

## Research Paper

## A spatio-temporal view of historical growth in Phoenix, Arizona, USA

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## HIGHLIGHTS

- We examine the growth trajectory of parcels in downtown Phoenix between 1915 and 1963.
- Parcels are placed in categories and analyzed to link change processes to landscape pattern.
- Results indicate land use homogenization; parcels of all types are likely to become like their neighbors.
- Despite downtown decline, nuisance parcels are decreasingly likely to be near higher-order land uses.
- This historical approach provides a new view of the rapidly growing, polycentric metropolis.

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## ABSTRACT

This study uses a spatio-temporal approach to analyze the historical development of Phoenix, Arizona. While historical narratives provide rich detail, there is also a strong quantitative tradition in urban growth research. Methods from urban growth models, ecological modeling, and spatial analysis provide sharper intuition into the effect that urban change processes have on the growth trajectory of individual land parcels and the entire urban landscape. Phoenix, Arizona is a popular case study for urban growth because of its rapid, decentralized expansion and the hegemony of its suburbs and outlying areas. It is often seen as the epitome of post-World War II suburban sprawl. We digitize parcel maps of downtown Phoenix from 1915, 1949, and 1963 in order to investigate the impact of regional change processes on the city's historic core. Using transition matrices, join-count autocorrelation, and spatial Markov chains, we find that the purported emptying out of the downtown area following World War II was more complex than the common story of retail exodus. Despite an increase in so-called nuisance properties and poor institutional land use controls, nuisance parcels showed a propensity toward aggregation and were less likely to exist in close proximity to higher order uses. Finally, we find that Phoenix's downtown is continually homogenizing by land use type. This paper provides a parcel-level view of the impacts that drivers of change have on urban landscapes, demonstrating the usefulness of spatio-temporal approaches in understanding the development of an urban morphology during a critical period of urban change worldwide.

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## 1. Introduction

The historical morphology of cities is often described via narratives with rich detail and thorough treatment of the peculiarities of each example. But there are also strong quantitative traditions that characterize urban growth and form, such as Burgess' concentric zone model that defined the Chicago School of urbanism (Park, Burgess, McKenzie, & Wirth, 1925), Adams' model of urban

transportation technologies (Adams, 1970), and Batty's cellular automata growth models (Batty, 2005). Quantitative approaches enable tests of widely held narrative contentions about urban landscapes. More specifically, parcel-level quantitative approaches connect individual land use decisions to the observed pattern of urban and urbanizing landscapes, strengthening our understanding of the underlying causal processes of land use change (Carrion-Flores & Irwin, 2004; Irwin, Bell, & Geoghegan, 2003; Newburn & Berck, 2006; Vaughan et al., 2005).

Lax annexation laws, ample land, and a post-World War II construction boom fueled a unique Sunbelt morphology in Phoenix, Arizona (Gober, 2006). This morphology is characterized by sprawling, automobile-dependent suburban expansion and speculative housing markets, contrasting with earlier eastern urban forms,

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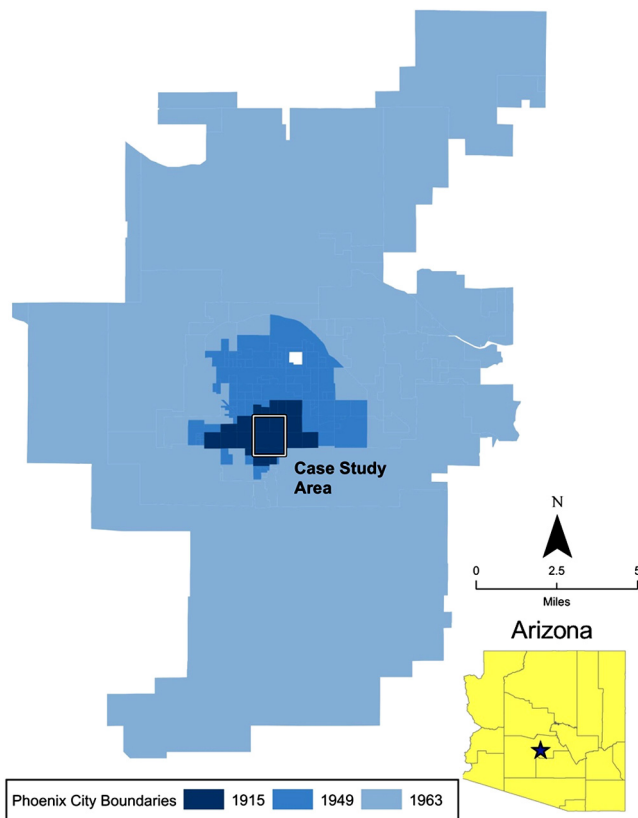


Fig. 1. The expanding boundary of Phoenix, Arizona.

which typically followed Burgess' or Adams' growth patterns around a downtown core. Phoenix represents a 20th century form of American urbanism described as rapid decentralized suburban growth (Luckingham, 1989), often at the expense of urban planning and environmental justice issues (Bolin, Grineski, & Collins, 2005). It is often considered part of a new, Sunbelt urban regime that is fast-growing and entrepreneurial in nature, but faces emerging challenges such as climate, air pollution, and traffic congestion. The causal processes of change that comprise this urban regime can inform development in regions with similar growth trajectories as Phoenix (Guhathakurta & Stimson, 2007; Keys, Wentz, & Redman, 2007). The city's central business district (CBD), the original point of modern settlement in the Phoenix Valley, fell into decline following World War II (Fig. 1). The CBD's pattern of decline and change can be seen as an indicator of structural economic and land use changes in the broader region. Most historical narratives of downtown decline emphasize the role of retail exodus as part of a larger structural shift and, in doing so, provide little understanding of how structural changes are manifested in land use changes and aggregate to create urban form. Similarly, the decline of the central core saw the emergence and intensification of environmental justice issues with the siting of undesirable properties near poor, minority residential neighborhoods – an action that was exacerbated by ineffective zoning and capital outflow (Bolin et al., 2005; Talen, 2012).

The objective of this paper is to use parcel-level land use data from Phoenix to link drivers of change from historical narratives to changes in urban morphology during the city's rapid period of expansion. While downtown decay, suburban-style land use homogenization, and the land use incompatibility that gives rise to environmental justice concerns have been studied (Bolin et al., 2005; Gober, 2006; Talen, 2012), they have not empirically considered parcel-level land use decision making – an important step in linking social and economic forces to land use change. We seek

to understand this link by addressing three questions: (1) what landscape results from the changing composition of the downtown that accompanied postwar suburban dominance, (2) to what extent is land use homogenization or incompatibility observable, and (3) how do nuisances and hazards become distributed as the city changes? In order to do so we draw on quantitative traditions in urban growth modeling, ecological modeling, and spatial analysis. First, we digitize and analyze Sanborn Fire Insurance Maps from 1915, 1949, and 1963 to characterize land use in the CBD. Second, we use simple parcel counts and transition matrices to measure the quantity of parcels in four broad land use categories and their propensity toward certain types of change. Third, we sharpen our understanding of transition types by measuring what Pontius, Shusas, and McEachern (2004) call allocation disagreement. Fourth, we explicitly model interactions between parcels and their neighborhoods using join-count tests to determine how the changing quantity or allocation of parcels changes their arrangement in space. Finally, we adopt a spatial Markov chain approach to determine the propulsive influence of a parcel's neighbors on its likelihood of undergoing change.

The insights that emerge from our spatio-temporal analysis highlight the causal processes of change that form urban landscapes. They also frame micro-level processes and urban morphology as a cause and effect relationship. A better assessment of the pattern and allocation of nuisance, hazard, or other incompatible uses in a rapidly growing metropolis may also inform decision-making in regions around the world that have similar growth trajectories as Phoenix. A historical approach to urban pattern is especially useful. New Urbanist ideas about walkability and land use complementarity are mostly derived from historic cities and continue to grow in popularity amongst planners (Berke, 2002; Jacobs, 1961; Talen, 2005). Planners and policymakers seeking to increase the sustainability of urban neighborhoods and cities can utilize insights from these quantitative parcel-level analyses instead of simply romanticizing pre-war urban form. Rather than describing the past or attempting to model future growth, we conduct a quantitative, historical analysis of one city that is emblematic of automobile sprawl, seeking to observe how the past trajectory of parcels yielded a historic landscape so as to better understand how current processes can yield future landscapes.

### 1.1. Phoenix urban history – a background

Known as a booster-driven boomtown, Phoenix, while not even settled by Westerners until after the Civil War, has maintained one of the nation's highest urban population growth rates for a century. However, it continually appears in the academic literature as a cautionary example for what is wrong with urbanism: a dismal early record of racial intolerance and inequality, a lack of place and identity (Gober, 2006), degraded perceptions of life quality (Guhathakurta & Stimson, 2007), and the environmental implications of sprawled development (Ross, 2011). Several aspects of these historical narratives are inherently linked to urban morphology: Phoenix is known for its polycentric urban development – rather than a single, strong core like older cities, it is characterized by several functional subcenters that provide a measure of organization by economic sector (Leslie & Ó hUallacháin, 2006). Following early-century flooding, an expansion of railroad-related industrial activity to the South, and an increase in the availability of land, there was a notable residential shift as wealthier, white, non-Hispanic residents gradually moved north while poorer, minority residents remained in South Phoenix. Land use homogenization and land use incompatibility existed side-by-side, but for different groups of people (Gammage, 1999; Gober, 2006). As the city's functions spread to subcenters and lower density outlying municipalities, the loudest complaints have come from concerns over

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