Urban Fringe Expansion Measured by Water Infrastructure Development: Phoenix, Arizona, 1954 – 2003

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Introduction

Clean water, distributed and collected through centralized infrastructure, is a driving force in North American urban growth. Our goal is to expand the development of quantitative measures on the location, timing, and spatial extent of urban fringe infrastructure. Ideally, the expansion of these utility service networks can be regularly monitored and modeled to indicate the distribution of water services and their impact on specific urban ecological processes, including habitat fragmentation. Multiple societal forces, including economic cycles, shape variations in local urban land development. These forces are summarized empirically in local building cycles that describe the number and location of building permits. Timing of water service provision may precede, be coincident with, or lag the development of road networks providing access to urban fringe building sites.

Objective

The objective of this poster is to identify the magnitude of urban fringe infrastructure within meaningful time periods for the City of Phoenix. The City of Phoenix, under permissive State of Arizona annexation laws, now includes about 540 square miles. Its water infrastructure of over 680,000 physical components serves both residential and non-residential users.

Methodology

We use GIS to identify local building cycles that shape the expansion of public water infrastructure into the evolving urban fringe. Periodic lows in the number of Maricopa County and City of Phoenix building permits occur at mid-decades since 1950. These local economic cycles reflect local availability of public and private funding, the impact of national legislative changes in lending and loan requirements, and state and national economic conditions. Annual building permit data is available for cities in Maricopa County starting in 1950 from the Arizona State University, Center for Business Research, and Center for Real Estate Research. Specifically, we use GIS procedures to develop six sequential analyses of urban fringe expansion for the City of Phoenix, Arizona, 1950 – 2003. The database is a proprietary City of Phoenix, Water Services Department file made available to the authors as part of the Arizona State University – City of Phoenix GPS Data Collection Pilot Project. Our current analysis summarizes the location of underground water pipeline segments by year of construction. Multiple entries for the same water segment in different time periods reflect routine maintenance and operations as well as building intensification requiring expanded infrastructure capacity. The existence of water infrastructure is an early spatial indicator in the development process. Once a building permit is issued, construction is required within a year.

Diagram 1. Method to identify urban fringe periods

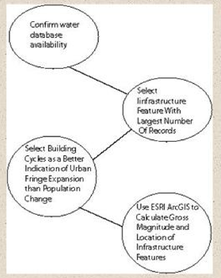


Table 1. Change in fringe water segments by period

Period	Added Segments	Cumulative Segments	% Cumulative Change
1900-1953	19,507	19,507	–
1954-1963	52,298	71,805	268.10%
1964-1973	60,160	131,965	83.77%
1974-1983	75,386	207,341	57.13%
1984-1993	69,235	276,576	33.39%
1994-2003	65,491	342,067	23.68%

Figure 1. Like most U.S. central cities, the City of Phoenix is constrained in its ability to annex developable land by adjacent suburbs. This location map displays the 2003 City of Phoenix street network, year 2000 urban freeways, and contiguous suburbs. Water infrastructure is laid in public easements or buried in city streets.

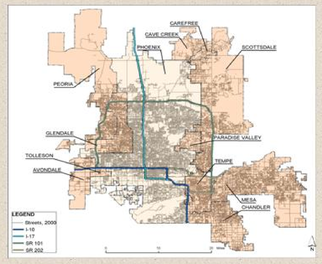


Figure 2. The City of Phoenix population over 50 years confirms its central city status in a growing metropolitan area where new development supported by outer freeways supports decentralization.

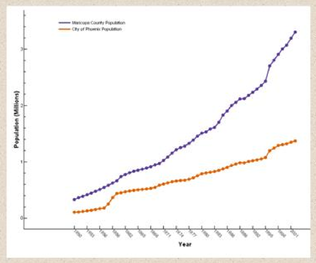
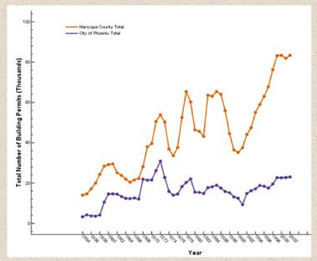


Figure 3. The annual magnitude of City of Phoenix building permits decreases, as expected, as a percentage of metropolitan building activity over the fifty-year period. Metropolitan Phoenix is an international example of automobile-dependence that supports suburban decentralization of physical, population, and employment growth.



Urban Fringe Development Periods

Figure 4-9. Spatial patterns of urban fringe infrastructure development reveal significant spatial variations that reflect the public-private development conditions of each building cycle. Six urban fringe development periods appear in the City of Phoenix. This study confirms that each expanding fringe is a zone of rural-urban transition. Isolated initial settlement, later leapfrog development and infill of bypassed areas occur. Areas of concentrated areas of infrastructure redevelopment also occur.

Figure 4. Initial water infrastructure development from 1900 through the early post-World War II period is the basis for later urban fringe expansion.

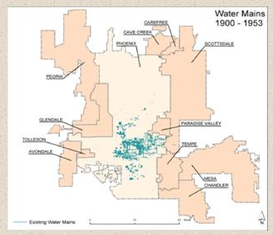


Figure 5. Water infrastructure increased by 268% in this peak building period and was primarily located near the original core.

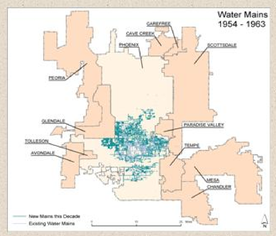


Figure 6. Continued fringe expansion pioneered portions of Phoenix beyond the North Mountains, west Phoenix, and near Tempe north of South Mountain.

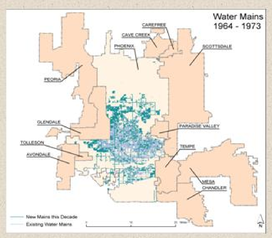


Figure 7. Fringe expansion reaches the Central Arizona Project canal in north Phoenix, includes leapfrog development near Cave Creek, and fills in bypassed areas. Initial development occurs in Ahwatukee south of South Mountain.

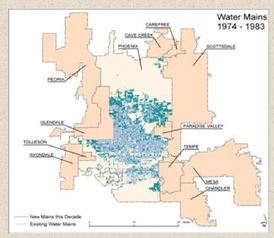


Figure 8. Water infrastructure in this urban fringe appears as infill in north and western Phoenix, leapfrog development near Cave Creek, and major Ahwatukee build-out activity.

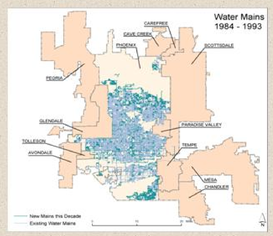
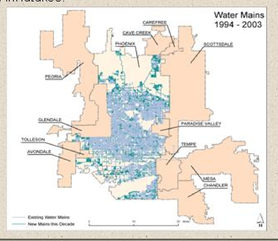
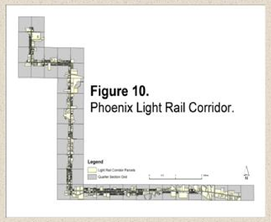


Figure 9. Current urban fringe development patterns are based on water infrastructure both near and far north of the Central Arizona Canal, redevelopment in the Central Business District, substantial new development in southwest Phoenix and Laveen, and final build out in Ahwatukee.



Extended Findings



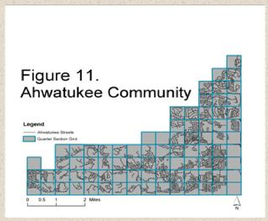
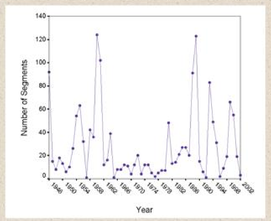


Figure 12. (Left) The number of water segments per year in the Light Rail Corridor reflects original construction through the early-1960s and redevelopment, especially in the Central Business District, in the late 1980s, mid-1990s and late-1990s.

Figure 13. (Right) The number of water segments per year in Ahwatukee describes a classic building cycle for new urban development with a peak in the mid-1980s and later decline.



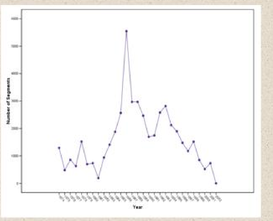
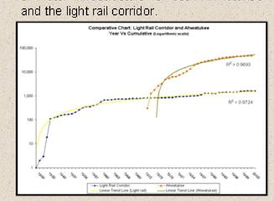


Figure 14. Logarithmic curves fit the pace of water infrastructure for both Ahwatukee and the light rail corridor.



Implications For Urban Fringe Research

This study offers an additional approach for urban fringe identification that can be expanded locally and used for future comparative studies. Additional analysis of decade-by-decade infrastructure may identify redevelopment locations and extent. The broadest implication is for expanded research on urban fringe formation and evolution.

Special Thanks:

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CES Center for Environmental Studies
ASU
City of Phoenix