Factors Influencing Residential Water Consumption for the City of Phoenix, Arizona

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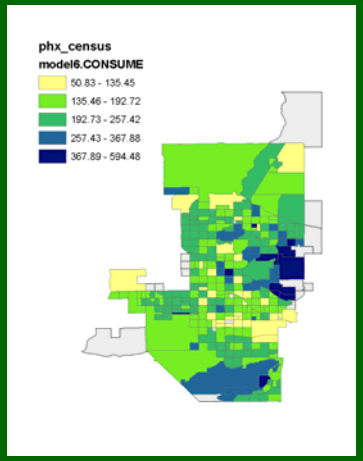
Abstract:

Continued population growth and the associated process of urbanization in the desert city of Phoenix, Arizona will require a reliable source of water for its residents. Although the city currently has an inexpensive and abundant supply of water, it is imperative that the city faces the challenge associated with providing continued safe drinking water. To better understand the demand side of this important water issue, we explored the relationship between detached single-family residential water demand and the factors influencing water demand. Determinants of residential water use reflect both indoor and outdoor uses. The factor associated with indoor use was measured by household size, reflecting usage associated with dish washing, laundry, bathing etc. The strongest determinant of outdoor use was the presence of a pool. Other factors were lot size and landscaping style. Two models analyzing these factors were compared. The first model was a global model based on ordinary least squares (OLS). The second model was a local model based on a geographically weighted regression (GWR), which factored in neighborhood relationships as well. Our model parameters can be used to investigate demand under different urban-growth and planning scenarios for policy and decision-makers in the city.

Objective:

Our goal is to determine what influences the patterns of water consumption we observe:



Methods:

We calculated and compared two models to evaluate the factors that influence residential water consumption. The first model is a global model based on ordinary least squares (OLS). The second is a local model based on a geographically weighted regression (GWR).

The OLS model is based on:

$$y_i = \beta_0 + \sum_k \beta_k x_{ik} + \varepsilon$$

Where the dependent variable y is regressed on a set of independent variables x_k,

The GWR model is based on:

$$y_i = \beta_0(u_i, v_i) + \sum_k \beta_k(u_i, v_i) x_{ik} + \varepsilon_i$$

Where the dependent variable y is regressed on a set of independent variables x_k, which vary over space denoted by (u,v)

Results:

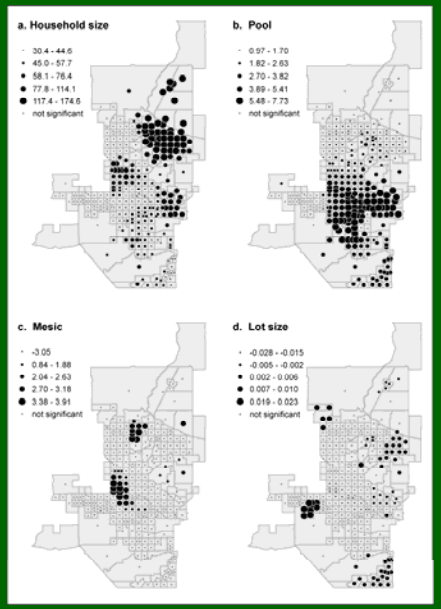
Ordinary Least Squares (OLS) $r^2 = .57$

Parameter	Parameter Estimate	Standard Error	T value
y-intercept	-44.52	19.57	-2.27
% pools	2.52	0.18	13.98
Avg. lot size	0.002	0.0007	3.256
% mesic	0.87	0.22	3.94
Avg. household size	48.6	5.40	9.00

Geographically Weighted Regression (GWR) mean r2 = .80

Label	Minimum	Lower Quartile	Median	Upper Quartile	Maximum
y-intercept	-290.120	-115.48	-38.863	56.08	305.78
% pools	0.29	1.37	2.60	4.214	7.73
Avg. lot size	-0.028	-0.003	0.002	0.004	0.023
% mesic	-3.05	-0.11	0.43	1.37	3.90
Avg. household size	-26.06	32.08	48.20	76.38	174.58

Spatial Distribution of GWR Parameters:



Conclusions:

Our study revealed that household size, presence of pools, mesic landscaping style, lot size, and the influence of neighbors were the most likely determinants of water consumption. Although the desert cities in Arizona currently have an abundant supply of freshwater, these growing regions need to face the challenges associated with providing adequate and safe drinking water to its residents. With knowledge on water usage, we can better protect water for future use.

Acknowledgment

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