Shaping the City: Development Trajectories and Land Cover Patterns in Phoenix, Arizona

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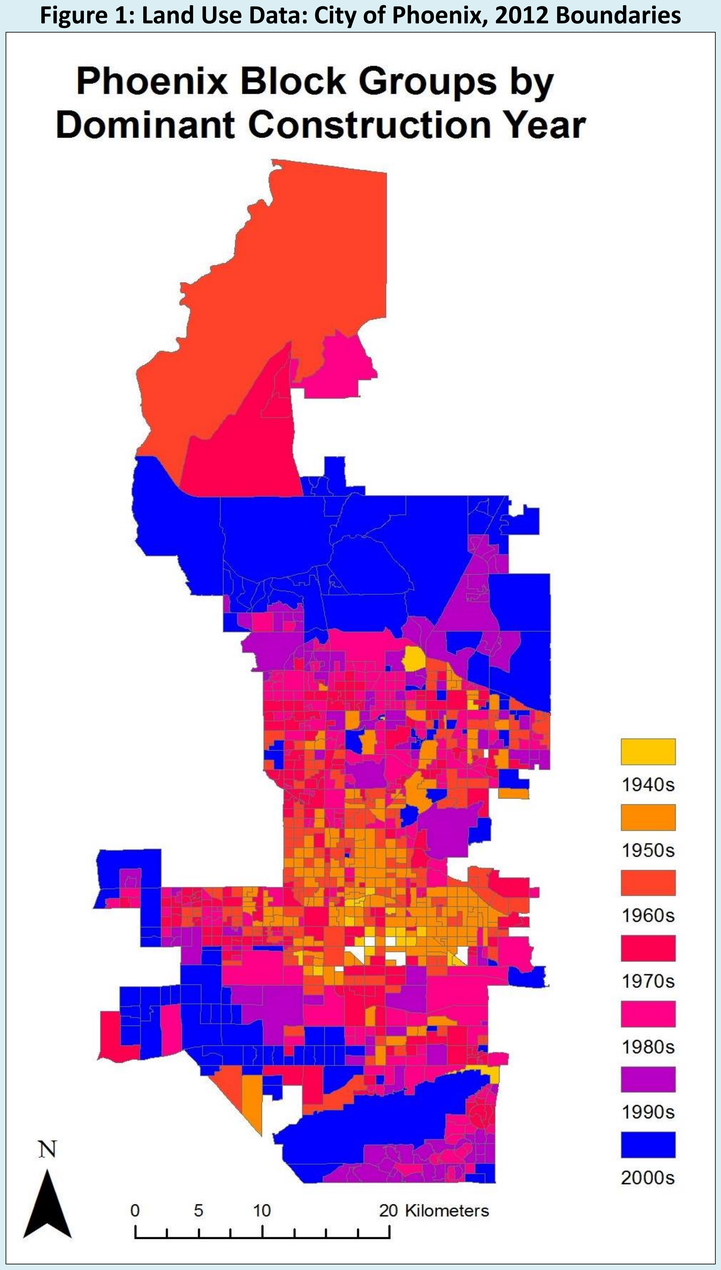
Figure 1: Land Use Data: City of Phoenix, 2012 Boundaries



Parcel-level construction data from the Maricopa County Assessor is aggregated by block group. Time is identified by **the decade by which half of the present-day structures had been built.**

OBJECTIVES

- We combine high-resolution (1m) NAIP imagery from 2010 with building construction data by parcel.
- We delineate areas (census block groups) in Phoenix based on the year by which most (>50% of land area) of the present-day structures were built.
- We compare landscape metrics measuring diversity and shape complexity to observe differences in land cover between older and newer-developing areas of Phoenix.

Figure 2: Example of a Classified Land Cover Map in an Urban Area

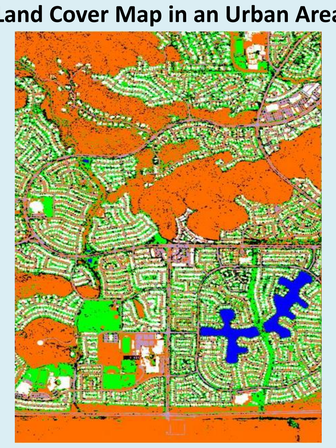


TABLE 2: ANOVA POST-HOC TEST RESULTS, SIGNIFICANTLY DIFFERENT METRICS SHOWN ($p<0.05$)

	1950	1960	1970	1980	1990	2000
1940	–	AI	AI	AI CONTAG	SIEI FRAC ED	SIEI* MSIDI* SIDI* SHEI* IJI* CONTAG* FRAC* ED
1950		CONTAG ED*	SIEI MSIDI* SIDI SHEI CONTAG ED*	SIEI* MSIDI* SIDI SHEI* IJI CONTAG* FRAC ED*	SIEI* MSIDI* SIDI* SHEI* IJI* CONTAG FRAC* ED*	SIEI* MSIDI* SIDI* SHEI* IJI* CONTAG FRAC* ED*
1960			–	–	AI DIVISION IJI* FRAC*	SIEI* SIDI SHEI* IJI* FRAC*
1970				–	IJI* FRAC*	SIEI* SHEI* IJI* FRAC*
1980					FRAC*	SIEI* SIDI IJI* FRAC*
1990						IJI* FRAC*

MOTIVATION FOR RESEARCH

- A common critique of urban sprawl is that it leads to increased land fragmentation, which has negative social and ecological implications.
- Scale: most earlier studies of urban extent rely on 30m resolution data, which analyzes differences between land parcels, not within them.
- Trajectory: most studies rely on some measure of distance to downtown (such as a linear transect) to identify peri-urban or newer-developing regions, though cities are not uniformly concentric.
- Consistent with theory, existing work generally finds evidence of increased fragmentation farther from the city center.
- Our study changes the scale at which fragmentation is observed; distinguishing between individual trees, sidewalk squares, etc. rather than whole lots.
- Our study delineates recently-developed (peri-urban) areas by time rather than distance to downtown.

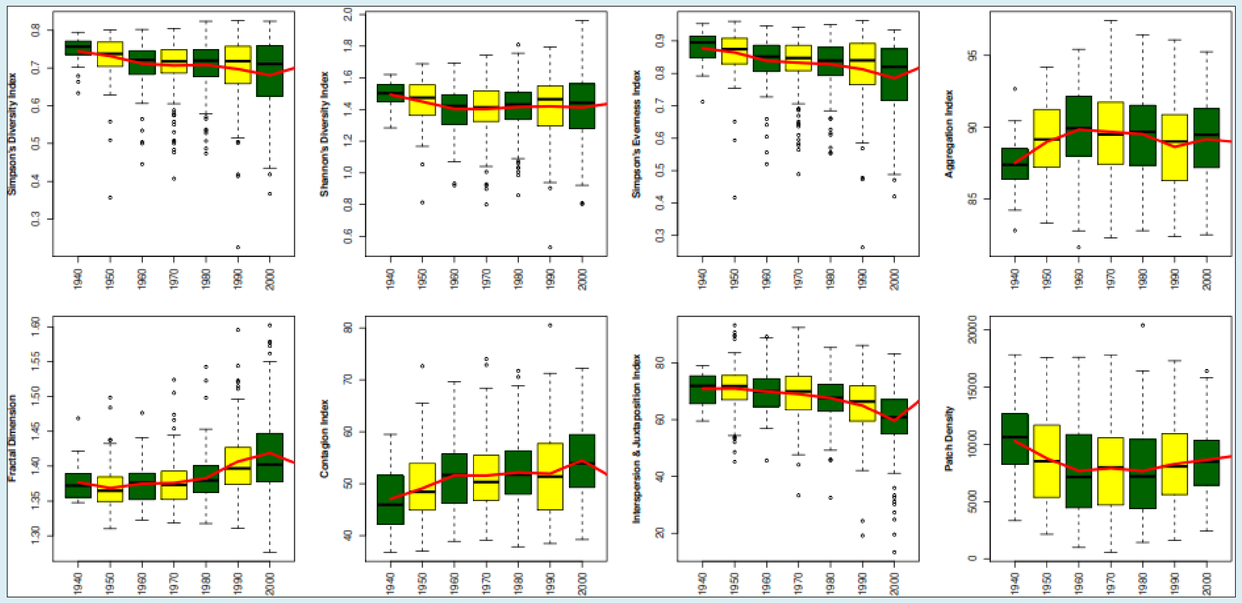


Figure 4: Selected Landscape-Level Metrics

Data Sources

USDA Farm Service Agency, ASU GIS Data Repository, Maricopa Co. Assessor's Office, Maricopa Assoc. of Gov'ts

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- TABLE 1: DESCRIPTION OF SELECT LANDSCAPE METRICS

Landscape Metric	Basic Description
Simpson's Diversity (SIDI)	The square of the proportion of the landscape occupied by a patch type, summed over all patch types. In other words, the probability that any 2 randomly selected pixels would be of a different class.
Shannon's Diversity (SHDI)	Similar to Simpson's Diversity Index but more sensitive to rare patch types.
Simpson's Evenness (SIEI)	The Simpson's Diversity Index divided by the maximum possible Simpson's Diversity. It approaches zero when the landscape is dominated by a single class.
Aggregation Index (AI)	A measure of "like adjacencies," i.e. adjacent patches of the same class. Maximum value is achieved when the landscape consists of a single patch, and minimum value is achieved when patches of the same type are never adjacent.
Contagion Index (CONTAG)	A measure often used to determine level of fragmentation between cells. Contagion is high when a single class occupies a very large percentage of the landscape. It increases with an inequitable distribution of pairwise adjacencies.
Fractal Dimension (FRAC)	A measure of landscape complexity or fragmentation based on perimeter-to-area relationships.
Interspersion and Juxtaposition Index (IJI)	Measures the level of intermixing of patch types. Maximum value is achieved when all patch types are equally adjacent to all other patch types.
Patch Density (PD)	The number of patches in the landscape divided by total area.

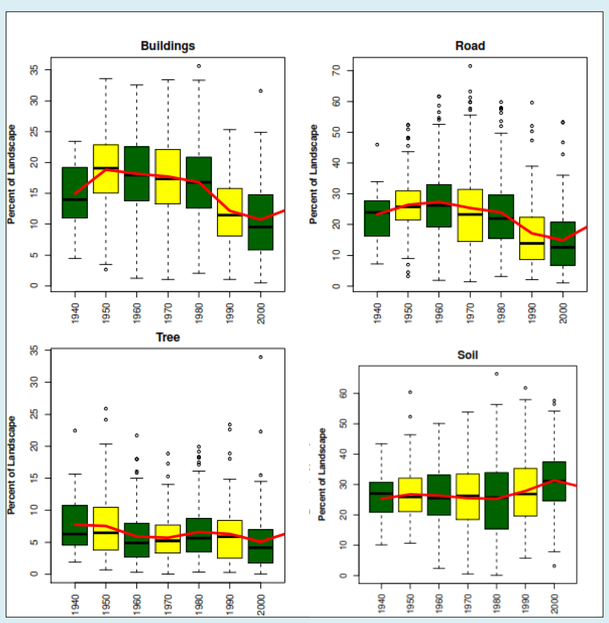

Figure 3: Class Metrics (omitted: soil, shrub, cropland)

KEY RESULTS

1. Results confirm substantial variation in present-day land cover characteristics based on periods of development: landscape structure is heavily path-dependent.
   - Block groups that developed principally during the nineties and 2000s were significantly different than earlier-developing regions in many metrics. They differed most from areas developed during the 1950s.
2. Results contrast somewhat with previous studies including Irwin and Bockstael (2007), Shrestha et al. (2012), and Zhang et al. (2013), who generally find increased levels of fragmentation near the urban fringe when using 30-m resolution data.
   - While decreases in landscape diversity were minimal over historical zones, the shape complexity of land cover in recently-developed areas is far higher.
   - Notably, landscape shapes appear more complex in newly-developing regions as opposed to older ones.
3. Sprawl is NOT uniformly an example of increasingly fragmented areas on the urban fringe. Development trajectory is heavily dependent on time period as well as on scale.

POSSIBLE CAUSES OR IMPLICATIONS

1.) Commercial uses fled the downtown area in the 1960s in favor of malls and arterial streets, resulting in a different style of business land use with larger footprints but more within-lot variation

2.) Increasing minimum residential lot sizes could result in increasing shape complexity within individual lots

3.) Possible higher incidence of leapfrog development since the 1990s

4.) May take longer to fill-in older areas (though, high vacancy possible too)

5.) Stronger preference for xeric (vs. mesic/grassy) landscaping in newer, outlying areas populated by migrants