

Analysis and simulation of land-use change in the central Arizona- Phoenix region, USA

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Purpose

- To understand how urbanization has transformed the desert landscape in Phoenix Arizona.
- To analyze the spatial extent of urbanization and the structural complexity



Study components

1. Statistical extrapolation of the historical trend of land use
2. Development of a Markov-cellular automata model to simulate land-use change.



Statistical extrapolation components

- The temporal change in selected spatial pattern indices was examined
- The influences of population size and topography on development of land use patterns was considered



Statistical extrapolation methods

- 5 reconstructed land-use maps from 1912, 1934, 1955, 1975, and 1995 were used to analyze the temporal land use changes
- Maps classified land use into three categories: Urban, desert, and Agriculture
- USGS topographic maps and census data were compiled.



Statistical extrapolation methods

- Land use patterns were correlated with population size and topography.
- Compared the urbanized areas to the interpolated population size generated by a population growth model.
- To examine the potential constraints of slope, the mean slope for each land-use class was derived using a DEM



Model components

- Objective was to simulate spatial patterns of land use change at a temporal resolution of 1 year.
- Land Use maps for 1975 and 1995 were implemented at two spatial scales to examine the effects of spatial scale.
- Land use maps were scaled down to a 1 year time step



Model components

- The model was implemented on the rasterized pixels of the 1975 land use map.
- The numbers of neighbors for each non urban cell was calculated based on an eight neighbor rule.
- Probability of a cell changing is based on the number of urban neighbors and the state of the focal cell.



Model validation

- Comparisons between the model output and the 1995 maps were made by examining the correspondence of spatial pattern indices.

Indices include patches, edge density, fractal dimension, and contagion

- Differences were determined through a Monte-Carlo confidence interval estimation



Pattern analysis Results

- Rapid urban expansion correlated with population growth was evident
- Urbanization increased the structural complexity of the landscape
- Topography does not appear to limit urban distribution



Model Results

- The 4 model sets: optimized and empirical parameters at a coarse and fine scale, differed substantially
- The optimized parameters at a coarse scale were statistically similar to the 1995 data for a variety of landscape indices
- In the fine scaled optimized parameter and the empirical parameters, the area of each pixel was smaller than the change over the temporal scale.



Model Analysis

- By using a smaller temporal scale, neighbor relationships can be seen in conjunction with urban sprawl.
- Models based over decadal temporal scales or larger often show no relationships between neighbors



Final Thoughts

- While studying land use change, temporal scales are important variables to consider.
- A better understanding of the effect time plays in land use change will implement stronger models, which can output more realistic and useful results.

