilates to soil CO_2 efflux was higher.

→Verifying the higher amount of ^{13}C in CO_2 efflux from soil at the grazed site.

Table 1: Carbon stocks of the grazed and ungrazed grassland

Shoot		(Mg C ha^{-1})		Aboveground C stocks		
grazed		2.350 ± 0.152	**	grazed	2.350 ± 0.152	**
ungrazed		7.276 ± 0.054		ungrazed	7.276 ± 0.054	
Root				**Belowground C stocks (0-30cm)**		
grazed	0-5	1.013 ± 0.012	**	grazed	34.70 ± 1.33	**
	5-15	0.331 ± 0.003	**	ungrazed	28.36 ± 1.54	
	15-30	0.537 ± 0.008	**			
ungrazed	0-5	0.299 ± 0.003				
	5-15	0.149 ± 0.004				
	15-30	0.312 ± 0.021				
Soil						
grazed	0-5	26.09 ± 1.30	**			
	5-15	41.77 ± 1.70	**			
	15-30	33.83 ± 1.52				
ungrazed	0-5	20.50 ± 1.44				
	5-15	29.12 ± 3.56				
	15-30	34.48 ± 0.66				

** denotes highly significant differences at $p<0.01$ obtained by factorial ANOVA (n=15).

7 years of grazing exclosure resulted in:

- higher aboveground C stocks
- lower root C stocks
- an negative effect on C storage in the upper 15cm.

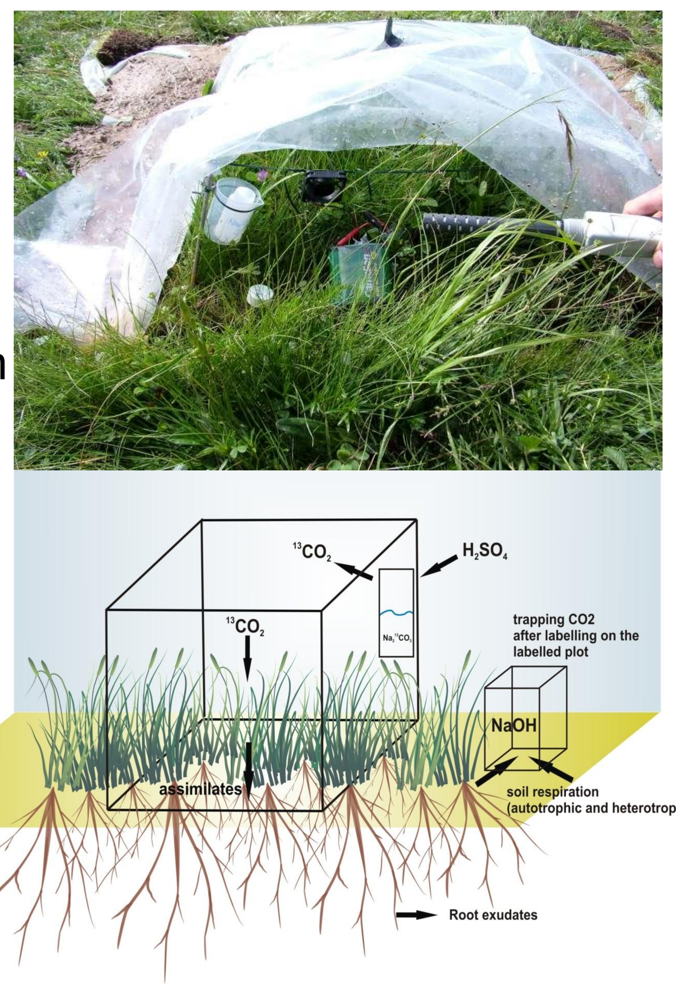
Material and Method

In situ $^{13}CO_2$ pulse labeling

Performed on July 27, 2009 in triplicates
Chase period: 27 days

Chamber:

- 50 cm 50 cm 10 cm
- Injection of H_2SO_4 into Na_2CO_3 (99% ^{13}C) solution
- Chamber was closed after labeling for 1 hour



Sampling:

Pools: shoot, root, soil, soil respiration
Time intervals: 1, 5, 12, 18, 27 days after labeling

Measurement:

Isotopic signature and total C
EA-IRMS in Bayreuth
Soil respiration: Alkali Absorption Method (AA)

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