Residential Water Use In Phoenix: Exploring Myths and Realities

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Summary

This research challenges traditional perceptions of residential water use. The perception that turf is the villian and xeriscape is the silver bullet appears not to be valid. The factors driving residential water use are more numerous and complicated than previously considered particulary among the highest water users. Many factors considered to be major contributors explain only a small amount of water use. Though the disconnect between attitude and behaviour in regards to water use was reaffirmed, the basis for this disconnect, the behavior and actions behind, it remains elusive.

Introduction

Phoenix water use patterns have been extensively studied by City of Phoenix staff, academic researchers and others (Mayer etal., 1999; Campbell, Larsen, Johnson, and Waits.,1999; ADWR, 2003; Martin, 2003; Quay, 2005a,2005b; Guhathakurta and Patricia Gober, 2007; Wentz and Gober 2007). Past research examines temporal differences in water use, with temperature and rainfall as key predictive variables. Certain research compares water use among households using factors such as household size, lot area, presence of a pool and other factors to explain differences in household use. However Phoenix Water Services Department has found cross-sectional models of single-family water use that often perform well in other cities are not always as useful in explaining use patterns in Phoenix. Research specific to Phoenix has not proved conclusive and household water use remains highly variable. The limitations of this research and models affect the ability to forecast water use and design programs to improve water use efficiency. Recent research of household water use conducted by the Arizona Municipal Water Users Association (AMWUA), City of Phoenix and BBC Research & Consulting (BBC) reveals that past perceptions of water use in Phoenix may not be accurate and that the factors affecting household water use are more complicated than previously thought. This report provides a summary of some of the results of this research.

Problem Statements: 1) Among single family residential customers, is there a relationship between attitude towards water use and reported behavior related to water use and actual water use? 2) What are the primary physical and socio-economic factors affecting residential water use?
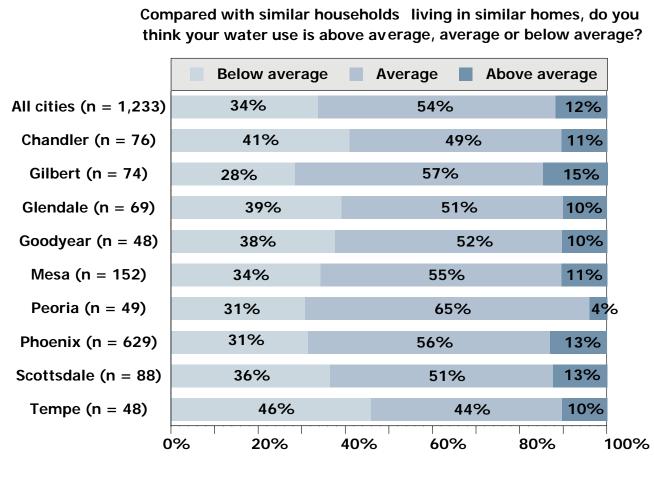
Methodology

Methodology: The Arizona Municipal Water Users Association (AMWUA) and BBC Research & Consulting (BBC) conducted a random sample telephone survey of households in the cities of Chandler, Gilbert, Glendale, Goodyear, Mesa, Peoria, Phoenix, Scottsdale and Tempe. These surveys included: 1) data from 1,416 single family customers including economic, demographic, attitudinal and behavioral information regarding those customers; 2) Monthly billing records for up to five years of water use for 1,055 of the residential water accounts included in the survey ; 3) Maricopa County Assessor data, providing additional information regarding physical characteristics of the homes and properties of the single family customers included in the survey; and 4) an aerial landscape assessment for the 1,055 households.

For Phoenix respondents, a more in depth analysis was conducted to examine outdoor water use. Based on monthly water use data and household characteristics for indoor water users, a regression model to estimate indoor water use for indoor-only accounts were developed. This model performed
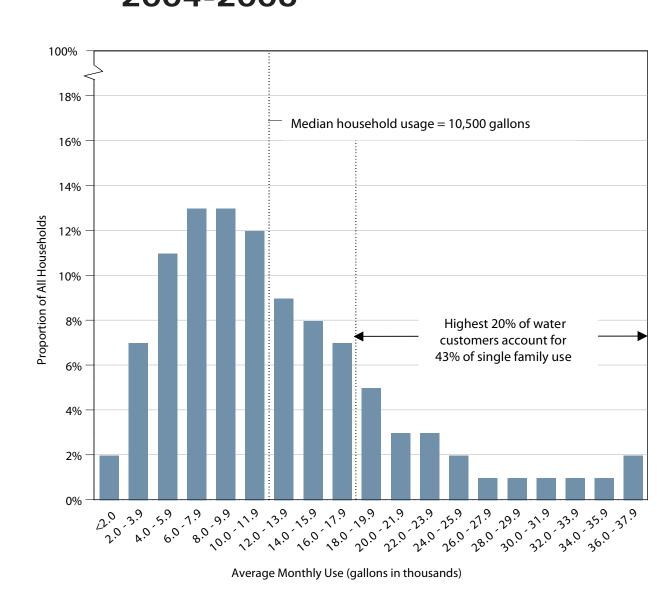
relatively well, explaining nearly two-thirds of the variation in average monthly water use across these households (R squared = 0.64). Primary factors found to influence indoor use include number of people in the home and proportion of low-flow showerheads in the household. The results from the indoor water use model were used to separate outdoor water use from total use. Each respondent was then classified based on landscape type as either: 1) desert landscape (no grass) no pool; 2) grass no pool; 3) grass with pool; 4) mixed landscape (desert and grass) no pool; or 5) mixed landscape with pool. Further investigation of the highest 20% water use was con-

Figure 1: Perceptions of Water Use

Compared with similar households living in similar homes, do you think your water use is above average, average or below average?

	Below average	Average	Above average
All cities (n = 1,233)	34%	54%	12%
Chandler (n = 76)	41%	49%	11%
Gilbert (n = 74)	28%	57%	15%
Glendale (n = 69)	39%	51%	10%
Goodyear (n = 48)	38%	52%	10%
Mesa (n = 152)	34%	55%	11%
Peoria (n = 49)	31%	65%	4%
Phoenix (n = 629)	31%	56%	13%
Scottsdale (n = 86)	36%	51%	13%
Tempe (n = 48)	46%	44%	10%

Figure 2: Distribution of average monthly water use by single family customer, 2004-2006

Median household usage = 10,500 gallons

Highest 20% of water customers account for 43% of single family use

ducted through in depth interviews. 200 households were random selected and contacted to request an interview. 37 households were visited in about seven days. Three of these visits were conducted in Spanish in exclusively Spanish-speaking households. An average of one hour was spent talking with homeowners and walking around their homes and yards in the in-home visits. Each was asked about household repair history; past leaks or home improvements; the number, type, age and condition of household fixtures, cooling systems, water consuming appliances and technologies, irrigation systems and controllers, pools and spas, outdoor watering practices and schedules, and their level of knowledge of indoor and outdoor leak detection. Questions addressed who in or outside the household had primary responsibility for landscaping, outdoor watering practices, and sprinkler and pool maintenance. Landscaping and swimming pools were photographed for each household, and condition of the landscaping was noted.

A portion of the in-home visit tested the acceptance of several water efficiency measures, including indoor and outdoor water use tips, offers of a free supply of liquid pool cover for pool owners, offers of printed materials about watering and landscaping, and an offer of a free ET controller for the homeowner's sprinkler system. Follow-up telephone interviews were conducted 30 to 45 days later to assess whether the household had applied any of the measures.

Results

The Relationship Between Water Use Efficiency Messages, Attitude, and Behavior.

No evidence was found to support that there is a relationship between those who recognize the "Water Use it Wisely" campaign (86%ferences said they did) and actual water use (ChiSquare = 1.1 df=2 p>0.5). Respondents did have a tendency to underestimate water use, but have a fairly accurate understanding of their water use related to general average water use (ChiSquare=81.6 df=6 p<0.001). Figure 1 shows the results of respondents estimate of the water use compared to others. There was statistically significant evidence found that a relationship between those who remembered the "Water Use It Wisely" campaign and a positive attitude about efficient use of water does exist (reported taking action to reduce water use last 5 years ChiSquare= 16.5 df=1 p<.001). These results are supported by other work done by the City of Phoenix and ASU that has found a high level of agreement with the importance of a low water use lifestyle but a disconnect between attitude and behavior (Quay 2005a).

High Residential Water Use Is Concentrated Among a Relatively Low Number of Households

Regionally the highest 20% of water users were responsible for over 40% of total residential water use.
Figure 2 shows the distribution of actual single family water use for surveyed households.

There are No Clear Spatial or Socio-Economic Patterns of Water Use

There remains no clear spatial or socio-economic pattern of water use. Variation of water use among all spatial and socio-economic groups remains high. Figure 3 shows physical, social, and economic charateristics of these two same groups. Figure 4 shows the spatial distribution of the highest and lowest 20% of water users suveyed in Phoenix.

Figure 3: Characteristics of Top and Bottom 20 Percent of Phoenix Water Users

	Top 20%	Bottom 20%	Full Sample
Average dailyuse (gallons)	933	132	429
Per household member	374	70	176
Household characteristics			
Number in household	3.19	2.45	3.05
Square footage of home	2,282	1,448	1,763
Number of full bathrooms	2.35	1.79	2.01
Proportion low-flow showerheads	45%	45%	45%
Market segment			
No grass and no pool	5%	28%	13%
Grass and no pool	19%	18%	20%
Mixed landscape and no pool	15%	36%	26%
No grass and pool	3%	5%	6%
Grass and pool	24%	6%	12%
Mixed grass and pool	34%	7%	23%
Landscape			
Grass landscape area (square feet)	4,349	1,691	2,085
Non-grass landscape area (square feet)	5,264	3,538	3,569
Plant a winter lawn	50%	15%	29%
Home construction dates			
Pre-1961	23%	29%	25%
1961-1975	22%	20%	23%
1976-1990	37%	28%	29%
1991-2006	18%	23%	23%
Irrigation method			
Hose	16%	50%	31%
Manual s prinkler	6%	13%	13%
Automatic s prinkler	78%	37%	56%
Have flood irrigation supply	11%	15%	10%
Household income			
Under $30,000	10%	31%	19%
$30,000 to $50,000	9%	23%	19%
$50,000 to $70,000	17%	23%	20%
Above $70,000	64%	23%	43%

Factors of Outdoor Water Use Remain Unexplained

Some correlation was found between total outdoor use and total landscaped area, but a major portion of outdoor use remained unexplained.

Attitude towards Turf and Desert is Mixed, and Appears Important to Water Use

Three distinct groups exist among landscape preferences, those who "love green and don't love desert" (27%), those who "love desert and don't love green" (34%) and those that "love both green and desert" (35%). On a regional basis these three groups describe 90% of all the respondents to the survey. Interestingly there was a correlation between these landscape groups and water use. Those loving desert tended to be in the below average water use group and those loving green tended to be in the above average water group (ChiSquare=33.8 df=4 p<.001). Figure 5 shows representative homes for these three landscape types .

Water Use Remains Highly Variable and Unpredictable

Average monthly outdoor use for single-family homes with no grass and no pool amounts to only 3,500 gallons per month, however the range is from under 1,000 gallons per month to a high of 17,000 gallons per month for one household.

Average monthly outdoor water use for households with mostly grass landscaping and no pool, was 6,500 gallons per month, however the range was as high as 20,000 gallons per month.

Mixed landscape homes are defined as homes that had some grass landscaping, but less than half of their landscape area planted in turf. Monthly outdoor use for these types of households averaged 4,500 gallons per month, ranging from less than 1,000 to over 20,000 gallons.

Figure 4: Lowest and Highest 20% of Phoenix Surveyed Water Users

Highest 20% of Water Users   Lowest 20% of Water Users
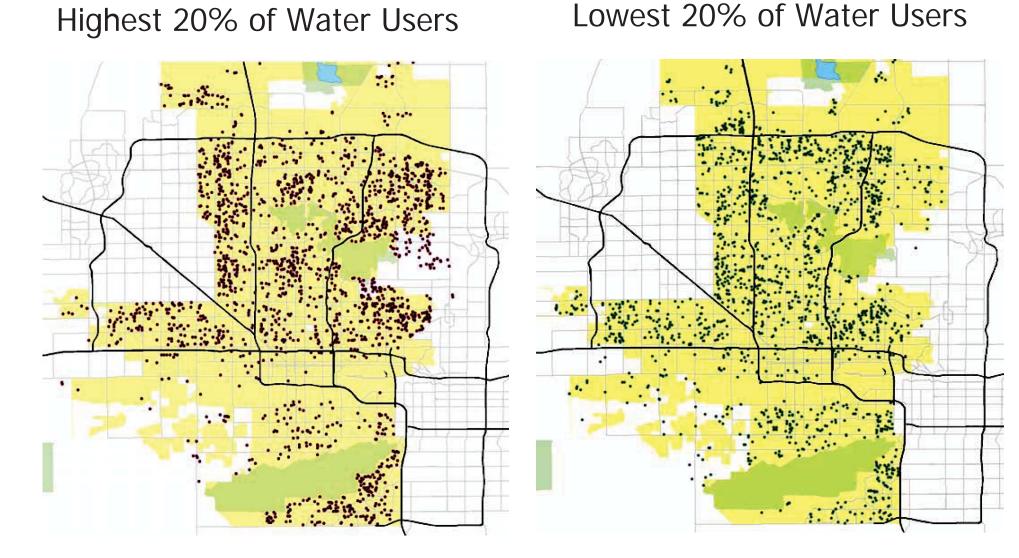

Figure 6 shows some of the large variation within household water use within these landscape groups.

Using a number of factors in a multivariate regression, a model was developed to explain outdoor water use. With the exception of winter lawns, all factors included in the model are significant at the 90 or 95 percent confidence level. However, these variables explain only about 4 percent of the variation in outdoor water use per square foot of landscape area. Model results suggest that a substantial portion of the variation in water use across households stems from differences in landscaping and watering practices that were not accounted for in the model (or not appropriately specified in the model).

Conclusions

Residential water use in Phoenix appears to be more complicated than traditionally has been considered when developing water efficiency policies. The factors, physical and socials, affecting water use are more numerous an complex than has previously been considered. Behavior appears to play a critical role in water use, particularly among the highest water use, but this behavior is not a result of lack of awareness or concern. The disconnect between a high acceptance among customers to the importance of wise water use and their actual water use was affirmed but the basis for this disconnect is not easily explained and may be due to factors not yet well understood.

Figure 5: Landscape Types

Grass   No Grass (Desert)

Mixed Grass & Desert

Several long held perceptions (Myths) about water use were challenged by this research.

Myths and Reality

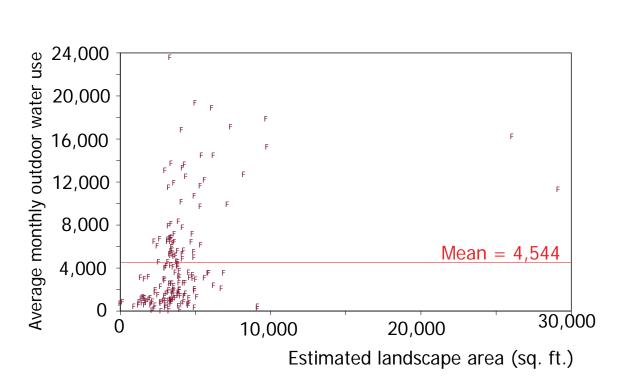**Myth:** Phoenix residents don't care about water use, thus waste water.
Reality: Phoenix residents value water highly and have a high awareness of the need to use water wisely.

Myth: Water use is a function of attitude, those who value water use less water.
Reality: It is not yet clear how attitude affects water use behavior. A positive attitude and awareness does not appear to translate into actual low water use behavior and practices.

Myth: Saving water outside is about minimizing grass.
Reality: Homeowners have been found to overapply water to xeric landscaping, while many residential lawns are either managed efficiently or deficit-irrigated. Education of homeowners about maintenance is key.

Myth: Phoenix homeowners are attuned to their outdoor use and think about how to conserve water outside.
Reality: Phoenix residents associated the term "water conservation" with saving water indoors and have little knowledge about their outdoor water use.

Factors Possibly Contributing to High Variation in Water Use within Single Family Water Use

- Hidden outdoor water leaks
- Over watering of desert and mixed landscapes.
- Wide variation in management of turf from deficit irrigation to overwatering and excessive mowing.
- Wide variation in pool management, primarily frequency of backwashing and draining/refilling.
- Larger lots tend to use less water per acre than smaller lots, even those with turf.

Further Research Needed

This research has raised more questions than it has answered. Questions that remian to be answered include:

1) Among high water users, what is the basis for the disconnect between positive attitude about and perception of water use and actual water use and behaviors related to water use?

2) What are the behavioral, socio-economic, and physical factors contributing to the high variability in residential water use? How can these factors be measured or estimated within the population of residential water users?

3) What type of model of Phoenix residential water use can be used to test the effectiveness water conservation and drought response policies?

4) What is the basis for the high degree of variation in water use among landscape types?

Figure 6: Average Monthly Outdoor Water Use by Estimated Landscape Area, Households with Mixed Landscapes and No Pools (gallons)

Mean = 4,544

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