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Grazing Behavior of Livestock in Settled and Nomadic Herders Households in Mongolian Plateau

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Abstract: In this study, we investigated the effects of settled grazing in Inner Mongolia and traditional nomadic grazing in Mongolia on grazing behavior of livestock using GPS satellite tracking. In summer of 2011 and 2012, we fitted GPS loggers to sheep and goats to quantify the behavior of livestock in Inner Mongolia and in Mongolia. We discovered that the mean grazing velocity (km/h) of sheep in Inner Mongolia was 0.65 ± 0.07 (km/h) and in Mongolia was 0.54 ± 0.30 (km/h). The result indicated a higher grazing velocity and longer moving distance of sheep in Inner Mongolia than that in Mongolia. However, the grazing area of the sheep in Inner Mongolia was smaller than that in Mongolia. The grazing area in Inner Mongolia was 214.88 ± 149.73 (ha/day) and 246.03 ± 197.36 (ha/day) in Mongolia. This may be a result of limited area due to the presence of fences in Inner Mongolia. We also calculated vegetation volume (height (cm) × coverage (%)) of each plant species. The vegetation survey showed that the mean volume of palatable species in Inner Mongolia was 87.5 ± 174.9 and 106.1 ± 202.6 in Mongolia. Therefore livestock have to spend more time grazing, increasing their step rate and moving longer distances. These results indicate that fencing associated with the settlement system of Inner Mongolia has created a new hot spot of land degradation and a new source of Asian dust storm outbreaks.

Key Words: Grazing velocity, Inner Mongolia, Mongolia, Sheep

1. Introduction

The Mongolian plateau is one of the largest remaining grassland ecosystems in the world and has provided stable feed resources for livestock for a long time. In recent times, however, rapid land degradation and desertification have disturbed pasture areas of the Mongolian plateau, resulting from various factors, such as climatic variation and human impacts. The herders in Mongolian plateau have lived a nomadic lifestyle. They live in gers (tent-type movable house) and move seasonally with their livestock herds. This lifestyle continues in Mongolia. However, in Inner Mongolia, the land sharing was carried out according to the establishment of People’s Commune in 1958. From 1978, the livestock and land have been distributed from People’s Commune to each family by the introduction of Household-responsibility system. These policy changes resulted in the end of thousands of years of nomadic life and the introduction of new methods for the management of pastures through the construction of and use of fences.

This has led to the settlement of nomads throughout Inner Mongolia. The emergence of fences has restricted movement of nomadic people and livestock and has forced them to graze the same pastures year around. This has led to heavy tread intensity and heavy grazing intensity around the settled house. With the increasing number of livestock, the crowded pastures are quickly overgrazed and degraded in these fenced areas. In recent years, the human impact, including fences and overgrazing, is the main reason for acceleration of natural processes associated with land degradation and desertification in settlements of Inner Mongolia (Hoshino *et al*., 2009). As result, the fencing in settlements of Inner Mongolia was a new hot spot of land degradation and also a new source of Asian dust storm outbreak. A large amount of dust is blown across the sea into Japan, and further across the Pacific Ocean. Such dust movement is having a negative impact across the globe.

The purpose of this research is to observe the effects of settled grazing in Inner Mongolia, as compared to traditional nomadic grazing in Mongolia, on grazing behavior of livestock using GPS satellite tracking.

2. Materials and Methods

2.1. Study area

The study area was located in Abag banner, Xilingol steppe, Inner Mongolia, China. The latitude was 43°04’-45°26’N and the longitude was 113°27’-116°11’E. The mean annual temperature is approximately 3°C and annual precipitation approximately 230 mm, (increasing from northwest to

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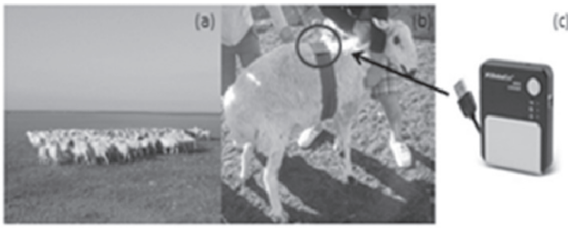

Fig. 1. Fixing the GPS data logger onto the sheep using a hand-made belt (a) sheep group; (b) picture of sheep fitted with GPS data logger; (c) GPS instrument.

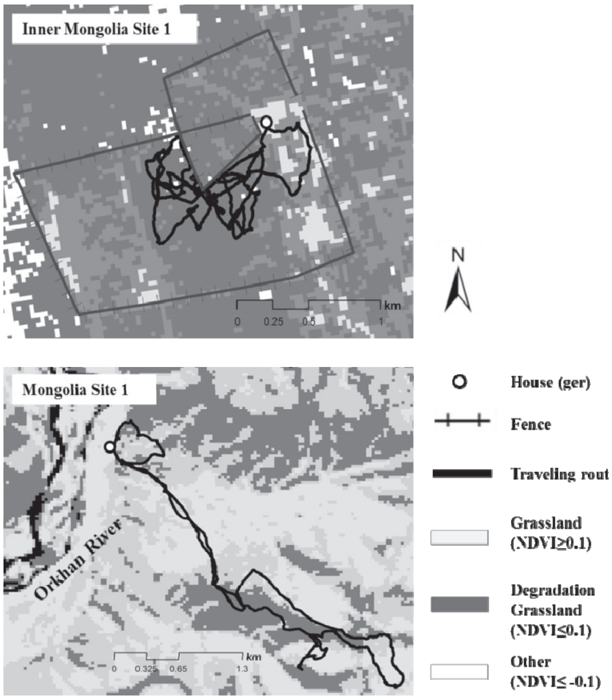

Fig. 2. Traveling routs of sheep on Landsat NDVI (a) Traveling routs of sheep in Site1 of Inner Mongolia, 2011; (b) Traveling routs of sheep in Site1 of Mongolia, 2011.

southeast). We selected two sites in Mongolia. One was located in Kharkhorin, N46.87°, E102.21°. The mean annual temperature is approximately -0.25°C and annual precipitation was approximately 250 mm. The other site was located in Choir N46.36°, E108.36°. The mean annual temperature is approximately 1.87°C and annual precipitation is approximately 150 mm.

2.2. Methods

Sheep from each of the groups were fitted with GPS loggers using hand-made belts, in summer of 2011 and 2012 (**Fig. 1**). Information regarding the livestock positioning was collected every 10 seconds and location signal was stored during grazing. In the evening after grazing, the data including 1) date 2) time 3) travel distance 4) speed 5) location (latitude/longitude), were downloaded to a computer.

Data recorded on velocity to the GPS logger were used to calculate the grazing velocity (km/h) of sheep. The 82% value of the histogram of velocity data of GPS signal point acquired served as the threshold value. The average rate of speed up to this threshold velocity is considered as grazing velocity (km/h) (Mitsumura, 1988). The grazing area by law was determined from the outermost point of the livestock traveling using Hawth's Analysis Tools (Saeki, 2006).

According to the grazing route of sheep, we set 1 m × 1 m quadrants along a transect from the house with the distance of 100 m, 200 m and 400 m, and recorded the vegetation coverage, height, species and soil moisture.

The satellite data were supplied by Landsat TM images taken in August 09, 2011 for Inner Mongolia and July 16, 2011 for Mongolia, and used to calculate NDVI (normalized difference vegetation index) by ENVI (ITT) software for processing and analyzing geospatial imagery. The NDVI maps were used to do the unsupervised classification (Cluster Analysis) by MultiSpec.

3. Results and Discussion

3.1. Daily traveling of sheep

The daily tracking of sheep groups in Inner Mongolia and Mongolia are shown in **Figure 2**. The movement of livestock is a function of seeking water and grass. While in Mongolia the livestock have no fences to restrict them and can move freely in search of more lush and palatable plants from ger to even the most distant places. This is not the case in Inner Mongolia. Lush, green grass inside fences attracted sheep as they grazed inside and along the fence. However, the presence of fences restricted the further movement of sheep outside the fenced area. In other words, the pasture is enclosed by fencing and sheep cannot move out, thus limiting them to grazing the same pasture during the entire grazing period. Existence of fences has restricted livestock movement and contributed to quick overgrazing and the acceleration of land degradation.

The result of the unsupervised classification also showed the same trend. We compared the same size area abounding the house (ger) both in Inner Mongolia and Mongolia. It was very clear that heavy degradation was occurring around the house in the settlement of Inner Mongolia caused by overusing (Fig. 2).

3.2. Grazing velocity (km/h) of sheep in Inner Mongolia and Mongolia

The grazing velocity and grazing area of livestock in Inner Mongolia and Mongolia are shown in **Table 1**. The mean grazing velocity (km/h) of sheep in Inner Mongolia was 0.65 ± 0.07 (km/h) and in Mongolia was 0.54 ± 0.30 (km/h). In

Table 1. Grazing velocity and grazing area of livestock in Inner Mongolia and Mongolia.

	Mean grazing velocity(km/h)	Mean grazing area(ha)
Inner Mongolia Site1	0.61±0.30	286.65±231.30
Inner Mongolia Site2	0.73±0.20	121.48±56.70
Inner Mongolia Site3	0.60±0.20	236.52±61.90
Inner Mongolia Mean	0.65±0.07	214.88±149.73
Mongolia Site1	0.37±0.40	145.70±127.00
Mongolia Site2	0.96±0.10	261.90±34.00
Mongolia Site3	0.52±0.40	129.90±102.00
Mongolia Site4	0.17±0.10	141.50±1.70
Mongolia Site5	0.69±0.30	549.80±164.00
Mongolia Mean	0.54±0.30	246.03±197.36

past studies livestock showed higher grazing velocity in the heavily grazed area (Hepworth *et al*., 1991; Lazo and Soriguer, 1993; Orr *et al*., 2004). This is because of the reduced quantity of the preferred species in the heavily grazed area. Within the heavily grazed area, animals spent more of their grazing time searching for edible green leaves among the unpalatable plants, which effectively increased step rate.

The grazing area in Inner Mongolia was 214.88 ± 149.73 (ha/day) and 246.03 ± 197.36 (ha/day) in Mongolia. This may result from the limited area because of the fences in Inner Mongolia.

3.3. Vegetation survey

Volume (height (cm) × coverage (%)) of all plant species was higher in Inner Mongolia compared with Mongolia. But the mean volume of palatable species in Inner Mongolia was 87.5 ± 174.9 and 106.1 ± 202.6 in Mongolia. This agreed with the past studies with the heavily grazed area showing lower percentage cover of grass and palatable plants (*e.g. S. grandis*) and higher cover of forbs and rhizomatous plant species than the lightly grazed area (Yoshihara *et al*., 2009).

4. Conclusion

Our results suggest that there were differences between settled grazing in Inner Mongolia and traditional nomadic grazing in Mongolia regarding grazing behavior. The decline of quantity of preferred species in Inner Mongolia required high searching efforts by sheep to select acceptable plants. Additionally, the grazing behavior of sheep was also affected by the presence of fences. This contributed to crowded pastures that are quickly overgrazed. Finally, the use of these fences in settlements of Inner Mongolia is contributing to the development of a new hot spot of land degradation.

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