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**EXPLORING THE EFFECTS OF EXTENSION WORKSHOPS ON HOUSEHOLD WATER USE
BEHAVIOR**

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EXPLORING THE EFFECTS OF EXTENSION WORKSHOPS ON HOUSEHOLD WATER USE BEHAVIOR

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Introduction

Population growth, droughts, and saltwater intrusion are putting a growing pressure on a finite water supply even in such water-rich state as Florida. Despite the average annual rainfall of 55 inches (Marella 2009), the Natural Resources Defense Council (2010) included Florida into the list of states with the greatest risk of water shortages in the coming years. Total domestic water use in Florida - 1,530 million gallon per day - is the fourth highest in the country (after California, Texas, and New York). A large proportion of this water is not used for basic consumption, but applied to landscapes. Haney et al. (2007) reported that in a sample of central Florida households, the average fraction of total water used by homeowners for outdoor irrigation was 64%. Similarly, South Florida Water Management District (2008) reports that outdoor water use constitutes up to 50% percent of total household water consumption, and up to 50% percent of the water applied to lawns is wasted through evaporation or overwatering (South Florida Water Management District 2008).

Landscape management outreach programs have been implemented by regional and local agencies, Cooperative Extension Service, and other outreach organizations to encourage more efficient irrigation water use and residential water conservation; however, limited information exists about the effectiveness of such programs. Outreach professionals typically rely on

information collected through surveys to evaluate changes in participants' knowledge, attitudes, and reported behaviors (see, for example, McKenney and Terri 1995, Hurd 2006, Hostetler et al. 2008, and Borisova et al. 2012). However, such surveys do not allow an assessment of the actual water use reductions associated with the educational programs.

In turn, several studies used actual water use data; however, they focused on a city or utility service area. Such studies face the difficulty of differentiating the effectiveness of individual water conservation programs applied at specific points in time or targeting specific groups of customers (Kenney et al. 2008, Syme et al. 2000). For example, Michelsen et al. (1999) found that non-price conservation programs (including educational programs) reduced water use by 1.1% - 4.0% in seven southwestern cities. However, the authors note that there was no consistent accounting of specific activities included in the non-price conservation programs in each city, and hence, the study results cannot be generalized. The authors recommended more detailed and consistent information about non-price programs to be collected to allow the evaluation of individual programs.

The results of the few studies that evaluated the effects of specific outreach programs using water use data for the targeted households are mixed (Syme et al. 2000). For example, Geller et al. (1983) examined educational programs targeting residents of 129 townhouses and single family homes in Blacksburg, VA, and showed that the educational programs had no statistically significant effect on water use. Specifically, in the study the residents were randomly assigned to a control group and three treatment groups that received (a) information about wasteful water use and water conservation strategies; (b) daily and weekly written feedbacks about their water use and changes in comparison with the baselines; and (c) low-cost water-saving devices. Using analysis of variance, the authors showed that only the group that received water saving devices showed statistically significant reduction in water use. Lack of in-person contacts and the inability to reach all members of participating households with the educational messages were suggested among the reasons for the lack of the effects from the educational programs.

In contrast, in a study of mail educational programs in Southern California, Thompson and Stroutemyer (1991) demonstrated that the effectiveness of a mail educational program

depends on the target audience and the educational message. In their study, a sample of 171 homeowners who agreed to participate in the study were randomly assigned to a control group (that only learned water conservation tips) and two treatment groups (received different educational messages in addition to the conservation tips). In addition, 36 households were assigned to the second control group that was not contacted about the study. The study then compared mean water use before and after the educational program, and compared the treatment and control groups. The authors found that the effectiveness of the programs depended on the socio-economic status of the target areas. In the lower-middle class area, residents were responsive to the educational programs; moreover, those who received information about the long-term consequences of water use conserved more water in comparison with those who learned only about economic advantages of water conservation. In contrast, neither educational message was effective in the upper-middle class area.

Finally, in a recent study, Fielding et al. (2013) showed that educational programs can be effective in the short-run, but require continuous reinforcement of the water conservation message to be effective in the long-run. Specifically, the authors examined mail educational programs targeting 221 residents in South East Queensland, Australia. The participants were randomly assigned to four groups: a control group, and three treatment groups receiving a combination of water conservation tips, feedback about their water use, and/or information about water conservation of other households. Participants' water use data were collected for the periods before, during, and after the educational campaign. Panel data analysis techniques were used to examine the differences in water use among the control and treatment groups over time. The authors show that over the program implementation period, water consumption (per person per day) increased for the control group, but decreased for the treatment groups. However, after the program completion, water use of the treatment groups showed an upward trend. The period over which the groups' average water use reached the pre-program levels ranged from approximately 4 to 12 months. The authors conclude that the long-term effectiveness of educational strategies depends on "the continued implementation of strategies and a context of water scarcity" (p. 349).

Overall, proponents of educational programs emphasize that such programs are more politically acceptable (in comparison with mandatory water use restrictions and conservation

pricing) and result in water use reduction, while opponents show that the programs are not cost-effective, result in only temporarily water use reductions (and only when immediate water shortages are apparent to public), and serve primarily as a public relations tool (Syme et al. 2000, and Fielding 2013). Additional studies evaluating short- and long-term effectiveness of educational programs can help better design and implement such programs to insure their effectiveness (Syme et al. 2000, Fielding 2013)

In this paper we evaluate the effectiveness of a specific horticultural extension program - irrigation management workshops - conducted by the Florida Cooperative Extension Service in cooperation with a local water provider. To examine potential short- and long-term impacts of the workshop attendance, monthly irrigation water use of the workshop participants are compared for the periods of 12 months before and 12 months after the workshop. Water use information for such an extended period allows differentiating seasonal water use change from the effects of the workshop attendance. In the following sections, we present a detailed description of the irrigation workshops, as well as the water use dataset. Next, in the *Methods* section, we describe the fixed effect models used to examine the water use patterns. In the following *Results* section, we show that the workshop attendance has a very short-term effect on the water use. Specifically, water use drops for the month of the workshop attendance, but then it increases to the level which is equal or exceeds the pre-workshop levels. The study implications are discussed in the *Conclusions* section.

Program Description

Two-hour free irrigation management workshops are offered twice a month by Osceola County Cooperative Extension, FL, in cooperation with the local water provider, Toho Water Authority. These workshops are a part of the larger Florida Friendly Landscaping™ program focused on educating homeowners and industry professionals about sustainable landscape management (Florida-Friendly Landscaping™ Program, 2009). The workshops are held in the local Extension office, and cover three main topics: (1) adjustment of irrigation system timers to satisfy the local irrigation restrictions (no irrigation is allowed between 10 am and 4 pm); (2)

measurement of irrigation sprinkler output, and (3) operating different types of timers that control automatic irrigation systems. Presentations and demonstrations are made by the natural resource extension agent or the Toho Water Authority's water conservation coordinator, followed by a question and answer session and hands-on exercises.

The workshops are advertised through Cooperative Extension newsletter and brochures, as well as through periodic water utility bill inserts and local newspaper advertisements. In addition, households that violated local irrigation ordinances (by irrigating on the wrong time) are sent invitations to attend an irrigation workshop as an alternative to the citation. The number of people attending the workshops ranges from 2 to up to 20, and approximately 25% - 50% of participants attend the workshop to avoid the citations (Elizabeth Block, personal communications). The other participants come to learn about their irrigation system (new homeowners and new Florida residents especially), to explore installation of an alternative irrigation system, or to find a way to reduce their water bills and conserve water. It is possible that water use patterns are different for those who are interested in water conservation, who is trying to avoid citations, or who is learning about new irrigation system; unfortunately, information about the reasons for workshop attendance (that would allow differentiating those attendees) was not available.

Data

Monthly irrigation water use data were provided by Toho Water Authority water conservation coordinator (Ms. Elizabeth Block), FL, for 57 households, members of which participated in one of the irrigation workshops conducted between April 2007 and March 2010, and for which irrigation water use was metered separately from the in-door water use (using irrigation or reclaimed water meters).¹ In this unbalanced panel dataset, monthly irrigation water use information is available for each household for 12 months prior to the date of the workshop, the month of the workshop, and 12 months after the workshop. Given that the workshops were

¹ The original sample included 74 households. In this sample, two households were recorded with the same identification numbers, and twelve households had the water meters that did not allow for a separate analysis of indoor and outdoor water use. These fourteen households were excluded from further analysis. Three additional households were excluded from further analysis as outliers (based on the home certified values and the estimated irrigated areas).

conducted in 2007 – 2010, the number of water use observations for 2006 and 2011 is relatively small (Table 1). Households' water use was measured in thousand gallons and rounded to the closest integer. Overall, the irrigation water use ranged from zero to 52 thousand gallons (Table 1).

Table 1. Information about the Workshop Participants

Household Characteristics	Mean / percentage	Standard deviation	Minimum	Maximum
Calendar year of the water use observations (N = 1425)				
2006				
2007	7.3%			
2008	15.3%			
2009	28.6%			
2010	33.0%			
2011	15.2%			
	0.6%			
Households' monthly irrigation water use, thousand gallons (N = 1425)	8.1	7.8	0	52.0
Percent of households by the type of water meters (N = 57):				
Irrigation meters	49.1%			
Reclaimed water meters	50.9%			
House certified value, thousand dollars (N = 57)	125.8	37.7	51.8	230.5
Estimated irrigated area, sq. ft. (N = 57)	4677.5	2637.3	1104.8	12,366.2
Estimated irrigation rate, gallon per sq. ft. per month (N = 1425)	2.0	2.1	0	26.2
Estimated irrigation rate, inches (N = 1425)	3.2	3.4	0	42.3

For each household, Toho Water Authority also provided certified values of the houses (acquired from the local property appraiser dataset, for the year 2010) and irrigated area of the lots (estimated via subtracting the lot areas classified as the base area, driveway area, sidewalk, and other area, from the total lot size) (Liz Block, personal communications). Based on this information, the households in the sample included both relatively wealthy households (with expensive houses and large lawns) and less affluent residents (with certified value of the houses less than 60 thousand dollars). For each household, irrigation rate (in inches per month) was estimated by dividing monthly irrigated water use by the size of the irrigated yard area, and then converting the results into inches. On average, estimated irrigation rate of the workshop participants was low – just 3.2 inches per month; however, maximum irrigation rate observed was 42.3 inches (Table 1). For comparison, according to the University of Florida researchers, irrigation of 12 inches per month is sufficient to sustain turfgrass during extreme summer conditions (Trenholm et al. 2006).

To differentiate the effect of the workshop attendance from other possible factors that coincided with the timing of the workshop (for example, higher atmospheric temperature or implementation of the public service announcement campaigns on local radio or television), it is important to compare the water usages of the workshop participants (i.e. treatment group) and those who are similar in their water use characteristics, but who did not attend the workshop (i.e. control group). The households in the sample attended irrigation workshops in different months, and hence, in each month (with the exception of a few months in the beginning and at the end of the observation period), the sample can be divided into the households that already attended the workshop (i.e., belong to the ‘treatment group’), and those that did not attend the workshop (i.e., belong to the ‘control group’). Comparing the water use of these two groups of households for each month, and then averaging the results across the household and months allows for the identification of the effect of the workshop attendance.

In addition, monthly irrigation water use data were provided for 43 households that had never attended the workshops and that were randomly selected from the same neighborhoods as those who attended the workshops (Ms. Elizabeth Block, personal communications) (referred to as ‘second control group’ below).² No information about the value of the houses and estimated irrigation areas households for the second control group was provided.

For the analysis of the workshop effects on the water use to be accurate, it is important to insure that prior to the workshop the individuals in both groups were similar in their water use characteristics. To ensure that this condition is satisfied, we selected the monthly irrigation water use of the workshop participants for the period 6 to 12 months prior to the workshop (assuming that this time period is sufficiently distant from the time of the workshop, and hence, households’ water use is independent from the decision to attend the workshop). For the workshop participants, there were 342 monthly water use observations spanning the period between April 2006 and August 2009, and the average monthly irrigation water use was 7.1 thousand gallons. In turn, average monthly irrigation water use for the second control group for the same time period was 11.4 thousand gallons (Table 2). The hypothesis that samples of water use for workshop participants and non-participants are drawn from similar distributions was rejected

² Six households were excluded from the dataset due to the fact that their water use records combined indoor and outdoor use.

(Kolmogorov-Smirnov test, $\alpha = 0.0001$), implying that the water use patterns of the workshop participants were different from the patterns of the non-participants, and hence, the comparison of their water use can lead to biased estimation of the effects of the workshop participation.

Table 2. Water Use of the Workshop Participants and Non-Participants (thousand gallons)

Sample	Number of monthly water use observations	Mean	Minimum	Maximum
Workshop participants (7 – 12 months prior to workshop)	342	7.1	0	52
Second control group	1762	11.4	0	192

To select a sub-sample of workshop participants and non-participants with similar water use patterns, we used *proc distance* in SAS 9.2 (SAS 2012) to estimate the difference in monthly water use for the households over the period of 7 – 12 months prior to the workshop. The analysis was conducted separately for the households on irrigation and reclaimed water meters. We then selected 24 workshop participants and 17 households from the second control group those water use was different by 5.5 gallons or less (Table 3). For this sub-sample, we failed to reject the hypothesis that water use for workshop participants and non-participants are drawn from similar distributions (Kolmogorov-Smirnov test, $\alpha = 0.01$), implying that the water use patterns are sufficiently similar. Note that for this sub-sample, the mean water use of both participants and non-participants is significantly smaller than the mean for the sample as a whole (compare the mean values in Tables 2 and 3). Descriptive analysis of the sub-sample of the workshop participants also showed that on average, the certified value of their houses (110.8 thousand dollars) and the irrigated area of their lawns (3882.7 sq. ft) are smaller than the corresponding values for the complete sample (125.8 thousand dollars and 4677.5 sq. ft., respectively).

Table 3. Sub-Samples of the Workshop Participants and Non-Participants

Type of water meter	Sub-Sample	Number of monthly water use observations	Mean	Minimum	Maximum
Reclaimed	Participants, 7 – 12 months prior to workshop (N = 9)	54	3.3	0	13
	Non-participants (N = 5)	101	3.4	0	29
Irrigation	Participants, 7 – 12 months prior to workshop (N = 15)	90	3.5	0	29
	Non-participants (N = 12)	265	4.3	0	48

Regression Analysis

When comparing water use patterns before and after the workshop attendance, it is important to account for the following factors. First, different households attended workshops at different dates, thus, the before and after periods correspond to different months, across households, and often even different years. Thus, in the analysis of the water use before and after the workshop, it is important to control for the specific time periods. Second, increases in water usage across households may be related to systematic changes in atmospheric temperature and precipitation, rather than to workshop attendance, and hence, weather changes should be accounted for in the analysis. Finally, there may be other unobservable factors that change systematically over time (e.g., implementation of public service announcement campaign), which may cause an increasing or decreasing trend that is not related to workshop effects; and hence, the use of the control groups is important. In order to control for or identify the effect of all these factors simultaneously, we use fixed-effect regression model.

Fixed-effect model is a linear regression model in which a unique intercept is estimated for each household in a sample. In other words, for each household, the model focuses on changes in the dependent variable (e.g., water use) over time as compared with this household's own mean; then these changes in water use are averaged across all households in the sample (Allison, date not found). Given that each household is compared with its own mean, a fixed effect model in fact controls for both observed and unobserved characteristics of these households (such as the size of the lawn, income level, household composition, or attitudes towards water conservation). In this study, the following fixed-effects statistical model is used:

$$y_{it} = \alpha + u_i + \mathbf{x}_{it}'\boldsymbol{\beta} + \varepsilon_{it} \quad (1)$$

where y_{it} denote the irrigation water use (in thousand gallon/month) by household i in month t and \mathbf{x}_{it} represents the matrix of explanatory variables that include (1) extreme minimum daily temperature for i th month (degrees Fahrenheit) and its squared term; (2) extreme maximum daily precipitation for i th month (inches); (3) dummy variables indicating periods before and after the attendance of the irrigation workshop (for workshop participants only); and (4) calendar year dummy variables. Note that the model does not include water rate as an independent variable

since the rates were relatively constant during the period of the study. In turn, α refers to the sample mean, while u_i is a household-specific parameter that integrates all time-invariant characteristics of the households (SAS, date not found). Finally, ε_{it} is a random variable, assumed to be normally distributed, with the mean of zero and variance of σ^2 .

For each household, the 25-month period over which the water use observations are available is divided into five intervals. Four months prior to the month of the workshop are taken as a base period against which water use in other time periods are compared (referred to as ‘period 2’). We hypothesized that the water use in the base period may be higher or lower than the use in the previous months. For example, households may observe a spike in water use and decide to attend the workshop to manage the increasing water bills. In this case, the water use in the based period would be larger than in the previous months. Alternatively, households may switch off irrigation systems for a few months, and then attend the irrigation workshop before turning the systems on. In this case, the water use in the based period would be smaller than in the previous months. To examine such changes in water use, a dummy referred to as ‘Period1’ is used to identify the period 5 – 12 months preceding the workshop. In turn, the month of the workshop is identified as ‘period 3’. The irrigation workshops were held in the beginning, middle, or end of the calendar months, and hence, it was difficult to combine period 3 with either the previous or the following periods.

In the study of homeowners in South Australia, Fielding et al. (2013) found that the effect on the water use of a mail educational program can vary from four to twelve months. In their analysis, the mail educational program included three contacts with the target audience. The program examined in this study included only one contact with the household (i.e. the irrigation workshop), with no follow-ups. We assume that the four-month time period following the month of the workshop is long enough to implement water conservation techniques studied during the workshop. This time period is identified using Period4 dummy variable. Finally, Period5 dummy was used to identify 5th – 12th months after the workshop attendance. All explanatory variables used in the model are described in Table 4.

Table 4. Variables used in the regression analysis

Variable	Description	Hypothesized effect on irrigation water use
EMNT	Extreme minimum daily temperature (degrees F) ¹	+
sqEMNT	Extreme minimum daily temperature, squared	+/-
EMXP	Extreme maximum daily precipitation (inches) ¹	-
year2007	Dummy variable identifying water use in 2007 ²	+/-
year2008	Dummy variable identifying water use in 2008 ²	+/-
year2009	Dummy variable identifying water use in 2009 ²	+/-
year2010	Dummy variable identifying water use in 2010 ²	+/-
year2011	Dummy variable identifying water use in 2011 ²	+/-
Period1	Dummy variable identifying the period 5 – 12 months prior to the workshop attendance ³	+/-
Period3	Dummy variable identifying the month of the workshop ³	-
Period4	Dummy variable identifying the period 1 – 4 months following the workshop attendance ³	-
Period5	Dummy variable identifying the period 5 – 12 months following the workshop attendance ³	+/-

¹ Data were downloaded from NOAA, for Orlando International Airport weather station

² 2006 is selected as the base for comparison

³ Period2 is selected as the base for comparison

Two fixed effect models were estimated: the first model examines the water use of the complete sample of all workshop participants (Model 1), and the second model focuses on the sub-sample of the participants and non-participants (Model 2). The models are estimated using *proc panel* in SAS 9.2. An option for the heteroscedasticity-consistent covariance matrix estimator was used.

Results

For the complete sample of workshop participants, the regression model explains 43% of variation in monthly irrigation water use (Table 5). The coefficients for temperature and precipitation have the expected signs and are statistically significant (at 5% and 10% confidence levels). The effect of temperature on water use is nonlinear, although the coefficient for the temperature squared is very small in the absolute value. No statistically significant changes in water use are observed from year to year. The coefficients for the period dummy variables show that the water use increases prior to the workshop participation (Period1 dummy is negative and statistically significant). The water use then drops in the month of the workshop (Period3), and

then increases to the level observed in the base period. In other words, the effect of the workshop seems to be very short-lived.

Table 5. Estimation results

Variable	Model 1 (all participants)			Model 2 (sub-sample of participants and non-participants)		
	Estimate	Standard Error	t value	Estimate	Standard Error	t value
Intercept	11.2	3.6	3.11***	10.61	2.47	4.30***
EMNT	0.25	0.11	2.24**	0.14	0.09	1.53
sqEMNT	-0.00	0.00	-2.09**	-0.00	0.00	-1.39
EMXP	-0.32	0.19	-1.69*	-0.02	0.19	-0.12
year2007	-0.79	1.06	-0.75	0.95	0.81	1.17
year2008	-0.21	1.32	-0.16	1.70	0.79	2.15**
year2009	-1.01	1.71	-0.59	2.24	0.81	2.76***
year2010	-0.36	2.14	-0.17	1.46	0.83	1.76*
year2011	1.39	3.04	0.46	NA ¹		
Period1	-1.90	0.54	-3.55***	-2.25	0.63	-3.55***
Period3	-2.12	0.76	-2.78***	-1.25	0.82	-1.52
Period4	0.74	0.59	1.25	1.89	0.86	2.20**
Period5	0.56	0.68	0.82	1.31	0.68	1.94**
F Test for no fixed effects (DF)	16.44*** (1356)			F value = 25.40*** (1094)		
R-square	0.43			0.51		

¹No water use observations for 2011 were available

The water use in the sub-sample of the participants and non-participants is remarkably different. The weather seems to have limited effect on the water use (though the coefficients for both temperature and precipitation have the expected signs). Water use seems to show an increasing trend from year to year, with the especially high levels in 2010. Interestingly, the attendance of the irrigation workshop does not have the expected effect on the water use. Specifically, the reduction in water use in the month of the workshop is not statistically significant. Furthermore, water use increases in the months following the workshop (since the coefficients for Period4 and Period5 dummies are positive and statistically significant). Overall, the model explains 51% of variation in water use.

Although the results for the sub-sample seem surprising at the first glance, they make an intuitive sense if one recalls that the sub-sample includes a large proportion of the households with low irrigation water use. Learning about water conservation may not result in significant water use reduction if households already use low volumes of water. Increase in the water use following the month of the workshop is still difficult to explain. One explanation could be that low-use households adjusted their timers upward following the irrigation workshop to better meet plants water needs. For example, Trenholm et al. (2006) suggest that even during winter months (i.e. during Florida's dry season when turfgrass is generally dormant), grass may still use 1.5 inches of water per month or more. Some households in the sample reported zero irrigation

water use for some months, and they may adjust the water use up following the workshop. Alternatively, there may be an upward trend in water use among the workshop participants that is not related to the workshop attendance. In this case, attendance of the irrigation workshop resulted in a delay in water use increase by one month (since the coefficient of Period3 dummy variable is not statistically different from zero, and hence, water use in the base period and periods 3 is similar, while water use increases in period 4). Finally, increase in the water use can be attributed to the offsetting behavior, when households change their behavior following an implementation of a water conservation strategy (e.g., increase irrigation acreage after reducing the irrigation intensity) (Geller et al. 1983, Nieswiadom 1992).

Discussion and Conclusions

The analysis of irrigation water use of the sample of irrigation workshop participants and non-participants leads to the following key conclusions. First, the proper design of the evaluation stage for the educational program is extremely important. Analysis of the water use of workshop participants can be significantly more informative if the information about such households' characteristics as the primary reason for attendance (e.g., interest in water conservation, citation avoidance, or new home ownership), attitudes toward environmental protection, household composition, and types of the irrigation systems installed were available. Such information can be easily collected via a survey of the workshop participants. Combining water use data with the information from the household surveys and the property appraisers' web-sites can allow examining (a) the audiences reached by the educational programs; and (b) the differences in the effects of the educational program on the water use of different types of households.

Secondly, in our study the water use patterns of the workshop participants (prior to the workshop) and a random sample of households who never attended the workshop (second control group) are statistically different. On average, participants' water use was lower than the use of the non-participants, implying that the households may have self-selected for the workshop participation, for example, following their interest in water conservation.

Thirdly, we found that for the workshop participants, irrigation water use tended to increase in the months preceding the workshop. This result implies that a main reason to attend the workshop can be the desire to combat the spike in the water use.

Fourthly, for the sample of the workshop participants as a whole, water use drops by approximately 2 thousand gallons in the month of the workshop (as compared with the water use in the preceding four months). However, this effect can differ depending on the sample of the households considered. For example, when a sub-sample of the workshop participants was examined (and compared with those who never attended the workshop), the participants' water use in the month of the workshop was similar to the use in the preceding months. This result implies that the effectiveness of the workshop differs depending on the household characteristics, and more information about the households should be collected to allow for a comprehensive study.

Fifth, we found that the effect of the workshop attendance is very short-lived. For a sample as a whole, water use returns to the base level in the months following the workshop. Fielding et al. (2013) suggested that the long-run effectiveness of an educational program depends on the continued reinforcement of the educational message. Given that there were no follow-up for the irrigation workshops, it is not surprising that the effect of the workshop was noticeable only in the short-run.

Moreover, for a sub-sample of workshop participants, the participants tended to increase their water use in the months following the workshop. Given the low irrigation water use, attending the workshops may have created incentives for the participants to adjust their water timers to *increase* their water use to meet plants' water requirements. In addition, the relatively low water use of workshop participants before the workshop makes it harder to induce further water use reductions through educational programs or other strategies. Such "demand hardening" is reported in other studies (e.g., Maddaus *et al.* 2008, Wilby and Miller, 2009). Finally, such an increase can be attributed to households' offsetting behaviors, which is reported by the other studies in relation to engineering approaches to water conservation. For example, Geller et al. (1983) report that installing water saving devices in a sample of houses in Blacksburg, VA, resulted in water use reductions, but these reductions were smaller in magnitude in comparison

with the devices' technical specifications. The authors concluded that the household members changed their behavior after the devices were installed that reduced water savings. Similarly, following the installation of an in-door water conservation device, households can increase their outdoor irrigation water use (Nieswiadom 1992). For the irrigation workshops discussed in this paper, offsetting behavior may include expanding the irrigated areas after the workshop (even if water use per acre was actually reduced).

It is important to emphasize that this study focuses specifically on evaluating the impacts of the irrigation workshops on water use. We did not evaluate the value of the educational program for promoting conservation ethics (Kenney et al. 2008), building the sense of the community, or educating residents about local irrigation restrictions, which can be important components of the overall value of the program.

Overall, we believe that this study is an important first step in developing a comprehensive approach to evaluating effectiveness of outreach water conservation programs. For example, Borisova et al. (2011) stated that consistent evaluation of the outcomes of landscape management programs is a key challenge identified for the *Yards and Neighborhoods* programs in Florida, South Carolina, and Tennessee. Developing a comprehensive evaluation approach can help quantify the impacts of such programs, design more effective educational programs, and to better target the programs. Evaluation of the actual water use reductions should be a key component of the evaluation process.

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