SPATIAL PATTERN DYNAMICS OF LAND USE IN YONGDING RIVER BASIN IN CHINA

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1. INTRODUCTION

The Yongding River basin, with great vulnerability and sensitivity, generates a series of ecological problems on account of climatic drought and human activities, such as serious water resources decline, vegetation degradation. Ecological and environmental crisis here has posed a serious threat to regional economic sustainable development. Though partially improved, it is now on the process of intensification and deterioration with intensified conflicts among regions. Landscape pattern in river basin is the result of integrated interactions among complicated drivers, such as natural, economic and social drivers. The research of spatial land use pattern dynamics and landscape pattern change evaluation is essential to understand the processes affecting ecosystem. Analysis of land use area change for different types and the resulting change in landscape ecological indicators can help comprehend the characteristics and contents of watershed ecosystem. To monitor land use and ecosystem dynamics in a river basin is useful to reveal the causes and mechanism of land use pattern and helpful in regional planning and sustainable development.

2. DATA SOURCE

Remote sensing images covering Yongding River basin in four periods are used in this study: Thematic Mapper images in 1987 and 2005, Enhance Thematic Mapper Plus image in 2000, and Multi-Spectral Scanner image in 1978. All the images are classified into land use/cover classification map after geometric, radiometric and atmospheric correction, integrating both unsupervised and supervised classification methods. Classification results are validated according to 230 field-surveyed land use/cover type data. The accuracy of classification is 81.1% and Kappa coefficient is 0.71.

3. METHODOLOGY

Spatial pattern dynamics characteristics of land use in Yongding River basin from 1978 to 2005 is studied based on indices representing spatial pattern characteristics of land use/cover such as gravity center migration, diversity index, dominance index, evenness index and fragmentation index.

(1) Gravity center migration analysis

Regional spatial dynamics of land use is generally characterized by gravity center migration of different types which can be reflected by the changes of gravity center coordinates.

$$X_t = \frac{\sum_{i=1}^{n}(C_{ti} \times X_i)}{\sum_{i=1}^{n} C_{ti}} \qquad Y_t = \frac{\sum_{i=1}^{n}(C_{ti} \times Y_i)}{\sum_{i=1}^{n} C_{ti}} \tag{1}$$

In formula, X_t, Y_t are the longitude and latitude coordinates of gravity center of a certain land use/cover type in year t; C_{ij} is the area of this type in zone i; X_i, Y_i is the longitude and latitude coordinates of the geometric center for zone i.The migration of gravity center of land-use types can reflect the spatial pattern changes of land use, and also mirror the overall change trend of land-use type quality.

(2) Diversity index

Land-use diversity index describes the number of patch types and the evenness of their spatial distribution. When the land-use landscape is constituted of a single type, the land-use landscape is homogeneous with a diversity index of 0; when land-use landscape constituted of two or more types, land-use diversity index is the largest when the proportion of every land-use type are the same, and the more the proportion differs, the larger the index is. Higher land-use diversity index means more diverse land use types and evener proportion. Land-use diversity index (H) can be estimated as follow [1]:

$$H = -\sum_{i=1}^{m}(P_i \ln P_i) \tag{2}$$

Where P_i is the proportion of the land-use type i, m is the total number of land-use types.

(3) Dominance index

Dominance index indicated the advantage of one or several types of patches in landscape, which reveals the degree of these types dominating the land-use landscape. The greater the dominance, the greater the difference of the proportion among every land-use type, namely, a certain type or some types of land-use dominate. The formula of dominance index is as follow:

$$D = H_{\max} - H = \ln(m) - H \tag{3}$$

Where H_{max} is the diversity index under the condition of maximum uniform, m is the number of landscape types.

(4) Evenness index

Evenness index describes the degree of land-use landscape controlled by a few ones and reveals distribution evenness degree of different land use types [1].

$$E = H / H_{\max} \tag{4}$$

(5) Fragmentation index

Fragmentation index reflects spatial structure complexity of land use, which is fragmentation degree of landscape and is usually represented by the number of patches for various land use types per unit area [1].

$$C = n_i / MPS \quad (5)$$

Where n_i is the patches number of landscape type i. MPS is the average patch area, which is calculated according to equation (6).

$$MPS = a_i / n_i \quad (6)$$

Where a_i is the total patch areas of landscape type i.

4. RESULTS AND DISCUSSION

The results show that: (1) Study of gravity center coordinate migration reveals that gravity center of farmland moved towards southeast because of conversion to farmland from forest and grassland in the southeast. Gravity center of residence and mining land moved towards east owing to the expansion of cities and towns. Meanwhile, in this period, as forest deforestation and converting to grassland and farmland occurred, gravity center of forest moved towards northeast, the same as that of transportation. And gravity center of grassland moved a little to the east. Then, during 1987 to 2000, gravity center of farmland kept nearly stable, because in this period the area of farmland increased constantly due to population growth and economy development, and the main source is forest and grassland conversion which is distributed in the whole basin. We look ahead to 2005 from 2000 and found that water body reduced in the whole basin and reduced more in the west than in the east, which cause the migration of gravity center to the east. Owing to the strategy of returning cropland to forestland, in this period gravity center of forest shifted a little back to the west.

(2) The research landscape structure characteristic indices show that: from 1987 to 2005 the amount of patches trended to increase gradually and the average area of patch decreased, which could help conclude that the landscape in this river basin was getting more and more fragmented. The gradual increase of diversity index stated that land use type became more and more abundant, and the proportion was not concentrated in certain of types. And this regulation was also reflected from dominance index. In this period, dominance index decreased, which demonstrated that the proportion of former dominating land use types diminished and that for every type tended to be equal. On other hands, landscape of different land use types distributed more and more even in the past years, concluded according to the increase of evenness index. On the contrary, fragmentation degree of Yongding River basin rose obviously. So, in the past years, the whole river basin was interrupted by various factors and compared with former conditions, the system is now unstable and more complicated and vulnerable.

Key words: Yongding River basin in China; land use; spatial pattern; dynamics

5. REFERENCE

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