Strategies for Developing Water-Conscious Communities: An Analysis of Water Conservation in Tucson, Arizona

by

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This project was made possible by the University of Arizona, Technology and Research Initiative Fund 2009/2010, Water Sustainability Graduate Student Fellowship Program
The Problem of Household Water Conservation in Arizona

In recent years, Arizona has consistently been one of the fastest growing states in the nation. Coupled with a semi-arid climate, this rapid growth places ever-larger demands on our water resources. Already in southern Arizona, increasing water use has demonstrably impacted the functioning of riparian and other ecosystems (Stromberg et al. 2006). These trends are expected to escalate as water available from the snowpack decreases due to climate change (Mote et al. 2005).

Because of these enormous challenges, water conservation practices must be examined more closely. Many observers feel that implementation of water conservation measures holds great promise for improving water sustainability. For example, the Community of Civano in southeastern Tucson has demonstrated its ability to reduce household potable water use by as much as 50 percent through comprehensive conservation practices and the cooperation of its citizens (Nichols 2002). Adoption of similar practices by other communities has the potential to substantially decrease water use throughout the region.

The challenge is that of encouraging widespread adoption of water conservation. Water conservation practices, such as rainwater harvesting, recycling gray-water and installation of high water-use efficiency devices, are growing in popularity. However, adoption of these practices is currently limited to a relatively small sector of the population. To achieve widespread adoption of water conservation practices amongst diverse communities we must first understand the motivations for households to adopt these practices.

Purpose and Objectives of the Study

The purpose of this study is to better understand the factors that influence a household to adopt water conservation practices so that more effective public policies can be developed. The ultimate goal of the research is to foster more widespread acceptance of water conservation practices amongst the citizens and communities in the semi-arid regions of Arizona. Specifically, the objectives of this project are:

1. Examine the factors that motivate or restrict individuals in the adoption of water conservation practices.
2. Analyze the spatial and social patterns of household water conservation practices.
3. Make policy recommendations to facilitate more widespread adoption of conservation practices.

Research Methods

Study Design

This study began by developing a survey in collaboration with multiple community stakeholders. Participants included representatives from Tucson Water, Watershed Management Group, Ward 2 and 3 offices, multiple neighborhood association presidents, and faculty members at the University of Arizona. From June to December 2009, I worked with this group of stakeholders to develop a survey that would address questions about the causes of household water conservation and the effectiveness of existing programs. The survey was designed to collect information about
household predictors of water conservation behavior over the past ten years. This ten year period between 2000 and 2009 coincided with Tucson’s driest and hottest decade on record (National Oceanic and Atmospheric Administration, 2010).

Survey questions were formatted for compatibility with a longitudinal, multilevel, logistic regression model. The longitudinal nature of the model will account for the ten-year period of analysis, and enable the model to elucidate the role of time in changing household behavior. Three levels of variables will be utilized in this model with level 1 being the household, level 2 being the neighborhood and level 3 being the larger Tucson community.

Level 1 predictor variables will be the household’s utilization of financial incentives to conserve water through rebates and tax credits; utilization of educational opportunities like water conservation workshops and trainings; civic engagement of the household; number of years living in Tucson; and exposure to local media. Additionally, Level 1 variables will be utilized to control for education, income, age, number of people in the household, and whether the home is owned or rented. Level 2 predictor variables will be acquired by geocoding the location of households in the GIS environment. Data from the U.S. Census Bureau about each household’s census block will be attributed to the dataset. These predictor variables will include median income and education in the census block. Finally, Level 3 variables will include data that varies at the city level. Two variables, the average monthly water bill from the municipal water supplier and a drought variable will be applied at this level.

The effect of these predictor variables will be assessed for their impact on five binary outcome variables. Each of these outcome variables will represent whether a household utilized one of five water conservation behaviors in a given year. These five behaviors are: installation of a rainwater harvesting system, graywater system, high-efficiency fixtures (e.g. toilet, showerhead, faucet), converted landscape to low water use plants, and volunteered for a public water conservation workshop. These five water conservation behaviors were selected because they each represent a discrete and measurable change in behavior. The binary nature of these outcome variables will enable us to understand, for example, what influences a person to convert from a non-graywater-utilizing household to a graywater-utilizing household in a certain year.

As demonstrated by Millock and Nauges (2009), simultaneous regression models will be executed on each of the five outcome variables so that the same set of variables can be analyzed across the five different behaviors. This comparison may reveal that a single variable may have different impacts on the different outcome variables. For example, I expect to find that owning a home increases the likelihood that a household will install a graywater system, but this may not be as important to volunteering for a public water conservation workshop.

### Data Collection
The City of Tucson’s Department of Neighborhood Resources provided contact information for each of the 134 neighborhood association presidents in Tucson. Each president was contacted by electronic mail or phone to discuss the project and to request participation of their neighborhood association in the project. Ninety-three of the neighborhood associations participated in the study, which is sixty-nine percent of Tucson neighborhoods. Surveys were distributed in both
electronic and paper formats through the neighborhood associations. Responses were collected beginning in January 2010 and continue to be returned at the time of this report.

Survey data is being compiled into the STATA statistical software program, where it was formatted for compatibility with the specified statistical model. This data will then be exported to the ArcGIS software program. Because each household was asked to provide an intersection close to their homes, I will be able to geocode all responses to a location in Tucson. Respondent locations will be used to identify attributes about each household’s neighborhood using U.S. Census Bureau data. This information can then be used to generate the Level 2 variables to be used in the multilevel regression model.

Results

While inferential statistics are forthcoming, at this time I am only able to provide descriptive statistics from the study. Surveys were returned from 656 households, representing 93 Tucson neighborhoods. With ten years of data being collected for each household, this would have increased the number of observations by a factor of ten. However, because not all of the responding households resided in Tucson for all of the past decade the current number of observations for the study is n=5,297.

Data was collected for three city and state programs in the survey. Tucson Water’s High Efficiency Toilet Rebate program offers up to $200 per household (Tucson Water, 2009). Tucson Water’s Zanjero Program which provides a free survey of home water use and strategies to reduce their usage and bills (Tucson Water, 2004). Finally, the State of Arizona offers up to $1,000 to households for the installation of rainwater harvesting or graywater systems (State of Arizona Department of Revenue, 2007). Of the 165 households that installed a rainwater harvesting or graywater system, 47 (28%) took the tax credit from the state. Of the 65 people who installed a high-efficiency toilet, 51 people (78%) took the rebate from Tucson Water. Of the 613 people who responded about Tucson Water’s Zanjero home water-auditing program, 34 (5%) utilized this free service.

Additionally, the survey asked respondents to indicate factors that influenced them to conserve water. Table 1 shows the factors that households identified as being “important” or “very important” to their water conservation efforts. Interestingly, factors related to environmental and public good are ranked higher than financial reasons, and the creation of a social ethic of water conservation ranks as the fourth, above information received from educational programs. Utilization of these variables in the regression models seems poised to add to our understanding of factors important to controlling demand for water resources amongst households (Renwick and Green, 2000).

Discussion

In developing policies to promote water conservation throughout the semi-arid regions of Arizona, it is important to elucidate the factors that influence households while assessing our current programs. Looking at individual programs, we find in this study that Tucson Water’s toilet rebate has been highly utilized, with 78% of eligible households taking the rebate. The
state’s rainwater harvesting and graywater system tax credit has been less successful, with 28% of eligible households taking the credit. Finally, Tucson Water’s Zanjero Program was poorly utilized, with only 5% of households taking advantage of the program. As Tucson Water and the State of Arizona faces budget challenges, it will be important to modify those programs that are not achieving their desired outcomes. It appears that the qualities that make the High Efficiency Toilet Rebate Program successful could be applied to other programs.

When asked why they didn’t participate in a financial incentive program, the most common response was that they didn’t know about the incentive. In the case of the rainwater harvesting and graywater system tax credit, fifty-one percent of respondents didn’t know about the program. In the case of the high efficiency toilet rebate, thirty-one percent of the households reported not knowing about the program. It seems that these programs could be utilized more extensively if more resources are put towards informing the public about the availability of the programs.

I am currently writing the statistical code for executing the five regression models and expect to have the preliminary numbers by mid-summer. I am scheduled to present the inferential statistics at the International Symposium on Society and Natural Resources in Corpus Christi this summer, and look forward to sharing the results with this community at that time. Following the symposium, I will be preparing a report of the findings which I will distribute to the participating neighborhood associations, Ward offices, Tucson Water, and the Watershed Management Group.

**Applications to Promoting Statewide Water Sustainability**

As Millock and Nauges, 2009 state, very few studies have been conducted on the behavioral factors contributing to household adoption of water-conserving devices. While much is known about the factors that lead households to conserve water through their existing infrastructure, the installation of water-conserving devices represents a substantially larger commitment to water conservation.

In the fall of 2008 Tucson became the first city in the nation to pass ordinances requiring the installation of graywater stub outs in new residential construction and water harvesting for new commercial construction (Shipek, 2008). The passage of these ordinances is a tangible example of the groundswell of support within Tucson for more progressive water conservation policies. The change in water consumption patterns that are currently underway in Tucson make it an ideal location for analyzing mechanisms for promoting more widespread adoption of water conservation practices across the state.

As water shortfalls pose a potential source of conflict and threatens the sustainability of our ecosystems and communities, the spread of water conservation practices presents a solution to mitigating these problems. Some factors are available to water suppliers for managing demand (Kenney et al., 2008), while others ought to be managed through other methods. By identifying the motivations and barriers to achieving widespread adoption, we can create more informed and effective public policies that will help alleviate the strain on this increasingly scarce resource.
References


Table 1: Factors "important" or "very important" to influencing household water conservation decisions

<table>
<thead>
<tr>
<th>Factor</th>
<th>Households reporting factor as “Important” or “Very Important”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve or protect the environment</td>
<td>414</td>
</tr>
<tr>
<td>Desire to improve your community</td>
<td>330</td>
</tr>
<tr>
<td>Save money on water bill</td>
<td>312</td>
</tr>
<tr>
<td>Use of water conservation methods by other people in your community</td>
<td>196</td>
</tr>
<tr>
<td>Information received from family or friends</td>
<td>135</td>
</tr>
<tr>
<td>Information received from a water conservation education event or workshop</td>
<td>129</td>
</tr>
<tr>
<td>Information received from television, radio or print media</td>
<td>100</td>
</tr>
<tr>
<td>Tax rebates or financial incentives available from the city or state</td>
<td>89</td>
</tr>
<tr>
<td>Information received from Tucson Water’s Zanjero water-auditing program</td>
<td>35</td>
</tr>
</tbody>
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