Abstract

The most extreme anthropogenic land cover/use transformation caused by urbanization has been a universal and important socioeconomic phenomenon around the world. Although urban areas cover a very small percentage of the world's land surface in comparison with other land cover types, their rapid expansion has marked effects on environment and socio-economy. Given the rapid urban growth and importance of its long term effect, it is becoming increasingly important to monitor and analyze the urban land cover change, as well as to adopt appropriate sustainable land use plans.

The previous studies presented some major challenges. Lack of geospatial database persists in developing countries, which makes the analysis and monitoring of urban land cover change more difficult. Furthermore, due to the complexity of the urban system, the analysis of urban growth suffers from a lack of knowledge and understanding of the urban growth process, as well as the physical and socioeconomic factors. In addition, the performance of urban growth models is significantly influenced by calibration, validation, and designing scenarios, which less attention has been given to. Considering these challenges and limitations in previous studies, the dissertation aims to propose an improved methodology for monitoring and analyzing urban growth process in order to understand them better and to support effective urban planning towards urban sustainable development. Xuzhou city in China is used as the case study.

The improved Remote Sensing (RS) image classification method that integrates Vegetation-Impervious Surface-Soil (V-I-S) model with hierarchical classification approach was proposed in order to classify multi-temporal Landsat images in 1990, 2001, 2005, and 2010. Furthermore, a set of spatial metrics were applied for quantifying the urban spatial patterns. The results confirm the effectiveness of the proposed classification method and the spatial pattern analysis for monitoring urban growth process. By comparing with Dortmund city region, Xuzhou city was characterized by rapid urban growth. The allocation of urban area included both the developing outward from the original urban core and the growth of new individual urban patches. As the increasing rapid urbanization process, Xuzhou experienced diffuse sprawling development.

The combination of Geographically Weighted Regression (GWR) and logistic regression models were suggested and applied to explore the underlying cause-effect relationships in the urban growth process. The new methodology extends the previous studies by investigating spatio-temporally varying effects of urbanization instead of global effects. Both negative and positive effects of urbanization on variation of spatial metrics values were explored. The effects of urbanization on the variations of spatial patterns varied over the study period, which can be explained by the socioeconomic processes and the consequence of urban development policy. In addition, the results generated from logistic regression model indicate that the historical urban growth patterns in Xuzhou city can, in considerable part, be affected by distance to CBD, distance to district centers, distance to roads, slope, neighborhood effect, population density, and environmental factors with relatively high levels of explanation of the spatial variability. The optimal factors and the relative importance of the driving factors varied over time, thus, providing a valuable insight into the urban growth process.

By involving natural and socioeconomic variables, the developed Cellular Automata (CA) model has proved to be able to reproduce the historical urban growth process and assess the consequence of future urban growth. The hybrid calibration method combining logistic regression with trial and error was designed to calibrate the CA model, which can capture the complex interaction of various variables and promote the computational efficiency of the calibration. The existing validation method was improved by considering both the location and spatial pattern similarity to ensure that the CA model can produce more accurate result. Furthermore, five scenarios for 2020 (business as usual, planning strengthened, compact development, dispersed development, and moderate development) were designed with focusing on specific urban development strategies. The dissertation proposed the integration method of Multi-Criteria Evaluation (MCE) and Analytic Hierarchy Process (AHP) that can be utilized to effectively translate the qualitative descriptions for scenarios into quantitative spatial analysis. Finally, the evaluation and comparison of the different scenarios presented in this dissertation provide an effective method for analyzing the impacts of different urban development strategies on urban spatial patterns at global and local scale and for supporting urban planning.

The CA modeling results have proved that the design of development scenarios, identification of parameters as well as the evaluation of scenarios are able to establish connection between CA models and the urban decision making processes. The evaluation of the scenarios suggests that the current urban development process was in a critical stage. If it continues as indicated by the business as usual scenario in the future, the new urban areas are sparsely developed in fringe and rural areas. The conflict between rapid urban growth and limited land resource becomes more apparent. Comparing with other scenarios, the moderate development scenario could be considered as the best one in achieving the objectives of compact urban form, good residential environment, as well as environmentally and economically efficient development.