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

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Introduction

Mongolia in the earthen Eurasia locates dry to semi- dry area and the grazing has carried on for more than 2000 years. Recently years Mongolia the social system changed radically, which transforms 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.

Methods

(1) Site description

The study site is a steppe grassland in Kherlen Bayaan-Ulaan (KBU, 47° 28'N, 108° 78'E, 1200 m above mean sea level), and locates 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 on all the year round. In this area, a protected area (200 m by 170 m) was constructed in autumn 2002 in order to study grazing impact.

(2) Measurement

Two flux stations by eddy correlation method, one in a protected area and the other in a grazed area, are installed and have operated since March 2003. At the stations the data sets of heat balance and CO2 flux (μmol m-2 s-1). Net Ecosystem Production (NEP, mgCO2 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 CO2 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.

(3) The analysis of surface heat balance

To compare the components of heat balance in two stations, sensible heat flux (H, W m-2), latent heat flux (lE, W m-2), soil heat flux (G, W m-2) and net radiation (Rn, W m-2), the regression coefficient c and e in a linear equation are evaluated (Fungrazed = c Fgrazed + e, F; the components of heat balance). And the seasonal change of c and e values is studied. In this analysis, the data sets of April through October in 2003 and 2004 were used.

Results

(1) The grazing intensity

Fugure 1 and 2 show grazing intensity, BOD (Mongolian livestock unit equal to one cow) per ha. The difference of the grazing intensity between of KBU and of the other area in Mongolia is not significant (Figure 1), but the grazing intensity of KBU in winter is much larger (Figure 2), because animals come from outside of KBU in winter.

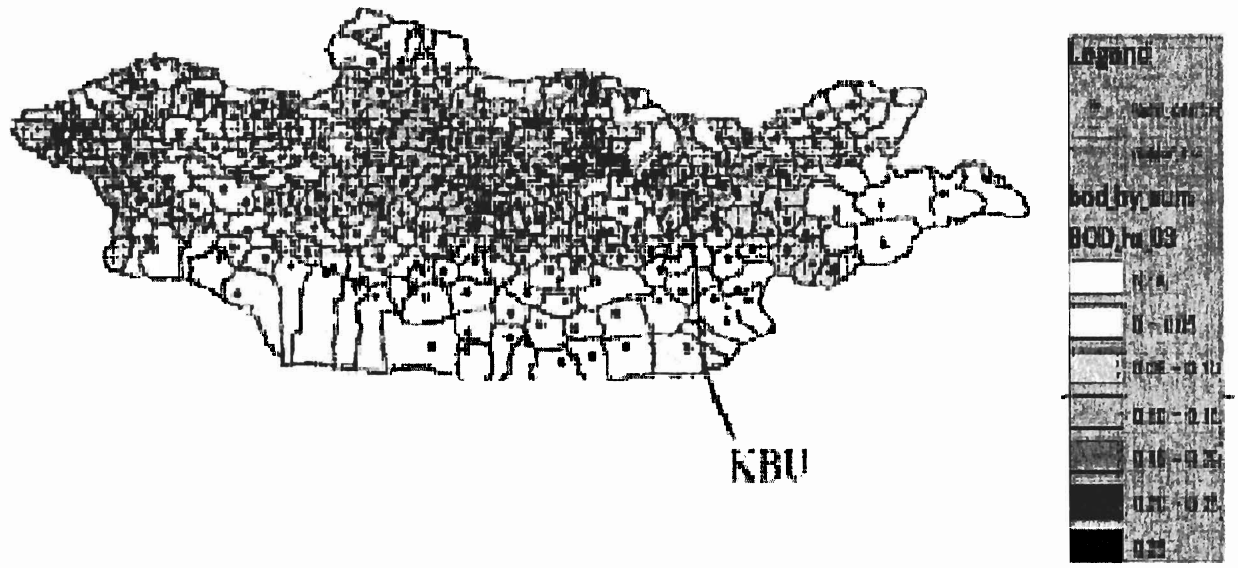

Figure 1. Grazing intensity in 2003. The unit is BOD, Mongolian livestock unit equal to **one cow or horse.**

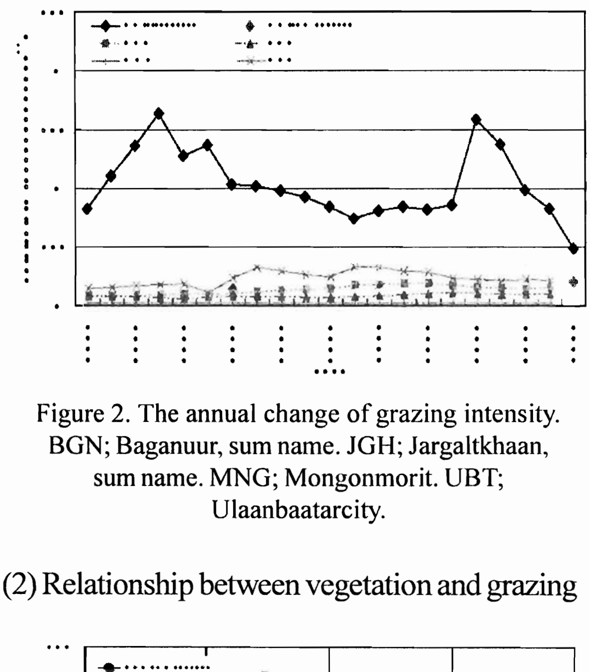

Figure 2. The annual change of grazing intensity. BGN; Baganuur, sum name. JGH; Jargaltkhaan, sum name. MNG; Mongonmorit. UBT; Ulaanbaatarcity.

(2) Relationship between vegetation and grazing

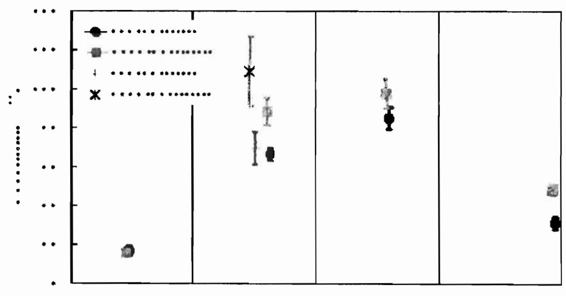

Figure 3. The seasonal change of Biomass. Mon:h

Figure 3 shows that the difference of the biomass values of two sites appears significantly after July and that grazing activity appears to control biomass. The values of both sites in 2004 are higher than in 2003 because precipitation between April and June in 2004 was about twice of that in 2003.

(3) Relationship between surface heat balance and grazing

Figure 4 and 5 show the seasonal change of regression coefficient *c* and *e* values, respectively, calculated by the components of heat balance in two stations. In summer (July and August) *c* values of the turbulent flux (*H* and *lE*) values are larger than 1.0, and therefore the turbulent flux values of ungrazed site are higher than those of grazed, which corresponds with result of biomass. But there is no significant change in *Rn*, and *G* values between grazed and ungrazed site. The values might be unrepresentative because they are measured at only one point. The measurements at more points around two stations are needed.

(4) relationship between carbon dioxide flux and grazing

One of NEP values was calculated from CO2 flux measured at flux stations and regressed by following equation.

$$NEP = NEPMAX \times (1-\exp(-a \times PPFD / NEPMAX)) - b \quad (1)$$

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 appears. Such a trend appears the biomass values of June

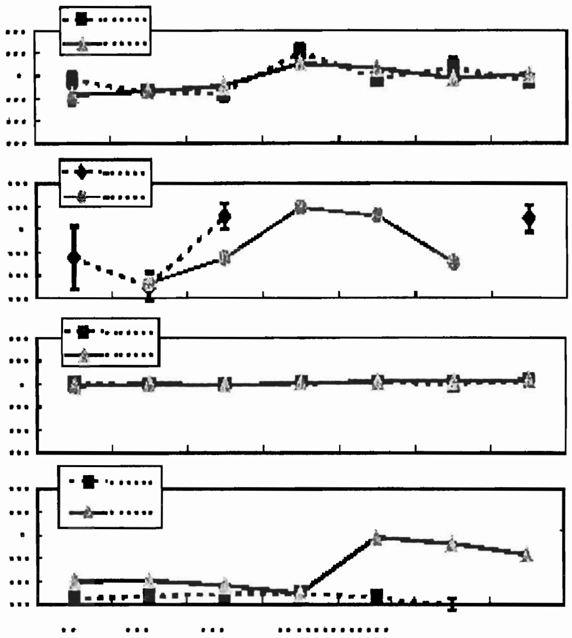

Figure 4. The seasonal change of regression coefficient *c* values (*F*ungrazed = *c F*grazed + *e*, *F*; the components of heat balance) calculated by the components of heat balance in two stations.

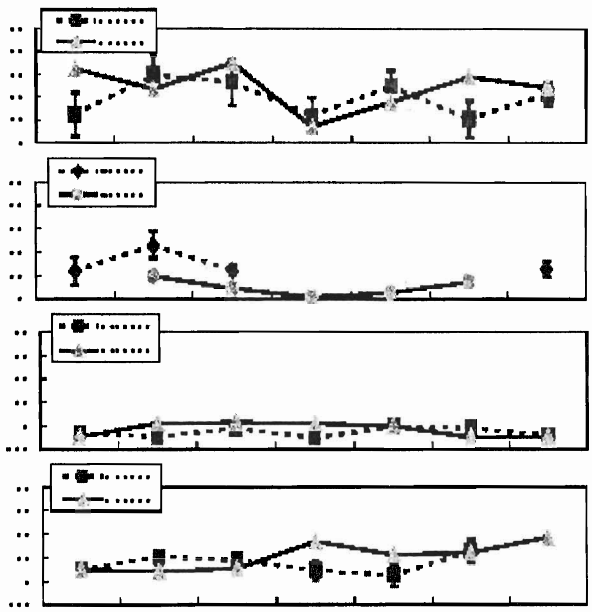

Figure 5. The seasonal change of regression coefficient *e* values (*F*ungrazed = *c F*grazed + *e*, *F*; the components of heat balance).

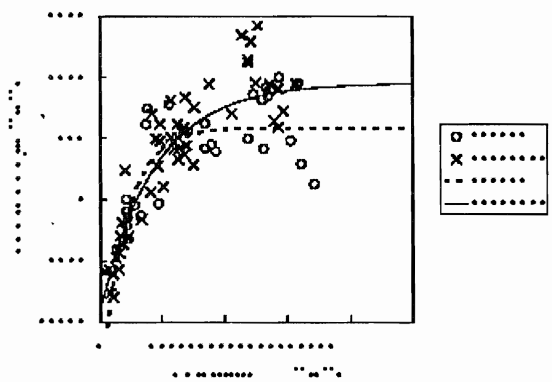

Figure 5. NEP calculated from CO2 flux measured CD method. A solid and broken line are regression line [equation (1)].

The other NEP values were calculated from CO2 flux measured by 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.

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

Reference

Kojima, T. (2004): The investigation on the factors which govern evapotranspiration of Kherlen river basin in Mongolia. MSc Thesis, University of Tsukba, p85.

The society for the study of species biology (2003): Introduction to plant physiological ecology. *Bun-ichi sogo shuppan Co.*, p319.

Sugita, M. (2003): Interactions of water cycle processes and ecology. *Science Journal, KAGAKU*, 15, 559-562.

S-, G-, Li., Harazono, Y., Oikawa, T., Ha, L, Z., Z-, Y-, He. And Xue, L, C. (2000): Grassland desertification by grazing and the resulting micrometeoroligocal changes in Inner Mongolia. *Agricultural and Forest Meteorology*. 102, 125-137.