Value of Using Irrigation Water in South Florida Agriculture

Preliminary Findings:

- From years 2000 to 2010, there has been significant economic loss (penalty) incurred from changes associated with surface and ground water usage in cropland of the Lower East Coast (LEC) and Upper East Coast (UEC) regions of the South Florida Water Management District (SFWMD).

- If there is a shortage of surface water, the preliminary research findings reveal that the Kissimmee Basin (KB) will experience the highest penalty, or approximately $2,300 of economic loss per one million gallons per day (MGD), among the four regions in the SFWMD cropland. These results indicate that if surface water is available in other regions, trading surface water to the KB from other regions is profitable for the entire SFWMD.

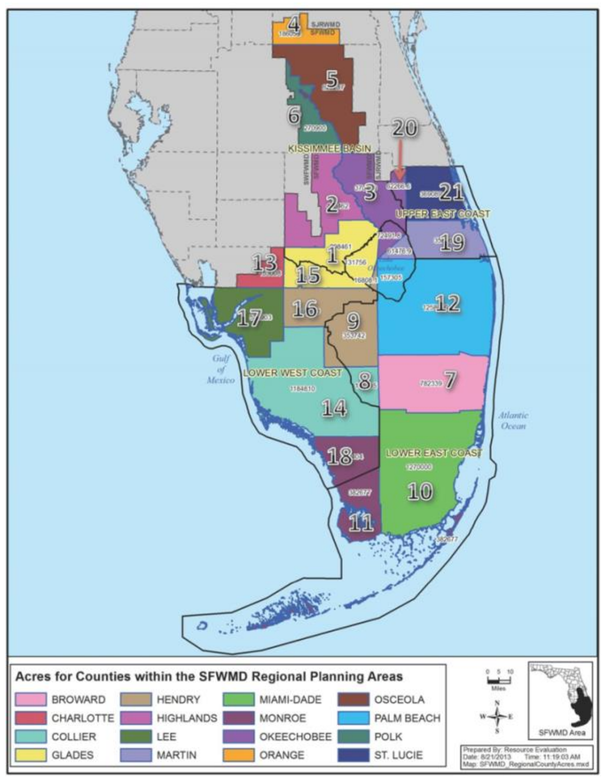
- Based on the research results, trading water from the northern Glades to southern Orange county is the efficient way to allocate water in order to minimize the economic loss in the KB. The penalty imposed to northern Glades county is about $300 per one MGD of irrigation water reduction, while the penalty is $2.98 million for the same amount of water reduction in southern Orange county.

- Trading water from Palm Beach County to Broward County or Miami-Dade County is the most efficient way to allocate water in the LEC. The penalty for reduction of water usage in Palm Beach is about $200 per one MGD, on the other hand the penalties imposed to Broward County and Miami-Dade County are $1.4 million and $10,000, for the reduction of the same amount of water, respectively.

Introduction:

Irrigation water is an important resource used for agricultural production. The Florida Department of Environmental Protection conveyed that traditional sources of fresh groundwater would have difficulty meeting all of the additional demands by 2030 (FLDEP, 2013 and SFWMD, 2012). The state of Florida produces approximately 65% of the U.S. oranges and 40% of the world's orange juice (FDACS, 2014). Sugarcane production in Florida is ranked number one in the nation (USDA, 2012). Shortage of water will impose significant damage to the rural and agriculture economy in Florida, which leads to higher prices and costs for consumers to purchase citrus or other agriculture products produced in Florida.

Figure 1: SFWMD Map and the Area Number[1]



[1] The original map is from the Regional County Acres, SFWMD, Aug. 21, 2013.

The present research study assesses the influence of irrigation water usage on the economic loss (penalty) for the South Florida cropland. Our research team focuses on cropland in the South Florida Water Management District (SFWMD), where 78% of the total value of farm products sold is comprised of cropland products. The majority of Florida citrus and sugarcane are produced in this area, and agricultural irrigation was the largest water use sector in 2010, followed by public water supply (FLDEP 2013). Changes in irrigation water use for agriculture production affect the economy in the district. This fact sheet highlights the economically efficient ways to allocate irrigation water, by comparing the penalties (economic loss), in the SFWMD regions.

Table 1: The Regions and Areas in the SFWMD

REGION NO	AREA NO	County	% County Area[2]
Kissimmee Basin (KB)			
1	1	Glades	0.60
1	2	Highlands	0.75
1	3	Okeechobee	0.75
1	4	Orange	0.32
1	5	Osceola	0.73
1	6	Polk	0.24
Lower East Coast (LEC)			
2	7	Broward	1.00
2	8	Collier	0.09
2	9	Hendry	0.48
2	10	Miami-Dade	1.00
2	11	Monroe	0.56
2	12	Palm Beach	1.00
Lower West Coast (LWC)			
3	13	Charlotte	0.35
3	14	Collier	0.91
3	15	Glades	0.40
3	16	Hendry	0.52
3	17	Lee	1.00
3	18	Monroe	0.44
Upper East Coast (UEC)			
4	19	Martin	1.00
4	20	Okeechobee	0.13
4	21	St Lucie	1.00

[2] % County Area is the percentage of the area out of the total county area.

SFWMD Regions:

The SFWMD is currently divided into four regions (SFWMD, 2013):

1. Kissimmee Basin (KB);
2. Lower East Cost (LEC);
3. Lower West Coast (LWC); and
4. Upper East Cost (UEC).

Each region contains several areas, with a total of 21 areas for the entire SFWMD[3]. Each area is numbered (AREA NO, as indicated in Table 1), and the area numbers are shown on the map in Fig. 1.

In the four regions, the total value of crop product sold and the number of employment are decreasing from 2000 to 2010. The use of surface and ground water is also decreasing significantly in the KB, LEC, and UEC regions, as more farmers shifted irrigation from surface to ground water on cropland (see Table 2).

Table 2: Cropland in SFWMD Regions[4]

REGION NO	REGION	YEAR	CROP VALUE ($ milion)	EMPLOYMENT	SURFACE WATER (MGD)	GROUND WATER (MGD)	RATIO of SW
1	KB	2000	$ 617	3,045	51	142	0.26
		2005	$ 649	2,724	59	119	0.33
		2010	$ 446	2,917	84	90	0.48
2	LEC	2000	$ 2,441	15,837	1,079	234	0.82
		2005	$ 2,533	14,321	869	174	0.83
		2010	$ 1,864	12,014	534	144	0.79
3	LWC	2000	$ 929	6,937	212	278	0.43
		2005	$ 886	6,953	166	197	0.46
		2010	$ 650	4,915	244	242	0.50
4	UEC	2000	$ 419	1,357	318	64	0.83
		2005	$ 402	1,182	196	42	0.82
		2010	$ 274	852	96	14	0.87
SFWMD	Total	2000	$ 4,406	27,176	1,660	718	0.70
		2005	$ 4,471	25,180	1,290	532	0.71
		2010	$ 3,234	20,698	957	490	0.66

[3] Areas 11 and 18 in Monroe County are not included in this study.

[4] CROP VALUE (CV) is adjusted by PPI cropland product in the year of 2010 (PPI 2010=100). PPI cropland product (PPI C) is estimated from PPI agricultural product (http://www.bls.gov/ppi/ppiover.htm). CV is compiled from the BEBR Florida Statistical Abstract 1997, 2002, 2007, and 2012 issued by University of Florida, (http://www.bebr.ufl.edu/data). EMPLOYMENT is obtained from the BEBR Florida Statistical Abstract 1997, 2002, 2007, and 2012 issued by University of Florida, (http://www.bebr.ufl.edu/data). SURFACE WATER and GROUND WATER were provided by the USGS Florida Water Science Center, Orland, FL. RATIO of SW is the ratio of surface water use out of the total irrigation water use.

What is the Effect of Producer's Benefit for a Unit Change of Water?

The producer's Value Marginal Product (VMP) of water is the effect of producer's benefit for a unit change in water usage (Johansson, 1993; Freeman 2003; Young, 2005). That is, VMP of water can indicate how producer's income changes when surface or ground water use is changed by one MGD. We studied which region can achieve the highest benefit to the agriculture sector in the SFWMD by utilizing one additional MGD (See Table 3) of water. Our study indicates that the KB region generates the highest benefit when one MGD of surface water is allocated, whereas the LEC and UEC regions generate the highest benefit for ground water use, from years 2000 to 2010.

Table 3: Value Marginal Product (VMP) of Surface or Ground Water in SFWMD Regions ($ million/MGD)

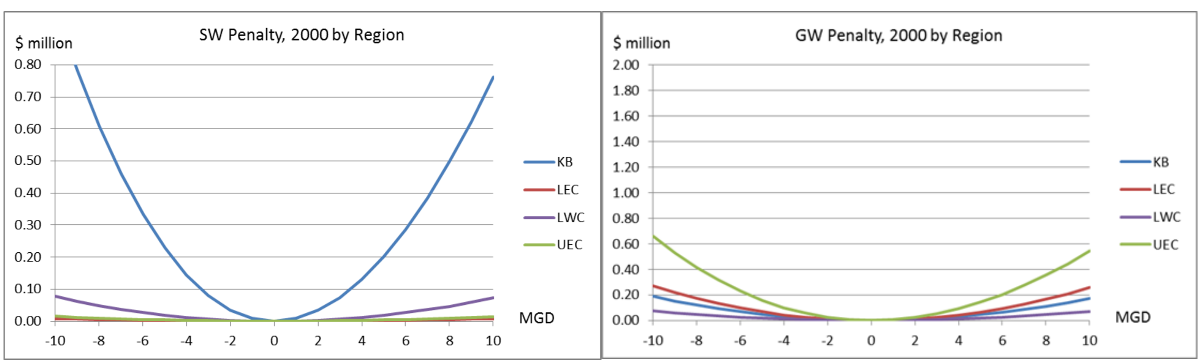
	SW			GW		
	2000	2005	2010	2000	2005	2010
KB	0.95	0.86	0.42	0.59	0.74	0.67
LEC	0.18	0.23	0.27	1.43	1.99	1.77
UEC	0.10	0.16	0.22	0.89	1.30	2.72
LWC	0.34	0.42	0.21	0.46	0.61	0.37
SFWMD	0.21	0.27	0.26	0.84	1.15	0.90

What is the Penalty Incurred to SFWMD Cropland if Irrigation Water is Under Shortage?

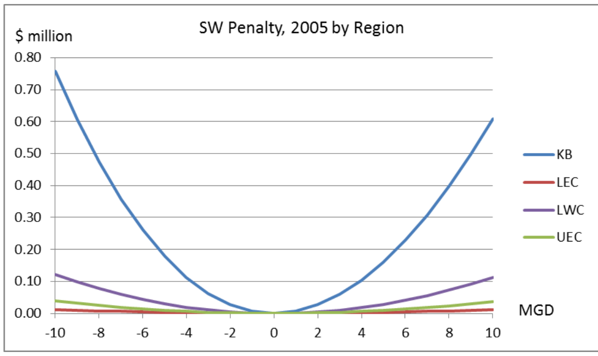
In this study, penalty is defined as an economic loss estimated by a loss of producer's profit when irrigation water is changed in the SFWMD cropland. Studying penalties are important for the economy of South Florida, because water supply shortages can lead to negative economic impacts for the agriculture sector, which also affects the other sectors of economies in Florida.

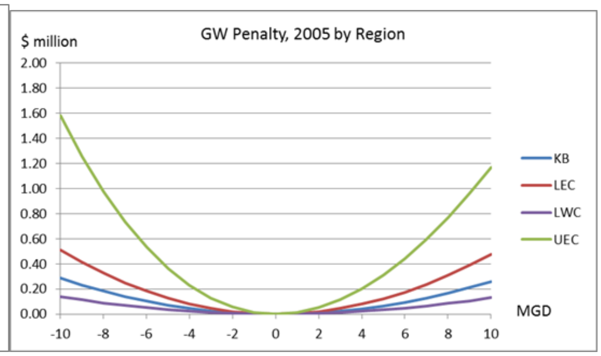
Our study finds that the KB would have a significant damage to crop farming if there is a shortage of surface water, although the degree of damage in the KB is diminishing over the last decade. The penalty to the KB is $2,300 per one MGD of surface water in 2010, which is more than ten times of the penalty for the LEC. Another notable trend is the penalty due to ground water use in the UEC is rising rapidly compared to the other regions (See Figure 2). The penalty to the UEC is $89,100 per one MGD of ground water use, which is about fifteen times more than the penalty associated with one MGD of ground water use to the LEC in 2010.

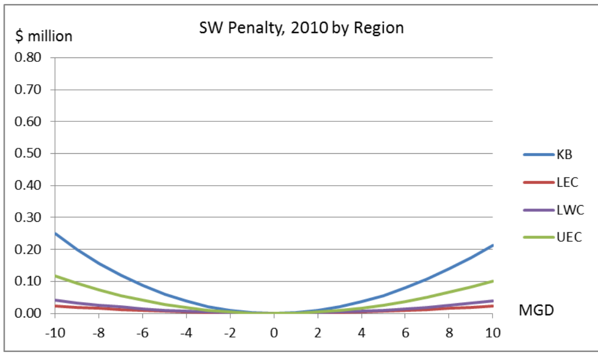
Figure 2: Penalty by Region in SFWMD from Years 2000 to 2010 (in $ million)[5]

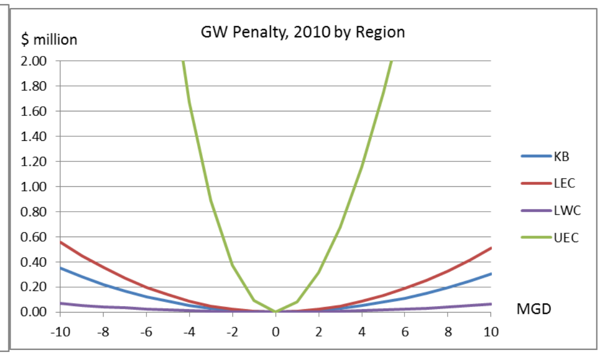


[5] The penalties ($ million) depict if an additional -10 to +10 MGD of surface or ground water is used across the four regions in years 2000, 2005 and 2010. The horizontal axis shows the change in surface (see figures on the left) or ground water (see the figures on the right) in MGD. The vertical axis shows the penalty in million dollars, and the scale ranges from 0 to 0.8 million dollars for changes in surface water and from 0 to 2 million dollars for changes in ground water use.









How Should Water be Efficiently Traded?

If each area needs additional irrigation water for cropland, producers will choose either surface or ground water based on the lowest penalty. Our study finds that if one MGD of water is under shortage in the KB, the most efficient way to allocate water is trading water from southern Glades (KB 1) to southern Orange (KB 4) county, which minimizes the economic loss to the entire KB. The ranking in Table 4 prioritizes the areas that should export water. The areas with the lower ranked number, with a lower penalty (or value) of surface water, should export water to the area with the high ranked number, which has higher penalty (or value) of irrigation water. For example, if water is distributed from Palm Beach county (LEC 12) or eastern Hendry county (LEC 9), and allocated to Miami-Dade (LEC 10) or Broward counties (LEC 7), then the LEC could end up with a lower penalty, which would result in minimizing the economic loss in the entire LEC.

Table 4: Penalties for changing surface or ground water by +1 or -1 MGD and the Ranking in the KB and LEC ($ million) Regions[6]

		d irrigation water= -1 MGD	d irrigation water= +1 MGD	Lower penalty	Rank (Lowest to highest penalty)
KB					
KB 1	Glades	0.0003	0.0003	SW	1
KB 2	Highland	0.0130	0.0125	GW	4
KB 3	Okeechobee	0.0052	0.0049	GW	2
KB 4	Orange	4.0357	1.5290	GW	6
KB 5	Osceola	0.0096	0.0089	GW	3
KB 6	Polk	2.9821	1.3050	GW	5
LEC					
LEC 7	Broward	1.3913	0.6508	GW	5
LEC 8	Collier	0.0083	0.0075	GW	3
LEC 9	Hendry	0.0004	0.0004	SW	2
LEC 10	Miami-Dade	0.0105	0.0103	GW	4
LEC 12	Monroe	0.0002	0.0002	SW	1

[6] We estimated the penalty resulting in using +1 or -1MGD of surface or ground water in the KB and LEC, and selected the lower penalty due to surface or ground water use. If a change in surface water use causes lower penalty, it shows in blue in Table 4. The table also indicates the penalty ranking from the lowest to the highest across the KB or LEC regions.

Further Study:

Our study assumed that the producers selected either surface or ground if they need additional irrigation water, but not combined surface and ground water. The effects of changes in combined surface and ground water use can also be examined. Figure 3 exhibits an example of a case study of the LEC. The amounts of surface and ground water uses are shown on the horizontal axis, and the penalty in millions of dollars is shown on the vertical axis. Figure 4 shows the optimal combinations of the surface and ground water use, which leads cropland farming to the lowest penalty of water use (red shaded area). Further analysis is needed for the cross regional analysis.

Figure 3 Penalty ($ million) Depending on the Combined Surface in LEC, in year 2010

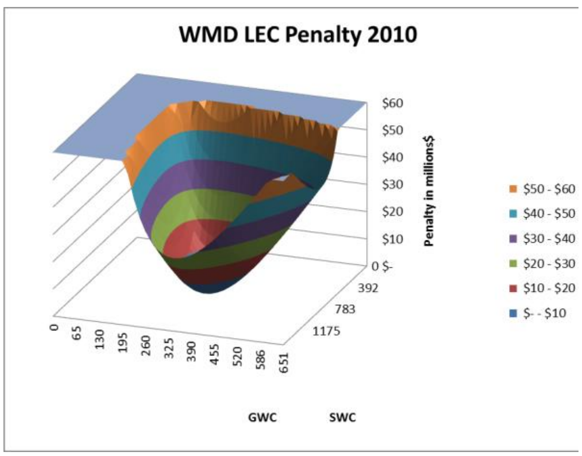
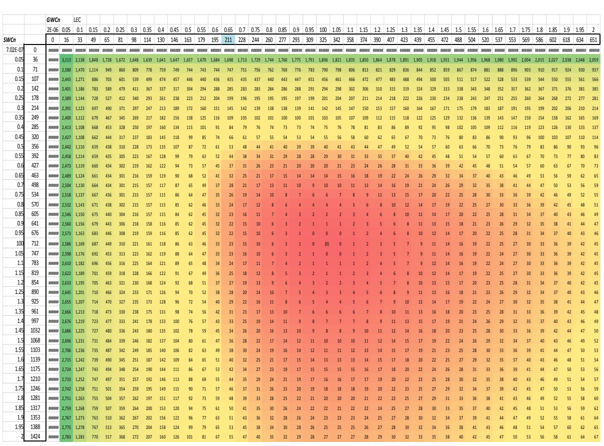


Figure 4 Optimal Minimal Penalties in a Two-input Combination of Surface and Ground Water Use in LEC, in year 2010



Summary:

Our study finds the penalties or economic losses associated with changing surface and ground water use in the SFWMD. The results of this study are important for the agriculture sector and water management entities, among others, in Florida. The recent data shows that the amount of irrigation water is declining in the SFWMD, which correlates to the value of crop product sold in the region. It is predicted that there will be a shortage of surface water by year 2030 in south Florida. The results of the research study provide options to minimize the economic loss by comparing water penalties across regions. Continued research of water pricing strategies and efficient water allocation mechanisms among regions is necessary for sustainable water resources and economies in Florida.

Acknowledgements:

The USGS Florida Water Science Center and SFWMD were helpful in providing data. This work was supported by grants from the National Science Foundation (#1204762) and the Agriculture and Food Research Initiative of the USDA National Institute of Food and Agriculture (NIFA) (#2012-67003-19862).

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