Evaluation of Sensor Based Residential Irrigation Water Application on Homes in Florida

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***Abstract:** An irrigation study to determine the effects of sensor based irrigation on residential in-ground irrigation water application in Southwest Florida will be presented. Experimental treatments evaluated were (1) automatic time based irrigation set and operated by the cooperator, (2) an automatic timer with the integration of a soil moisture sensor, (3) an automatic timer with a rain sensor, and (4) an automatic timer with a rain sensor along with educational materials including a run time schedule given to the cooperator. Outdoor water use, semi-annual turf quality ratings, and weather data was collected for the 58 homes over a two year period. In addition to elapsed weekly irrigation water use, hourly use was recorded and fraction of total household use (indoor vs. outdoor) was calculated. Results presented include irrigation water application cumulative and event reduction based on experimental treatment. Irrigation practices relative to plant-water needs as determined through a soil water balance, and watering day compliance observations.*

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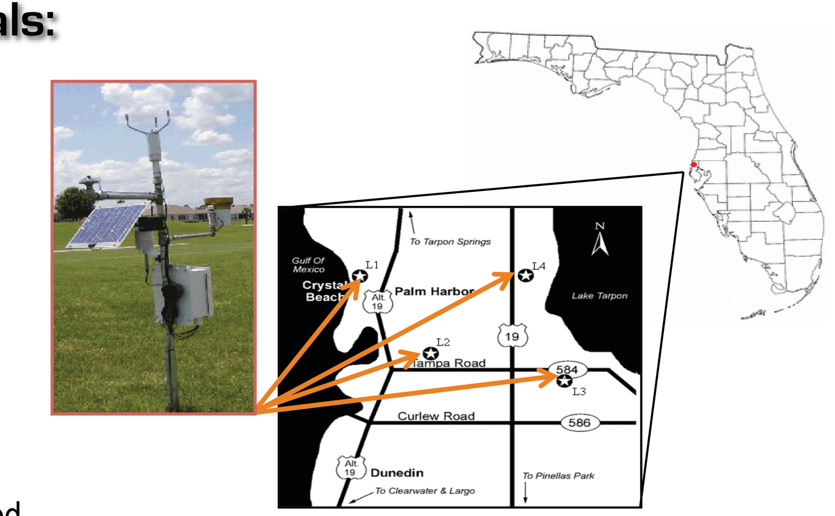
(1) Introduction:

The Florida climate consists of dry and warm weather in spring and fall, coupled with frequent rain events in summer months (NOAA 2003). With these environmental conditions occurring in areas of mostly sandy soil, which has a low water holding capacity, irrigation is often used to supplement rainfall to maintain high quality landscapes. Therefore, automatic in-ground irrigation is common in Florida. Of all new home construction within the United States, more than 15% occurred in Florida from 2005-2006 (USCB 2007). Further, the majority of new homes are sold with automatic in-ground irrigation systems already in place (TBW 2005; Whitcomb 2005). Homes with automatic irrigation systems have been reported to have higher water use compared to manual irrigation or hose-end sprinklers (Mayer et al. 1999).

(2) Methods & Materials:

Data Collection & Analysis

- Irrigation water use
  - Cumulative
  - Frequency
- Seasonal turf quality
- System evaluations
- Weather data
- Turf quality rating
- Comparison to theoretical need



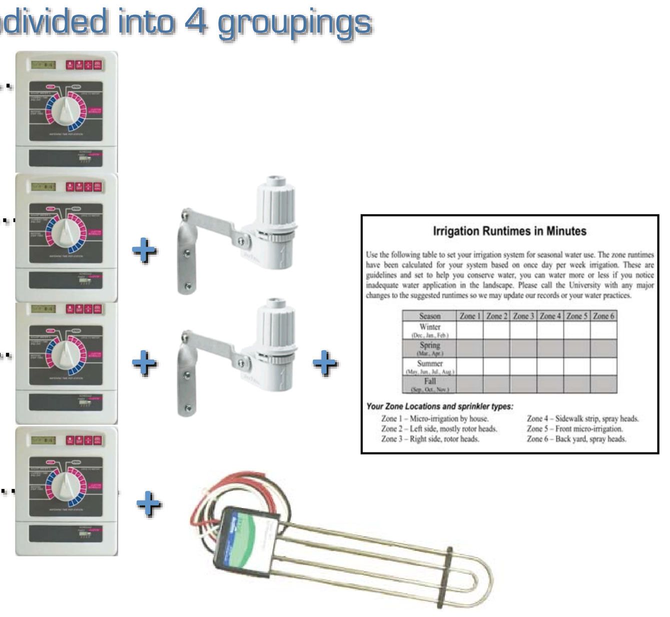
All homes have the following

Automatic in-ground irrigation | Water and irrigation meters | Automatic meter recording device | Turf Quality ratings based on NTEP procedures (1-9 scale)

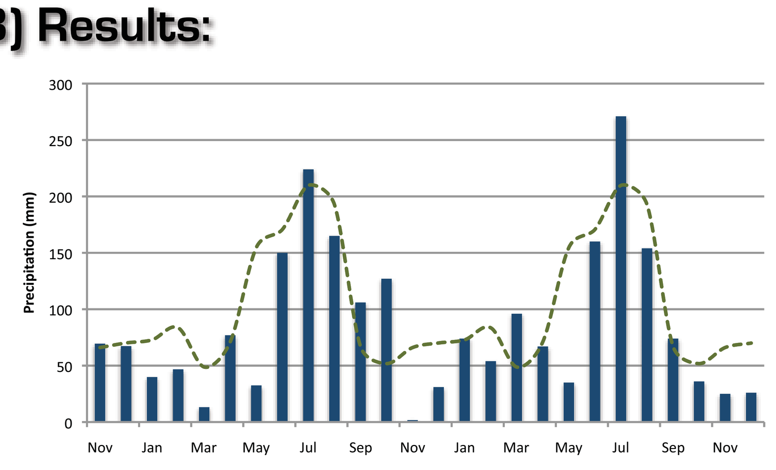
Experimental Treatments

Homes are subdivided into 4 groupings

1. Monitoring only……………………………
2. Current irrigation system plus rain sensor (¼" setting)……………………
3. Current irrigation system plus rain sensor and educational materials……………
4. Current irrigation system plus a soil moisture sensor system……………………



(3) Results:



During this period the rainfall was 17% less (41 in) than historical (50 in). Using a soil water balance, the calculated gross irrigation requirement averaged 2 inches per month and 4 irrigation events per month.

Mean monthly irrigation application by treatment for all homes during the data collection period Jan 2007-Dec 2008.

Treatment[Z]	I_{actual}[Y] (inch/month)	N[X] (#)	Range (inch/month)	Std Dev (inch/month)	CV (%)
2007					
SMS	1.0b[W]	92	0-12.2	1.8	165
RS	2.6a	123	0-37.4	4.7	149
MO	3.0a	122	0-30.5	3.8	158
EDU	1.1b	101	0-6.5	1.8	103
2008					
Treatment	I_{actual} (inch/month)	N (#)	Range (inch/month)	Std (inch/month)	CV (%)
SMS	0.7b	151	0-12.5	2.4	189
RS	1.7a	137	0-7.8	1.7	101
MO	2.1a	126	0-9.5	2.3	109
EDU	1.9a	149	0-14.6	2.4	130

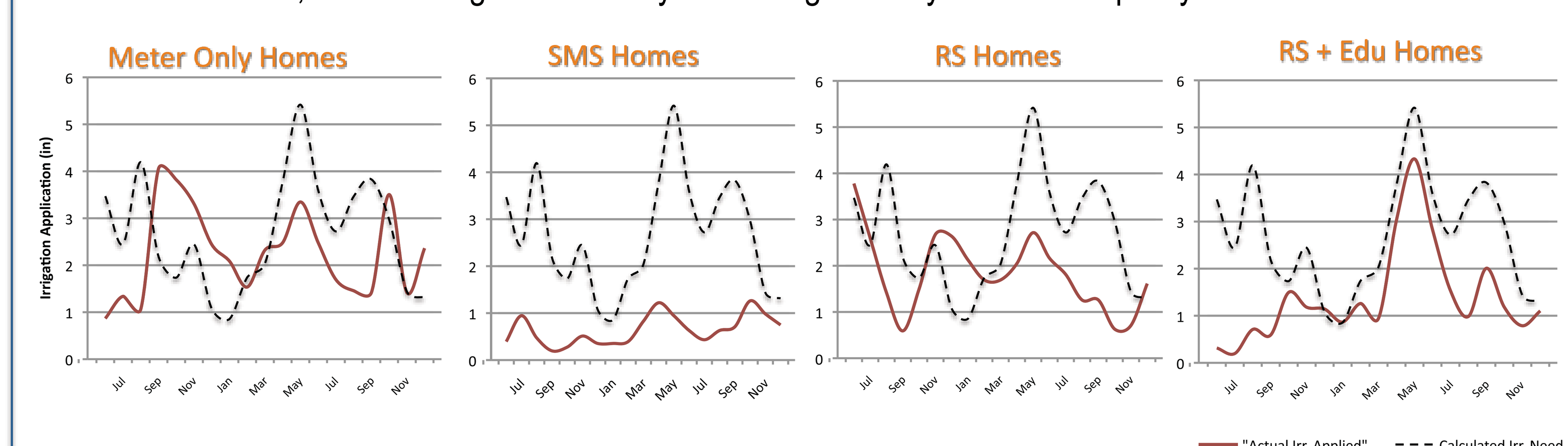
Note: Uppercase superscript letters indicate footnotes.
[Z] Treatments are: SMS, time-based controller plus soil moisture sensor system; RS, time-based controller plus rain sensor; MO, time-based controller only; EDU, time-based controller plus rain sensor and educational materials.
[Y] Monthly average irrigation applied.
[X] N = number of observations in the comparison.
[W] Numbers followed by different letters are statistically different at the 95% confidence level within a year.

Number of irrigation events per month, for the AMR irrigation meter data from study homes during the collection period June 2007–Dec 2008.

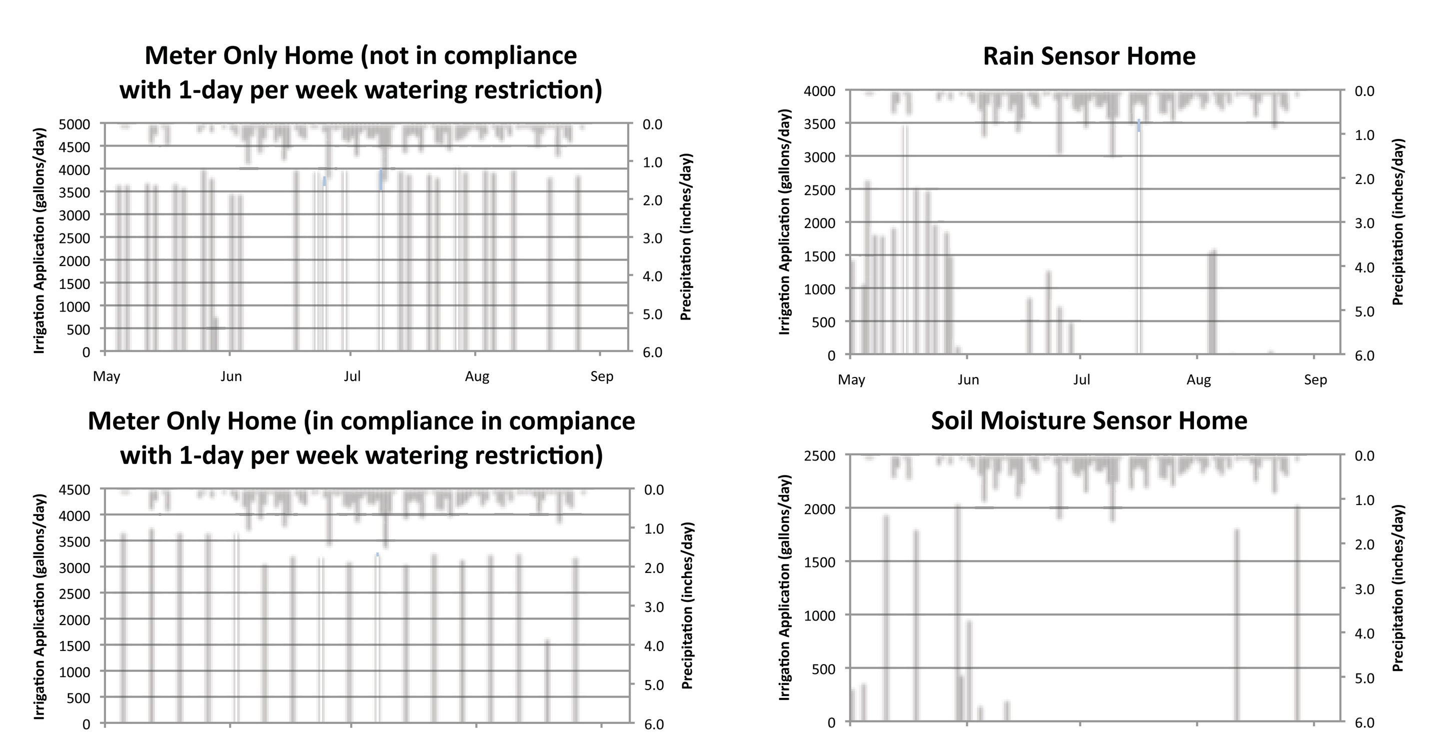
			Number of Irrigation Events					
			I_{actual}[Z] (#/month)	N[Y] (#)	Range (#/month)	Std Dev (#/month)	CV (%)	I_{calc}[X] (#/month)
Treatment[W]		SMS	2.1c[V]	185	0-11	2.8	136	4
		RS	4.7a	195	0-22	5.6	114	
		MO	5.2a	173	0-29	6.5	125	
		EDU	3.6b	187	0-20	4.1	113	
Season[U] by Year	2007	Spring	—	—	—	—	—	—
		Summer	2.1	32	0-21	4.3	210	5
		Fall	4.5	81	0-29	6.7	153	4
		Winter	4.1	46	0-21	4.9	137	2
	2008	Spring	5.6a	144	0-29	5.6	109	7
		Summer	4.1b	138	0-26	5.0	135	3
		Fall	2.8c	117	0-20	3.6	143	5
		Winter	3.5bc	138	0-29	4.7	151	2

Note: Uppercase superscript letters indicate footnotes.
[Z] Monthly average number of actual irrigation events applied.
[Y] N = number of observations in the comparison.
[X] Number of irrigation events per month, calculated from the soil water balance.
[W] Treatments are: SMS, time-based controller plus soil moisture sensor system; RS, time-based controller plus rain sensor; MO, time-based controller only; EDU, time-based controller plus rain sensor and educational materials.
[V] Numbers followed by different letters are statistically different at the 95% confidence level within a year.
[U] Seasons defined as: spring, March, April, May; summer, June, July, August; fall, September, October, November; winter, December, January, February.

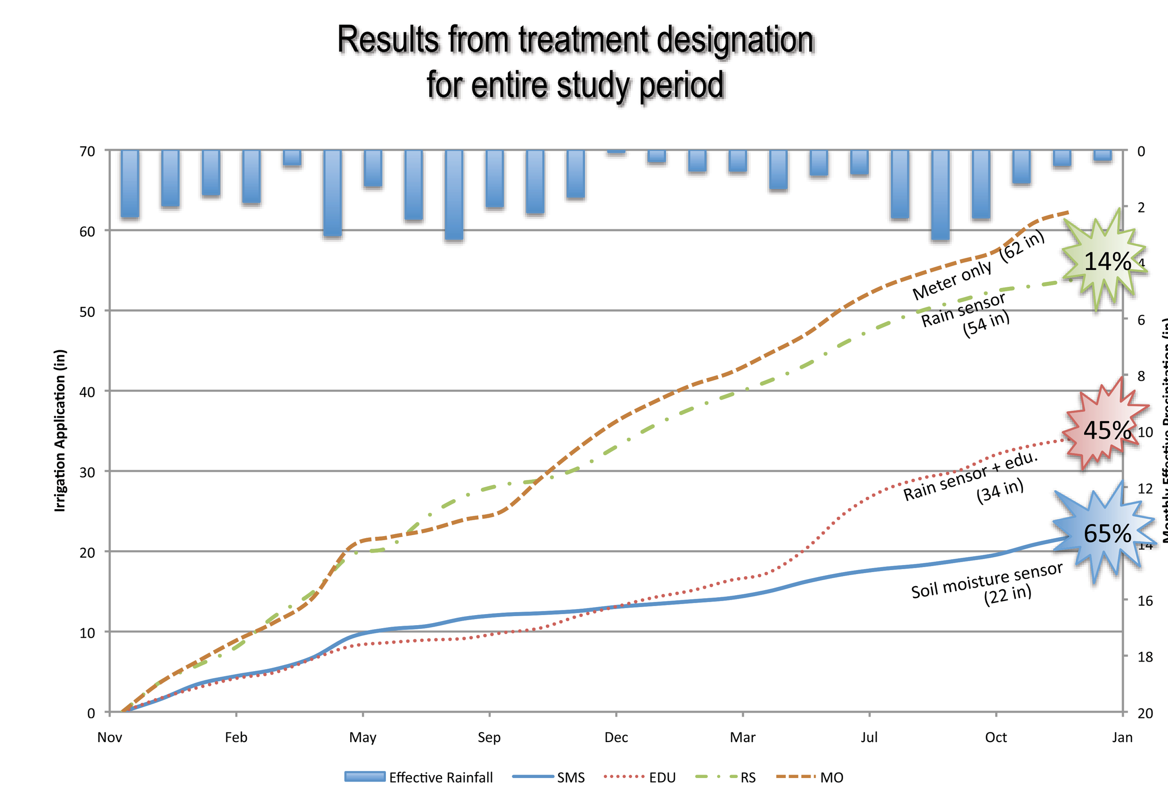
When comparing the actual irrigation application with the calculated gross irrigation need, the actual water application from the educational materials plus rain sensor treatment most closely parallels the calculated irrigation requirements. Although all of treatments resulting in some under-irrigation during spring 2008, the meter only treatment resulted in the greatest over-irrigation, particularly from September 2007 through January 2008 . Although the soil moisture sensor treatment consistently under irrigated as compared to the soil water balance, water savings in this study did not significantly reduce turf quality.

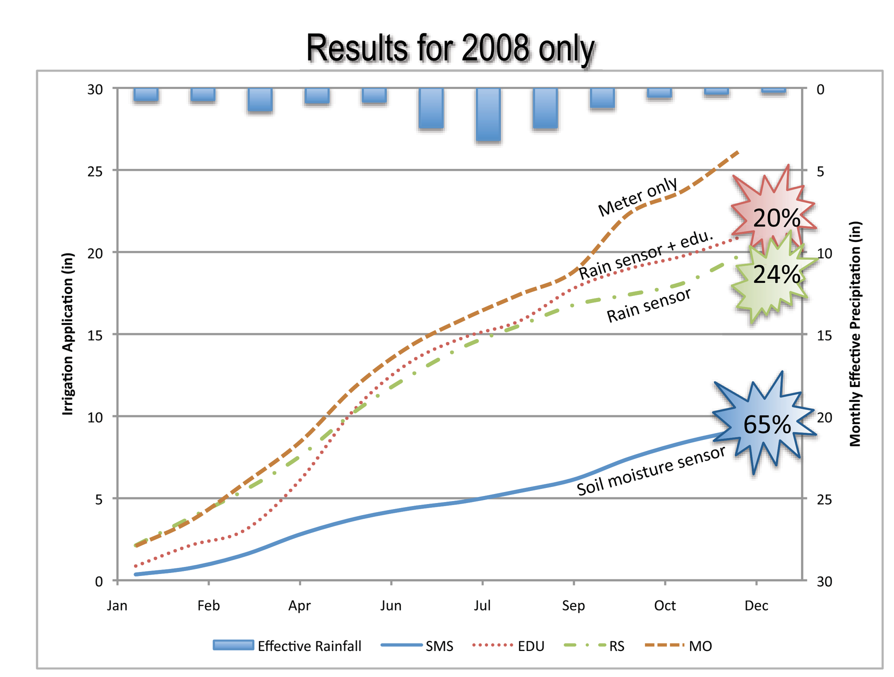


In addition to volume of water use, irrigation frequency was determined from automatic meter reading (AMR) device data. The SMS treatment resulted in the lowest number of irrigation events, which were half to a third less than the other study homes. This result indicated that the SMS irrigation controllers resulted in bypassed irrigation events. The MO, RS, and EDU homes each had at least one home that had 20 or more irrigation events a month over the study time frame. The SMS systems appeared to have limited the number of irrigation events, where the maximum number of monthly events was 11 versus the 29 events of the MO treatment. Thus, the SMS systems limited unnecessary irrigation regardless of homeowner controller programming.



The total cumulative savings were calculated compared to the meter only treatment. The SMS treatment yielded the greatest savings; with 65% less water applied (22 in) for irrigation than the MO treatment (62 in). Although the EDU treatment initially showed substantial savings, over the 26 month study period, the total irrigation savings was 45% with 34 inches applied. Lastly, the RS treatment yielded a 14% savings over the MO treatment with 54 inches applied.





(4) Conclusions:

- The soil moisture sensor group
  - has statistically the lowest cumulative and mean irrigation application
  - and least number of weekly irrigation events
- The rain sensor groups
  - resulted in moderate saving compared to the meter only group
  - however the method and timing of educational material distribution is critical
- By inspection of the frequency of the irrigation events for each treatment (from AMR data)
  - the soil moisture sensor effectively bypasses irrigation events
    - this is the only treatment in which the range of monthly irrigation events is successfully governed

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