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THE EFFECT OF LAND USE CHANGES ON SOIL CONDITIONS IN ARID REGION

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ABSTRACT: Land use change may influence a variety of natural and ecological processes, including soil nutrient, soil moisture, soil erosion, land productivity and biodiversity. In this paper, 9 typical land use patterns sustainable 15 – 20 years have been chosen to study the effect of different land use patterns on soil nutrient, soil erosion, soil moisture, saline and so on. We drew conclusions as follows: Firstly, it is clear of the effect of land use change on soil. Land use change results in the decline of soil nutrient and erosion rate, but the increase of land productivity; secondly, the erosion rate and the rate of vegetation cover is the subtractive correlativity. It reflects the effect of soil erosion on land productivity. It is clear of the positive correlativity between land productivity and soil moisture and explains the role of land surface vegetation to preventing aridity in the northwestern China; lastly, it is feasible to develop animal husbandry properly in arid region. The topgallant land use pattern is the combination of forest and meadow in arid region. The rational land use may prevent or weaken the intensity of soil erosion in a certain extent. Therefore, activities accorded with ecological principal such as readjustment of land use structure, rational reclamation along with adoption of prevention and control measures can reverse land degradation process.
KEY WORDS: land use change; soil nutrient; soil moisture; soil erosion; land productivity; Korla City

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1 INTRODUCTION

Land use change may influence a variety of natural and ecological processes, including soil nutrient, soil moisture, soil erosion, land productivity (FU *et al.* , 1999), biodiversity, cycle of biographical geochemistry, and so on (VITOUSEK, 1994). So, it is very important that the studies of land use changes understand regional eco-environment and global environmental change. At percent, the studies of land use change fasten on the effect and response to global change. For instance, climatological change (SKUKLA, 1990), let-off of CH_4 and N_2O (MASTON, 1990), and hydrological change (FUNG, 1991; MOONEY, 1987; RICHEY, 1989; CARPENTER, 1992). But the studies of ecological evolvement and physical geographical process in regional scale are relatively lack. Eco-environment is quite fragile in arid region and its response is very sensitive. Wind erosion, water shortage, saline and land degradation menaces seriously agricultural sustainable development in arid region, the irrational land use aggravates the aforementioned processes (FAN,

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1996) . The authors choice Korla City as the study area, analyze the effect of land use changes on soil nutrient, soil salinity, soil erosion, soil moisture and land productivity from space-time transformation and the response of eco-environmental sensitivity and suitability to land use changes from landscape security.

2 STUDIED AREA

The study area, Korla city with an area of 7209.69 km^2, lies in the northeast of Tarim basin and the south foot of branch range (Huolashan Mountain) of Tianshan mountain in the middle of Xingjiang Autonomous Region, China (85°13' to 86°26', 41°11' to 42°14'E). Above 80% terrain is alluvial plain with the altitude of 890m to 950m. General terrain inclines from northeast to southwest, its average rate of slope decline is 1/1000 - 1/2000. It belongs to warm temperate zone continent climate with the average annual precipitation of 50.1 mm/a, the average annual evaporation of 2788.0 mm/a, the average wind speed of 3.0m/s, the fastest speed of 22.0 m/s, and the average erosion rate of 3954.06 km^2/a (PU *et al.*, 1998). The initial land use types are Gobi, desert and primeval forest of *Populus euphratica*, the different land use patterns have been formed with reclamation about 40 years(Table 1)(CHEN *et al.*, 1998).

3 MATERIALS AND METHODOLOGY

Nine typical land use patterns, including desert, meadow, pasture, upland, crop rotation triennially, fallow, wasteland, orchard, and *Populus euphratica*, sustaining 15 - 20 years have been chosen to study the effect of different land use patterns on soil nutrient, soil erosion, soil moisture, saline, land productivity and so on. According to field survey and investigation during July, 15 to 18, 1995, the authors collect the samples in Halayugong countryside of Korla City (Table 2).

Table 1 The area and percentage of land use patterns in Korla City

	Arable land	Forest	Meadow	Pasture	Built-up land	Water area	Desert
Area($\times 10^4$ha)	3.361	5.291	28.159	5.324	1.220	2.03	26.72
Percentage(%)	4.66	7.33	39.06	7.38	1.74	2.81	37.05

The authors collect 90 samples with various depth and measure the soil moisture of 0 - 10 cm, 10 - 20 cm, 30 - 50cm, 50 - 70cm and 70 - 90cm depth with postal TDR. 0 - 20cm surface soil were taken from 14 cross sections. The samples were air-dried, then sieved and analyzed, the analysis methods are as follows:

Available N(A.N): Available nitrogen is determined by the cornfield method.

Available P(A.P): Available soil-P is extracted with 0.5 mol/L $NaHCO_3$ solution (pH 8.5) . Phosphate-P in solution is determined colorimetrically by the formation of the blue-phosphomolybdate complex following reduction with ascorbic acid.

Available K(A.K): Available soil-K is extracted with 1mol /L NH_4OAc, phosphate-K in solution is determined by the flame-spectrum method.

Table 2 The distribution and number of cross sections under different land use patterns

	Desert	Meadow	Pasture	Dryland	Crop rotation	Fallow	Wasteland	Orchard	*Populus euphratica*
Number	1, 2	3, 4, 5	6, 7	8, 9	10	11	12	13	14

Organic Matter(O. M.): Organic matter is determined by the oil bath-$K_2Cr_2O_7$ titration method.

Total N(T. N): The determination of soil total nitrogen is semi-micro Kjeldahl method.

Total P(T. P): Total soil-P is digested with double-acids(H_2SO_4 - $HClO_4$), Phosphate-P in solution is determined colorimetrically by the formation of the blue-phosphomolybdate complex following reduction with ascorbic acid.

The ^{137}Cs levels of 0 - 10 cm, 10 - 20 cm, 30 - 50 cm, 50 - 70 cm and 70 - 90 cm depth were measured the intensity of Y radiation with equipment made by ORTEC Corporation in U. S. A.

It is relative difficult of measuring the NPP. Land productivity was replaced with the weight of soil root and the rate of vegetation cover. The root in 0 - 30 cm surface soil was picked up, sieved and weighted up with soil, then calculated the weight of soil root. The authors measure respectively the rate of penetrating light in the open air (P_o) and the rate of penetrating light in the vegetation of samples, then calculated the rate of vegetation cover in different land use types according to formula 1.

$$C = (1 - P_v / P_o) \times 100\% \quad (1)$$

In order to assure the precision of the determinate results, every sample was measured 3 times, then the average value was computed and used.

4 RESULTS AND DISCUSSION

Fig. 1 shows the change of soil nutrient and salinity in different land use types. The forest of *Populua euphratica* has the most abundant nutrient. After 15 - 20 years sustaining use, the soil nutrient of reclaimed land all declined besides the A. N of arable land. The analysis of soil nutrient in different land use types shows that the loss of soil nutrient is meadow <pasture <crop rotation triennially <upland <fallow land <orchard <wasteland. The salinity has a variety, meadow and pasture has declined, crop rotation triennially, fallow land and arable land has ascend, the change of orchard has clear very much and dramatically ascended 6 - 7 times in wasteland.

Fig. 2 shows the change of soil moisture in different land use types. Pasture has the most abundant moisture, about 17.2%. The analysis of soil moisture in different land use types shows that the content of soil moisture is pasture > primeval forest> upland > crop rotation triennially > fallow land > wasteland > orhard > desert, the content of soil moisture in desert only is 2.4%. Vertical change of soil moisture in different land use is poles apart. The summit of soil moisture in pasture appears in 20 - 30 cm. The sum mit in meadow, forest of populus euphratica and orchard appears in 30 - 40 cm, the summit in upland, crop rotation triennially and fallow land appear in 40 - 50 cm and the summit in wasteland and desert appears in 50 - 70 cm.

Fig. 3 shows the change of soil erosion in different land use. According to formula(ZHANG *et al.*, 1994), erosion rate of desert is the highest, about 5987.21. Erosion rate of waste land, fallow land, upland, crop rotation triennially, orchard, meadow, pasture, and forest of *Populus euphratica* is 5527.19,

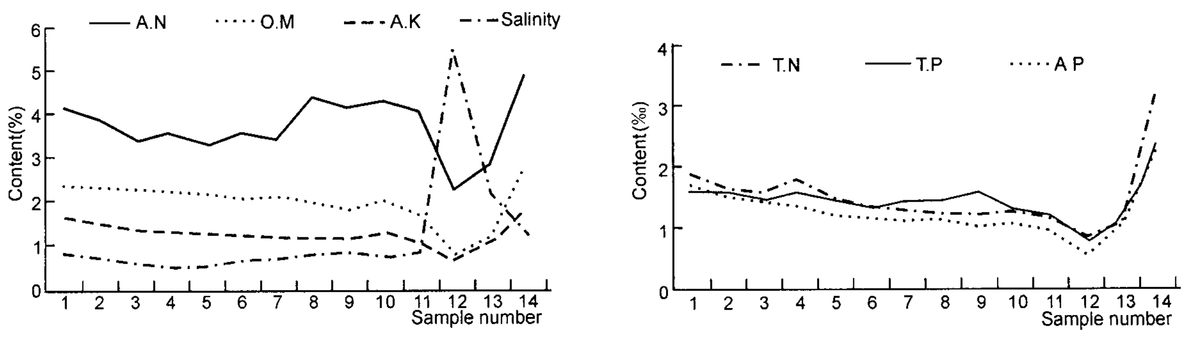

Fig. 1 The change of soil nutrient and salinity in different land use in Korla City

3833. 29, 3537. 29, 3604. 88, 3215. 56, 3171. 31, 1973. 44 , and 1647. 78t/(km^2 · a) respectively.

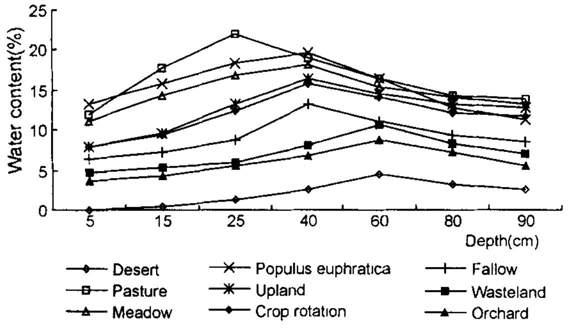

Fig. 2 The change of soil moisture in different land use

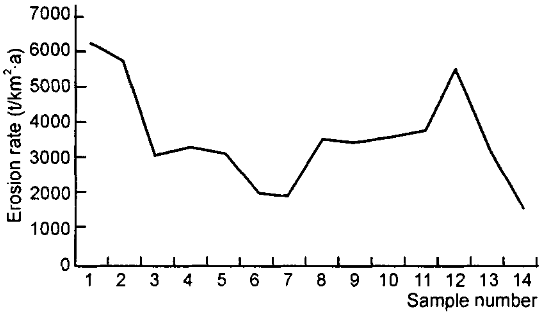

Fig. 3 The erosion rate change in different land use

Fig. 4 shows the change of land productivity in different land use. The rate of soil root in pasture is the largest, about 2. 21g/kg. The rate of soil root in the forest of *Populus euphratica*, meadow, upland, crop rotation triennially, fallow land, orchard, and waste land is 2. 05, 1. 58, 1. 01, 1. 08, 0. 88, 0. 83 , and 0. 30 g/kg respectively. The rate of soil root in desert is the smallest, only 0. 23 g/kg. The rate of vegetation cover in the forest of populus euphratica is the highest, about 94. 0%. The rate of vegetation cover in pasture, meadow, upland, crop rotation triennially, fallow land, and waste land is 90. 0%, 74. 0%, 49. 0%, 54. 0%, 42. 0%, and 16. 0% respectively. The rate of vegetation cover in desert is the lowest, only 10. 0%.

The initial land use patterns are Gobi and desert. The area of collecting samples is less, only 360ha. The type of soil belongs to brown desert soil. We discovered that the distribution of soil nutrient and so on is very equal and the characteristic of change is not very clear when the authors evaluated land quality using GIS and Geostatistic with spatial analysis (CHEN *et al.* , 1998) . So from space-time diversion, current land use patterns are the change of land use types during the time sequence. The paper studies the effect of land use change to soil with the frame of reference of desert and forest of populus euphratica. We draw conclusions as follows:

Firstly, the environment of Gobi and desert is frail very much. Land use change results in the decline of soil nutrient. The A. N of upland and crop rotation ascends because of man-made fertilization. The interference of meadow is least, orchard goes against the protection of soil nutrient, the topgallant approach improving of regional environment is the protection of primeval forest of populua euphratica. Secondly, as a result of land cover change and cultivation, land use change results in the change of soil moisture. The increasing of land cover reduces the evaporation of soil moisture, cultivation transforms soil ventilation and soil structure. Thirdly, the change of soil erosion driven by land use change is clear. The rational land use prevents or weakens the intensity of soil erosion in a certain extent. Lastly, the effect of land use changes on land productivity is very clear. The rate of soil root and the rate of vegetation cover in the forest of populua euphratica and pasture also are higher and by far land productivity of desert. But land productivity of wasteland caused by irrational use is approximate to those of desert. The result shows that land degradation and/or desertification can be combated. Even though its eco-environment is very frail in arid region, land use according with ecological principle also is feasible.

5 CONCLUSION

According to aforementioned analysis, we can draw conclusions as follows:

(1) It is clear of the effect of land use change on soil conditions. Land use change results in the decline of soil nutrient and erosion rate, but the increase of land productivity. (2) The erosion rate and

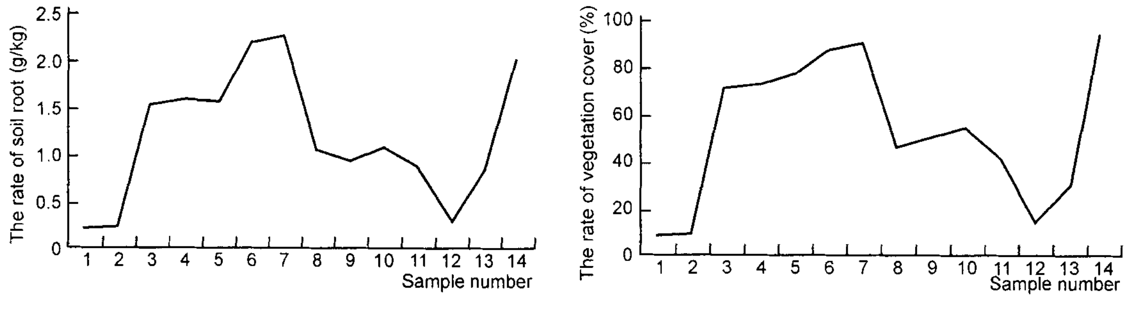

Fig. 4 The change of land productivity in different land use in Korla City

the rate of vegetation cover is the subtractive correlativity. It reflects the effect of soil erosion on land productivity. It is clear of the positive correlativity between land productivity and soil moisture and explains the role of land surface vegetation to preventing aridity in the northwestern China. And (3) It is feasible to develop animal husbandry properly in arid region. The topgallant land use pattern is the combination of forest and meadow in arid region. The rational land use may prevent or weaken the intensity of soil erosion in a certain extent. Therefore, activities accorded with ecological principle such as readjustment of land use structure, rational reclamation along with adoption of prevention and control measures can reverse land degradation process.

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