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STUDY ON SPATIAL AUTOCORRELATION OF URBAN LAND PRICE DISTRIBUTION IN CHANGZHOU CITY OF JIANGSU PROVINCE

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ABSTRACT: This paper uses a spatial statistics method based on the calculation of spatial autocorrelation as a possible approach for modeling and quantifying the distribution of urban land price in Changzhou City, Jiangsu Province. GIS and spatial statistics provide a useful way for describing the distribution of urban land price both spatially and temporally, and have proved to be useful for understanding land price distribution pattern better. In this paper, we apply the statistical analysis method to 8379 urban land price samples collected from Changzhou Land Market, and it is turned out that the proposed approach can effectively identify the spatial clusters and local point patterns in dataset and forms a general method for conceptualizing the land price structure. The results show that land price structure in Changzhou City is very complex and that even where there is a high spatial autocorrelation, the land price is still relatively heterogeneous. Furthermore, lands for different uses have different degrees of spatial autocorrelation. Spatial autocorrelation of commercial lands is more intense than that of residential and industrial lands in regional central district. This means that treating land price as integration of homogeneous units can limit analysis of pattern, over-simplifying the structure of land price, but the methods, just as the autocorrelation approaches, are useful tools for quantifying the variables of land price.

KEY WORDS: spatial autocorrelation; land price; Moran's I; GIS; Changzhou

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1 INTRODUCTION

The level and periodic changes of land price are interesting subjects for the governors, investors, researchers and grass-roots. Currently, the higher land price in China has become the focus among the people, from central government to common citizens, especially in the Changjiang (Yangtze) River Delta area around Shanghai City. So that studying this problem have both an academic and practical meaning.

One characteristic of land is fixed location (the others are high cost of supply, durability, and heterogeneity) (ANSELIN, 1998). Hence, the importance of land markets in space is unquestioned. Recently, there has been rapidly increasing in technical literature on spatial statistics and its implications for statistical estimation in land price management (ANA et al., 2004; BRADFORD et al., 2004; JAMES and KELLEY, 2004). A general spatio-temporal model that subsumes repeat sales, panel data, and spatial hedonic models is provided (ALAN et al., 2004). They illustrated these models using real estate data from Baton Rouge. The commercial land price gradients for an emerging real estate market are estimated using spatial regression techniques (DAVID and BRZESKI, 2001). Spatial statistics are used to explore the extent of spatial autocorrelation in the residuals of an OLS land price gradient model. A methodology is developed by the Scottish Executive to capture land value uplift around improved transportation facilities (ASTRON, 2004). The methodology proved that there was little spatial autocorrelation within a very heterogeneous residential property market.

In classic statistics, land price parameters are usually estimated by using procedures that assume independent observations (BASU and THIBODEAU, 1998). But land price appears to be spatially relative, it exists as surfaces

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of continuous variation. The purpose of this study was to descript the distribution and variations of land price within Changzhou City, Jiangsu Province, using spatial autocorrelation analysis.

2 STUDY AREA AND DATA

2.1 Study Area

Changzhou City, Jiangsu Province is located in the Changjiang River Delta, whose land price grows as fast as its economic growth. Changzhou is apart with similar distance from Shanghai and Nanjing. The total area is about 4375km^2, in which 457km^2 is urban built-up area (31°38′-32°2′N, 119°51′-120°5′E). The total population is 3.85×10^6, of which 850×10^3 are living in built-up area. The built-up area is chosen as a typical area in this study (Fig. 1).

In 2004, the economy of Changzhou achieved a rapid growth rate. The GDP of the whole city reached 90.14×10^9 yuan (RMB), increasing 14.5% over the previous year. The social fixed assets investment completed was 44.66×10^9 yuan with a growth rate of 78.6% (CSB, 2004). It is the rapidest increase year since 1995, which make demand of construction land keep an increasing rate (Fig. 2).

2.2 Data

The raw data used in this study are more than 10 000 samples from1999 to 2003 collected from the Changzhou Land Market. We selected and enhanced the data in order to distinctly represent spatial relation of land price (SUN et al., 2004). First, we used market approach, cost approach, etc., to assess land price of every samples on January 1, 2004. Second, we used outlier test method

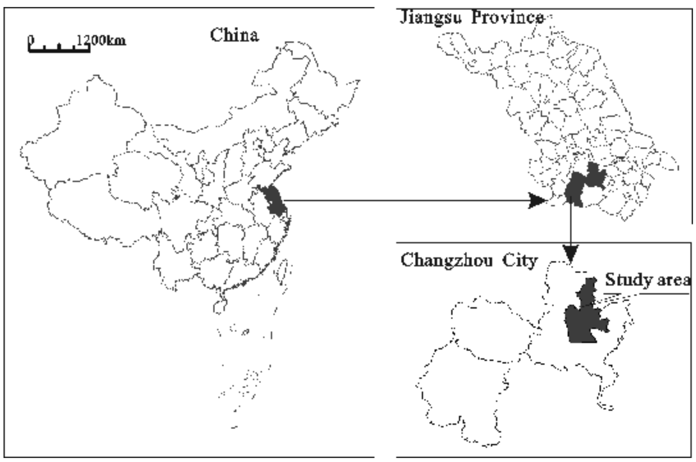

Fig. 1 Location sketch of study area

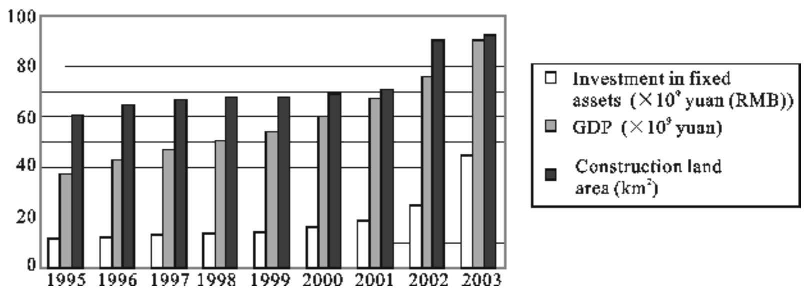

Fig. 2 General description of economic development in Changzhou

(Normal QQ Plots) to eliminate these abnormal, incomplete samples (Fig. 3).

At last, there are 1255 samples for commercial land, 6605 samples for residential land, 519 samples for industrial land, and the total is 8379 samples (Table 1). Then street addresses of these data are matched for the working map using ArcGIS (Fig. 4).

3 METHOD

A problem concerning the conventional statistical methods in spatial analysis on land price is that these methods assume the data to be statistically independent. In fact, spatial land price data have the tendency to be dependent, a phenomenon known as spatial autocorrelation.

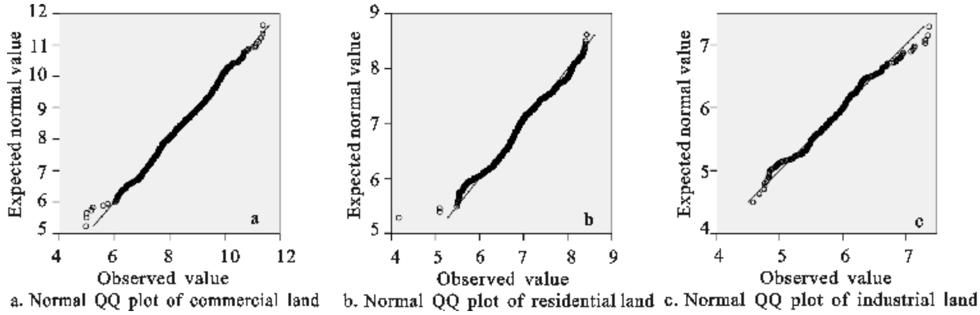

Fig. 3 Normal QQ Plots of samples

Table 1 List of Changzhou's land price sample (part)

ID	Address	Plot ratio	Land use	Land price (yuan (RMB))
C0001	7- 9 # Wujiaochangbei Road	1.40	Commercial land	1170.55
R1068	95 # Huaidenan Road	1.21	Residential land	2476.23
…	…	…	…	…
I2152	Baizhang Industrial Area	0.62	Industrial land	253.01

The first Law of Geography (TOBLER, 1979) asserts that "everything is related to everything else, but near things are more related to each other". It means if factors situated close together have similar attribute information, then the pattern in the data could be described as positive autocorrelation; and if features close together are more dissimilar in attribute value than those further away, patterns in the data could be negatively autocorrelation. Zero autocorrelation exists when attributes or their values are independent of location (GOODCHILD, 1986; DIANE, 2002).

Generally, there are four indices of spatial autocorrelation: Moran's I, Geary's C, Ripley's K and Join Count Analysis. This study uses correlograms of the Moran's I (Equation (1)).

$$I=\frac{n\sum_{i=1}^{n}\sum_{j=1}^{n}W_{i,j}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n}W_{i,j}\sum_{i=1}^{n}(x_i,\bar{x})^2} \qquad (1)$$

In Equation (1), n is the number of cases, x_i is the variable value at a particular location i, x_j is the variable value at another location j, $\bar{x}$ is the mean of the variable, and $w_{i,j}$ is a weight applied to the comparison between location i and location j. It is a contiguity matrix: if zone j is adjacent to zone i, the interaction receives a weight of 1, whereas the weight is 0. In this paper, the matrix is to make $w_{i,j}$ a distance-based weight because the data are spatial point pattern. If the distance between locations i and j is longer than a predefined value, the interaction receives a weight of 1, whereas the weight is 0. Similar to correlation coefficient, it varies between - 1.0 and +1.0. When autocorrelation is high, the coefficient is high. A high I value indicates positive autocorrelation. In order to understand the pattern of land price distribution, ArcGIS was used to overlay the rivers and roads on the autocorrelation surfaces (MOCCY et al., 2001).

4 RESULTS AND DISCUSSION

The positive spatial autocorrelation was detected in the land price data of the case study in Changzhou. The Moran's I of commercial land is 0.0505, of residential land is 0.5822, and of industrial land is 0.2282, in general. The residential land is more significantly positive auto-correlation than commercial and industrial land. LISA (Local Indicators of Spatial Association) is required to study the right measure of spatial autocorrelation for each individual location, which is implemented as LISA maps (ANSELIN, 1995; GILLEN et al., 2001). The slope of the regression line is Moran's I statistic, marked at the top of the window. The four quadrants in the scatter plot correspond to different types of spatial correlation, including spatial clusters in the upper right (high-high) and lower left (low-low) quadrants, and spatial outliers in the lower right (high-low) and upper left (low-high) quadrants. Note that the magnitude of Moran's I as such does not indicate significance, nor is the statistics comparable directly across weights and variables. The cluster maps (LISA maps) show the significant locations by type of association (Fig. 5, Fig. 6, and Fig. 7).

Through distribution patterns, the dependence of the spatial autocorrelation of the commercial land price is presented and distributed linearly, and there is obvious dependence distributed in all directions in the residential land and industrial land so that it is presented as regional

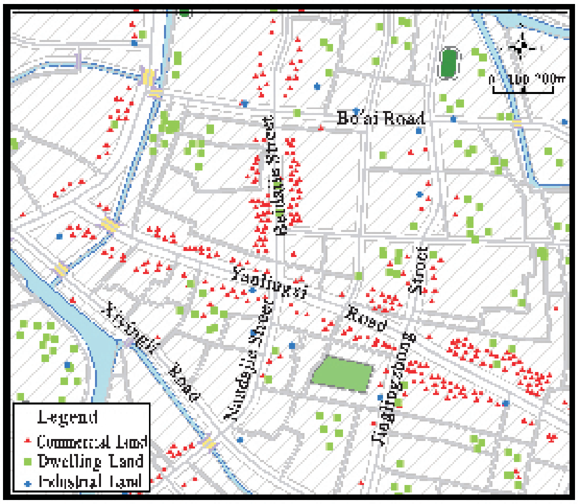

Fig. 4 Distribution map of samples in central district

distribution, besides that, residential land will be segmented by railways, highways and rivers. The industrial land is affected deeply by economic policy of the development area. Based on degree of cluster, the commercial land is gathering higher along the flourishing area of the commercial route (the high-high clusters of commercial land are near the Yanlingxi Road, the Beidajie Street, the Huaidenan Road, and the low-low clusters are near the Laodongxi Road, the Tongjiangdadao Street, etc.). The land price has a rapid decline about 300m away from the route, even has negative spatial autocorrelation. As to residential land, neighborhood share location amenities, such as the same police and fire departments protecting community residents, and neighborhood children's access to the same public schools (DUBIN, 1992). But there are some exceptional cases, too. For example, the

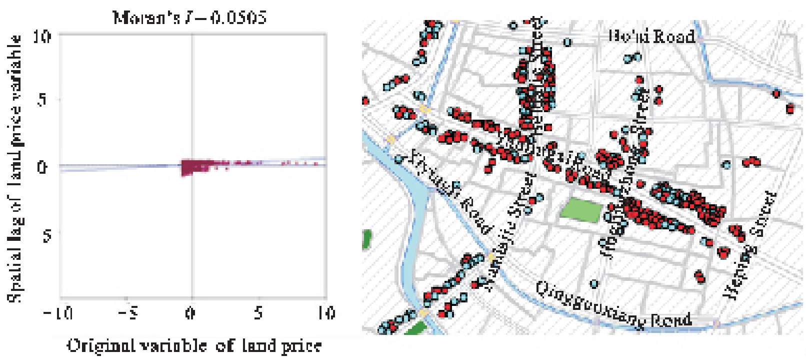

Fig. 5 LISA cluster map of commercial land in Yanlingxi Road, Changzhou

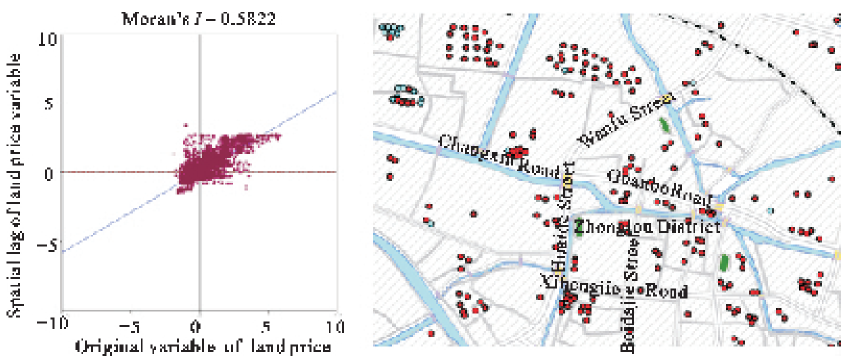

Fig. 6 LISA cluster map of residential land in Zhonglou District, Changzhou

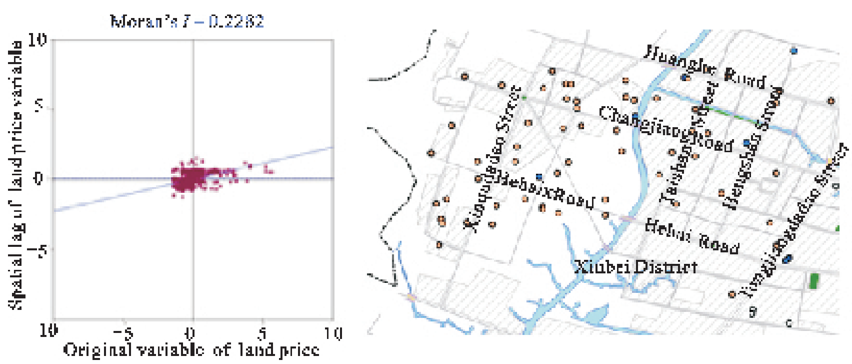

Fig. 7 LISA cluster map of industrial land in Xinbei District, Changzhou

land price of Yuanfengyuan Community in Tianning District is lower than the neighborhood land, which is presented by an outlier relation. Through field investigation, the reason is found out: because the investor of Yuanfengyuan Community cannot make terms with the Jiefanglu Elementary School, children at Yuanfengyuan Communtiy cannot go to the school free though it is in the welfare district of Jiefanglu Elementary School.

5 CONCLUSIONS

Through study on spatial autocorrelation of land price in Changzhou City, we can get the following conclusions:

(1) GIS and spatial statistics are very useful tools for quantitatively describing distribution patterns of urban land price. Urban land price is a spatially relative phenomenon, and GIS can help analyze its intrinsic relation.

(2) The spatial autocorrelation can help identify an appropriate neighborhood distance for a spatial variety of land price. This is very important for land price estimation and the establishment of land price indices, for example, to find the distance where spatial autocorrelation is strongest for the allocation of land price monitoring sites and spatial interpolation of land price surface modeling.

(3) By summarizing the diffusion of land price over space, the land price remains isolated and concentrated or spread. The spatial autocorrelation can be very varied in different land use patterns, even though those are in the same region.

(4) The spatial autocorrelation can be analyzed on the residuals of a regression analysis. If autocorrelation is detected in the regression residuals, this will imply that the regression model should have an autoregressive structure or that non-linear relationship between the dependent and independent variables (trend surface analyses) is presented, which is neglected in many regression models.

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