Effectiveness of Residential Irrigation Inspections Program in Alachua County

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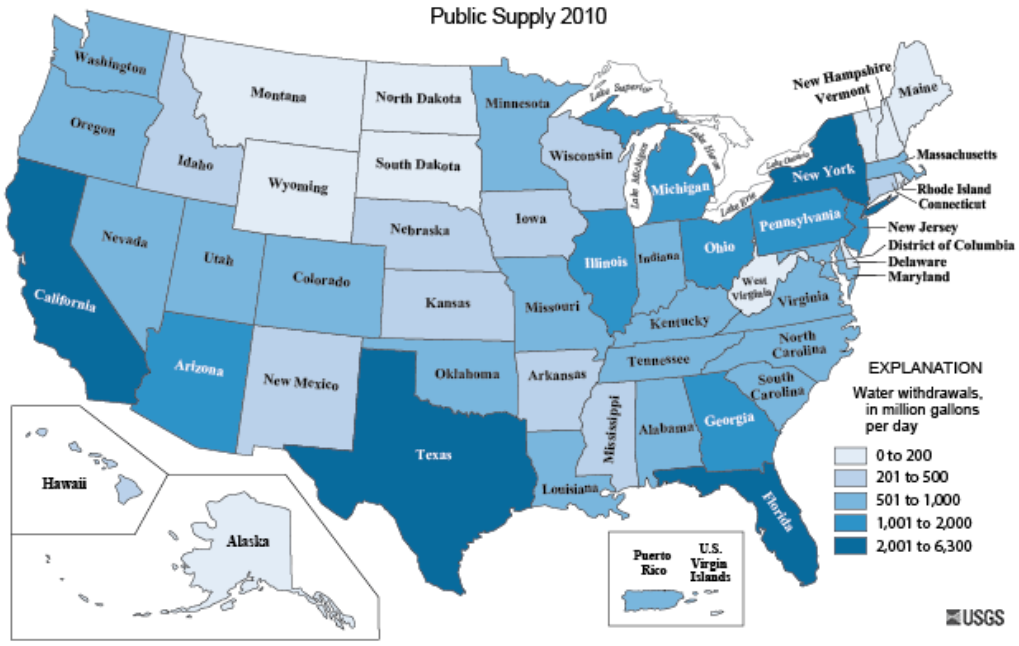
Acknowledgements

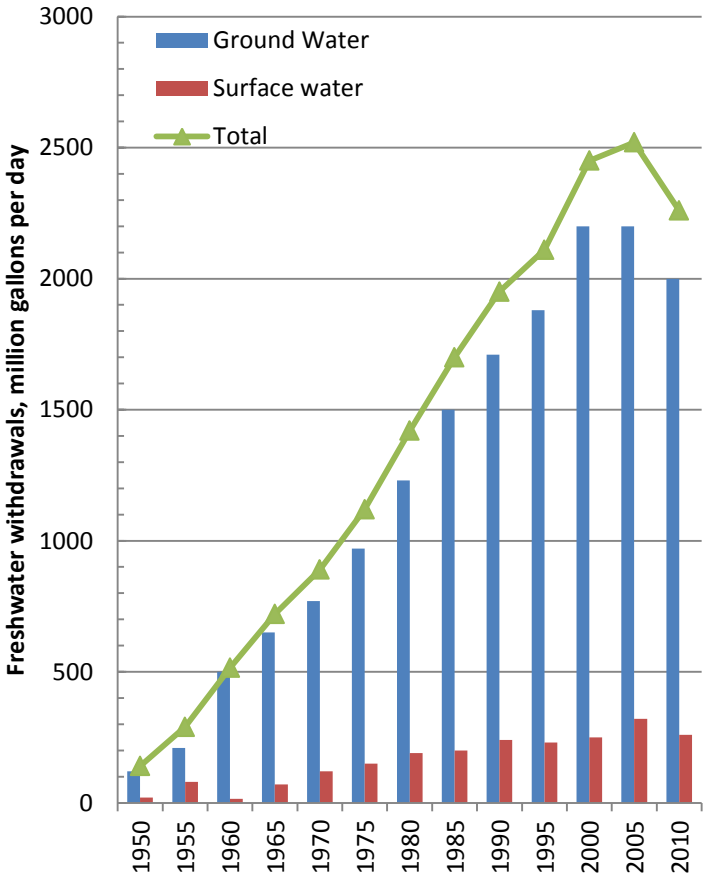
- Alachua County Environmental Protection Division
- Gainesville Regional Utilities
- Program for Resource Efficient Communities, University of Florida

Water Withdrawals for Public Supply

Water Withdrawals for Public Supply (USGS 2014)



Historical public-supply freshwater withdrawals in Florida by source, 1950–2010



Marella 2014, http://pubs.usgs.gov/sir/2014/5088/pdf/sir2014-5088.pdf

Water Withdrawals for Public Supply (USGS 2014)

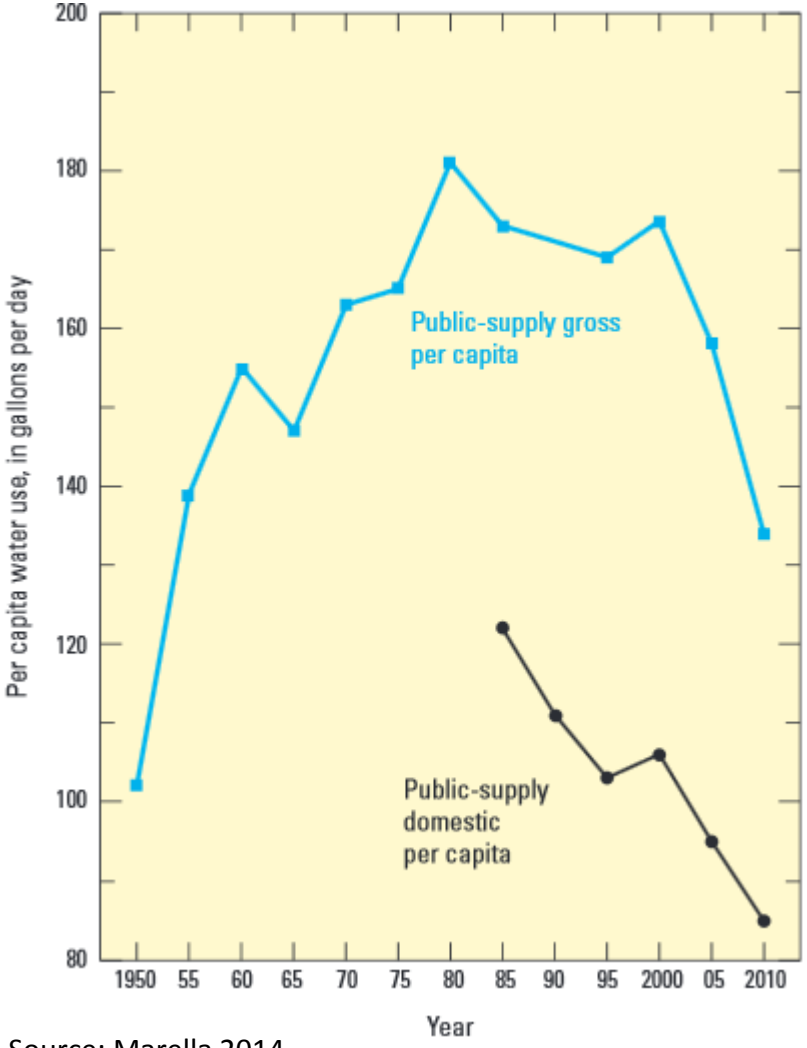
State	Percentage of nationwide withdrawals
California	15%
Texas	9%
Florida	**5%**
New York	5%
Illinois	4%

http://water.usgs.gov/watuse/wups.html

Residential Water Demand Management

- Price-based strategies: Price elasticity
  - Mean: -0.36 (range: -0.002 to -3.054)
  - Less elastic demand of high-income customers
  - Selected studies: Espey et al. 1997; Dalhuisen et al. 2003; Olmstead et al. 2007; Klaiber, 2012; Sebri 2014.
- Non-Price Strategies
  - Diversity of strategies; Water Restrictions are common
  - Not always enforced
  - Effective for reduction in water use (Olmstead and Stavins 2009; Mansur and Olmstead 2012)
- No studies on effectiveness of inspection programs

Historic public-supply gross and domestic per capita water use in Florida



Source: Marella 2014, http://pubs.usgs.gov/sir/2014/5088/pdf/sir2014-5088.pdf

Residential irrigation restrictions in Florida

- Imposed by regional water authorities
  - Irrigation is allowed once or twice a week
- Goals:
  - improving technical efficiency of irrigation water use
  - Reduction in per-capita water use in water resource-limited areas
- Monitoring and enforcement – vary among municipalities

Water Resource Caution Areas in Florida (FDEP 2011)

Example of overwatering in Florida

Photo by the University of Florida

Residential irrigation restrictions: *Alachua County*

Irrigate only on your day(s), and not between 10 am and 4 pm		
Location	Summer (2nd Sun. in Mar - 1st Sun. in Nov)	Winter (1st Sun. in Nov - 2nd Sun. in Mar)
Odd House #	Wednesday and/or Saturday	Saturday
Even House #	Thursday and/or Sunday	Sunday

- The change in allowed irrigation frequency is tied to the changes in weather and the growing season

Alachua County and Florida map – source: http://www.floridacountiesmap.com/alachua_county.shtml

Source: Alachua County, http://www.alachuacounty.us/DEPTS/EPD/WATERRESOURCES/WATERCONSERVATION/Pages/Irrigation-Restrictions.aspx

Alachua County Irrigation Inspections

- Started in April 2011
- Focus on high water use subdivisions
- 1-2 inspections per week
  - Approximately 1 inspection per month per subdivision
- Warning letters for those not complying with restrictions

Alachua County
Environmental Protection Department

Chris Bird, *Director*

March 16, 2015

«AddressBlock»

Re: **Watering Restrictions for Residential Irrigation (Case # «Case»)**

Dear Residents,

Landscape irrigation restrictions are in effect year round to promote the efficient use of water. We have observed a possible violation of the current irrigation restrictions at your property. If you haven't already done so, please adjust your watering practices to comply with the restrictions described below. Repeated violations may result in a fine.

During Eastern Standard Time (November 2, 2014 to March 07, 2015) irrigation is allowed only one day per week. If you have an odd numbered address you may only water on Saturday, while even numbered addresses may only water on Sunday. Many plants go dormant in the winter and may not even require weekly irrigation.

During Daylight Saving Time (March 8, 2015 to November 1, 2015) irrigation is allowed up to two days per week. If you have an odd numbered address you may only water on Wednesday and/or Saturday, and even numbered addresses may only water on Thursday and/or Sunday. With all of the rain we receive, you may not even need to water on both days.

Water only as needed on your irrigation day and only before 10 a.m. or after 4 p.m. (this reduces losses to evaporation). State law requires that all automatic irrigation systems have a functioning rain shut-off device which bypasses scheduled irrigation when a rain event has recently occurred. To see how your water and energy use compares to your neighbors, visit www.Gainesville-green.com.

For more information please visit www.AlachuaCountyWater.org. Feel free to contact me at 352-264-6809 if you have any questions or concerns.

Sincerely,

Emily Rodriguez

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Environmental Specialist
erodriguez@alachuacounty.us

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E-Mail: epd-reception@alachuacounty.us ■ Home Page: http://alachuacounty.us/government/depts/epd

Study Questions

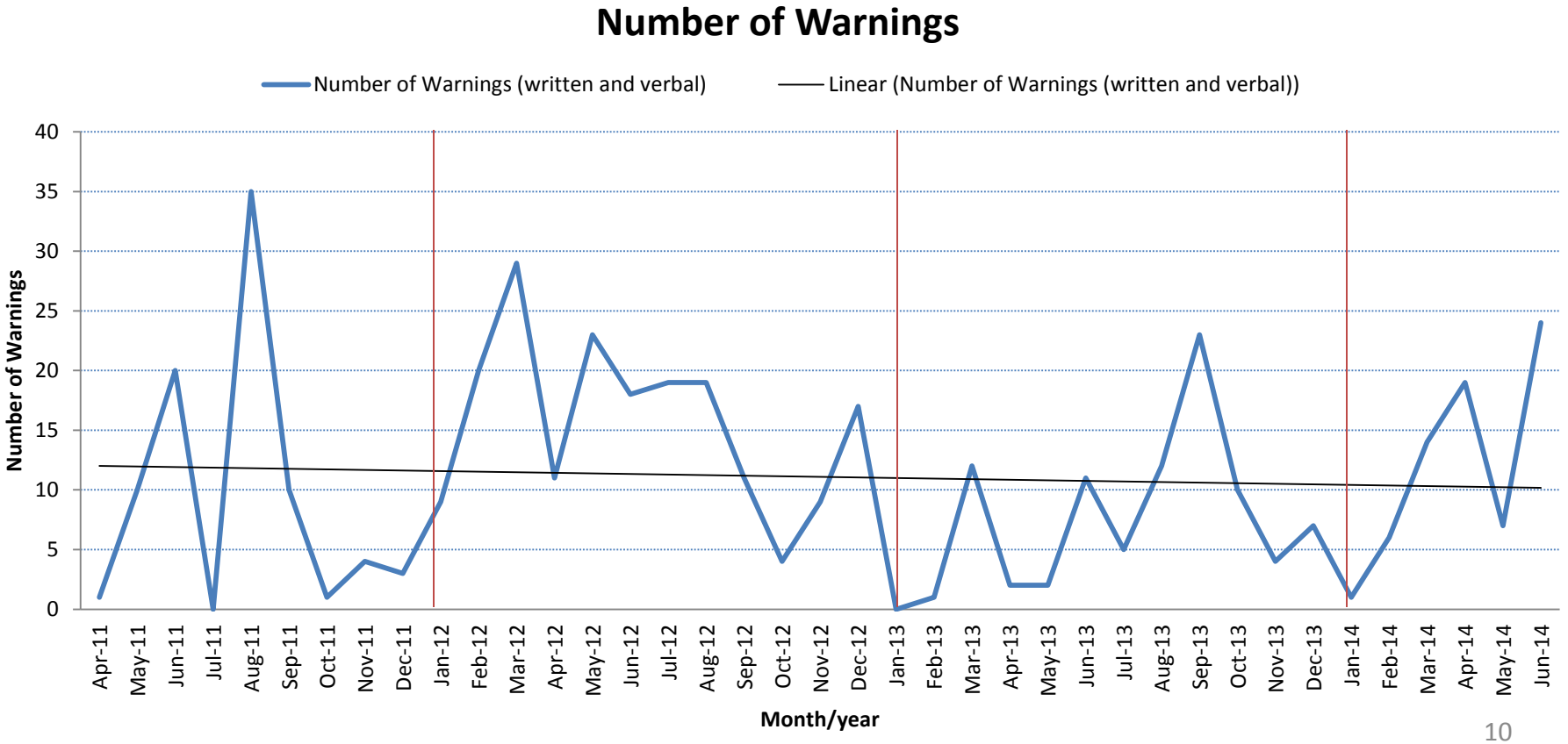
- How accurate is the targeting of the program?
  - Are the warning letters sent to high water users?
- Effectiveness of the inspection program
  - Do the warning letters influence residential water use?

Data

- Monthly property-level water use: Jan 2008 – May 2014
  - Single family residential homes with combined indoor / outdoor meters, identified as having "sprinklers"
  - Single family residential homes with separate indoor / outdoor meters
- List of properties that received warning letters, with the dates when the letters were sent
- Water rate structure (Gainesville Regional Utilities)
  - Inclining block price structure both for indoor use and outside irrigation (if separate meter is used).
  - Example: 2014 price structure for combined / indoor water use
    - $2.30/Kgal – 0 - 6 Kgal,
    - $3.75/Kgal – 6 - 20 Kgal,
    - $6.00/Kgal – more than 20 Kgal.
- Weather (NOAA): monthly total precipitation and average temperature

Warnings

- Issued year-around, with fewer warnings issued in winter
- No statistically significant decline in the number of warning per month over time



Water Use

- Water use for 2008 – 2014: Summary statistics

Properties	Water use	Number of properties	Number of monthly observations	Water use per month (KGA)			
				Mean	Median	Min	Max
Combined meters	Total	8,449	639,053	9.0	6	0	632
Separate meters	Irrigation	1,441	105,822	9.9	6	0	696
	Indoor	1,441	111,235	5.2	4	0	1195

- "Outliers" that have to be omitted
  - **Leaks**: monthly water use observations above 70.00 thousand gallons / month
    - Combined meters: 0.2% (1138 monthly observations, for 604 properties)
    - Separate meters, outdoor use: 0.4% (434 monthly observations, for 204 properties)
    - Separate meters, indoor use: <0.1% (49 monthly observations, for 49 properties)
  - **No irrigation**:
    - Combined meters: properties consistently using less than 6 thousand gallons per month (371 properties, including 9 properties that received warning letters)
    - Separate meters: properties with zero reading on irrigation meters (34 properties, including 1 property that received warning letter)

Water Use

- Water use for 2008 – 2014: Summary statistics

Properties	Water use	Number of properties	Number of monthly observations	Water use per month (KGA)			
				Mean	Median	Min	Max
Combined meters	Total	8,078	609,721	9.14	6	0	70
Separate meters	Irrigation	1,407	103,521	9.69	6	0	70
	Indoor	1,407	110,952	5.11	4	0	70

Combined Meters: 8078 properties

426 - received the warning letters

2685 – "neighbors" from the same subdivisions

4967 - the rest of the Alachua County

Separate meters: 1407 properties

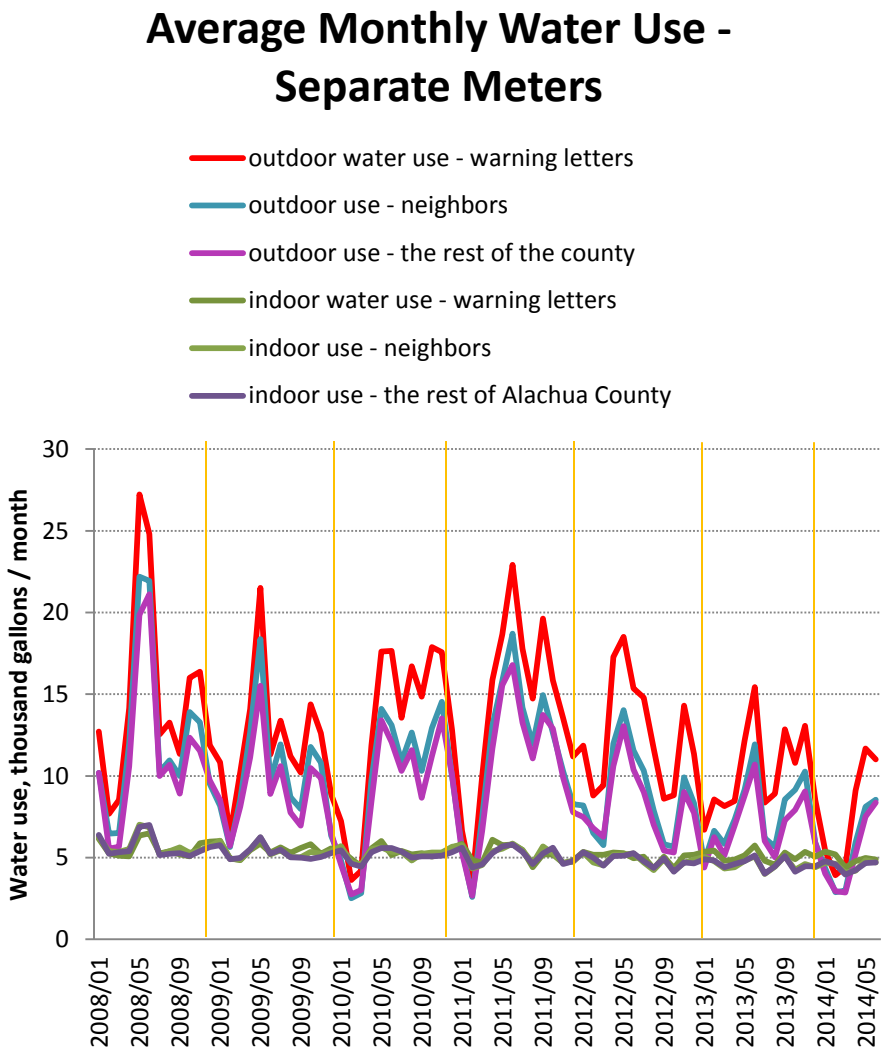
165 - received the warning letters

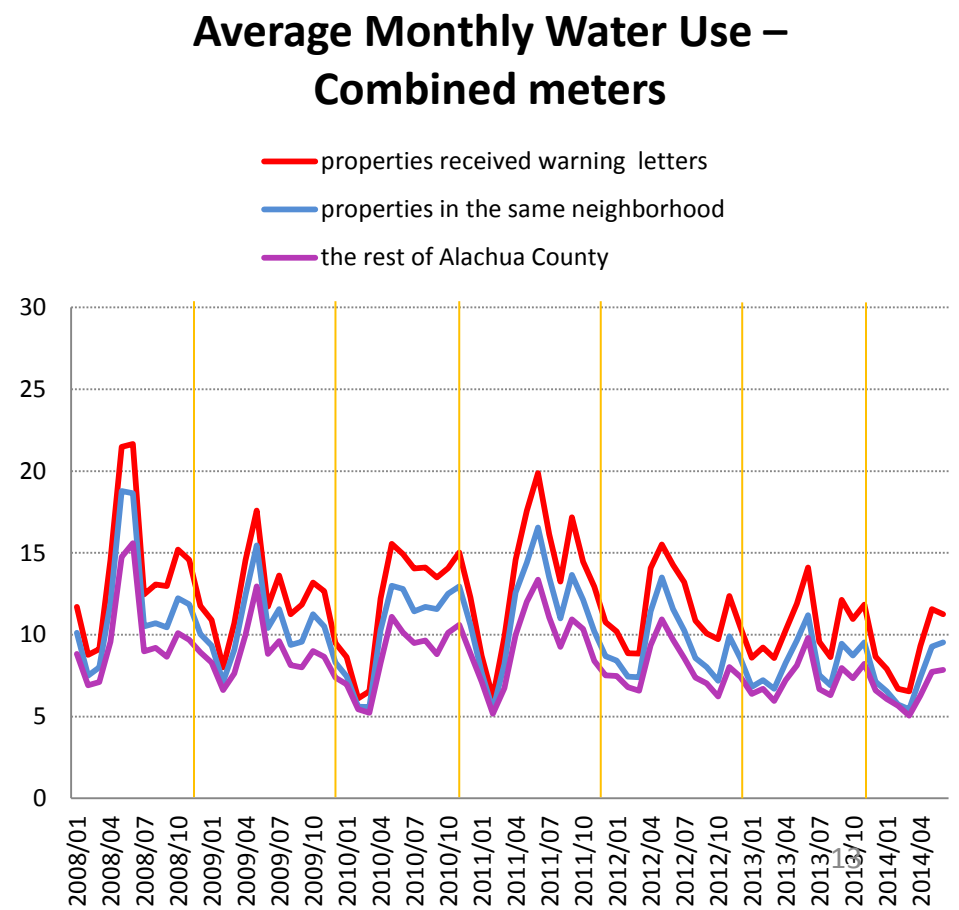
750 – "neighbors" from the same subdivisions

492 - the rest of the Alachua County

Inspection Program: Targeting

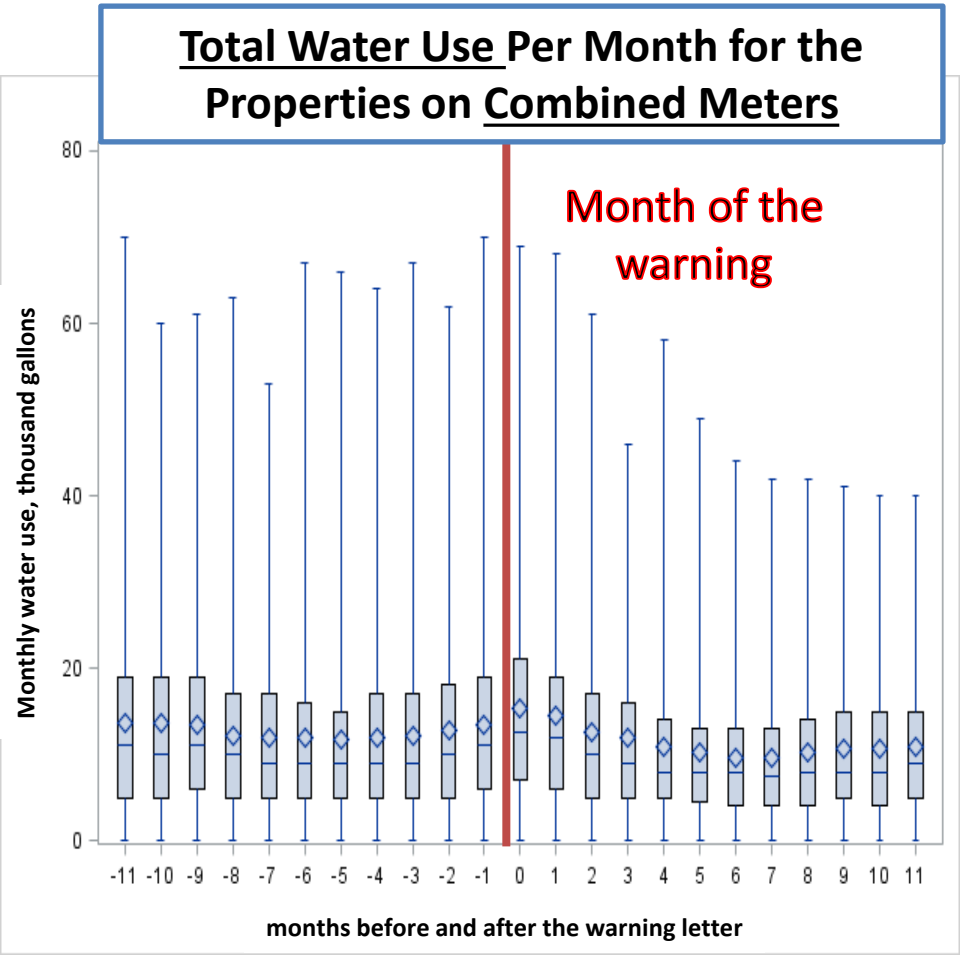
- On average, those who received warning letters used more water than their neighbors or the other properties
- Decreasing water use over time, with possibly steeper reduction in inspected subdivisions

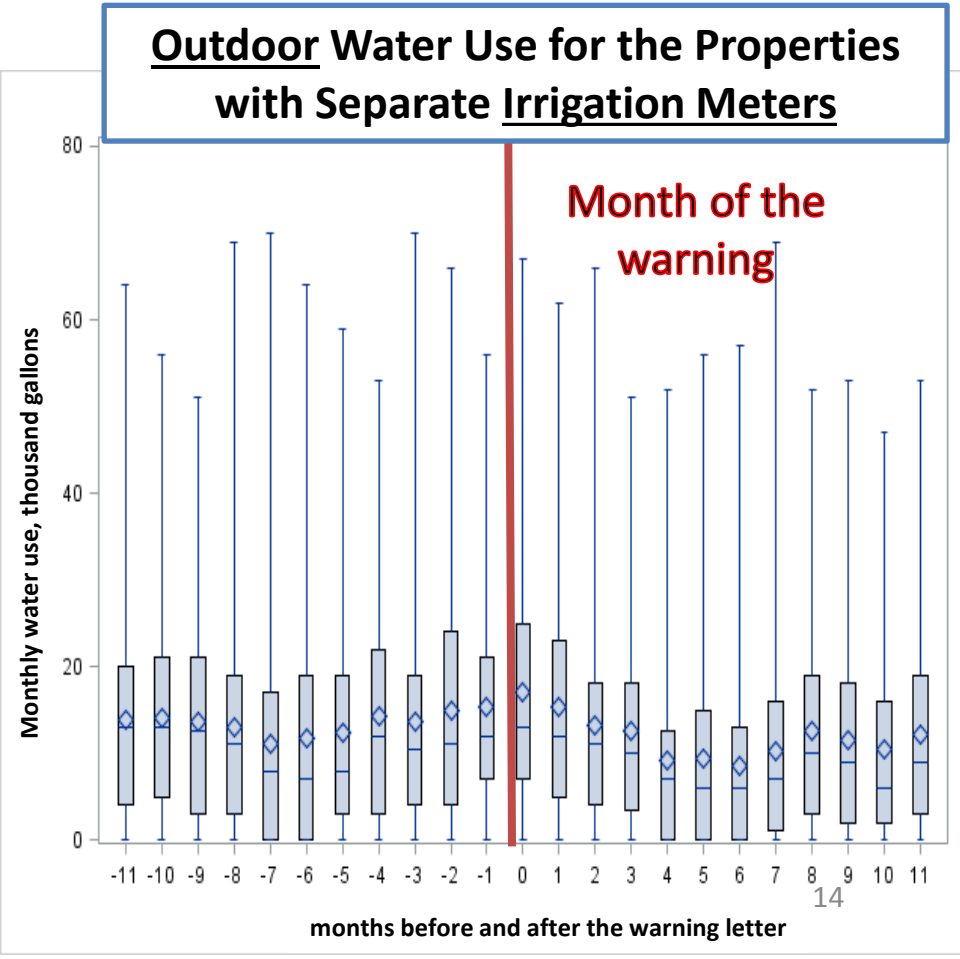




Water use before and after the warnings

- Properties that received the warning letters:
  - Plots of the water use in the months before and after the warning letters
  - Reduction water use after the letter





Measuring the Effectiveness of the Inspection Program

- Fixed-effects panel regression model (Baltagi, 2008)
  - Monthly water use by property as a function of:
    - Price (Marginal Price and Price Difference instrumental variables)
    - Weather (Precipitation and Temperature)
    - Warning Letter: time period after the warning letter (for “violators” only)
    - A property-specific parameter (to account for the property characteristics not captured by other variables)

Treatment effect of Inspection on Customers with Combined Meters

Fixed-effects (within) IV regression Number of obs =595659 Number of groups = 8607

Water Use	Coefficient	Standard Error	Z	P>|Z|
Marginal Price (MP)	-0.843	0.022	-37.55	0.000
Price Difference (PD)	0.277	0.002	154.47	0.000
Warning Letter	-0.955	0.083	-11.43	0.000
Precipitation	-0.001	0.000	-51.90	0.000
Temperature	0.156	0.002	104.11	0.000
Constant	8.492	0.065	130.27	0.000

F-test	Panel variables		R-square	Instruments
F(8606,587047)=7.32	sigma_u	3.337	Within= 0.177	Lag MP
Prob > F= 0.000	sigma_e	5.909	Between = 0.899	Lag PD
	rho	0.242	Overall = 0.350	

Treatment effect of Inspection on Irrigation Use

Fixed-effects (within) IV regression Number of obs =60975 Number of groups = 1315

Water Use	Coefficient	Standard Error	Z	P>|Z|
Marginal Price (MP)	-1.243	0.136	-9.14	0.000
Price Difference (PD)	0.303	0.009	33.59	0.000
Warning Letter	-0.911	0.317	-2.87	0.004
Precipitation	-0.001	0.000	-18.52	0.000
Temperature	0.320	0.009	35.78	0.000
Constant	9.166	0.435	21.09	0.000
F-test	Panel variables		R-square	Instruments
F(1314,59655) = 4.73	sigma_u	6.729	Within= 0.123	Lag MP
Prob > F= 0.000	sigma_e	11.257	Between = 0.619	Lag PD
	rho	0. 263	Overall = 0.241	

Program Impacts

Water use / meter type	Water Use Reduction (KGAL/month)	Number of Properties Affected	Savings per year ($)	
			Water Bill Savings ($)[a]	Water Delivery Cost Savings for the Water Supplier ($)[b]
Total / combined meters	0.955 [0.791 – 1.118] [c]	426	$18,000 [14,920–21,090][c]	$9,760 [8,090 – 14,430] [c]
Outdoor / irrigation meters	0.911 [0.290 – 1.532] [c]	165	$6,655 [2,120 – 11,190] [c]	$3,610 [1,150 – 6,070] [c]
		Total Annual	$24,655	$13,370

[a] Average price: $3.35/thousand gallons * 1.1 (tax) = $3.69/Kgal

[b] On average, tap water costs are slightly more than $2/Kgal (US EPA, 2004)

[c] Numbers in bracket shows the coefficient at the 95% confidence interval.

Next Steps

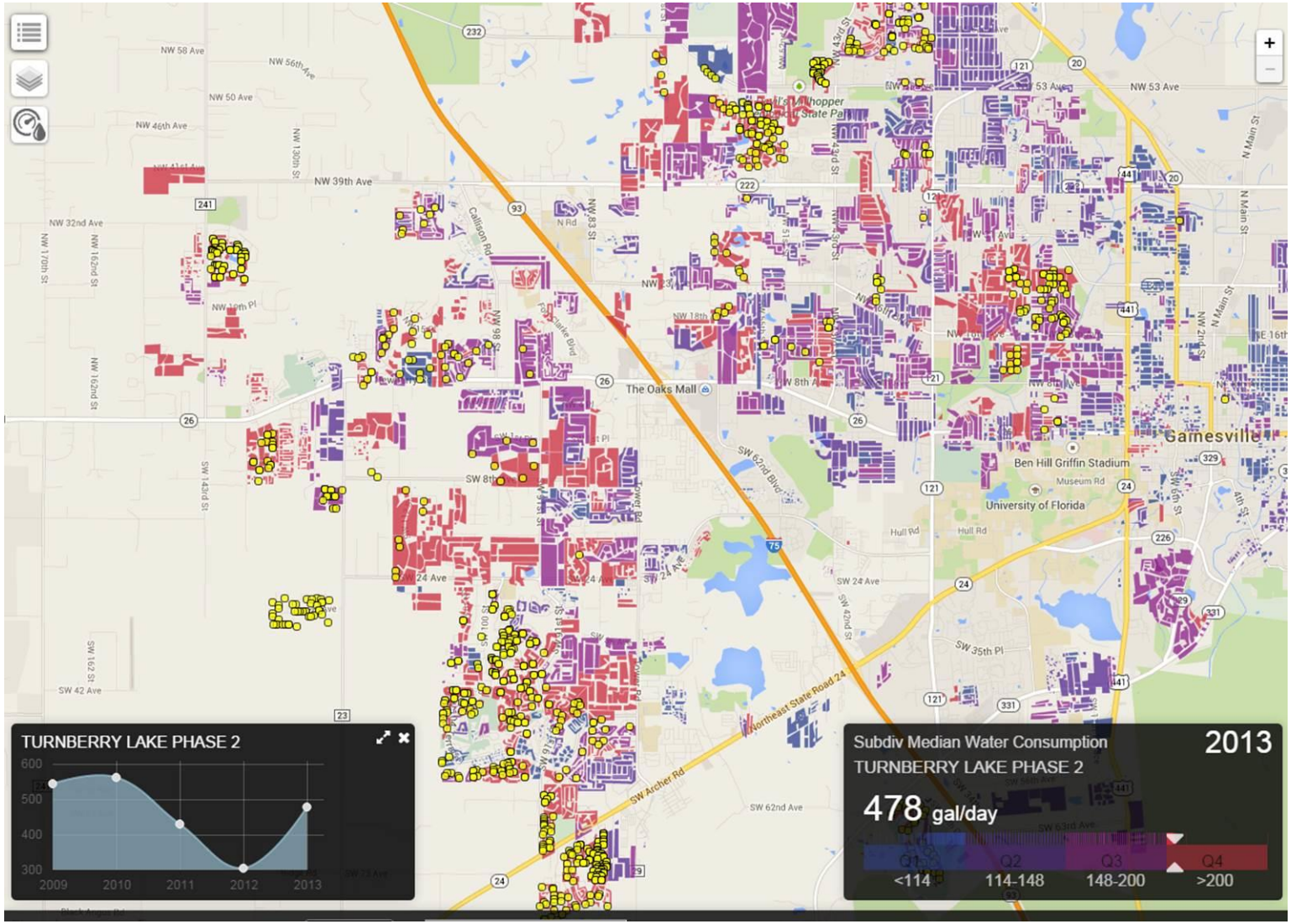
- Examine the effect of the inspection program on water use by all properties in the inspected subdivisions
  - Can seeing the inspection car and knowing about warning letters received by neighbors change a household's water use?

- Examining the robustness of the estimation results to the changes in the estimation methodology

- Compare the effectiveness of the restrictions (+inspection program) with other tools in the toolbox of the local governments
  - Soil and moisture sensors / smart irrigation controllers
  - Targeted education and outreach programs
  - Certification / peer pressure

Water Use Visualization Tool

Program for Resource Efficient Communities — University of Florida



Color coding: Average water use by subdivision

Yellow dots: warning letters

UF/Program for Resource Efficient Communities: http://buildgreen.ufl.edu/

Thank you!

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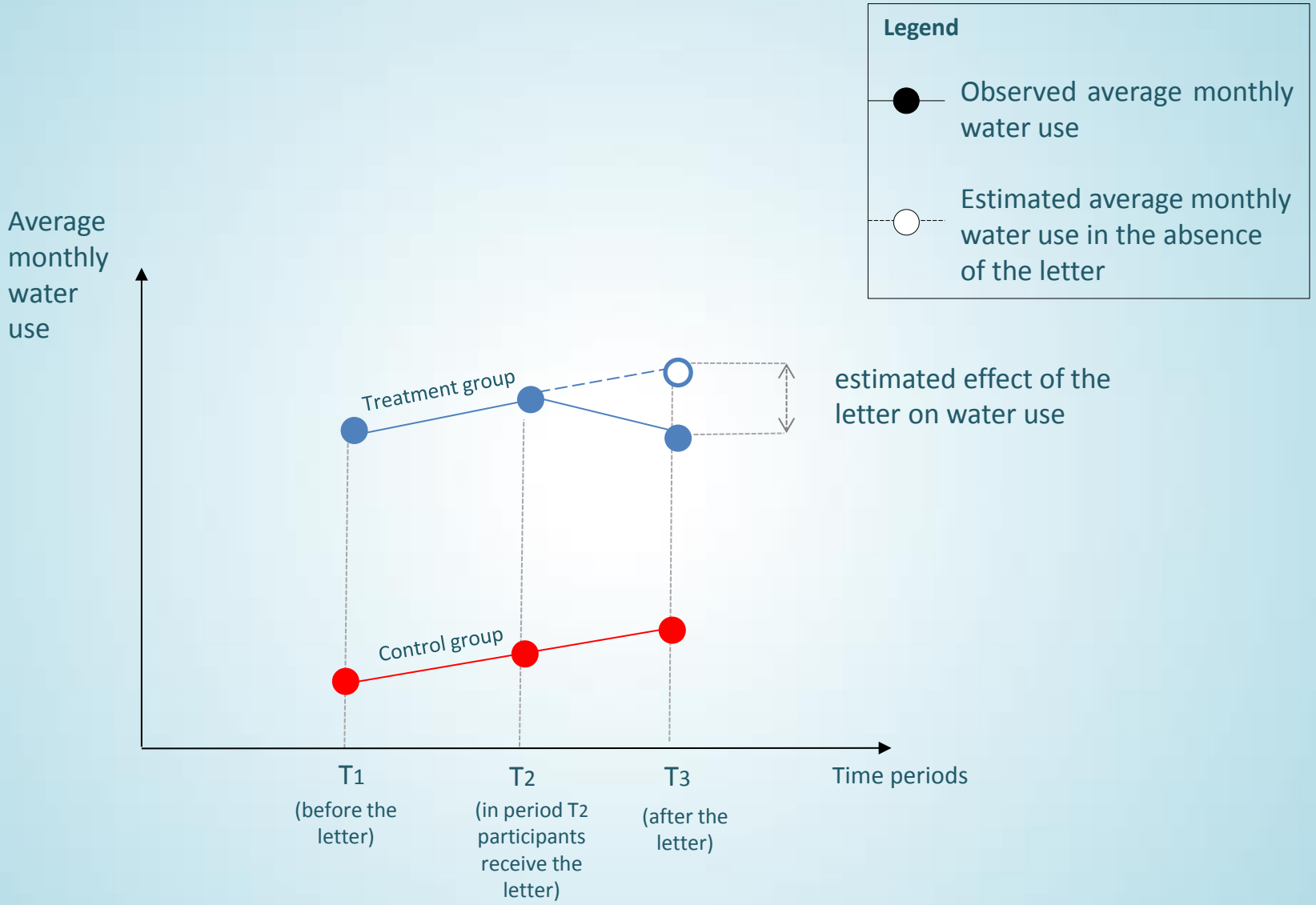
Method



#WaterConservation

Study Objective

- To estimate the effectiveness of ACEPD's inspection program:
  - Describe / analyze the properties receive warning letters.
  - Examine the changes in water use of those receiving ACEPD warning letters.

#WaterConservation