Influence of grazing on surface heat balance, vegetation and carbon dioxide flux over the Mongolian grassland

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I Introduction

Mongolia in the earthen Eurasia locates in dry to semidry area and the grazing has carried out for more than 2000 years. Recently in Mongolia the social system changed radically, which has transformed lifestyle and the way of grazing. The serious influence of such a change is anticipated because Mongolian grassland is a sensible area to the changes of eternal conditions (Sugita, 2003).

Li *et al*. (2000) suggested the influence of grazing on heat balance, carbon dioxide flux, and grassland desertification through artificial three-year grazing experiments in Inner Mongolia. Kojima (2004) described the relation; the more grazing intensity was, the less the amount of vegetation was in Kherlen River basin, Mongolia.

The object of this study is to assess influence of grazing on ground surface heat balance, vegetation and carbon dioxide flux over the Mongolian grassland.

II Methods

The study site is a steppe grassland in Kherlen Bayaan-Ulaan (KBU, 47° 28' N, 108° 78' E, 1,200 m a.m.s.l.), and locates at some 100 km southeast of Ulaanbaatar. The mean annual temperature is 2 °C and the mean annual precipitation is 202 mm during 1993-1998. Grazing has been carried out all year round. In this area, a protected area (200 m by 170 m) was constructed in autumn of 2002 in order to study grazing impact.

Two flux stations by eddy correlation method, one in the protected area and the other in a grazed area, have been installed and have operated since March 2003. At the stations the data sets of heat balance and CO_2 flux (μmol m^{-2} s^{-1}). Net Ecosystem Production (NEP, mg CO_2 m^{-2} s^{-1}) was measured in July, August, October 2003 and July 2004 by Closed Dynamic Chamber method (CD method), and NEP also was calculated from CO_2 flux measured at stations. Aboveground biomass (g m^{-2}), vegetation height (m) and leaf area index (LAI) were measured between June and September 2003 and July 2004. The data set of grazing intensity was obtained data of the number of registered animal by State Statistical Office, Mongolia.

In this analysis, the data sets of June 2003 and June-July 2004 were used, because all data sets were available.

III Conclusion

1. The annual change of grazing intensity

Maxmum number of BOD (Mongolian livestock unit equal to one cow) per ha appears in 1998 or 1999 when the social system changed radically.

2. Relationship between vegetation and grazing

The biomass values of ungrazed site are 80.2 g m^{-2} in 2003, 109.1 g m^{-2} in 2004, and those of grazed are 51.6 g m^{-2} in 2003, 64.1 g m^{-2} in 2004. That is consistent with Kojima (2004); grazing activity appears to control biomass. The values of both sites in 2004 are higher than in 2003, which is because precipitation between April and June in 2004 was about twice of that in 2003.

3. Relationship between surface heat balance and grazing

Fig. 1 shows the comparison Soil heat flux (G, W m^{-2}) between grazed and ungrazed site. G values of ungrazed site are about half of those of grazed. But there is no significant difference in net radiation (R_n, W m^{-2}) values between grazed and ungrazed site. And turbulent flux (W m^{-2}) values of ungrazed site are higher than those of grazed. This is probably because the less quantity of vegetation and trampling by grazing result in less ability to store up heat in soil.

4. Relationship between carbon dioxide flux and grazing

One of NEP values was calculated from CO_2 flux measured at flux stations and regressed by following equation.

$$NEP = NEP_{MAX} \times (1 - \exp(-a \times PPFD / NEP_{MAX})) - b \quad (1)$$

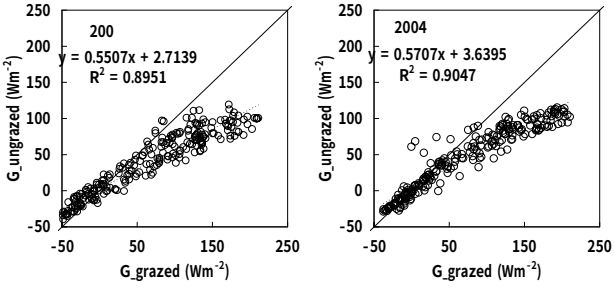

Fig. 1 The comparison *G* between grazed and ungrazed site in 2004 (right) and 2003 (left).

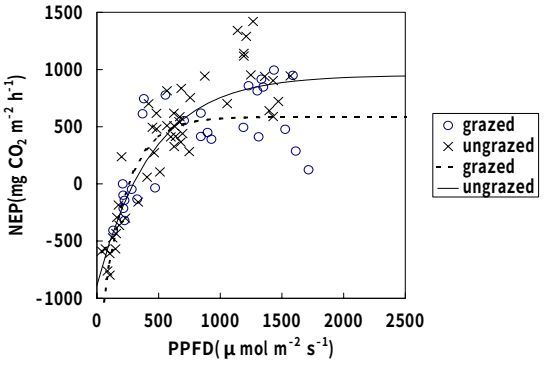

Fig. 2 NEP calculated from CO_2 flux measured CD method. A solid and broken line are regression line (eq. (1)).

where *a* is initial slope, *b* the rate of respiration, *PPFD* photosynthetic photon flux densities. There is no significant difference in the NEP values of June between grazed and ungrazed site, and those of July in 2003.

The other NEP values were calculated from CO_2 flux measured by the CD method. The NEP values of ungrazed site in July 2004 are higher than those of in 2003. And the NEP values of July 2004 at grazed site are lower than those at ungrazed site.

There appears a strong relationship between NEP and biomass, which gives the relation between NEP and grazing intensity.

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