Optimal Integration of Outdoor Water Use Management With Other Options

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Urban Water Demand Workshop

Arizona State University

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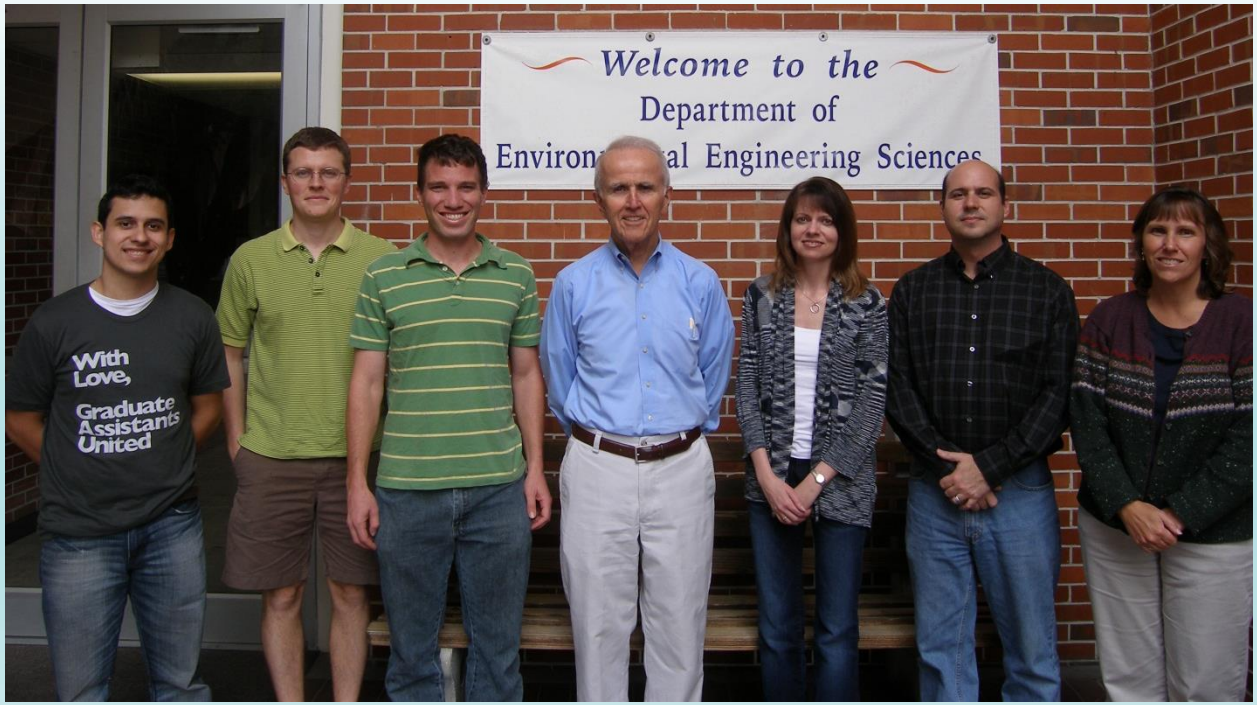
Urban Water Systems Team (2007-15)

- Engineering School for Sustainable Infrastructure and the Environment, U. of Florida
- Hope to graduate 4 PhDs in this area



Acknowledgement of Support

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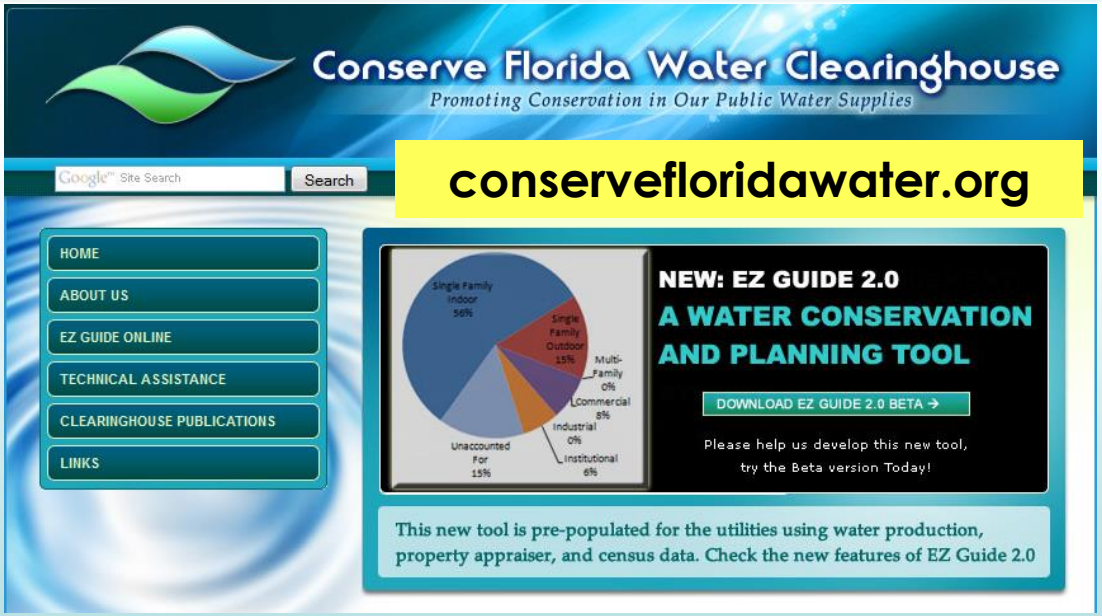
USGS science for a changing world

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT SJR

SANFORD FLORIDA 1877



FESC Florida Energy Systems Consortium

Universities Addressing Florida's Energy Needs

Water Research Foundation SM

Relevant papers on outdoor water use and integrated optimization

1. Friedman, K. , Heaney, J.P., Morales, M., and J. Palenchar. 2013. Predicting and Managing Residential Potable Irrigation Using Parcel Level Databases. *Journal of American Water Works Association.* Vol. 105, No. 7
2. Friedman, K. , Heaney, J.P., Morales, M., and J. Palenchar. 2014a. Estimation of Single Family Residential Irrigation Demand Management Effectiveness. *Journal of American Water Works Association. Vol. 106, No. 5*
3. Friedman, K. , Heaney, J.P., Morales, M., and J. Palenchar. 2014b. Analytical Optimization of Demand Management Strategies Across All Urban Water Use Sectors. *Water Resources Research,* 50, doi: 10:1002/2013WR014261.

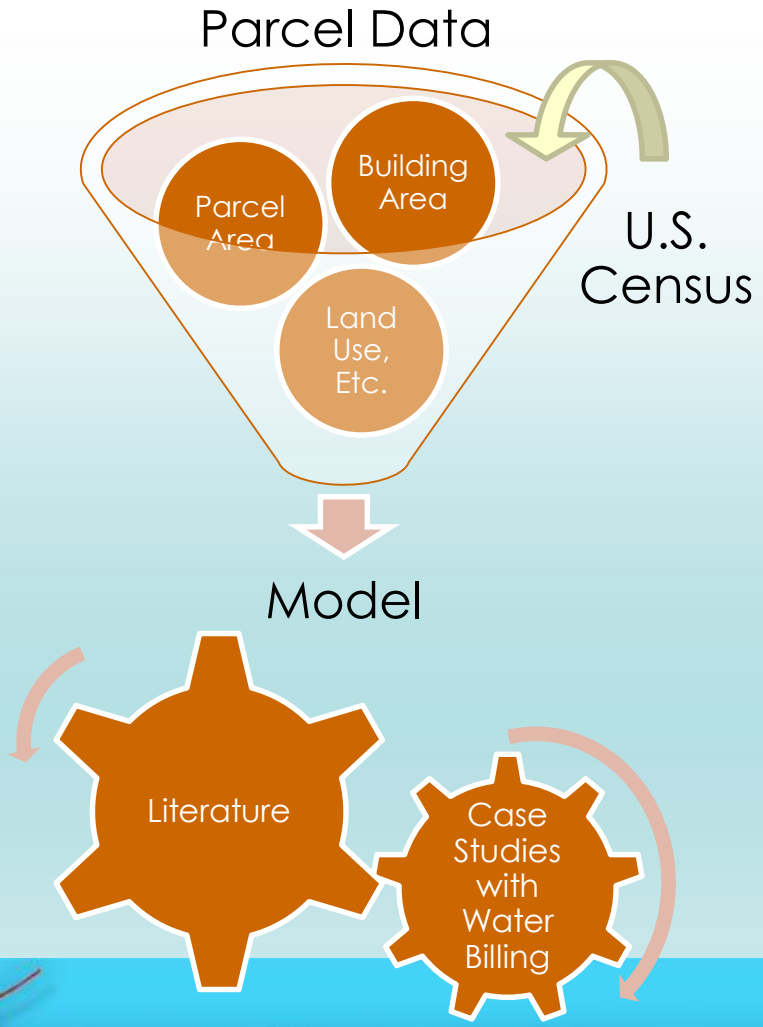
History of CFWC and EZ Guide

- In February 2004, Florida stakeholders signed the "Joint Statement of Commitment for the Development and Implementation of a Statewide Comprehensive Water Conservation Program for Public Water Supply."
- In March 2006, the University of Florida was selected to house, manage, and expand the operation and functions of the Conserve Florida Water Clearinghouse (CFWC).

- The CFWC developed EZ Guide, a web-based tool to allow any utility in the state to evaluate current water use, project future water use, and prioritize water conservation practices based on cost-effectiveness.

EZ Guide methodology

Land, building, and economic information on each of the **9 million parcels in the state of Florida**



Results

- Parcel-level estimates of:
  - Fixture inventory (number & efficiency)
  - Fixture water use (frequency of use & efficiency)
  - Cost-effectiveness of implementable water conservation options
- Target customers and BMPs to optimize utility and customer objectives

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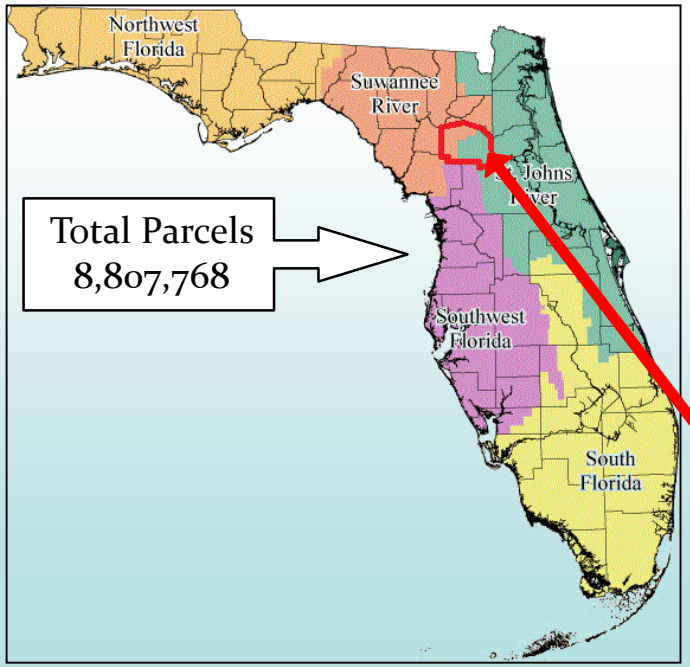
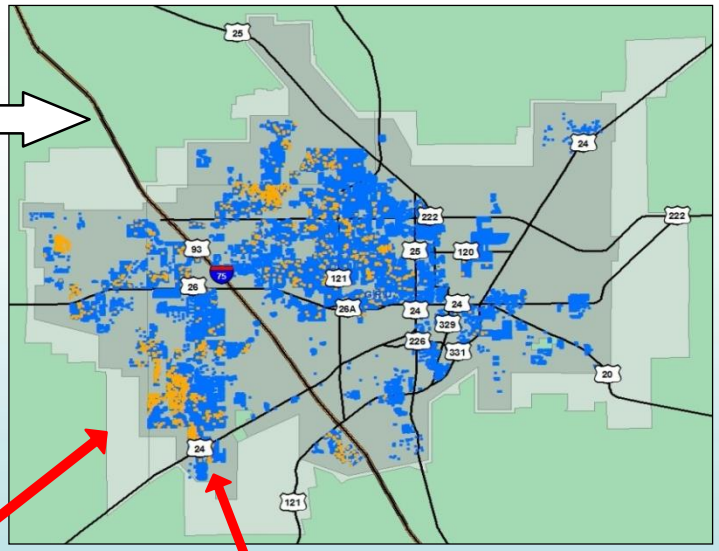
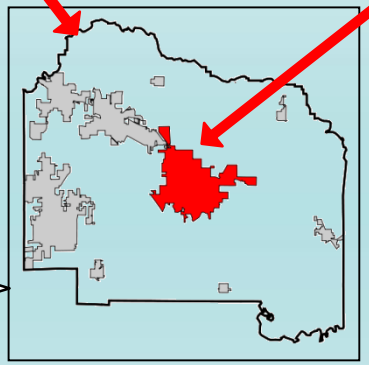
Bottom-up approach



Total Parcels
8,807,768

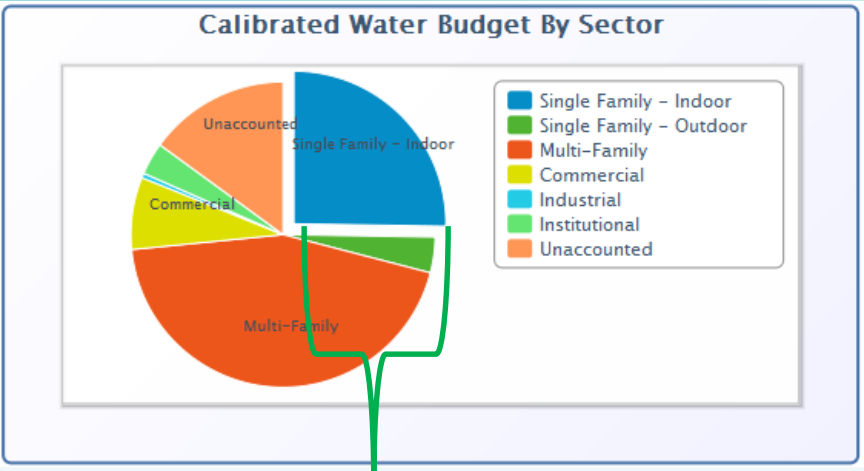
Total Parcels GRU
55,551





Parcels Alachua
99,305

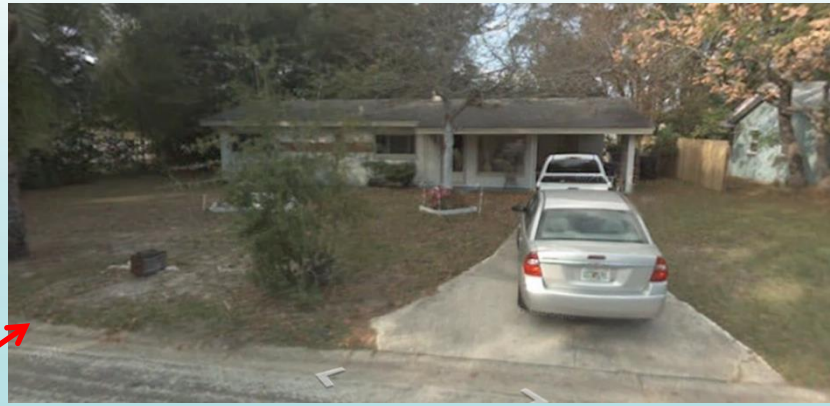
SFR parcels GRU
30,910



Optimal urban water demand management methodology-indoor example

Market segmentation of toilet usage

Current Fixture Group	Toilets / house	Existing Fixtures	Existing Gal./toilet/ day	Retrofitted Gal./toilet/ day	Water Savings Gal./toilet/ day
Pre 1983	1	17	88.44	13.85	74.59
Pre 1983	2	6,246	44.22	6.93	37.30
Pre 1983	3	1,302	29.48	4.62	24.86
Pre 1983	4	4	22.11	3.46	18.65
1983-1994	1	93	62.54	13.85	48.68
1983-1994	2	1,944	31.27	6.93	24.34
1983-1994	3	2,379	20.85	4.62	16.23
1983-1994	4	103	15.63	3.46	12.17
1995-2008	1	30	29.29	13.85	15.44
1995-2008	2	3,006	14.65	6.93	7.72
1995-2008	3	171	9.76	4.62	5.15
1995-2008	4	36	7.32	3.46	3.86
	Total	15,331			



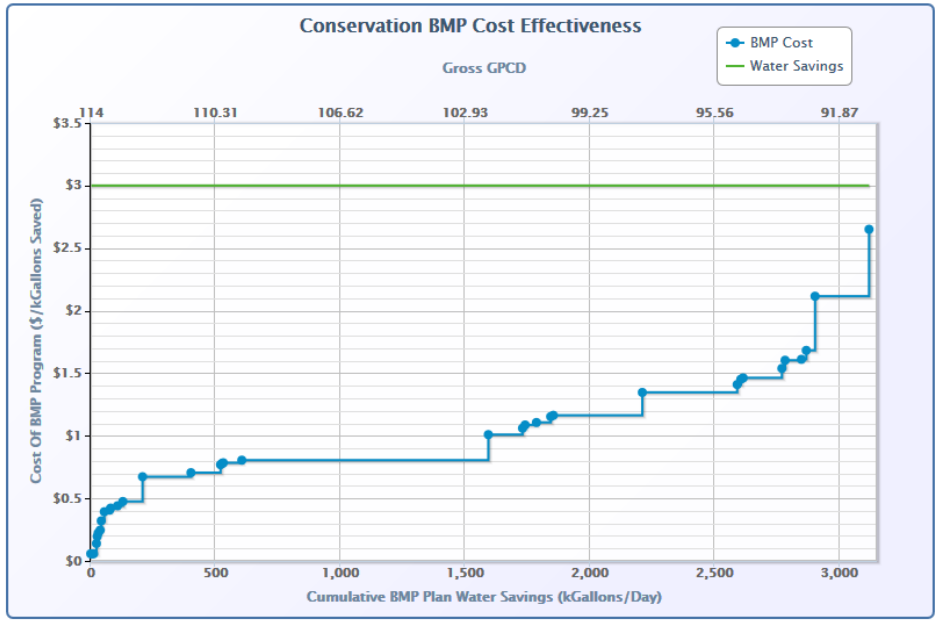
Savings=current usage-usage if 0.8gpf toilet installed

EZ Guide results

- Water budget section estimates water use at the parcel level and allows for calibration to known water supply
- Provides segmentation on water demand and population served

Water Use Summary By Sector

Sector	% Water Use	Residential GPCD	Gross GPCD	Population	% Total Population
Single Family	61.8%	97	81	91,147	83%
Single Family - Indoor	42.7 %	67	56	---	---
Single Family - Outdoor	19.1 %	30	25	---	---
Multi-Family	9.6%	73	13	18,841	17%
CII	13.6%	--	18	---	---
Commercial	9.9 %	--	13	---	---
Industrial	1.5 %	--	2	---	---
Institutional	2.2 %	--	3	---	---
Unaccounted	15.0%	--	20	---	---
Total	100.0%	--	131	109,988	100%



Parcel-level estimates of current water use by fixtures

Refined estimates of water savings associated with BMPs + Cost data

Cost-effectiveness evaluations of BMPs at fine spatial scale

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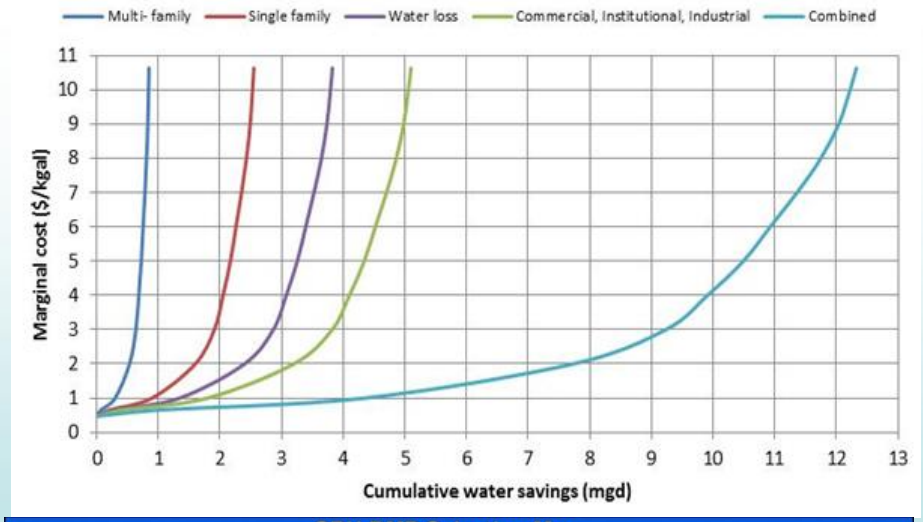
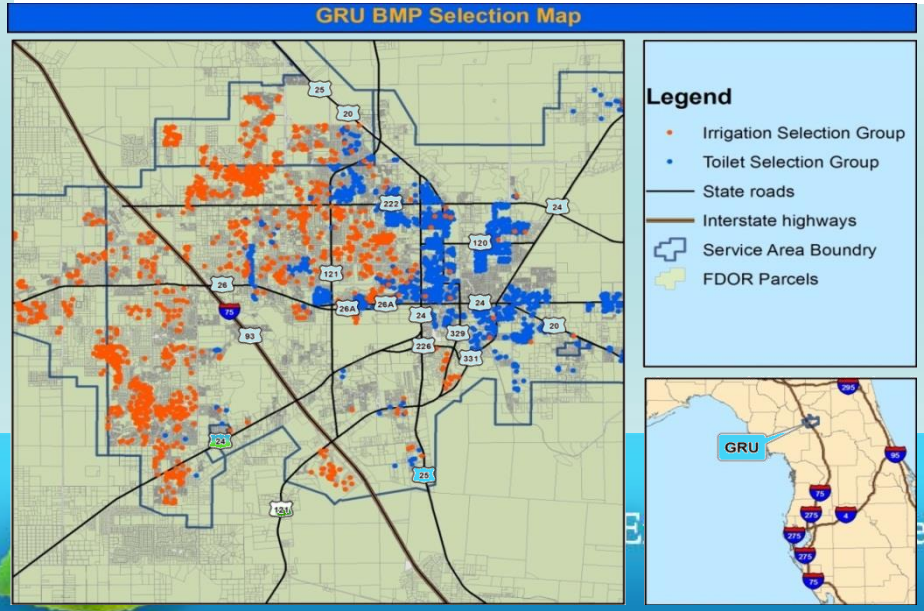
Optimal blend of demand management across all 64 sectors





- Dual variable to minimum cost solution is marginal cost of water savings
- Methodology has been extended to include demand management across all 64 sectors
  - Most studies just focus on residential indoor uses
- Identity of parcel level water savings maintained throughout analysis
  - Allows for spatial clustering

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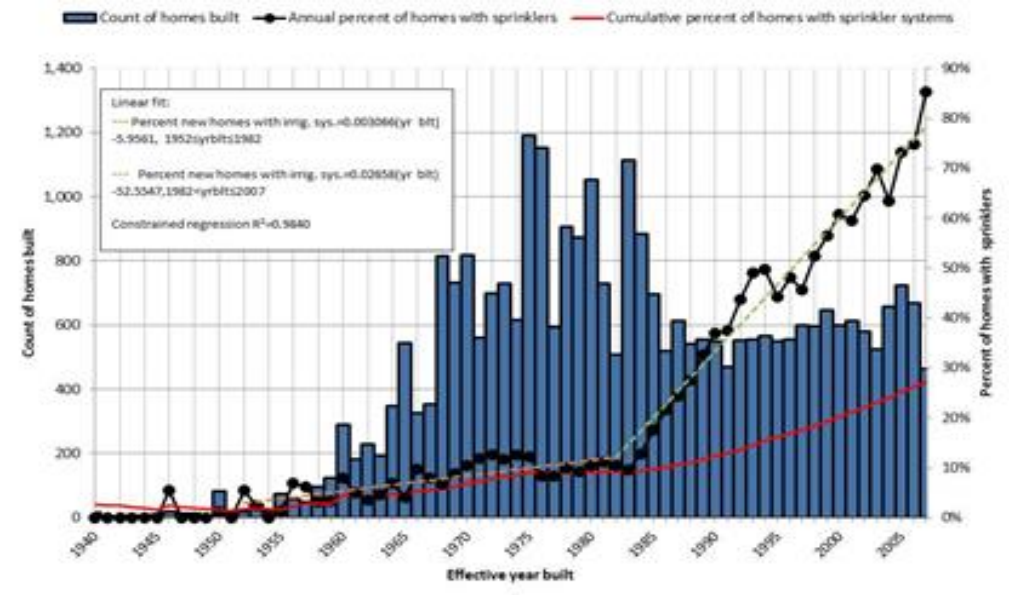
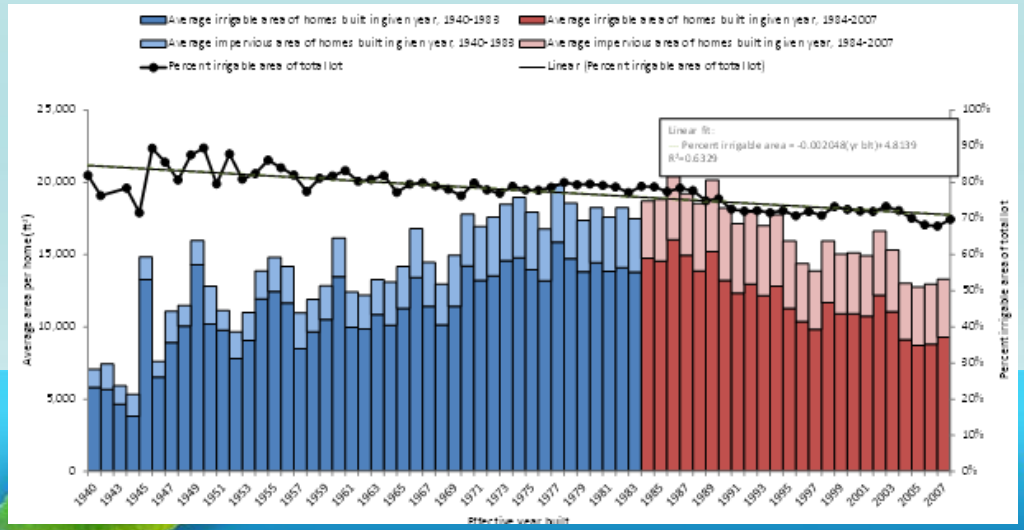
Optimal solution for the residential irrigation sector

Single family residential housing trends in Gainesville Florida for about 31,000 parcels

Friedman et al. 2013





- Significant increase in homes with automatic sprinklers from 10% of new homes in 1982 to about 90% of new homes at present
- Increase in irrigable area from 10,000 sf in 1960 to 15,000 sf in 1980
- Decline in irrigable area after 1980 to about 8,000 sf at present
- Overall, about 27% of homes have irrigation systems at present

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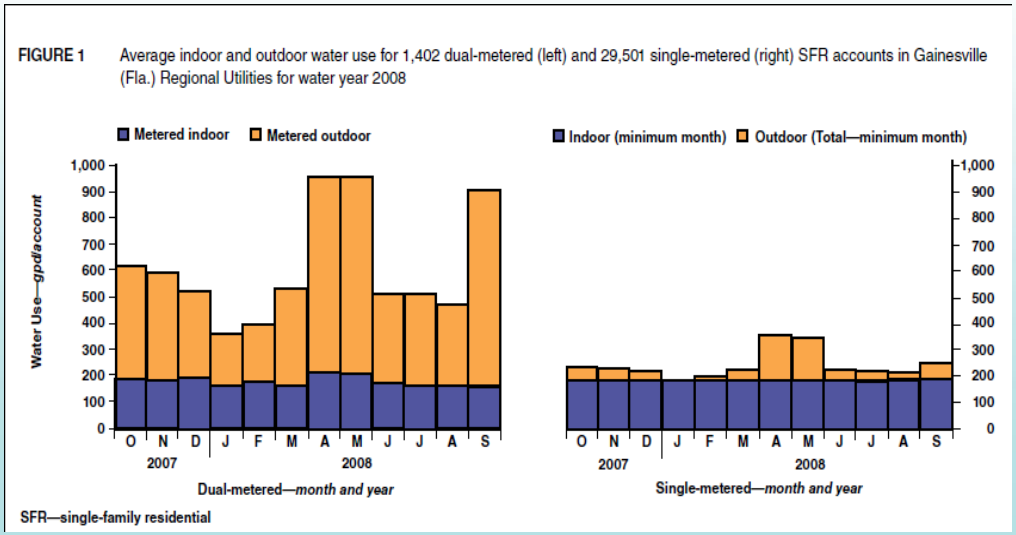
1,402 irrigation systems have significant outdoor water use as compared with 29,501 single meter accounts

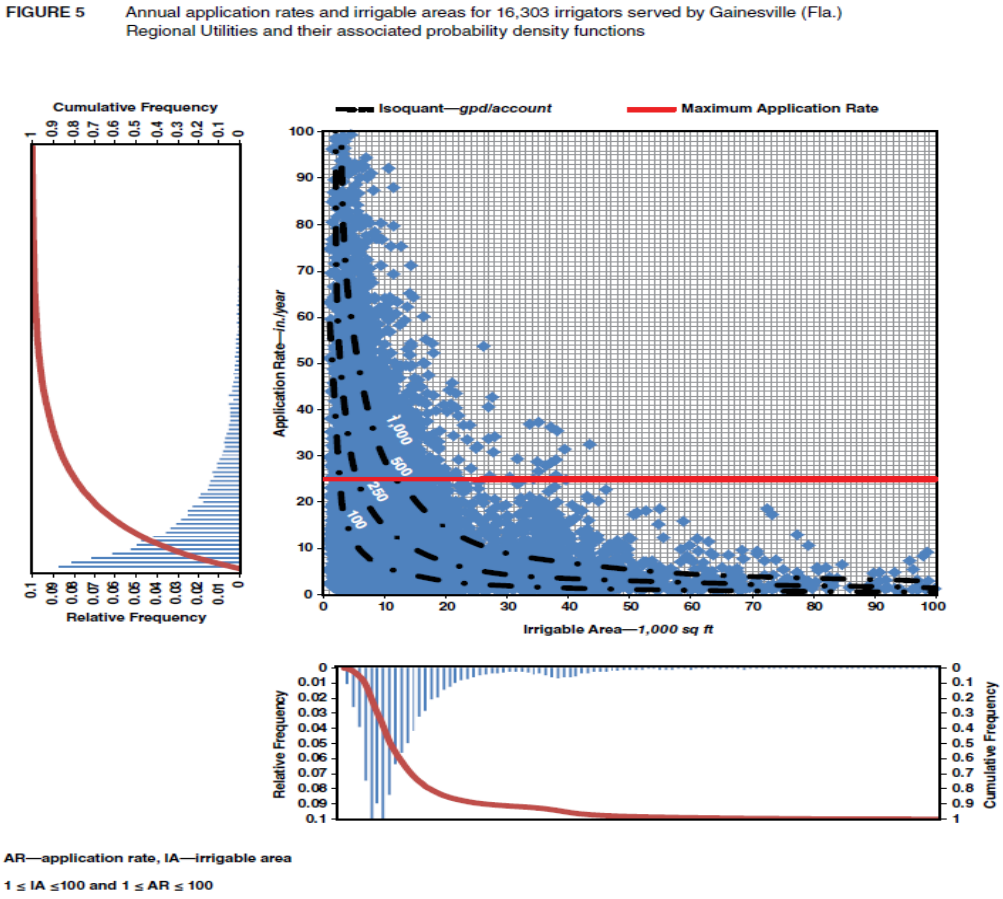
Friedman et al. 2013



- 1,402 dual metered homes with irrigation systems average about 400 gpad outdoor and 200 gpad indoor
- Peak outdoor usage of about 750 gpad in April and May

Irrigable areas and annual application rates for 16,303 irrigators in Gainesville

Friedman et al. 2013

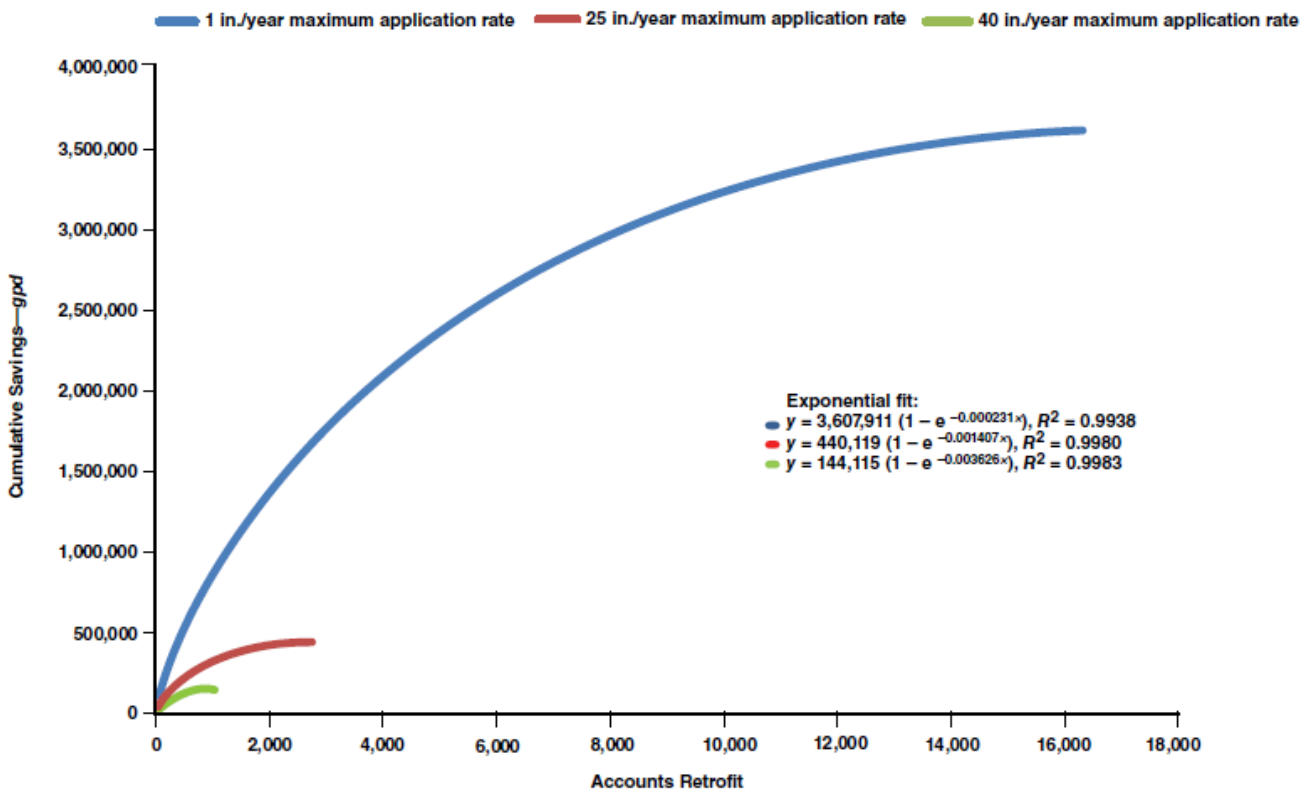


- Horizontal red line denotes a benchmark application rate of 25 inches/yr.
- Want to target "overirrigators"
- Isoquants of outdoor water use are shown

Water savings potential for benchmarks of 1, 25, and 40 in./yr.

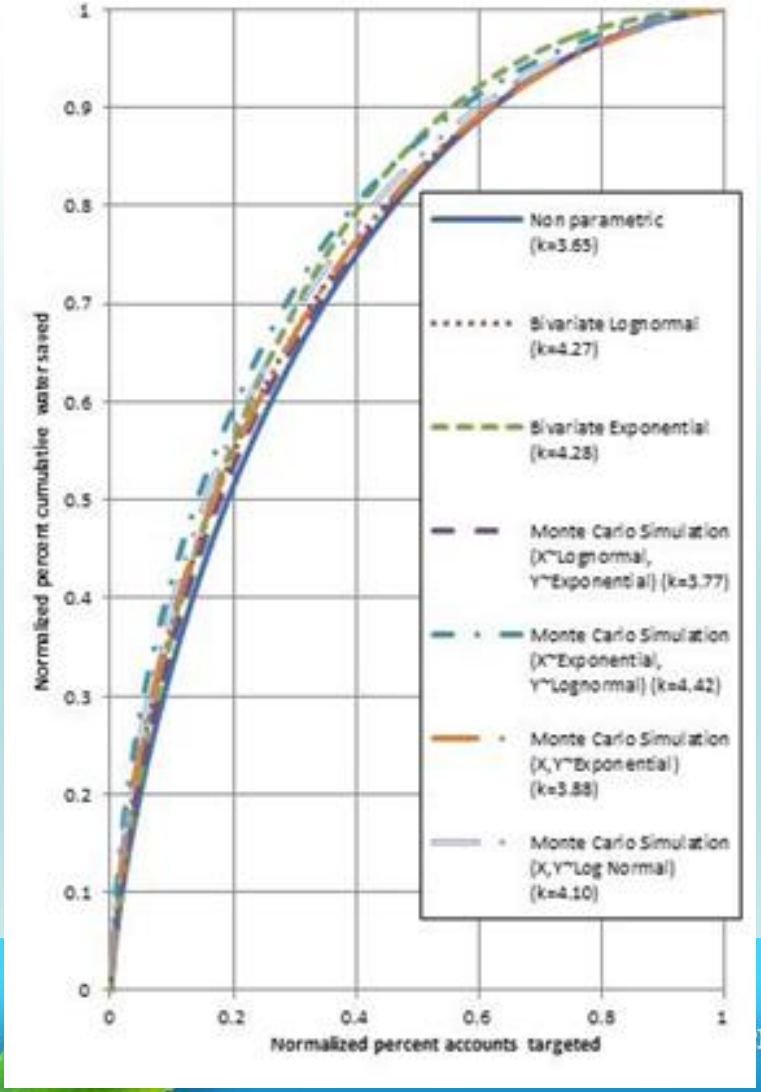
Friedman et al. 2013

FIGURE 7 Comparison of savings potential for varying maximum application rates for Gainesville Regional (Fla.) Utilities irrigators



Normalized irrigation water savings distributions

Friedman et al. 2014a



- Fitted irrigation water usage distributions can be transformed into normalized water savings production functions
- Results: both exponential and lognormal distributions work well, with the bivariate lognormal performing slightly better than bivariate exponential
- This approach provides a generalized theory which can be utilized in absence of direct data

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Finding optimal % of irrigators to target

Friedman et al. 2014b

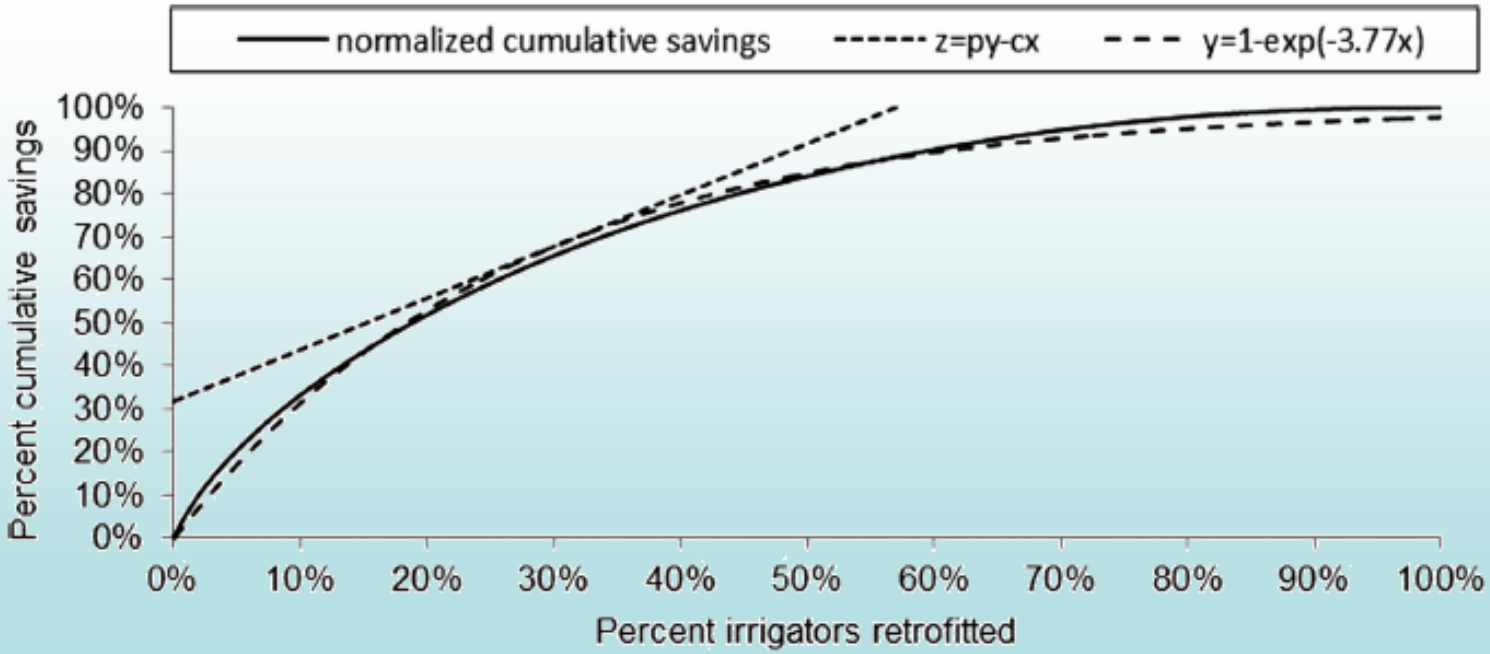
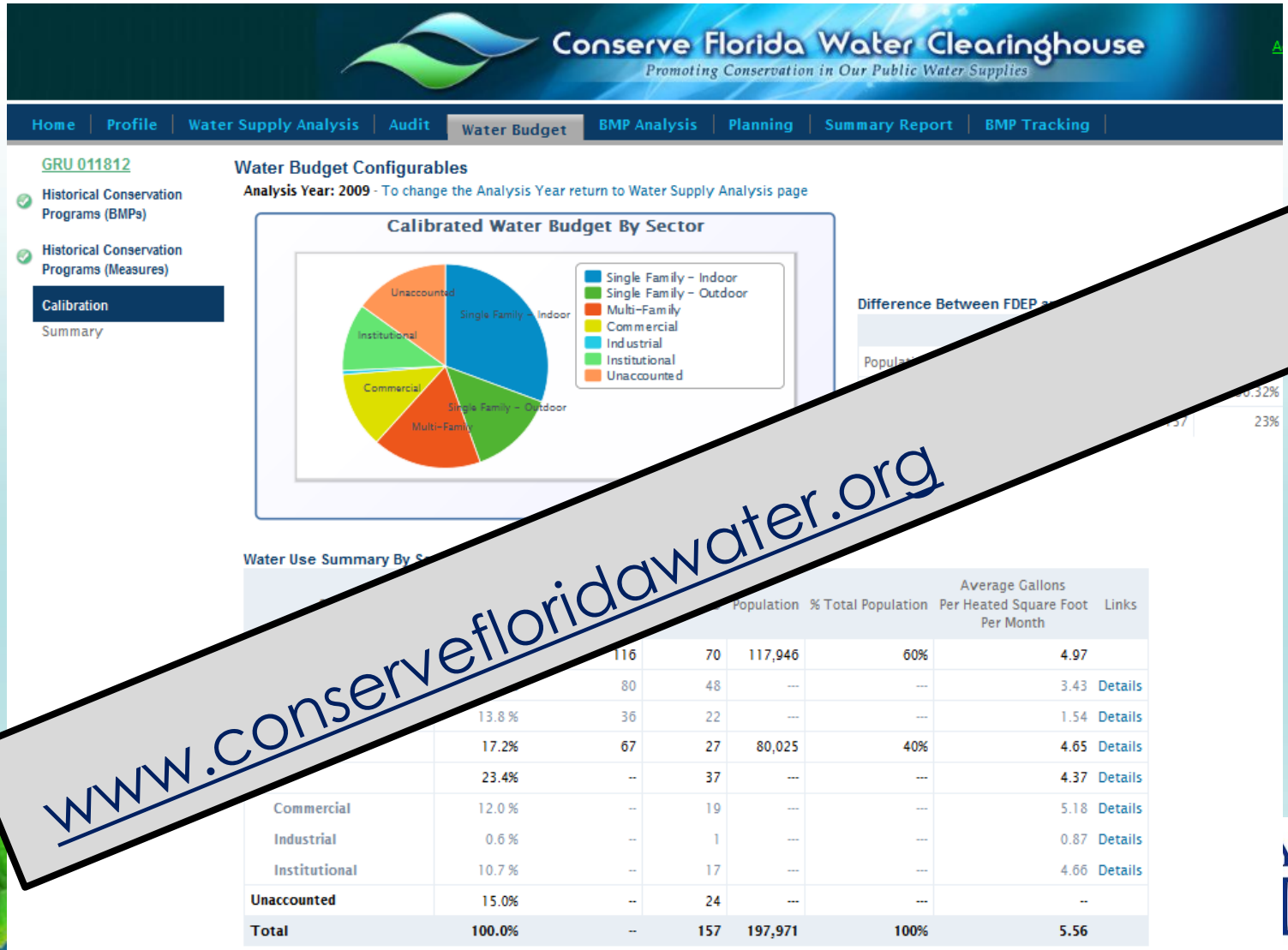


Figure 2. Normalized cumulative savings from soil moisture sensor retrofits and associated benefit-cost objective function for 2,746 eligible irrigators currently above 63.5 cm./yr.

Summary and conclusions

- Bottom-up, process-oriented, approach evaluates conservation options at the parcel scale.
- In Florida, the basic parcel level information is available from public sources for 9 residential and 55 CII sectors.
- Outdoor water use is a major concern because of the growing popularity of in-ground sprinkling systems. The impact of this growth is partially offset by the trend towards smaller irrigable areas.
- EZ Guide can provide a high quality estimate of the end use of water for any utility in Florida. The same methods can be applied elsewhere if property appraiser and related data are available.
- Best mix of BMPs for a given incremental cost can be found using this extensive data and associated analytical techniques.
- Our current research is focused on the impact of pricing on outdoor water use.

More Information?



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