

Parcel Level Landscape Vegetation Tradeoffs

Jessica Jia¹, Elizabeth A. Wentz¹, Kelli L. Larson^{1,2}

Arizona State University ¹ School of Geographical Sciences and Urban Planning, ² Julie Ann Wrigley Global Institute of Sustainability

Context

Increased Temperature & Water Demand Threaten Urban Sustainability

Urban sustainability in the Southwest is a balance of limited resources in the face of climate change. While climatologists document trends in drought and elevated temperatures, cities in the greater Phoenix area seek to better understand the non-linear relationship between irrigated vegetation, water demand, and the urban heat island effect.

Question

How do vegetation and landscape structure affect water demands and summer daytime temperatures?

Major Findings

Temperature and Grass Correlate to ~20% of Water Consumption Variation

Dependent Variable = Water Consumption		
Adjusted R ²	Significant Predictors	Standardized Beta Coefficient
0.178	Daytime Temperature	-0.426
0.203	Daytime Temperature Grass	-0.450 0.170

Analysis: Linear Stepwise Regression

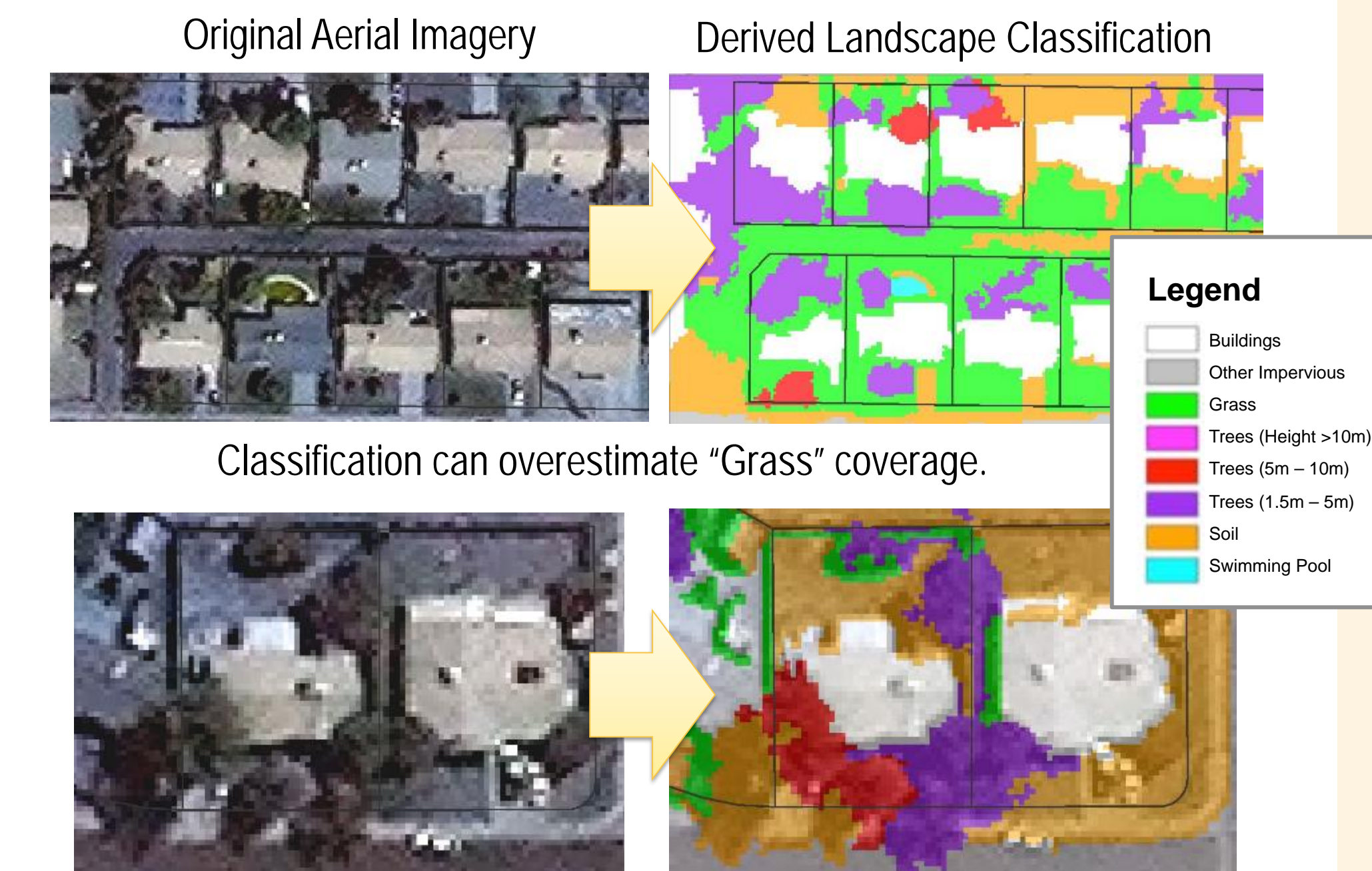
The study suggests a negative correlation between heat and water demand, i.e. some houses that experience hotter temperatures used less water.

Shrub, Soil and Tree Area Correlate to ~20% of Temperature Variation

Dependent Variable = Daytime Temperature		
Adjusted R ²	Significant Predictors	Standardized Beta Coefficient
0.148	Trees (1.5m-5m)	-0.390
0.185	Trees(1.5m-5m) Soil	-0.296 0.221
0.200	Trees(1.5m-5m) Soil Trees(5m-10m)	-0.244 0.201 -0.151

Trees of height 1.5m-10m were shown to correlate with lower daytime temperatures, while soil correlated with higher daytime temperatures.

Discussion



Tree vegetation misclassified as "Soil" or as "Grass".

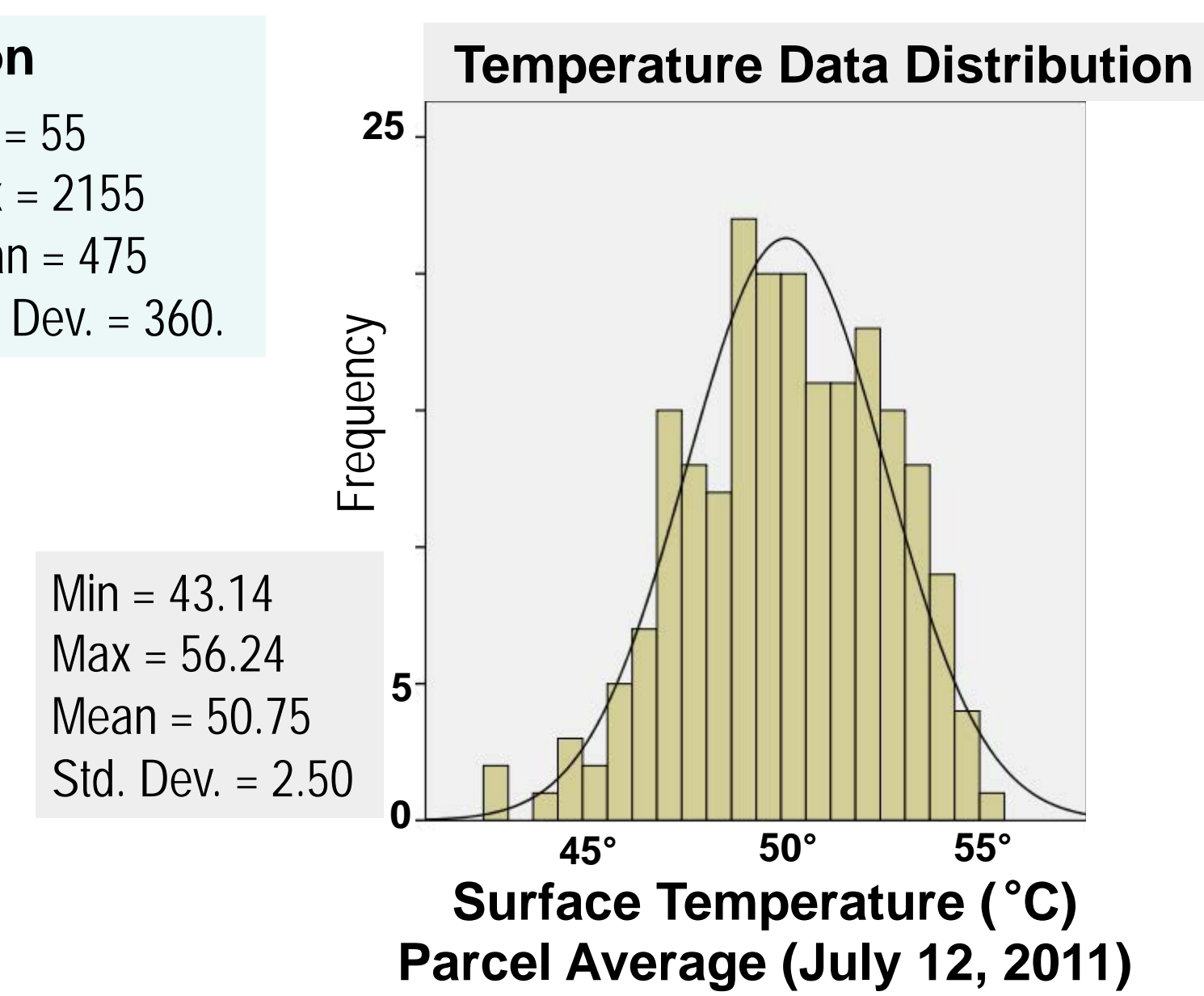
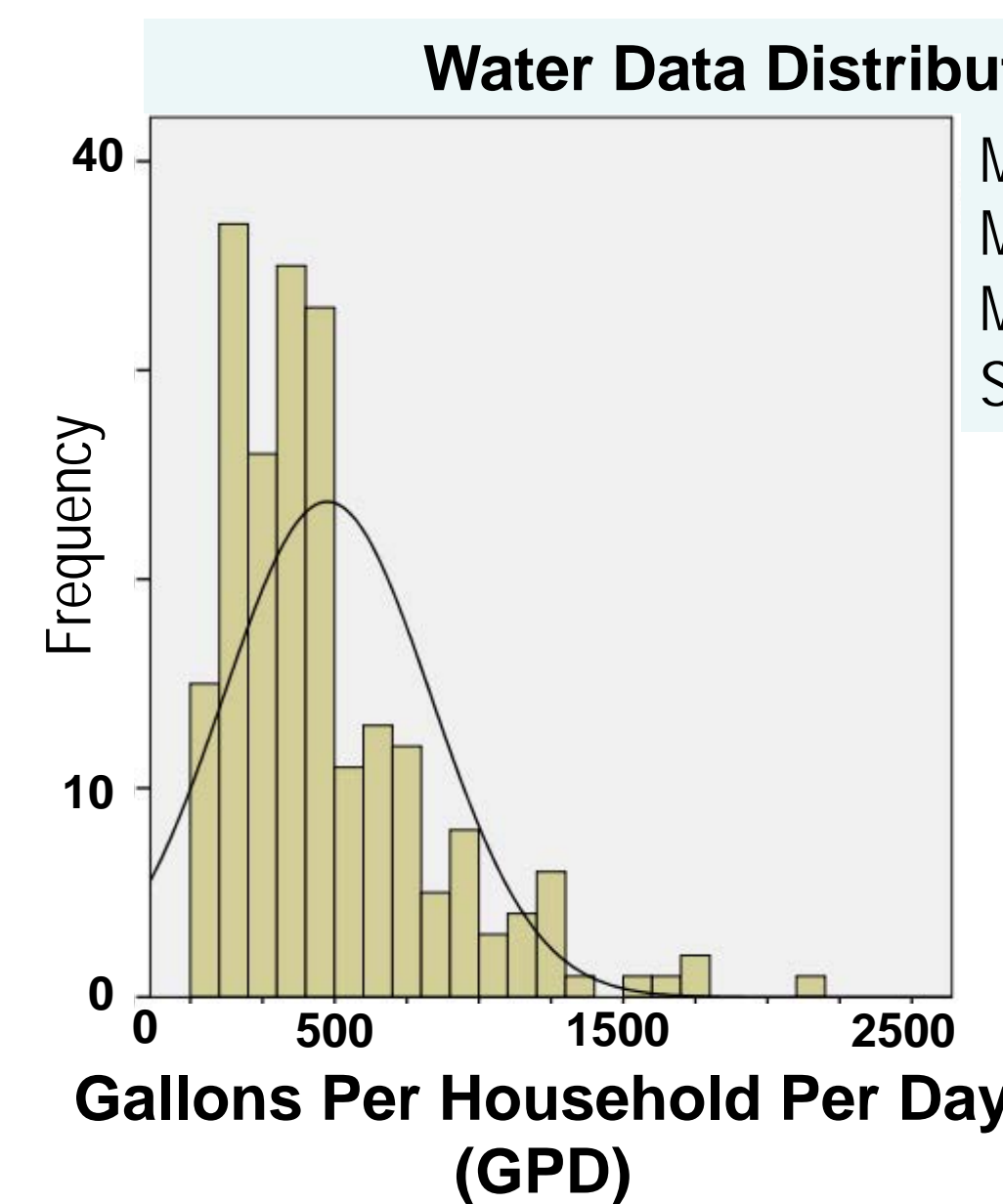
- Remotely-sensed landscape classification varies in accuracy and does not delineate between native and non-native vegetation.
- Weak correlations to water consumption are likely due to the exclusion of lot size, household size, and pools – variables shown to be more significant than vegetation in other studies (e.g. Wentz & Gober, 2007).

The Study Area: 214 Single-Family Residential Homes in Tempe, Arizona

- Two Census-Blocks
- No Pools
- Similar age and lot size



Landscape Descriptive Statistics (Meter ²)				
	Min	Max	Mean	Std. Dev.
Buildings	32.16	280.93	127.91	32.64
Other Impervious Surfaces	0.00	64.98	3.89	9.81
Grass	0.00	412.21	124.38	78.11
Trees (Height > 10 meters)	0.00	86.21	1.17	8.11
Trees (5m-10m)	0.00	223.39	16.39	32.79
Trees (1.5m - 5 m)	0.00	437.37	78.71	77.46
Soil	0.00	266.27	78.71	77.46



Data

Results and Significance

Water may be an effective cooling technology when used towards shrubs and trees, defined as vegetation between 1.5m-10m tall.

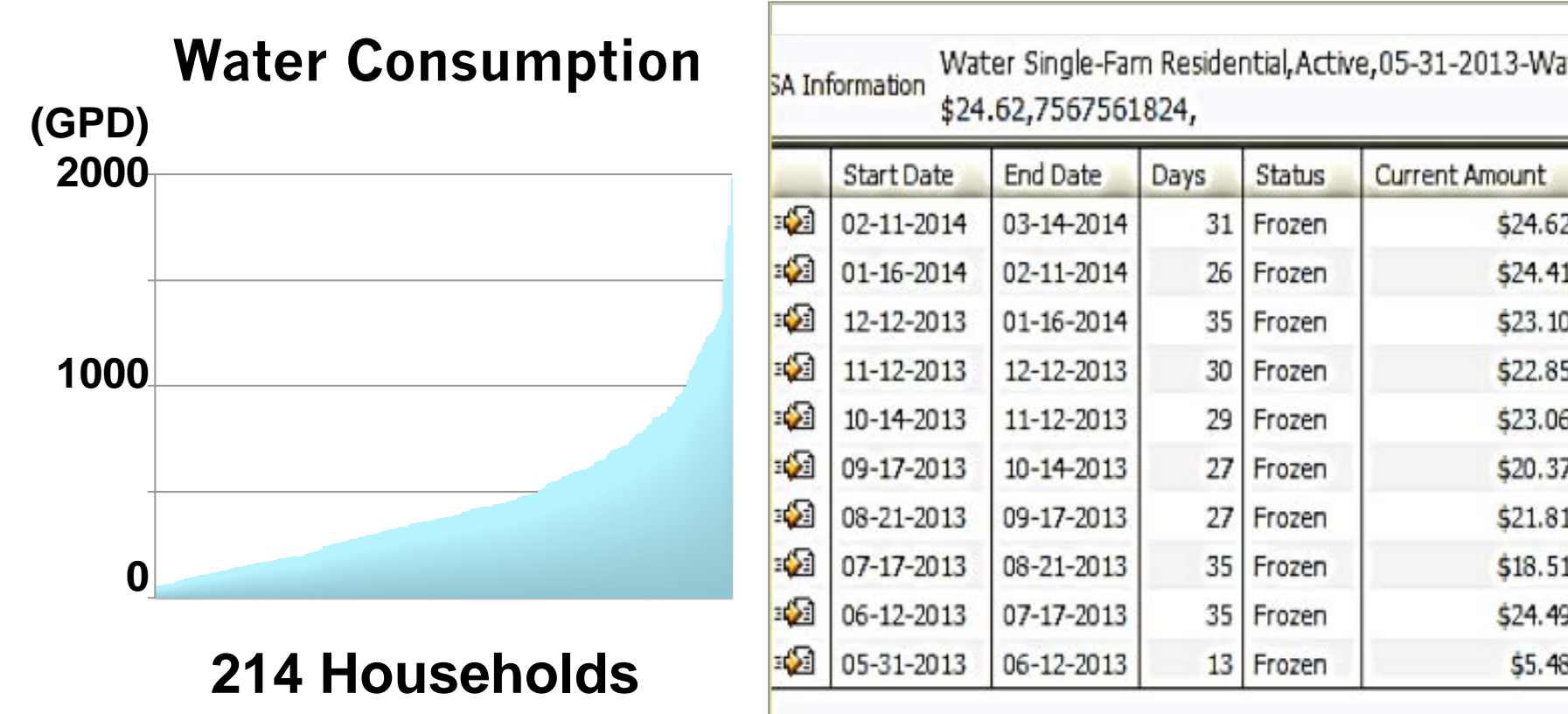
Despite the classification of vegetation height in this study, landscaping explains a limited percent of temperature variation.

Vegetation patterns alone do not significantly correlate with residential water consumption. A combination of indoor and outdoor variables need to be considered for water sustainability.

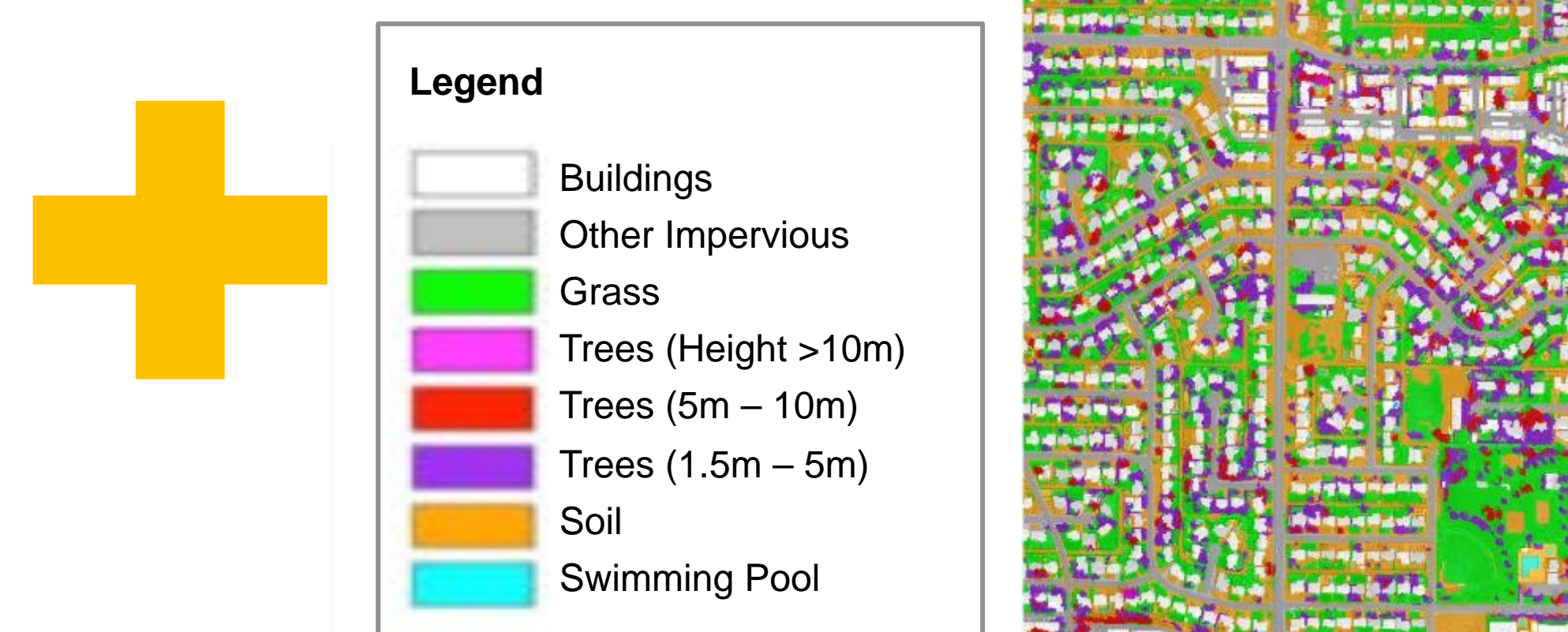
These findings are consistent with past studies. We reiterate the importance of identifying the complex drivers of both water demand and urban heating.

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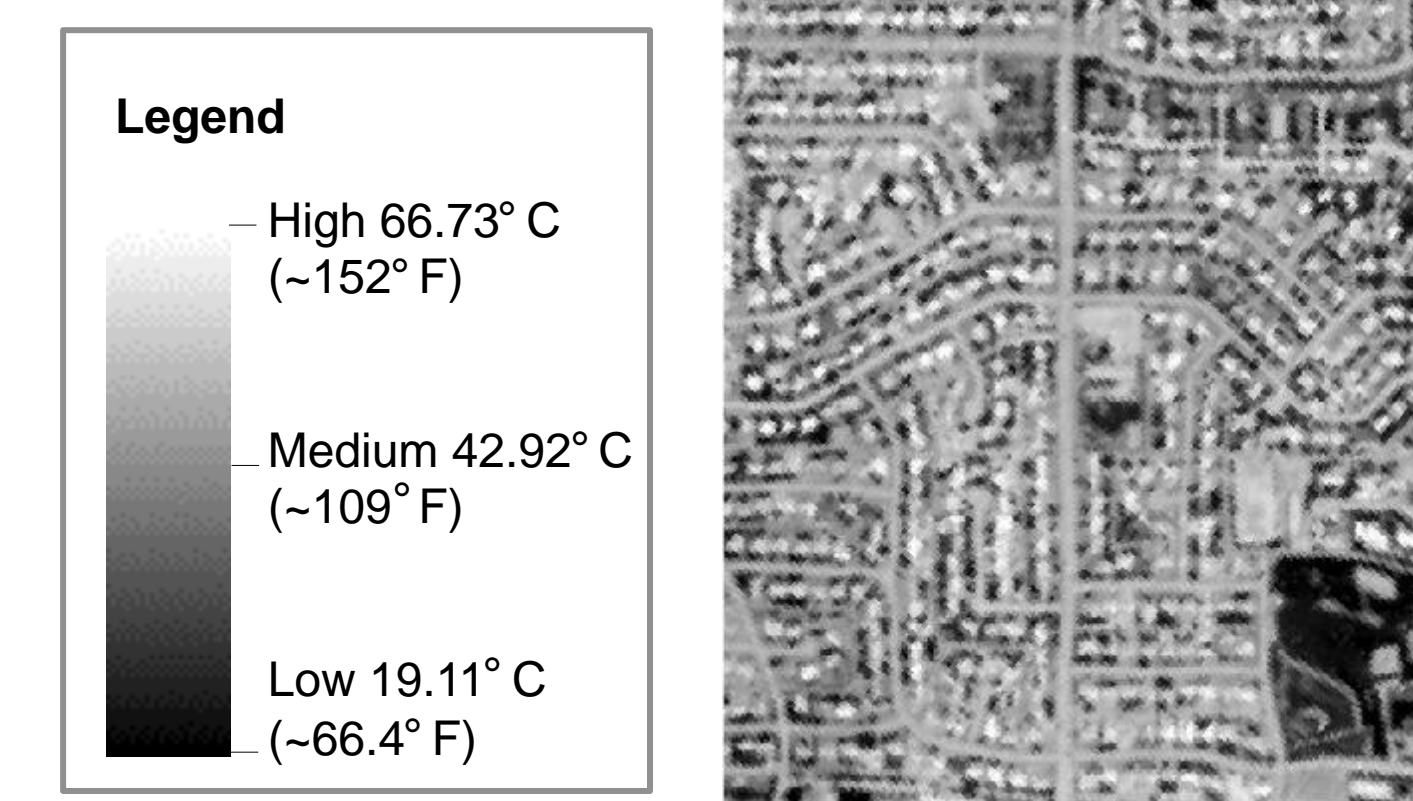
Municipal Billing Accounts Provide Household Water-Usage Data



High-Resolution Satellite Imagery Provides 7 Landscape Coverage Classes



MASTER Overflight Provides Daytime Surface Temperature Data



Water billing data for July 2011 was extracted from the city billing system for each household. Tempe Water Utilities records total water consumption (indoor + outdoor).

Quickbird LiDAR imagery taken on March 08, 2008 provided land cover classification at a 0.61 m/pixel resolution. Most previous studies used roughly 30 m/pixel.

The MODIS/ASTER Airborne Simulator (MASTER) overflight of the Phoenix region on July 12, 2011 provided continuous surface temperature data at a 7 m/pixel resolution.