Effects of cultivation and grazing on water retention of soils in the Kherlen river basin, Mongolia

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Introduction

Recently, Mongolian land is deteriorated by improper cultivation and overgrazing, resulting in desertification in some area. In the process of desertification, vegetation change is widely observed (Huzita, 2003). Vegetation is mainly controlled by soil moisture regime (Yasunari 2003, Miyazaki et al., 2003).

The objective of this study is, therefore, to investigate the soil water characteristics of crop and grazing land.

Method

1) Study sites

Study sites were located in Kherlen Bayan Ulaan (KBU 47°12'N, long. 108°44'E), a village of the Kherlen river basin in north-eastern Mongolia. Average annual precipitation at KBU is about 200mm. Four sites were investigated: non-grazing field for 2 years (PF: Protected Field), grazing land (NG: Natural Grassland), cropland(CL) and abandoned field (AF).

PF : A fence of 170m×200m was set up to exclude grazing pressure since July 2002.

NG : Common natural grassland in Mongolia.

AF : Feed crops were cultivated from 1962, followed by wheat were production with irrigation from 1982 and abandoned in 1992.

CL : Adjacent to AF and under cultivation of feed crops.

2) Soil sampling

We selected each site having similar subsoil by checking with soil auger. We set up quadrates, 20m×20m, at each site. Soil samples were taken from the surface horizon of 0 to 5cm. Undisturbed soils samples were taken from 0 to 5cm using cylindrical core (100ml) samplers for physical measurement. Sixteen samples for soil physico-chemical analysis were taken at each site.

3) Vegetation survey

The vegetation survey was conducted with quadrate method (Yamamoto et al. 1995) of 1m×1m. Five quadrates were set up for each site.

4) Soil physico-chemical analysis

Three phase ratio was determined with the method of effective volumetric capacity. Saturated hydraulic conductivity was measured with the falling head method. Soil pH was determined with the glass electrode method. Soil salinity was evaluated in terms of electrical conductivity of 1:5 soil-water suspension. Total organic carbon contents and total nitrogen contents of the soils were measured with dry combustion method using NC-analyzer.

5) Hydraulic properties

Water retention curve and unsaturated hydraulic conductivity were determined with the multistep outflow method.

Results and Discussion

1) Vegetation at each site

Average plant cover ratio at PF site was 60%, the highest among 4 sites. Bent grass was strongly dominant at PF site, while, some spices were comparable level at NG site. *Artemisia*, an indicator of over grazing, was more dominant at NG site than at PF site. Number of plant spices of NG site and PF sites were 15 and 11, respectively, while there were only a few plants.

2) Soil physico-chemical analysis

EC of 1:5 soil-water suspension at AF site was 0.41mS/cm. EC of saturation extract at AF site was 5.3mS/cm which was the highest among 4 sitesÿTable.1 ÿ. This may indicates that grass at AF site was under saline stress. Total-C and total-N contents of soils at NG site was higher than those at PF site. It seems that decreases in total-C and total-N were maybe caused by plants growth and cease of the application of livestock's waste.

Bulk density of soil at CL site was 1.4, the highest among 4 sites. However, the ratio of macro pore / capillary pore at CL site was 0.23 which was similar to NG site. Bulk density at AF and PF sites were 1.21 and 1.27, respectively. No significant difference was found among 4 sites with regard to saturated hydraulic conductivity. Sand fraction (>2mm) per cylindrical core sample from CL site was higher than any other sites. These results mean that although sand fraction ratio was higher at CL site, smaller particles in CL site soil might be lower the permeability to the similar level as other sites. On the other hand, volumetric water content at 10^{-6}cm/s of unsaturated hydraulic conductively (i.e. field capacity) was higher at PF and NG sites (Fig.3). Extrapolation of soil water-retention curve to drier range gave similar value of water content at wilting point. Therefore, available moisture, difference between water content at field capacity and wilting point, NG and PF sites were higher than that of CL and AF sites (Fig.2). There was good correlation between available moisture and Total-C (Fig.1).

There was not a clear tendency regarding soil water characteristics caused by non-grazing. Also, a soil water characteristic was not improved, even over 13 years of fallow at AF site.

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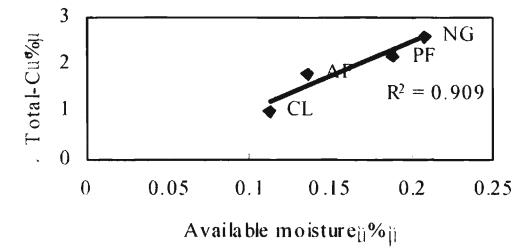

Fig.1 Relation of Available water and Total-C

Table.1 Some chemical properties of soils at 4 study sites

	EC (mS/cm)	pH	Total-C (ü)	Total-N (ü)
PF	0.24b	5.3c	2.18b	0.22b
NG	0.18c	5.7b	2.57a	0.27a
AF	0.41a	5.5bc	1.81c	0.17c
CL	0.14d	6.2a	1.03d	0.12d

Alphabet denotes 5% significant difference by using Student's *T*-test.

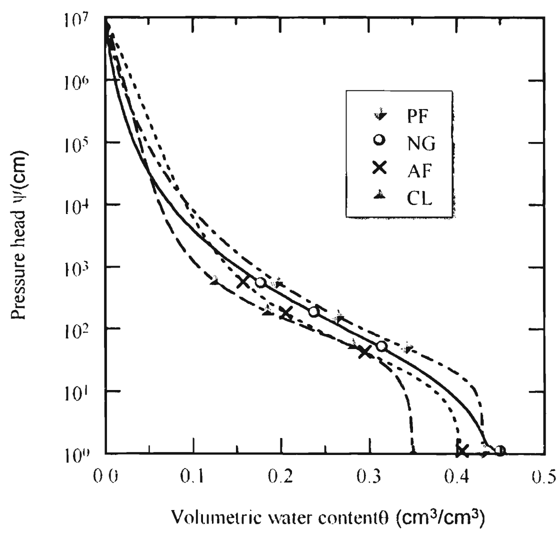

Fig.2 Soil water characteristic curve

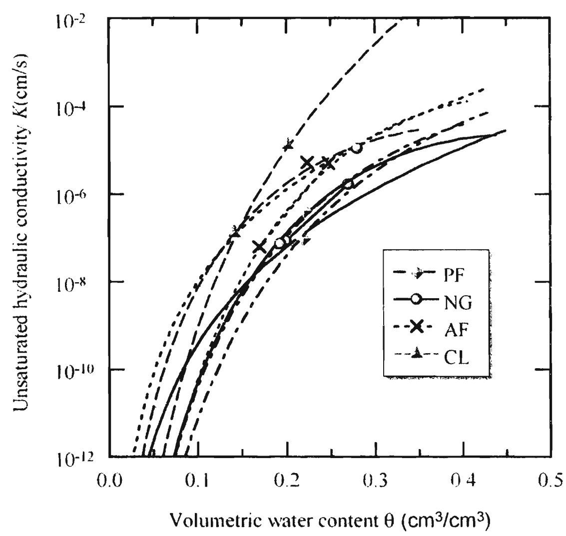

Fig.3 Relation of Unsaturated hydraulic conductively and Volumetric water content.