Smart Irrigation – Making Every Drop Count

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• Mission
  – To protect and conserve Florida's natural resources through research-based sustainable urban landscape practices.

• Vision
  – To be the leading source of science-based information on horticulture and the urban environment in Florida.
Why Worry About Water?

• 17.5% population growth 2000→2010
• Florida will be 3\textsuperscript{rd} most populous state by 2030
Water – How Much and Where?

• How much water is used in the home?
Water – How Much and Where?

• Total FL municipal consumption (2005):
  – 95 gal/person/d
    • 7,125 gal/mon (2.5 people/home)
    • 85,500 gal/yr
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  – Avg: 69 gal/person/d
    • 5,175 gal/mon (2.5 people/home)
    • 62,100 gal/yr
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    • 3,200 gal/mon
    • 38,400 gal/yr
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    • 3,200 gal/mon
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• How much water is used in FL landscapes?
Mean Water Use Distribution (gal/mon)

Tampa Water Dept.
121,728 gal/yr

Orange Co. Utilities
158,148 gal/yr

Indoor Irrigation

5,283 4,861

8,717 4,462

Indoor Irrigation
Irrigation Requirements Estimation

1” = 623 gal/1,000 sq ft

Turfgrass Annual Water Req.
N FL, 33 inches/yr
S FL, 43 inches/yr

=3,700 gal/1,000 sq ft

Irrig Water Req - Turf 8 inch RZ
Precip
ETc

1 inch = 623 gal/1,000 sq ft

Turfgrass Annual Water Requirement:
- N FL: 33 inches/yr
- S FL: 43 inches/yr

The chart illustrates the depth of irrigation water required by turfgrass, along with precipitation and evapotranspiration (ETc) for each month of the year. The data indicates that the annual water requirement for turfgrass in N FL is 33 inches per year, and in S FL, it is 43 inches per year.
Annual Irrig. Requirement

Volume over 4,000 sq ft

Gallons/year

North

Central

South

Typical

Low Req.

High Eff.
How Much Water Can Be Saved?

- **Toilets:** 2,484 gal/yr
- **Dishwasher:** 288 gal/yr
- **Washing Machine:** 5,220 gal/yr

*DeOreo et al. 2011. California Single-family Water Use Efficiency Study*
How Much Water Can Be Saved?

- *Toilets*: 2,484 gal/yr
- *Dishwasher*: 288 gal/yr
- *Washing Machine*: 5,220 gal/yr
- Irrigation Scheduling (25%): 18,837 gal/yr
  – 240% of all indoor

*DeOreo et al. 2011. California Single-family Water Use Efficiency Study*
Irrigation controllers that respond to conditions in the irrigated system to automatically adjust to plant needs.

Smart Water Application Technologies (SWAT)

Soil moisture controllers (SMS)

Evapotranspiration (ET) based controllers
Soil Moisture Sensor Controller
Bypass Control: How Does It Work?

Soil Moisture Sensor (SMS)

Timer

SMS Interface

Switch

Common

Hot

Valve

Water

Image credit: Melissa Baum Haley
Bypass Control: How Does It Work?

Soil Moisture Sensor (SMS)

Timer

Common

Hot

Valve

Water

SMS Interface

Soil Moisture Sensor (SMS)

Image credit: Melissa Baum Haley
ET Controllers

• Can determine runtimes and days
• Programming is key!
  – Soil type
  – Plant type
  – Microclimate
  – Application rates
  – Slope
ET Controllers Calculate Plant Water Use

- Runoff and drainage assumed negligible for irrigation calculation
- Irrig = ET - Rain
Irrigation Requirements Estimation

Turfgrass Annual Water Req.
N FL, 33 inches/yr
S FL, 43 inches/yr

1" = 623 gal/1,000 sq ft

=3,700 gal/1,000 sq ft

Depth (inches)

Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Irrig Water Req - Turf 8 inch RZ
Precip
ETc
Research Based Irrigation Savings Potential

<table>
<thead>
<tr>
<th>Method</th>
<th>Rainy</th>
<th>Dry</th>
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<td>No data</td>
</tr>
<tr>
<td>SMS, homes</td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>SMS homes recalim</td>
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<tr>
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<td>No data</td>
</tr>
<tr>
<td>ET Controller, homes</td>
<td>No data</td>
<td>No data</td>
</tr>
</tbody>
</table>
Current

- Smart Controllers just a fraction of total controller sales
- Utilities resistant to "count on" smart controllers
- Everyone hesitant to change….
OCU Smart Controller Demonstration Objectives

- Will smart controllers reduce irrigation on moderate to high use single family homes?
- What is effectiveness of ET vs. SMS controllers?
- Impact on landscape quality?
- Customers feelings about technology?
Smart Technologies

- ET Controller (ET)
  - Rain Bird ESP-SMT

- Soil Moisture Sensor (SMS)
  - Baseline WaterTec S100
Determine Potential Cooperators
Water Use Data

- Gather monthly water billing records for 7 years (2003-2009) from OCU for 8 locations in Orange County:
  - Apopka
  - Windermere
  - Ocoee
  - Gotha
  - Winter Garden
  - ORLANDO
  - Winter Park
  - Maitland
Irrigation Estimation

\[
\text{Estimated irrigation expressed as depth (mm or inches) per month} = \frac{\text{monthly metered water use} - \text{per capita indoor water use}}{\text{irrigable area}}
\]

- Per capita indoor use = 70 gal/person/d ~ 5,000 gal/month
- Irrigable area = total lot area – built area
- Estimated irrigation expressed as depth (mm or inches) per month
A soil water balance (Dukes, 2007) was used to calculate the irrigation requirements from 2003-2009.

Every city had its own inputs based on weather and soil variability.

Irrig = ET - Rain
Irrigation Requirements Estimation

Turfgrass Annual Water Req.

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=3,700 gal/1,000 sq ft

1” = 623 gal/1,000 sq ft

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Month

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Irrig Water Req - Turf 8 inch RZ
Precip
ETc
Selecting Potential Homes

- Within each subdivision, select customers that:
  1) Exceed average monthly theoretical limit by 1.5-4 times, and
  2) Over-irrigate at least 3 months out of every year from 2006-2008
Selection of High Irrigators

Theoretical limit = 77 mm month\(^{-1}\)

1.5 times theoretical limit = 116 mm month\(^{-1}\)

4 times theoretical limit = 308 mm month\(^{-1}\)

Area where ‘potential cooperator’ were identified

7,407 possible participants
Recruit Potential Cooperators
Initial Questionnaire Respondents

- Of the OCU service area,
  - 7,407 met the initial study requirements
  - 843 responded to the questionnaire
Criteria for Study Removal

• Of the 843 respondents, participants were removed from consideration unless they met the following requirements:
  – Utilized automatic time clock for irrigation
  – Irrigation connected to potable water supply (not reclaimed)
  – Lived in home for more than 2 years (2008 - 2009)
  – Year round resident
  – Owned home (does not rent)
  – Indicated automatic or manual irrigation habits
Criteria for Study Removal

• Some respondents chose to remove themselves from the study due to:
  – Lack of trust in that there were no fees or products being sold
  – Did not understand that there were future commitments after the questionnaire
  – Decided that future commitments to the study were too much to handle
Irrigation Inspection: The System Review

- Activate all zones
- Observe and document which components are not operating correctly
  - The Sprinkler System Review form can help with recording and reporting
Low Pressure
Broken Sprinklers
Bad Seals
Mismatched Sprinklers
## Statistics from On-site Evaluations

<table>
<thead>
<tr>
<th>Location</th>
<th>Number Evaluated</th>
<th>Average Number of Zones</th>
<th>Avg. Zone Area (ft²)</th>
<th>Irrigating on Non-watering Days (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunters Creek Area</td>
<td>54</td>
<td>4.3</td>
<td>967</td>
<td>9</td>
</tr>
<tr>
<td>Keenes Pointe Area</td>
<td>37</td>
<td>6.0</td>
<td>1267</td>
<td>3</td>
</tr>
<tr>
<td>N. Tanner Rd Area</td>
<td>29</td>
<td>4.0</td>
<td>896</td>
<td>10</td>
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<tr>
<td>Turtle Creek Area</td>
<td>28</td>
<td>4.7</td>
<td>1102</td>
<td>0</td>
</tr>
<tr>
<td>Waterford Lakes Area</td>
<td>96</td>
<td>3.7</td>
<td>1060</td>
<td>10</td>
</tr>
<tr>
<td>Not grouped</td>
<td>40</td>
<td>4.6</td>
<td>879</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>284</strong></td>
<td><strong>4.3</strong></td>
<td><strong>1033</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>
Statistics from On-site Evaluations

• Minor problems
  - 415 total
  - Average of 1.5 per home
  - 65% had at least 1 minor problem

• Major problems
  - 59 total
  - Average of 0.21 per home
  - 15% had at least 1 major problem
Select Treatments and Install Equipment
Summary of Treatments

- **ET**
  - Rain Bird ESP-SMT installed by contractor
  - Received educational pamphlet in mail

- **ET + Edu**
  - Rain Bird ESP-SMT installed by contractor
  - Follow-up visit from UF
  - Physically handed educational pamphlet
Summary of Treatments

- **SMS**
  - Baseline Watertec S100 installed by contractor
  - Received educational pamphlet in mail

- **SMS + Edu**
  - Baseline Watertec S100 installed by contractor
  - Follow-up visit from UF
  - Physically handed educational pamphlet

- **Comparison (MO)**
  - No changes
### Summary of Final Participants

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Soil type</th>
<th>ET&lt;sup&gt;a&lt;/sup&gt;</th>
<th>ET + Edu&lt;sup&gt;b&lt;/sup&gt;</th>
<th>SMS&lt;sup&gt;c&lt;/sup&gt;</th>
<th>SMS + Edu</th>
<th>MO&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Hunters Creek A</td>
<td>Flatwoods</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>20</td>
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<tr>
<td>Hunters Creek B</td>
<td>Flatwoods</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>20</td>
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<td>Keenes Pointe Area</td>
<td>Sand</td>
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<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>19</td>
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<td>North Tanner Road Area</td>
<td>Sand</td>
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<td>5</td>
<td>0</td>
<td>5</td>
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<td>15</td>
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<tr>
<td>Turtle Creek Area</td>
<td>Sand</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Waterford Lakes – East</td>
<td>Flatwoods</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Waterford Lakes – South</td>
<td>Flatwoods</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>20</td>
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<tr>
<td>Waterford Lakes – West</td>
<td>Flatwoods</td>
<td>4</td>
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<td>Sweetwater Apopka Area</td>
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<td>5</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>13</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>28</strong></td>
<td><strong>38</strong></td>
<td><strong>28</strong></td>
<td><strong>38</strong></td>
<td><strong>35</strong></td>
<td><strong>167</strong></td>
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</table>

<sup>a</sup>ET designates cooperators that received a Rain Bird ESP-SMT ET controller  
<sup>b</sup>Edu designates cooperators that received an on-site educational training  
<sup>c</sup>SMS designates cooperators that received a Baseline WaterTec S100 soil moisture sensor  
<sup>d</sup>MO designates cooperators that did not receive a technology
Begin Monitoring
Reference ET (ET\textsubscript{To}) & Rainfall

<table>
<thead>
<tr>
<th>Month</th>
<th>ETo (in)</th>
<th>Rainfall (in)</th>
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<tr>
<td>Nov-11</td>
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<td>Dec-11</td>
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<td>May-12</td>
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<td>Jun-12</td>
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<td>Jul-12</td>
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<td>May-13</td>
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<tr>
<td>Jun-13</td>
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</table>
Residential Avg. Irrigation

**Flatwoods**

- Comparison: 1.22 a
- ET: 1.1 a
- ET+Edu: 0.77 b
- SMS: 0.82 b
- SMS+Edu: 0.77 b

**Sand**

- Comparison: 0.99 a
- ET: 0.78 b
- ET+Edu: 0.69 b
- SMS: 0.77 b
- SMS+Edu: 0.53 c
Cumulative Irrigation

Flatwoods
- GIR Range
- Comparison
- ET
- ET+Edu
- SMS
- SMS+Edu

Sands
- 20%-30%
- 48%
- 25%-34%

Date (2012-2013)
Turfgrass Quality

• What is the turfgrass quality rating?
Turfgrass Quality

Average Turfgrass Quality

Comparison ET ET+Edu SMS SMS+Edu ET
Before treatments Fall 2011 Winter 2011-2012 Spring 2012 Summer 2012 Fall 2012
6.4 abcd 6.7 c 6.2 d 6.6 c 7.6 a 7.1 b

Season

Preliminary Results
• Turfgrass Quality
Customer Concerns

– Too much irrigation/high water bill
– Too little irrigation
– Watering too soon after rainfall
– Non-functioning controller/sensor
## Customer Concerns

<table>
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<tr>
<th>Treatment</th>
<th>Count</th>
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<td>ET</td>
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<tr>
<td>ET+Edu</td>
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<tr>
<td>SMS</td>
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<tr>
<td>SMS+Edu</td>
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<td><strong>Grand Total</strong></td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>Months Per Year</th>
<th>Count</th>
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<td>2012</td>
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<td>2013</td>
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<td></td>
<td><strong>Grand Total</strong></td>
<td><strong>71</strong></td>
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Questions?

mddukes@ufl.edu
http://abe.ufl.edu/mdukes/