Landscape Structure of the Phoenix Metropolitan Region: Evaluation of an Urban Model

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ABSTRACT

Cellular Automatons (CA) are well suited to investigations of complex urban form due to their spatially explicit nature and their ability to generate very complex global forms from simple local rules, utilizing the principles of self-organizational theory. We have developed an urban growth model for the Phoenix region (PHX-HILT) based on a model (HILT) that was originally designed for the San Francisco Bay Area. To better represent Phoenix, PHX-HILT contains a number of modified and new growth rules, and is parameterized with data on land use and a suite of other variables collected within the Phoenix area. As part of the evaluation of PHX-HILT, we compare the shape complexity of land use types between the simulated and empirical maps using fractal dimension and other landscape pattern indices, to determine if the model produces a reasonable representation of the actual urban form. Several class and landscape level metrics were obtained and compared at five different grain sizes: 1km, 500m, 250m, 100m and 60m. The fractal indices compared include the Double Log Fractal Dimension (DLFD) the Mean Patch Fractal Dimension (MPFD) and the Area-Weighted Mean Patch Fractal Dimension (MPWFD). Other indices include Patch Density (PD), Landscape Shape Index (LSI), Contagion (CONTAG) and Shannon's Diversity Index (SHDI).

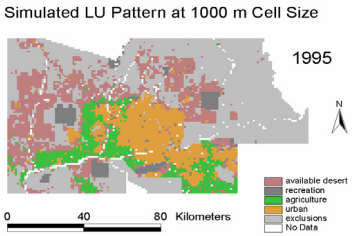
METHODS AND PROCEDURES

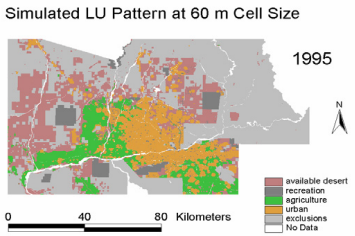
- ArcView Spatial Analyst was used to rasterize the 1975 empirical LU map at 5 grain sizes: 60, 100, 250, 500, and 1000 m (linear dimension).
- PHX-HILT was run 15 times at each grain size; landscape metrics were computed for each simulation output and then the mean and variance were calculated for each grain size (sample size = 15).
- The mean values of the metrics at each grain size were compared with the metrics computed from the 1995 empirical LU map.
- FRAGSTATS was used to compute the landscape metrics.

CONCLUSIONS

- Model accuracy decreases with increasing grain size for some metrics (e.g. DLF), increases with some others (e.g. PD), and remains more or less the same for still some others.
- Model accuracy also depends on whether class- or landscape-level metrics are used.
- In general, higher model accuracy is obtained at larger grain sizes with the sacrifice of fine-scale details.

Visual comparison at different scale resolutions

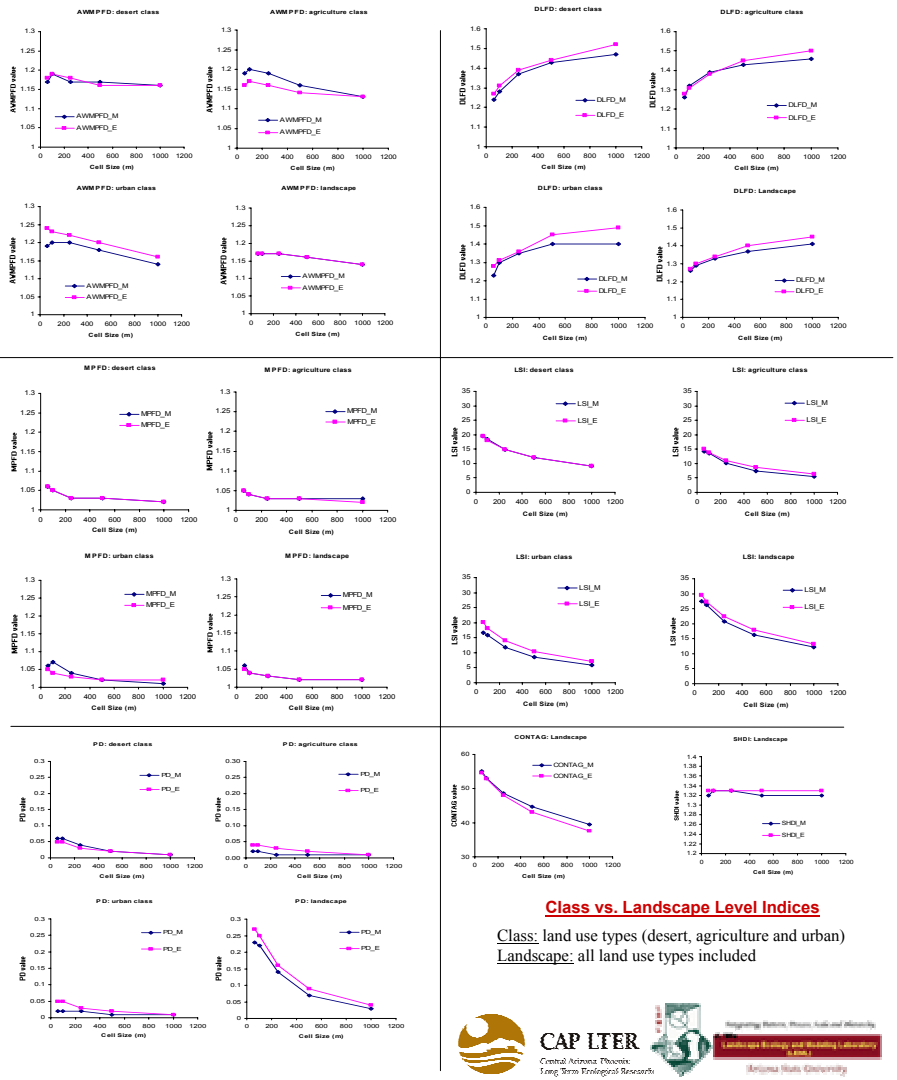




Patch Density: PD=N/A	PD	The number of patches per square kilometer
Landscape Shape Index	LSI	LSI=1 when all patches in the landscape are square; and increases without limit as the patch shapes become more irregular
Double-Log Fractal Dimension	DLFD	For a 2 dimensional patch, a fractal dimension greater than 1 indicates a departure from euclidean geometry (increasing shape complexity)
Mean Patch Fractal Dimension	MPFD	see DLFD
Area Weighted Mean Fractal Dimension	AWMFD	see DLFD
Contagion	CONTAG	CONTAG approaches 0 when the distribution of adjacencies (at the level of individual cells) among unique patch types becomes increasingly uneven. CONT=100 when all patch types are equally adjacent to all other patch types.
Shannon's Diversity Index	SHDI	SHDI=0 when the landscape contains only 1 patch, and approaches 1 as the number of different patch types increases or the proportional distribution of area among patch types becomes more equitable, or both.

% area	Desert		Agriculture		Urban	
	Simulated	Empirical	Simulated	Empirical	Simulated	Empirical
1000 m	21.35	18.84	9.85	10.04	14.19	16.51
500 m	20.66	18.71	10.02	9.99	14.21	16.19
250 m	20.32	18.82	10.64	9.87	13.83	16.10
100 m	20.60	18.83	10.91	9.87	13.39	16.20
60 m	20.25	18.84	10.08	9.89	14.37	16.17

* Other LU types make up the missing percentages of total land



Class vs. Landscape Level Indices

Class: land use types (desert, agriculture and urban)
Landscape: all land use types included

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