Chapter IV
GIS-Based Simulation and Visualization of Urban Landuse Change

Md Mahbubur R. Meenar
Temple University, USA

ABSTRACT

This chapter introduces the use of geographic information systems simulations and visualizations in urban landuse changes as a means of studying spatial pattern of crime incidents. Through literature reviews the chapter provides a survey of different simulation tools and techniques that have been used in landuse planning. It also provides an overview of the models available for examining landuse changes in the context of planning processes. It argues that three-dimensional simulations of urban landuse change scenarios encourage public participation in the decision making process. The author hopes that the chapter would be useful for criminologists unfamiliar with landuse scenario simulation models and techniques. Furthermore, the chapter suggests how the crime analysts could utilize the available landuse simulation models and tools in analyzing existing crime patterns or predicting future patterns in an urban setting.

INTRODUCTION

Landuse is considered as one type of physical variable behind any crime incidence. Research has shown that the physical characteristics of urban neighborhoods influence crime patterns and particular landuses, such as bars and liquor stores, may attract more crime in their vicinity (Block & Block 1995; Byrne 1986; Greenberg 1986; Loukaitou-Sideris, Liggett, & Iseki, 2002;). This chapter introduces the techniques, methods, and models available for simulating urban landuse changes over time in two and three dimensional (2-D or 3-D) geographic information systems

(GIS) based environment to the criminologists unfamiliar with such models.

The application of GIS based simulation and visualization in the filed of urban and regional planning is a growing one. This chapter focuses on issues related to urban landuse changes over the time. Simulating urban landuse change is a complex problem, as the process requires inter-disciplinary communication among planning professionals, technicians, citizens, and stake-holders. Today's GIS software allows the users to visualize 2-D or 3-D virtual simulations of future landuse scenarios with the capability of creating still images and video clips for presentation purposes.

It is the visual representation of any proposed landuse changes—not only numerical output—that attracts the general citizen to get involved in the planning process. Technologically improved and user friendly visualization techniques of urban simulations have always encouraged people to participate in the decision making process.

The use of GIS and other geospatial technologies can play an important role in building trust among planners, policy makers, and citizens. When planners and policy makers make decisions on future development pattern of any community or a subdivision, the use of advanced visualization techniques can overcome the trust issues, especially in disadvantageous communities, which are traditionally the least informed or consulted but the most detrimentally impacted group.

This chapter will discuss some GIS-based methodology and software used for developing and visualizing 2-D or 3-D simulations in the context of urban landuse changes in the United States. It will start discussion on landuse planning, specifically on how the landuse pattern changes over the time and how it affects the spatial distribution of crime pattern. The next section discusses the development process of GIS simulations and scenarios, followed by another section on the creation process of 3-D GIS visualization. Finally some issues and future trends will be discussed with remarks on how these simulation methods could become useful to the criminologists.

BACKGROUND

Change of Urban Landuse Over the Time

Land is a finite resource for most human activities, including settlement, agriculture, communication, and recreation. Land transformation is considered as one of the most important fields of human induced environmental transformation (Wolman & Fournier, 1987). According to Wegener (2005), "the distribution of landuses, such as residential, industrial, or commercial, over the urban area determines the locations of human *activities*, such as living, working, shopping, education, or leisure" (p. 206). However, landuse pattern is constrained by topography, soil type, or vegetation, and landuse-change decisions are frequently driven by property rights, politics, changing demographics, technological advancements, mobility, and market forces of any particular community.

In the United States, the landuse pattern of a community often is a result of the zoning ordinance. Zoning acts as a planning instrument to limit densities, floor-area ratios, or unwanted development; whereas landuse regulations separate the land uses, limiting mixing of residential with commercial or industrial uses (Cullingworth & Caves, 2003; Levine, Inam, & Torng, 2005). Subdivision regulation is another type of landuse tool, which controls the division of larger parcels into smaller ones for sale or redevelopment.

Landuse and zoning regulations vary from region to region or municipality to municipality. For example, the Delaware Valley Regional Planning Commission consists of five counties of Pennsylvania and four counties of New Jersey. This regional planning commission develops digital landuse data based on digital ortho-photography after every five years. Same landuse categories