The Impact of Homeowner Association Landscape Guidelines on Residential Water Use

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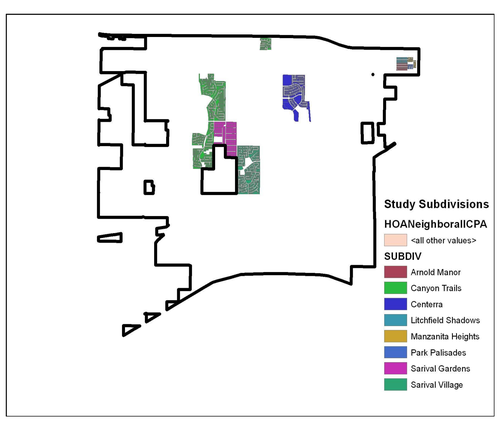
Research Question

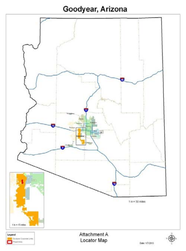
Does the presence and type of requirements for grass, shrub, and tree landscaping influence summertime water use in single family residential housing in Goodyear AZ?

Background

It is widely reported that outdoor water use represents up to 70% of the total water used in single family housing in the Phoenix metropolitan area. In particular, prior studies have shown that lot size, grass, presence of pools, and the urban heat island effect, control water use (Aggarwal et al. 2012; Harlan et al. 2009; Wentz and Gober 2007). Turner and Ibes (2011) show that the presence of a homeowners association (HOA) did not show a significant correlation to water use – raising the question whether an HOA can influence water conservation strategies. The Turner and Ibes study, as well as many other studies, are limited however to water use reported at an aggregated scale, such as census tracts or block groups. The study here analyzes the water use data on a per parcel basis.

Study Area





- Area covers 9 neighborhoods within the City of Goodyear, Arizona in the western Phoenix metropolitan area.
- Five of the study subdivisions have HOAs and the remaining four do not.

Data

Neighborhood Name	Number of Parcels	Mean TreeShrub (m^2)	Mean Grass (m^2)	Mean Pool (m^2)	Mean LotSize (m^2)	Mean BuildSize (m^2)	Mean July Use (1000 gal)	Landscape Guideline
Arnold Manor	96	88.1	13.3	6.4	709	137	14	None
Canyon Trails 3 HOA	960	58.8	10.5	0.5	539	114	10	Medium-trees, shrubs
Canyon Trails 4S HO	672	90.6	22.1	7.8	710	137	16	Medium-trees, shrubs
Centerra HOA	637	106.1	30.0	9.1	706	135	18	Minimal 1-2 tre
Litchfield Shadows	80	45.8	8.1	2.4	638	177	10	None
Manzanita Heights	73	14.1	16.6	1.2	747	223	6	None
Park Palisades	31	39.0	19.6	2.1	578	180	9	None
Sarival Gardens HOA	97	33.2	27.7	3.5	697	199	10	Turf, 70% plant cover
Sarival Village HOA	1110	180.9	701.3	14.7	4270	330	48	High-trees, shrubs, ground

Table 1. Study Neighborhood Attributes

Figure 1. L-R: Centerra ,Litchfield Shadows, and Sarival Gardens neighborhoods

Water Use

The dependent variable for the study was water use per parcel for the July 2010 billing period (35 days) from the City of Goodyear. We selected only parcels with active accounts to eliminate unoccupied and unbuilt lots. This reduced our total study to 3830 parcels.

Parcel Data

Our study has 7 independent variables including LotSize, BuildSize,TreeShrub, Grass , Soil, Pool, and HOA (dummy). LotSize and BuildSize were acquired from Maricopa County Assessor parcel records. The land cover variables, including Grass, TreeShrub, Soil, and Pool were acquired through object-oriented classification of the National Agriculture Imagery Program (NAIP) with a ~1.0 meter spatial resolution (Figure 3). NAIP data also include Building, FallowCrop, Road, and Unclassified land cover classifications that we did not use. Independent variables for land cover were converted to percent (%) of parcel, recognizing that HOA guidelines often require a percent cover. The dummy variable HOA designated whether a parcel was within an HOA (1) or not.

Figure 2. Sample NAIP data in the Goodyear neighborhoods

Analysis and Results

Because of high correlations among parcel variables, we used principal components analysis to create independent variables. Two new components emerged that accounted for 84% of the variation in the original data (Table 2).

Factor Analysis	Component 1	Component 2
HOA	0.193	0.945
treeshrub %	0.911	-0.198
grass %	0.923	-0.196
soil %	0.879	0.104
pool	0.978	-0.104
BldSqM	0.746	0.254

Table 2. Components for principal factor analysis

Using these as variables in a regression analysis, the resulting equation with July water use in 1000 gallons per parcel is:

$$Water_{July} = 77.8 + 162.4\ LandCover\ component\ (C1) - 19.4\ HOA\ component\ (C2)$$

The adjusted R^2 is 0.97 and the standardized coefficients were 0.98 (C1) and -0.12 (C2). The HOA component explained most of the variation in July water consumption.

Recognizing that pool usage contributes to water consumption and that HOA guidelines focus on vegetation, we analyzed the parcels without pools separately. The independent data were not highly correlated, so we did not perform a data reduction. Our resulting equation (Adjust R^2=.33) for July water use per parcel is:

$$Water_{July} = -1.4 + .05Build + 37.0TreeShrub\% + 79.0Grass\% + 5.0Soil\% - 4.5HOA$$

Table 3 reports the coefficients for the model. The only variable not significant at the .0001 level was the Soil%.

	B	Standardized Error	Beta	t	Signficance
Build (m2)	0.051	0.004	0.240	12.511	0.000
TreeShurb %	37.071	3.574	0.206	10.373	0.000
Grass %	79.058	3.366	0.469	23.487	0.000
Soil %	5.173	1.903	0.058	2.791	0.007
HOA	-4.516	0.748	-0.118	-6.036	0.000

Table 3. Coefficients for July water for 2192 parcels without pools

Conclusion

Results from both analyses suggest that the presence of an HOA negatively impacts water consumption. That is, houses within an HOA use less water than houses outside one. The presence of HOA regulations may influence water conservation behavior. In parcels without pools, Grass % positively influenced water use and explained most of the variation. HOA guidelines without grass coverage requirements could be used to reduce overall water use. HOAs specify only front yard landscaping. Investigators will extend the study to segregate the front yard cover, and identify its explanatory power.

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