International Grassland Congress Proceedings | XXII International Grassland Congress

Carbon Density Distribution and Carbon Storage Estimation under Different Grazing Degradation in the Typical Steppe

Sarula Wu
Institute of Grassland Research of CAAS, China

Xiangyang Hou
Institute of Grassland Research of CAAS, China

Yong Ding
Institute of Grassland Research of CAAS, China

Weibo Ren
Institute of Grassland Research of CAAS, China

The XXII International Grassland Congress (Revitalising Grasslands to Sustain Our Communities) took place in Sydney, Australia from September 15 through September 19, 2013.

Proceedings Editors: David L. Michalk, Geoffrey D. Millar, Warwick B. Badgery, and Kim M. Broadfoot

Publisher: New South Wales Department of Primary Industry, Kite St., Orange New South Wales, Australia

Carbon density distribution and carbon storage estimation under different grazing degradation in the typical steppe

Sarula Wu, Xiang-Yang Hou, Yong Ding and Wei-Bo Ren

Institute of Grassland Research of CAAS, Huhhot, Inner Mongolia, People's Republic of China
Contact email: houxy16@126.com

Keywords: Typical steppe, grazing degradation degree, carbon density, carbon storage estimation, plant-soil system.

Introduction

Carbon (C) is a crucial component of living organisms on planet earth, and C cycling is an important symbol of healthy development of the biosphere (Han *et al*. 1999). Human activity has adversely affected the global C cycle, and contributed to an alteration of climate that will generate discernible feedbacks to all organisms and ecosystems on earth (He *et al*. 2008). Grasslands are one of the most widely distributed terrestrial ecosystems on the earth and it is estimated that C storage of global grassland ecosystem was 761Gt (1Gt=10^9t), which accounts for about 15.2% C storage in terrestrial ecosystem (Scurlock *et al*. 2002). A typical steppe consisting of *Stipa grandis* and *Leymus chinensis* was the most representative grassland to research the response mechanism of an ecosystem to human disturbance and climate change. It is of great scientific value to do research about C distribution and storage in this area.

Methods

Field sampling

The research was conducted in 3 areas (see Fig. 1) with field data collected in August 2011, and the verification data being collected from random sites in the research areas in 2012.

Remote sensing data analysis

Using MODIS-NDVI data in August 2011 and the estimate model Y_{MODIS} = 368.273X+2.973 (R=0.908) that was established by Zhang *et al* (2008) to estimate the biomass. The biomass data was used to divide the grassland degradation degree in the research area. The specific standards for the divisions based on biomass were non-grazing (CK) (≥230g/m^2), light grazing (GL) (170-230 g/m^2), moderate grazing (GM) (100-170 g/m^2) and high grazing (GH) (≤100 g/m^2). The stimulation process is shown in Figure 2.

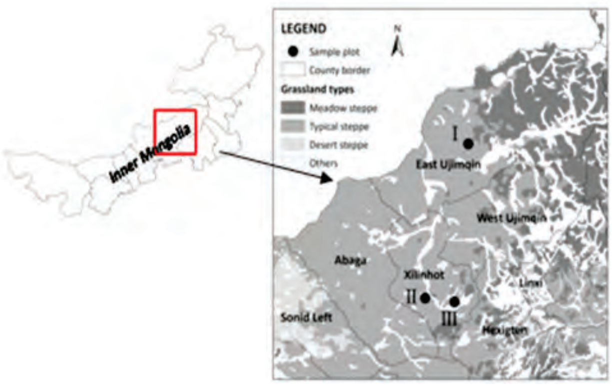

Figure 1. Map of research plots.

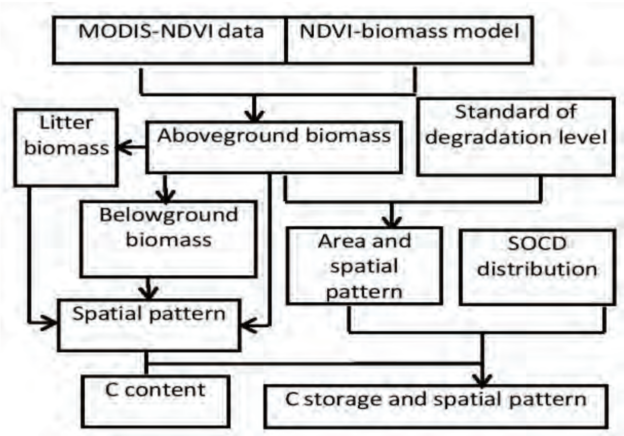

Figure 2. Technology roadmap of carbon storage estimation in plant-soil system.

Results

C content varied from 41.70% for GH to 43.47% for CK in aboveground biomass and varying from 39.54% for CK to 42.53% for GL in belowground biomass (Figure 3a). The C density of both above- and below-ground biomass was decreased by grazing (Fig. 3b). There was significant positive correlation (P<0.01) between above- and below- ground biomass.

The soil organic carbon store (SOCD) of different grazing degradation varied from 9.72 kg/m^2 to 14.84 kg/m^2 in 0-100 cm soil depth (Fig. 4). The result of two-way ANOVA showed that the SOCD varied remarkably among different grazing treatments (P<0.01) with no significant differences among the three different research areas. This indicates that the values among different research areas under the same grazing management were more similar than among the different grazing degradation in the same research area. Through the variance analysis we found the difference of measured data and simulation value have no statistical significance (P>0.05), which illustrated the regression models are reliable.

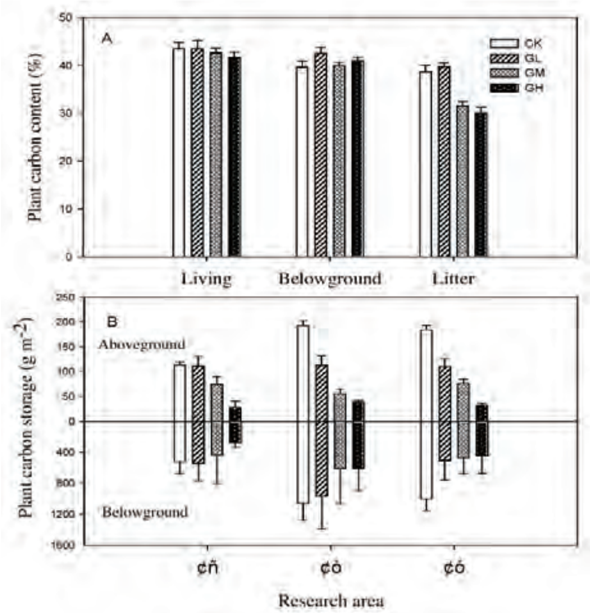

Figure 3. Changes in C content (A), C storage in above- and below- ground biomass (B) based on different grazing degradation degree in the three research areas. Data are represented as mean ±1 SEM. Ⅰ, Ⅱ and Ⅲ represent *Stipa grandis* grassland in Dongwu and *Leymus chinensis* grassland in Baiyinxile; underCK, GL, GM and GH

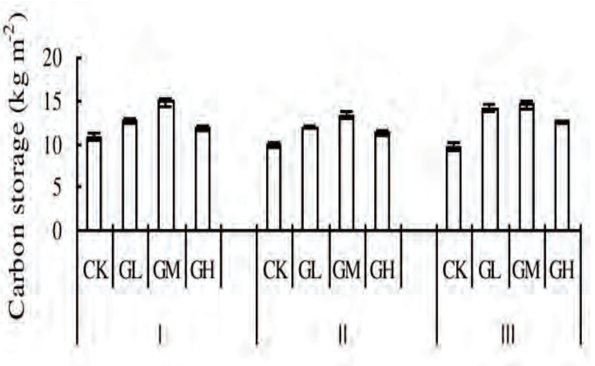

Figure 4. SOC density (0-100cm) of different grazing degradation degree among different research areas. Ⅰ, Ⅱ and Ⅲ represent Stipa grandis grassland in Dongwu and Leymus chinensis grassland in Baiyinxile; under CK, GL, GM and GH

Table 1. Carbon estimation of plant-soil system (1Tg=10^{12}g).

Index	CK	GL	GM	GH
Area (km^2)	839	12446	51970	42674
C storage in living biomass (Tg)	0.10	1.07	2.85	1.42
C storage in litter (Tg)	0.02	0.26	0.48	0.17
C storage in belowground biomass (Tg)	0.62	7.58	23.81	18.49
SOC storage (0～100cm) (Tg)	8.80	163.83	764.18	513.99
C storage of plant-soil system (Tg)	9.53	172.73	791.32	534.07

The estimate result was shown in Table 1. Most of the C was stored in the soil, accounting for 96.22% in plant-soil system.

Conclusion

The order of the grassland ecosystem C density under different grazing degradation degree was GM>GL>GH>CK, and grazing moderately benefited C storage. C density of above- and below- ground biomass was 27.54-156.98 g C/m^2 and 275.61-1053.09 g C/m^2, respectively; C storage of above- and below- ground biomass was 5.43Tg (1Tg=10^{12}g) and 50.50 Tg, respectively, in the Xilingol typical steppe. SOCD decreased with soil depth and there was 9.72-14.53 kg C/m^2 in the 0-100cm soil; SOC storage in the research area was 1.45Pg (1Pg=10^{15}g); C storage in plant-soil system was 1.51Pg, and 96% of it was stored in the soil.

References

Han Xing-Guo, Li Ling-Hao, Huang Jian-Hui. (1999). The fundamental of biogeochemistry. pp177-185 (Beijing: Higher Education Press)

He NP, Yu Q, Wu L, Wang YS, Han XG (2008) Carbon and nitrogen store and storage potential as affected by land–use in a *Leymus chinensis* grassland of northern China. *Soil Biology and Biochemistry* **40**, 2952-2959.

Scurlock JM, Olson RJ (2002). Estimating net primary productivity from grassland biomass dynamics measurements. *Global Change Biology* **8**,736-753.

Zhang LY, Zhang JX, Saiyinjiya, Bao HX, Shan JG, Guo ZZ (2008) Remote sensing monitoring model for grassland vegetation biomass monitoring in typical steppe – a case study from Xilinguole. *Pratacultural Science* **25**, 31-36.