

Seasonal dynamics of biomass and carbon dioxide fluxes in a Mongolian grassland

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I Introduction

Mongolia is in the center of the Asian continent which leads to extreme continental climate and very low precipitation, and primarily a mountain country, on average 1,580 m above sea level varying from 533 to 4,355 m. A woodland-rangeland-desert ecotone is formed along a steep gradient in the geographical and climatic conditions. Especially grassland ecosystems occupy 75% of this country (Fernandez-Gimenez and Allen-Diaz, 1999). An ecotone is generally regarded as a sensitive region for climate and vegetation change (Di Castri, 1988). In addition, overgrazing causes deterioration of ecosystems (desertification) in arid and semi-arid areas. It is necessary to understand the responses of water/carbon cycle processes in the Mongolian ecosystems to climatic change and human disturbance for their sustainable management. In the RAISE project, we will make an integrated ecological study on the impacts of grazing and climate on Mongolian grasslands. Here we report the results of biomass and carbon fluxes of a rangeland ecosystem during a growing season in 2003.

II Site description

The study site is a grassland in Kherlen Bayaan-Ulaan (47° 28' N, long. 108° 78' E, 1,250 m a.m.s.l.), 100 km east of Ulaanbaatar. The mean annual temperature is 1.4 °C and the mean annual precipitation 202 mm (1993-1998). Vegetation has been grazed by livestock all the year around. In the RAISE project, the grazing impacts on structure and function of the grassland ecosystem have been studied in a protected area (200 m × 170 m), which was enclosed by 1.5 m-high fence in autumn, 2002. Water and carbon fluxes, vegetation structure, and ecological processes have been determined inside and outside the protected area, ungrazing site and grazing site respectively, since spring in 2003.

Vegetation census showed that the study grassland was covered by *Stipa* and *Artemisia*-dominated steppe vegetation. And some C4 plants existed, e.g. *Cleistogenes squarrosa* and *Salsola collina*. *Salsola* species are strongly resistant to arid stress less than 100 mm of annual precipitation. The percentage of number of species of C4 to C4+C3 plants was 10%. But biomass of percentage of C4 to total biomass was 20%. According

to Pyankov *et al.* (2000), the north-eastern part of Mongolia includes about 30% of C4 plants. Therefore, our study site seems to be less in C4 proportion.

III Methods

Aboveground biomass was measured between June and September. As a result, aboveground biomass increased rapidly from June to July, it reached to the peak in August, and decreased from August to September. The decreased biomass in September was caused by death of C4 plants which contributed to more than 20% of biomass in August (Fig. 1). But there was no significant difference in aboveground biomass between the protected site and the grazed site.

NEP was measured by closed dynamic chamber method in July, August, and October. And soil respiration measured by closed chamber method in May, June to August, and November. As a result, the light response patterns of NEP were almost same in July and August, but maximum value of NEP decreased in October. Soil respiration in June was low as compared to those in July and August, and no correlation with soil temperature when soil was very dry and soil water content was about 4% (Fig. 1). There was exponential correlation at soil respiration with temperature in July, August, and October. Low soil respiration in November was due to low soil temperature. There was no significant difference

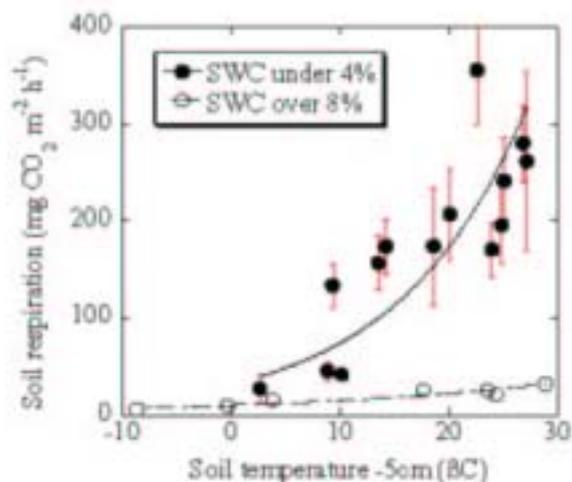


Fig. 1 Relationship between soil respiration and soil temperature.

in soil respiration between grazed and protected site.

In conclusion, aboveground biomass and CO₂ fluxes varied during a growth period in relation to temperature and soil moisture. In particular, Mongolian grasslands show CO₂ fluxes decrease despite of high temperature. This indicates that rainfall events control CO₂ fluxes in the dried grassland.

References

Di Castri, F. (1998): A new look at ecotones: emerging

international projects on landscape boundaries. *Biol. Inst. Sqec. Iss*, **17**.

Pyankov, V. I., Cunin, P. D., Tsoog, S. and Black, C. C. (2000): C4 plants in the vegetation of Mongolia: their natural occurrence and geographical distribution in relation to climate. *Oecologia*, **123**, 15-31.

Fernandez-Gimenez, M. E. and Allen-Diaz, B. (1999): Testing a non-equilibrium model of rangeland vegetation dynamics in Mongolia. *Journal of Applied Ecology*, **36**, 871-885.