Analysis on the Tendency of Land Use Type Conversion and Construction of Spatial Map

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Abstract. In order to display the land use change intuitively, this paper analyzes the trend and law of land use change, scientific land resource management and planning. Based on the TM and ETM + images of 1987, 2000 and 2013 in Huailai County, this paper introduces the probability matrix of landscape symbiosis to construct the model of land class conversion tendency, and makes quantitative research and analysis on the evolution of land use structure in Huailai County. The results show that the analysis of the tendency of land use type conversion and the construction of spatial map can clearly show the spatial pattern of land use change and provide basic support for scientific land management and planning.

Keywords: Land Use Type, Conversion Tendency, Spatial Atlas

The study of land use type transformation and its mechanism play an important role in the rational use of land resources and the coordinated development of ecology, economy and environment [1-4]. Traditional expressions such as words, tables and maps of land cover types are not intuitive enough and quantitative research is difficult, while geo-information tupu can express the essential attributes of complex problems succinctly and intuitively. It can not only reflect the spatial difference, [5] but also reflect the information that changes with time. In time and space, it is an effective way to realize land use research efficiently.

1. Data sources and research methods

1.1. Data sources

In this study, Huailai County, Hebei Province is taken as an example. The data types are the Landsat5TM data in May 1987, Landsat7TM data in May 2000 and ETM + image data in August.
2013. The average cloud cover is less than 3%. The accuracy of supervised classification of remote sensing image is more than 80%. According to the classification system of Chinese Academy of Sciences Resources and Environment, Huailai County is divided into forest land, garden land, construction land, water area, unused land and cultivated land.

1.2. Methodology

1.2.1. Tendency of land use type conversion

The probability matrix of landscape symbiosis is introduced into the spatial analysis of land change and associated with the land class transfer matrix, and the land class change tendency model is obtained. To some extent, the capacity of exchange between different land use types can indicate the trend of regional land use change \cite{6}. The probability matrix of landscape symbiosis is shown in Table 1. \(X_{ij}\) indicates the probability that the two land use patterns are adjacent in the landscape, with a minimum of 0% and a maximum of 100%.

**Table 1. landscape symbiosis probability Matrix**

| Type \(i\) | Type \(j\) |
|------------|------------|
| Type \(i\) | \(X_{ii}\) | \(X_{ij}\) |
| Type \(j\) | \(X_{ij}\) | \(X_{jj}\) |

Probability Matrix of land use type transfer:

\[
P_{ij} = \frac{X_{ij}}{\sum_{j=1}^{n} X_{ij}}
\]

In the formula, \(P_{ij}\) represents the transfer probability of the \(i\) land type to the \(j\) land type, and represents the area of the \(i\) land type to the \(j\) land type.

Probability Matrix of landscape symbiosis:

\[
X_{ij} = C_{ij} / \sum_{j=1}^{n} C_{ij}
\]

In the formula, \(X_{ij}\) represents the probability that land use type \(i\) and \(j\) are adjacent to each other, and the grid number \(C_{ij}\) of similar patches is the number of similar patches in landscape.

The model of the tendency of the earth class transformation: When the earth class \(i\) is adjacent to the earth class \(j\), \(f_{ij} \times P_{ij} \times X_{ij}\) represents the tendency index of the earth class \(i\) to \(j\), and \(Y=(y_{ij})\) is a matrix of \(P_{ij} \times X_{ij}\).

\[
f_{ij} = \begin{cases} 
\frac{y_{ij}}{y_{ji}} & j > i \\
y_{ij} & j = i 
\end{cases}
\]

When the value of \(f_{ij}\) is greater than 1, the tendency of adjacent land classes \(i\) to change \(j\) is greater than that of land classes \(j\) to \(i\). The greater the value of \(f_{ij}\), the easier it is for land classes \(i\) to change to land classes \(j\), it shows that the tendency of the adjacent land classes to change is smaller
than that of the land classes $j$ to $i$, and the smaller the value, the more difficult it is to change the land classes $j$ to $i$.

1.2.2. Mapping of land use change
The land use change atlas can directly express the land use change [7-8] of the specific location and specific period in the study area. In this paper, the vector data are transformed into grid data with grid size of 50×50m, and the attribute values of raster cells are all single digit, which represents the land use types of each period. Map algebra was used to calculate the land use data of each period. According to the decrease and increase of land use types, the series of increasing trend maps and decreasing trend maps are formed respectively to show the direction of land use type transformation.

2. Analysis on the tendency of land use type conversion
From 1987 to 2000, except for water area and unused land, the conversion tendency index of cultivated land to other land types was generally high, and the conversion tendency of cultivated land to forestland was high, the index was as high as 17.63, which came from advocating the improvement of ecological environment by afforestation; The conversion of cultivated land to garden land is related to the large-scale planting of grapes in this area, and the conversion of cultivated land to constructive land is mainly due to the expansion of towns. The conversion of construction land into cultivated land is mainly related to the reclamation of mine waste land into cultivated land.

From 2000 to 2013, the tendency index of mutual conversion of different land use types increased, compared with the previous stage, the conversion index of cultivated land to construction land decreased to 5.63. In addition to the above two changes, the index of conversion of water to forest land has increased.

Table 2. 1987-2000 and 2000-2013 trends in land use type conversion in Huailai County

| Type of land $i$ | Type of land $j$ | Tendency Index of 1987-2000 | Tendency Index of 2000-2013 |
|-----------------|-----------------|-----------------------------|-----------------------------|
| Plowland        | Forest          | 17.63                       | 16.71                       |
| Plowland        | Garden          | 9.30                        | 13.23                       |
| Plowland        | Construction land | 10.52                     | 5.63                        |
| Unused land     | Plowland        | 1.59                        | 7.36                        |
| Construction land | Plowland       | 13.06                       | -                           |
| Waters          | Plowland        | 4.36                        | 20.33                       |

3. Analysis of spatial tupu of land use type change
From 1987 to 2000, the land use conversion area was 16,514.38 hm$^2$, accounting for 9.27% of the total area of the county. The most important land use change pattern is the conversion of cultivated land to garden land, followed by the conversion of garden land to cultivated land and water area to unused land. From 2000 to 2013, the conversion area of land use was 33039.32 hm$^2$, accounting for 18.54% of the total area of the county. The main land use change pattern was the conversion of cultivated land to garden land, accounting for 20.08% of the total change, followed by the conversion between garden land and unused land. The conversion of cultivated land to garden land is the most important change type, other main change types are similar, but the change area is quite different, and the change of land use type is more violent in the later period.
The increasing potential map and the decreasing potential map can directly show the spatial variation trend of different types.

Figure 1. 1987-2000 map of land use change in Huailai County

Figure 2. 2000-2013 map of land use change in Huailai County

Figure 3. 1987-2000 map of increasing trend of land conversion type
From 1987 to 2000, stable regions accounted for 91.25% of the total area of counties. During the
period from 2000 to 2013, the proportion of stable region in county area decreased to 82.58%. During this period, the change of land use types was more drastic, the increase of garden land was the most, the increase of water area was the least, and the increase of cultivated land and construction land was the same, 2.85% and 2.80%, respectively. The reduction of cultivated land, garden land and unused land is directly related to the exploitation and utilization of unused land, the occupation of original cultivated land and the intensive adjustment of garden plot layout.

4. Conclusion
The analysis of the tendency of land use type conversion and the construction of spatial map are more intuitive than the description of words and the presentation of figures, it can provide a clearer view for managers to analyze and study from the angle of the overall spatial land use layout and the formulation of land use policy.

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