Estimating Nonresidential Water Use Within a Water Budget

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Conserve Florida Water

UF Environmental Engineering Sciences

Motivation

Historically, nonresidential water use has been estimated by the total number of employees within a given sector (Opitz et al. 1998; Maddaus and Maddaus 2004). Employment data is available from U.S. Economic Census or from private surveys. The U.S. Census is only available in five year increments and the employment data is aggregated to a geographical block. Commercial surveys are more thorough and precise, but their accuracy depends on the diligence of the respondent. This data must be purchased, and only provides a snapshot in time. In order to carry out a parcel-level water budget, a more accurate, frequently updated and robust database is required.

The Conserve Florida Water Clearinghouse (CFWC) EZ Guide 2.0 is a tool that is used to develop a water budget for a utility and evaluate conservation best management practices (www.conservefloridawater.org). Given the limitations of past models, including access to reliable data, EZ Guide 2.0 incorporates a new methodology to estimate nonresidential water use based on parcel-level land use and water billing databases. Parcel-level land use characteristics from the Florida Department of Revenue (FDOR)database were linked with historic water billing data for Commercial, Industrial, and Institutional (CII) customers in Hillsborough County Water Resources Services (HCWRS) to develop average, base, and peak water use coefficients normalized by heated building area. Heated building area is a consistent and well-defined measure of size, as well as good estimator of water use. Dziegielewski et al. (2000) investigated various CII sectors and only building area was found to be a significant indicator of water use across all customer categories. The water use coefficient of interest can be either average or peak use depending on the nature of the water conservation evaluation. Total water use over n sectors is calculated using Equation 1:

$$Q_{Total} = \sum_{k=1}^{n} (\alpha_k * x_k) \quad (1)$$

Where: Q_{Total} = water use for n sectors,
α_k = water use coefficient of sector k,
x_k = size of sector k, and
n = number of sectors.

By understanding what drives water use at the customer and end-use level, a utility is better equipped to formulate an optimal water conservation plan tailored to their service area.

Databases

The FDOR database, in conjunction with County Property Appraiser (CPA) databases, provide the heated building areas for every parcel in the State along with their land use classification, allowing for sector specific water use coefficients. By applying the water use coefficients developed by CFWC, any utility in the State can carry out a water budget at the parcel-level. The three databases used, along with their attributes of interest, are presented in Table 1. These relational databases are powerful, allowing analysis across spatial scales: macro (state, water management district, or county), meso (city or utility), micro (parcel), and nano (end use such as toilets) as shown in Figure 1.

Table 1. Databases and parcel attributes used to develop water use and area conversion coefficients.

Database	Attributes of Interest	Period of Record
HCWRS	• Monthly Water Use	2003 - 2006
FDOR	• Land Use Code • Effective Area	1920 - 2008
HCPA	• Heated Area • Land Use Code	1920 - 2008

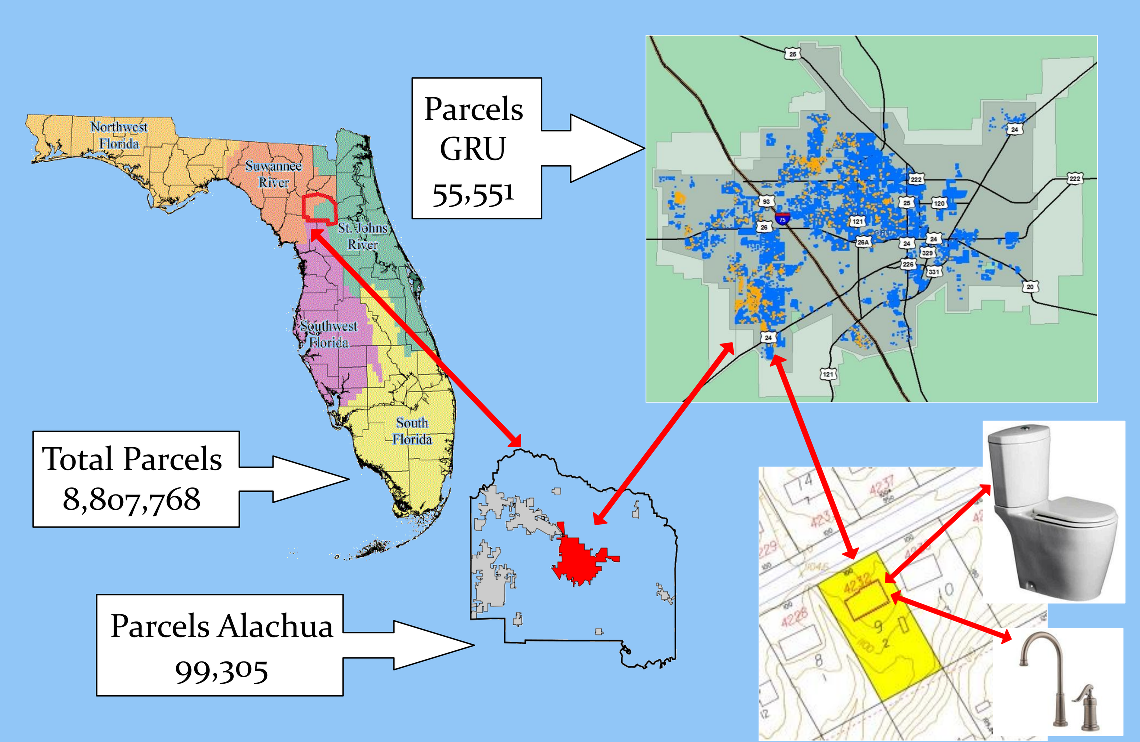

Figure 1. Macro to nano-scale evaluation of urban water use in Florida.

Methodology

Through the database-driven approached developed by CFWC, every utility in the State of Florida can determine the relative water use by different sectors of customers in their service area. This estimate of water use can then be calibrated with known total water use. Figure 2 presents a schematic of how the databases are related, along with particular attributes of interest. FDOR serves as the foundation for a Florida urban water database allowing for both spatial and attribute joins, and providing a consistent definition of terms. Population data from U.S. Census, utility service boundary information, utility flow data from the Florida Department of Environmental Protection (FDEP), and water billing records from select utilities are joined with the FDOR data as appropriate.

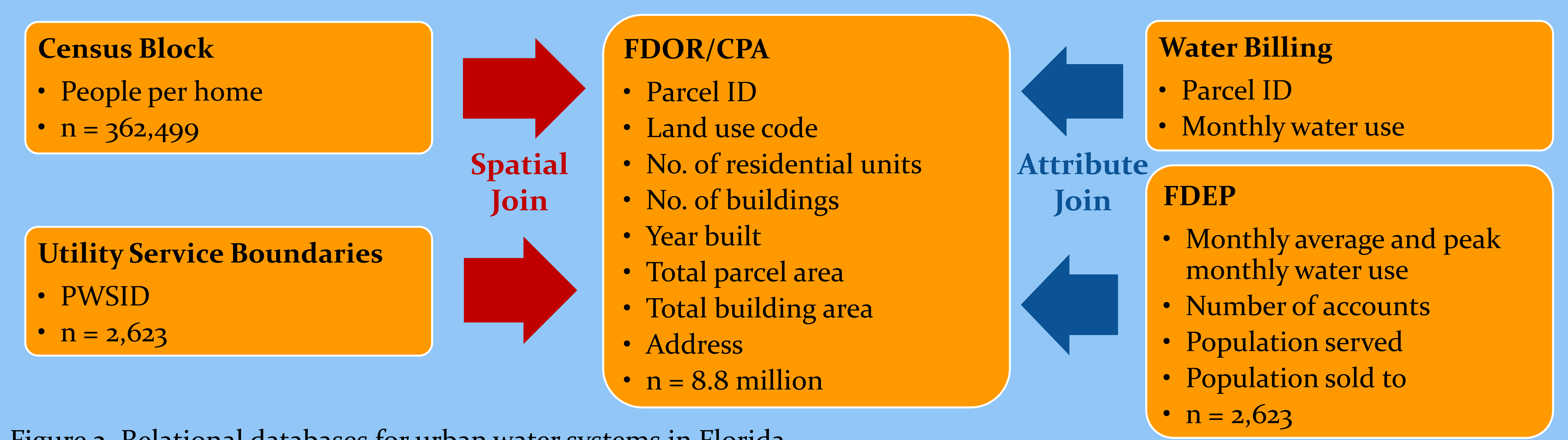

Figure 2. Relational databases for urban water systems in Florida.

The water use time series information from HCRWS for the CII sectors, as shown in Figure 3, was found to be fairly non-seasonal with insignificant trending. Thus, point estimates of water use coefficients were reasonable. The overall and May average water use throughout the four year period was computed for each parcel. The average May usage is the peak month use for most water utilities in Florida. Base water use coefficients were also similarly developed using the minimum average month of water use for each individual FDOR sector. The seasonal coefficient can be obtained by subtracting the base coefficient from the average water use coefficient. The adjusted billing records were then linked to FDOR and HCPA via the unique parcel ID. FDOR provided the two-digit land use codes for each parcel, allowing for their classification. The measure of size used to normalize the water use data and develop the activity coefficients is heated area from the HCPA. The water use coefficients were developed by summing the average monthly water use of all parcels within a given sector and dividing by their total heated area. This method of calculating the coefficients provides a weighted average which compensates for the skewness often found in the distribution of CII water users. Table 2 presents a cross-section of the water use coefficients developed. In this study, water use coefficients were developed for 37 of the 57 CII FDOR sectors, using a total sample size of 1,857 parcels in HCWRS.

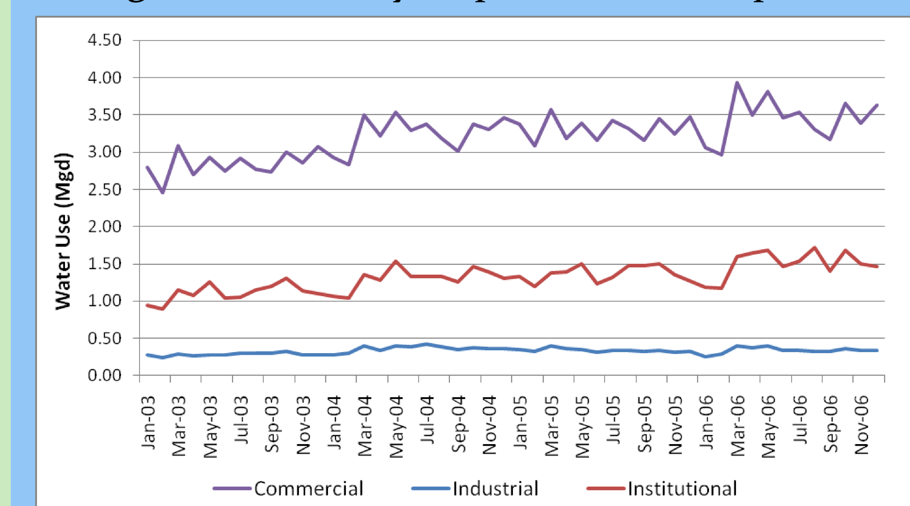

Figure 3. Time series plots for CII sectors in HCWRS.

Table 2. Cross-section of CII water use coefficients based on four years of monthly water use data from HCWRS.

FDOR	Description	Sample Size	Average Heated Building Area (sf)	HA/EA	Weighted Water Use Coef. (gal/hsf/mo) Average	Base	Seasonal	May Peak	SBUR	% Heated Area in Sector	% Water Use in Sector
11	Stores, One-Story	114	9,657	0.95	2.18	1.85	0.33	2.36	0.18	5.2%	2.8%
14	Supermarkets / Conv. Stores	121	6,619	0.95	7.92	7.14	0.78	8.63	0.11	3.8%	7.4%
16	Community Shopping Centers	165	39,444	0.95	3.49	3.25	0.25	3.56	0.08	30.8%	26.7%
21	Restaurants	70	5,133	0.96	25.52	23.29	2.23	26.50	0.10	1.7%	10.8%
39	Hotels / Motels	10	36,875	0.95	8.20	7.27	0.93	8.56	0.13	1.7%	3.5%
	Total Commercial	**1,207**	**17,521**	**0.95**	**4.03**	**3.62**	**0.42**	**4.20**	**0.12**	**100.0%**	**100.0%**

The limited number of 2-digit CII FDOR codes ensures that within each code multiple facility types with differing drivers of water use are grouped. Disaggregated groupings can be achieved by developing categories based on heated building area and age built of a facility, given the requirement or availability of certain end-use devices at the time of construction. Predicting what fixture types are prevalent in certain customer groups greatly improves estimates of water use, as well as facilitates the weighing of water conservation options. Table 3 presents an example analysis where FDOR 14 parcels less than 10,000 square feet were found to be predominantly gas stations.

Table 3. FDOR 14 water use coefficients by age group for size group less than 10,000 sf.

Age Group	Sample Size	Average Heated Building Area (sf)	Weighted Water Use Coef. (gal/hsf/mo) Average	May Peak
Pre-1983	17	2,436	4.67	6.76
1983-1994	45	2,281	12.35	13.16
1995-Present	49	3,496	19.09	20.83
Total	**111**	**2,841**	**15.00**	**16.49**

Through further investigation, it was determined that the time series increase in water use rate, shown in Table 3, correlates with the increased prominence of car washes and restaurants within newer gas stations.

Conclusions and Future Work

This CII water use estimating method should offer a significant improvement over traditional methods of estimating CII water use by combining water billing records with parcel-level land use databases, principally FDOR. These databases allow for the size of sectors and their activity coefficients to be developed by parcel-level data, which is a finer resolution than Census block data. They also provide a standardized classification system to categorize land uses across the State.

The available data can be used to improve the accuracy of water estimates, as well as further disaggregate FDOR sectors and their water use to the end use or process level. FDOR incorporates year built in its database. This information can be used to carry out time series analysis and find trends for both heated areas and activity water use coefficients over time. This analysis improves the accuracy of water use estimates and forecasts, and could provide insight into end uses. Indoor water use can be derived through estimates of fixture counts via the Florida building and plumbing codes, as well as frequency of use estimates from the literature. Outdoor water use can be evaluated by estimating irrigated area and cooling tower requirements.

References

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