USING REMOTE SENSING AND GIS TO INVESTIGATE LAND USE DYNAMIC CHANGE IN WESTERN PLAIN OF JILIN PROVINCE

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ABSTRACT:

By using two-period(1980,2000)remote sensing images and with the support of GIS and RS, spatial pattern of land use change of Jilin province in recent 20 years is interpreted and extracted, and elucidated the human driving forces for the changes of cultivated 1and. Results showed that in the period 1 980 to 2000, the main trends of Jilin province's 1and use change were the transforming from grassland, woodland, and unused 1and to cultivated 1and.Among which, the transformed area from grassland to cultivated 1and was 35.01 percent of the tota1 transformed area. And the dynamic degree of grassland was the biggest. In the process of land use change, the intensity of human 1andscape has been enhanced. The spatial difference of 1and use change was obvious, and the change in western of Jilin province was very big. The transformed cultivated land from grassland and unused 1and mainly distributed in the northwest. The transformed area from woodland 1ocated in the edge region of woodland: the transformed urban from cultivated land distributed in the middle district where gathered many cities. In addition, part of grassland in the west as degraded to unused land. Population increase, economic development and macroscopic policy were the major driving forces for 1and use change of the studied area.

1. INTRODUCTION

The land cover changes due to human land use activities are regarded as the main reason for global environmental change, so the study on them become the forefront and hot spots of research to scholars(Liu Jiyuan et a1 , 2002). The current researches on global land use change generally based on regional case, which focused on the integrated impact research in regional scale. They integrated with the regional plan, decision-making and management of socio-economic sustainable development provide basis for greater scale or global climate change research (Lambin E F et a1, 1999).

The analysis of temporal and spatial process of land use change and familiarity of the key drive factor in this process along with its role help to in depth understand the driving mechanism which causes land use change, and in addition they are valuable scientific basis of the regional management, decisions and sustainable use of land (LI Rui et a1, 2002).

Jilin Province is located in the central area of Northeast China, the central part of the West Bank of Pacific. It possesses a very conspicuous geopolitical relation and strategic position. In recent years the changes of land use were significant. There was ecological environment phenomenon of lawn reclamation, land degradation and deterioration in some areas. Based on the analysis of dynamic changes of land use during recently 20 years in Jilin Province, the characteristics of land use change and its causes were clarified, which laid the foundation for the sustainable use of land resources and environmental protection.

2. DATA PROCESSING AND RESEARCH METHODS

2.1 Remote Sensing Image Processing

First, the Landsat TM images were adjusted by the Geometric Exactly Correction of Image which was based on ground control points. 36 control points were selected by contrasting remote sensing images with the 1:10 million topographic maps. The control points were the crossover points of the clear linear features (.roads, rivers, and channels), or corners of the permanent features which had provided with clear contour. Then the adjustment calculation of control points was done by using cubic-polynomial fitting, and the precision correction TM image which was used for the classification test can be obtained after pixel resampling with the bilinear interpolation method was completed. The whole error of registration was less than one pixel. At the same time linear stretch processing of the images was taken to eliminate the intervals that distributing in both sides of 256 gray-scales. Improving the contrast and definition of images and extruding the details of images make the interpretation of the various land categories easier. The RGB543 false color composite was achieved by the bands which were with the greatest amount of information, the least redundancy and low relativity.

2.2 Classification Method

Bayes supervised classification algorithm is provided with strict theoretical basis, so it can set up the discriminant function for normal distribution data easily, and it has better statistical properties because of applies of the mean and the variance of

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bands in each type as well as the covariance between multi-band synthetically, thus, it has been considered to be the most advanced classification method (Sun Dan Feng et a1, 1999). With the continued development of spatio-temporal dimension of remote sensing data, when we take the Bayes supervised classification we can use the existing land use maps and add expertise knowledge to make sure the region of training. By taking this step and by ameliorating the quality of training sample the accuracy of classification can be improved. Finally, the results of classification are tested by sampling on the spots. In the support of Arcview and Arc / Info software, we can combine the field surveys with other information to extract spatial information of land use types by using the human-machine interactive method.

This study refers to the national common system of land use classification. With the capacity of remote sensing, the land use classification can be divided into six types: cultivated land, woodland, grassland, water area, town residential and industrial land and unused land. Cultivated land refers to the which crops planted on, which includes cultivated area, newly reclaimed land, leisure land, swidden land, crop and grass rotation land. And some other types such as the land that mainly used for farming fruit, farming mulberry and farming forestry, and the land of bottomland and tidal flat which are farmed for more than three years. Woodland is the forestry land that arbor, shrubs and bamboo grow on. Grassland mainly refers to the lawn that herbaceous plants grow on and covered more than 5 degrees, which includes shrub grassland that is used for animal husbandry and scattered grassland that whose crown density is in the following of 10. Water area is the natural inland water bodies and irrigation-land. Urban and rural residential and industrial land is urban and rural residential land as well as mining and transportation land besides of county and town. Unused land includes sand, saline-alkali soil, wetlands, desert as well as other the land that difficult to be used of.

2.3 Model of the Land Dynamic Study

2.3.1 Model of Land Use Change Dynamic Degree: The dynamic degree of land refers to the amount change of certain types of land-use in a certain period of time in the study area. The expression is:

$$LC = (U_b - U_a) \cdot U_a^{-1} \cdot T^{-1} \cdot 100\%$$

where: LC represents dynamic degree of a certain type of land-use within study time; U_a and U_b represent the number of the certain land-use type at the beginning and at the end of the research; T represents the time that the study covered. When we set T as year, the LC represents annual change rate of a certain type of land use in the study area. The analysis of land use types dynamic change is done by analyzing the land-use dynamic degree can truly reflect intensity of the changes of the regional land use / land cover types. Dynamic degrees are positive that show the number of the land use types have an upward trend in this time, in the contrary, there is a decreasing trend.

2.3.2 Deviation Degree of the Landscape: Landscape deviation degree which reveals the extent that human activities change the natural landscape from the aspect of quantity refers to the deviation extent of the human landscape from the nature landscape. And it The expressions is: landscape deviation=(various construction land+ artificial wafer area+ cultivated land+ garden plot+ planted forest+ artificial grassland)/ total area of land (Wang Xiulan and Bao Yuhai, 1999).

2.3.3 Matrix of Land Use Change: In the Arc / info 8.1 environment, the spatial overlay using two periods land-use maps was put up to obtain the matrix of land use change. Then according to the original transfer matrix, the mutual conversion rate between two periods different types of land use is obtained. Finally the table of land-use conversion matrix is achieved.

3. ANALYSIS OF LAND USE SPATIAL CHANGE

3.1 Dynamic and Landscape Deviation Degree of Land Use Types Analysis

Table1 shows that the calculation results of the areas of land use type changes and dynamic degrees in Jilin Province. From Table 1, we can find out that, in the past 20 years in Jilin Province, areas of cultivated land and town land have increased, however, the areas of other types have reduced in which grassland had most dramatically decreased in rate of 1.39% and followed by the changes of waters in rate of 1.05%. According to the results of landscape deviation degree in 1980 and 2000 we can see that landscape deviation degree has increased from 40.58 percent in 1980 to 46.03 percent in 2000 that showed the intensity of human activities impact has increased.

Land use type	area of change (km^2)	dynamic degree
cultivated land	4340.21	0.31
woodland	-180.41	-0.01
grassland	-3100.57	-1.39
water area	880.08	-1.05
town residential and industrial land	161.26	0.13
unused land	-241.68	0.09

Table 1. Changes of different land use types and their dynamic degree in Jilin Province

3.2 Land use change matrix of Jilin Province

The land use conversion matrix of Jilin Province form 1980 to 2000 was achieved by using the method described above (Table2).

3.3 Land use change and the flow of the core type

As shown in Table 2, the main types and sizes of land use change in Jilin province that showed as Table 3 were obtained by using the conversion matrix of land use. According to the rate of change in size, Table3 included grassland conversed to cultivated land, unused land conversed to cultivated land, woodland conversed to cultivated land, grassland conversed to unused land, water area transferred to unused land, and cultivated land transferred to woodland, unused land transferred to grassland, cultivated land transferred to grassland, cultivated land transferred to cities and towns as well as water area transferred to cultivated land and so on in turn.

The 10 types of land use change hereinbefore occupied 94.28% in the total area of land use change, of which seven kinds of changes correlated with cultivated land that change area occupied 72.37% in the total area of land use changes and four kinds of changes correlated with grassland that change area occupied 54.68% in the total area of land use changes.

types of land use change	areas of land use changes (km^2)	percent（%）
grassland conversed to cultivated land	3255.76	35.01
unused land conversed to cultivated land	1218.53	13.10
woodland conversed to cultivated land	919.31	9.88
grassland conversed to unused land	802.65	8.63
water area conversed to unused land	751.31	8.08
cultivated land conversed to woodland	697.73	7.50
unused land conversed to grassland	606.52	6.52
cultivated land conversed to grassland	221.27	2.38
cultivated land converse to cities and towns	148.09	1.59
water area conversed to cultivated land	146.83	1.58
other conversion types	581.98	5.72

Table 2. Changes of different land use types and their dynamic degree in Jilin Province.

3.4 The spatial distribution of land use change in Jilin Province

The analysis of land use change on the spatial distribution in Jilin Province showed that changes in land use of Jilin Province had significant regional differences, dramatic changes in the western region, by contraries relatively small changes the eastern part. During 20 years, the cultivated land in whole region increased by 4340.21 km^2, primarily from the conversion of grassland, unused land, woodland and water area, thereinto the area that grassland conversed to cultivated land occupied 35.01% in the total area of changes and 75.02% in the total area of cultivated land increased. Nearly 20 years, 28.19% of the grassland has conversed into cultivated land, mainly in the north-western part of Jilin Province. The decrease of grassland area resulted from the effects of the natural conditions and socio-economic environment. As the rise of temperature level and the heavy demand on cultivated land caused by population pressure, the grassland which in the region where light and heat resources adapted to growth of crops has been assarted to cultivated land. This leaded to the mass conversion of grassland to cultivated land.

The area that unused land conversed to cultivated land occupied 13.1% in the total area of changes. These area locate in the northwest of Da'an City, the northeastern part of Taonan County, the south of Tongyu County, the northeast of Qianguo County, the north of Fuyu County, central north of Dehui City, central and southern part of Shuangliao County. The main reason of the area change is the use of wetlands and other difficult used land to be cultivated. Due to the drive of economicinterests,some mountain valley, slopes, hummock, and other better hydrothermal conditions woodland was cultivated, so the area that unused land conversed to cultivated land occupied 9.88%in the total area of changes, mainly located in the northern part of Shulan County, the east of Jiutai, Lishu and Shuangliao County, the western part of Changling County, the east and the south of Qianguo County. The conversion of farmland to forest mainly distributed in the eastern low mountains and hills region and the western plains staggered area, which is at the edge of the forest. The conversion of water area to farmland mainly located in the intersection of Da'an, Zhenglai and Taonan counties, which strip extended along both sides of the Tao'er River; at one time, many areas distributed in the southwest of Jiaohe County, the north of Huadian City, as well as along the upper reaches of the Songhua River and the Songhua Lake around was mainly due to the development waters by local farmers for the indraught of rice paddy fields.

1980-2000		cultivated land	woodland	grassland	water area	town land	unused land	total in 1980
cultivated land	A	69933.05	697.73	221.27	19.24	148.09	118.68	71138.06
	B	98.31	0.98	0.31	0.03	0.21	0.17	37.25
	C	92.65	0.83	2.65	0.58	2.25	0.91	
oodland	A	919.31	83356.12	85.35	5.19	8.87	39.59	84414.43
	B	1.09	98.75	0.10	0.01	0.01	0.05	44.20
	C	1.22	98.95	1.02	0.16	0.13	0.30	
grassland	A	3255.76	56.99	7405.67	19.58	7.52	802.65	11548.17
	B	28.19	0.49	64.13	0.17	0.07	6.95	6.05
	C	4.31	0.07	88.71	0.59	0.11	6.15	
water area	A	146.83	7.50	29.79	3256.51	0.06	751.31	4191.99
	B	3.50	0.18	0.71	77.68	0.00	17.92	2.19
	C	0.19	0.01	0.36	98.33	0.00	5.76	
town land	A	4.80	0.31	0.00	0.00	6416.50	0.00	6421.61
	B	0.07	0.00	0.00	0.00	99.92	0.00	3.36
	C	0.01	0.00	0.00	0.00	97.47	0.00	
unused land	A	1218.53	115.64	606.52	11.38	1.84	11322.15	13276.06
	B	9.18	0.87	4.57	0.09	0.01	85.28	6.95
	C	1.61	0.14	7.26	0.34	0.03	86.86	
total in 2000		75478.27	84234.29	8348.60	3311.91	6582.87	13034.38	191092.73

Table 3. The transfer matrix of land use of Jilin Province from 1980 to 2000

The area that grassland conversed to unused land occupied 8.63% in the total area of changes, mainly located in the southern part of Da'an City and Qianguo County, the east and the south of Taonan County, the central part of Changling County; and the conversion of water area to unused land mainly distributed in Zhenlai County, Da'an City and the south of Jiaohe City. The conversion of grassland and water area to unused land mainly due to grassland desertification, salinization and level of the waters decline which result from the unreasonable reclamation.

The area that cultivated land conversed to woodland occupied 7.50% in the total area of changes, mainly in the east and the south of Qianguo County, the southern part of Taonan County, and the west of Tongyu and Changling County; and cultivated land conversed to grassland occupied 2.38%, mainly in the central part of Tongyu County, the north of Zhenlai County and the southern part of Taonan County; as well as the conversion of unused land to grassland mainly in the west of Zhenlai County, the central part of Da'an City and the southwest of Tongyu County. These counties are the ecological damage serious and ecological environment relatively poor areas. And these phenomena are closely related with the vigorous construction of ecological province promotion, which show that the returning farmland to forest and grassland policies emerge initial effect.

A large number of cultivated land is occupied for town land as the rapid economic development in recent years of the region which is an area important cities distribute in, so the conversion of cultivated land into town residential and industrial land accounted for 1.59%, mainly located in the northwestern and the central part of Changchun City, the central part of Jilin City, the north of Siping City, Jiutai City, Dehui City and so on, which taked on band distribution, along the Changchun City -- Jilin City-- Siping City, a line was a Siping City - Distribution.

4. ANALYSIS OF LAND USE DRIVE FACTOR

Despite from the view of long time scale, natural and man-made factors are both driving the land use / land cover changes, but in a short time scale, human activities are the main driver factors of land use. Compared with other parts of the country, Jilin Province is the area that mainly droved by the best economic benefits and the variety of food security, and together with many other driven factors. As mentioned above, the area of land use change relative with cultivated land occupied 72.37% in the total area of changes, so the change of cultivated land is the core type of land use change in Jilin Province and also a breakthrough of land use change driver analysis. In this paper, we take the changes of cultivated land as an example to analyze the driver factors of land use change in Jilin Province.

Some deviations occurred between graphical spatial data of land use and statistical data because of graphical spatial data of

land use was obtained by interpreting the spectral reflectance characteristic of surface covered area in the study region; however, statistical data were reported by all levels of administrative departments. But in terms of land use change, the trends of the both data were unified in the same period of the same study area. Because the current spatial data were shorter time-series data so they could not meet the demands of land use dynamic change mechanism, so in this paper, the dynamic changes of cultivated land were analyzed based on the statistical information during the study time in Jilin Province.

4.1 The impact of land use change on population growth

Population change is one of the most important driving forces also the most dynamic one which leads to the regional land use change. On the one hand, it indirectly impacts on the changes of land use and its spatial distribution through affecting the demand of agricultural products, on the other hand it will direct impact on the land use change in a certain extent, for instance as the increase in the number of population, the quantity of cultivated land resources for human life and the need to survive as well as the amount of town aggregation land for human habitation and livelihood and its accompanying traffic volume have increased rapidly, resulting in changes of land use patterns, extent and land cover.

From 1980 to 2000, the population of Jilin Province has increased from 22106500 to 27279900 with a total rate of 23.40%, and the average annual rate of increase reached 1.17%. Correspondingly, in the same period cultivated land increased 6.01 %, town residential and industrial land increased 2.51%, grassland decreased 27.70%, water area decreased 20.99%, unused land reduced 1.82%, which showed the trend that various types of land use transformed to cultivated land. The population growth and the demand for grain caused by population growth in Jilin Province are the root causes that grassland, unused land, and even water area were assarted to cultivated land.

4.2 The impact of macroeconomic policies on land use change

In the mid-1980s, due to higher grain prices and the comparative advantages of farming compared with animal husbandry operations, coupled with the influence of a new wave of reserve land resources exploitation in whole country, the grassland was cultivated. In the late 1990s, the central government launched policies of returning farmland to forest and grassland and ecological construction in time. Jilin Province put forward the target of ecological province construction that leaded to the conversion of some cultivated land to woodland, grassland to farmland, unused land to grassland. During the 20 years, the total area of conversion which cultivated land changed to grassland and woodland as well as unused land to grassland reached 1525.52 km^2 that accounted for 16.40% in the total area of changes. However, returning farmland to forest and grass and the protection of forest and grass need for more input of manpower and financial resources. The ecologically fragile area in west of Jilin Province is one of the main reversed areas, which also needs sustained efforts for the real reversed forest and grass.

5. CONCLUSIONS AND DISCUSSIONS

(1) In nearly 20 years, the major performances of land use change in Jilin Province are on the conversions of grassland, woodland, unused land to woodland. The conversion of grassland to cultivated land is the main source of cultivated land area increase. Land use change of Jilin Province has significant space differences, thereinto the changes in the western region are even more. The regions of grassland and cultivated unused land locate in the western part, as well as the transformation of cultivated land to grassland and woodland. The regions of the woodland are opened up more distribute at the edge of forest. The conversion regions of water area into cultivated land locate along the strait of river which is closely related with the cultivation of paddy fields by farmers. Conversion of cultivated land to town land mainly distributes in the aggregation area of central city in Jilin Province.

(2) Land use change is one of the most significant manifestations which reflect the role of human activities on natural resources and the environment. The human driving force is the main driving force of land use change in this region. Recent 20 years, the population growth is the fundamental reasons for cultivated land increase and series of land use change in Jilin Province, and the economic development is an important human driving force of land use change; moreover, macroeconomic policy of national and provincial government is also one of the driving forces which impact on land use change
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(3) Grassland is an important natural resource. In Jilin Province, a great many of grassland was cultivated, and that some grassland become to unused land because of desertification and salinization which resulted from unreasonable use. With reversed policy and objectives of the construction of an ecological province established, the trend of woodland and grassland to cultivated land is certainly controlled. We should strengthen the protection measures, in addition, control population growth, improve the level of agricultural intensive, vigorously develop secondary and tertiary industries, and reduce population and economic development pressures on land resources to effectively protect the natural ecological environment.

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