The Evolution of Urban and Rural Construction Land Based on Spatial Econometrics: A Case Study of Bijie City

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Abstract Based on the theory of spatial econometrics, we test and process the urban and rural construction land data during the base period of planning and late period of planning in Bijie City. And we conduct comparative analysis of the spatial pattern and evolution characteristics of urban and rural construction land in 41 towns of Bijie City before and after the planning. According to Getis-ord G_i coefficient test results, the cold spot area of urban and rural construction land in northeast of Bijie City will gradually disappear, and the key point of hot spot area will be gradually transferred from the central region to the central and eastern regions. The results show that under the guidance of the overall land use planning in Bijie City, the urban and rural construction land will show strong spatial autocorrelation; agglomeration benefits and scale merit will appear clearly, in line with the actual situation of current development of Bijie City.

Key words Urban and rural construction land, Spatial econometrics, Bijie City

According to *National Land Statistics* from 1989 to 1995, and *Statistical Yearbook of Land Resources* from 1999 to 2006, the national residential land, mining land, transportation land and other urban and rural construction land increased year by year in these two stages[3]; the process of urbanization in China entered a rapid development stage. To implement the requirements of the scientific concept of development, the construction of a well-off society in an all-around way and " Five Balances" on the land use, rationally use limited land resources and effectively coordinate the relationship between the protection of farmland and construction land security, all regions in China have developed corresponding overall land use planning, in order to promote the efficient use of land resources and socio-economic development[2-3]. In accordance with the overall land use planning of Bijie City, from the perspective of spatial econometrics, we conduct a comparative analysis of the urban and rural construction land data between the base period of planning and the late period of planning in the study area, use the base period to simulate the characteristics and trend of evolution of urban and rural construction land, so as to provide a reference for the work of planning formulation and revision.

1 Data source and research method

1.1 Overview of the study area Bijie City (104°51′ –105° 56′E, 27°03′ –27°47′N) is located in the northwest of Guizhou Province, with a total land area of 3 410.98 km^2, accounting for 1.93% of the total area of the province. Bijie City is the political, economic, cultural and information service center in the Bijie area; one of the major urban nodes in the Bijie, Shuicheng and Xingyi Economical Belt; the service base and demonstration base of poverty alleviation and ecological construction experimental area in Bijie area of Guizhou Province; the transport hub and material distribution center in the junction of the three provinces of Sichuan, Yunnan and Guizhou; the regional industrial layout base on the basis of energy industry, relying on light industry, advanced industry and high-tech industries, with prominent advantages of special industries; a city with open economy, civilized society, prosperous culture, historical culture, and rich ethnic characteristics.

It has jurisdiction over 6 offices, 27 towns, and 8 townships (including nationality townships), inhabited by 22 ethnic groups. At the end of 2009, the total population was 1.416 1 million, including 0.361 8 million of urban population and 1.054 3 million of rural population. In 2009, the city's GDP exceeded 10 billion yuan, an increase of 19%. It is the first county-level city breaking through 10 billion of GDP, with 5.2 billion yuan of fixed assets investment, 0.655 8 billion yuan of total fiscal revenue, and 2.05 billion yuan of total retail sales of social consumer goods.

1.2 Sample data The base map adopted by this research is the administrative map of Bijie City, provided by the Bijie planning project of Guizhou University. The spatial sample data are arranged in accordance with the *Overall Land Use Planning of Bijie City*, taking the base period of planning (2009) and late period of planning (2020) as the time points, containing the urban and rural construction land data concerning 41 towns in Bijie City, Guizhou Province.

1.3 Research method In order to analyze and research the

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dynamic spatial evolution of urban and rural construction land after a new round of planning in Bijie City, in accordance with the basic assumptions of spatial econometrics[3], we conduct autocorrelation test, cold spot area and hot spot area analysis on the urban and rural construction land during the base period of planning and the late period of planning in the study area, using Global Moran's I index and Getis-ord G_i coefficient; conduct comparative analysis of the spatial pattern and evolution characteristics of urban and rural construction land in the study area[5-6].

1.3.1 Global Moran's I index. Global Moran's I index was advanced by Moran in 1948, which reflects the degree of similarity in the unit property value between spatially adjacent or nearby regions. Its calculation formula is as follows:

$$Global\ Moran's\ I=\frac{n\sum_{i=1}^{n}\sum_{j\neq i}^{n}W_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=i}^{n}\sum_{j\neq 1}^{n}W_{ij}\sum_{i=1}^{n}(x_i-\bar{x})^2}$$

where $\bar{x}=\frac{1}{n}\sum_{i=1}^{n}x_i$; x_i is the property value of region i (such as the total urban and rural construction land in this study); n is the number of regions (41 towns in this article); W is the spatial weight matrix; W_{ij} signifies the degree of interaction between space unit i and j.

The value range of Global Moran's I index is (−1, 1). The much the value closer to −1, the greater the difference between the units or the greater the deconcentration of distribution; the much the value closer to 1, the closer the relationship between units and the more similar the nature (high-value aggregation or low-value aggregation); if it is close to 0, there is no correlation between the units, and this space follows random distribution.

1.3.2 Getis-ord G_i coefficient. Getis-ord G_i coefficient is used to test the local spatial dependence. The calculation formula is as follows:

$$G_i=\sum_i W_{ij}x_j/\sum_j x_j$$

where x_i, x_j are the property values of region i and j; W_{ij} is the spatial weight matrix.

In order to facilitate explanation and understanding, we conduct standardization of G_i coefficient, and get the following formula:

$$Z(G_i)=\frac{\sum_{j\neq i}W_{ij}(x_j-\bar{x}_i)}{S_i\sqrt{W_i(n-1-W_i)/(n-2)}}$$

In the formula, if the value of $Z(G_i)$ is positive and significant, it indicates that around this area unit, the area units with high observation values tend to spatially concentrate, which are hot spot areas; conversely, if the value of $Z(G_i)$ is negative and significant, it indicates that around this area unit, the area units with low observation values tend to spatially concentrate, which are cold spot areas.

Getis-ord G_i coefficient is based on the spatial agglomeration, so it can help to deepen the analysis of spatial agglomeration around the area unit, when it is not susceptible to the observation value of area unit i.

2 Results and analysis

2.1 Global Moran's I index test Using the Global Moran's I index, we conduct global spatial autocorrelation test on the total urban and rural construction land in 41 towns of Bijie City during the base period of planning and the late period of planning, respectively. The results are shown in Table 1.

From Table 1, we see that as time goes on, as against as the Global Moran's I index value in the base period of planning, the Global Moran's I index value in the late period of planning increases, P value decreases and the spatial autocorrelation is significantly enhanced, indicating that during the planning period, the urban and rural construction land in various towns shows increasingly strong spatial autocorrelation, and significant state of spatial agglomeration, that is, the towns with a lot of urban and rural construction land tend to be relatively close to the towns with considerable urban and rural construction land; the towns with less urban and rural construction land tend to be relatively close to the towns with less urban and rural construction land.

Table 1 Global Moran's I index and the test of it in Bijie City

Year	Moran's I index	*P* value	Expected value	Mean	Standard deviation
The base period of planning	0.158 3**	0.043	−0.025 0	−0.025 1	0.101 3
The late period of planning	0.496 7***	0.001	−0.025 0	−0.026 8	0.096 6

Note: We use rook first-order spatial weight matrix; in the random test, we use 999 permutation; **, *** denote significant at level of 5% and 1%, respectively.

2.2 Getis-ord G_i coefficient analysis The global assessment of spatial autocorrelation often tends to cover the abnormal local situation or a small range of local instability, so there is a need to adopt the Getis-ord G_i coefficient to detect the degree of local spatial aggregation.

Therefore, we select the data on urban and rural construction land in various towns of Bijie City during the base period of planning and the late period of planning; calculate Getis-ord G_i coefficient and the test value of $Z(G_i)$ in accordance with the formula; draw the statistical map (Fig.1, 2).

Fig.1 shows that in the base period of planning, $Z(G_i)$ value of Longchangying Town is significant at 1% level; $Z(G_i)$ value of Tiankan Township and Datun Township is significant at 5% level.

The above three towns are contiguous in the space, located in the northeast of Bijie City, indicating that based on spatial econometrics, as for the towns adjacent to this area, the urban and rural construction land is not in a state of random distribution, but tends to be surrounded by the towns with the same low values of urban and rural construction land; these towns are cold spot areas.

$Z(G_i)$ value of Shixi Office, Shidong Office, Tianbaqiao Town, Daxinqiao Office, Yachi Town, and other towns in the central region of Bijie City, passes the significance test under

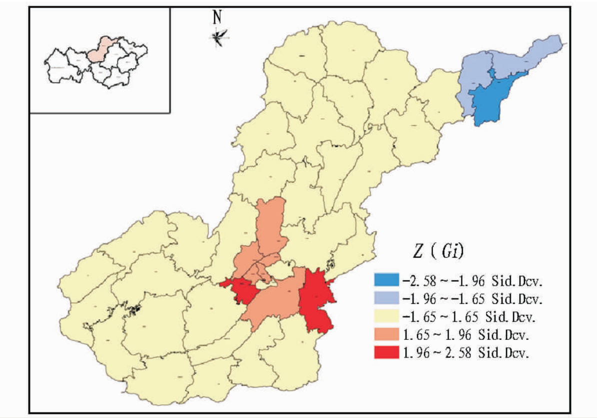

Fig. 1 The distribution of cold and hot spot areas reflected by $Z(G_i)$ value of urban and rural construction land in 41 towns of Bijie City in the base period of planning

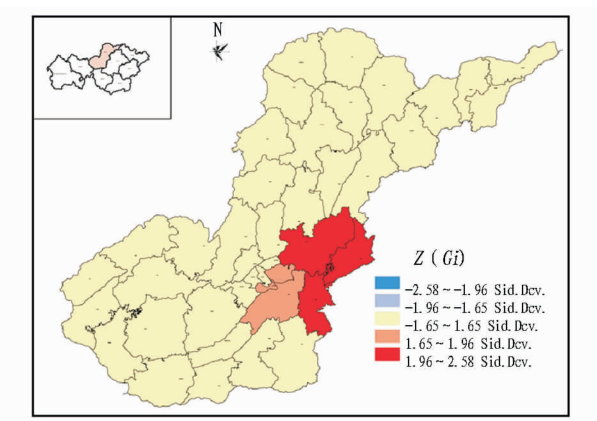

Fig. 2 The distribution of cold and hot spot areas reflected by $Z(G_i)$ value of urban and rural construction land in 41 towns of Bijie City in the late period of planning

5% level. $Z(G_i)$ value of Sanbanqiao Office and Lishu Town passes the significance test under 1% level, indicating that the total amount of urban and rural construction land in this region is high, and the land tends to be surrounded by some adjacent towns with a lot of urban and rural construction land; the central region in Bijie City is the hot spot area of urban and rural construction land,

By comparison in Fig. 2, we find that $Z(G_i)$ value of Liucangqiao Office and Yachi Town is significant at 5% level, and $Z(G_i)$ value of Lishu Town, Xiaoba Town and Haizijie Town is significant at 1% level, indicating that under the guidance of overall land use planning, the urban and rural construction land in 41 towns of Bijie City shows greater vitality and more significant state of agglomeration over time; the cold spot areas gradually disappear, and the key point of hot spot area gradually evolves from the central region in Bijie City to the central and eastern regions of Bijie City.

3 Conclusions

Based on the spatial econometrics, we use Global Moran's I index and Getis-ord G_i coefficient to test and process the urban and rural construction land data in Bijie City during the base period of planning and the late period of planning. We draw the distribution map of cold and hot spot areas, and conduct comparative analysis of the spatial pattern and evolution characteristics of urban and rural construction land in 41 towns of Bijie City before and after the planning.

(i) Through spatial autocorrelation test, we find that as against as the Global Moran's I index value in the base period of planning, the Global Moran's I index value in the late period of planning increases, *P* value decreases and the spatial autocorrelation is significantly enhanced, indicating that during the planning period, the urban and rural construction land in various towns shows increasingly strong spatial autocorrelation, and significant state of spatial agglomeration.

(ii) Using the Getis-ord G_i coefficient to detect the degree of local cold and hot spot areas, we find that under the guidance of overall land use planning in Bijie City, with the development of Bijie Urban Economic Zone and gradual improvement in the key state construction projects, the benefit of construction land for industrial economy and infrastructure in Bijie City will gradually play a role; the cold spot area of urban and rural construction land in northeast of Bijie City will gradually disappear, and the key point of hot spot area will be gradually transferred from the central region to the central and eastern regions; the agglomeration benefits and scale merit have become prominent, in line with the current actual situation of socio-economic development in Bijie City.

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