INFLUENCE OF HUMAN ACTIVITIES AND LIVESTCK ON INNER MONGOLIA GLASSLAND

Ayumi FUKUO*, Genya SAITO*, Tsuyoshi AKIYAMA**, Zuozhong CHEN***

*National Institute for Agro-Environmental Sciences
3-1-3 Kannondai Tsukuba Ibaraki, 305-8604 JAPAN
Tel:+81-298-38-8221, Fax:+81-298-38-8199,
E-mail:fukuo@niaes.affrc.go.jp
**Institute for Basin Ecosystem Studies, Gifu University
1-1 Yanagido Gifu, 501-1193 JAPAN
***Institute of Botany, Chinese Academy of Sciences
No.20 Nanxincun Xiangshan Road Beijing, 100093 CHINA

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ABSTRACT: At Inner Mongolia, livestock grazing in grassland has the history of a few thousand years. The livestock number of grazing is increasing rapidly in this area, because the demands for wool and meat are larger and larger along with the increase of income and population in China. As the result of increasing the livestock number, the over-grazing is being continued, and land degradation is being extended in the grassland. Land degradation process is related with biomass declining and botanical composition change. Our purpose of this study develops effective spectral index which can detect grass biomass and botanical composition. Our experimental site is covering 10 km by 10 km, which is located north-west of Dali Nol lake. The center of the site was named as Sulean Village in Baiyinrinko Farm, and there is a water supplying facility for livestock in the village. Number of livestock in this area is increasing in recent years. Satellite image analysis and ground observations were carried out including vegetation and soil survey, and spectro-radiometric measurements of steppe vegetation using a portable radiometer. We investigates the influence of the grassland by livestock and human activities using satellite image analysis and field survey. We get some results about present condition of grassland and clarified the mechanism of land degradation process.

1. INRTODUCTION

In Inner Mongolia, the people who are named nomads grazed livestock for many centuries. The grazing number of livestock has increased across all rural areas, because the demands for wool and meat production have risen along with the increase in human population in recent years. As a result of increasing the livestock number, the condition of the over-grazing continues in the grassland and desertification extends (Fig. 1, Fig. 2). One of largest desertification has being carried out at the grassland degeneration.

China is one of the countries facing most serious desertification problem in the world. The preliminary assessment of desertification in 1997 shows that the total area of the affected land is approximately 2.62 million sq. km, covering 27.3% of total territory of China.

2. POURPOSE

Overgrazing beyond carrying capacity may cause land degradation. Earth observation satellite has been described such process of vegetation change since 1970's. It is urgent problem to find effective methods for sustainable livestock utilization in harmony with steppe conservation in Inner Mongolia.

We have started a joint research between Institute of Botany, Chinese Academy of Sciences since 1997 to find coexistent method for sustainable livestock utilization in harmony with effective steppe conservation in Xilin gol, Inner Mongolia. In this study, satellite image analysis accompanied with ground experiments were carried out including vegetation and soil survey, and spectro-radiometric measurements of steppe vegetation using portable radiometer.

3. MATEREAL AND METHODS

3.1 Study area

The experiment is focused on a small village to find land degradation process through detailed ground experiments including spectral measurement, soil survey and vegetation survey. The experimental site is covering 10 km by 10 km of area, which is located west of Dali Nol lake (Fig. 3, Fig. 4). The center of the experimental site is named as Sulean Village in Baiyinrinko Farm, and here is a water supplying facility. The location of this point is 43°23'55 ?N and 116°28'11 E?. The number of farm houses is about 20 in this village.

3.2 Weather

The annual precipitation is about 280-500mm. A change in the annual precipitation of each year are very large. About 80% of the precipitation gets from May to September, the period of high temperature, and helps a plant with the growth (Fig. 5). The annual average temperature -1.2 - 2.1 degrees centigrade. The highest temperature of average month is 18.7 degrees of July and the lowest of that is -21.4 degrees of January. The annual sunlight hours are 2600 hours. A frost-less period is 80 - 100 days in a year. The area is the strict climate condition of the continent and there is large gap in each year.

2.3 Field Survey

In the experimental site, we selected 21 survey point from the village center to four directions (Table 1). We investigated the point every 1km away from the center of a village in the four directions.

Soil survey, vegetation survey and spectral measurements were carried out at the typical point of the each location. After deciding the survey point (point C), then north (N), south (S), east (E) and west (W) points are decided automatically 10m intervals. Design of each survey is summarized in Figure 6.

(1) Vegetation survey

Vegetation survey was done by a quadrat method and a line-setting method. Total coverage, canopy height, botanical composition and biomass were measured at C, N and E points using 1m x 1m quadrat. Species frequency was examined by two 20-m lines (N-S and E-W directions) with 0.5m intervals. After the vegetation survey, aboveground parts and surface litter were cut and collected separately. The plant materials of sampling were oven dried at 80 degrees for 48 hours before weighing.

(2) Soil survey

Soil hardness (Push-cone type Soil Hardness Meter by Daiki Rika Kogyo Co.,LTD) and surface soil moisture content (oven dry method) were measured in 1998 and 1999. In addition, pH (UC-23 pH Meter by Central Kagaku

Corp.) and soil color (SPAD-503 type Soil Color Reader by Minolta Co.,LTD) and three phases rate (DIK-1121 type Three Phases Meter by Daiki Rika Kogyo Co.,LTD) were measured in 1999. These soil samples were collected at C, N, E points with 3 to 5 replications.

(3) Spectral reflectance measurement

Spectral reflectance of vegetation and soil were measured using a portable spectro-radiometer (PREDE Co.,LTD). It measures 6 wavelengths including four visible bands (450, 545, 650 and 699nm), and two near infrared bands (750 and 850nm). Spectral measurements are carried out under clear sky between 9 am to 3 pm at Chinese Standard Time with 3 to 7 replications at each 9 sample points. It was carried out always coupled with vegetation survey and soil survey. After the spectral reflectance measurement, inside 1m x 1m of quadrat at same point was sampled as mentioned vegetation survey, and reflectance of bare soil after sampling was also measured.

3.4 Satellite data analysis

Landsat/TM image in summer is used. Date of data acquisition is Sep. 15, 1998 and Jul. 30, 1999. NDVI of the same point which conducted spectral reflectance measurement was computed from the TM image. The package software of ERDAS Imagine was used in this analysis.

4. RESULTS AND DISCUSSIONS

Vegetation list is Table 2. *Leymus chinense* and *Stipa grandis* are the indicator for high-quality grassland. *Filifolium sibiricum* is the indicator for meadow steppe. *Agropyron cristatum* and *Artemisia frigida* are the indicator for grazing under medium to heavy intensity. *Potentilla acaulis* is the indicator for heavy grazing. *Plantago asiatica* is general appearance near by people houses.

Houses of nomads are distributed along the pipeline of the water system from the Tank no.3 (Site 00) to east-west direction and all grassland is used for grazing at this direction. As closer as to water tank, grazing pressure is increased more and more. The vegetation of center of village is poor. The grassland is used for grazing within 3km distance at north part, and used as mow from 3 to 5km at the part.

Figure 7 shows relationships between the distance from water tank and vegetation factors as biomass, coverage, canopy height and soil hardness measured by spectro-radiometer. Approaching closer to the village, grazing pressure became higher, and biomass, cover and plant height decrease, soil hardness increased.

Figure 8 shows spatial biomass change in the experimental site. In accordance with the distance from Tank 3 (Site 00), observed biomass was increased. This similar pattem was appeared again by NDVIs derived from spectro-radiometer and Landsat data in 1998 and 1999. High correlation was observed between the biomass and NDVI.

5. Refarences

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Table 1 Survey point

1.	Center of village (Tank no. 3)	Site 00
2.	From center to North-East (We call this direction “East Direction”)	Site E01-E05
3.	From center to South-West (We call this direction “West Direction”)	Site W01-W05
4.	From center to North (We call this direction “North Direction”)	Site N01-N05
5.	From center to South-East (We call this direction “South Direction”)	Site S01-S05

Table 2 Dominant species at each site

Site00 : Bare Soil
SiteW01 : *Artemisia frigida, Cleistogenes squarrosa, Potentilla tanacetifolia, Potentilla acaulis*
SiteW02 : *Cleistogenes squarrosa, Potentilla tanacetifolia, Potentilla acaulis*
SiteW03 : *Scabiosa comosa, Stipa grandis, Cleistogenes squarrosa*
SiteW04 : *Stipa grandis, Cleistogenes squarrosa, Filifolium sibiricum*
SiteW05 : *Stipa grandis, Cleistogenes squarrosa, Aneurolepidium chinense, Thymus serpyllum*
SiteE01 : *Cleistogenes squarrosa, Artemisia frigida, Aneurolepidium chinense*
SiteE02 : *Cleistogenes squarrosa, Artemisia frigida, Agropyron cristatum*
SiteE03 : *Plantago asiatica, Potentilla bifurca, Carex korshinskyi*
SiteE04 : *Stipa grandis, Aneurolepidium chinense, Thymus serpyllum*
SiteE05 : *Scabiosa comosa, Stipa grandis, Aneurolepidium chinense*
SiteN01 : *Cleistogenes squarrosa, Aneurolepidium chinense, Pocockia ruthenica*
SiteN02 : *Stipa grandis, Aneurolepidium chinense, Allium tenuissimum*
SiteN03 : *Stipa grandis, Potentilla tanacetifolia, Achnatherum sibiricum*
SiteN04 : *Filifolium sibiricum, Bupleurum chinensis, Aneurolepidium chinense*
SiteN05 : *Filifolium sibiricum, Astragalus adsurgens, Iris lactea*
SiteS01 : *Artemisia frigida, Stipa grandis, Cleistogenes squarrosa*
SiteS02 : *Aneurolepidium chinense, Stipa grandis, Cleistogenes squarrosa*
SiteS03 : *Cleistogenes squarrosa, Scabiosa comosa, Scutellaria baicalensis*
SiteS04 : *Cleistogenes squarrosa, Filifolium sibiricum, Stellera chamaejame*
SiteS05 : *Aneurolepidium chinense, Cleistogenes squarrosa, Potentilla tanacetifolia*

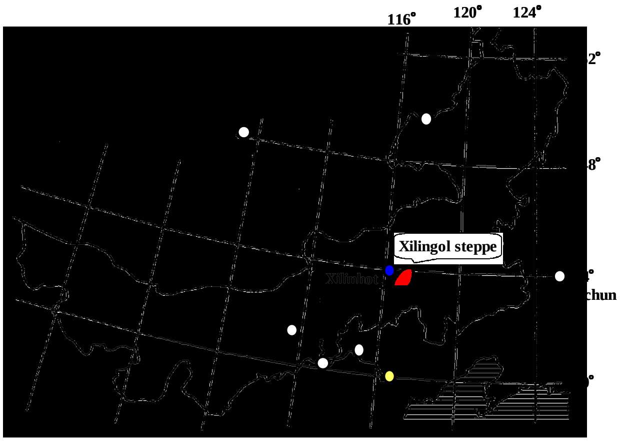

Fig. 1 Location of study area.

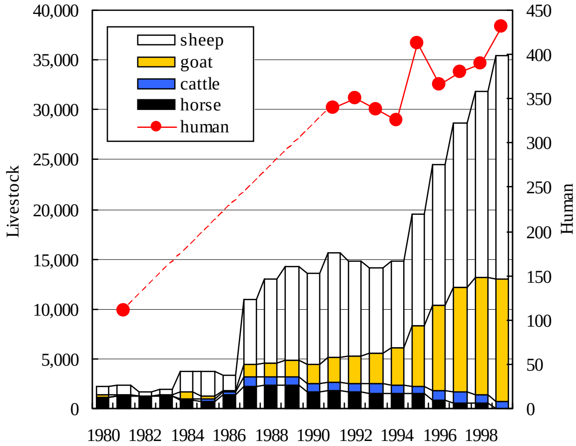

Fig. 2 Change of population of human and livestock in Baiyinrinko Farm.

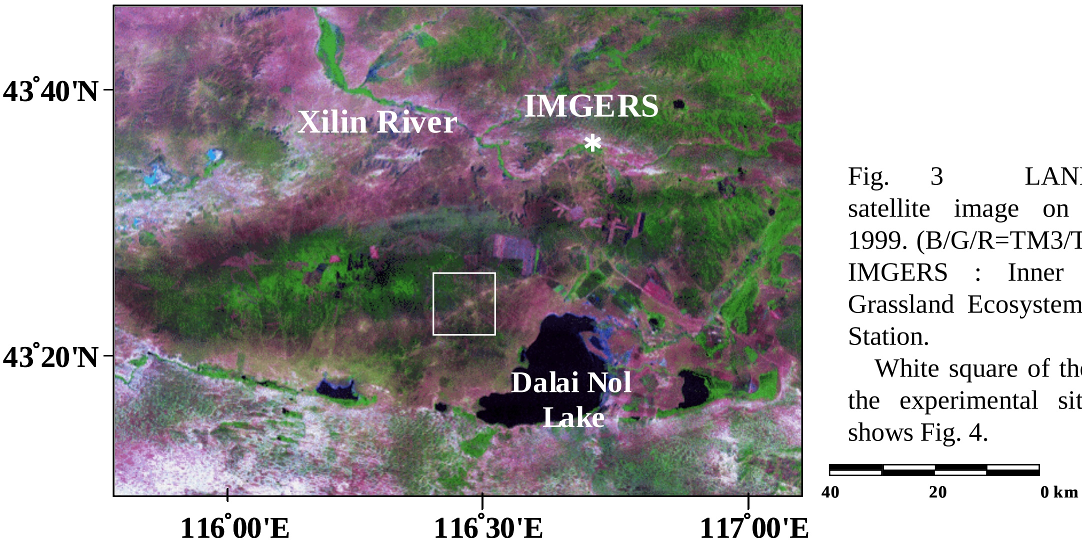

Fig. 3 LANDSAT/TM satellite image on July 30, 1999. (B/G/R=TM3/TM4/TM5) IMGERS : Inner Mongolia Grassland Ecosystem Research Station.

White square of the image is the experimental site, and it shows Fig. 4.

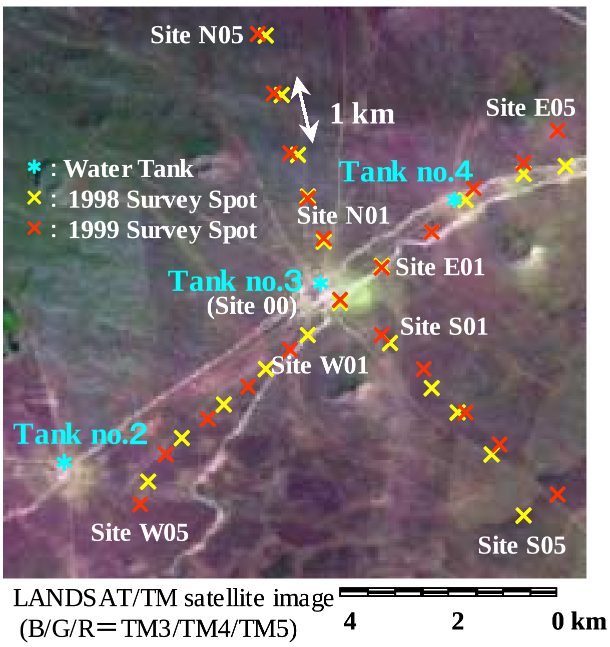

Fig. 4 Survey point and water tank at the experimental site.

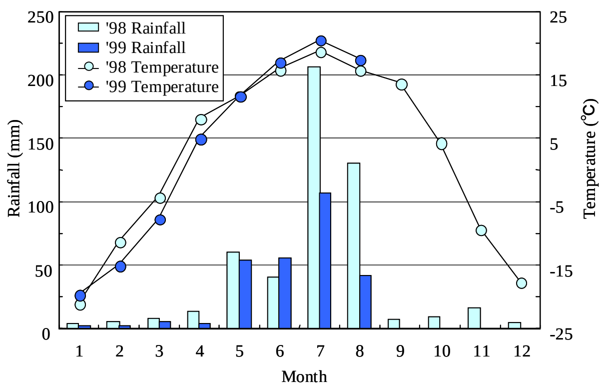

Fig. 5 Temperature and rainfall at Xilin gol.

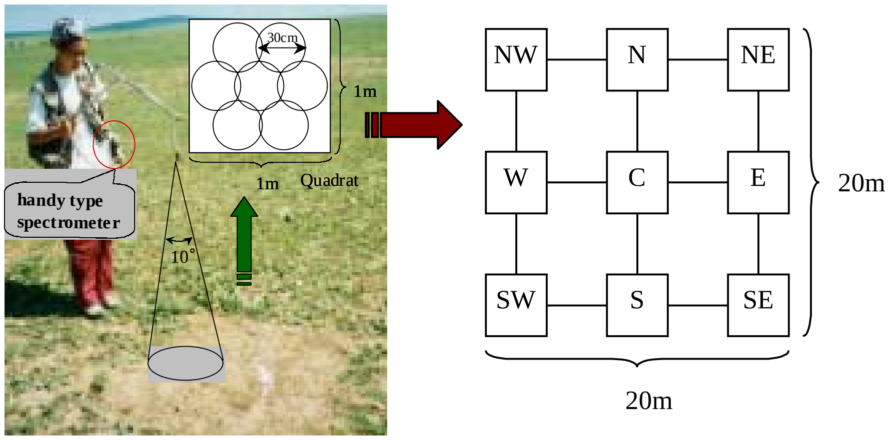

Fig. 6 Spectral reflectance measurement and field survey point.

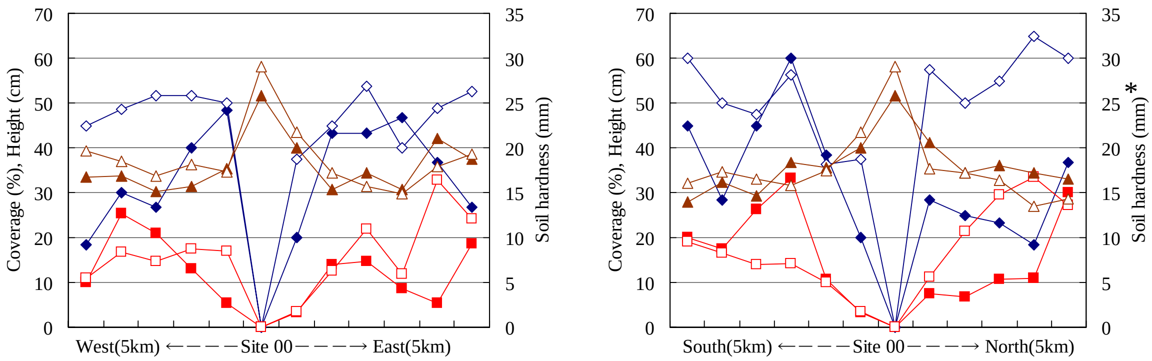

Fig. 7 The changes of vegetation (coverage, canopy height) and soil hardness in relation to the distance from a water tank (WT3: Site-00).
*Soil hardness : The value is indicated by the meter and large value is harder.

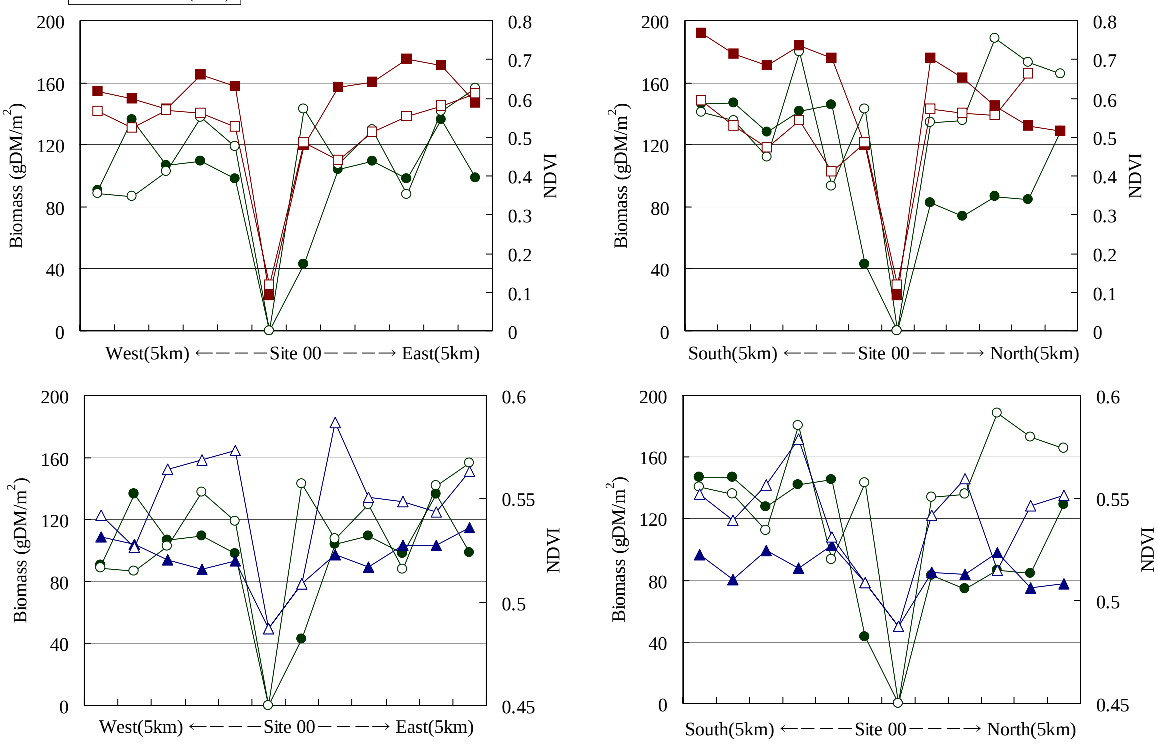

Fig. 8 The changes of vegetation (biomass, spectral vegetation index) in relation to the distance from a water tank (WT3: Site-00).
NDVI = (NIR-Red)/(NIR+Red)
NDVI 1: Handy Spectro-radiometer (NIR : 850nm, Red : 650nm)
NDVI 2 : Satellite Data (NIR : TM4, Red : TM3)