An Exploration of Quantitative Methods for Comparing Urban Development Scenarios

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Abstract

Cities are the focal points for cultural, economic, political, and social activity across the globe (Harvey 1996). As a result, urban growth models (UGMs) are growing in popularity for testing municipal and regional policies. However, no standardized procedure exists to evaluate the outputs of these models (U.S. EPA 2000). This project seeks to develop methodologies for comparing different forms of development using spatial statistics, accessibility and landscape metrics. 'What If?' is applied to Calgary, Alberta to test the methods proposed.

Background and Relevance

Urban growth models have existed since the 1960's. The first basic UGMs leveraged Cellular Automata (CA). But, these urban growth models were widely criticized for their lack of flexibility and inherent biases (Lee 1994). Recently, however, UGMs have experienced a renaissance due to growing accessibility of geospatial technologies, geographic data, and concerns about the impacts that current urban growth trends have on quality of life (Batty 1997; U.S. EPA 2000; Klosterman 1998; Waddell and Ulfarsson 2004). Furthermore, the new UGMs are more flexible and theoretically sound than their predecessors (Batty 1997, Britton 1985, Lee 1994, King and Kraemer 1993).

For this project, 'What If?' is used to simulate four different urban development policies: 1) ecological design,[1] 2) smart growth,[2] 3) urban and suburban sprawl,[3] and 4) a scenario based on the findings of the Imagine Calgary Project (Imagine Calgary 2006). Spatial statistics, landscape metrics, and accessibility are applied to each of the development scenarios to explore their costs and benefits. It is believed that this exploratory study will help produce a standardized methodology for quantitatively and analytically comparing UGM simulation outputs for various development policies, as well as assessing the potential impacts of development policies on the urban landscape and its inhabitants.

Methods and Data

The four development scenarios listed above are simulated by interpreting the guidelines for, and typologies of, the four development types and translating

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[1] For this study ecological design will be related to sustainable development and signifies development where the built environment is constructed in 'harmony' with local ecology and topology (Gibson et al. 1997).

[2] Smart growth will also includ elements of New Urbanism and Transit Oriented Design as all of these form of development are significantly related (Godschalk 2004).

[3] No formal definition of suburban and urban sprawl exists, but it is typified by low density residential, segregation of land uses, and high reliance of the automobile for transportation (Chin 2002; Cieslewicz 2002; Torrens and Alberti 2000)

them to coincide with the 'What If?' framework (Klosterman 1998). This is accomplished using a variety of datasets pertaining to the topography, land use, and demographics of the Calgary region. The outputs from the UGM simulations for each of the development scenarios will be compared using spatial-quantitative methods. Spatial statistics, Moran's I and Local Indicators of Spatial Association (LISA), are used to explore the spatial structure of land use for each of the scenarios (Burrough and McDonald 1998; Torrens and Alberti 2000). The Moran's I and LISA statistics are applied to the final projection year of the UGM simulations. Landscape metrics are most widely used in ecological studies to assess spatial patterns and processes acting on a landscape. They are used in this project to evaluate temporal shifts in land use patterns by applying them to each projection year of the UGM simulations (Herold et al. 2003). The landscape metrics used for this project are number of patches, mean patch size, patch size standard deviation, edge density, contagion, simpson's evenness index, fractal dimension, mean nearest neighbor distance. Finally, accessibility is assessed for the final projection year of the UGM simulation by exploring the spatial relationships between residential and amenities locations (Bloomquist et al. 1998; Torrens Alberti 2000).

Expected Results

It is hypothesized that the Moran's I and LISA statistics will demonstrate variations in land use patterns between development scenarios simulated using 'What If?'. Each development scenario simulated encourages different levels of density resulting in different Moran's I and LISA values (Torrens and Alberti 2000). These results should be further corroborated by the temporal changes in the landscape metric values calculated for each project year. Additionally, the landscape metrics will provide more detailed information about landscape form and pattern (Herold et al. 2003). It is also expected that the spatial relationships analysis will produce meaningful global measurements of accessibility to amenities, such as grocery stores and recreational facilities (Bloomquist et al. 1998; Torrens Alberti 2000). Thus the values produced from these spatial-quantitative methods which evaluate form and pattern can be related to the urbanization process and issues of quality of life.

Conclusions

As result of the impacts of urban growth on quality of life, UGMs are becoming powerful tools in the debate about how best to shape our cities for the future. However, currently few analytical techniques exist for comparing the results from urban growth models. This project attempts to provide a quantitative, spatially explicit, and analytical toolset for assessing landscape form, pattern and process in order to compare UGM simulation outputs. This will be accomplished by applying 'What If?' to Calgary, Alberta. Four alternative development scenarios will be simulated to test the toolset proposed.

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