Introduction

Parklands and other urban recreational open space areas have played major roles in urban planning processes throughout the nineteenth and twentieth centuries. As spatial complexity in urban regions increases, models of urban land use will increasingly find the need to consider the effects of recreational open space development on general urban function, development opportunities, and quality of life concerns for urban residents. This has become especially apparent as studies of urban open space have shown that significant market failures exist that relate to a common undervaluation of open space in spatially expanding urban centers (Brueckner, 2000). In order to address the mounting complexity in achieving efficiency and distributional equity in allocating and locating open space, a simulation model was constructed replicate the patterns currently seen in open space distribution throughout the St. Louis study region (Figure 1 shows the current open space distribution in the E/W Gateway Region). This model was developed to act as a tool for assisting urban and recreation planners in assessing the range of future consequences that may arise from their present open space-related decisions and policies as part of the LEAM program at the University of Illinois.

Simulations of the rate and behavior of land-use change can be used to inform and enhance the planning process. By simulating the development of urban open space on both a regional and city level, it becomes possible to demonstrate the dynamic nature of recreational open space systems and enhance the ability of planners, policymakers, interest groups and laypersons to visualize and test the impact of policy decisions. The classic approach to land-use modeling typically has involved simulating the allocation and location of new land uses, typically divided into residential, commercial, and open space land use categories or sub-categories. However, few land use models spend much time simulating the dynamics of open-space development (Chin, 1995). Rather, land-use models tend to concentrate on the urban dynamics of that result in commercial and residential development. In the past, urban land-use models that have attempted to model open space creation have tended to view open space merely as a land fraction required with concurrent residential construction. Here, the objective is to develop a mechanism that captures how open space is allocated and subsequently located within the LEAM framework for simulating land-use change.

Methods

The simulation model that has been developed is broken into models of open space allocation and location. Open space allocation uses the concept of Level of Service (LoS) in order to determine open space demand and supply. Level of Service (LoS) calculations have been established to determine the level at which infrastructure services are provided to the public (usually calculated as X-units of service per person) (Mertes and Hall, 1996). Here, we use Level of Service (LoS) as a basis for the spatial allocation of open space development as it is integrated with urban residential and commercial development (acres of open space per thousand people). This established approach allows us to explore spatial outcomes associated with different policies and ordinances governing municipal open space requirements, as well as their interaction with other public policy and investment choices (LoS measurements were originally established more than a hundred years ago as a method for provisioning public infrastructure and were later adapted by the National Recreation and Park Association (NRPA) and the American Academy for Park and Recreation Administration (AAPRA)). The output of the allocation model is the cells needed to satiate open space demand (this demand is usually derived from population growth, but it can be used as an abstract representation of factors such as political pressure or public willingness to invest in open space).

The locational aspect of the model uses a spatial analysis that creates a correlation between various land-cover types with established open space areas. Through this analysis, the local attractive-influence of various land covers can be determined. The location model then assigns each cell a probability of development into open space. This probability is calibrated by using open space demand (allocation model output) to determine how high open space development probability needs to be in order for LEAM to create the necessary amount of open space to satiate demand. This approach is innovative because it allows us to incorporate past patterns of open space development into our dynamic description of how future open space might be located.

Results

Preliminary results take the form of spatial analyses that look at the localized correlation (specific to the study area) of various land-covers on spatial distribution of recreational open space. In this case, wetlands, open water, and forests all act as direct, monotonic attractors of open space (Figure 2) since open space tends to be located nearby these land-covers. This is an important empirical finding that will greatly enhance the LEAM's ability to accurately assess the location of future open space areas under current locational methods used by planners. Slope and residential areas have slightly more complicated spatial relationships with open space (Figures 3 and 4). We have found that in the study area, both low and high slope acts as attractor for open space. We believe this to be due to several factors:

- The desirability of flat areas for open space (such as playfields and basketball courts);
- The competitive role that more "valuable" land-uses play at mid-slopes, and finally;

- The marked inability to develop any commercial, residential or transportation land-uses on extremely steep slopes.

Residential areas also have an interesting relationship with open space proximity. Residential locations seem to attract very small pieces of open space at very close ranges, while larger tracts of open space tend to be created some distance away from residential areas. We believe this parabolic relationship to be due to distortion by rural areas, where large tracts of economically available land allow open space to be developed quite a distance away from residential centers. However, in terms of numbers of open space areas, our analysis supports the literature associating open space with residential areas. Here, we are able to draw a distinction between *number* of recreation locations and *area* of recreation locations.

Conclusion

The use of more established and flexible techniques for open space allocation and location analysis will allow for increased accuracy in LEAM's future projections of urban development. In coming months, more visual results will become available as regression analysis from the above open space attractors are integrated into the LEAM modeling framework (See Figure 5 for a preliminary probability regression map). Future work may include implementation of hedonic price models to incorporate land valuation into location procedures as well as increasingly sophisticated methods of simulating different types of open space development such as neighborhood and regional level park areas. This model represents a first step in increasing LEAM's open space sophistication, while opening the door for significant advancement in open space location and allocation precision.

References

Brueckner, Jan. 2000. Urban Sprawl: Diagnosis and Remedies. *International Regional Science Review*, 23: 160-171.

Chin, Yoihee. 1995. Multi-Stage and Multi-Objective Allocation Procedures of Urban Parks Using Location Decision Support System (UPLDSS). University of Illinois Department of Urban and Regional Planning: PhD Dissertation.

Mertes, James D. and James R. Hall. 1996. Park, Recreation, Open Space and Greenway Guidelines. National Parks and Recreation Association: Alexandria, VA

Appendices

Figure 1. E/W Gateway Open Space

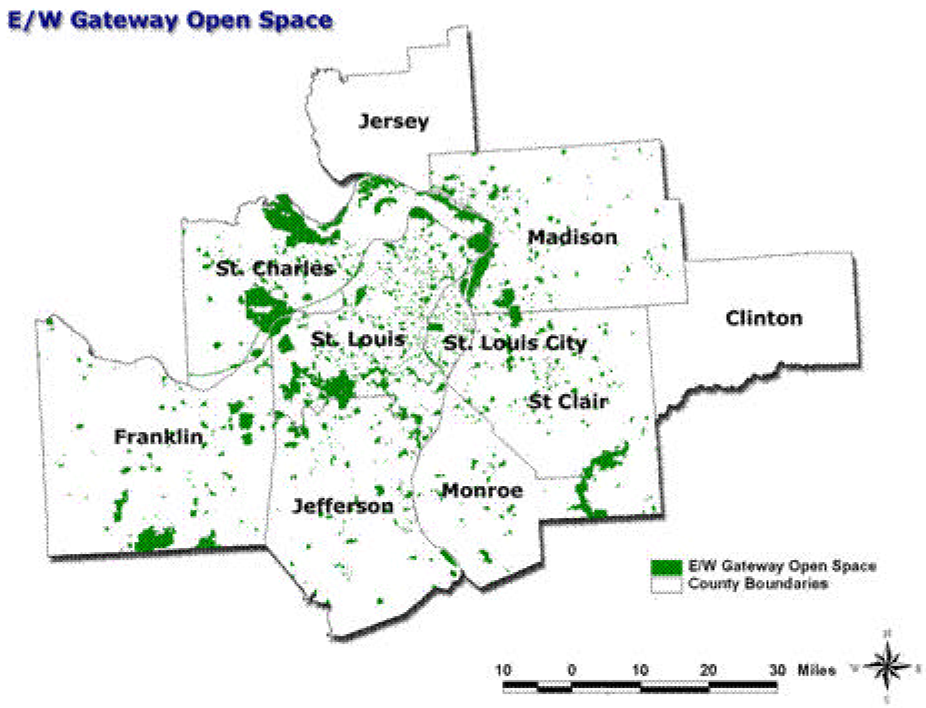

Figure 2. Normalized Probability of Open Space Location as Function of Distance from Wetlands

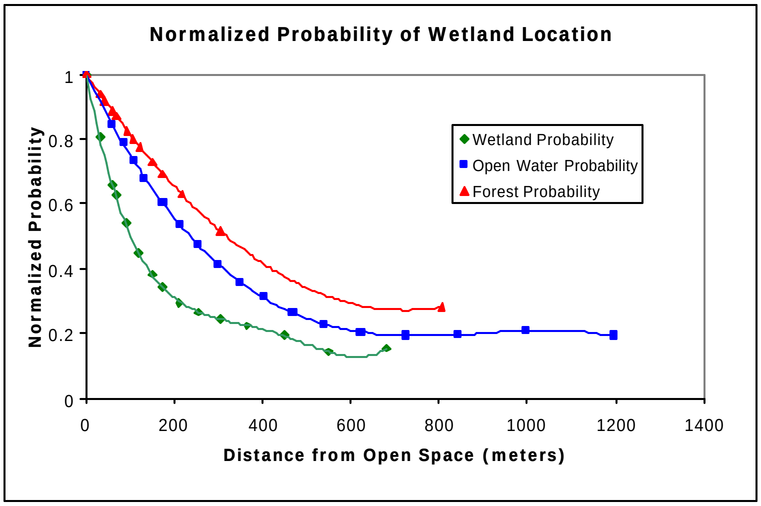

Figure 3. Normalized Probability of Open Space Location as Function of Slope

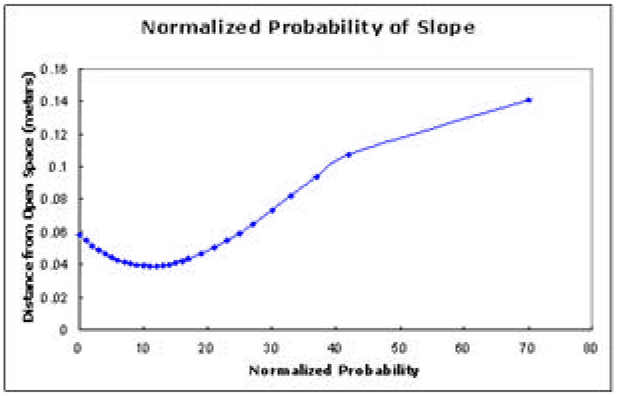

Figure 4. Normalized Probability of Open Space Location as Function of Distance from Residential Locations

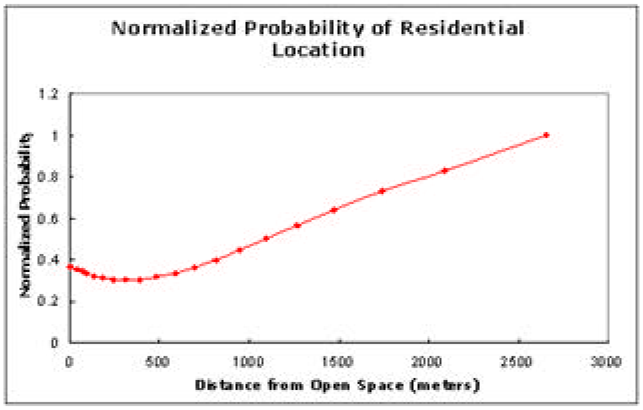

Figure 5. Normalized Initial Probability of Open Space Development with Current Open Space Overlayed