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Research on spatial calculating analysis model of landuse change

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Abstract: The spatial calculating analysis model is based on GIS overlay. It will compartmentalize the land in research district into three spatial types: unchanged parts, converted parts and increased parts. By this method we can evaluate the numerical model and dynamic degree model for calculating land-use change rates. Furthermore, the paper raises the possibility of revising the calculating analysis model of spatial information in order to predicate more precisely the dynamic changing level of all types of land uses. In the most concrete terms, the model is used mainly to understand changed area and changed rates (increasing or decreasing) of different land types from microcosmic angle and establish spatial distribution and spatio-temporal principles of the changing urban lands. And we will try to find out why the situation can take place by combining social and economic situations. The result indicates the calculating analysis model of spatial information can derive more accurate procedure of spatial transference and increase of all kinds of land from microcosmic angle. By this model and technology we can conduct the research of land-use spatio-temporal structure evolution more systematically and more deeply, and can obtain a satisfactory result. The result will benefit the rational planning and management of urban land use of developed coastal areas in China in the future.
Key words: land use; dynamic change; spatial calculating analysis model

1 Introduction

The general analysis of the quantity, structure and environment of land-use change is useful to perceive the trend and character of spatio-temporal land-use change. The fixity and distinction of spatial position is one of the remarkable characters of land use. We need to recognize the changing processes of different kinds of land-use spatial structure, the positioning and the quantitative spatial information analysis of change of different kinds of land-use should be carried out. For instance, there may be two different kinds of land-use changes in the same period. In one industrial suburban area, an abandoned brickfield may be changed to arable land; while in the other suburban area, the same acreage of arable land may be used for a newly founded industrial park. In the cases like this, the land-use changes appear to cancel each other out. The actual condition can be revealed only through quantitative spatial information analysis. As shown in Figure 1, during the research period, from $t1(LA_{(i,\ t1)})$ to $t2(LA_{(i,\ t2)})$, there are three kinds of spatial models in the changes of the ith land-use category: 1) unchanged part (ULA_i), its land-use type and spatial position has not changed (Proceeding from the consideration of time scale, this paper will take the changing process of initially converted land-use type but eventually transformed to its original type during the research period as invalid change, and will not be discussed); 2) converted part ($LA_{(i,\ t1)} - ULA_i$), the ith land-use type changing into one of the other non-ith land-use types; and 3) increased part ($LA_{(i,\ t2)} - ULA_i$), another non-ith land-use type converting into the ith type ($LA_{(i,\ t1)}$ and $LA_{(i,\ t2)}$ represent the area of this land-use type at the beginning and end of the period respectively).

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spatial information analysis of land-use change. By the calculation and spatial statistic analysis of land-use map for different periods, we can identify the unchanged part, converted part and the part to where it is converted, the increased part from where it comes.

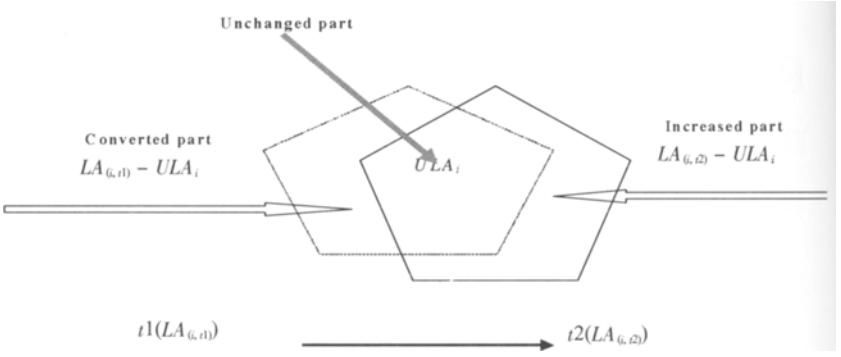

Figure 1 Spatial meaning of land-use change

2 Research method

At present, the quantitative model for calculating land-use dynamic change basically includes a traditional numerical model and a dynamic degree model.

2.1 Numerical model

Bruce P and Maurice Y, the famous quantitative geographers, provided a traditional and ordinary model for analysis in 1993. The principle of his model is as follows: the land-use changes during a certain period can be shown by calculating the average changing rate of land-use model in the researched region (Bruce and Maurice, 1993). It is called the single dynamic land-use model (Wang, 1999). The mathematical expression is:

$$K_i = (LA_{(i,t2)} - LA_{(i,t1)}) / LA_{(i,t1)} / (t2 - t1) \times 100\% \quad (1)$$

where K_i is the yearly average changing rate of the land-use type i; $LA_{(i,t1)}$ and $LA_{(i,t2)}$ represents the area of this land-use type at the beginning and end of the period respectively.

The main advantage of the calculating model is conciseness, and we can use it without complicated professional analysis technique. It has been extensively applied in the professional or non-professional reports and papers (Zhao, 2001), but the disadvantage is obvious because:

(1) This model ignores the fixity and particularity of land-use spatial position, and cannot reflect the spatial process and interrelated attributes of land-use dynamic change. For example, two changes happening with different spatial locations and attributes but with the completely same acreage: on one hand, the barren unused land in remote areas is reclaimed; on the other hand, the field of high quality agricultural value may be converted into land for urban construction. The two changing processes counteract each other, and cannot reflect the actual condition when we analyze the dynamic change of the region by this model.

(2) This model cannot calculate and compare the active degree of land-use change, that is to say, it cannot discern the "hot" or "sensible" district, as it has no spatial characters.

2.2 Dynamic degree model

The dynamic degree or land-use changing rate of a certain type of land use in the research region during the changing period can be calculated with the expression below (Liu, 1996; Wang, 2001):

$$S_i = (LA_{(i,t1)} - ULA_i) / LA_{(i,t1)} / (t2 - t1) \times 100\% \quad (2)$$

In the formula, $(LA_{(i,t1)} - ULA_i)$ represents the area of converted part, namely, the total area of the ith category of land-use being converted into the other ith type of land-use in the research period; $LA_{(i,t1)}$ represents the area of the ith land-use type at the beginning of the period; and ULA_i represents the area of the unchanged part of the ith land-use type during the research period (Figure 1).

The expression of land-use dynamic degree in the research district is given below: