Geology, Topography and Soils in Naiman, Inner Mongolia, China

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Abstract

The characteristics and distribution of soils in Naiman, Inner Mongolia were studied. Soils were classified into 3 types, which were distributed corresponding to geology and topography; loess-derived soils in the southern loess plateau, aeolian sandy soils in Horqin sandy land and alluvial soils along rivers or in inter-dune areas. It was pointed out that each type has a different type of land degradation.

Introduction

Desertification or land degradation is an important environmental problem in the world today. In Jirem prefecture, eastern Inner Mongolia, desertification-prone land has enlarged from 20% in 1950's to 54% in 1970's (Zhu,1988). This area is situated in the semi-arid zone, where the moisture and vegetation conditions are much better than that in arid zone. The main cause of land degradation in this area seems to be human activities such as overgrazing and over-cultivation. When the excessive human pressures ere dispelled, desertification-prone land can be rehabilitated. It is important to establish adequate land use systems to prevent land desertification. And it is necessary to evaluate productivity and environmental capacity of soils for such purpose.

The objective of this study was to obtain informations about the caracteristics and distribution of soils in relation to geology and topography in Naiman, eastern Inner Mongolia.

Materials and methods

1. Study area

Naiman is located in eastern Inner Mongolia, about 500 km northeast of Beijing, as shown in Fig.1. The mean annual air temperature in this area is about 6 to 7 ℃ and the mean annual precipitation is about 370 mm; 70% of it is concentrated in summer season, June to August. The natural vegetation of this area was temperate sparse woodland rangeland (Zhu, 1988).

Geologically this area can be divided into 2 parts as shown in Fig.2; the north part is the open plain of the Xiliao River and the south is a loess plateau. The surface sediment of the north part is sandy alluvial deposit of the Xiliao river (Zhu, 1988) and this region is called "Horqin Sandy Land". Elevation is high in the south (about 500 to 700 m above sea level) and low in the north (about 200 to 300 m).

2. Soil profile survey, soil sampling and analytical methods

Totally 14 soil profiles were surveied in August and September, 1995 (Fig.3). Land use of survey sites was grassland or woodland. Soil samples were collected from each horizon after examining morphological features of soil profiles.

Soil analysis for physico-chemical properties was carried out using the methods described by Hamazaki and Paningbatan Jr.(1988).

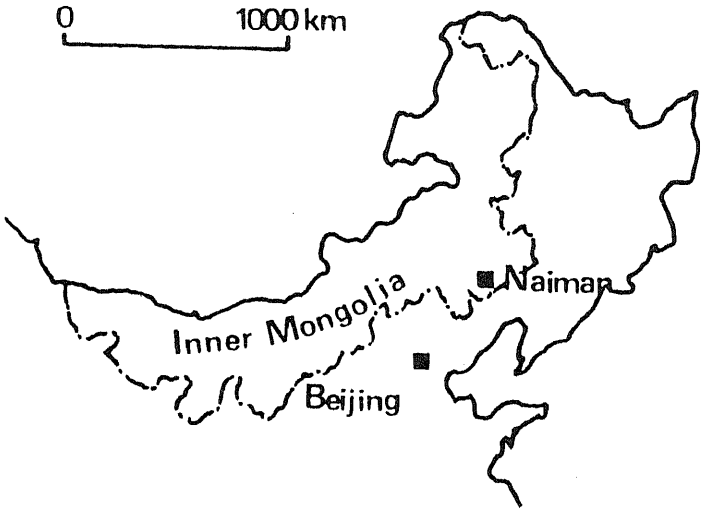

Fig.1. Location of study area

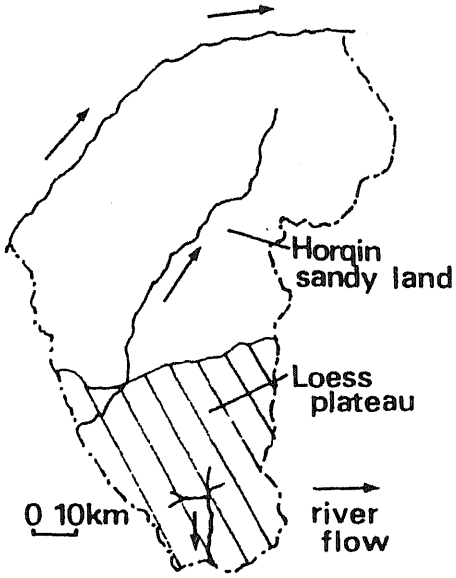

Fig.2. Geology and topography of Naiman

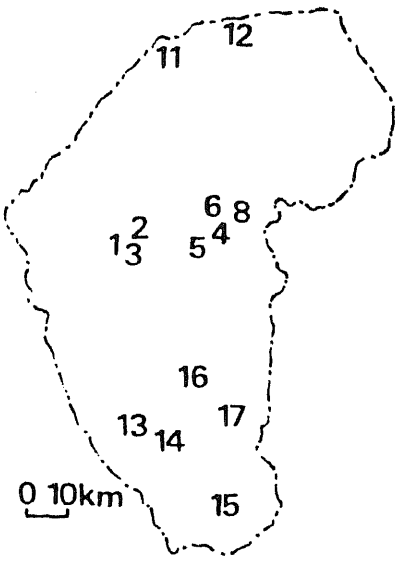

Fig.3. Map of soil survey site

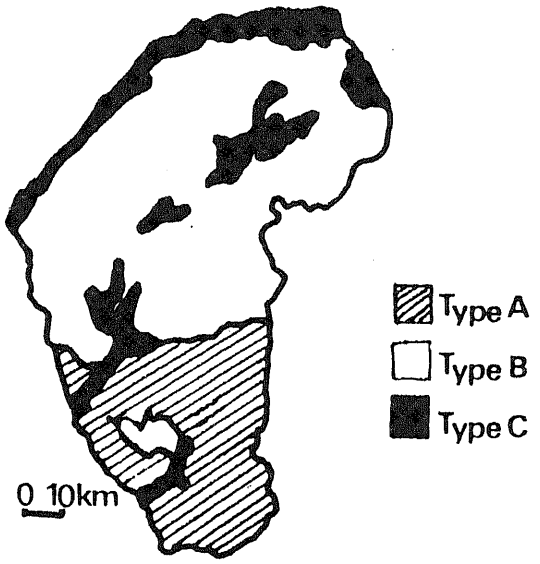

Fig.4. Distribution of major soil types

Results and discussion

1. Major soil types: The soil of Naiman can be classified roughly into 3 types according to their morphology and physico-chemical properties. The distribution of soils corresponds to geology and topography as shown in Fig.4.

TypeA: Soils derived from loess in the southern area of Naiman.

TypeB: Aeolian sandy soils in the Horqin sandy land. This type can be divided into 2 subtypes; one is moving aeorian sandy soil and the other is fixed or half-fixed aeolian sandy soil.

TypeC: Alluvial soils distributed along the river and in inter-dune areas. This type can be divided into 2 subtypes; saline soil and non-saline soil.

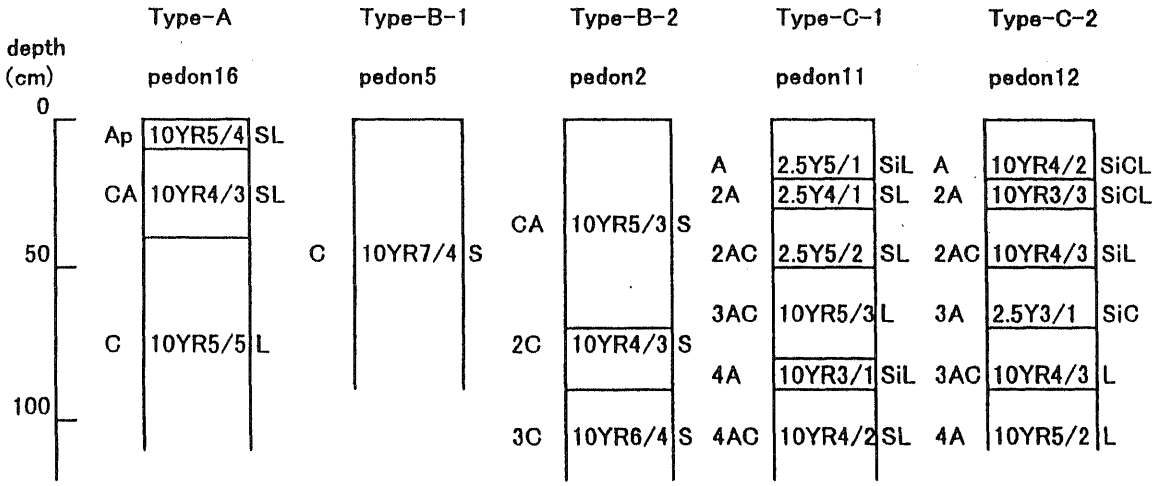

Fig.5. Soil profiles of major soil types in Naiman

2. Morphology:

Fig.5 shows the morphology of major soil types. Type A has a thin A horizon and a C horizon of loessial deposit. Type B-1 does not have a differentiation of horizons and type B-2 has a weakly developed soil profile. Type C has many stratas, which are typical in alluvial soils.

3. Physico-chemical properties

Table 1 shows the physico-chemical properties of major soil types.

Particle size analysis: Type A has about 10% of clay and almost 0% of coarse sand fraction. Silts and fine sands are main particles in this type of soil. Type B-1 has only 1 or 2 % of clay and major particles are coarse sands. Type B-2 also is sandy but finer than B-1. Type C has variant texture in each horizon, but type C-1 has coarser texture than type C-2.

Availabl moisture: Almost all soils have moderate values except for B-1 which has low available moisture because of its coarser texture.

Saturated hydraulic conductivity: Almost all soils have moderate values, but type C-2 has very low value because of its clayey texture and alkalization.

pH: About 8.0 to 9.0 in type A and B. Type C has higher pH and specially in C-2 it is about 10.0, which indicates the alkalization.

EC: Only type C-2 has a very high value and it indicates the salinization. Other soils have normal values.

T-C: Low in all soils but it varies from 0.04 to 1.2 %. It is very low in type B and relatively high in type C.

CEC: Type A has moderate, type B has very low and type C has high values, corresponding to clay and organic matter content.

Exchangeable cations: Ca is very rich in almost all soils because of the semi-arid climate and characteristics of parent materials of soils. Type C-2 has much Na, which indicates the alkalization.

Available phosphorus: All types of soils have low values except for type C-2.

Table 1. Physico-chemical properties of Naiman soils

soil type	pedon	horizon	depth (cm)	particle size distribution(%) clay <0.002 mm	silt 0.002-0.05mm	fine sand 0.05-0.2mm	coarse sand 0.2-2mm	textural class	available moisture pF1.8-4.2 (vol.%)	saturated hydraulic conductivity (cm/s)	pH (H2O)	EC (mS/cm) 1:5 extract	T-C (%)	CEC	exchangeable cations Ca (cmol(+)kg-1)	Mg	K	Na	available phosphorus (mgP2O5 /100g soil)
	16	Ap	0-7	7.0	17.8	75.1	0.1	SL	31.6	1.34E-03	8.2	0.08	0.27	7.5	7.7	1.5	0.3	0.02	0.65
A		CA	7-25	9.2	28.6	62.1	0.1	SL	30.1	1.30E-03	8.3	0.08	0.23	9.5	11.6	1.4	0.2	0.04	0.17
		C	25-110+	9.6	39.6	50.7	0.1	L	28.7	1.29E-03	8.2	0.03	0.12	10.6	10.4	2.2	0.2	0.03	0.20
B-1	5	C	0-85+	1.1	1.2	14.8	82.8	S	8.8	4.59E-03	8.0	0.02	0.04	1.8	1.2	0.2	0.1	0.00	0.69
	2	CA	0-72	4.8	31.6	47.0	16.6	SL	28.2	1.00E-03	8.7	0.07	0.24	6.8	16.3	0.8	0.3	0.03	0.14
B-2		2C	72-88	5.0	25.5	59.2	10.2	SL	30.6	1.24E-03	8.7	0.07	0.26	7.0	17.0	0.8	0.3	0.03	0.55
		3C	88-155+	0.9	0.8	17.9	80.4	S	9.6	5.89E-03	8.6	0.04	0.07	2.4	2.4	0.2	0.1	0.01	0.55
	11	A	0-18	5.6	74.2	20.1	0.1	SiL	35.2	1.16E-04	8.8	0.18	0.56	8.7	22.2	3.7	0.3	0.74	1.21
		2A	18-30	8.4	39.0	48.2	4.5	SL	17.8	2.48E-07	9.7	0.39	0.41	8.1	18.7	3.2	0.2	4.47	0.27
C-1		2AC	30-52	4.4	34.9	49.3	11.4	SL	27.0	2.37E-04	9.3	0.19	0.30	7.2	17.5	6.2	0.2	1.17	0.19
		3AC	52-75	7.5	48.7	42.8	1.0	L	29.6	5.72E-04	8.9	0.22	0.50	8.5	18.2	7.2	0.1	0.78	0.30
		4A	75-93	17.4	64.7	17.2	0.7	SiL	26.4	3.67E-04	8.5	0.17	0.95	16.5	41.4	7.7	0.4	0.18	0.74
		4AC	93-120+	4.3	23.7	32.9	39.1	SL	18.6	7.20E-04	8.5	0.13	0.48	5.5	17.3	2.8	0.4	0.09	1.17
	12	A	0-21	39.1	56.4	4.2	0.3	SiCL	37.0	4.87E-07	10.3	3.05	1.01	22.4	34.7	6.5	1.6	38.52	18.45
		2A	21-25	40.4	56.6	2.8	0.1	SiC	30.4	7.02E-07	10.3	2.01	0.93	27.2	32.3	5.4	0.9	37.11	10.32
C-2		2AC	25-52	11.7	77.5	10.7	0.1	SiL	31.4	1.80E-07	10.5	1.46	0.29	9.3	15.7	3.0	0.3	16.47	4.69
		3A	52-64	43.0	55.8	1.1	0.1	SiC	33.4	2.39E-08	9.8	1.44	1.24	31.3	33.8	6.8	0.9	33.23	4.34
		3AC	64-89	7.2	42.0	50.2	0.5	L	32.0	2.06E-06	10.2	0.54	0.14	6.2	15.9	2.3	0.2	5.97	2.60
		4A	89-110+	19.9	45.3	21.5	13.3	L	20.0	1.65E-08	9.9	0.68	0.46	12.5	35.6	8.0	0.8	9.95	4.97

4. Present state of land degradation

Each type of soil has another type of land degradation, which corresponds to geology, topography and characteristics of soil.

In type A, water erosion is the main problem caused by silty texture and hilly topography. Surface soils were removed by water erosion and it causes the decline of soil productivity. There are many deep gully erosions, which are difficult to be recovered.

In type B, wind erosion is a serious problem caused by its sandy texture and low water retention. If vegetation cover is destroyed, surface sand starts moving by wind, specially in the windy season in spring. Soils become coarse sandy and poor in nutrients, productivity is very low in this type.

In type C, the productivity of soils is higher than other types. But salinization is a problem in type C-2 caused by a high water table and clayey texture.

Adequate measures and rational utilization of land based on soil characteristics will be needed to prevent land desertification and facilitate rehabilitation of already degraded land.

References

Hamazaki, T. and Paningbatan Jr., E.P. (1988) "Procedures for soil analysis", 94pp., College of Agriculture, University of the Philippines at Los Baños and Tropical Agriculture Research Center.

Zhu, Z., Liu, S. and Di, X. (1988) "Desertification and Rehabilitation in China", 222pp., The International Center for Education and Research on Desertification Control.