Classification and Evaluation on Urban Sprawl Quality in Future Shenzhen Based on SOFM Network Model

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1 Introduction

Urban sprawl has become a significant part of the regional socio-economic progress since the 20th century. The growing demand for urban land brings the issue that urban sprawl caused increasingly prominent. Studies in aboard on urban sprawl are comparatively earlier, mainly including the concept deconstruction in multi-angle, the shape and path of urban sprawl, and the measure of urban sprawl and its impact evaluation. Domestic researches are relatively late, focusing on urban land expansion, urban land use change, urban form evolution and its driving mechanism by using RS and GIS techniques.

In our study, the expansion of construction land was used to represent the urban sprawl. The future land-use pattern in Shenzhen City was simulated with a land-use evolution model. Then an urban sprawl quality evaluation system was established with indicators from respects of the sprawl speed and intensity, the landscape patterns, the social and economic benefits, and the ecological environment benefits. On this basis, we evaluate the differences on urban sprawl quality among different zones.

2 Method

2.1 Analysis procedures

The urban sprawl quality analysis consisted of two parts. First step was simulating future land use patterns with past remote sensing images. Then combined with other socio-economic data and the established urban sprawl quality evaluation system, we processed the evaluation of future urban sprawl. The method is shown as figure 1.

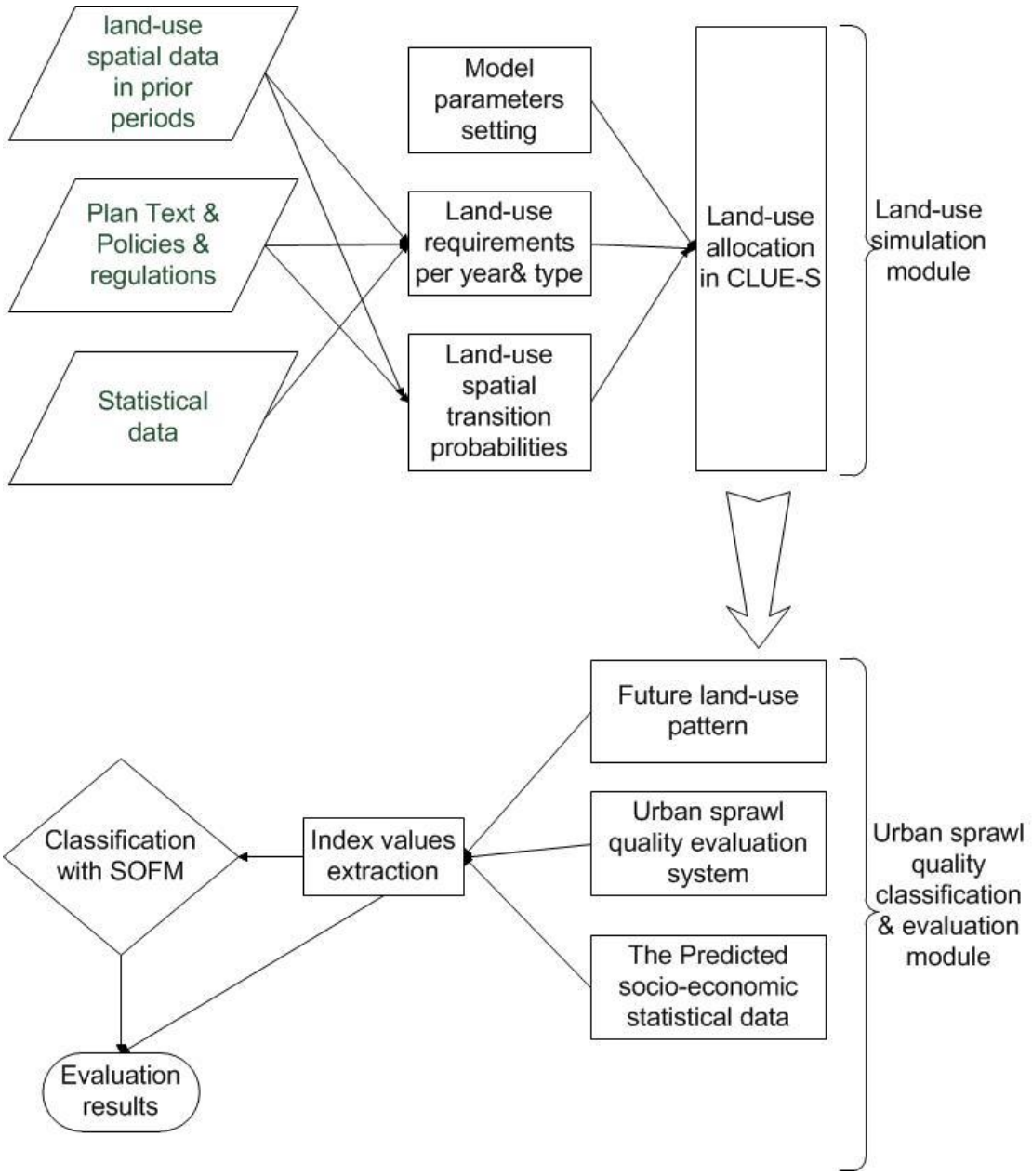

Figure 1 Flow chart of research process

2.2 Simulation of land-use evolution

As a typical empirical model in statistical analysis, CLUE-S has an advantage in simulating land-use spatial and temporal dynamic changes on regional scale. Though establishing the relationship between spatial allocation and driving factors of certain land-use, CLUE-S simulates its dynamic evolution, and shows the main driving factors which lead to land-use changes. As a result, we chose CLUE-s model to simulate the spatial evolution of land use in Shenzhen City.

2.3 Urban sprawl quality classification and evaluation

SOFM is abbreviation of Self-Organizing feature Map, which is an unsupervised classification method. Different with traditional classification method, the sorting center it forms can be mapped to a curved or flat, and maintain its same topological structure. After establishing the urban sprawl quality evaluation system, and extracting the indicator values from the land-use evolution results as well as other socio-economic data, we employed SOFM model to classify and evaluate the urban sprawl quality in future Shenzhen City.

3 Data & Results

3.1 Study area

We chose Shenzhen City as a research area, whose results could be the study reference for other cities.

3.2 Simulation of land-use evolution

Based on the remote sensing interpretation images of 2004 and 2008, together with some socio-economic data, land-use map of Shenzhen City in 2020 was simulated by CLUE-S, whose result achieved the accuracy requirements with a 69.4% kappa coefficient.

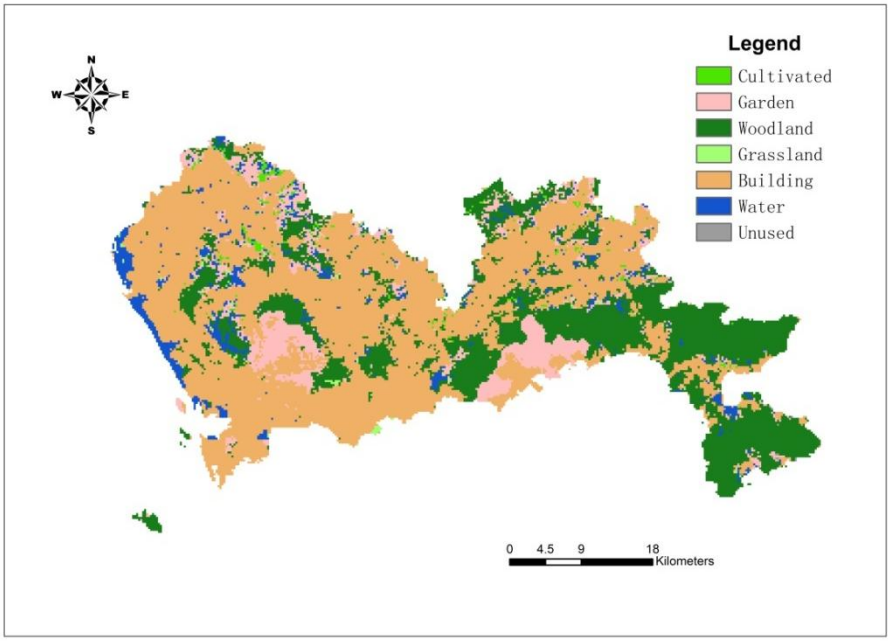

Figure 2 The simulated land-use of Shenzhen in 2020

3.3 Urban sprawl quality evaluation system

Society, landscape, ecology and environment were all considered while establishing the urban sprawl quality evaluation system. The values of indicators were calculated in the basic unit of "block"（table 1）.

Table 1 The urban sprawl quality evaluation system

Fist Indicators	Secondary Indicators
Speed & Intensity	The planning consistency/Sprawl speed index/ Sprawl intensity index
Landscape Form	Open space proportion index/Change rate of the average plaque area index of construction land/Change rate of mean patch shape index of construction land/Change rate of construction land aggregation index/Change rate of The construction land Plaque split index/ Compact degree change index
Social & Economic Benefits	Economic benefit index/Demographic indicators/Change rate of the distance to regional centre.
Ecological & Environmental Benefits	Gradient index/Arable land proportion index/Change rate of the woodland mean patch area index/The ecological control area encroachment index/ Urban green space reachability/The per capita green index/ Green coverage/Change rate of the area Shannon diversity index

3.4 Classification & Evaluation on urban sprawl quality

Using Matlab neural network toolbox functions, the SOFM network classification algorithm was programed. The indicator values were regarded as the input of the SOFM network, whose epoch was set 1000 and structure set 4×1. The quality of urban sprawl of Shenzhen City in 2020 could be classified into four regions: ① medium speed and intensity, high landscape integrity, high social and economic benefits, high ecological and environmental benefits.; ②high speed and intensity, medium landscape integrity, high social and economic benefits, low ecological and environmental benefits; ③high speed and intensity, low landscape integrity, medium social and economic benefits, high ecological and environmental benefits; ④low speed and intensity, medium landscape integrity, low social and economic benefits, high ecological and environmental benefits. Different zones should develop different plans according to their unique feature to achieve high overall benefit and special

attentions should be paid to improve the socio-economic and ecological environmental benefits collectively.

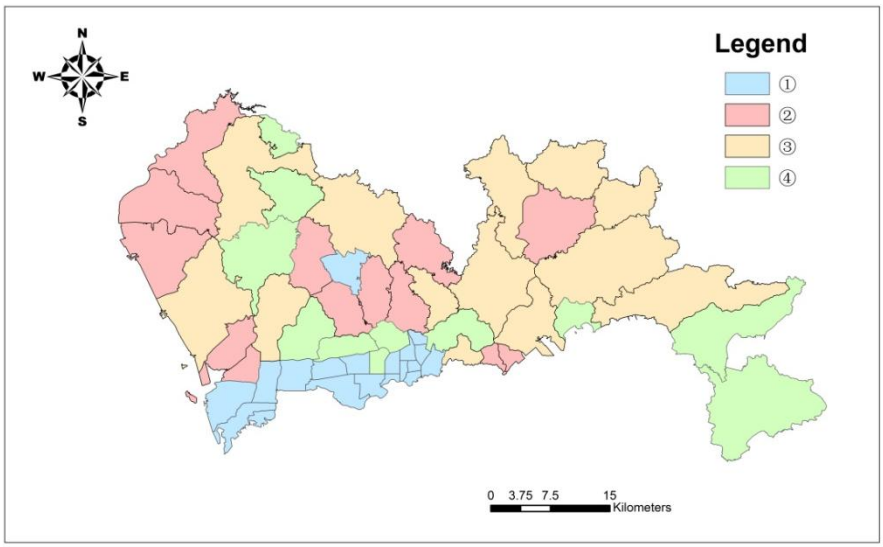

Figure 3 SOFM classification result

4 Conclusions

(1) According to the urban sprawl quality, the 55 blocks of Shenzhen can be classified into 4 regions. Different urban developing strategies should be made for the different four regions.

(2) The urban sprawl quality is high in Shenzhen on the whole, and the result is consistent with the Shenzhen City Master Plan (2010-2020).

(3) Regions whose urban sprawl has a high social and economic benefit are often low in ecological environmental benefits, which indicating environment-friendly development should be paid more attention to in further developed regions.

(4) The forecast, classification and analysis of future urban sprawl can effectively achieved with CLUE-S and SOFM models, which is also suit for other related policy researches.

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