Simulation of spatio-temporal land use pattern based on LISA–Markov model

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1. Introduction

The rapid development and urbanization in China has been posing great research needs for better understanding the spatio-temporal patterns of urban structure and its evolvement process. Advances in spatio-temporal modeling has enabled the design and simulation of spatial patterns for land use/cover changes (LUCC). Among these advances, the Markov model has become one of the most commonly used model for LUCC simulation with time series. However, previous researches on LUCC simulation with this model lacked of considerations on spatial effect and spatial knowledge.

Spatial autocorrelation is an essential spatial effect in land use changes. That is, the land use change in one region is affected by the change in its surrounding regions. A number of quantitative indicators have been developed for measuring these neighboring effect on the land use change, among which a most popular one is LISA (Local Indicators of Spatial Association).

Despite of the great advantages of LISA and the Markov model for land use change studies, both of them have their limitations. The Markov model has been widely applied to land use change modeling, but the traditional model has difficulty in predicting the spatial pattern of land use changes. The LISA indicator is powerful in spatial computation and can be used to simulate spatial variations of land uses effectively, but lack of the consideration of land use in time series.

This study proposes a LISA–Markov model to simulate the spatio-temporal pattern of land uses. A case study was conducted in Wuhan, China. From the result of the experiment it shows that:

(a) The form of the spatial weight affects the LISA greatly and thus affects the result of the proposed model. Among the various spatial weight matrices, experimental results suggested that the inverse distance weight matrix was the most appropriate to express the spatial relationship of land uses.

(b)The proposed LISA-Markov Chain model is good for simulating the spatio-temporal land use changes. Compared to the classical Markov model (the new model resulted in generally greater quantity Kappa index values and significantly higher accuracy of prediction.

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(c) According to the model forecast, the area change of cultivated land will turn from the sharp reduction in 2000-2004 to a slow decrease in 2012-2016. In contrast, built-up land will turn from the rapid expansion to a slow growth. Area variations of waters, woodland and unutilized land are relatively small. As for the spatial distribution, the scope of built-up land expands gradually in 2000-2016, while the scope of cultivated land shrinks slowly. A part of unutilized land and woodland are changed actively in spatial location. Preliminary analysis on the above results revealed a direct relationship between the spatio-temporal land use change, government policies, economic development, and population growth in Wuhan.

Results obtained is this study can help government decision makers to get better knowledge spatio-temporal land use change principles, and provide scientific evidences for activities such as land use planning. The proposed LISA-Markov Chain model offered can also be further adapted to spatio-temporal land use change research in other geographical areas.

2. References

Veldkamp A,Lambin E F,2001,Predicting land-use change. Agriculture Ecosystems and Environment,85(1-3):1-6.

Verburg P H,Schot P P,Dijst M J,2004,Land use change modeling:Current Practice and research priorities.GeoJournal,61:309-324.

Costanza R,Ruth M,1998,Using dynamic modeling to scope environmental problems and building consensus.Environemtal Management,22:183-195.

Lambin E F,Rounsevell M,Geist H,2000,Are current agricultural land use models able to predict changes in land use intensity.Agriculture.Ecosystem and Environment,82:321-331.

Gobin A,Campling P,Feyen J,2002,Logistic modeling to derive agricultural land use determinants,a case study from southeastern Niggeria.Agriculture,Ecosystems and Environment,89:213-228.

Kitamura T,Kagatsume M,Hoshino S,1997,A theoretical consideration on the land use change model for the Japan case study area.IIASA Interim Report ir2972064,Laxenburg.

Morita H,Hoshino S,Kagatsume M,and Mizuno K,1997,An application of the land-use change model for the Japan case study area.Interim Report IR-97-065.

Li L,S Simonovic P,2002,System dynamics models for predicting floods from snowmelt in North American prairie watersheds.Hydrological processes,16:2645-2666.

White R,Engelen G,2000, High-resolution integrated modeling of the spatial dynamics for urban and regional systems.Computers,Environment and Urban Systems24:383-400.

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