Advances in Geographic Information Science

Zhenjiang Shen

Geospatial Techniques in Urban Planning

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Editorial Introduction

The book will bring together some of the theoretical and empirical perspectives about application of Geotechnology in the field of urban planning and design. From an integrative viewpoint on Geosimulation, Geovisualization and Geography information system, we give readers a valuable insight into the following subjects:

- Simulation of planning policy impacts on urban land use using cellular automaton (CA) and multi-agent system (MAS) process,
- Visualization of design guideline for improving coordinative design and gaining consensus using virtual reality (VR),
- Development of planning support tools using geography information system (GIS) and integration GIS with CA, MAS and VR.

Currently the three concepts of Geosimulation, Geovisulization and Geography information system are not integrated together so as to build a complete platform of Geotechnology. For example, Google earth is an integrated platform of virtual reality and geography information system. The integrated multi-user environment based on agent-based simulation and virtual reality is also constructed by Secondlife Inc. In this book, we discuss these three concepts and their intended effects on planning support respectively, which imply inspirational possibilities of Geotechnology integration in planning practice. Accordingly, this book will be edited as three parts, which are Geosimulation and land use plan, Geovisualization and urban design, Geography information system and planning support.

For application of CA in urban growth simulation, Chap. 1 discussed about how to predict urban boundary in Beijing and argued about spatial constraints and relevant spatial policies in Beijing. However, the essential thought of constraint CA that spatial constraints decide the urban form, is not true in planning process of a real city. In planning practice, there are more complicated factors that make planners to draw alternative land use plans. The authors propose the concept of “form scenario analysis” (FSA), which is utilized to investigate relationships between planning alternatives and corresponding spatial policies and to adapt spatial policies as necessary for various planning alternatives. Chap. 2 is about a case study in Chuangdong, Guizhou province in China, in which CA is used for simulating urban growth and predicting developed area of a new city with 80 minion populations while considering growth of households in the predicted 20 years in the future. Households are designed as agents in this work who consuming energy and producing waste in their daily life, in which MAS approach is instrumented. Thereby, a low carbon city policy is expected to be conducted in our further research work. In chap. 3, the methodology of CA and MAS are argued with respect to land use planning from viewpoints of farmland conversation quota during urban growth, in which the authors explain the interactions between various driving stakeholders, such as governments, residents, farmers, and industrial enterprises. Furthermore, special attention has been paid to spatio-temporal allocation efficiency of farmland conversion quotas for land use planning. Chap. 4 investigates the implications of introducing planning behaviors into complex organizational systems. As a great progress of Chap. 5 in current CA literatures, alternative plans proposed by urban planners are introduced into CA simulation, while impacts of relevant policies with respect to spatial constraints are retrieved in CA simulation. We suggest that constrained CA simulation can be an approach for negotiation between planners and developers by identifying the required spatial policies for predefined alternative plans in planning practice. For integrating with environmental issues in the CA and MAS approach for urban growth simulation, the household water consumption simulation (HWCSim) model is designed in Chap. 6 to reflect the process of total amount control of household water consumption. As validated by the real data for Kanazawa City, the HWCSim model is found to be applicable for simulating the process of household water consumption regulated by local government in planning practice. The simulation results, including water price and household water consumption, are very similar to the actual data obtained for Kanazawa City.

Regarding Geovisualization, Chap. 7 argued that VR technology has been played very important role in urban planning and managing process, and introduced many case studies of 3D digital city model projects for representing urban design of centre business districts of several metropolitan areas in China. In chap. 8, the authors concentrate on the digital preservation of historic buildings, which is a combination of theoretical methods and real-life measurement and experiment; it offers a detailed description for the process of 3D digitization and virtual simulation. We argued in Chap. 9 about how to use virtual reality for visualizing design guideline, meanwhile, a web-based planning committee is suggested for gaining consensus of design guideline without spatial and temporal limitation. In this Chapter, using some video tapes recorded in deliberation process of a local planning committee, the effectiveness of VR representation is analysed. Some exciting ideas of advanced application of VR in urban planning are introduced in Chaps. 10–12. In Chap. 10, an on-line tool using VRML takes the original icon game as model for design game of a public park in Kanazawa city, Japan, which is used to collect participants' proposals in their community. Participants can use this on-line tool to arrange design elements on a park site, which coordinate information can be saved in a web database for generating a 3D scene of his/her design. In Chap. 11, a VRML tool with prescribed design elements for representing alternatives of townscape design can be changed by users on the internet for gaining consensus of a design guideline in a traditional district. This tool is developed for residents' design learning of traditional style buildings in historical conservation areas. By using this tool, planner can help stakeholders to coordinate alternative designs or review them through multi-user environment, which replace drawings, documents and other traditional media for representing urban planning and design. In chap. 12, we conducted a questionnaire, the results of which verified that virtual representations using Google SketchUp and Google Earth are suitable for improving residents' understanding of the historical landscape. The idea of opening the model to public view on the Internet was evaluated positively by respondents to a questionnaire. Accordingly, Geovisualization can be used to visualize participants' alternatives who are non-experts for representing their proposals of planning and design. Meanwhile, change of those alternatives can be shared between participants on multi-user environment for getting mutual understanding and reaching consensus in deliberation process. Otherwise, visualization is also useful for design review after a consensus of design guideline is reached.

As for GIS that is the most important part of Geotechnology and has longer history than Geosimulation and Geovisualization in planning support, the customized GIS tools with powerful spatial analysis functions can be used for diversified purposes of planning and design. Part III argues about how to customize GIS tool according to different requirements in different urban planning projects. Meanwhile, we also introduced some ideas and tools from an integrative viewpoint on Geosimulation, Geovisualization and Geography information system. In chap. 13, we propose a GIS and CG integrated system that automatically generates 3D building models as 3D city model. In urban planning practice, a 3D city model is quite effective in understanding what will be built, what image of the town will be changed in an urban area for all stakeholders including residents, citizens as well as planners and designers to gain consensus on design alternatives. A urban growth control planning support system (UGC-PSS) tool proposed in Chap. 14 offers a platform for urban growth control analysis. For the Beijing Metropolitan Area, 60 control factors, together with their indicators, were included to reflect urban growth conditions in the study area. The UGC-PSS tool enables complex urban growth control problems to be solved by using multi-disciplinary knowledge, such as flooding control, eco-zone protection, noise prevention, and disaster prevention, which had not previously been possible for a single urban planner with limited education background. In Chap. 15, a planning support system based on ArcGIS is developed to retrieve alternatives of conservation plan for traditional houses in Beijing, which integrates all possible data sources of household and traditional house in the platform of ArcGIS and generates alternatives of the traditional house with a decision tree referred to deducting process using the spatial features' attributes. In Chap. 16, a tool is developed for retrieving ecological network from aero photography and local urban system database, which use not only features' attributes but also raster data for classification of land use types from aero photograph. A decision tree based on features' attributes is also employed as the retrieving rule for generating ecological map. For integration with CA, MAS and

GIS, spatial analysis functions, such as neighbour statistic is employed in Chap. 17 for CA simulation tool in the case of irregular polygons, which are vector dataset of GIS geodatabase. Chap. 17 showed that it is possible to employ CA for simulating land use change at the level of urban partitions using a data set of irregular blocks and parcels, which reflect impacts from urban planning conditions and parcel attributes after an urban project in Kanazawa city, Japan. Finally, approach of MAS that simulating land use policy for regulating locations of large-scale shopping centers is employed to take different scenarios of commercial policies into account in Chap. 18, which shows the possibility of integration of MAS and GIS.

In this book, we try to combine VR, MAS with GIS for Geovisualization and Geosimulation, which imply the prospective integration of virtual reality, simulation and geography information.

Our main objectives as the following:

- Investigating substantial planning problems and visualizing land use plan & policy impacts on land use based on Geosimulation
- Visualizing and coordinating design alternatives using virtual reality and improving deliberation, decision-making and gaining consensus through Geovisulization in cooperative design process and reaching consensus for design guideline and regulations
- Customized tools for planning and design using Geography information system and tools for diversified planning projects through integration of VR, MAS and GIS

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