An Introduction to Urban Land Use Change (ULC) Models

Prof. Yuji Murayama – Instructor

Wang Ruci – Teaching Assistant

Division of Spatial Information Science

University of Tsukuba

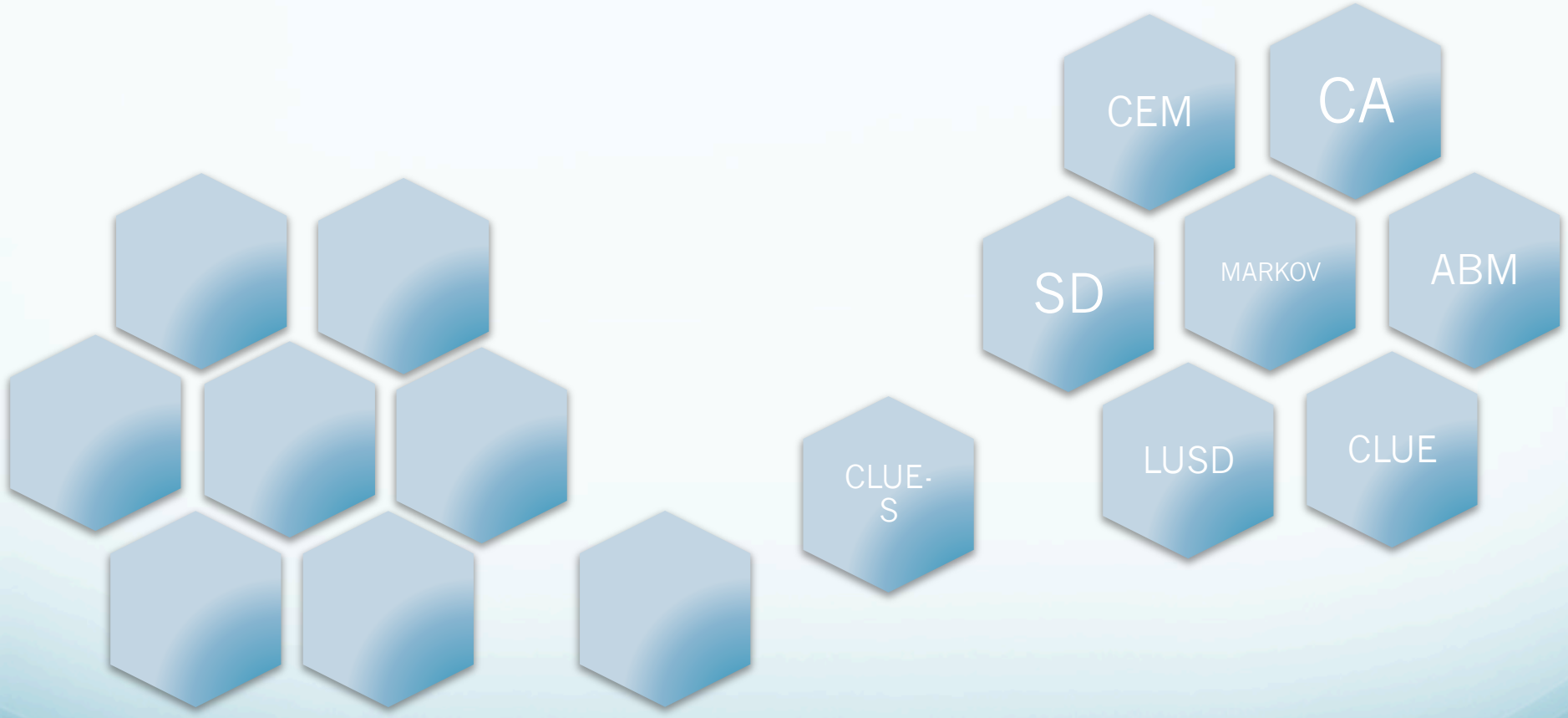
Introduction

- Urbanization is one of the most complex and dynamic processes of landscape changes.
- Driving factors contributing to urban land changes (ULCs) are different spatiotemporally.
- Recently, modeling ULCs with GIS and remote sensing has become a central component in urban geographical studies.

Land Use Change Modeling

- Describes the changes of land use and land cover over time.
- Can be used to predict different scenarios of land use changes.
- Uses currently available data or condition to combine with attributes (including population, economic, politics) and dynamic factors (including distance to water, distance to CBD, distance to road, etc.) to predict the future scenarios.

ULC models enumeration……



http://www.wisegeek.com/what-is-a-simulation-model.htm

Continued

2020 ?

2030 ?

2040 ?

http://blog.sina.com.cn/s/blog_6352e4c40100pswc.html

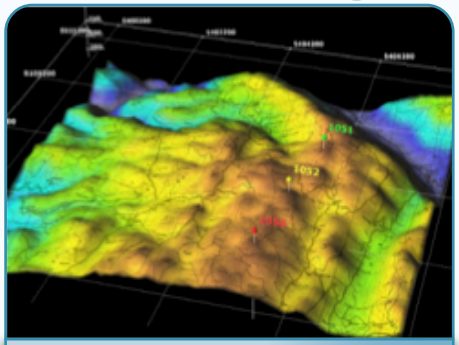
Features of land use modeling

- Level of analysis
- Cross-scale dynamic
- Driving factors
- Spatial interaction and neighborhood effects
- Temporal dynamics
- Level of interaction

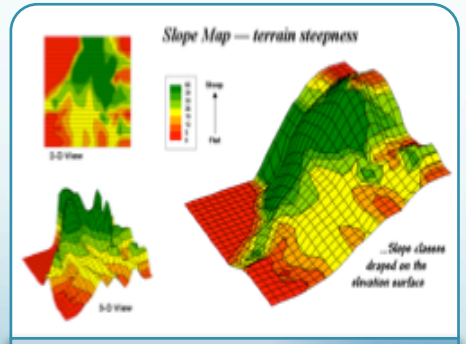
Factors selected for ULC modeling

population

GDP



DEM

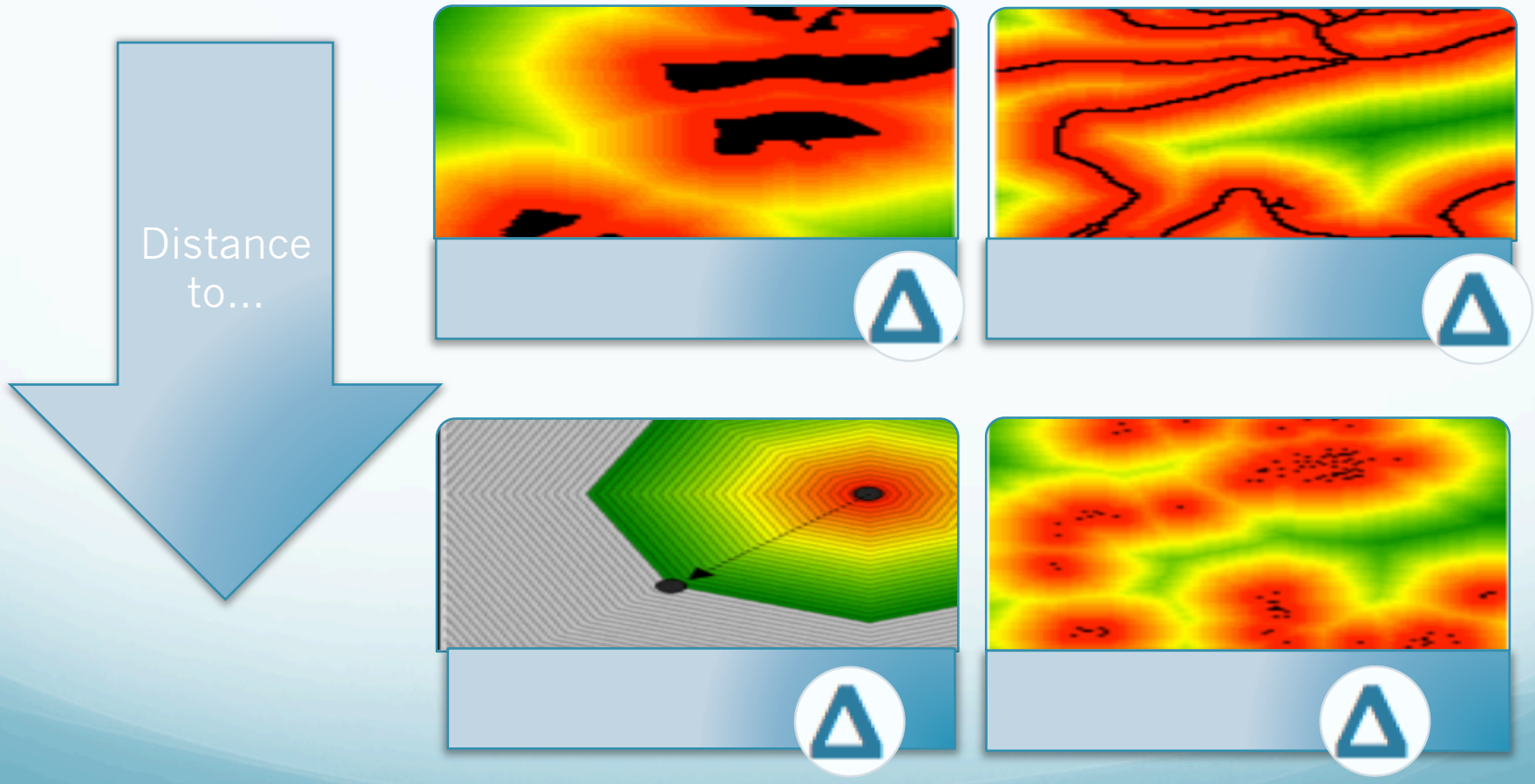


Slope

Social factors

Environmental factors

Dynamic Factor Selection

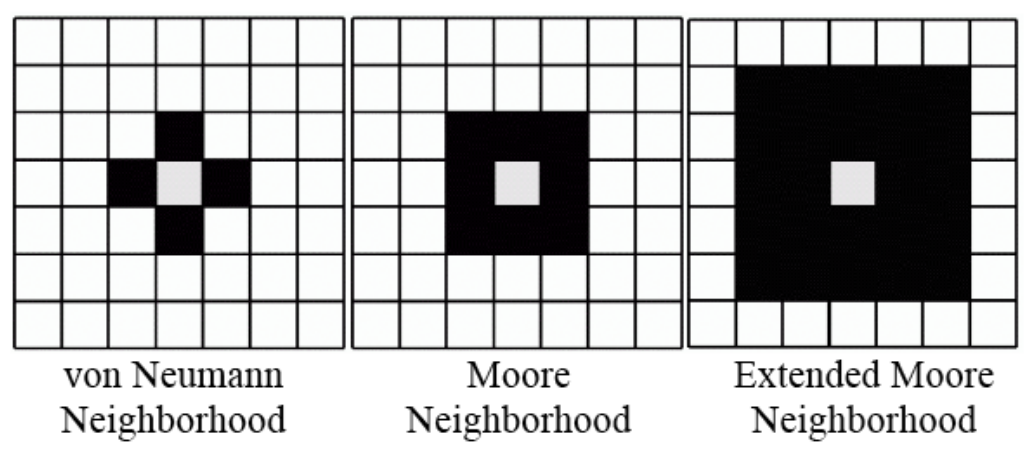


http://www.innovativegis.com/basis/mapanalysis/Topic24/Topic24.htm

Types of ULC models

Cellular Automation (CA) Model

A cellular automaton (CA) is a collection of cells arranged in a grid, such that each cell changes state as a function of time according to a defined set of rules that include the states of neighboring cells.

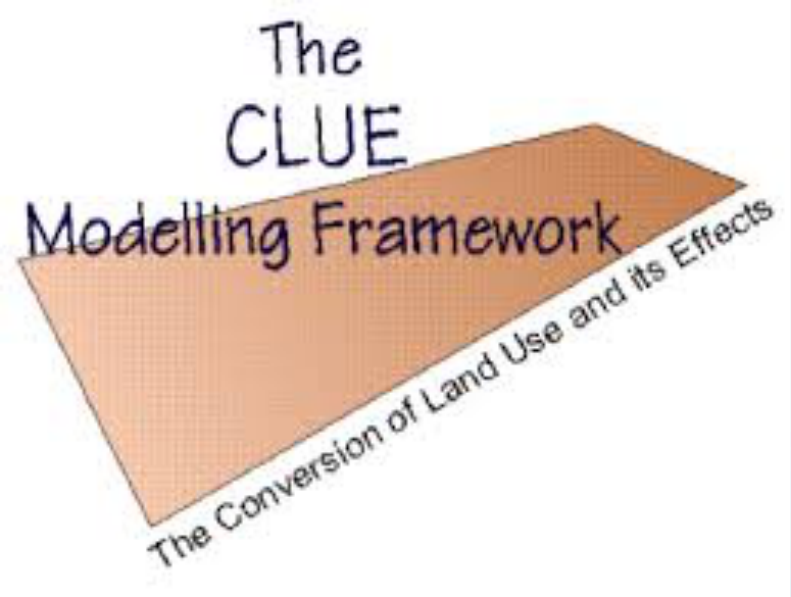


https://www.openabm.org/book/export/html/1949

Continued

The conversation of land use and its effects (CLUE) model

The CLUE model is a dynamic, spatially explicit, land use and land cover change model.

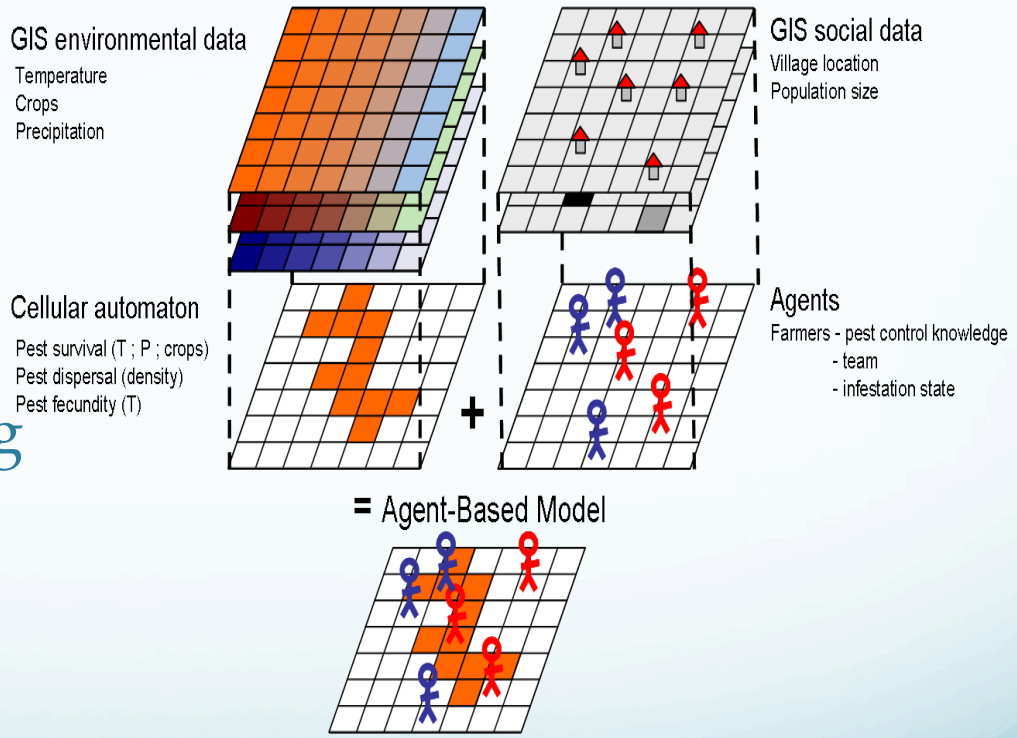


http://www.ivm.vu.nl/en/Organisation/departments/spatial-analysis-decision-support/Clue/

Cont'd

Agent-Based Model(ABM)

An agent-based model is a computational model for simulating the actions and interactions of autonomous agent with a view to assessing their effects on the system.



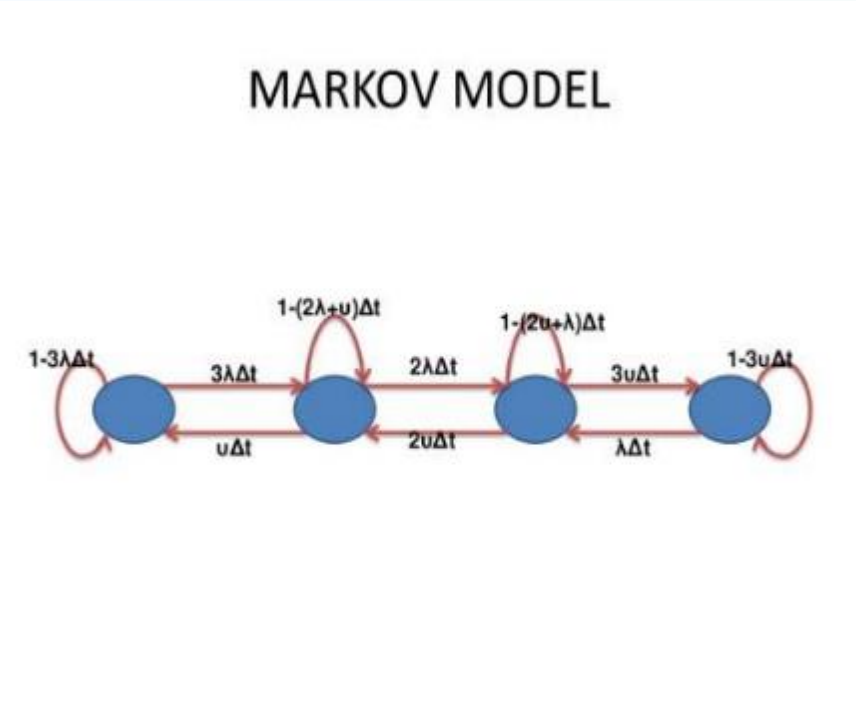
http://jasss.soc.surrey.ac.uk/14/3/7.html

Cont'd

Markov Model

A technique for predictive change modeling.

Predictions of future changes are based on the current condition.

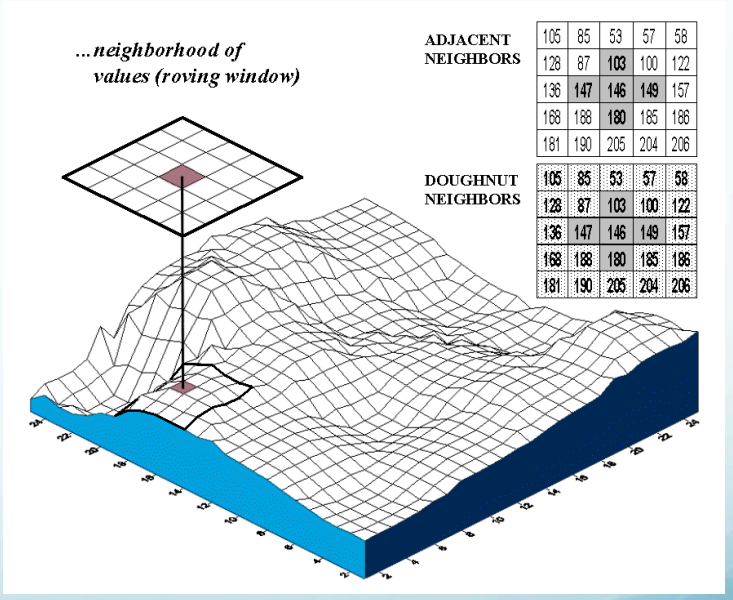


http://www.slideshare.net/suj1thjay/markov-model-for-tmr-system-with-repair

Continued

Land use scenarios dynamics model (LUSD Model)

The basic idea of LUSD is from SD model and CA model, both of which have statistical and spatial signification.

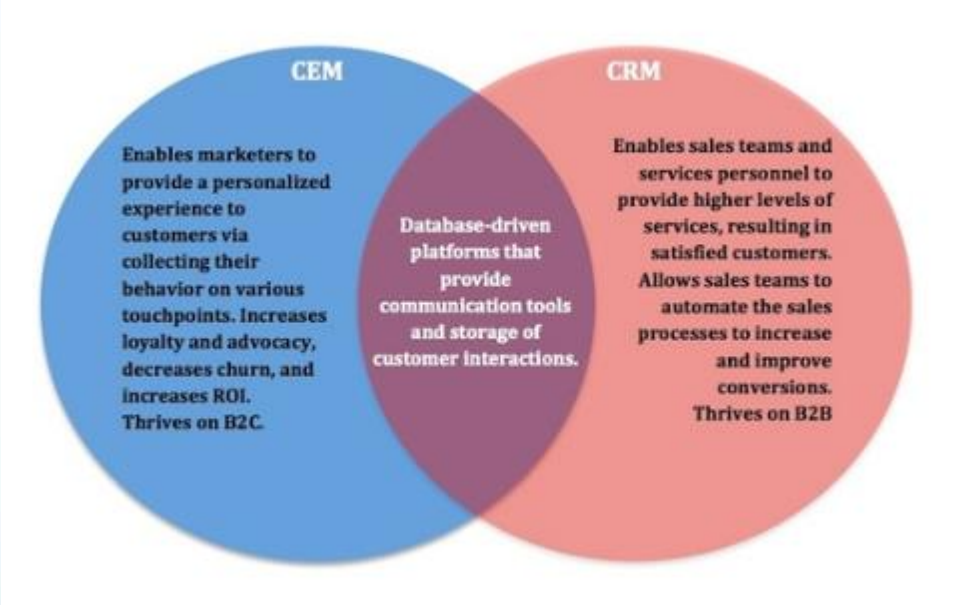


http://www.innovativegis.com/basis/mapanalysis/Topic8/Topic8.htm

Continued

City expansion model in metropolitan area(CEM) model:

The CA model and Tietenberg model are composed to CEM model. It is an effective model to investigate the relationship between the urban expansion and population growth.



http://kungpao.tv/cem-vs-crm-which-platform-is-better/

Model Selection

Model	Advantages	Disadvantages
CA Model	Statistical and spatial signification	Difficult to guarantee space resolution
CLUE Model (the conversation of land)	Simulate multiple LULC change simultaneously	Invalid in the case without historical condition
MARKOV Model	Simulate the condition of T2 time point based on that of T1	No spatial signification
LUSD Model (land use scenarios dynamics model)	Combine CA model and SD model Can do the factor analysis	Invalid for climate and resources factor analysis

Conclusions

Projecting future states of land use and land cover is the precondition in numerical predictions about global changes. The current state of the ULC models is very useful for geographers, and using model to do LULC has good prospects for development.

Reference

- Focks D A, Daniels E, Haile D G, et al. A simulation model of the epidemiology of urban dengue fever: literature analysis, model development, preliminary validation, and samples of simulation results. *American Journal of Tropical Medicine and Hygiene*, 1995, 53(5): 489-506.

- Waddell P. UrbanSim. Modeling urban development for land use, transportation, and environmental planning. *Journal of the American Planning Association*, 2002, 68(3): 297-314.

- Stephenne N, Lambin E F. A dynamic simulation model of land-use changes in Sudano-sahelian countries of Africa. *Agriculture, ecosystems & environment*, 2001, 85(1): 145-161.

- White R, Engelen G, Uljee I. The use of constrained cellular automata for high-resolution modelling of urban land-use dynamics. *Environment and Planning B: Planning and Design*, 1997, 24(3): 323-343.