Long-term Performance of Smart Irrigation Controllers
Irrigation Association Show
Nov., 6-10
Orlando, FL

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Central Florida Water Initiative
Soil Moisture Sensor Controller
Evapotranspiration (ET) Controllers

- Some can determine runtimes and days
- Programming is key!
  - Soil type
  - Plant type
  - Microclimate
  - Application rates
  - Slope
Selection of Cooperators

~130,000 Single Family Customers
Estimated Irrigation

- Census per capita estimate, people/home
- Monthly potable billing data, gal/month
- Per capita indoor use, 69 gcpd

Estimated monthly irrigation
Gross Irrigation Requirements

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth (inches)</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>22</td>
</tr>
</tbody>
</table>

Turfgrass Annual Gross Irrig. Req.
N FL, 33 inches/yr
S FL, 43 inches/yr
Irrigation Requirements

- Daily weather data
- Soil type
- Landscape plant composition

Daily gross irrigation requirement (GIR)
Orange County Evaluation Selection of Excess Irrigators

Number of customers

Estimated irrigation (mm month$^{-1}$)

- Theoretical limit = 3 in month$^{-1}$
- 1.5 times theoretical limit = 4.6 in month$^{-1}$
- 4 times theoretical limit = 12 in month$^{-1}$

Area where 'potential cooperators' were identified

7,407 possible participants
Selection of Cooperators

~130,000 Single Family Customers

7,407 Possible Participants
Cooperator Questionnaire

- Determined homeowner’s study interest & Irrigation knowledge
- Irrigation controller or automated irrigation system needed.
- Not a renter
- Intended on living at residence for two or more years
Selection of Cooperators

~130,000 Single Family Customers

7,407 Possible Participants

843 Questionnaire Respondents
Selection of Cooperators

~130,000 Single Family Customers

7,407 Possible Participants

843 Questionnaire Respondents

353 On site Evaluations
# Irrigation System Evaluation

**IRRIGATION SYSTEM EVALUATION**

- **Address:**
- **Timer location:** Garage □, Outside wall □, Other:
- **Original schedule:**
  - A) Start time(s):
  - A) Run time/zone (min): Mon, Tue, Wed, Thu, Fri, Sat, Sun
  - B) Start time(s):
  - B) Run time/zone (min): Mon, Tue, Wed, Thu, Fri, Sat, Sun
- **Rain sensor:** Location: Roofline, Not connected □, Obstructed □, Misplaced □, Absent □

### Irrigation Zones (stations)

<table>
<thead>
<tr>
<th>Zone location from the house</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Front</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Left</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>c. Center</td>
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<td>d. Right</td>
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<tr>
<td>e. Back</td>
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### Sun reaching the zone

<table>
<thead>
<tr>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<tbody>
<tr>
<td>a. Full sun</td>
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<td></td>
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<td></td>
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<tr>
<td>b. Mostly sunny</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Mostly shady</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>d. Full shade</td>
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### Plant type

<table>
<thead>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Turf</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>b. Ornamentals</td>
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<tr>
<td>c. Mixed (%) Turf</td>
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<tr>
<td>Orn.</td>
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</tbody>
</table>

### Turf Quality (1=Dead, 9=Top Qual.)

<table>
<thead>
<tr>
<th>Num. of</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<tbody>
<tr>
<td>a. Sprinklers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>b. Rotors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Microirrigation</td>
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</tr>
</tbody>
</table>

### Irrigated Area

- Calculated (Aerial photo) _________ ft²
- Corrected (In situ) _________ ft²

### Flow Test

- Run time per zone _________ minutes
- Meter reading before _________ Meter reading after _________

### Comments:

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**FOR UF USE ONLY**

Evaluator: 

Y □ M □ N □
Selection of Cooperators

~130,000 Single Family Customers

7,407 Possible Participants

843 Questionnaire Respondents

353 On site Evaluations

167 Selected Households
Summary of Participants

Sources:
- County Boundary: Orange County GIS Program (2007), Scale Unknown
- Roadways: FDOT Transportation Statistics Office (2011), 1:24,000

Legend:
- ★ Cooperator
- ✯ Rain Gauge
- 👾 Weather Station
Two Smart Controllers Evaluated

- Rain Bird ESP-SMT
  • ET treatment

- Baseline WaterTec S100
  • SMS treatment
Contractor Groups

• **ET**
  – Contractor programmed with default landscape settings
  – Daily water windows
  – Rare interaction with homeowner

• **SMS**
  – Buried at 6 inches in minimally compacted soil
  – Re-programmed time clock schedules for daily irrigation:
    • 20 minutes spray
    • 45 minutes rotor
  – Rare interaction with the homeowner
“EDU” Groups

• Educational Training
  – ET+Edu treatment
    • Reprogrammed for site specifics
    • 5 minute tutorial
  – SMS+Edu treatment
    • Inserted into soil column at 3 inch depth
    • Reprogrammed for 0.25” per event, 2 events per day, 3 d/wk
    • 5 minute tutorial
Automatic Meter Recording devices (AMRs)

- Separated flow meter to measure irrigation only
- Records hourly irrigation volumes
- Monthly downloads
### OCU Technologies & Expt. Design

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ET</th>
<th>ET+Edu</th>
<th>SMS</th>
<th>SMS+Edu</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain Bird ESP-SMT</td>
<td>Rain Bird ESP-SMT</td>
<td>Baseline WaterTec S100</td>
<td>Baseline WaterTec S100</td>
<td>--</td>
<td></td>
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</table>

#### Technology

<table>
<thead>
<tr>
<th>Locations Installed</th>
<th>7</th>
<th>9</th>
<th>7</th>
<th>9</th>
<th>9</th>
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<tbody>
<tr>
<td>Number Installed</td>
<td>28</td>
<td>38</td>
<td>28</td>
<td>38</td>
<td>35</td>
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</table>
Phase I

Irrigation Nov 2011-Nov 2014

<table>
<thead>
<tr>
<th>Comparison</th>
<th>ET</th>
<th>ET-EDU</th>
<th>SMS</th>
<th>SMS-EDU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flatwoods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average Weekly Irrigation (in)

-12%/-16%  -38%/-26%  -38%/-21%  -42%/-45%

- Comparison A: 1.21
- ET B: 1.06
- ET-EDU C: 0.75
- SMS BC: 0.72
- SMS-EDU D: 0.50

Legend:
- A: 0.91
- B: 0.76
- C: 0.67
- BC: 0.72
- D: 0.50
Phase II

Irrigation Nov 2014-Oct 2015

Average Weekly Irrigation (in)

Comparison: 0.96
ET: 0.83
ET-EDU: 0.74
SMS: 0.79
SMS-EDU: 0.72

-14%  -23%  -18%  -25%
Phase I & II

Irrigation Nov 2011-Oct 2015

Comparison ET ET-EDU SMS SMS-EDU

<table>
<thead>
<tr>
<th></th>
<th>Average Weekly Irrigation (in)</th>
<th>-19%</th>
<th>-31%</th>
<th>-28%</th>
<th>-40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison</td>
<td>1.01 a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ET</td>
<td>0.83 b</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ET-EDU</td>
<td>0.71 c</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMS</td>
<td>0.74 c</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SMS-EDU</td>
<td>0.62 d</td>
<td></td>
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</tbody>
</table>

Note: The letters (a, b, c, d) indicate statistical significance.
Irrigation/Week Nov 2011-Feb 2016

Sand Locations | Flatwoods Locations

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Comparison</th>
<th>ET</th>
<th>ET+OPT</th>
<th>SMS</th>
<th>SMS+OPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>28.12</td>
<td>27.40</td>
<td>20.20</td>
<td>17.50</td>
<td>20.80</td>
</tr>
<tr>
<td>A</td>
<td>20.80</td>
<td>15.54</td>
<td>14.44</td>
<td>16.17</td>
<td>11.53</td>
</tr>
<tr>
<td>A</td>
<td>20.80</td>
<td>15.54</td>
<td>14.44</td>
<td>16.17</td>
<td>11.53</td>
</tr>
<tr>
<td>A</td>
<td>20.80</td>
<td>15.54</td>
<td>14.44</td>
<td>16.17</td>
<td>11.53</td>
</tr>
<tr>
<td>A</td>
<td>20.80</td>
<td>15.54</td>
<td>14.44</td>
<td>16.17</td>
<td>11.53</td>
</tr>
</tbody>
</table>

Note: The comparison groups are labeled with lowercase letters (a, b, c, d) for statistical significance.
Irrigation/Event Nov 2011-Feb 2016

Average Irrigation Depth (mm/event)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sand Locations</th>
<th>Flatwoods Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison</td>
<td>18.09</td>
<td>15.67</td>
</tr>
<tr>
<td>ET</td>
<td>11.67</td>
<td>8.16</td>
</tr>
<tr>
<td>ET+OPT</td>
<td>11.33</td>
<td>9.13</td>
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<tr>
<td>SMS</td>
<td>13.52</td>
<td>15.27</td>
</tr>
<tr>
<td>SMS+OPT</td>
<td>13.80</td>
<td>12.73</td>
</tr>
</tbody>
</table>

Legend:
- **a**: Significant difference compared to Comparison
- **b**: Significant difference compared to ET+OPT
- **c**: Significant difference compared to ET
- **d**: Significant difference compared to SMS
Irrigation Events/Week Nov 2011-Feb 2016

Average Number of Irrigation Events (#/wk)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sand Locations</th>
<th>Flatwoods Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison</td>
<td>1.84 c</td>
<td>1.45</td>
</tr>
<tr>
<td>ET</td>
<td>3.32 a</td>
<td>2.05</td>
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<td>ET+OPT</td>
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<td>SMS</td>
<td>1.88 d</td>
<td>1.17</td>
</tr>
<tr>
<td>SMS+OPT</td>
<td>1.61 e</td>
<td>1.02</td>
</tr>
</tbody>
</table>

Comparison of irrigation events between Sand Locations and Flatwoods Locations under different treatments.
ET+OPT Results

Average Weekly Irrigation (mm/wk)

Date

Total Rainfall (mm)

Irrigation
Rainfall
NIR

Nov-11
Mar-12
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
Jul-15
Nov-15
SMS+OPT Results

Average Weekly Irrigation (mm/wk)

Date

In the chart, the graph shows the average weekly irrigation over the years from Nov-11 to Nov-15. The y-axis represents the average weekly irrigation in millimeters per week, ranging from 0 to 60. The x-axis represents the dates from Nov-11 to Nov-15.

The chart includes three different types of data:
- **Irrigation** indicated by green bars.
- **Rainfall** indicated by blue bars.
- **NIR** (Normalized Difference Irradiance Ratio) indicated by grey lines.

The data points show fluctuations in irrigation and rainfall over the years, with notable peaks and troughs. The chart illustrates the relationship between irrigation and rainfall, with periods of higher irrigation coinciding with lower rainfall and vice versa.
Turfgrass Quality
Turfgrass Quality

<table>
<thead>
<tr>
<th>Season</th>
<th>Comparison</th>
<th>ET</th>
<th>ET + Edu</th>
<th>SMS</th>
<th>SMS + Edu</th>
<th>Average of Season</th>
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</thead>
<tbody>
<tr>
<td>Fall 2011</td>
<td>6.7 c</td>
<td></td>
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<tr>
<td>Winter 2011-2012</td>
<td>6.2 d</td>
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<tr>
<td>Spring 2012</td>
<td>6.6 c</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Summer 2012</td>
<td>7.6 a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall 2012</td>
<td></td>
<td>7.1 b</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Winter 2012-2013</td>
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<td>6.8 c</td>
<td></td>
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<td>Spring 2013</td>
<td></td>
<td>7.1 b</td>
<td></td>
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<tr>
<td>Summer 2013</td>
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<td>7.0 b</td>
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<tr>
<td>Fall 2013</td>
<td></td>
<td>6.9 b</td>
<td></td>
<td></td>
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<tr>
<td>Winter 2013-2014</td>
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<td>7.0 b</td>
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<tr>
<td>Spring 2014</td>
<td></td>
<td>6.9 b</td>
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</table>
Smart Controllers – Bottom Line

• ET/SMS significantly reduce over-irrigation
• ET controllers must be targeted to sites with savings potential
• Proper installation enhances savings
• Longevity of savings?
Acknowledgements: Water Research Foundation, Orange County Utilities, St. Johns River Water Management District, Southwest Florida Water Management District, Stacia Davis, Eliza Breder, Michael Gutierrez