Farmland Landscape Pattern Change in Changping District of Beijing in Recent Ten Years

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Abstract- **With the development of economy in recent years, Beijing's urbanization is rapid expansion and it has great influence on suburban farmland. This article analyzed the variation of the cultivated land and landscape pattern during the period of 1998-2009, based on TM images data in 1998 and 2009, land use map and administration planning map of Beijing in 2005, by the RS, GIS and Fragstas software platform. The results showed as follows: That the cultivated land in Changping District of Beijing had converted mainly into construction land about 10818.36 ha with the percentage of 48.45,but also forest land converted into cultivated land about 7740.99 ha. The indexes of landscape pattern had different change trend. The CA decreased about 13.8%, however, NP and Pd increased 75.7%, which meant that the fragmentation degree of landscape had increased; the AI and CONTAG of mosaic indexes had decreased 5.9% and 11.9%, and also the same declined trend for the PLAND and LPI of dominance indexes with 13.8%, 72.7% respectively, but the increased 16.2% for the Shannon diversity index, which meant that the heterogeneity intensity of landscape had increased, and connectivity decreased; the LSI and ED had the same increased trend of 36.1% and 26.3% respectively in the past 10 years, which meant that the boundary of patches had more complex characteristic.**

Keywords- **cultivated land; landscape pattern index; transition matrix; suburban area of Beijing**

Ⅰ INTRODUCTION

As public resource products, the quantity and quality of cultivated land has close relationship with the country's food security, and it plays a significant role in maintenance the national security and social stability [1]. China has the most stringent farmland protection policy in the world. It has become the general consensus of the whole country of sticking to the "red line" for 18 million mu of cultivated land [2]. Conversion of arable land has a more profound impact to the quality of cultivated land in the current system of balance arable land [3-4].

After China reform and opening to the world, with the rapid development of society and economy, as the political and cultural center, Beijing has undergone enormous changes in the past 20 years. With the rapid development of urbanization process, Beijing is mainly a lot of land occupied by construction land [5], such as factories, shops, residential and so on.

As the main elements of land-use landscape [6], the spatio-temporal pattern of cultivated land change plays an important role on spatial pattern of land use. Maintaining and preserving the stability of the landscape of cultivated land is the most urgent problem to be solved in order to plan land use and protect farmland [3]. Urbanization has basically been completed in urban Beijing, and residual arable land is scarce [7]. Consequently, it is strategic significance for the research on farmland landscape in the suburb area of Beijing, and will also provide reference basis for the sustainable development of suburb area of Beijing. This paper studies the changes of farmland landscape in Changping district located in northwest of the city center of Beijing.

Ⅱ BACKGROUND OF RESEARCH LOCATION

Changping district is (40°2′18″N ～ 40°23′13″N;115°50′17″E～116°29′49″E) located in the northwest of Beijing center, and is one of the suburban districts and counties in Beijing（see Figure 1）. Its total area is 1352 km^2, and the size of arable land is 28 million mu. Changping is situated on the combined area of floodplain of Wenyu River and offshoot of Yanshan and Taihang mountains. Terrain is from high in northwest to low in southeast. Two third of total area is mountain or mid-mountain. The elevation of mountain area is from 800m to 1,000m, and plain area is from 30m to 100m. The main rivers belong to Wenyu River. Changping is characterized by warm temperate, semi-humid continental monsoon climate. The mean annual sunshine is 2684h. The mean annual temperature is 11.8℃, and mean annual precipitation is 550.3 mm.

Ⅲ DATA AND METHODS

The source datum are consist of two periods of LANDSAT-5 TM images in 1998 and 2009 with 30 meter spatial resolution, and DEM data from the huttle Radar Topography Mission（SRTM）of Global land cover facility（GLCF）with 90 meter of spatial resolution.

On ERDAS and ARCGIS software, pre-processing of TM images at two periods, geometric correction, polygon

subset were done, image enhancement, and then it applied supervised classification and unsupervised classification

Figure 1 The administrative map of Beijing

to obtain polygon maps of land use. The accuracy of overall classification can reach 98.72%. Then extracting of thematic data based on human-machine interactive interpretation under the support of ARCGIS. Combine with the characteristics of on-spot investigation in Changping, It was classified into 6 landscape types and 18 patch types. In this study, landscape patches were classified into: cultivated land, forested land, construction land, water, grassland and unused land. Then it calculated the transfer matrix of land use and landscape pattern index under the support of ERDAS and FRAGSTATS （version3.3. The transfer matrix of land use and landscape pattern index were seen in Table 1. It should be pointed out that due to measurement difficulties, some linear features were included in the landscape patch, such as roads and ditches [8]. The flowchart of this research was seen in figure 2.

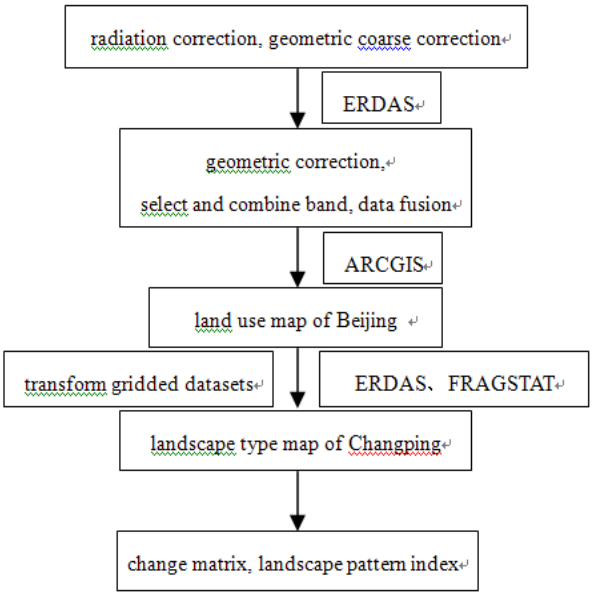

Figure 2 The flowthart of this research

Ⅳ RESULTS AND DISCUSSION

A. The trend of landscape land use changes

The Figure3 showed the changes of landscape land use in Changping area from 1998 to 2009. We could see that cultivated land and it's quantity were sharply reduced, and that it was broken distribution. At the same time, construction land was increased. It is account for the sharply urbanization in Changping area from 1998 to 2009.

Table 1 Landscape pattern index

Index	Formula
Fragmentation Index	
CA	$CA=\sum_{j=1}^{n}a_{ij}(\frac{1}{1000})$
NP	$N_P=\sum_{i=1}^{m}N_i$
PD	$PD=\frac{N}{A}(10{,}000)(100)$
Mosaic index	
AI	$AI=\left[\sum_{i=1}^{m}\left(\frac{g_{ii}}{\max\rightarrow g_{ii}}\right)P_i\right](100)$
CONTAG	$CONTAG=\left[1+\frac{\sum_{i=1}^{m}\sum_{k=1}^{m}\left[(P_i)\left[\frac{g_{ik}}{\sum_{k=1}^{m}g_{ik}}\right]*\left[\ln(P_i)\left(\frac{g_{ik}}{\sum_{k=1}^{m}g_{ik}}\right)\right]\right]}{2\ln(m)}\right](100)$
Shape index	
LSI	$LSI=\frac{0.25E}{\sqrt{A}}$
Dominance	
PLAND	$PLAND=P_i=\frac{\sum_{j=1}^{n}a_{ij}}{A}(100)$
LPI	$LPI=\frac{\max_{j=1}^{a}(a_{ij})}{A}$
Edge character	
ED	$E_D=\frac{E}{A}10^6$
Diversity	
SHDI	$SHDI=-\sum_{i=1}^{m}(P_i\ln P_i)$

B. Land use change matrices

The transition matrices（Table 2 and 3）highlighted the dominant dynamic events during the study period. It could be seen that cultivated land converted to forest, construction land, water, grassland and unused land from 1998 to 2009. The transition areas were 2674.62 hm^2, 10818.36 hm^2, 196.65 hm^2, 1691.73 hm^2 and 128.43 hm^2, respectively, corresponding transferring rates were 11.98%, 48.45%, 0.88%, 7.58%, 0.58%. The most prominent land use change has been happened from cultivated land to construction land. It is resulted from rapidly urbanization in Changping district.

In addition, forest land, construction land, water, grassland and unused land also shifted to cultivated land. The transition areas were 7740.99 hm^2, 3838.32 hm^2, 940.32 hm^2, 117.72 hm^2 and 78.21 hm^2, respectively, corresponding transferring rates were 8.95%, 20.41%, 26.49%, 0.21% and 49.57%. The unused land, water and forest land is more convert to cultivated land. This is inseparable from the sand control project.

C. Landscape pattern index

The table4 showed changes of landscape pattern index of Changping from 1998 to 2009. We could see that CA of cultivated land decreased from 22858.83 m^2 to 19698.12 m^2, the NP increased from 931 to 1636, the PD also increased from 0.4165 to 0.7319, which indicated the landscape fragmentation of cultivated land had been increased. AI and CONTAG were decreased from 88.8551% and 62.6052% in 1998 to 83.5801% and 55.1412% in 2009, and respectively decreased by 5.9% and 11.9%. It indicated that common boundary of cultivated land were reduced, and that polymerization degree and connection degree of patches were reduced. LSI increased from 57.0526 to 77.6261during 1998-2009, which showed that the shape of landscape patch in Changping is more and more irregular and the degree of shape complicated increased. PLAND and LPI were decreased from 10.2271% and 2.0468% in 1998 to 8.8130% and 0.5585% in 2009, respectively. It's the result of human activities on farmland landscape, which made the large area of cultivated land patches rapidly decreased and the trend to be more human planning. ED was increased from 15.4377 in 1998 to 19.5044 in 2009, which reflected the degree of patch fragmentation and spatial heterogeneity increased. SHDI increased from 1.2686 to 1.4747, reflected the land use more diversification and the patch types increased or the trend of various patch types in the landscape were balanced distribution for recent 10 years.

Ⅴ CONCLUSION

The area of cultivated land in Changping district has been lost during 1998-2009. It mainly changed into construction land. The landscape pattern of cultivated land had tend to increasing fragmentation, and decreasing mosaic degree, and its spatial connectivity, spread degree, and dominance were reduced. The shape of patch was more complicated, and space heterogeneity was greater, and the overall landscape pattern was diversity. Certainly, there are still inadequacies in this article. With only two LANDSAT TM images in 1998 and 2009, and the interpreting error of water types based on supervised classification and so on.

ACKNOWLEDGMENT

Partial funding for this research was provided by National Natural Science Foundation of China (No. 40871232 & 40501029)，Beijing youth backbone teachers project" of Beijing higher education school education plan in 2011 (No. PHR201108286), and the Project of construction of innovative teams and teacher career development for universities and colleges under Beijing Municipality, and the creative group project from Prof. Zhao Jianzhuang. Otherwise, Liu Yun and Li Chunlei have the same contribution for the article, and they are the corresponding authors.

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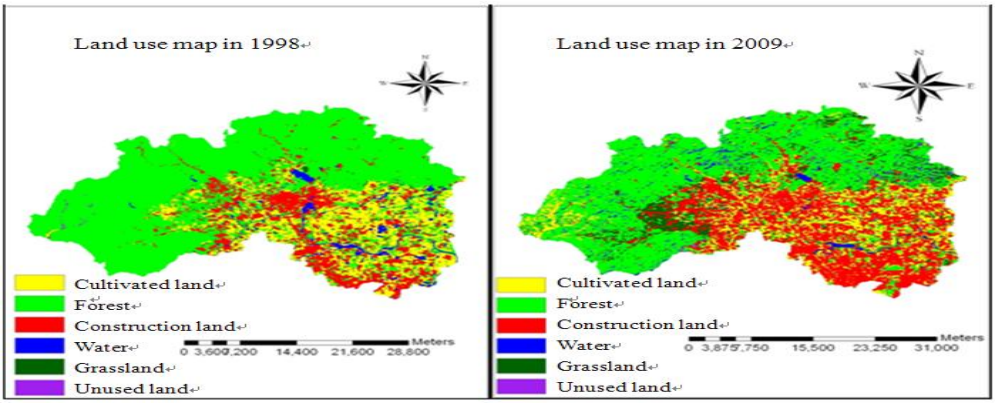

Figure3 Land use map of Changping District in Beijing

Table 2 Transition matrix of and use in 1998 and 2009(unit: hm^2)

1998	2009						Total
	Cul	For	Con	Wat	Gra	Unl	
Cul	6819.57	2674.62	10818.36	196.65	1691.73	128.43	22329.36
For	7740.99	56092.23	10170.27	2708.01	8924.31	882.72	86518.53
Con	3838.32	1584.09	12526.29	110.52	725.58	23.49	18808.29
Wat	940.32	489.6	1562.22	404.1	146.16	7.38	3549.78
Gra	117.72	259.29	204.48	2.34	122.31	7.47	713.61
Unl	78.21	59.04	10.62	4.05	5.67	0.18	157.77
Total	19535.13	61158.87	35292.24	3425.67	11615.76	1049.67	132077.34

Note: Cul=Cultivated land; For=Forest; Con=Construction land; Wat=Water; Gra=Grassland; Unl=Unused land.

Table 3 The transfer percentage of land use (unit: %)

1998	2009					
	Cul	For	Con	Wat	Gra	Unl
Cul	**30.54**	11.98	48.45	0.88	7.58	0.58
For	8.95	**64.93**	11.76	3.13	10.31	1.02
Con	20.41	8.42	**66.6**	0.59	3.86	0.12
Wat	26.49	13.79	44.01	**11.38**	4.12	0.21
Gra	16.5	36.33	28.65	0.33	**17.14**	1.05
Unl	49.57	37.42	6.73	2.57	3.59	**0.02**

Note: Cul=Cultivated land; For=Forest; Con=Construction land; Wat=Water; Gra=Grassland; Unl=Unused land.

Table 4 Landscape pattern indexes of cultivated land between 1998 and 2009

Index type	Index	1998	2009	Change rate (%)
Fragmentation Index	Classes area (CA)	22858.83	19698.12	-13.8
	Numbers of patch (NP)	931	1636	+75.7
	Patch density (PD)	0.4165	0.7319	+75.7
Mosaic index	Assimilate index (AI)	88.8551	83.5801	-5.9
	Cotangent index (CONTAG)	62.6052	55.1412	-11.9
Shape index	Landscape shape index (LSI)	57.0526	77.6261	+36.1
Dominance	Percentage of landscape (PLAND)	10.2271	8.813	-13.8
	Largest patch index (LPI)	2.0468	0.5585	-72.7
Edge character	Edge density (ED)	15.4377	19.5044	+26.3
Diversity	Shannon diversity index(SHDI)	1.2686	1.4747	+16.2