

Response by the Residential Sector to Phase III Drought Restrictions of 2008 in Suburban Portions of Collier County

L. Donald Duke and Geoffrey C. Burgerhoff

L. Donald Duke, Ph.D., P.E., is a professor in the Department of Marine and Ecological Sciences at Florida Gulf Coast University. Geoffrey C. Burgerhoff, M.S., received a master of science degree in environmental science from Florida Gulf Coast University in 2010.

Post-implementation assessment is crucial to environmental programs. Agencies that need to respond to repeated challenges, such as drought conditions that recur at some time in the future, can design and implement more effective programs if they know what kinds of responses have succeeded in the past. If responsible agencies know to what extent their programs have

achieved their aims, which portions of their programs were effective, and in what ways they might have fallen short, they can improve future efforts to achieve their goals.

This research assesses the effects of certain programs implemented in Collier County that were intended to reduce utility-served residential water usage during the declared drought of 2007-2008. The research uses utility billing information, collecting data from several samples of residences designed to separate effects of different drought-reduction interventions and from several time periods to capture responses at different points during the declared drought.

Table 1. Florida Administrative Code Chapter 40E-21, Water Shortage Plan: Elements for residential usage.

| Phase of drought | Proportional reduction, target: % | Daily usage per capita, target: gallons/day | Residential irrigation restrictions * |
|------------------|-----------------------------------|---|---------------------------------------|
| I: Moderate | 15 | 60 | 3 days/wk @ 4 hrs |
| II: Severe | 30 | 50 | 2 days/wk @ 4 hrs |
| III: Extreme | 45 | 40 | 1 day/wk @ 3 hrs |
| IV: Critical | 60 | 30 | 1 day/wk @ 1 hr |

* Excluding exempted uses, e.g. reclaimed water; low-volume technologies; etc.

Source: SFWMD (2007a).

Objectives

The objectives of this research were to: 1) determine if any reduction in residential water usage occurred in suburban northeast Collier County during the period of Phase II and Phase III drought restrictions; 2) determine whether enhanced interventions implemented by responsible agencies led to increased water conservation, compared to the restrictions imposed on the entire service area; and 3) determine whether this utility-bill method is effective in this form of post-implementation assessment for agency programs designed to reduce water usage in the residential sector under declared drought conditions.

Background

Florida Drought Planning and the Collier County Water Department Response to 2007-2008 Drought

The Collier County Water Department's response to the drought of 2007-2008 was governed by the Florida Department of Environmental Protection's guidelines for response to drought. The state's water management districts are obliged to implement these guidelines and to require certain actions by their permit holders, including municipal utilities. The Florida Administrative Code, chapter 40E-21, includes a water shortage plan that articulates four degrees of severity of drought: Phases I, II, III, and IV. It includes requirements, some for residential use, shown in Table 1.

Continued on page 18



CONTACT PERSON:
PEGGY GUINGONA

PHONE: 407-957-8448
EMAIL: FSAWWA@GMAIL.COM

CALL FOR ENTRIES

2011 WATER CONSERVATION AWARDS FOR EXCELLENCE

THE AWARDS

This awards program recognizes outstanding achievements in water efficiency throughout Florida.

Awards will be presented on
Wednesday, November 30, 2011!

DEADLINE FOR ENTRY:
Friday, September 23, 2011

ENTRY FEES:
\$25 - First or single entry
\$20 - Each additional entry

ENTRY GUIDELINES:
Visit www.fsawwa.org/

Table 2. Monthly precipitation, Naples FL, inches.

| | Total, 2007 | Total, 2008 | Monthly mean, period of record: 1942 - 2010 |
|--------------|-------------|-------------|---|
| January | 0.74 | 1.06 | 1.86 |
| February | 2.09 | 2.09 | 1.96 |
| March | 0.19 | 0.88 | 2.23 |
| April | 1.45 | 7.50 | 1.98 |
| May | 2.11 | 0.56 | 4.10 |
| June | 2.67 | 10.2 | 8.50 |
| July | 9.94 | 13.3 | 8.47 |
| August | 8.24 | 11.4 | 8.52 |
| September | 5.75 | 6.96 | 8.89 |
| October | 5.68 | 4.40 | 3.80 |
| November | 0.78 | 0.19 | 1.69 |
| December | 0.83 | 1.77 | 1.50 |
| Annual total | 40.47 | 60.30 | 53.46 |

Source: Southeast Regional Climate Center (2011).

Continued from page 16

The focus on limiting lawn irrigation is rational given the large proportion of water use in that area in a typical Florida household (Morales and Heaney 2010), and given the ‘optional’ nature of that kind of water use compared to drinking, cooking, and sanitation uses indoors. However, it is notoriously more difficult to influence the decisions of large numbers of residential decision makers to attain a public policy goal than to influence a smaller number of entities, with more direct lines of influence, such as corporations or public agencies.

Table 2 depicts monthly precipitation at the Naples weather station (SRCC 2011), which shows rainfall well below normal beginning in January 2007. In April of that year, the South Florida Water Management District (SFWMD) declared drought, triggering Modified Phase II Severe Water Restrictions, which were upgraded from the Modified Phase III Water Shortage restrictions in effect from Jan. 15, 2007, until April 17, 2008 (SFWMD 2007b). Phase III restrictions were rescinded in response to one month of high precipitation in April 2008, but Phase II continued in effect until March 15, 2010.

Under the drought declaration, SFWMD enacted the lawn watering restrictions and the target usage conditions, and also required actions from municipal agencies that held permits for residential water supply. One of the actions required the permit holding agencies to implement and enforce the district-specified landscape watering requirements. Another was to require those agencies to design and implement additional measures for public and private users to reduce usage by a collective target of 45 percent.

The Collier County Water Department (CCWD), a municipal agency, supplies water within the Collier County Water-Sewer District,

a portion of the county which lies inside the SFWMD regional jurisdiction. The CCWD was obliged to enforce the SFWMD’s lawn-watering restrictions and to take additional actions to reduce residential water usage.

One action it chose was to impose an additional fee on residences using more than 10,000 gallons of water each month, shown on their monthly statement as “Water Restriction Surcharge.”

Another action was to work with local news outlets to publicize the drought restrictions, an activity that is difficult to quantify but which appears to have had a substantial effect, as described elsewhere (Burgerhoff 2010). Both of these actions applied more or less equally to all water users served by the CCWD.

The CCWD chose two further interventions. First, the Department enforced the SFWMD’s guidelines for lawn watering restrictions by issuing a fine to residences observed irrigating outside the allowed times, beginning at \$80, with larger fines imposed depending on the severity of the violation. The violating households

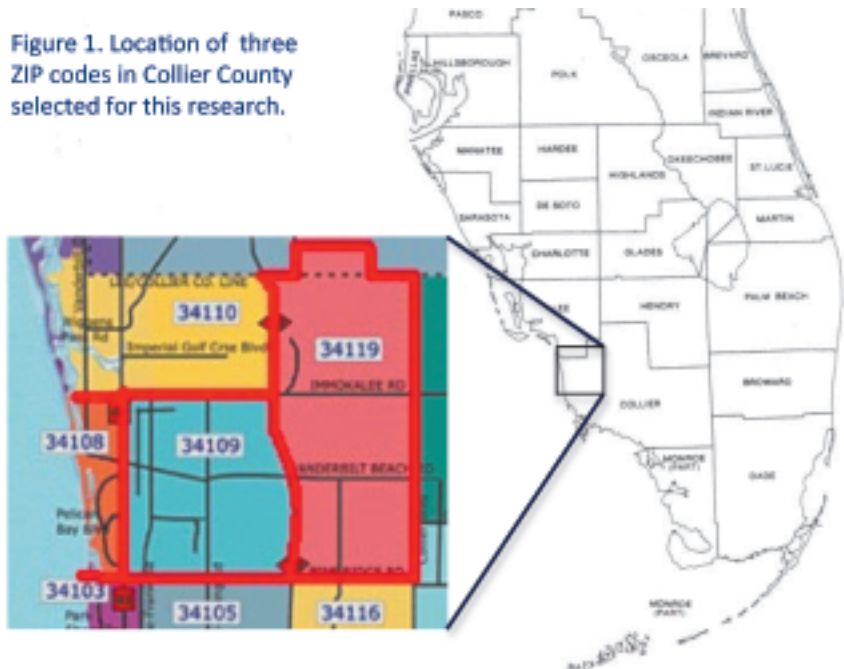
were identified using a somewhat unstructured system of phoned-in tips, observations by meter readers on their regular rounds, and evidence visible to a small roving enforcement staff.

Second, the CCWD arranged for representatives of the SFWMD to make specialized drought-response briefings to the homeowners associations (HOAs) of a number of housing developments. The briefings described the dangers of the low available water supply in local aquifers and urged residents to consider it their civic duty to conserve water. The CCWD publicized the availability of the briefings and the SFWMD conducted them at HOAs that asked to receive them. Attendance at these meetings was strictly voluntary among HOA residents.

The Phase III-declared drought lasted only four months, from January to April of 2008. The city of Naples received 7.5 inches of precipitation in April 2008—nearly four times the normal amount. Water reserves remained low, but the SFWMD declared an end to the Phase III drought restrictions on April 17th.

The two enhanced interventions were conducted in February and March, with April being the first month in which their effects would be noticed in the billed usage. However, the unusually high rainfall during that billing cycle led residents to sharply reduce their outdoor usage for lawn irrigation, so any effects of the enhanced interventions on reduced irrigation were not visible in the utility bills. This research, therefore, is unable to distinguish any influences of the enhanced interventions from residents’ changes in their need to irrigate because of greatly increased precip-

Figure 1. Location of three ZIP codes in Collier County selected for this research.



Source for outline map: U.S. Department of Commerce Economics and Statistics Bureau of the Census: Maps, Appendix G, Florida: G-1. Source for ZIP Code map: <http://www.city-data.com/zipmaps/Naples-Florida.html>

Methods

The research used utility bills to measure water usage directly for a large sample of residences in one part of the CCWD service area, comparing usage “before” drought restrictions with usage “after.” The “after” month coincided with a sudden break in the drought, a high-precipitation month in which lawn irrigation would be expected to decrease sharply, in order to evaluate the impact of that kind of change in the need for utility-supplied water for irrigation. The research focuses on a small portion of the county where households are dominated by single-family homes organized into HOAs, and where the CCWD conducted some enforcement and outreach activities in support of residential lawn watering restrictions specified by the SFWMD.

This research is limited to one portion in the northwest corner of the CCWD and is not considered to be representative of Collier County or of the CCWD service area as a whole. Three ZIP codes were selected, where residential characteristics are relatively uniform, in order to minimize potential confounding by factors such as age of homes, size of lawns, and responsibility for landscape irrigation. The target ZIP codes also were selected for their high proportions of single-family

Table 3. Historic and projected population growth, portions of southwest Florida

| | Total population x 10 ³ | | | | Population served by public water supply x 10 ³ (2) | | |
|---------------------|------------------------------------|---------|------------------------|---------|--|---------|-------|
| | Collier Co. | Lee Co. | LWC ^{(1),(2)} | Florida | Collier Co. | Lee Co. | LWC |
| 1960 | 16 | 55 | n.a. | 4,951 | n.a. | n.a. | n.a. |
| 1970 | 38 | 105 | n.a. | 6,789 | n.a. | n.a. | n.a. |
| 1980 | 86 | 205 | n.a. | 9,746 | n.a. | n.a. | n.a. |
| 1990 | 152 | 335 | n.a. | 12,938 | n.a. | n.a. | n.a. |
| 2000 | 251 | 441 | n.a. | 15,982 | n.a. | n.a. | n.a. |
| 2005 | 318 | 541 | 908 | 18,801 | 272 | 458 | 760 |
| 2025 ⁽³⁾ | 608 | 906 | 1,583 | n.a. | 532 | 828 | 1,406 |

(1) Lower West Coast planning area of SFWMD, including Lee and Collier Counties and portions of Hendry, Glades, and Charlotte Counties.

Sources: U.S. Census Bureau (2010); U.S. Census Bureau (1995).

Source for (2): SFWMD (2006).

(3) Projected population for 2025 was estimated in 2006, prior to the economic slowdown that profoundly affected new housing in southwest Florida.

housing developments subject to HOA restrictions. Target ZIP codes are shown in Figure 1.

Single-family residential use constitutes a large portion of water usage in Florida. A study of one unnamed South Florida utility estimated that residential use comprised about 71 percent of total utility demand, and outdoor usage by the residential sector about 33 percent of total utility demand (Morales and Heaney 2010). Any plans to reduce usage during drought con-

ditions clearly need to consider the residential sector, especially its domestic irrigation. Usage by that sector is influenced by housing density and design, landscape design and drainage, and many institutional factors, including HOAs.

The state of Florida has experienced rapid population growth in recent decades. The counties of Southwest Florida have been among the leaders in growth, as shown in

Continued on page 20

Continued from page 19

Table 3. Much of the growth has been in the form of single-family homes with landscaping and, particularly in recent years, grouped into sizable housing developments, where a single developer constructs homes on adjacent lots, commonly encompassing between 20 and 400 homes—in some cases many more. Many of these developments are organized from the outset to be subject to regulations of an HOA.

The HOA is akin to a fourth level of government (along with federal, state, and local), in that all homeowners within the development are obliged to be members, to pay a recurring fee, and are subject to decisions about collective actions and expenditures. There is surprising variation in the HOA leaderships' degree of authority, including the selection of

leaders and the nature of collective decisions for which the leadership is responsible. In most locations, structural decisions (landscaping, irrigation infrastructure, stormwater management facilities) are completed by the developer at the initiation of the development, but ongoing maintenance and operation of those facilities—most particularly, irrigation decisions—are made by the HOA leadership.

Most developments include irrigation of common areas by the central authority, and increasing numbers include irrigation of privately-owned parcels by the HOA. The latter are excluded from this research, since the residents are insulated from landscape irrigation decisions and do not see the consequences reflected on their water bills. Also excluded are developments of multi-family housing such as

condominiums, and developments, primarily older, where irrigation water is supplied by wells and not purchased from the utility.

These exclusions are necessary to develop a research sample where landscape irrigation is at the behest of the individual homeowner and where it accounts for something on the order of the 33 percent of utility-supplied water that was estimated (Morales and Heaney 2010). Nevertheless, it is not clear to what extent residents within HOA-governed developments can be influenced by the kind of drought restrictions that are currently and widely used in Florida. That is one of the motivations of the research.

Sampling Scheme: Four Groups of Residences; One Base Case, Two Enhanced Interventions

Four samples of residences were selected within the three target ZIP codes. Each of the samples is intended to isolate, to the extent possible, the influence of one of the drought interventions implemented by the CCWD and the SFWMD. One sample includes only residences within developments where no fines were issued for lawn watering violations, and where no HOA outreaches were conducted; we term this the “base case” sample. A second sample consisted only of residences receiving fines, encompassing all 128 fined residences within the targets. A third sample consisted of randomly-selected residences within developments that received HOA outreach presentations by SFWMD personnel. The final sample consists of residences of “nearby fined” locations (homes in the same subdivision as other homes that received fines) in order to test the possibility that neighbors of fined residents may tend to reduce their own water use. Table 4 summarizes the sampling scheme, which is also described in more detail in Burgerhoff (2010).

“Very small users” are excluded from the sample for one practical reason and one conceptual rationale. The practical reason is that CCWD meters are an older type that are read manually, and readings routinely are truncated to the nearest 1,000 gallons per month. This situation is of no consequence for billing, since truncated usage merely appears on the subsequent month's bill, but for this research, as described in Burgerhoff (2010), it produces a substantial bias in computing month-to-month percentage usage change. The conceptual reason is that, for this part of Florida, many residents are seasonal, leaving homes vacant for substantial parts of the year. Residences reporting little or no usage in a given month might well be vacant during that month, and therefore the residents are not making the kind of decisions about water use that this research is intended to explore.

For these two reasons, residences with usage of less than 2000 gal/month are omitted

Continued on page 22

Table 4. Sampling scheme: Subdivisions and residences randomly selected within three targeted ZIPs.

| | Description of sampling universe | Number of subdivisions randomly selected within universe | Number of residences in sample: about 30 in each subdivision, "small users" omitted | | |
|---|--|--|---|---------------------|-----------------------------|
| | | | Jan 2008 – Apr 2008 | Apr 2007 – Apr 2008 | Apr-Oct 2007 – Apr-Oct 2008 |
| Base case: Watering restrictions, usage surcharges, public info | Subdivisions with no fines, no outreach | 9 | 245 | 256 | 302 |
| HOAs receiving briefing | All HOAs briefed | 14 | 340 | 380 | 472 |
| Violators of lawn watering restrictions - fined | All residences issued fines | n/a | 104 | 107 | 126 |
| Residences near those receiving fines | Non-fined residences in subdivisions where fines were issued | 6 | 133 | 131 | 152 |
| Total residences in sample | | | 822 | 874 | 1059 |

Table 5. Mean Change in Water Usage in Sample Households.

| Intervention | January 2008 – April 2008 | | April 2007 – April 2008 | | Apr-Oct 2007 – Apr-Oct 2008 | |
|-----------------|---|---------------------|---|---------------------|---|---------------------|
| | Difference, gal x 10 ³ (p-value) | Per cent difference | Difference, gal x 10 ³ (p-value) | Per cent difference | Difference, gal x 10 ³ (p-value) | Per cent difference |
| Base case | -3.8 (<.01) | -24 | -4.4 (<.01) | -23 | -8.8 (<.01) | -11 |
| HOA briefing | -1.1 (.03) | -8.2 | -7.6 (<.01) | -30 | -5.1 (.14) | -5.8 |
| Violators fined | -2.2 (.01) | -14 | -6.0 (<.01) | -33 | -22 (<.01) | -23 |
| Nearby fined | -1.0 (.02) | -9.3 | -4.5 (<.01) | -30 | -17 (<.01) | -23 |

(From Duke and Burgerhoff, 2011.)

Table 6. Change in water usage at base-case residences compared to changes at residences subject to enhanced interventions.

| Intervention | January 2008 – April 2008 | | April 2007 – April 2008 | | Apr-Oct 2007 – Apr-Oct 2008 | |
|-----------------|---|--|---|--|---|--|
| | Difference from base case sample, as % of usage (p-value) | | Difference from base case sample, as % of usage (p-value) | | Difference from base case sample, as % of usage (p-value) | |
| HOA briefing | -11 (<.01) | | -1.5 (.68) | | -2.4 (.44) | |
| Violators fined | -2.8 (.60) | | -1.4 (.79) | | 4.5 (.31) | |
| Nearby fined | -12 (.02) | | -7.2 (.16) | | 7.1 (.09) | |

(Adapted from Burgerhoff, 2010.)

Continued from page 20

from the sample. The samples are sufficiently large to accommodate the omissions, and there is no reason to believe that households with actual low use (not a result of metering errors) will behave differently from others, so long as they are responsible for their own lawn irrigation and their lawns are typically about the same size. These exclusions explain why the three before-after periods have different numbers of residences in their samples.

Sampling Scheme: Selected Times for “Before” and “After” Conditions

Identifying changes in usage by this research methodology depends crucially on the choice of the time periods compared. For this

research, three before-after periods were selected. All three span the Phase III period of January through April 2008; two of the three focus on the crucial month of April 2008, after the enhanced interventions had been applied and during the high-rainfall month when lawn irrigation can be expected to decline.

Before-After Period 1 compares the final month before Phase III restrictions, January 2008, with the first month in which Phase III was no longer in effect—the high-rainfall month of April 2008. This comparison might be expected to capture the most immediate effect of any Phase III gains in water reduction, but it introduces the problem of seasonality: in addition to the substantial change in rainfall in South Florida, population measurably declines

after the end of tourist season – about March each year. With that annual season change, residential water usage can be expected to decline.

The second before-after period attempts to compensate for seasonal fluctuation by comparing April 2007 (a time when no drought restrictions were in effect) to April 2008. The third period is a six-month total, comparing the period from April to October 2007 (when Phase II restrictions were in place) with the period from April to October 2008 (also subject to Phase II restrictions, but after the interventions of the Phase III restrictions had been implemented and rescinded). This final comparison serves to even out any variability in residency, short-term precipitation responses, and other factors that could influence usage at a single-family residence. It is intended to capture any lasting gains that the Phase III interventions might have made in reducing consumption.

Figure 2. Frequency distribution, change in individual residences’ usage before – after Phase III drought was declared in February 2008. “Base case” intervention, three Before-After periods.

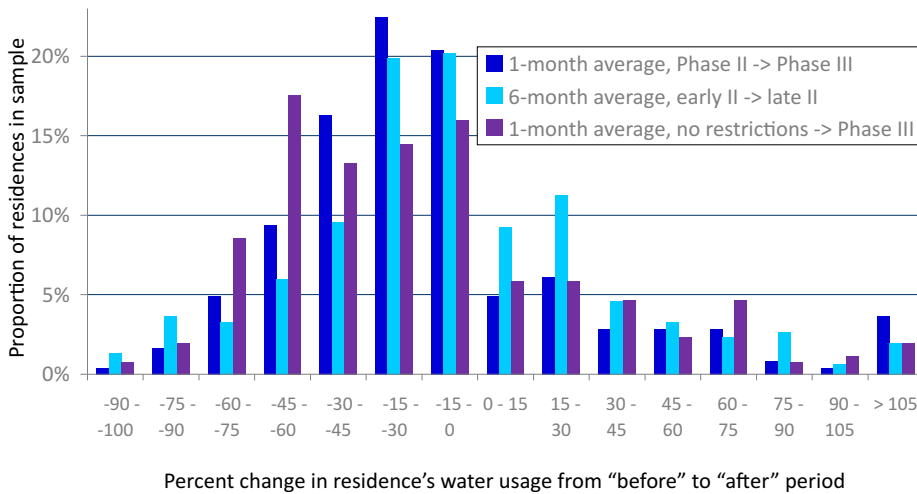
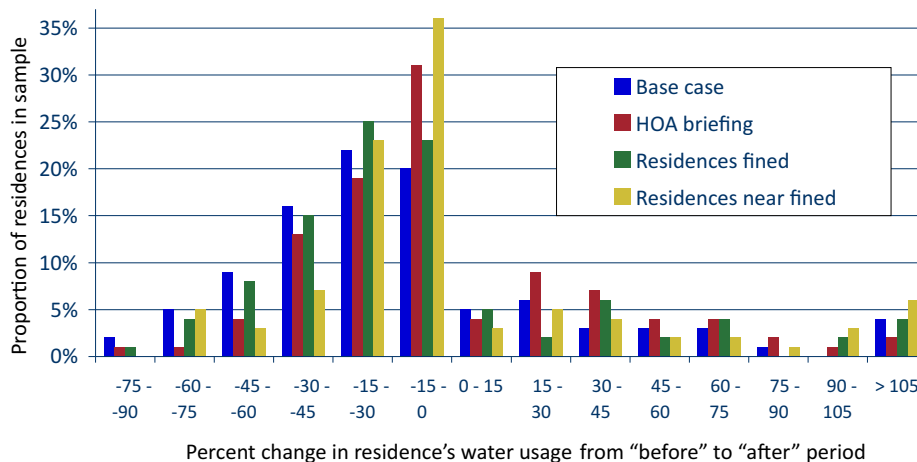


Figure 3. Frequency distribution, change in individual residences’ usage before – after Phase III drought was declared in February 2008. Four interventions, all January – April 2008 (Phase II -> Phase III).



Results: Aggregate Data Analysis

Response to the changing weather conditions was immediate and substantial. Table 5 summarizes a paired-differences t-test in which we compute the usage change for each residence as usage in the “after” month minus usage in “before” and test for significance of the change. The April consumption declined substantially in all samples, by about 24 percent in the base case sample of suburban residences when compared both to January 2008 and to April 2007. That calculation also demonstrates little difference between April 2007 and January 2008, i.e., almost no change in consumption from the month prior to drought declaration in April 2007 to a time when Phase II had been in place for about nine months.

Table 5 suggests that the households receiving enhanced interventions behaved differently than the base case residences, but comparison of the changes in the three enhanced-intervention samples to the base case changes shows little statistically significant difference among the four, as summarized in Table 6.

As a percentage, the difference between the enhanced intervention and the base-case was very small. The base case reduced consumption by 23 percent, and households near fined by 30 percent, so the difference was 7 percent of total usage—not trivial, but with enough variation in the sample that in most cases the difference in sample means was not significant (in this case with 91 percent confidence).

Results: Frequency Distribution Analysis

The differences in changing water use depending on the time frames compared clearly are evident in Figure 2. This figure shows the frequency distribution of water usage change among residences of the sample subject to base case drought restrictions, i.e., the proportion

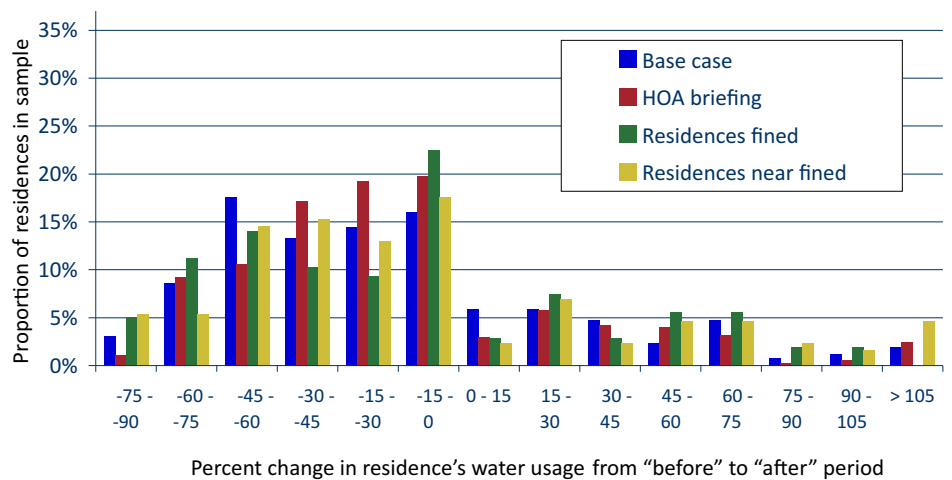
of households that changed water usage by various proportions in their monthly utility bills.

Figure 2 shows that most residences reduced usage during the high-rainfall month of April 2008, which was expected. It confirms that lawn irrigation is a substantial proportion of water usage among single-family households in South Florida by demonstrating convincingly that “reducers” were a much higher proportion than “increasers” for the two before-after periods, using April 2008 as the “after” month. In these data it is not possible to separate the influence of the Phase III restrictions, including the enhanced interventions, from the influence of the much greater precipitation that occurred in April 2008, but data further described below suggest that precipitation change is the predominating factor.

The six-month usage before-after period, plotted on these same axes for the base case sample in Figure 2, does not show this same pattern. Instead, it resembles a normal distribution centered on zero, in that “increasers” were roughly equal to “reducers,” and the proportions by which usage declined in the water-reducing residences are very nearly symmetrical with the proportions by which usage increased in water-increasing residences. This point is discussed further with reference to Figure 5.

The different signatures of differing com-

Figure 4. Frequency distribution, change in individual residences’ usage before – after Phase III drought was declared in February 2008. Four interventions, April 2007 – April 2008 (no drought -> Phase III).



parison dates are demonstrated even more clearly when Figures 3, 4, and 5 are compared. These figures each show frequency distribution for one of the three before-after periods, each with the four different intervention samples shown on the same axis.

One striking observation is a remarkable similarity among the four samples within each

of the three before-after periods. This suggests little or no direct effect on consumption by the enhanced interventions, since there is little discernible difference between residences experiencing the base case restrictions and those residences directly subject to the enhanced interventions.

Continued on page 24

In both Figure 3 and Figure 4, a notable minority of residences show increases in usage even during the high restrictions, even though the “after” period in both cases is the high-rainfall month of April 2008. For example, Figure 3 shows that in the base-case sample—households subject to restrictions, surcharges, and the sustained public relations efforts of the SFWMD and the CCWD—about 24 percent of all customers increased their water use by 15 percent or more in April compared to January of that same year, and about 12 percent increased by more than 30 percent.

As seen in Figure 4, slightly more (about 27 percent) of those same customers increased usage when compared to April of the previous year, a low-rainfall month when drought had not been declared and none of the surcharges, lawn-watering restrictions, or public information campaigns were in place. Similar or greater proportions of the other samples increased usage when compared to either of the “before” periods.

Figure 5 shows that when the two six-month periods are compared, about as many users increased their usage as decreased. This is not unexpected given that Phase II drought restrictions were in place during both periods; the nearly normal distribution may simply imply that users had already reduced their consumption and any changes were influenced by other factors than drought restrictions (residency patterns, etc).

The comparison does demonstrate, however, that if there were any gains from the Phase III restrictions and the enhanced interventions designed to increase awareness among residents, those changes did not endure for any period beyond the actual Phase III because a remarkably similar pattern appears among all four samples: the base case sample

that serves as a control in this comparison and the three samples designed to capture any changes from the enhanced interventions. In this case, we would argue that neither the direct nor indirect influence of the enhanced interventions produced any lasting changes in usage by customers of this utility.

Discussion

The enhanced interventions of enforcement and outreach did not lead conclusively to quantifiable usage reduction among residential water users who were subject to them, but likely were valuable components of the region-wide publicity campaign. As documented in Burgerhoff (2010), news stories about the drought, accompanied by exhortations for residents to reduce usage, appeared in much larger numbers on local broadcasts and print media when the stories included news about residents being subject to fines.

That public information campaign may have been substantially more effective for all residents of Collier County because of the fact that a few residents were fined—regardless of whether the fined residents changed their own behavior in response. That indirect contribution to the entire region’s reduction in residential usage may outweigh any direct impact on specific households that were subject to the outreach and enforcement efforts. This research was not able to quantify any such indirect effect.

The approach of this research, based on data from utility bills, proved to be effective in documenting actual usage by a large-enough sample to identify usage changes. By careful sample selection, it should be able to distinguish the effects of a variety of potential drought reduction programs and offer some evidence as to which of those programs had the desired ef-

fect, and to what degree. It is by nature subject to important limitations: sample selection might not be sufficient to separate the effects of various actions on the typical residential water user, and it does not provide information on how residents make their decisions or which actions most strongly influenced those decisions. This form of analysis, however, is capable of valuable post-implementation observations that can be used to guide improvements in future drought-response programs by utilities purveying water to the residential sector.

This research focused on a portion of Collier County where the HOA as an institution is a powerful factor in residents’ activities. An HOA is in some ways a barrier standing between the water utility and the homeowner as decision maker in one important category of water usage: landscape irrigation. Factors designed to influence homeowners in their water usage (pricing, public information campaigns, information about lawn response, and recovery during low rainfall) may not have the same effect on HOA leadership when balanced against other factors, such as a desire to keep homeowners satisfied with the condition of their grounds—especially when some units are for sale, where appearances can be critically important.

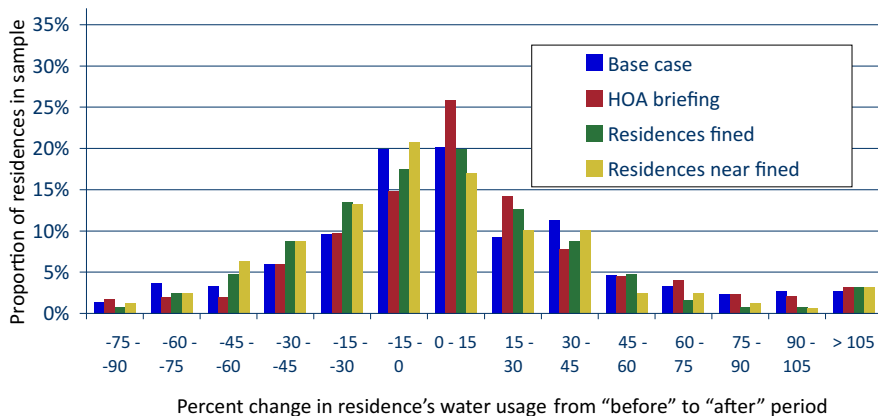
HOA decision makers are an important resource for utilities that are seeking to reduce consumption. In any utility service area, HOAs are far fewer in number than residents, and thus are easier to reach with outreach or enforcement. Public meetings to which many HOA directors are invited, and where attendance can be verified by the utility, can reach decision makers for far more irrigated acres than meetings to which homeowners are invited but not obliged to attend.

HOAs as corporations likely are better attuned to legal requirements such as irrigation restrictions, and are protective of their public images so would seek to avoid publicly-reported fines for violating restrictions. Finally, HOAs can be deputized as the entity verifying that individual homeowners comply with watering restrictions, avoiding the need for water utilities to field enforcement personnel.

Conclusions

In the target region of Collier County characterized by suburban, single-family, HOA-regulated residential developments, water usage by residential customers declined measurably during a high-rainfall month after a year of drought restrictions. This strongly suggests that outdoor irrigation is as substantial a portion of usage at residences of this nature as it is among residential users in other parts of Florida. It also demonstrates that outdoor irrigation continues to make up a substantial proportion of usage, even during a declared drought period when

Figure 5. Frequency distribution, change in individual residences’ usage before – after Phase III drought was declared in February 2008. Four interventions, April-October 2007 – April-October 2008 (Phase II before Phase III -> Phase II after end of Phase



residential customers have been subject to a year or more of publicized restrictions, surcharges, and public service announcements. This was true even after a few months of enhanced interventions, including targeted informational outreach, enforcement fines, and related intensified news coverage.

Results were inconclusive about any possible effect of the two enhanced interventions. No statistically significant difference was detected in usage reduction between residences subject to base case drought restrictions and residences subject to the enhanced enforcement or outreach activities. Neither homes directly subject to fines nor homes in housing developments that received agency presentations measurably reduced water usage under Phase II or during the high-rainfall month that ended Phase III, compared to homes in the same part of Collier County that were not fined and did not receive outreach presentations.

Results are conclusive that, during a month when high precipitation led many households to reduce water usage, a substantial proportion of households increased their usage—some by a substantial amount. Roughly one-fourth of the residences in all four of the samples increased residential usage during the wet month of April 2008, compared both to the pre-drought month of April 2007 and the Phase II restriction month of January 2007. That was true of households subject only to the broad-based restrictions, public information, and rate surcharges, and also of households subject to those actions as well as to either of the two enhanced interventions implemented by CCWD.

Comparison of two six-month periods of usage, one at the beginning of the declared drought and one a year later after Phase III re-

strictions had come and gone, showed very nearly equal proportions of residences increasing usage as opposed to decreasing usage. That also was true of residences subject to base-case restrictions as well as those subject to enhanced interventions. Taken together, these findings suggest that drought-reduction efforts did not penetrate the residential sector fully and that greater usage reduction could be attained if more intensive publicity or other interventions are applied during future droughts.

Acknowledgments

Data acquisition and analyses were conducted in part by Mr. Burgerhoff during an internship with the South Florida Water Management District's Big Cypress Basin Service Center. The authors are grateful to Collier County's Water Department, Utility Billing and Customer Service Department, and Property Appraiser's Office for assistance in acquiring data. Some of this material appeared in Duke and Burgerhoff (2011), including some text describing drought restrictions implemented by CCWD and some tables of summary statistics. Geoffrey Rosenaw, Department of Marine and Environmental Sciences at Florida Gulf Coast University, conducted additional policy analysis, data acquisition, and data review for this article. The authors are grateful for detailed comment by Professor Win Everham and Professor Joseph Cudjoe, who contributed to Mr. Burgerhoff's master's thesis research, and from the Watershed Council of Southwest Florida during a presentation of this material.

References

- Burgerhoff, G. C. (2010). "Influence of Agency Interventions to Reduce Residential Water Use in Drought

- Conditions, Collier County Florida 2008." A thesis for the degree of Master of Science, Department of Marine and Ecological Sciences, Florida Gulf Coast University.
- Duke, L.D. and Burgerhoff, G.C. (2011). "Residential Water Use Reduction during Drought: Relative Effects of Various Water Agency Interventions, Collier County Florida, 2008." Proceedings of the 2011 World Environmental and Water Resources Congress [American Society of Civil Engineers], Palm Springs CA, May 22-26 2011. R.E. Beighley and M.W. Kilgore, editors.
- Morales, M.A. and Heaney, J.P. (2010). "Predominant Commercial Sectors in Florida & their Water Use Patterns." Florida Water Resources Journal, August 2010, 29-34.
- Southeast Regional Climate Center (2011). Naples, Florida (086078). Period of Record Monthly Climate Summary. <http://www.sercc.com/cgi-bin/sercc/CLIMATE.pl?fl6078> Accessed June 2011.
- South Florida Water Management District (2007a). "Water Shortage Plan. Chapter 40-E21, Florida Administrative Code." <https://my.sfwmd.gov/pls/portal/url/item/0c3aa2cf3ad8b361e040e88d82525ec2>
- South Florida Water Management District (2007b). "Water Shortage Order No. 2007-870-DAO-WS: Declaration of Modified Phase III Extreme Water Shortage Restrictions." https://my.sfwmd.gov/pls/portal/docs/page/common/pdf/splash/order2007_870_mod_phase3.pdf Accessed October 2010.
- South Florida Water Management District (2009a). "Water utilities water demand reduction during the 2007-2009 water shortage restrictions." http://www.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/water_demand_reduction_report_final.pdf Accessed October 2010.
- South Florida Water Management District. (2009b). "Water Shortage Order No. 2008-166-DAO-WS: Order Rescinding Restrictions and Imposing Modified Phase II Severe Water Shortage Restrictions Within Specified Areas of the District – Effective April 18, 2008 – 4/11/08." https://my.sfwmd.gov/pls/portal/docs/page/common/pdf/splash/order_no_2008_166_dao_ws.pdf Accessed October 2010.
- U.S. Census Bureau. (2010). "State and County Quickfacts." <http://quickfacts.census.gov/qfd/states/12000.html>, accessed June 2011.
- U.S. Census Bureau. (1995). "Florida Population of Counties by Decennial Census 1900 – 1990." <http://www.census.gov/population/cencounts/fl190090.txt>