Survey of Residential Water-wise Irrigation Practices and Perceptions

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Abstract. *Much research has been conducted proving the effectiveness of technology in reduction of lawn/landscape water use. However, studies are primarily conducted in controlled settings. When attempting to incorporate recommendations into residential arenas, savings are not as significant. The results of this study will identify unique barriers with regards to residential irrigation water use. In order to effectively change behavior, factors that contribute to perceived attitudes of homeowners must be considered. A mail-out questionnaire was used to determine public awareness, if/why watering restrictions are followed, and influence of water source. The results presented here represent the initial survey analysis (n=157). Seventy-five percent of the respondents reported to having automatic systems using irrigation timers and with 16% running an automatic system manually. Fifty-six percent of the homes reported having mixed head types within the zones. Homes using some form of low-volume irrigation to water their landscape account for 31%; with drip-tubing as the most commonly selected choice. Forty-seven percent of the homes have rain-shutoff devices, of these, 54% of them were reported to be connected and functioning. Significant differences were observed between the number of irrigation events per week and automation of the system as well as water source.*

Keywords. Behavior, conservation, irrigation, landscape, rain sensor, residential irrigation, survey, turfgrass, water use

Introduction

The desire for a lush landscape often requires irrigation and fertilization, both which are commonly over applied (Mayer et al. 1999). Research has shown that residential in-ground automatic irrigation systems can account for over 50% of the customer's total monthly water consumption and that residential customers in Florida tend to over-irrigate (Haley et al., 2006). While Water Management Districts (WMDs) have implemented allotted irrigation days and times, as well as the requirement of rain shut-off devices for newer systems (Florida Statutes 2007), anecdotal evidence suggests that customers may not be following watering regulations and restrictions (Whitcomb 2005). It has also been seen that domestic irrigators do not understand plant water needs related to irrigation. Domestic irrigators rarely choose alternative, low-input methods, because of aesthetic desirability which does not allow for lawn heterogeneity (Bormann et al. 1993), time, effort, and perceived expense for individual households (Templeton et al. 1998).

Water use efficiency has become a growing concern on both the local and national level. The water used for residential irrigation can be separated into three unique water categories: potable (drinking) water, domestic well water, and reclaimed water. Reclaimed water as an irrigation source is a practical use for treated effluent, however this source requires available additional infrastructure. The most accessible water for the homeowner to use for outdoor purposes is the treated potable water line that is already supplying water to the residential property. This is a costly source with water rates steadily increasing due to the considerable amount of energy it takes to treat and deliver this source. Depending on the aquifer composition, groundwater from an on-site well may lead to some savings in energy costs, but not a decrease in the depletion of reservoirs and groundwater aquifers. Decreasing the water table can lead to saltwater intrusion, higher concentrations of natural contaminants (e.g. radon and arsenic), and human pollutants (e.g. fertilizers and pesticides). Over irrigation can specifically contribute to nonpoint source pollution by increasing runoff containing such pollutants from the suburban landscape.

In 2000, Florida's population was nearly 16 million which ranked Florida as the fourth most populous state in the United States (USCB 2001). In Florida, 88% of the state's population receives their potable water from the public supply. The public supply is that water which is withdrawn by either public or private suppliers and delivered to multiple users. In Florida, the public supply is made up of 90% ground water (2nd highest in U.S.) and 10% surface water withdrawals. Over half, 53%, of the total public supply comes from the Floridan aquifer (Marella 1992). The public supply is usually treated ground or surface water, which is used for both domestic (indoor and outdoor) and public uses (e.g. firefighting and street washing). This sector of the water supply is critical when ensuring that the total water demand can be met.

The domestic self-supply refers to quantities of potable water withdrawn, via well or pumped from surface water, small enough that a permit is not required from the WMD. Although individual household wells fall under this definition, they are only included when water is used for both indoor and outdoor purposes. When the water is pumped solely for irrigation purposes it is not accounted for in this category (Marella 1999). Pinellas County Florida has initiated rebate programs for the installation of a shallow well for outdoor water use (PCU 2007a). The contemporary attitude is that the best way to decrease the need from irrigation water on the potable water demand is to encourage the use of alternative water sources. This avenue gains further support from Florida's Legislature which has allocated funds to the WMDs for the promotion of alternative water sources for irrigation water.

The overall objectives of this study are to quantify the outdoor water use practices and level of community knowledge of water conservation technologies and policy through a mail out survey questionnaire. It will be assumed that the survey respondents will fill out the questionnaire honestly. Since some of the questions will be asking about excessive outdoor water use practices or practices not incompliance with local policy, participants may be reluctant to disclose truthful information. A limitation of this study is that typically homeowners with more water conservative practices have a greater interest in participating. To substantiate this, actual water use statistics will be performed on the non-respondents as well. The ability to generalize these results prove to be another limitation because the dissemination of the instrument will only be in one county within Florida. Therefore the information will not be truly generalized across the entire state.

Previous Work

Previous surveys in Southwest Florida have looked at homeowner concern relating to water cost (Whitcomb 2005) and participation in Cooperative Extension Service yard care programs

(Israel and Hague 2002). Through previous residential irrigation cooperator studies it was observed that the homeowners did not have a clear understanding of when and how much to irrigate (Haley et al. 2007) and that watering day ordinances are recurrently ignored (Haley and Duke 2007)

Residential irrigation research, in Florida, has indicated that the use of technology can decrease outdoor water use without causing plant/turfgrass stress or degradation of appearance (Haley et al. 2007; Haley and Dukes 2007). However, there is reluctance on the part of the domestic irrigator to incorporate this new technology. One such device is an automatic rain shut-off sensor for irrigation systems. In Florida, it is required for homes with automatic in-ground irrigation systems installed since 1991 to have a functioning rain shut-off device (Florida Statutes 2007). However, this ordinance is not enforced and many homes, including new construction, do not use rain sensors (Whitcomb 2005).

There are two aspects which affect the functionality of the irrigation system: technology and user interaction. The technological components include weather-based controllers, soil moisture, and rain sensors, which will electronically bypass unnecessary irrigation events. The regulations stated by the local WMD have an influence on the use of bypass technology as well as the time and day settings for the automatic irrigation timer.

Research has been conducted proving the effectiveness of technology in reduction of outdoor (lawn and garden) water use. However, these studies have been primarily conducted in controlled settings. When attempting to incorporate the recommendations of the research into the residential arena savings are not as significant (Campbell et al. 2004; Geller et al. 1983). In order to effectively change behavior, factors that contribute to perceived attitude must be considered.

Baumann (1990) established three factors which affect the intensity of water use by residential users. The first two are economically derived; the consumer's ability to pay for and the willingness to pay for water at a given price. The non-economic factor is the consumer's conservation behavior. This reflects the motivation to employ effort or technological innovations for water conservation. Weather plays a major role in conservation practices as well. During periods of drought, consumers are more willing to employ conservation techniques than during wet years (Baumann 1990). According to the *Florida Water Rates Evaluation of Single-Family Homes*, completed in 2005, the main concern of homeowners with respect to increased costs is outdoor use (Whitcomb 2005). The current rate for potable water from Pinellas County Utilities is $4.16 per 1000 gal (3780 L) as of December 19, 2007 (PCU 2007c).

Methodology

The project target area is within the Pinellas-Anclote River Basin which is under jurisdiction of the SWFWMD. This area is located in the Southern Water Use Caution Area, meaning the expected demand may be larger than the supply. According to the U. S. Census Bureau's 2006 estimates, Pinellas County has 924,413 residents. This population is 52.4% female and 47.6% male with an average age of 43 years (USCB 2001). The response population will include a representative sample of homes that reflect this demographic data and which use both potable and alternative water sources (reclaimed and well water). Previous surveys in Southwest Florida have looked at homeowner concern relating to water cost (Whitcomb 2005) and participation in Cooperative Extension Service yard care programs (Israel and Hague 2002).

Surveys were mailed following the Multi-wave Method (Dillman 2000), advertising 1,000 mail-outs. Although municipal customers have the most significant impact on potable water demand, the sample population also includes customers who draw water from alternative water sources (i.e. reclaimed water or private wells). Mailing lists were acquired with the assistance of Pinellas County Utilities to ensure representative samples of customers using both public supply and alternative water sources. The sample population was selected randomly with the aid of the local water purveyor. To promote increased response rate, the survey process included a cover letter, survey packet with a water conservation kit as an incentive, and a reminder postcard.

This new survey specifically targets lawn (turfgrass) and landscape (bedded areas) watering practices, knowledge of water conservation ordinances, motives for water conservation/overuse, and perception of community water conservation/overuse. Water conservation ordinances include watering days and percentage of allowable turfgrass. To investigate technological advances, such as the inclusion of a functioning rain shut-off device (e.g. rain sensor, soil moisture sensor, weather-based (ET) controller with rain bypass switch), it is assumed that the irrigation system is operated by an automatic time-based controller. Socio-demographic variables will include income, lot size, education, swimming pool, homeownership, level of water conservation technology, and automation of irrigation system. Latent attitudinal variables will be lifestyle, recreation, landscape interest, conservation attitude, and social desirability towards conservation. The independent variables include irrigation system type, outdoor water source, ownership and economic profile.

Univariate data analysis was used to describe the data set sample with mean, standard deviations, and percentages. The level of measurement was the range of response from frequency statistics. The bivariate analysis was used for the evaluation of the independent variables and the hypothesis testing between the independent and dependant variables. For this data set, control variables were not considered because there was no known relationship between any variable which could be considered control variables and the dependant and independent variable.

Results

The results presented here represent the initial analysis of the outdoor water use practices and perception survey. Thus far, a 27% response rate was achieved and this initial data analysis was performed on first 157 surveys. The property, irrigation system, and demographic attributes of questionnaire respondents are presented in Tables 1 and 2. Water source can be categorized into three types, potable, reclaimed, and well/surface. Well water users made up the largest percentage (36%) of the respondent sample. Three quarters of the respondents reported to having automatic systems using irrigation timers and 16% utilize an automatic system manually. The percentage of irrigatable area was normally distributed. The reported average irrigatable area was approximately 54% of the total lot area with turfgrass making up approximate 38% of the irrigatable area. Luxury attributes such as the homes having lawn maintenance service and additional water features were also evenly distributed across the sample. Ninety-one percent of those who reported having water features selected swimming pool.

Looking at the design of the irrigation system, 56% of the homes reported having mixed head types within a zones. Homes using some form of low-volume irrigation to water their landscape account for 31%; with drip-tubing as the most commonly selected choice, followed by micro-irrigation. Forty-seven percent of the homes have rain-shutoff devices, almost exclusively rain sensors; seven homes reported having a soil moisture sensors and only one having a weather-

based controller. Of the homes with rain shutoff devices 54% of them were reported to be connected and functioning.

Table 1. Attributes of the respondent's property and irrigation system.

	Percentage
Water Source	
Potable	32%
Reclaimed	32%
Well/surface	36%
Irrigation type	
Automatic system set	75%
Automatic system used manually	16%
Hose end sprinkler	5%
Hose or watering can	3%
Do not apply any water	1%
Percentage of lot that is lawn/landscape	
0-25%	11%
26-50%	37%
51-75%	37%
Over 75%	14%
Has a lawn maintenance service	
Yes	55%
No	45%
Has additional water features on property	
Yes	57%
No	43%
Has mixed zones (spray and rotor)	
Yes	55%
No	40%
Don't Know	5%
Use of low volume irrigation	
Yes	31%
No	63%
Don't Know	6%
Use of rain shutoff device	
Yes	54%
Connected and functioning	*66%*
Not connected and functioning	*20%*
Don't know	*14%*
No – turns off system manually	25%
No	21%

There is a significant difference between the three water sources (potable, reclaimed and well/surface) and how often the respondent admits to watering their lawn/landscape ($p<0.0001$). The homes that receive reclaimed water for irrigation use had a mean response of irrigating 3.1 times per week; this was statistically significantly higher than the other two water sources. While well/surface and potable users did not have significantly different responses from each other, the mean response for well users was slightly higher reporting 1.2 times per week.

Table 2. Respondent demographics and residency information.

	Percentage	Mean (Std. Dev.)
Owns the house	95%	
Number of years living in Florida		24 (15) yrs.
10 or less	27%	
More than 10	73%	
Number of months of the year in Florida		11 (3) mo.
1-3 months	13%	
4-9 months	11%	
10-12 months	76%	
Age		59 (11) yrs.
40-65 yrs.	77%	
66-81 yrs.	23%	
Educational level		
Completed high school	10%	
Some college	15%	
Completed college	42.5%	
Advanced degrees	32.5%	
Household income		
Under $30,000	10%	
$30,000 - $49,999	10%	
$50,000 - $74,999	15%	
$75,000 - $149,999	47.5%	
Over $150,000	17.5%	

Other attributes that affected irrigation frequency included timer location and the inclusion of a rain shutoff device. Timer location resulted in significant differences with p=0.0295. The homes with the statistically highest irrigation frequency, which are those who reported to irrigate more than three times per week, had timers either in the garage or on an exterior wall of the house. Concurrently, homes that reported having a rain shutoff device also reported to having an irrigation schedule that is set to run less frequently (p= 0.0062). In this category, homes that do not have a rain shutoff device but reported that they manually turn off the system following a rain event resulted in more irrigation events scheduled per week versus those homes that did not report any rain interaction.

Three indexes were developed from Likert scale attitudinal questions. The Likert scale asks the respondent to rate his/her agreement to statements based on an interval scale. In this questionnaire the scale ranged from “strongly agree” to “strongly disagree” in five even intervals with an additional “don’t know” option. Indexes were developed statistically based on Eigen value criteria. Indexes serve as a means to group strongly related questions together resulting in a numeric score than can be used for statistical analysis.

Index of conservation attitude:

- When watering with reclaimed water, outdoor water use conservation is not necessary.
- When watering with well water, outdoor water use conservation is not necessary.

- We are all responsible for water conservation in out community.

Index of conservation knowledge:

- I am not aware of watering restrictions in my area.
- I am aware of lawn appearance requirements in my neighborhood.
- New irrigation systems are required to have shutoff devices.

Index of personal lawn/landscape interaction:

- I spend a lot of time outside in my lawn/landscape.
- I am very concerned about the appearance of my yard.
- I am familiar with seasonal water needs of my lawn/landscape plants.

The index for knowledge has a correlation with education level, having a Pearson correlation coefficient of 0.60. There was also a moderate correlation between the knowledge index and the statement that the "homeowner would like to consider changes but [does not] have the money." The strongest correlation (0.87) existed between the conservation attitudinal index and the statement that the homeowner would "prefer more lawn (turfgrass) and would like to increase the lawn area of [their] yard." There were only weak correlations between the personal lawn/landscape interaction and the attitudinal preferences about the present landscape and the desire to make changes.

Conclusions

This paper presents the initial analysis of the outdoor water use practices and perceptions survey, distributed summer 2008. From the reported irrigation system attributes, approximately one third of the homes use some form of low-volume irrigation to water their landscape and half of the homes have rain-shutoff devices. Further, according to the respondents the majority of these devices were reported to be connected and functioning. These percentages of conservation technology and equipment incorporated into the system were much higher than expected for the area based on previous studies. However, the percentage of homes with mixed head types within the zones was 55%, which concurs with visual inspection of similar homes in the County.

The significant difference between water source and how often the respondent admits to watering their lawn/landscapes concurs with the watering day restrictions within Pinellas County. According to Pinellas County Code 82-1, homes using county water or wells, lakes, and ponds are allocated one day of irrigation a week for established lawns and landscaping. The homes surveyed using well/surface or potable water fell within the once per week categorical level. However, it should be noted that although the respondents reported once per week irrigation, previous research in the target area has observed far great irrigation frequencies for potable users. Irrigation using reclaimed water is on a voluntary schedule (Resolution No. 01-329) permitting up to 4 days of irrigation per week. The mean response for homes receiving reclaimed water was 3.1 times per week.

There were also significant differences observed between the number of irrigation events per week and automation of the system. Homes which allow the rain shutoff device to bypass irrigation following rain events reported less weekly irrigation event scheduled. Although a homeowner may suspect conservative irrigation practices when manually turning off the automatic controller after rain events, these homes also seem to have their timers set to higher frequencies. Additionally, homes without irrigation time clocks irrigate less often than those

homes with automatic systems, this concurs with previous findings about residential end use by the AWWA.

The correlation between water use knowledge level and the educational level of the respondent was not surprising. Furthermore, an increased knowledge index score correlates with the attitudinal factor of money affecting the desire to change the landscape. This would infer that the homeowners are aware of the expected costs for changes to the lawn/landscape when adding or removing turfgrass or conservation technology devices. What was most interesting about the correlation between conservation attitude and the desire for increased turfgrass area was that the correlation was positive. Recall, the questions that make up this index were contrary, meaning the questions were negative resulting in a reverse code. What this could imply is that the homeowners' attitude toward alternative water sources is that they do not require irrigation conservation practices and in turn provide the additional water needed for an increased turfgrass lawn area.

Unexpectedly, there were no obvious correlations between the personal lawn/landscape interaction, which is the index that attempts to quantify the level of time spent in the lawn/landscape, and any of the attitudinal choices about the present landscape, which express the homeowner's satisfaction or want to make changes. It would have been expected for this index to have a more defined opinion clearly observable. This may require additional investigation, as these interactions may be masked by spurious effects.

Further analysis will be performed to quantify the outdoor water use practices and level of community knowledge of water conservation technologies and policy. Continued analysis will also consider actual water use data from the local water purveyor records to find out how accurate the responses are. The ultimate goal of this research is to determine a means to promote knowledge of water conservation related to residential irrigation by understanding why people over irrigate.

References

Baumann, D. D. (1990). "Water Conservation Issues: introduction to Water Supply and Conservation Planning." *Journal of Contemporary Water Research and Education* 83, 9-18.

Bormann, F. H., Balmori, D., and al., e. (1993). *Redesigning the American Lawn*, Yale University Press, New Haven.

Campbell, H. E., Johnson, R. M., and Larson, E. H. (2004). "Prices, Devices, People, or Rules: The Relative Effectiveness of Policy Instruments in Water Conservation." *Review of Policy Research*, 21(5), 637-662.

Cardenas-Lailhacar, B., Dukes, M. D., and Miller, G. L. (2008). "Sensor-based automation of irrigation on bermudagrass during wet weather conditions." *Journal of Irrigation and Drainage Engineering*, 134(2), 120-128.

De Young, R. (1996). "Some psychological aspects of a reduced consumption lifestyle: The role of intrinsic satisfaction and competence motivation." *Environment and Behavior*, 28, 358-409.

Dillman, D. A. (2000). *Mail and Internet Surveys, the Tailored Design Method, 2nd Ed.* , John Wiley and Sons, Inc. , New York.

Dunlap, R. E., and Van Liere, K. D. (1978). "The new environmental paradigm." *Journal of Environmental Education*, 9, 10-19.

Florida Statutes (2007). "Water conservation; automatic sprinkler systems." Title XXVIII Natural Resources; Conservation, Reclaimation, and Use, Florida Department of Environmental Protection, Florida Statutes.
Geller, E. S., Erickson, J. B., and Buttram, B. A. (1983). "Attempts to promote residential water conservation with educational, behavioral and engineering strategies." *Population and Environment*, 6(2), 96-112.
Haley, M. B., and Dukes, M. D. (2007). "Evaluation of Sensor Based Residential Irrigation Water Application." 2007 ASABE Annual International Meeting, Minneapolis, MN.
Haley, M. B., Dukes, M. D., and Miller, G. L. (2007). "Residential Irrigation Water use in Central Florida." *Journal of Irrigation and Drainage Engineering*, 133(5), 427-434.
Israel, G. D., and Hague, G. W. (2002). "A Recruiting Challenge for Extension Education: A Comparison of Nonparticipants and Participants in Homeowner Landscaping Programs." *Journal of Agricultural Education*, 43(4), 76-87.
Kurz, T. (2002). "The psychology of environmentally sustainable behavior: fitting together pieces of the puzzle." *Analysis of Social Issues and Public Policy*, 2(1), 257-278.
Marella, R. L. (1992). "Factors that affect public-supply water use in Florida, with a section on projected water use to the year 2020." U.S. Geological Survey and Florida Dept. of Evironmental Regulation, Tallahassee, FL.
Marella, R. L. (1999). "Water withdrawals, use, discharge, and trends in Florida, 2000." U.S. Geological Survey, Reston, VA.
Mayer, P. W., W.B. DeOreo, E.M. Opitz, J.C. Kiefer, W.Y. Davis, B. Dziegielewski, and Nelson, J. O. (1999). "Residential end uses of water." American Water Works Association Research Foundation, Denver, CO.
Oskamp, S., Harrington, M. J., Edwards, T. C., Sherwood, D., Okuda, S., and Swanson, D. (1991). "Factors influencing household recycling behavior." *Environment and Behavior*, 26, 25-37.
PCU. (2007a). "Pinellas County Utilities: Alternative Water Sources Rebates."
PCU. (2007b). "Pinellas County Utilities: Current watering schedule."
PCU. (2007c). "Pinellas County Utilities: Water & sewer rates."
Stern, P. C., Dietz, T., and Kalof, L. (1993). "Value orientations, gender, and environmental concern." *Environment and Behavior*, 27, 723-734.
Templeton, S. R., Zilberman, D., and al., e. (1998). "An economic perpective on outdoor residential pesticide use." *Policy Analysis*, 32(17), 416-423.
Thompson, S., and Barton, M. (1994). "Ecocentric and anthropologic attitudes toward the environment." *Journal of environmental Psychology*, 14, 149-157.
USCB. (2001). "Statistical abstract of the United States 2002 (122nd ed.)." U.S. Department of Commerce, Bureau of the census, Washington D.C., 999.
Whitcomb, J. B. (2005). "Florida water rates evaluation of single-family homes." Southwest Florida Water Management District, Brooksville, FL.