STUDY ON DYNAMIC CHANGES OF DESERTIFICATION IN THE FARMING-PASTORAL ZONE OF THE NORTHERN SHAANXI PROVINCE

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ABSTRACT

Integrating remote sensing (RS) with geographic information system (GIS), distribution digital maps of land desertification, spatial database and their statistics in the year of 1986, 1993 and 2000 were obtained by correcting, amplifying and auto classifying the RS images of interlaced zone for agriculture and animal husbandry in northern Shaanxi. The results showed that in the last 15 years desertified land area expanded and desertification degree reduced. The area of land desertification increased 5.09% which was worsened. While the land of serious desertification was diminished by a big margin which decreased 26.48%. Moderate and light desertification was increased. The spatial and temporal changes of desertification were complicated due to cultivated land desertification, which contributed 55.36% of total changed area, and forest land degradation, which contributed 25.72% of total changed area. Fundamental farmland constriction and ecological natural recovery reversed the land of desertification. Although the regional land desertification has been under control, but the land ecosystem is so fragile that desertification is liable to occur. The rising number of people and livestock and social economic development has been the primary elements that cause desertification.

1 INTRODUCTION

The farming-pastoral zone of the Northern Shaanxi Province is situated in the transitional zone of the Maowusu Desert and the Loess Plateau. This region has extreme climatic and environmental conditions and long history of anthropogenic interventions. The ecological system is rather fragile and land degeneration is serious. The region has been one of the representative areas of desertification and a main origin place of sandstorms. In recent years, with the constructions of heavy and chemical energy industrial infrastructures and implementation of western development projects in the Northern Shaanxi Province, the environmental problems become more severe, which presents significant challenges for sustainable development of local society and economy. Therefore preventing land desertification and ecological system deterioration has theoretical and practical significance. This research employed remote sensing and GIS modeling to investigate the spatial and temporal distribution and conditions of land desertification in this region, reveal the type, degree and dynamic change of desertification, discuss mechanism of desertification formation and evolution patterns. The result of this study will provide a science and technology-based reference for study and decision-making in battling desertification in such a significant section of farming-pastoral zone in northern China. [1]

2 MATERIALS AND METHOD

2.1.SKETCHY CIRCUMSTANCES IN THE STUDIED AREA

The studied area of the Northern Shaanxi Province is situated in the transitional zone of Maowusu Desert and the Loess Plateau with average elevation of 800～1800 m, at 37° 35′ ～39° 02′ N and 107° 35′ ～111° 29′ E, the total area of land is 3.6136×106 hm2.The terrain trend of this region is incline from northwest to southeast of eastern Hengshan , high in the south and low in the north of western Hengshan. With the Great Wall as the boundary, Maowusu Desert has smooth terrain and sand-dunes with beach in Northwestern area; Loess Plateau located in southeastern part with loess hilly-gully region covered by sheet sand and relatively small slope angle; most part of northeastern loess hilly-gully region covered by beam with crushing land and distribution of sand as well as uncovering bedrock. The studied area is arid and semi-arid lands of the inland monsoon climate with enough light, plenty of heart, low precipitation, high evaporation, cold in winter, hot in summer, short forst-free period, too much gale weather and the natural environment is atrocious in this region.

From southeast to northwest region, vegetation by forest steppe to dry steppe and then to desert steppe. The vegetation system in this area is so poor that bio-diversity is very low and ecosystem is not stability. North of Great wall is grassland areas and distribution of Mang long grass, thyme, Artemisia frigida, Xing'an Lespedeza, which compose the typical steppe community, meanwhile super-xerophytes such as Sand Stipa, the Gobi Stipa, clubfoot flowers, leaves Euphorbia wide, and Reaumuria soongorica, Younuo Chenopodium album composed the desert steppe. South of Greatwall its vegetation from forest steppe to grassland, composed highwood and brushy grassland, such as Oriental arborvitae, Chinese pine, black locust, willow and ， yellow roses, sea buckthorn, Caragana, Chen Tao Mu, Lespedeza, long silver grass, thyme, Baekyangsa grass, sand cherry.

In dry sandy area growth of plants such as Salix psammophila, sand spin-flowers, hearts cattle Park, Ji Zhao Reed, sand bamboo, Artemisia seeds, bubble beans, oil Artemisia, stinky shrub Parker, riding Lang, bitter beans, and-inch grass, moss grass, Achnatherum splendens, alkali Peng, salt claw feet, thorn, cattail and reed, Spartina grass, and so on.

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Since the soil and water erosion, wind erosion and desertification, the differentiation and development of soil in this region are mainly in physical weathering stage; soil texture mostly composed of sand and silt particle and low in organic matter and nutrition; the main soil types are Cambosols and Primpsols, meanwhile some place distributive Isohumosols、Alkalic Halosols、Gleysoil and Histosol.

The study area includes 7 countries and regions respectively YuYang, ShenMu, FuGu, HengShan, JinBian, DingBian,JiaXian.In this 174 villages and towns, the total population is 21,299,000, which agriculture population is 17,871,000 and population density is 58.7P/km2. This area is the typical zone for agriculture and animal husbandry and agriculture is the main China's national economy in which animal industry and planting industry playing a leading role. Because of the harsh nature conditions especially irrational land utilization and denudation, the ecological system is rather fragile and land degeneration is serious.

2.2.Research Methods

This research employed remote sensing and GIS, got the image dates from the Landsat 5 based on 1986,1993 and 2000, through image correction, enhancement processing, application supervised classification, spatial analysis, multivariate statistical method to analysis[1−4].

2.2.1.Image geometric rectification and image mosaics: Based on control point coordinate of 1:250 000 topographic map, mosaic, segmentation and geometric correction of remote sensing digital map, such as using Yaerbosi plot conical projection, the choice of re-stitching space to the regional match, a pixel grayscale values overlap, and got complete digital imaging of the study area; geometric correction using quadratic polynomial, passed 32-34 on the coefficient of ground control points by the least squares estimation, gray-pixel sampling points chosen neighboring bilinear interpolation, the correction pixel resolution of the space 36m. Control point square error is less than a pixel and edge match square error is less than two pixels.

2.2.2.Image enhancement processing: In ERDAS8.5 image processing system, to the geometric correction and color mosaic of images of conversion, interactive drawing, histogram equalization, and other enhanced processing. Using synthesis color image With TM4 (R), 3 (G), 2 (B), produced for the classification of remote sensing images.

2.2.3.Supervised classification and digitization: Application of man-machine interactive mode to selection and extraction interpretation of sample area and establishment of classification model and discriminate function; With the maximum likelihood Classification (MLC) for the period to monitor image classification, during the initial formation of different distribution of land desertification; processing classification graphs, removed out no real sense polygon and classified calibration error pixel; Finally, classification of vector images and vector classification map formatted.

2.2.4.Spatial overlapping and statistics analysis: Based on ARC / GIS, processing the classification vector graphs, created a topology and the established spatial database; By analysis of the spatial overlay and database, extracted the spatial and temporal information of land desertification in this region and generated the thematic maps; According to the regional natural conditions and socio-economic situation and associated analysis, ensured the major factor cause of land desertification and reveal the causes of land desertification drive mechanism.

3 DYNAMIC CHANGES AND PROCESSING OF LAND DESERTIFICATION.

3.1.The situation of land desertification

Northern Shaanxi farming-pastoral zone land desertification situation is shown in table 1. 1986 has been desertification land in the area are more than 900,000 hm2, representing the region's total land area of 1 / 3, land desertification situation more serious. The area of desertification land are mainly distributed in areas north of the Great Wall, especially above valley of Wuding River town and Yu River town , Yuxi River and the river on both sides of desertification land on sectors-connecting, covers an extensive area, which is a main serious desertification area in the zone. At the same time, north of Shenmu country, southeast of Hengshan country and northwest of Jia, Loess hills area has been patchy distribution of quicksand, the loess areas facing a serious threat of desertification. Severe desertification land widely distributed and in a dominant position in the year of 1986 and 1992, respectively accounting for the region's total land area of 49.7％ and 43.4％; In the year of 2000, moderate desertification lead a dominate type of land desertification and account for the region's total land area of 35.8 ％. Desertification in Shenmu country is the largest area of land in counties of this region (more than 340,000 hm2), and mainly serious desertification;

Yuyang,Hengshan and Jingbian followed, desertification of land in the area are more than 100,000hm2, in which moderately desertification land widely distributed in Yuyang and Hengshan and serious desertification area distributed in Jingbian larger than other countries in the region; land desertification is weak and less than 10,000 hm2 in Jia country and Fugu.

3.2.Dynamic changes of land desertification

Northern Shaanxi farming-pastoral zone land desertification dynamic changes as shown in table 1. The study area of land desertification' scope has expanded and the extent of land desertification is obviously weakened in the past 15 years, and the area of extent land desertification increased by 5.09 ％.Serious desertification of land is shrinking and reduced 26.84 ％ in the past 15 years, and more important index of smaller gradually, the spatial distribution of the contract, the domination of the regional environmental decline; Moderate land desertification was "V" shape change, decreased trend from 1986 to 1993, and then gradually increase from 1993 to 2000, the rate of change as much as 41.8％, and according to the abundance index and important index, moderately desertification land tend to focus on distribution in space, block is lager and the degree of fragmentation is lower than the past, when the region has become the dominant type of land to 2000; Slight changes in land desertification process in a "∧" shape, the area has a substantial increase from 1986 to 1993 ,tend to decrease after 1993 but still higher than 1986, slight desertification land's abundance index and important index is higher than the past in monitoring periods, which shows the spatial distribution extended , block increased and obvious characteristics of fragmentation.

Desertification types	1986	1993	2000	1986-2000		1986-1993		1993－2000	
				Area Change	Change rate	Abundance	Importance	Abundance	Importance
Serious Desertification	452664.9	401077.5	331190.4	-121474.5	-26.8	11.11	17.93	9.43	15.05
Moderate Desertification	241355.7	208249.9	342317.1	100961.3	41.8	9.46	14.85	5.70	23.60
Slight Desertification	215662.9	312938.8	282482.9	66819.9	31.0	5.73	10.90	10.01	16.55
Total	909683.6	922266.3	955990.4	46306.8	5.1	26.30	43.69	24.16	39.01

Table1 Change of Land Areas（hm^2） and Important Indexing the Faiming-Pastoral Zone of Northern Shaanxi Province

3.3.The analysis of land desertification types

Using land use types maps and desertification land distribution maps of different times, through space overlay analysis, statistics the area of transformation, dynamic transformation changes matrix as shown in Table 2, Table 3 and Table 4.

The conversion between desertification land and other land use types. Since 1986, desertification land of the farming-pastoral zone of the Northern Shaanxi Province mainly came from cultivated land desertification and degraded forestland, respectively accounting for 55.36% and 25.72%，grassland and uncovered land have little contribution to land desertification. Especially from 1993 to 2000, more than 110,000 hm2 degradation of forest land transformed to the sand land, accounting for a new form of desertification land 36.99% at the same period. In the same of land desertification, but also a large number of desertification land through comprehensive prevention and treatment for other types downturn, from 1986 to 1993, primarily through reforestation and development of cultivated land, management of the desertification land; from 1993 to 2000, the main way is the combination of development of cultivated land and vegetation and natural ecological restoration, reversed the desertification land.

Land Use Types	Other land types into desert		desert into Other types land	
	1986－1993	1993－2000	1986－1993	1993－2000
Arable Land	202.56	131.25	89.92	143.50
Forest Land	43.37	111.77	123.93	25.49
Grassland	23.04	17.60	27.77	21.70
Residential Land, Industrial and Mining Land, and Transport Land	0.10	0.07	0.39	0.57
Unused Land	31.75	41.51	45.90	77.27
Total	300.82	302.20	287.91	268.53

Table 2 Matrix Type of Land Use Conversion 1986－2000（$103hm^2$）

Desertification types		1993			
		Serious Desertification	Moderate Desertification	Slight Desertification	Total
1986	Serious Desertification	204493.0	70790.0	77680.0	352963.0
	Moderate Desertification	48399.4	45257.8	64669.0	158326.3
	Slight Desertification	67406.2	15338.4	27757.4	110502.0
	Total	320298.6	131386.2	170106.4	621791.3

Table 3 Desertification Land Conversion Type Matrix from 1986 to 1993 Ai j（hm^2）

Desertification types		2000			
		Serious Desertification	Moderate Desertification	Slight Desertification	Total
1993	Serious Desertification	196669.3	91692.4	62422.9	350784.6
	Moderate Desertification	24040.7	110134.5	22417.9	156593.1
	Slight Desertification	36827.1	34238.1	75290.5	146355.7
	Total	257537.1	236065.0	160131.3	653733.5

Table 4 Desertification Land Conversion Type Matrix from 1993 to 2000 Ai j（hm^2）

Internal conversation of land desertification. From 1986 to 2000, the conversion land from serious desertification land to slight and moderate land significantly in study area9 (totally 302585.3hm^2), and moderate desertification land transform to slight desertification (totally 139959.5hm^2). However, some slight desertification land transformed to serious and moderate desertification land, and large area moderate desertification land transformed to serious desertification land. Among them, the transformed area from slight and moderate desertification land to serious desertification land is 176673.4hm^2; from slight to moderate is 49576.5hm2; especially in the 7 years from 1986 to 1993, the transformed area from slight desertification land to serious desertification land is 67406.2 hm^2.

3.4.Characteristics of spatial changes of land desertification

Land desertification of Northern Shaanxi farming-pastoral zone mainly occurred in an area north of the Great Wall in the past 15 years, including the northern Dingbian and Jingbian, the northwestern Hengshan and Shenmu, the most area of Yuyang, a little area of Fugu and Jiaxian. Land surface features are quicksand, barchans and dune distribution widely. From 1986 to 1992 in Jingbian and Dingbian, serious desertification of the land area reduced, moderate desertification of land to the North to back down and sporadic spread of slight desertification land; South of the Yuyang Reservoir, amount of slight desertification land transformed to serious desertification land; Wudaohe waters and northwestern Shenmu, moderate desertification land reduced, surface vegetation coverage increased, while Daliuta area had significant expansion in serious desertification land area. Hengshan, Yuyang, Shenmu is the most active desertification areas, land desertification is extended to southeastern Loess Hills and loess areas are facing the risk of desertification. By the year 2000, large area land got to the moderate desertification along Dingbian and Jingbian, and has significantly expanded to the south than in 1992; serious land desertification in Hengshan eastwardly and the area's mild quicksand has replaced by sand; southeast of Yuyang and Shenmu loess area showing a marked characteristic of desertification.

To sum up, the farming-pastoral zone of Northern Shaanxi Province desertification land area has increased in the past 15 years and shown a slight expansion to the southeast; The extent of desertification has decreased significantly, serious desertification of the land area decreased gradually and steadily into a moderate and slight desertification, moderate and slight desertification area accounts desertification land area more than 65％, desertification dominant type has been from serious desertification into moderate desertification. Which shows that in some fragile ecological environment, such as in farming-pastoral zone, through a large-scale ecological environment construction, land desertification situation can be controlled, and the ecological environment can get to a good condition, the surface land from the initial spread of surface quicksand to most sand dunes fixed and some vegetation covered. However, the region ecological system is rather fragile. Its surface and vegetation on covered extremely unstable and the weather in the drought situation, forest and grassland prone to wilt and degradation due to lack of water. Together with the unreasonable human activities, serious land desertification is likely to occur and land desertification situation is still very grim.

4 CONCLUSIONS

Desertification is land in arid, semi-arid and parts of sub-humid areas, due to climate variability and human-made irrational economic activity, and destroyed the fragile ecological environment caused by land degradation. The dynamic process was integrated control by natural factors and man-made.

4.1 Impact of natural factors

Climate impact of land desertification is the important factors, including rainfall, temperature, evaporation rate, light, and other factors. Northern Shaanxi farming-pastoral zone is the conjoin area of the Ordos Plateau and the Loess Plateau and it is the transition zone from arid region to the semi-arid area. Climate characteristics in this region is scarce rainfall, light enough, strong evaporation, dry surface, strong winds and frequent, and easily prone to wind erosion and sandstorms. In recent years regional temperatures gradually increased, the steady decline in rainfall, the weather tended to drought and induced the desertification development. Strong air-conditioning in the winter under the control of the corporation, formed windy weather, the average maximum wind speed of 16.5 m • s-1, t In winter, strong windy weather is formed by cold air mass control and the average maximum wind speed is 16.5 m • s-1; The sparse desert grassland vegetation is difficult to resist the erosion of wind, sand, dunes, and other mobile driven by the strong winds and move forward. Especially in the spring, not only with drought and little rain, dry surface, but strong winds frequently. From March to May, the average windy day is 9.3 d, which are the most serious wind erosion and sandstorm season

in the year. At the same time, many plants in this period has not yet begun growth, surface vegetation cover sparse; it is farmers planting season, and the surface vegetation and soil structure was destroyed which lead the surface vegetation can not be covered by effective protection and extent the erosion sediment. Therefore, wind erosion and sandstorm's handling and stacking, is most important and direct reason leading to the development of regional land desertification.

4.2 Impact of social and economic factors

It was in the 1980s by the Chinese Academy of Sciences in Lanzhou Desert survey of modern Northern China's expansion of the causes of desertification, 94.5 percent due to human factors [5], and the development and construction of unreasonable human activities leading to desertification is the main reason for growing. After the After Ming Dynasty, the construction of Great Wall had began in Northern Shaanxi farming-pastoral zone and people began to live; In the middle of Qing Dynasty, human occupied a lot of land and natural vegetation destroyed by severe, leading to the occurrence of land desertification[6]. The study area population was 689,800 at the early days of The Liberation, in 2000 reached 2.1299 million, with an average rate of growth 28,800 •a-1, population density 58.9 people • km-2, far exceeding the relevant United Nations organizations identify the critical indicators. Population growth on food and other basic means of subsistence needs of the increase, the solution way is developing resources. And then extensive land resources management, leading to the fragile ecological environment further damage, land desertification intensified.

With the development of technology and socio-economic, the study area blessed the use of grassland resources, vigorously develop animal husbandry, has made significant economic benefits, and "be famous of full husbandry in the world".

livestock from the early 1950s of 672,700 to the end of the 20th century the development 2369,300, large-scale increase in the number of livestock, caused degradation of grassland resources, the productive capacity of grassland decline. In addition, the destruction of the nature risk and sandstorms, the area of sandy land into grassland, and the doubling of livestock also gather to gradual reduction of grassland, pasture for more than its ultimate strength and degradation, gradually replaced by desert. At the same time, the area has abundant coal, petroleum, natural gas and other mineral resources, and promotes urban development. Resource exploitation and urbanization, could destruct surface vegetation, land and water resources, such as desertification and provide the conditions for the occurrence of the land desertification process.

In order to qualitative analysis land desertification drive of human socio-economic factors, select from 1986 to 2000, desertification land area (Y) as the dependent variable, population density (X1), total agricultural output value (X2), the total industrial output value (X3) , The total social investment (X4), annual per capita income of farmers (X5), the total power of agricultural machinery (X6), total grain output (X7), head of livestock (X8) as variables associated analysis and regression analysis, and results shown that sand land various factors and the area met the significant correlation (Table 5) and the factors on the occurrence of land desertification has played a positive role in promoting.

	x1	x2	x3	x4	x5	x6	x7	x8
Sand land	0.90827**	0.99674**	0.98526**	0.9801**	0.99993**	0.99819**	0.96352**	0.7755*

Table 5 the Correlation Coefficient between Desertification Land and Socio-economic Factors

Thus it can see the growth of population need more food, water, fuel, energy resources. While limited land to meet the basic needs of excess population's survival, will increase the utilization of land resources. At the same time, in order to shake off the poverty, farmers had to rely on limited land resources; the development of mining enterprise made the over-exploitation of land resources, which causing surface vegetation was destroyed and vegetation coverage reduced. In arid climate conditions, because of the reason, the ecological environment is fragile and land desertification is serious.

REFERENCES

[1] SUN Jiabin, 1998, Multi-source remote sensing image date fusion. Journal of Remote Sensing, 2（1）,pp, 47～50.

[2] YANG kai, 1998, Principles of remote sensing image processing. Press of Surveying and Mapping, Beijing, pp. 192～348.

[3] Tiancunxiuxing(Japan), 1998, Graph and image technology by computer. Press of Beijing Normal University, Beijing,pp. 45～187 .

[4] ZHU zhenda，1981, Desertification in Northern China and its governance zoning. Press of China Forestry, Beijing,pp. 125～293.

[5] LIU yansui，2002. Analysis of land desertification along Great Wall in Northern Shaanxi Province. Geography Journal, 57（4）,pp. 443～450.

[6] C. petit, T. scudder and E. lambin. Quantifying processes of land-cover change by remote sensing: resettlement and rapid land-cover changes in south-eastern Zambia [J]. International Journal of Remote sensing, 2001,22(7):3435～3456.