HAZARDS OF CHANGE: AGRICULTURAL LAND DEVELOPMENT NEAR PHOENIX, 1992-2014

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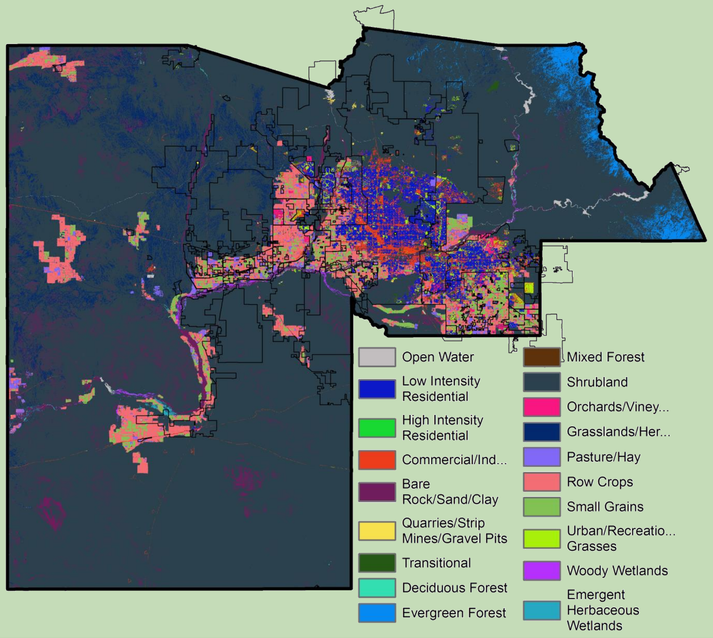
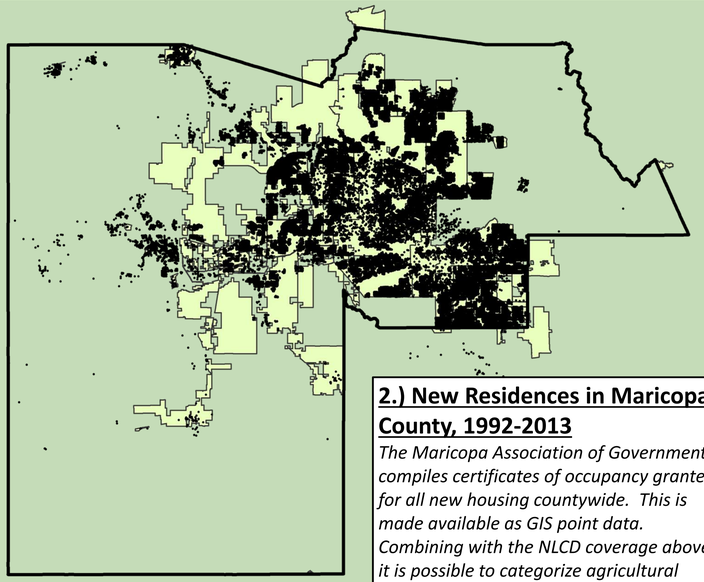
AGRICULTURAL CONVERSION



1.) Land cover in Maricopa County, 1992

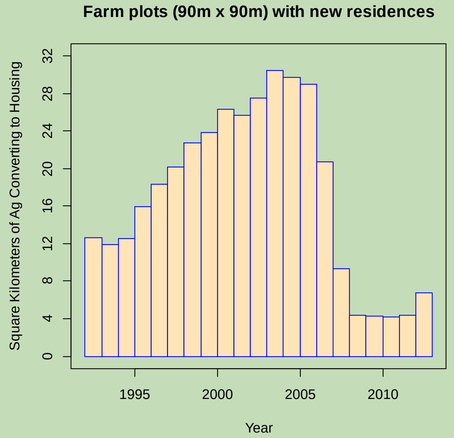
Remotely-sensed imagery is first used to identify agricultural land as of 1992. The National Land Cover Database (NLCD), a free US Geological Survey product, classifies 30m-resolution pixels by cover type across the US. Reliability is higher in desert areas (Shrestha et al. 2012)



2.) New Residences in Maricopa County, 1992-2013

The Maricopa Association of Governments compiles certificates of occupancy granted for all new housing countywide. This is made available as GIS point data. Combining with the NLCD coverage above, it is possible to categorize agricultural plots by whether or not they converted to housing – and when this took place.

The conversion of farmland to housing increased steadily from 1992 until about 2006, then dropped off dramatically, mirroring Kane et al. (2014). While 563,205 new residences were certified from 1992-2013, 44,539 90m agricultural plots (out of 266,132 total) were developed. Since the object of this study is land that converts, observations are "plots of land that were in agricultural production in 1992." To address scale-sensitivity, three plot sizes are analyzed: 60x60m, 90x90m (shown here), and 360x360m. While this analysis doesn't consider specific parcels, its high resolution helps make the connection between pattern and development drivers.



Central Arizona-Phoenix Long-Term Ecological Research
CAP LTER

Data Sources- National Land Cover Database (NLCD – USGS), the Maricopa Assoc. of Gov'ts Residential Completion Database, St. Louis Fed, Soil Conservation Survey, and others

Acknowledgements

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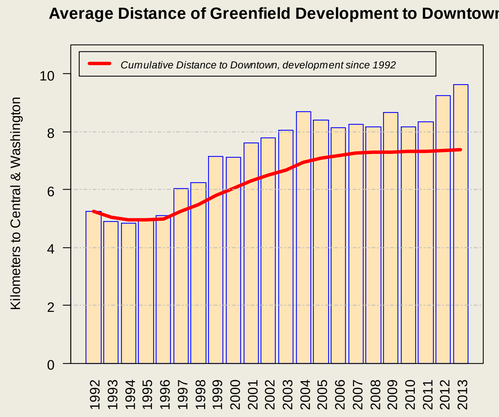
•Contact authors for a complete reference list

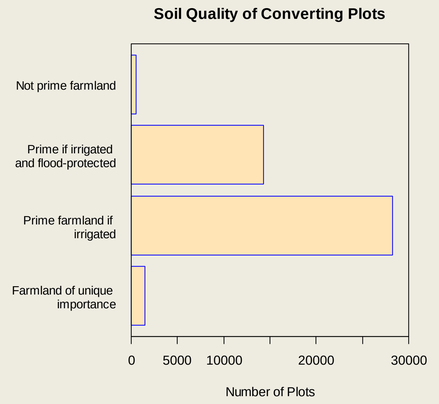
OBJECTIVES/RESEARCH QUESTIONS

- What drives the conversion of agricultural land to housing in Maricopa County over a long time horizon?
- Is the decision to develop new housing on agricultural land sensitive to infrastructure provision and municipal incorporation (**institutional**), intraurban location (**spatial**), or is it simply a response to fluctuating returns on housing and ag commodities (**temporal**)?
- To what extent can this help understand future development probabilities and policies to manage future growth, and to better handle Phoenix's notorious boom-and bust cycles?

DEVELOPMENT DRIVERS

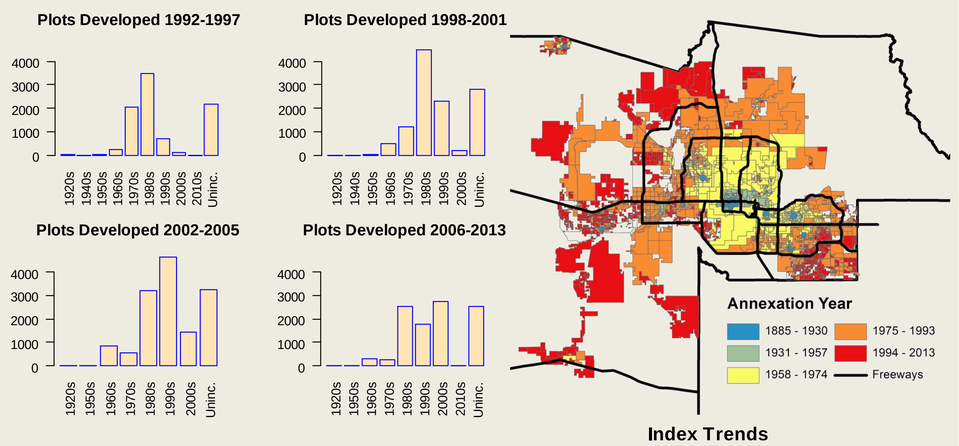
1. SPATIAL. *Following classical urban economics, the tradeoff between use (farmland) and exchange (residential) values is largely location-specific. This study considers the side of town, distance to the CBD, and soil quality.*



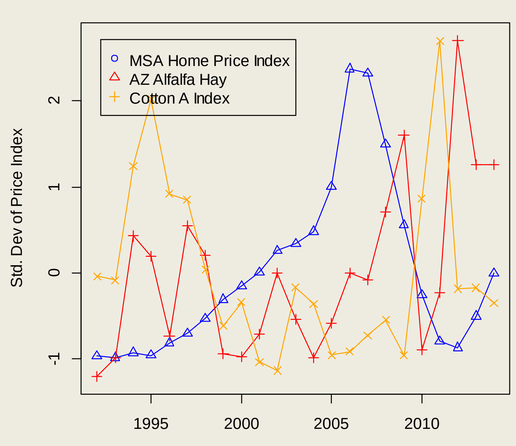


2. INSTITUTIONAL. *While agricultural zoning and tax codes confer minimal special treatment to farmland, the level of infrastructure and public service provision is of interest to land developers. Whether new residences are built on incorporated land, and the length of time land has been incorporated are used to proxy service provision. Most local freeways were built during this study period; distance to the nearest (completed) freeway is also considered.*

Annexation: When were development plots first incorporated?



3. TEMPORALLY-VARYING. *Market characteristics varied widely over the 23-year study period. Previous results (Kane et al. 2014) suggest that zoning and location had far less to do with new development locations than before, suggesting a greater role for market forces. A commodity price spike also mirrored the real estate collapse. Real local (AZ) alfalfa hay prices and global cotton prices (A index) are compared with a Metropolitan-level home price index to characterize the varying use and exchange value of land. Oil prices are a major farm input, but also an economic bellwether. Time-varying covariates are infrequently used in land change science due to the necessity of panel data (An and Brown 2008).*



MOTIVATION FOR RESEARCH

- A high proportion of the Phoenix area's water is used for agriculture. This contrasts with regional development pressures and population increases (ADWR 2010)
- Greenfield development – on both farmland and open desert land – is a major component of local boosterism and regional growth (Gober 2006), though this has slowed dramatically since 2006 (Kane et al. 2014)
- The urbanization of farmland near Phoenix is fairly unconstrained by zoning, tax benefits, or demands for historic preservation
- Given that the real estate bust corresponded with a boom in agricultural commodity prices, is land conversion mostly market driven?
- Urban land-use change is very place-specific and scale-sensitive: high-resolution, parcel-level analyses are needed to establish a link between the decision-making process and the observed pattern of development
- Hazard modeling, which uses full panel data to consider the length of time until an event, can consider development drivers based on location and timing, though are still seldom used in land change science (An and Brown 2008)

HAZARD MODEL

A semi-parametric Cox proportional hazards model is used to analyze the likelihood of development based on several covariates. The model considers the hazard that each plot converts to housing in each year, either until it converts or until the end of the study period (2013). Hazard ratios (reported below) reflect the increase (>1) or decrease (<1) in "hazard of conversion" offered by each covariate and are listed in decreasing order of predictive power (Wald χ^2 used)

TABLE 1: COX PROPORTIONAL HAZARDS MODEL RESULTS (360m)

Type	Covariate	Hazard Ratio	Wald χ^2	
Spatial	Intraurban location		2569***	HIVV
Spatial	Central (vs. west)	0.368		
Spatial	Northeast (vs. west)	0.193		
Spatial	Southeast (vs. west)	2.640		
Spatial	Distance to CBD	0.209	2119***	PREDICTIVE PWR vv LO
Spatial	Soil Quality		588.9***	
Spatial	Farmland of unique importance	0.325		
Spatial	Not prime farmland	0.547		
Spatial	Prime farmland if irrigated	1.313		
Temporal	Crude Oil Price	0.979	500.5***	
Temporal	Phoenix MSA Home Price Index	1.007	332.7***	
Institutional	Incorporated (vs. unincorporated)	2.175	321.8***	
Institutional	Distance to nearest highway	1.200	237.7***	
Institutional	Number of years since annexed	0.977	144.0***	
Temporal	AZ Alfalfa Hay Price	0.994	119.2***	
Temporal	Cotton Price (A Index)	1.004	21.11***	

KEY PRELIMINARY RESULTS *(360m resolution shown)*

1. **SPATIAL**
   - Expectedly, plots nearer downtown develop more quickly
   - Over all of 1992-2013, the Southeast valley dominates, followed by the West Valley, and central areas (City of Phoenix), and Northeast
2. **INSTITUTIONAL**
   - Proximity to highways is important, but overall the side of town and distance to CBD are far stronger
   - Being incorporated – and thus having greater access to public services – is a very important precursor to urbanization
   - However, more recently annexed areas experience greater development: new areas are perpetually favored
3. **TEMPORAL**
   - Region-wide housing prices are strongly related to conversion risk
   - Alfalfa prices are negatively related to conversion hazard while cotton prices are actually positively related to development (albeit more weakly). Exchange value appears more important than use value.
   - Low oil prices are correlated with development: disposable income and homebuilding are more strongly related to conversion risk than low cost for farmers. This is the strongest time-varying component.

FUTURE RESEARCH

- Monte Carlo simulations can provide a glimpse into which areas are likely to develop in Phoenix **given various financial futures** such as a housing price boom, oil price spike, slow growth, etc.
- Development interests appear to perpetually outstrip agricultural ones. This may pose issues for local food security and farmland preservation advocates, but depending on water rights allocation it may in fact be beneficial for regional water demand.