QUANTIFY THE LANDSCAPE EFFECT OF RURAL REGION PLANNING NEAR METROPOLIS USING HIGH SPATIAL RESOLUTION REMOTE SENSING-CASE STUDYIN GAOLIYING TOWN IN BEIJING

Shiliang Liu [1,*], Yuhong Dong [2], Wei Fu [1], Min Yang [1]

[1] *School of Environment, State Key Laboratory of Water Environment Simulation, Beijing Normal University, Beijing 100875*

[2] *Yucheng Comprehensive Experimental Station, Institute of Geographic Science and Natural Resources, Chinese Academy of Sciences, Beijing 100101*

[*] *Corresponding author, Address: School of Environment, State Key Laboratory of Water Environment Simulation, Beijing Normal University, Beijing 100875 P. R. China, Tel: +86-10-86965659, Fax: +86-10-58800397, Email: shiliangliu@163.com*

Abstract: The urban fringe which can be seen as a special form of regional ecosystems with a spatial structure gradually from urban to rural areas of transition, has strong heterogeneity and is typical of ecologically sensitive areas. The expansion of city caused wide attention to the landscape effect of the changes. With the help of GIS, we got landscape pattern changes before and after town planning of Gaoliying town in Beijing by using high resolution image and large-scale map. The results showed that landscape shape index, contagion index and Simpson evenness index increased while landscape diversity index reduced. The pattern of reasonable land use would improve and landscape pattern come to perfect. The intensity index of human disturbance increased. Comparing three increase modes of town development, the landscape pattern change of Gaoliying town is peripheral increase mode.

Keywords: edge of city; land use; landscape pattern index; land plan; landscape effect

1. INTRODUCTION

Urban fringe is a certain stage of urban development when the social, economic functions and impacts spreading from the core areas to the surrounding region. It was formed between urban and rural areas and its features, structure and function exhibit between urban and rural region. The interaction and integration of social, economic, environmental, and other elements between the villages, towns and city existed in these special zones. From formation and development process of urban fringe, it is a result of urban centralization and extension. It can be seen as a specific phase of a typical form of urbanization (Mao and Liu, 2005). The edge zone of Beijing covers most of the plain areas where arable land is the major land use. It is also the frontal areas undergoing urbanization process (Li, 2006). Small towns' development is the center in the development of edge zone of Beijing and play important role in the process of urbanization and sustainable urban development (Cui, 2001). It is practical to study The development of cities will inevitably lead to land use and land cover changes (Bao and Men, 2003). At present, the ecological and environmental effect of land use/land cover changes and land planning causes increasing attention. At landscape scale, most studies focused on quantifying the structure and characteristics of regional land-use changes (Lu et al., 2001).

Although in China, many researchers have carried out a great deal of studies on this topic, most studies focused on the large-scale urban or representative land use change (Li, 2004). Also, these studies mainly focused on the comparison between historical and current situation. Modeling method was used to elucidate the landscape effect of land use change which often results in large errors. The scope of small-scale land-use change and landscape effects of land planning was little touched. At town scale, landscape effect study of land planning in the urban edge area has not yet been involved.

This paper takes Gaoliying town in Shunyi district in Beijing as an example to study the landscape effect. We used high spatial resolution SPOT image, GIS and landscape software FRAGSTAT to quantify the landscape pattern before and after the landscape planning.

2. THE OVERVIEW OF STUDY AREA

Gaoliying town is located in the northeast suburbs of Beijing in Shunyi Distric covering an area of 54 square kilometers. It is one of the 27 key planning towns in Beijing and was identified as the central town in Shunyi District. The town is also an important agricultural and industrial base. There are 24 administrative villages with 230,000 resident populations. Transport

facility and transportation network was developed with vantage location conditions. The climate in Gaoliying is warm temperate and semi-arid sub-continental monsoon with ample sunshine throughout the year and four distinct seasons. At present, the landscape is mainly agricultural ecosystem and lies in the transitional zone of urban and rural areas.

3. METHODS

3.1 Data acquisition

Current land use type map was derived from SPOT image in 2006. RS and GIS software was used to classify the landscape. The 1:30000 scale topographic maps were used for geometric rectification Then image-to-image registration was conducted between the image and 1:30000 map using the nearest neighbor resampling algorithm. Root mean square (RMS) errors of each registration were maintained below 0.5 pixels (<1m). Also a field survey was conducted to rectify the map. The land plan map was digitalized from the papery land plan map (1:30000). In order to compare, a consistent system of classification were used.

3.2 Methods

Landscape consists different size of patches and the spatial distribution of patches is called as landscape pattern (Fu et al., 2001). Landscape pattern is the result of long-term natural or anthropic effect, also the landscape pattern can directly affect the process.

Landscape indexes can highly concentrate the information of landscape patterns. They can reflect landscape composition and spatial configuration by simple quantitative indicators (Wu, 2007).

Based on the regional landscape features, We selected Patch Density, Fractal Dimension, Landscape Shape Index, Contagion Index, Shannon Diversity Index, Simpson Evenness index, Human disturbance index to characterize the landscape effect of planning. With the support of Arcinfo, land use and land planning vector map were converted into landscape grid map (grid resolution of 2m). The landscape indexes were calculated by FRAGSTAT program (Deng et al., 2005; Yang et al., 2005).

4. RESULTS

4.1 Land use change before and after town planning

In this paper, a uniform classification of landscape was used to avoid the error from different classification (Yan, 2004). Landscape in Gaoliying town was divided into farmland, woodland, water, constructed land (including public facilities, industrial sites), residential area, town land, road, green land and other types (Figure 1). Land use change before and after town planning was listed in Table1.

The proportion of a landscape type of the entire landscape area represents the contributing rate of each landscape type (He et al., 2005). From Table 2, the landscape area was farmland > woodland > constructed land > residential area > garden land > water body > road> waste land > town land > green land. After land planning, landscape area will show farmland > green land > road > constructed land > town land > water body > residential area > garden land. Obviously, the farm land are the main land use type before and after land planning which accounts for 35.52% at present and for 59.78% after planning. This result showed that agricultural landscape is the dominant landscape type in Gaoliying town. Also, the intensive land planning will bring out more farmland. Woodland, constructed land, residential area, garden land, and water body will reduce after planning while the Town land, Road and Green land will increase.

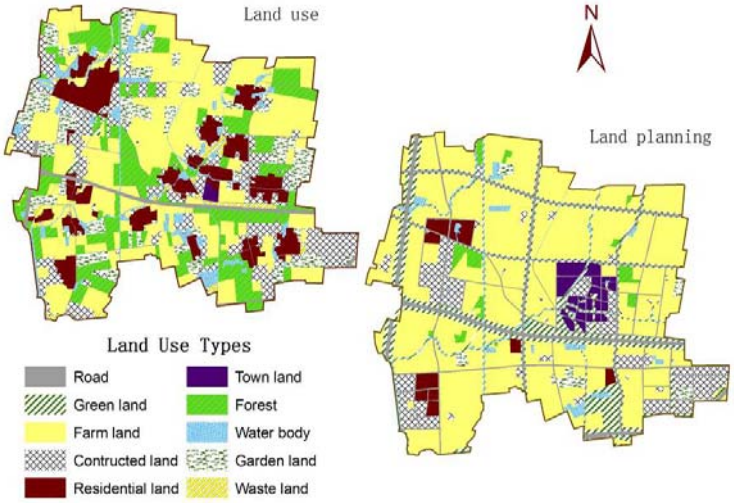

Fig. 1: Land use and land plan Map in Gaoliying town

Table 1 Changes of land use before and after town planning in Gaoliying

Landscape type	Present		Land planning		Area changed
	Area (hm^2)	Ratio(%)	Area (hm^2)	Ratio(%)	Area (hm^2)
Road	180.01	3.36	505.99	9.44	325.98
Green land	6.87	0.13	631.19	11.78	624.32
Farmland	1904.06	35.52	3204.47	59.78	1300.41
Constructed land	765.72	14.29	451.19	8.42	-314.53
Residential area	617.18	11.51	131.42	2.45	-485.76
Town land	15.84	0.3	134.8	2.51	118.96
Woodland	931.72	17.38	93.94	1.75	-837.78
Water body	280.84	5.24	134.74	2.51	-146.1
Garden land	562.23	10.49	72.27	1.35	-489.96
Waste land	95.53	1.78	—	—	-95.53
Sum	5360	100	5360.01	100	0.01

The proportion of town land can scale the urbanization level (Yuan et al., 2003). Obviously, the urbanization level of Gaoliying town is very low at present which the town land proportion is only 0.30%. Also, the town infrastructure of roads and green land account for a smaller proportion with 3.36% and 0.13% respectively. After land planning, the urbanization level will increase to 2.51%, waste land will be fully developed and the roads and green land increase to 9.44 % and 11.78%.

4.2 Land-use transfer matrix analysis

Using GIS spatial analysis, land use and land plan vector map were overlaid for statistical analysis. The transfer probability matrix before and after land use planning was shown in Table 2.

Table 2 Transfer probability matrix between different land use before and after town planning

Landscape type	Before planning									
	Road	Green land	Farm land	Constructed land	Residential area	Town land	Wood land	Water body	Garden land	Waste land
Road	77.0%	5.5%	7.2%	9.2%	7.5%	13.3%	5.5%	5.8%	6.3%	10.1%
Green land	8.1%	3.3%	9.7%	10.2%	7.1%	30.6%	19.0%	12.1%	8.6%	42.2%
Farmland	11.3%	33.9%	72.8%	38.9%	57.4%	0.0%	65.6%	36.2%	72.2%	29.2%
Constructed land	2.0%	57.4%	6.5%	33.1%	2.1%	0.0%	2.7%	2.0%	3.2%	5.2%
Residential area	0.1%	0.0%	1.3%	2.6%	13.6%	0.0%	0.0%	1.1%	0.0%	0.0%
Town land	0.3%	0.0%	1.1%	2.2%	10.0%	55.1%	0.4%	1.6%	1.3%	11.1%
Woodland	0.3%	0.0%	0.6%	2.0%	0.0%	0.0%	6.2%	2.4%	0.2%	0.0%
Water body	0.7%	0.0%	0.3%	0.8%	1.4%	1.1%	0.6%	36.9%	0.2%	2.2%
Garden land	0.2%	0.0%	0.5%	0.9%	0.9%	0.0%	0.0%	1.7%	8.1%	0.0%

From table 3, the transfer of different land uses were as follows: 1) the increase of road area is mainly from the town land, waste land, constructed land and the conversion ratio was 13.3%, 10.1%, 9.2%; 2) The decrease of garden land, woodland, residential area, constructed land contribute to the increase of farmland and the conversion rate was 72.2%, 65.6%, 57.4%, 38.9%, 36.2%; 3) the increase of town land comes mainly from waste land and residential area and of which 11.1% of waste land and 10.0% residential area have been developed for town land; 4) the increase of green land is mainly from the waste land and town land and the conversion rate is 42.2% and 30.6%. 5) Wasteland will be fully transferred into other landscape types except woodland and garden land.

4.3 Quantitative analysis of landscape pattern changes

4.3.1 Patch level

We selected patch number, patch density and fractal dimension to analyze the landscape change after landscape plan (Table 3).

Table 3 Patch number, patch density and fractal dimension changes before and after planning

Landscape types	Patch number		Patch density		Fractal dimension	
	Present	Planning	Present	Planning	Present	Planning
Road	51	34	4.367	1.704	1.4565	1.4283
Green land	2	180	0.038	3.838	1.1311	1.4299
Farmland	90	121	0.750	0.917	1.2741	1.2886
Constructed land	165	95	1.443	0.805	1.3206	1.2966
Residential area	41	10	0.375	0.112	1.2517	1.1782
Town land	1	24	0.019	0.187	1.0147	1.2248
Woodland	85	19	0.862	0.206	1.2925	1.2263
Water body	71	53	2.493	2.378	1.3804	1.3883
Garden land	44	10	0.656	0.131	1.2521	1.1943
Waste land	28		0.694	—	1.3166	—

As shown in table 4, the road have more patch numbers and the largest patch density which suggest the high fragmentation and scattered distribution. After planning, the road patch number and patch density decreased which suggest the concentrated road distribution and developed network. And the road network will strengthen the link between villages. The patch number of farmland, town land and green land increase which suggest these land types were greatly impacted by human activities.

For the fractal dimension, the town land is close to 1.0 and most fractal dimension decreased after planning. It is obvious that the shape of town land

is simple and regular. Also, the road, constructed land, residential area, wood land, garden land, waste land would be modified by human interference and tend to shape simple.

4.3.2 Landscape scale

At landscape scale, we selected landscape shape index, contagion index, Shannon diversity index, Simpson evenness index, human disturbance index to analyze the overall landscape pattern changes (Table 4).

Table 4. Changes of landscape pattern index before and after planning

Landscape index	landscape shape index	Contagion index	Shannon diversity index	Simpson evenness index	human disturbance index
Present	14.3118	48.8020	1.8027	1.1111	3.0766
Planning	16.4249	56.1687	1.3962	1.1250	5.2338

Table 5 showed that the landscape shape index, contagion index increased after land planning. The results suggest that a few large patches will be dominant in the landscape with high connectivity between the same types of patches. The phenomenon is mainly due to the village centralization policy in the planning. The centralization will combine a number of small near villages with similar natural conditions, customs and habits into a centre village. This will result in the decrease of patches of rural settlements. Also, with the decrease of woodland, water body, garden land, constructed land patch number and the increase of farmland, the connectivity of adjacent patches will increase.

The reason for the decrease of Shannon diversity index is mainly due to the great variation of landscape types after planning. The farm land account for more than 59% and the wastelands were all converted into other lands. After planning the Simpson evenness index increased which indicated that landscape types will distribute more evenly and the fragmentation level decrease.

The human disturbance index increased and this is mainly because the farmland increased greatly. Also the woodland and water body with less human disturbance will decrease after planning.

5. CONCLUSIONS AND DISCUSSIONS

The study takes Gaoliying town as an example to analyze the landscape effect of land planning. Evidently land use will take on great changes with different land use conversion. At patch and landscape scale, further

quantitative analysis was conducted to get a whole condition of land use change. After planning, landscape diversity decreased and the landscape shape index, contagion index and evenness index increased.

The results showed human disturbance and the urbanization level will increase, while at the same time the farmland will also increase with the intensive agriculture development. The planning is a rational approach for farm land protection and urbanization. In Beijing, the development pattern is a suitable mode under the quick urbanization area. From the study, we can derive that Gaoliying town belong to merging growth pattern, that is, integrating farmlands and constructed land to meet the relative concentration of urban development and management.

In the process of urbanization, urban fringe should be frontier for the ecological protection. Reasonable landscape pattern should be established for the land use planning. At the town scale, it is obviously that high resolution image can play important role in the land use management.

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