Grassland monitoring system for sustainable utilisation in Inner Mongolia, China. 2. Real-time monitoring of grass and animal interaction using satellite data and GPS

K. Kawamura[1], T. Akiyama[1], H. Yokota[2], M. Inoue[2], T. Yasuda[3], O. Watanabe[4] and Y. Wang[5]
[1]River Basin Research Center, Gifu University, 1-1 Yanagido, Gifu 501-1193, Japan. E-mail: kawamura@green.gifu-u.ac.jp, [2]Graduate School of Bioagricultural Sciences, Nagoya University, Japan, [3]Division of Natural Sciences, Yamanashi Institute of Environmental Sciences, Japan, [4]Laboratory of Levee Vegetation Management, National Agricultural Research Center for Western Regions, Japan, [5]Chinese Academy of Sciences, China

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Introduction Overgrazing is one of the primary causes of desertification in Inner Mongolia grassland. A previous paper estimated herbage quantity and quality (Kawamura *et al*., 2005), and quantified the grazing intensity on grass biomass using Terra MODIS satellite, Global Positioning Systems (GPS) and GIS (Kawamura *et al*., 2003). The aim of this study is real-time monitoring of both grass biomass and animal behaviour to evaluate the effect of grazing intensity (GI) on grass growth rate during the growing season using Terra MODIS satellite and GPS.

Materials and methods Seasonal changes of grass biomass were estimated in grassland near the Xilin river (12 km^2) using time series of Terra MODIS imageries. Sixteen-day MODIS/EVI composite data (MOD13GQK), from the EROS Data Center, USA, for 6 April to 11 August 2004, was used in this study. The biomass measurements were carried out on 18-19 May and 8-10 July 2004 at the same ten sites. The experimental farm, with total area of 5 km^2, was selected for measuring the spatial distribution of sheep. Here, 720 sheep (360 female, 60 castrated and 300 under 1-year-old) were grazing during June to September. Five sheep were fitted with GPS (four with handy type GPS (Sony HGR3S) and one with GPS collar (Televilt, Posrec Collar 600UD)). To quantify grazing intensity, the grazing distribution map for the flock of sheep was created using a grid cell method from the tracking data recorded by GPS. Grazing intensity in each cell was calculated by the numbers of sheep visits from 1 June 1 to 19 July, 2004.

Results There was a significant relationship between green biomass (GBM) and MODIS/EVI (GBM = 675.836 EVI - 52.414, $R^2 = 0.769$, $P<0.01$). This equation was used to make the distribution map of GBM between early April and early August. The spatial distribution of the flock of sheep between June 1 and July 19 is shown in Figure 1. Grass growth rate between late April and late July ($\Delta G = (GBM_{July\ 26} - GBM_{April\ 22}) / 180$ days) decreased with increasing grazing intensity (Figure 2).

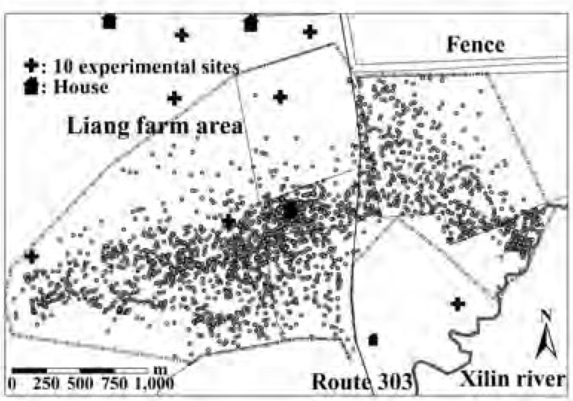

Figure 1 Spatial distribution of herd of sheep from June 1 to July 19

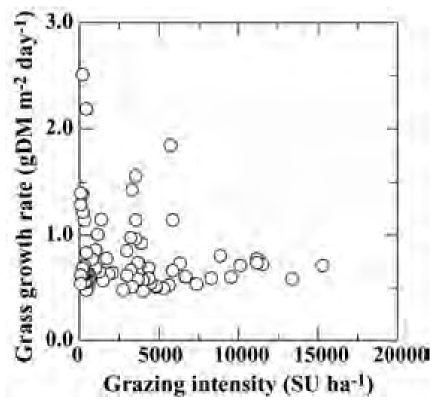

Figure 2 Relationship between GI and grass growth rate between June 1 and July 19

Conclusions GBM and grazing behaviour were monitored with integrating field experiment, satellite remote sensing, GPS and GIS tools. Grass growth rate and GBM were affected by grazing intensity. These results suggested that grazing intensity could be used as a primary parameter when estimating grass production with climate factors.

References

Kawamura, K., T. Akiyama, H. Yokota, M. Tsutsumi, O. Watanabe & S. Wang (2003). Quantification of grazing intensities on plant biomass in Xilingol steppe, China using Terra MODIS image. *International Workshop organized by Working Group VII/6 ISPRS*. 21 October 2003, Kyoto, Japan.

Kawamura, K., T. Akiyama, H. Yokota, M. Tsutsumi, T. Yasuda, O. Watanabe & S. Wang (2005). Comparing MODIS vegetation indices (VIs) with AVHRR NDVI for monitoring the forage quantity and quality in Inner Mongolia grassland, China, *Grassland Science,* (In press).