Mortgages and Maintenance: Characteristics of Greenness Change in an Urban Desert Landscape

Joshua Randall[1,2]; Bethany Cutts, PhD[1,2]; Jelena Vukomanovic, PhD[1,2] Michael Minn, PhD[3], Jonathan Greenberg, PhD[4]

[1]Department of Parks, Recreation, and Tourism Management, [2]Center for Geospatial Analytics, North Carolina State University, [3]History, Politics and Geography, Farmingdale State College,

[4]Department of Natural Resources and Environmental Science, University of Nevada-Reno

How do foreclosures affect the urban landscape?

The 2000's housing crisis and subsequent foreclosures drastically altered the landscape of urban property ownership in Maricopa County, AZ. Previous research has shown changes in lawn management due to foreclosures has a noticeable effect on greenness levels at a parcel scale[1]. However, there is little research on the spatial variability of greenness change in relation to foreclosures, and in particular the drivers of changing greenness**. The purpose of this study is to assess whether foreclosure helps explain 1) residential vegetation cover or 2) changes in residential vegetation cover over time and space.**

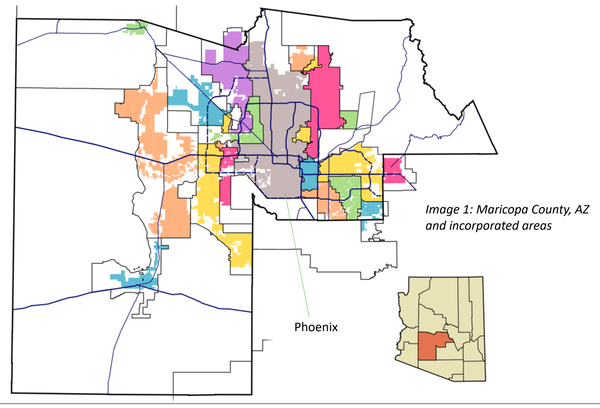

Image 1: Maricopa County, AZ and incorporated areas

Data and Methods

- The study area consists of 880 census tracts in Maricopa County, Arizona. These consist of all census tracts under 100 sq km, around the Phoenix Metropolitan area. The time period consists of the years 2002 to 2014.
- The normalized difference vegetation index (NDVI) of 16-day MODIS imagery are used as a proxy for greenness. A linear model of NDVI values for the entire time period was created for each tract, the slope was considered the *change in greenness* and the intercept (set at the midpoint) the *overall greenness.*
- Two spatial error (global models) and geographically weighted regression (GWR) models (spatially specific) were used to look at relationship between greenness and demographic/structural characteristics of households in conjunction with foreclosure. These models are:
  - **1. Change in Greenness model**
    How green or brown does an area get over time?
  - *2.* **Overall Greenness model**
    What is the overall greenness level for an area in a time period?

Greenness	Structural	Demographic
Change in Greenness	HH Construction Year	HH Income
Slope of census reg.	Foreclosure Area-Days	HH Median Age
Overall Greenness	Lawn Area	% Born in US
Intercept of census reg.	Parcel Land Area	% Owner Occupied
	% Owner Occupied	% Turnover
		% Unemployed

Table 1: Variables used

Results: Change in greenness is spatially specific

Exploration into this data set provided four distinct conclusions that help explain the relationship between landscape greenness and foreclosure:

1. If areas are green, they generally become browner. If they are brown, they generally become greener
2. Based on the two model approach, *median age, construction year* and *lawn size* are significant in explaining **overall greenness** but not **change in greenness**
3. Based on the two model approach, **overall greenness** was explained much better than **change in greenness.** However there are spatial differences where each model performs well
4. Foreclosure area explains **change in greenness** highly where areas became brown

1

Overall Greenness	Estimate	Std. Error	z value	P-value
(Intercept)	-0.04964	0.07715	-0.6434	0.51996
CHANGE IN GR	-0.18997	0.02625	-7.2368	< 0.0001
MEDIANAGE	-0.12628	0.05316	-2.3754	0.01753
MEDHHINC	0.30039	0.04685	6.4122	< 0.0001
MEANHHSIZE	-0.05714	0.05237	-1.0911	0.27525
PCOWNEROCC	-0.05769	0.05111	-1.1286	0.25905
PCTURNOVER	-0.00247	0.03265	-0.0757	0.93964
PCBORNUSA	0.12091	0.03803	3.1793	0.00148
PCUNEMPLOYED	-0.00379	0.02744	-0.1382	0.89010
MEDCONSTYR	-0.32377	0.03768	-8.5924	< 0.0001
SQMLAWN	0.32865	0.05475	6.0029	< 0.0001
FDAYSQM	-0.25260	0.04906	-5.1492	< 0.0001
SQMLAND	0.04822	0.02750	1.7537	0.07949

Table 2: Overall greenness spatial lag regression – red is significance at 0.1 level

2

Change in Greenness	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.01409	0.04909	0.2870	0.77408
OVERALL GR	-0.30676	0.03813	-8.0454	< 0.0001
MEDIANAGE	0.06758	0.06481	1.0428	0.29706
MEDHHINC	0.29218	0.05601	5.2165	< 0.0001
MEANHHSIZE	0.06591	0.06230	1.0580	0.29004
PCOWNEROCC	-0.07647	0.06472	-1.1815	0.23741
PCTURNOVER	-0.03098	0.04126	-0.7508	0.45278
PCBORNUSA	0.11419	0.04596	2.4844	0.01298
PCUNEMPLOYED	-0.03565	0.03490	-1.0214	0.30706
MEDCONSTYR	0.04196	0.04480	0.9365	0.34900
SQMLAWN	0.09794	0.06868	1.4260	0.15388
FDAYSQM	-0.10507	0.06167	-1.7039	0.08840
SQMLAND	-0.07942	0.03531	-2.2495	0.02448

Table 3: Change in greenness spatial lag regression – red is significance at 0.1 level

GWR Model	Psuedo-R^2
Change in G	0.525
Overall G	0.808

Table 4: GWR models pseudo r-squared

3

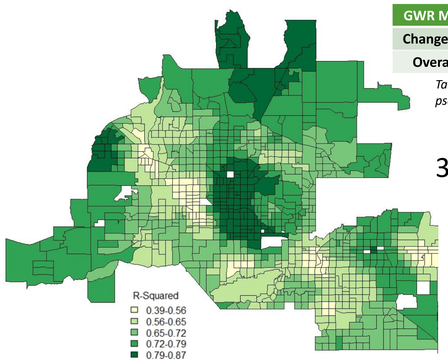

Image 1: Overall greenness GWR r-squared values. Model variables are significant variables from corresponding model above

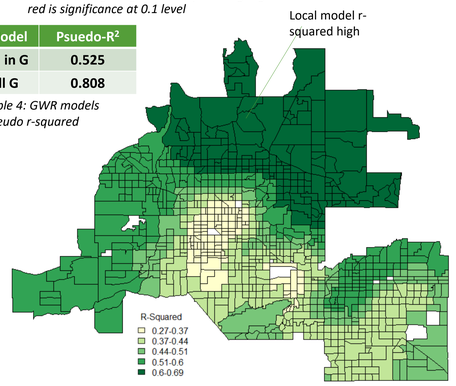

Image 2: Change in greenness GWR r-squared values. Model variables are significant variables from corresponding model above

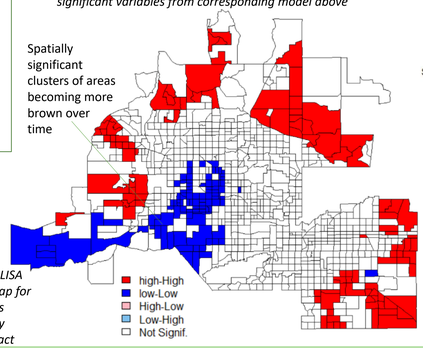

Image 3: LISA cluster map for greenness change by census tract

4

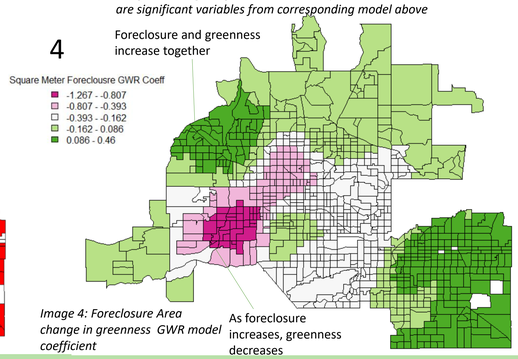

Image 4: Foreclosure Area change in greenness GWR model coefficient

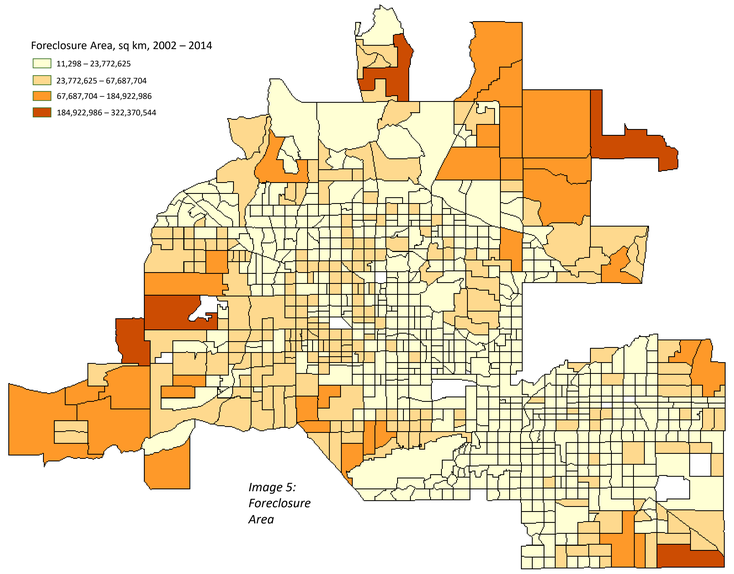

Image 5: Foreclosure Area

Discussion

1. These two models are extremely similar to each other, where only **change in greenness** and **overall greenness** are switched as dependent and independent variables. Generally extreme greenness and brownness becomes less so in relation to each other indicated by inverse relationship.
2. The discrepancy of *median age, construction year*, and *lawn size* all not being significant in both models, only **overall greenness** indicates that these factors are not important in defining change, particularly because *construction and lawn size* are structural variables and are more important long term greenness of a household overall than change.
3. GWR models better for **overall greenness** than **change in greenness** as expected. Areas of best model fit areas and range indicate some variables may be missing especially for **change in greenness** model
4. Areas where *foreclosure* was important in explaining **greenness change** occurred where actual rates of **greenness change** were negative, indicating *foreclosure* may have some effect on tract-level browning.

Conclusions

These results highlight the spatial variability of foreclosure importance to an urban system. The drastic increase in foreclosures in a short amount of time is a unique shock to a large system in a unique desert landscape, and understanding how these changes manifest could have a variety of benefits. Most importantly they provide specific locational information where policy may make differences in recovery from large scale events. Social systems such as homeowners associations, or town policy initiatives, will be drastically different across the Phoenix Metro area. Therefore spatial context is vital to the foreclosure, and greenness generally even in a single urban area.

Contact

Joshua Randall
Department of Parks Recreation and Tourism Management
Center for Geospatial Analytics
College of Natural Resources, NCSU
jnrandal@ncsu.edu

References

1. Minn, M., Cutts, B. B., Greenberg, J. A., Pavlovic, N., Fraterrigo, J. M., & Kelly Turner, V. (2015). Detection of foreclosure-related landscape management changes using Landsat. *Applied Geography*, *62*, 217–224. https://doi.org/10.1016/j.apgeog.2015.04.023

Acknowledgements: Dr. Joshua Gray for comments and suggestions

NC STATE UNIVERSITY College of Natural Resources — Department of Parks, Recreation & Tourism Management

Center for Geospatial Analytics