AN UPDATE OF

"AN ANALYSIS OF PUBLIC SUBSIDIES AND EXTERNALITIES AFFECTING WATER USE IN SOUTH FLORIDA"

Prepared for

THE EVERGLADES FOUNDATION

by

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Moonrise (Big Cypress) Photo courtesy of Clyde Butcher

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Additional recognition is due Mr. Jim Webb (deceased) of The Wilderness Society who conceived of the original 1990 publication and also to previous research assistants Mike Heimbach, Martin Schneider, and Darrell Davis of the FAU-FIU Joint Center who had collected and pored over government and industry data, prepared many tables and figures, and drafted several of the original sections on Federal program support and the water management district tax structure upon which substantive portions of this update are based. Dr. Tim Lynch, author of the sections relating to the regional economy in the original study and former chief Florida environmental economist and president of Econometric-Consult, generously provided his thoughts regarding this update.

Executive Summary

This report is an update to a study published in 1990 and reflects the changes in the conditions of South Florida affecting water use, the regional economy, the equitable use of tax dollars, and opportunities for the restoration of the Everglades.

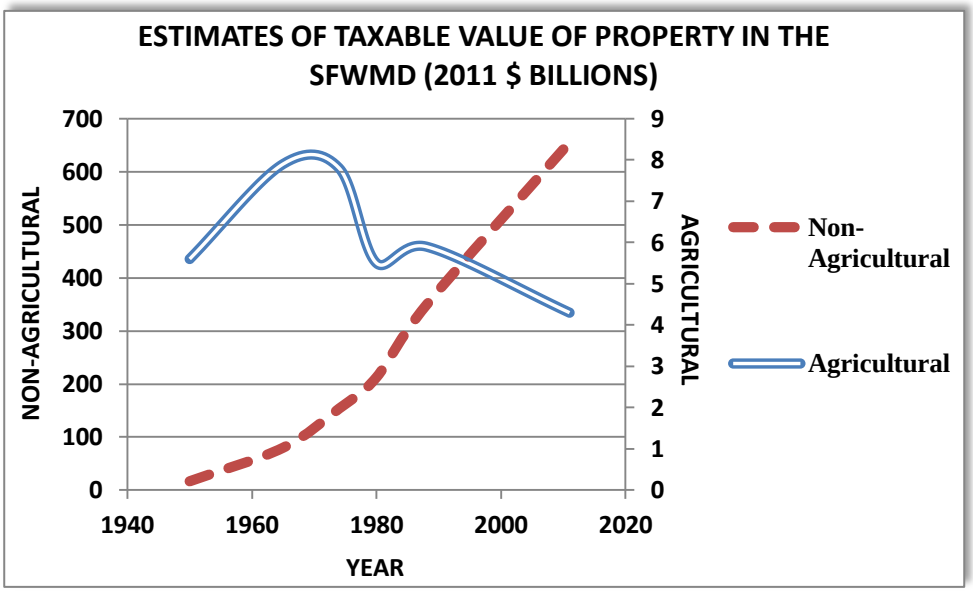
The original report concluded that the funding of water management led to distortion in the allocation and valuation of water supplies throughout the South Florida Water Management District, particularly in the three highly populated counties of the Lower East Coast (Miami-Dade, Broward and Palm Beach):

- Agriculture in South Florida operated at the expense of urban taxpayers locally and nationally;
- Subsidies such the allocation of water management expenditures and the Federal sugar program, and externalities such as degraded water quality, contributed to maintaining an industry that would otherwise revise its operations and impacts;
- The structure of water management has locked water into less highly-valued uses that generate inefficiencies and increasing conflicts during scarcity; and
- The existing framework of water management would continue to subsidize a declining industry.

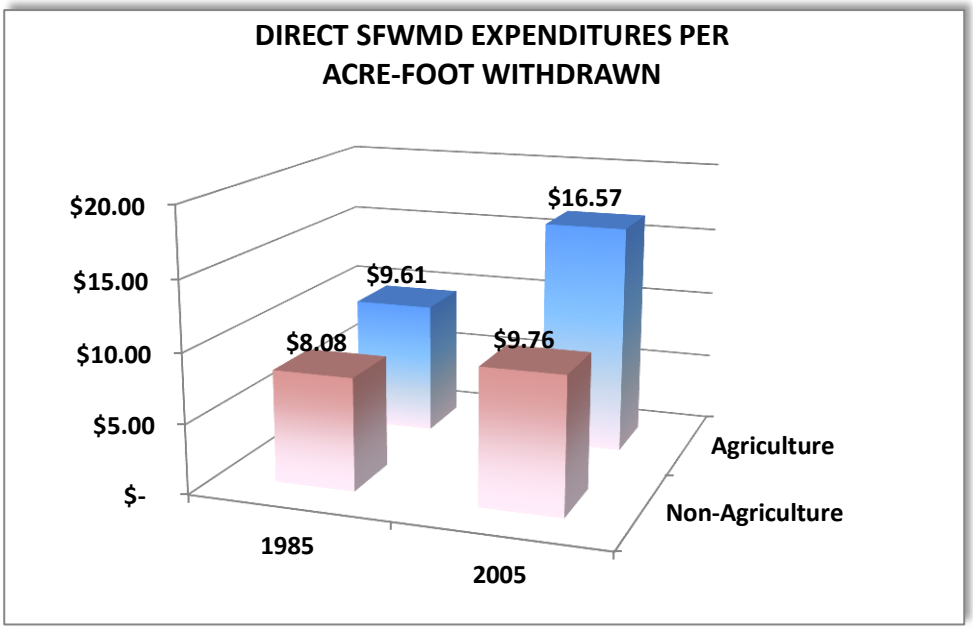
The analysis conducted in this update finds these original conclusions remain valid and offers numerous new findings reflecting the South Florida experience with regard to the above points during the past twenty years:

- Thousands of acres have changed their use and water demand characteristics over the past twenty years and a similar amount of land is expected to be transformed over the next twenty.
- Previous disparities in the relative costs of water for agricultural and non-agricultural use have become larger.
- The funding of water management for all purposes is born increasingly by the non-agricultural sectors of South Florida's economy.
- Between 1988 and 2011, the increase in the taxable value of non-agricultural lands was more than 393 times the increase in value within the agricultural sector.

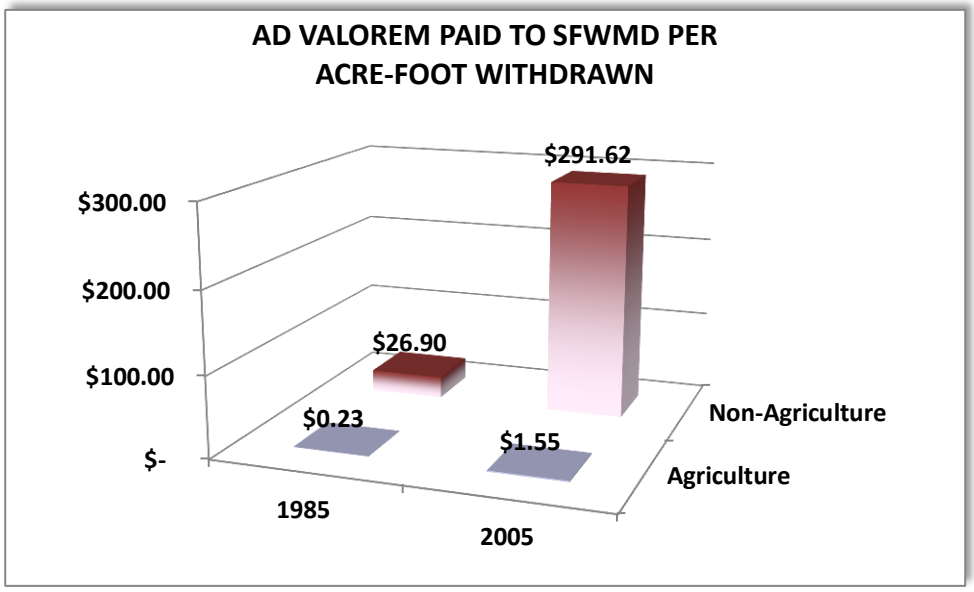
- Agricultural lands now contribute a smaller percentage of South Florida Water Management District ad valorem taxes than in 1990, providing less than $3 million for all District functions:



- The SFWMD now expends roughly twice as much money to ensure water supply for agriculture than it does to support the water supply for the urbanized Lower East Coast:

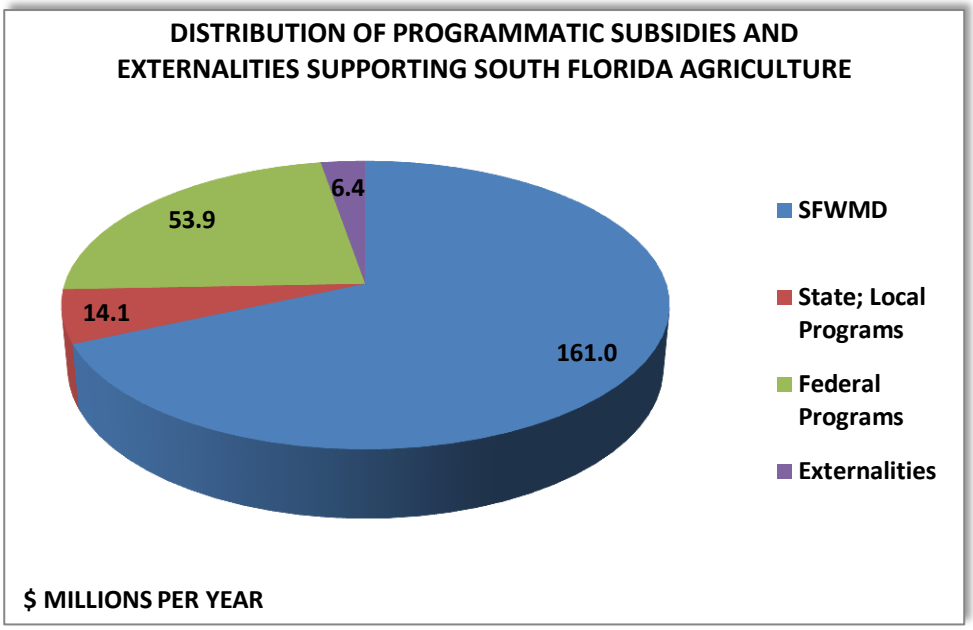


- Based on its share of ad valorem taxes, agriculture pays $1.55 per acre-foot of water withdrawn while the non-agricultural sectors pay $291.62 per acre-foot, 188 times as much. This is a greater disparity than had been determined in the 1990 study:



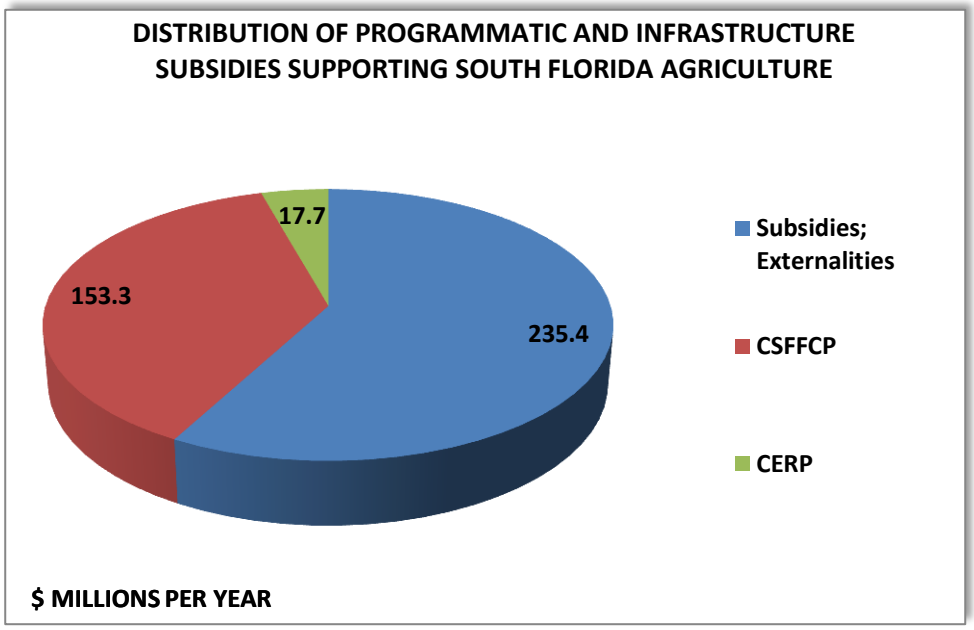
- While a few Federal and State programs have been superseded or replaced, agricultural programmatic, insurance and research subsidies now total $66 million per year.
  - In the context of operating the Central and South Florida Flood Control Project, the subsidy from the non-agricultural sectors to agriculture for SFWMD field operations and maintenance expenditures is $28.6 million per year and total subsidies via the District for other elements of water management in general are at least $64.6 million per year.
  - Despite adjustments to the State of Florida's leasing program, Everglades Agricultural Area (EAA) growers still benefit by about $1 million per year from below market-rate leases.
  - Despite the EAA Agricultural Privilege Tax, the net subsidy associated with the current plans for the Everglades Construction Project is $92.8 million per year.
  - The magnitude of subsidies and externalities that are most connected with water use that benefit agriculture in South Florida is about five and one-half times the subsidies that benefit non-agricultural uses.

- SFWMD Operations and Maintenance, other administrative functions, and the Everglades Construction Project produce an estimated $161 million in subsidies to the agricultural sector each year, two-thirds of the tabulated total from all sources:



- Recreational visits and tourists to areas impacted by EAA discharges have remained flat (relative to expected use) while unimpacted areas have seen increased usage.
    - The previous study underestimated the number of acres affected by nutrient-rich discharges from the EAA by more than 20,000 acres.
    - In addition to previously estimated reductions in bed taxes, quantified externalities now include sales of hunting and fishing licenses and boating registration fees.
    - Losses in the value of freshwater-based outdoor recreation and saltwater fishing are estimated conservatively to be about $2 million each.
    - Using several approaches to the issue not explored in the 1990 study, externalities are conservatively estimated to be $6.4 million per year.
    - Despite significant investment to reduce the environmental consequences of altered water quality and hydroperiod that have been the hallmark of regional water management for decades, the externalities of water use persist and have yet to diminish.

- State and federal programmatic subsidies and externalities of water use now total more than $235 million per year, about 58 percent of the support provided to the agricultural sector. Major multi-objective capital projects (the CSFFCP and CERP) contribute about 42 percent of the total support.



- In constant dollars, the unit costs of water (dollars per mgd, including all costs of delivery) declined about 16 percent for agricultural use, but increased about 92 percent for non-agricultural use.
    - Were the impact of subsidies and externalities included in the costs of water the unit costs of water for agriculture would rise by 343 percent, while the unit costs for the non-agricultural sector would *decline* by more than 12 percent.
    - The average marginal costs for water for agricultural use exceed the average marginal costs for non-agricultural uses when operation and maintenance and other programmatic subsidies are accounted for (i.e., it is not necessary to account for the subsidies provided through existing or proposed infrastructure to reverse which sector has higher average marginal costs).
    - Internalizing the costs of the externalities and subsidies would increase production costs in the EAA by about $161 per acre.
- Agriculture uses roughly the same water in 2005 as it did in 1985, but its role in the regional economy has declined.
    - Agricultural employment has declined by more than 40 percent.
    - Farm income and the number of farm proprietors have remained effectively flat.
    - Agriculture's share of regional exports has declined.

  - Agriculture now represents about 0.76 percent of the Gross State Product.
  - Sugar's share of agricultural revenues has declined and as of the 2007 USDA Agricultural Census represents 5.5 percent of Florida's crop value and 11.9 percent of the crop market value of the SFWMD.
- Options exist at the local and federal levels that would reduce the inequities in the costs of water between the agricultural and non-agricultural sectors:
  - Relying less on ad valorem as the primary vehicle for funding water management;
  - Using supplemental special taxing districts that would include compensation for loss of use as a primary purpose;
  - Redefining administrative basins within the SFWMD and adjusting millages to better reflect the division of operations costs between the sectors;
  - Modifying federal subsidies (insurance and direct payments) to address impacts to federal resources;
  - Revising state lands lease rates to reflect the share of generalized externalities associated with those specific tracts;
  - Emphasizing water and water management as public goods, and prioritizing the restoration and protection of natural systems in South Florida in the context of consumptive use permits and planned water use.
- Additional research (employing ecological economics in conjunction with traditional tools of environmental economics) is indicated regarding the economic impact and political feasibility of the various above options:
  - Emphasis upon inter-disciplinary studies, as water use affects both biological / ecological and socio-economic aspects of the region; and
  - Defining benefits in the context of water quality regulation and the need to conducting willingness-to-pay studies and to employ indirect valuation tools.

In sum, all sectors of the South Florida economy benefit from the significant investments made by local taxpayers, the State of Florida and the federal government in regional water management infrastructure and its operations. However, the non-agricultural sectors of the economy bear a disproportionately large (and increasing) share of these costs. Unless altered, the institutional frameworks that fund water management, provide direct and indirect subsidies that misallocate water resources, and shield the value of the externalities of water management ensure that these inequities in the costs of water will persist.

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Acronyms Used

Ac-ft/yr	Acre-feet per Year
AMC	Average Marginal Cost
ASCS	Agricultural Stabilization and Conservation Service
BCNP	Big Cypress National Preserve
BGD (bgd)	Billions of Gallons per Day
CCC	Commodity Credit Corporation
CERP	Comprehensive Everglades Restoration Project
COE	(US Army) Corps of Engineers
Corps	(US Army) Corps of Engineers
CPI	Consumer Price Index
CSFFCD	Central & South Florida Flood Control District
CSFFCP	Central & South Florida Flood Control Project
DEP	(Florida) Department of Environmental Protection
District	South Florida Water Management District
DOI	(United States) Department of the Interior
USDA	United States Department of Agriculture
E#	Scientific Notation, times ten to the power #
EAA	Everglades Agricultural Area
ECP	Everglades Construction Project
ENP	Everglades National Park
EPA	Everglades Protection Area
FCIC	Federal Crop Insurance Corporation
FWC	(Florida) Fish and Wildlife (Conservation) Commission
FY	Fiscal Year
GRP	Gross Regional Product
GSP	Gross State Product
KRB	Kissimmee River Basin
LEC	Lower East Coast
LOK	Lake Okeechobee
MGD (mgd)	Millions of Gallons per Day
MGY (mgy)	Millions of Gallons per Year
NRCS	Natural Resources Conservation Service
NPS	(United States) National Park Service
O&M	Operations and Maintenance
SFWMD	South Florida Water Management District
SOR	Save Our Rivers
SWIM	Surface Water Improvement and Management
TIITF	(Board of the) Trustees of the Internal Improvement Trust Fund
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WCA(s)	Water Conservation Areas
WRDA	Water Resources Development Act
WY	Water Year

Chapter 1.
Introduction

> "*One of the unfortunate legacies of an institutional structure that developed when supplies were vast in relation to the needs of an economically nascent country is a legal system of allocation which thwarts flexibility in water-use patterns. When water is locked into uses that are no longer high-valued, inefficiency abounds. When the distribution of resource use cannot adapt to changing economic conditions, conflict escalates.*"[1]

With a statewide average of more than fifty inches of rainfall annually and large groundwater resources Florida remains a water-rich state, but conflicts over water worsen and are exacerbated in part by the framework under which water is allocated. Historically, there has been enough water to meet society's diverse needs, including water to protect and restore natural systems, but there are insufficient economic incentives and signals for wise use of the resource and effecting a sustainable allocation among competing demands.

In reviewing conditions unique to Florida, Barnett (2007) noted that "the price of water is based upon politics rather than economics." She quoted staff of the National Water Research Institute ("The underpricing of this resource [drinking water] has led to the under-valuing of water") and the Yale School of Forestry and Environmental Studies ("As long as those long-run issues are not folded into the current price of water, no one is going to understand the true value of the resource).

This study teases apart some of the economic components of water use that have been in place in South Florida for decades. While the quote from Gibbons (above) had been in the context of water use in the American West, it is the position of the authors that existing circumstances in South Florida make manifest her conclusions and the report presents data and documents trends to this effect. More important, these conclusions point to the fundamental issues of equity that (1) will be difficult to remedy and (2) will escalate in scale.

Florida has had multiple examples of local and regional water shortage (e.g., the "water wars" of Pinellas, Hillsborough, and Pasco counties). However, the context of South Florida (the "Okeechobee Basin" in particular) is different in terms of the size of the region – 16 counties – and the degree of interconnection (natural and man-made) of all of its hydrological components: its issues are more akin to those of California.

Florida and South Florida in particular, has a lengthy history of water resources planning, misapplication, and manipulation. Despite this history and substantive legal requirements for communities, water management districts, and the state to adequately plan for the water needs of citizens, businesses, and the integrity of natural systems, water supply remains a core problem area for growth and development in the state. In spite of its high average rainfall,

[1] Gibbons, 1986.

Florida expects serious supply problems for many of its fast-growing urban areas. Approximately 80 percent of the state's population is located in the coastal zone where water resources are already strained. Seasonally low water tables along the coast, coupled with droughts, have resulted in the need for strict, mandatory conservation measures on several occasions and many areas continue to be under permanent restrictions. Land use measures, such as wellfield protection ordinances, have become necessary to isolate recharge areas from development. Further, where plentiful water resources previously existed in parts of the state where population is sparse, over-pumping and over-commitment of supply (especially higher quality groundwater) has resulted in marked reductions of flow at springs and related runs. Statewide, agricultural withdrawals continue to be more than double those of all non-agricultural use because of the need for irrigation throughout the year-round growing season and because rainfall is highly variable, both seasonally and across years (United States Geological Survey, 2005).

A. Purpose of Study

In 1989, the Wilderness Society contracted with the Florida Atlantic University / Florida International University Joint Center for Environmental and Urban Problems to perform an analysis of the economics of water resources in South Florida in the context of the various subsidies and tax structures that were contributing to the degradation of South Florida ecosystems, the Everglades in particular. The report examined the costs and benefits of four main subjects:

1. Capital projects, including the Central and South Florida Flood Control Project;
2. Operations and maintenance expenditures of the South Florida Water Management District;
3. Agricultural subsidies, including the Sugar Act; and
4. The use of water in general.

Of special concern were the relative benefits to the agricultural and urban sectors of South Florida's economy associated with the dollars paid for water management, and the study developed a methodology to address that subject.

The draft report was released in August, 1990 and the final report was published by the Wilderness Society in December 1990. The report concluded with a need for additional data, including more detailed information regarding public and private expenditures for water-related infrastructure, expenditures that affect patterns of development, and water use, among other topics.

To address some of these residual questions and data needs, the Everglades Foundation contracted with the Florida Institute of Government at Florida State University in February, 2012. This study, then, provides an opportunity to revisit the core issues of the earlier report, to include data from the roughly 20 intervening years, and to reflect on trends and changes in conditions. While this study tracks the general logic and outline of its predecessor, new tools of economic analysis are applied, the reviews of capital expenditures and selected externalities of water use are expanded, and trends in regional economics are given a more thorough treatment. Several programmatic subsidies at the federal and state levels were not updated as

part of this update, however. These were minor at the time of the original study (some no longer exist independently) and had been included only for completeness.

Central Problem Statement

At issue are perceived inequities between the minority of property holders who benefit from the economic institutions that impact the Everglades and the public interest concerned with ecosystem protection and the long-term sustainability of those economic systems which depend on the integrity of the Everglades. The purpose of this study, then, is to identify whether inequities exist and the degree of disparity in the values of these sectors to the regional economy relative to their consumption of water.

It is proposed here that South Florida agriculture (which includes the Everglades Agricultural Area and portions of southern Dade County) operates at the expense of the region's urban community and taxpayers nationally. Subsidies such as import quotas and guaranteed loan programs for sugar, misallocation of water and water management activity, underassessment of taxable property, and externalities of water management and pollution all contribute to maintaining the status quo of an industry that would otherwise dramatically change its scale and mix of operations. Further, the system of funding water management, from the per-acre tax of the early drainage districts to today's use of ad valorem, generates inappropriate economic signals regarding the value of water within the regional economy.

B. Description of South Florida

Water drives South Florida's economy. Drainage from the state's central interior irrigates important agricultural regions, recharges municipal groundwater supplies for a still expanding urban population, feeds extensive seafood-producing estuaries, protects municipal wellfields from saltwater intrusion, and supports a variety of subtropical ecosystems, including the Everglades National Park. To place the economics of water in context, it is necessary to briefly address the physical setting and general ecology of the region.

Boundaries

The boundaries of this study are those of the South Florida Water Management District (SFWMD, or "the District"), which includes the Everglades and Big Cypress watersheds. The former basin consists of the headwaters of the Kissimmee River and Chain of Lakes (located in the center of the state, south of Orlando), Lake Okeechobee, the Everglades Agricultural Area, the Water Conservation Areas (including the Arthur R. Marshall Wildlife Refuge), and the central and eastern portions of the Everglades National Park. The latter basin consists of the Big Cypress National Preserve and the western portion of the Everglades National Park (see Figures 1-1 through 1-3). In addition to these watersheds, the study area includes the lower east Atlantic coast, defined as the urbanized area extending from the St. Lucie Canal (Ft. Pierce) to Homestead, and the urbanized southwest coast extending from Ft. Myers to Naples. For selected economic analyses, the Big Cypress Basin (taken as Collier County and mainland Monroe County) is excluded.

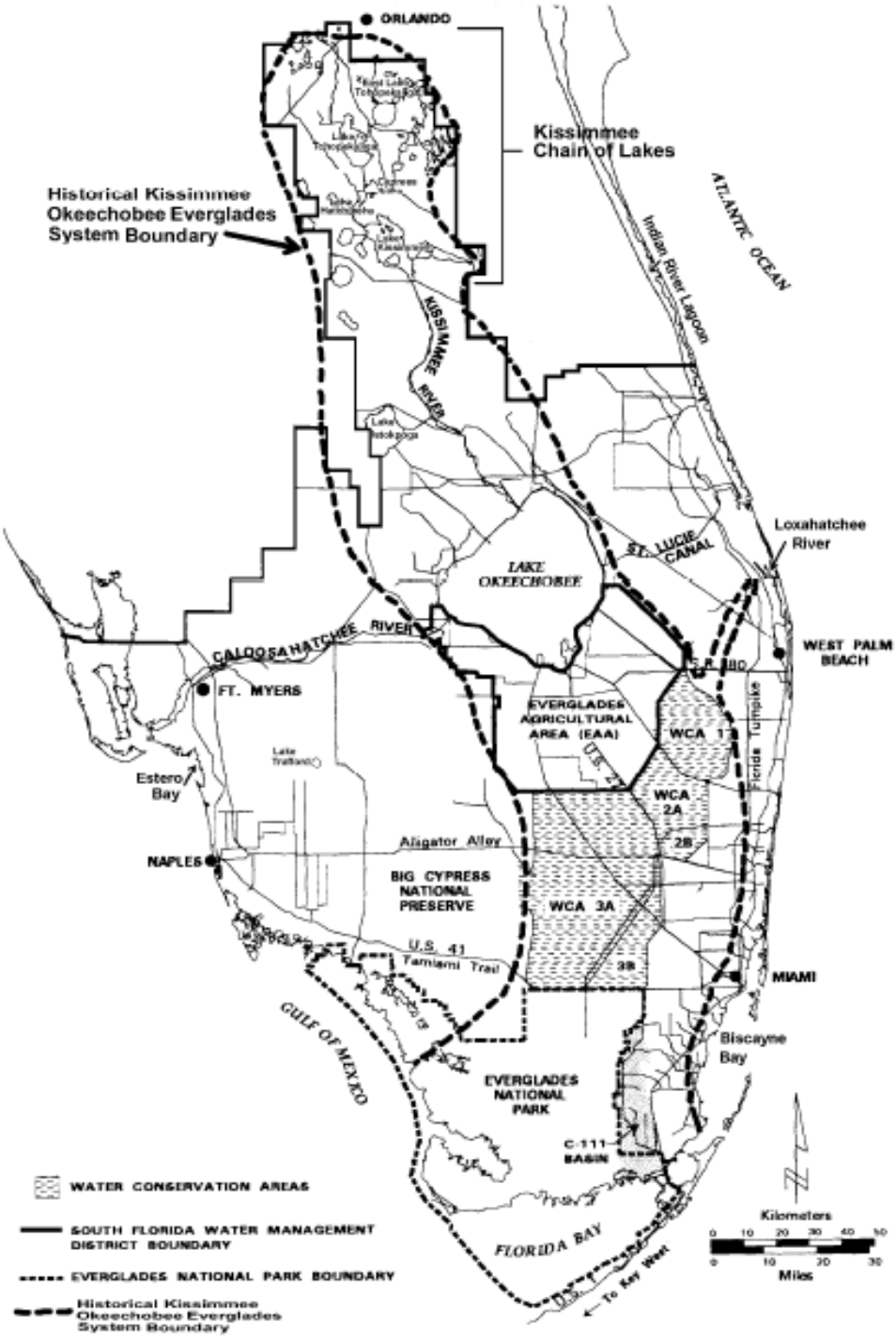

Figure 1-1. The Kissimmee-Okeechobee-Everglades System, "Everglades Watershed"

Figure 1-2. General Map of South Florida

Topography

Florida is a relatively flat peninsula surrounded by and saturated with water. While fragments of the Lake Wales Ridges in Orange and Polk counties exceed 125 feet above sea level, the land elevations from Lake Okeechobee south all lie below 25 feet mean sea level and

slope gradually downward from north to south with an overall grade of less than one-half foot per mile.[2] The elevation of the historical Everglades ecosystem, including Everglades National Park, the Water Conservation Areas and the Everglades Agricultural Area, ranges from sea level to about 15 feet with a slope on the order of one inch per mile. This extremely small gradient is responsible for the natural pooling of water in the peninsula's interior and its slow southward movement.

Climate

South Florida's climate is humid subtropical, characterized by a high average rainfall and temperature. The average annual maximum is approximately 84 degrees Fahrenheit and the average annual minimum is about 62 degrees Fahrenheit north of Lake Okeechobee and about 68 degrees Fahrenheit south of the Lake. Annual, region-wide precipitation averages approximately 54 inches while parts of the coastal zone receive as much as 63 inches. Over the periods of record for various stations in the region, 70 percent of the annual total (i.e., 41 inches) falls during the rainy season of June through October.

Total rainfall provides enough water to meet urban consumption needs, but not enough to protect municipal wellfields from saltwater intrusion.[3] Consistent, high temperatures, insolation and steady coastal breezes contribute to relatively high rates of evapotranspiration, much of which is cycled within the region through summer convectional storms.[4]

South Florida, however, is subject to marked climatic shifts characterized by decadal (or longer) patterns of drought and heavy rainfall. Since the previous study, significant droughts marked by seasonal rainfall less than 70 percent of the long-term average occurred in the years 1989-91, 1992-93, 2002-04, and 2007-09.

The region experiences the highest frequency of hurricane strikes in the United States, as exemplified by the 2004-05 hurricane seasons when six storms crossed the region. Following droughts in 1922 and 1924, two hurricanes hit the area in 1926 and 1928 resulting in $76 million in damage and the loss of 2,400 lives. After the 1945 drought, the 1947 hurricane produced flood damages totaling more than $100 million. Recent major hurricanes (Category 3 or greater) to hit South Florida include Andrew (1992), Charlie (2004), France (2004), Jeanne (2004) and Wilma (2005).

Droughts and flooding from hurricanes and tropical storms compound the challenges of providing adequate and consistent water supplies for all parties to the system of water management, including the natural sector.

[2] The Immokalee Rise exceeds 50' msl, but is not included in the primary focus of this study.
[3] Per Appendix F, gross rainfall totals in the Lower East Coast exceed water withdrawals by the urban sector.
[4] Water Management Implications of the Greenhouse Effect in South Florida, FAU-FIU Joint Center, 1988.

Hydrology

The region's hydrology is driven by its topography and overall climate. High rainfall coupled with a low gradient generates extensive sheet-flow; high temperatures and large, open surfaces generate large volumes of evapotranspiration in turn contributing to rainfall.

The major surface hydrological systems of the region are the Kissimmee River and Chain-of-Lakes, Lake Okeechobee and outlets, the Water Conservation Areas, and the coastal canal network of Dade, Broward, and Palm Beach Counties. These systems are connected by a comprehensive canal and levee network now stretching roughly 1,969 miles. Water flow is managed via 500 primary control structures, about 2,000 smaller control structures, and a series of nineteen high-capacity, low-head pumping installations and roughly 40 lower capacity pump stations.[5]

Surface water flow of the Okeechobee Basin begins in the upper Kissimmee region and is released through the control structures at the south end of Lake Kissimmee. It then flows south through a series of impoundments until it is discharged from the Kissimmee Canal into Lake Okeechobee. While Lake Okeechobee is the second largest freshwater lake within U.S. boundaries in terms of area, it has an average maximum depth of just 12 feet. The diking of Lake Okeechobee made it possible to raise the water level of the lake by several feet to provide flood protection and increase water storage. Water is released from the Lake to the coasts or into the Everglades Agricultural Area (EAA) via gates. Now lower in elevation than surrounding lands because of subsidence, compaction and soil loss from oxidation and erosion, the EAA has little natural drainage and depends heavily on privately managed pumps and the District's high-capacity pump stations to prevent flooding after heavy rains. Independent stations pump excess water from the area in wet months but also draw water from major canals for irrigation during the dry winter vegetable season. The publicly-operated pumps transfer excess water south into the Water Conservation Areas before discharge through structures to Everglades National Park.

With regard to groundwater, the Biscayne Aquifer is the primary freshwater supply for Dade, Broward, and southern Palm Beach Counties. This water table aquifer has a high level of transmissivity and an eight-inch well can yield in excess of 10 million gallons of water per day (VanArman, et. al., 1984). The balance between this freshwater supply and the adjacent saltwater is sensitive to disturbance. Development, such as the construction of the drainage canal system, subsidence, and the earlier water management practices lowered the freshwater head and facilitated the encroachment of salt water into the aquifer.

Ecosystems Encountered

The major ecosystems of the region, especially its interior, are the consequence of its flat topography and seasonal rainfall patterns. The dominant ecosystem of inland, southern Florida is the Everglades, comprised primarily of sawgrass marshes (*Cladium Jamaicense*) and tree islands featuring a variety of South Florida hardwoods. Tree islands and hammocks typically are found at grades only inches above the freshwater marshes, their longitudinal shape created

[5] http://www.sfwmd.gov/portal/page/portal/xweb%20drought%20%20and%20%20flood/canal%20and%20structure%20operations. New pumps are proposed for selected projects under CERP.

by the overall flow of water. The Everglades "River of Grass" is bounded by the Big Cypress Swamp, a separate hydrological basin on the west, and by the coastal ridge on the east. The perimeter of the lower peninsula is characterized by mangrove swamps and coastal marshes that are essential links in estuarine-oceanic food cycles, as well as providing a breeding ground for a variety of organisms.

True Everglades marshes extended from the southern edge of Lake Okeechobee to the middle of what is now Everglades National Park. Their western boundary approximated the current Broward-Collier County line, and their eastern extent was demarcated by the western base of the coastal ridge in Palm Beach, Broward, and Dade Counties. They historically occupied between 2 million and 3 million acres; they now cover about 600,000 acres. Over 700,000 acres were drained for agriculture in Palm Beach and Hendry Counties and the remainder was drained and filled for westward urban expansion, primarily in Dade and Broward Counties.

Prior to drainage and flood control projects, the northern part of the Everglades, immediately south and east of Lake Okeechobee, was covered by a layer of peat and muck, as thick as twelve feet in some pockets, derived from partially decomposed sawgrass. This layer supported dense vegetation characterized by sawgrass, marshes, sloughs, and tree islands dominated by pond apple. During dry periods, these marshes occasionally burned when struck by lightning. Drainage, however, has resulted in the muck layer drying and disappearing due to the rapid rates of soil oxidation and windblown losses. Ground levels have subsided by as much as eight feet.

This part of the original Everglades system has been developed for agricultural uses, primarily sugarcane. Drainage and flood control measures opened up approximately 700,000 acres in this area, and it has become an important farming center. The Everglades Agricultural Area (EAA), centered in Palm Beach County, produces diverse commodities such as vegetables, ornamentals, citrus, and beef and dairy cattle, along with sugarcane. Over 90 percent of the nation's winter vegetables are grown here and in the agricultural area east of the Park in southern Dade County.

The Water Conservation Areas cover 1,345 square miles and were constructed primarily to detain flood water during periods of excessive rainfall and serve as reservoirs during dry periods. For the most part, these areas encompass sensitive wetlands having once comprised a major portion of the original Everglades. The eastern edge of the Water Conservation Areas 2 and 3 overlies shallow recharge zones of the Biscayne Aquifer (Ft. Thompson formation) and thus contribute groundwater flow to the east during high stages. In addition to their hydrological value, the conservation areas are also managed for wildlife. The Arthur R. Marshall Loxahatchee National Wildlife Refuge occupies Water Conservation Area 1 and is an important wading bird nesting and breeding area. While sawgrass remains the dominant species, there has been marked encroachment of cattails (*Typha spp*) in open marshes, and extensive expansion of non-native invasive plant species Melaleuca (*Melaleuca quinquenervia*), Brazilian Pepper (*Schinus terebinthifolius*) and Old World Climbing Fern (*Lygodium microphyllum*) in areas with shorter hydro-periods. Further, in portions of open waters of the Conservation Areas there remains a shift towards higher concentrations of blue-green algae and a decrease in filamentous green algae and diatoms (Swift, 1981).

Everglades National Park was established in 1947 to become a permanent wilderness reserve for the preservation of its unique flora and fauna. It encompasses 2,188 square miles of the southern tip of the Floridan peninsula and most of the waters of Florida Bay. Its topography is that of a shallow basin underlain by Pleistocene limestone. The southern land edge of the Park is characterized by thin soil, rock outcrops, and less dense vegetation. The altitude of the Park ranges from sea level to a maximum of seven feet. On average, two-thirds of the Park is subject to yearly inundation. Approximately 36 percent of the Park is a shallow seawater bay sprinkled with numerous small, exposed islands and brackish water marshes. Vegetation in the Park is dominated by sawgrass prairies dotted with scattered tree hammocks. The Park supports 25 species of native mammals including two endangered species, the Florida Panther and the manatee; more than 300 bird species including the bald eagle, Everglades kite, and the great blue heron; and 60 known species of reptiles and amphibians including the American alligator, the endangered American crocodile, and the loggerhead turtle. As with the Conservation Areas, the Park suffers from non-native invasive species, including Chinese privet (*Ligustrum sinense*), and the problematic Burmese Python (*Python molurus bivittatus*), Nile Monitor (*Varanus niloticus*), and Cuban Treefrog (*Osteopilus septentrionalis*).

Effects of Water Management on the Environment

As far back as 1943, there had been documented displacement of Everglades sawgrass by elderberry, willow, maidencane, and wax myrtle. Reasons for this change in the natural marsh vegetation, which acts as a natural filtering agent, included drainage, the drop in Lake Okeechobee stage, increased nutrients in runoff from agricultural activities, and the modified flows of water that have been an integral part of the water management system.

Subsidence, or lowering of the soil level, is another problem facing the area. Subsidence results from drying, compaction, wind erosion, burning, decomposition of soil, and loss of buoyant force of water. Subsidence has been shown to be linearly related to depth to water table, regardless of type of crop grown. The overall rate of subsidence was estimated by the SFWMD to average 2.2 cm per year during the period from 1935 to 1975. As of 2010, the rate of subsidence is perhaps one-tenth the historical rate, i.e., less than one inch per decade.[6] There has been a complete loss of muck in the southernmost portions of the EAA, which has eliminated opportunity for traditional cultivation. This loss represents approximately 185,000 acres, equivalent to between 185,000 and 300,000 acre-feet (acre-ft) of muck, i.e., 50 million tons of topsoil. The average decline in ground elevation between 1912 and 1970 was more than five feet, and more than six feet nearer to canals.

Regionally, as the ground level declined the water table was lowered to maintain proper depth to table for agriculture. Therefore, additional water had to either be backpumped or drained from the area, effectively drying out interior South Florida. In addition to the community displacement mentioned, increased frequency of fires and severity of droughts were considered outcomes of this phenomenon.

[6] http://edis.ifas.ufl.edu/ss523; calculations of volume based on area of the EAA.

C. Context of Study

The analysis of the economics of water in South Florida must be understood in the context of its demography and water use characteristics, as well as the evolution of the region's system of water management.

1. Demography of the Region

The availability of land (once adequately drained), coupled with the state's other attributes, has caused Florida to become, and to remain, one of the nation's fastest growing states. During the period between 1970 and 2010, Florida (statewide) averaged more than 822 new residents per day. It is now the fourth largest state and is poised to become the third largest state by 2020.[7] If development trends follow those since the early 1950s, most of these new residents will settle in the densely populated coastal communities. Roughly 80 percent of the state's population lives in coastal counties which comprise about 25 percent of the state's total land area. More than 98 percent of the state's coastal population lives in those coastal counties with sandy beaches, and the coastal counties of the SFWMD all feature such shorelines.[8]

Appendix A-1 provides data about population trends for the 16 counties comprising the SFWMD. Adjusted estimates of population for the SFWMD based on those portions of the counties not wholly within the SFWMD are provided in Appendix A-2. The populations of the four urban counties of South Florida (Palm Beach, Broward, Miami-Dade, and Monroe) whose municipal water supplies are most directly affected by SFWMD operations are described in Appendix A-3.

The population of the region (i.e., the SFWMD) grew by more than 187 percent in the years between 1970 and 2010, and grew by an estimated 16.1 percent between 2000 and 2010. The population of the four urban counties of South Florida grew by more than 143 percent between 1970 and 2010, and grew by an estimated 10.8 percent between 2000 and 2010. The share of the district represented by the four-county urban area has declined from a maximum of about 87 percent in 1960 to about 74 percent in the last census (2010). This shift is expected to continue as the populations of counties such as Collier, Lee and Orange are increasing more rapidly.

Regardless of these changes in regional and local rates of growth, the SFWMD represents 40 percent of the population of the State of Florida, and the four-county urban core of South Florida, at more than 5.6 million persons, is 30 percent of the state's population (Figure 1-3). Looking ahead to 2030, with an estimated (adjusted) population of 9.5 million the District is expected to comprise about 39 percent of the state's total population, with the share represented by the urban core of South Florida declining from 74 percent to about 69 percent of the District.[9]

[7] Florida Statistical Abstract, 2011

[8] While mainland Monroe County is mangrove edged, the county is included by the FDEP among those subject to the Coastal Construction Control Line rules.

[9] Florida Demographic Estimating Conference, July 2011.

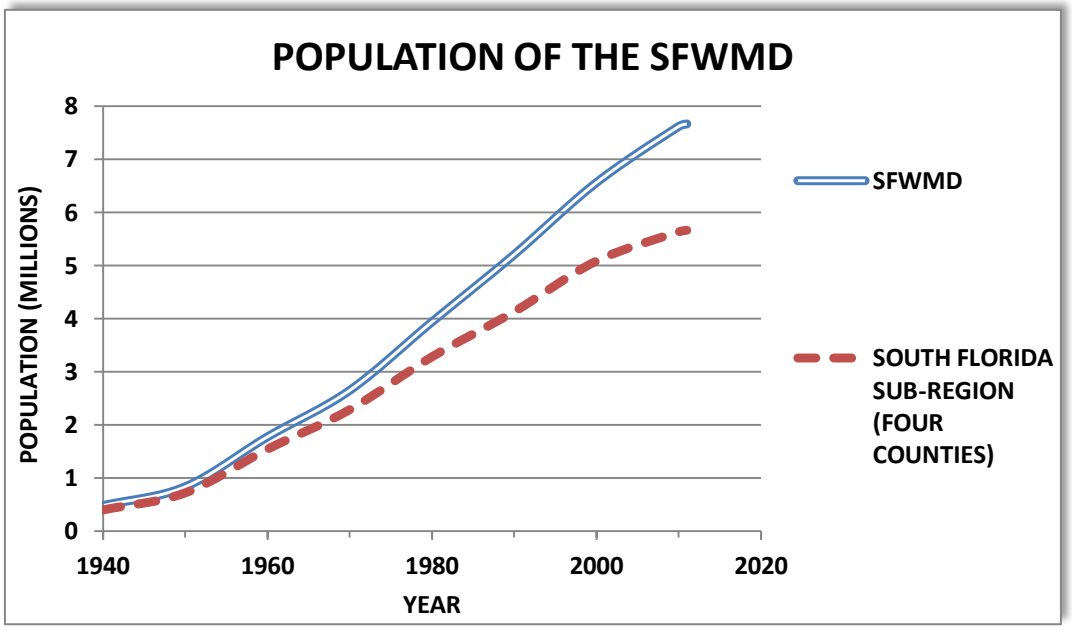

Figure 1-3. Population of the South Florida Water Management District, 1940-2011

By the year 2030, the population of the urbanized counties of South Florida is expected to increase another 16.1 percent to an estimated 6.6 million. This localized growth has significant implications for the urban share of the ad valorem property taxes that support water management. Discounting the projected growth in Osceola County that is part of the Orlando metropolitan area, population growth of interior, predominantly agricultural counties is expected to be modest, increasing by about 36,000 persons, or 24 percent.

Table 1-1 describes the change in population since the 1990 study, which estimated the population in 1987. The most significant increases occurred in Miami-Dade, Palm Beach, Broward and Lee counties. Modest increases in population have occurred in the rural areas within the District (Charlotte, Hendry, Highlands, and Okeechobee counties). Based on non-vacant parcel data, that portion of Orange County within the District did not exhibit marked growth. The total change within the District over the past twenty-four years is estimated to be 2.77 million persons, an increase of about 56.6 percent, or about 1.86 percent per year district wide.

Population of the Everglades Agricultural Area

The demography of Everglades Agricultural Area (EAA) is tied to the area's evolving role in the economy of the District as a whole. The incorporated communities of the EAA include the cities of Moore Haven (Glades County), Clewiston (Hendry County), Pahokee and South Bay (Palm Beach County). The incorporated population of the EAA in 2010 was less than 20,000 and grew by about 5,870 persons between 1970 and 2010, or by about 43.5 percent.

Table 1-1. Change in Population of SFWMD, by County, Adjusted for District Boundaries (1000s)

COUNTY	1987	2011	Numerical Change	Percent Change
Broward	1,181	1,753	572	48.4%
Charlotte*	0	0	0	174.5%
Collier	127	324	197	154.9%
Dade	1,802	2,517	715	39.7%
Glades	7	13	6	83.0%
Hendry	25	39	14	55.6%
Highlands*	8	9	1	11.1%
Lee	294	625	331	112.7%
Martin	89	147	58	64.8%
Monroe	75	73	-2	-3.1%
Okeechobee*	28	39	11	39.5%
Orange*	235	243	8	3.4%
Osceola*	88	236	148	167.6%
Palm Beach	790	1,326	536	67.8%
Polk*	19	47	28	148.0%
St Lucie	128	280	152	118.5%
TOTALS	**4,896**	**7,669**	**2,773**	**56.6%**

***** Estimates based on the number of non-vacant, residential lots within the SFWMD. The District estimated less than 1,000 residents in Charlotte County through 2007 and then ascribed an estimate of more than 6000 individuals in the several years since then. While the District's numbers for individual counties do not match those reported by BEBR or the EDR, despite reference to these sources, the total population for 2011 is the same.

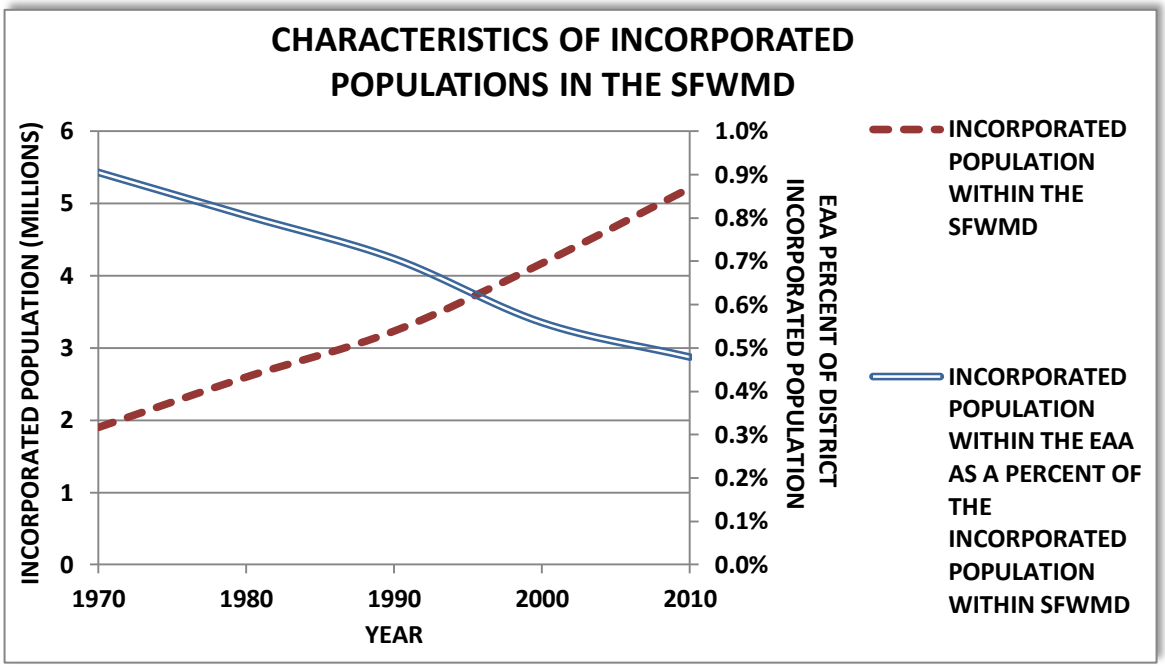

Figure 1-4. Relative Decline in the Share of the Population of the EAA, 1970-2010

Figure 1-4 indicates that while the incorporated population of the EAA has increased, its share of the incorporated population of the entire District (which is about 94 percent of the total District population – incorporated and unincorporated) has declined from about 0.9 percent in 1970 to less than 0.5 percent over the past 40 years. Based on the statewide and local demographic trends of coastal communities, the percentage of the District population represented by the EAA will decline further.

Figure 1-5 documents the significant shift in the relative rates of population growth in these sub-areas over the past four decades. While the growth rate of the EAA has been less than that of the rest of the District (and the Lower East Coast), there was only modest growth in the 1980s and 2000s and only nominal growth during the 1990s. Further, while the growth rate of the District as a whole has been declining from 35 percent per decade to less than 25 percent per decade, the difference between growth rates between the EAA and the rest of the District has increased over time. The EAA-centered population will become less significant in the context of the region.

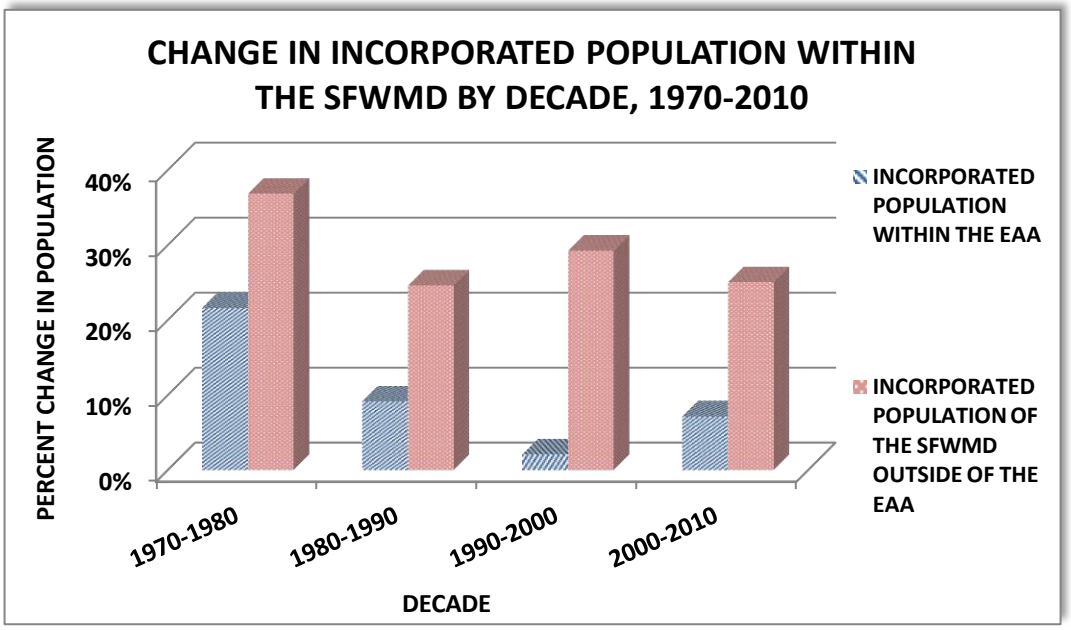

Figure 1-5. Percent Change in Population Within and Outside of the EAA, 1970-2010

2. Water Use in the Region

Water is a necessary component of production, both for urban and agricultural output. The 1990 report reviewed water use as a snapshot in time – using the 1985 county level withdrawals for specific end uses. This update includes data for the intervening years – through 2005 – documenting changes in the patterns of use. The USGS data for 2010 is not yet available. Appendix B-1 summarizes water use for all counties within the SFWMD in 2005 and Appendix B-2 reports freshwater withdrawals by end use and source for the period 1985-2005.

Figure 1-6 describes the changes in water source over time. Within the region, groundwater use has represented between 52 percent and 55 percent of total freshwater withdrawals. Total freshwater use has declined by about 13 percent between 2000 and 2005, bringing freshwater water withdrawals to roughly that of 1990, despite population growth. However, the trendline in Figure 1-7 makes evident the increase in use over the 20-year period.

Figures 1-7 and 1-8 describe the changes in demand by end use. In 2005, agriculture accounted for 31 percent of groundwater use, a reduction from the estimated 43 percent in 1985. Agriculture used 85 percent of surface water, a decline from the estimated 96 percent in 1985. Agriculture's share of total freshwater use has declined from 67 percent to about 55 percent, i.e., about an 18 percent reduction in its share. Demand for irrigation water has increased slightly above the level of use in 1985.

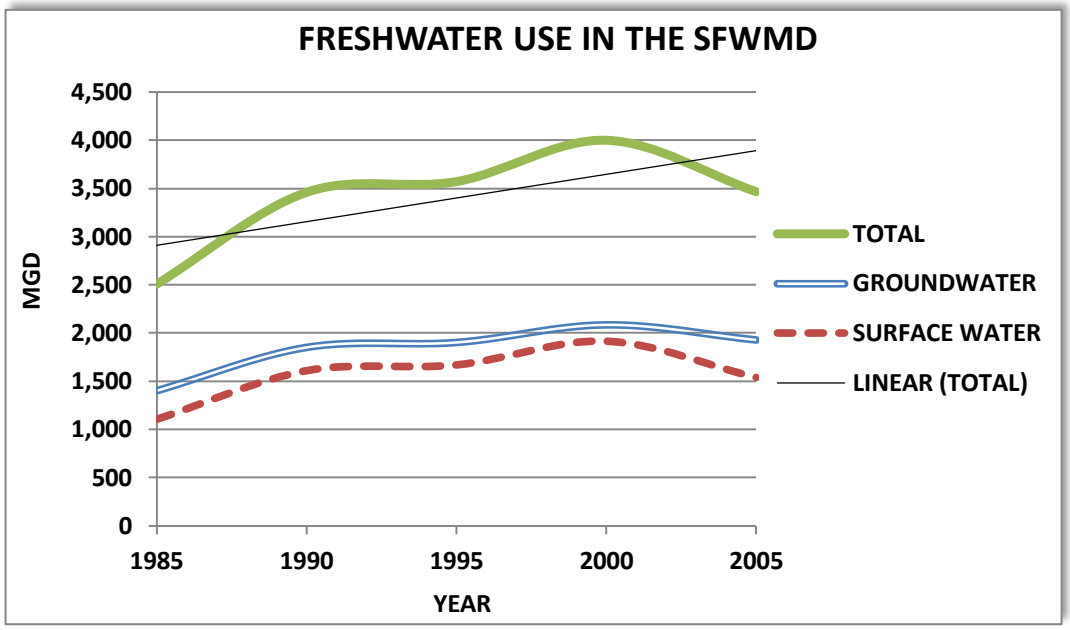

Figure 1-6. Freshwater Withdrawals within the SFWMD, 1985-2005

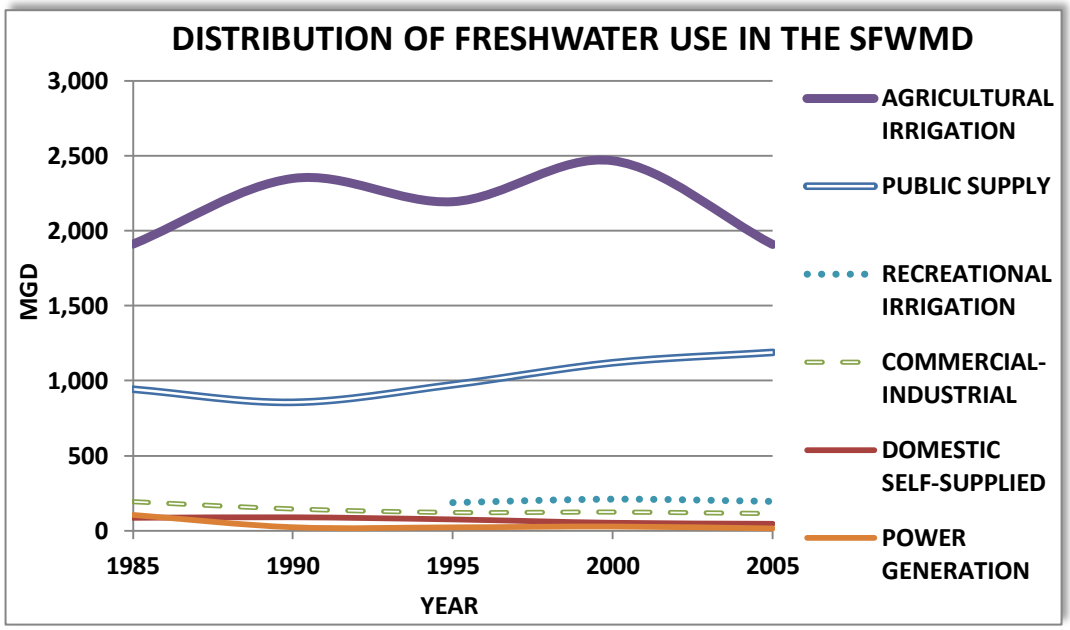

Figure 1-7. Distribution of Freshwater Withdrawals within the SFWMD, 1985-2005

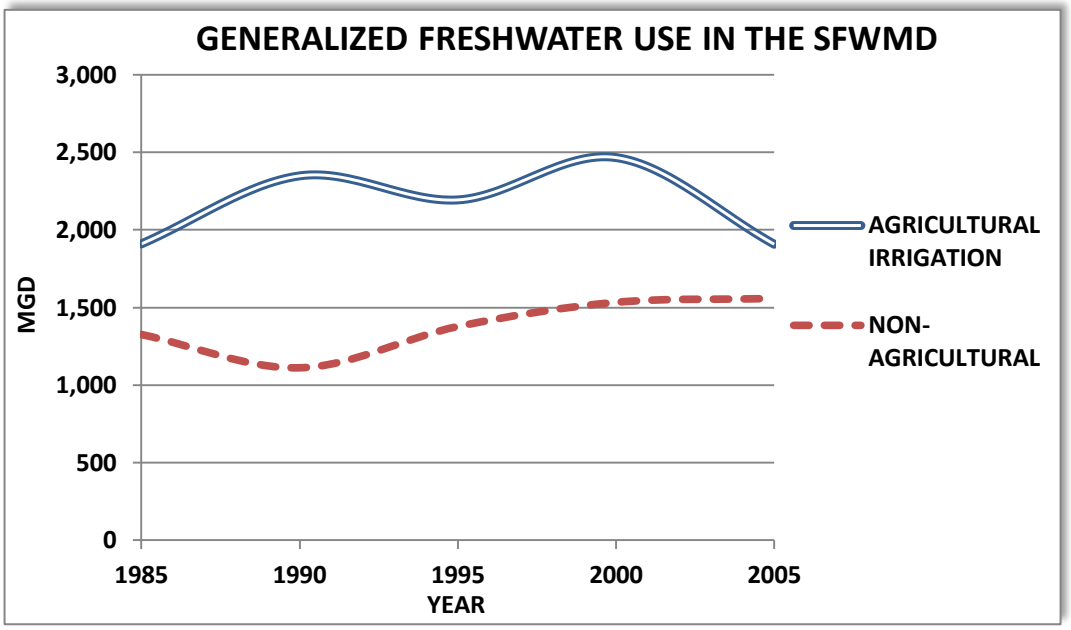

Figure 1-8. Generalized Distribution of Freshwater Withdrawals within the SFWMD, 1985-2005

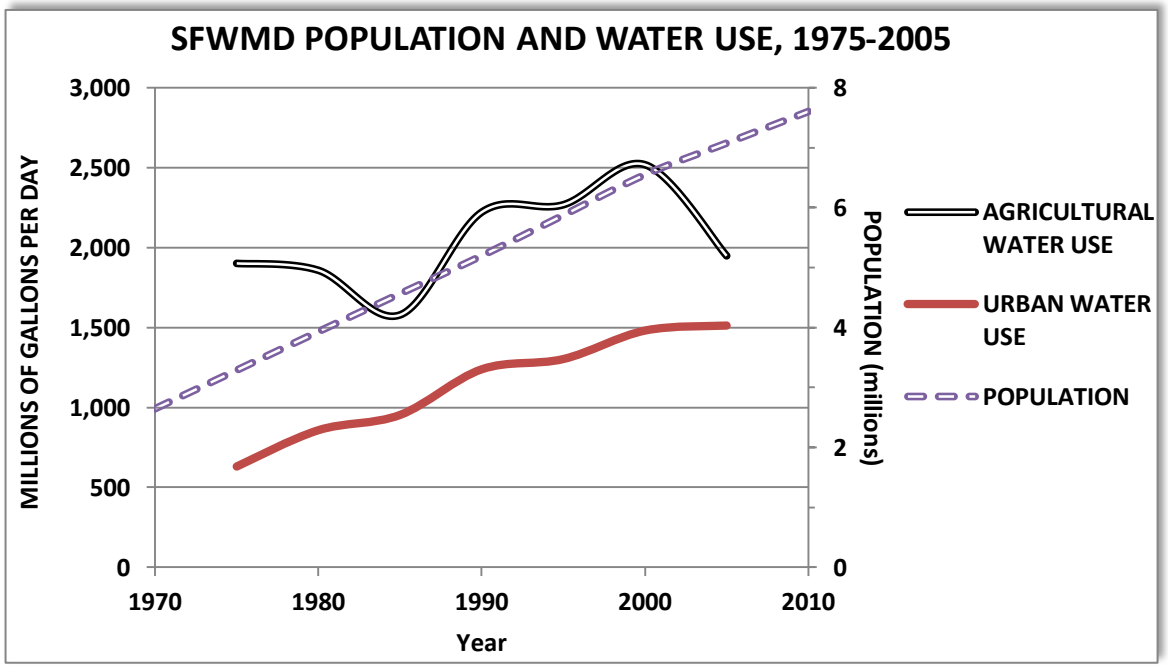

Figure 1-9. Population and Generalized Water Use in South Florida, 1975-2005

Figure 1-9 relates water use to population in the region. Urban water use parallels the growth in the region, but the rate of increase in water consumption for non-agricultural purposes appears to be declining since 2000. Agricultural use is still the dominant end use, but land use conversions and within-industry changes in irrigation strategy suggest a continued decline in demand.

Consumptive Use Permits

Appendix B-3 summarizes the current numbers of the Individual and Major General consumptive use permits (CUPs) in the SFWMD. These classes of permits are for between 0.1 and 0.5 mgd (Major General) and greater than 0.5 mgd (Individual). Minor General permits (less than 0.1 mgd) were not tabulated as they do not represent significant withdrawals.[10]

The current number of these larger permits is 2,360, a 27 percent increase from 1990. However, at the time of the previous study an estimated 1,579 CUPs, or more than 85 percent, were for agricultural purposes. Currently, 1,121 permits are for agricultural purposes, a 29 percent decrease. Conversely, the numbers of non-agricultural permits have increased from 277 to 1,239, a 347 percent increase. While the number of public water supply permits has actually decreased (from 207 to 136), and the number of industrial permits has increased from 70 to 92, the bulk of the increase in non-agricultural permits is tied to golf course and landscaping permits, many of which were formally supplied by public water supply systems.

Appendix B-4 examines the allocations associated with these permits. Based upon the total "recommended annual allocation" values associated with these individual and major general permits, approximately 8.96 bgd have been allocated by the District. Maximum month and maximum daily rates are greater than this amount as they address peak (and time-limited) needs. It should be noted that the 8.96 bgd that is allocated (as of 2012) is nearly 2.6 times the volume of actual withdrawal, as estimated by the USGS for 2005.

As of 2012, agriculture holds 50.6 percent of these total annual allocations, but (as of 2005) withdrew 55.1 percent of total withdrawals. Using the 2005 use rates as a proxy for 2012, agriculture is withdrawing approximately 76.4 percent of its allocation while the non-agricultural sectors are withdrawing only about 35.2 percent of their allocation. There is less remaining flexibility in agricultural use under the current allocation of permits by the SFWMD.

3. Water Management in South Florida

The impetus for the original study was lack of substantive progress in the decades-long effort to protect and restore the remnant Everglades. While landmark efforts such as the partial restoration of the Kissimmee River and the Congressional authorization of the Comprehensive Everglades Restoration Plan represent a shift in the direction of how water and water-dominated ecosystems are viewed and managed in South Florida, the larger system of water management remains intact. *Because water management is inextricably linked to changes in the physical environment, the ecology, and the economy of the region, it is appropriate to provide a brief overview of the evolution of the current situation.*

The purpose of water management in South Florida evolved from drainage to include flood protection and water supply, primarily in response to extreme climatic events such as hurricanes and droughts. Protection of natural systems and environmental enhancement are relatively new objectives, but flood protection and drainage remain important foci in terms of the physical operation of the system's infrastructure.

[10] Personal communication, SFWMD.

Historically, Florida was a poor, sparsely populated state. Prior to the 20th century, most of South Florida was considered uninhabitable swampland. In a concerted effort to develop and capitalize on its abundant land and water resources, land reclamation and drainage projects were undertaken by the mid-1800s. In 1913, the Florida Legislature created the Everglades Drainage District and charged it with designing and constructing an Everglades drainage project. The Everglades Drainage District was to provide flood protection to existing farmlands and lower the water level in the Everglades by five feet in an attempt to reclaim over six million acres of wetlands for agricultural use. Between 1907 and 1929 the Everglades Drainage District spent $18 million (roughly $233 million in 2011 dollars) to create 440 miles of major canals. A dike was constructed around Lake Okeechobee primarily to prevent flooding, but also served to store excess water and maintain adequate water supplies for the area. Water could then be routed from the interior of the state to the coast via the hundreds of miles of canals already dug. The drainage project was completed in 1927; however, the great hurricanes of 1926 and 1928 made clear the need to incorporate flood protection into the focus of water management.

In 1944-45, South Florida experienced its (then) most severe drought on record. Two years later it was hit with an unusually wet season combined with two hurricanes less than one month apart. Severe flooding and property loss emphasized deficiencies in the water management system. Congress authorized the U.S. Army Corps of Engineers in 1948 to draft a comprehensive plan at the state level and to establish the Central and South Florida Flood Control District to implement the plan (the Central and South Florida Flood Control Project– CSFFCP). Concurrently, Everglades National Park was established in 1947 through an act of Congress. Preservation and protection of the Park took on a key role in water allocation and management practices for the region.

By the early 1960s, the flood control components were nearly complete. Figure 1-10 shows the evolution of the project. This system was designed to control water levels during periods of both drought and flooding and the Central and South Florida Flood Control District assumed operation and maintenance of each section as it was completed. The water management system was expanded to include 1400 miles of canals, 440 miles of levees, five water retention areas, 16 locks and dams, and a series of pumping stations constructed by the U.S. Army Corps of Engineers. Lake Okeechobee became a freshwater storage area, supplemented by over 1,330 square miles of water conservation areas lying in western Dade, Broward, and Palm Beach Counties. As part of a federally funded public works project, the (now) 143,874 acre Loxahatchee National Wildlife Refuge was obtained in 1951 under the mitigation requirement of the Migratory Bird Conservation Act. The U.S. Fish & Wildlife Service chose not to designate the remainder of the Conservation Areas as part of the refuge, and responsibility for managing them has remained with the State of Florida.

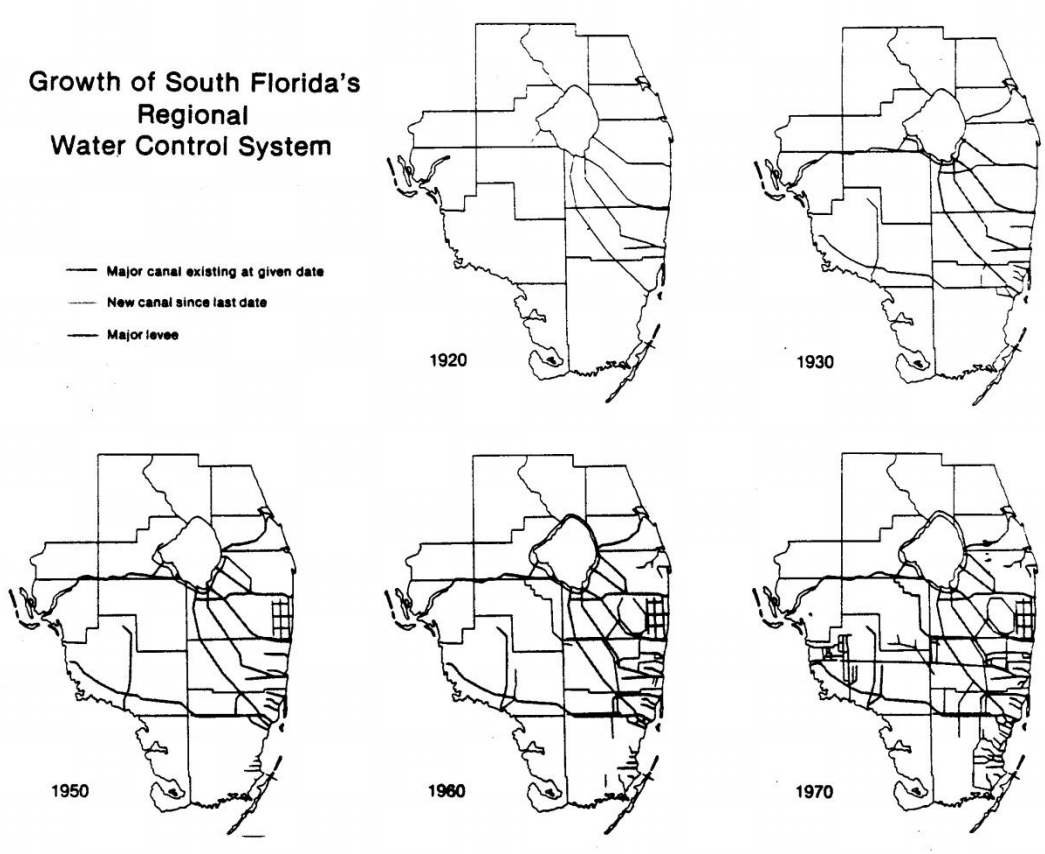

Figure 1-10. The Development of Drainage in South Florida[11]

Beginning with the early drainage efforts and ending with the CSFFCP, water management practices altered the natural sheetflow of water southward from the Upper Kissimmee Basin to the Everglades National Park. Canals and agricultural channels accelerated regional runoff while levees and other infrastructure impounded waters. For example, the construction of the Tamiami Trail across the Everglades (completed in 1928) did not permit free sheetflow under the roadbed and exacerbated these impacts. In addition to hydrological changes, water quality degraded by agricultural runoff threatened the ecology of the Water Conservation Areas and ultimately the Park.[12]

Water management practices driven primarily by agricultural economics resulted in the southern Everglades receiving either too much or too little water during periods deemed critical for that system's ecological health (Carter, 1974). These deteriorating conditions and a drought during 1970-71 prompted the 1971 Governor's Conference on Water Management Issues. Out of this conference's recommendations, the Water Resources Act of 1972 was passed and the District's authority was increased. In 1976, the Central and South Florida Flood Control District became the South Florida Water Management District (SFWMD), covering 31 percent of the land area in the state and a region of 17,930 miles in 16 counties.

[11] Figure 1-10 was taken from the 1990 study. The source was believed to be the SFWMD; however, the District library could not locate the original image.

[12] These circumstances led to the 1988 lawsuit filed by the office of the United States Attorney General against the State of Florida.

Included in the authority of the SFWMD are the maintenance of water levels and scheduling of water delivery throughout the system. The Florida Department of Environmental Protection has retained primary responsibility for the management of water quality although certain water quality regulatory functions have been delegated to the District. With the completion of the CSFFCP and the expansion of duties of the SFWMD as its manager, the focus of water management policy has evolved from flood control to include allocation and environmental concerns. This has come to mean a balancing of competing interests such as homeowners' flood protection, agricultural irrigation during periods of reduced supply, urban water supply for a growing population, habitat protection and wetlands preservation in the face of increased demand for developable land, water quality enhancement, and re-creating the historical hydroperiod of Everglades National Park and portions of Water Conservation Areas 2 and 3.

Comprehensive Everglades Restoration Plan

The Comprehensive Everglades Restoration Plan (CERP) was born out of the congressionally-authorized "Restudy" of the CSFFCP. By the early-1990s there was recognition that roughly 6 million acre-feet of water storage, half of it in Lake Okeechobee, had been lost as a result of the drainage provided in large part by the CSFFCP. Further, an estimated 2 million acre-feet of freshwater was being diverted to tide annually, primarily through the Caloosahatchee and St. Lucie outlets, which negatively impacted adjoining coastal ecosystems. The loss of long-term storage, compounded by annual discharges, made the timing of water deliveries to the Park and to Florida Bay problematic and interfered with other localized restoration initiatives.[13] The Restudy, authorized by WRDA of 1992, was to examine the feasibility of modifying the design and operation of the CSFFCP to improve the sustainability of the region with respect to water supply and ecological character.

With regard to water management, the Restudy proposed additional storage necessary to deliver more water, appropriately timed, to the Everglades Protection Area. The Restudy contrasted then-current conditions (the "1995 Base Condition") with what would be expected by the year 2050 under several scenarios of physical and operational modifications to the CSFFCP.

4. The Evolving Landscape of South Florida

At the time of the original study, save for the steady conversion of agricultural lands east of the East Coast levee, the fundamental partitions of the South Florida landscape (i.e., the Everglades Agricultural Area, the Lower East Coast, the Park) had remained the same for decades. However, the needs to address longstanding water quality problems and the over-arching objectives of protection and restoration of the residual everglades ecosystem have resulted in changes to these historical partitions. These changes constitute both shifts in the allocation of land resources and consequently the allocation of water.

Responding to the 1988 Federal lawsuit over enforcement of water quality standards and the degradation of the Loxahatchee Wildlife Refuge, in 1994 the Florida legislature passed the Everglades Forever Act (EFA). The Act directed the District to acquire land and construct

[13] http://www.evergladesplan.org/docs/comp_plan_apr99/sect1.pdf

stormwater treatment areas (STAs), which has taken roughly 52,000 acres of agricultural land out of production. Continuing efforts to settle the case (and fully implement the intent of the Act) will require the purchase of thousands of additional acres for more STAs and supporting flow equalization basins to optimize operations. This shift in land use will affect the demand for irrigation water and pumping operations (Figure 1-11).

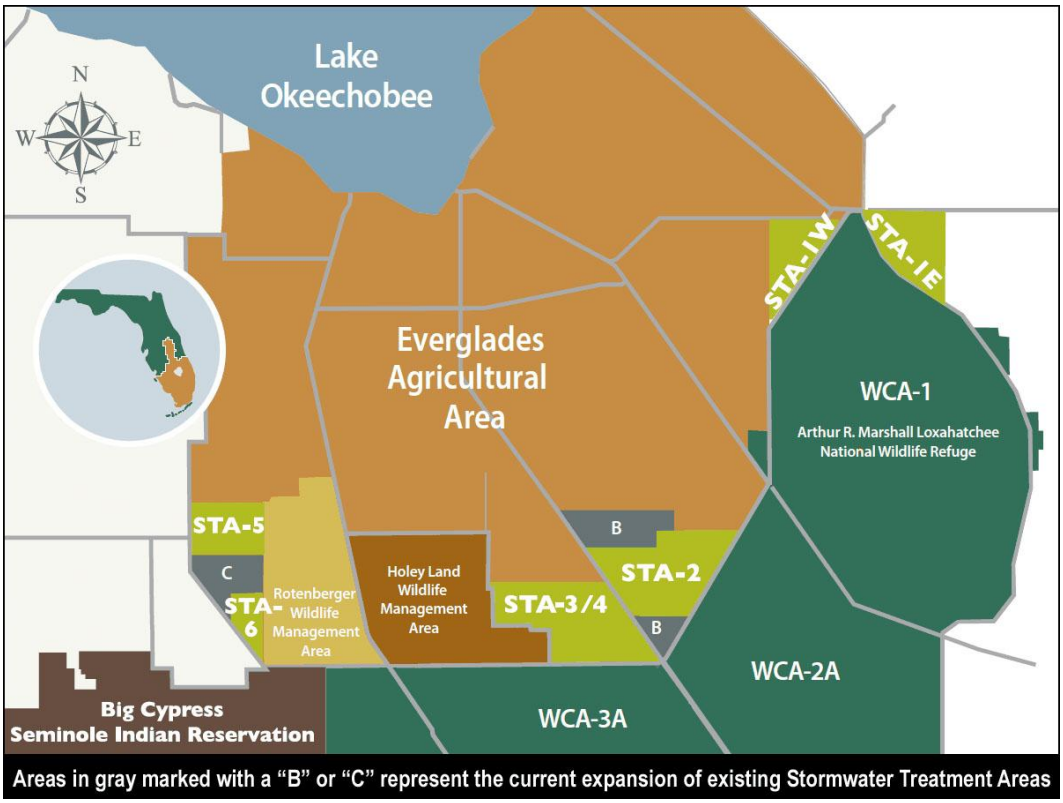

Figure 1-11. Land Use Changes within the EAA[14]

The other major shift in the landscape of the region is attributed to the Comprehensive Everglades Restoration Plan (CERP), the outcome of the "restudy" by which Congress directed the Corps of Engineers to evaluate the effects of the CSFFCP and to define alternatives for actions to improve the reliability of water supply, the capacity for flood control, and the opportunity for ecological restoration. CERP was authorized in 2000. Initially proposed as a 20-year plan, it is now expected to require at least 36 years to complete. The cost-shared initiative includes 68 unique projects throughout the District, and many will require dedication of acreage now in agriculture to serve as water storage facilities, either to enhance supply or to buffer downstream areas (such as Pine Island Sound and Estero Bay at the mouth of the Caloosahatchee River, or the Indian River Lagoon) from major freshwater releases.

CERP projects also build upon "legacy" projects of the SFWMD and the Corps such as the Modified Waters Project, the 8½ Square Mile Area, the Water Preserve Areas along the East Coast Perimeter Levee, and the Biscayne Bay Coastal Wetlands all of which will require transformations of land from one use to another. Removing land from the market for

[14] Source: Briefing materials for the SFWMD Governing Board, February, 2012

development, these projects may be expected to reduce total demand for water than may have occurred otherwise.

Beyond the demands for land required to fulfill CERP and the EFA, agriculture continues to shift to other uses. For example, since the 1990 study, but for a few nurseries there is now almost no land in other types of agriculture, such as row crops, within Broward County. Significant conversion of land from abandoned citrus and improved pasture to residential has occurred at the north end of the system as well: several developments of regional impact (DRIs) were approved in the 2000s in the Lake Tohopekaliga area (Osceola County).

There also are conversions within the sector itself affecting the demand for water. In Hendry, Lee and Miami-Dade Counties, areas in unimproved pasture have been converted to citrus, ornamentals and nurseries – all of which require more water than pasture, even if managed for efficiency. Further, not all such enterprises are located where the use of reclaimed water is a cost-feasible option. For example, north of Lake Okeechobee, tens of thousands of acres in unimproved pasture are being considered for the production of biofuels, requiring irrigation where now there is none.

In sum, scores of thousands of acres have changed use (and their water demand characteristics) over the past twenty years and a similar amount of land is expected to be transformed over the next twenty in response to changes in the economy at large as well as approved capital improvements deemed critical (and legally necessary) to the region.

D. Outline of Remainder of Report

This update includes information not previously available and is structured differently than the original study. In each chapter, wherever appropriate, contrasts between the findings of the original study and this are highlighted, and trends are identified. Rather than being included as part of this Introduction, the trends in the demography, employment and the economy of the region, i.e., the framework for the demand for water, are addressed in Chapter 2. Chapter 3 now addresses the tax base for water management and other budget considerations while Chapter 4 presents revised findings about the allocation of the costs and benefits of water management infrastructure and its operation. Chapter 5 updates the character of major subsidies, historical and new, while Chapter 6 explores several externalities resulting from water use in the region in a different manner from the 1990 report. Chapter 7, Conclusions and Discussion, brings the findings of the preceding chapters into a more holistic view of the economics of water use in South Florida. As with the original study, appendices pertaining to population, water use, the regional economy, property values, recreational use, etc., are provided as a separate volume.

Important Points

- *The region's population has grown by 57% since the time of the 1990 study.*
- *Agricultural water withdrawals in 2010 are roughly what they were in 1985.*
- *Non-agricultural water use has increased in proportion to population.*
- *The number of consumptive use permits for agriculture has declined while the number for non-agricultural uses has increased over time.*
- *Thousands of acres have changed their use and water demand characteristics over the past twenty years and a similar amount of land is expected to be transformed over the next twenty.*

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Chapter 2.
The Regional Economy

A core objective of this study is to relate water use to the Everglades regional economy and its corresponding key economic or industrial sectors. Aside from short-term trends in employment, the 1990 study evaluated the region's economy based on a snapshot of agricultural and non-agricultural output. The analysis in this update benefits from the data of the intervening years.

A. Evolving Characteristics of Regional Employment

For purposes of this update, the economy of South Florida has been divided into two sectors, agricultural and non-agricultural. Following the usage in the 1990 study, the latter may be referred to as "urban" when this update refers to a specific attributes or findings reported in the prior study. Both sectors are strongly dependent on water management practices for survival and growth. Appendix E describes employment within these sectors for the period ranging from 1985 through 2010.

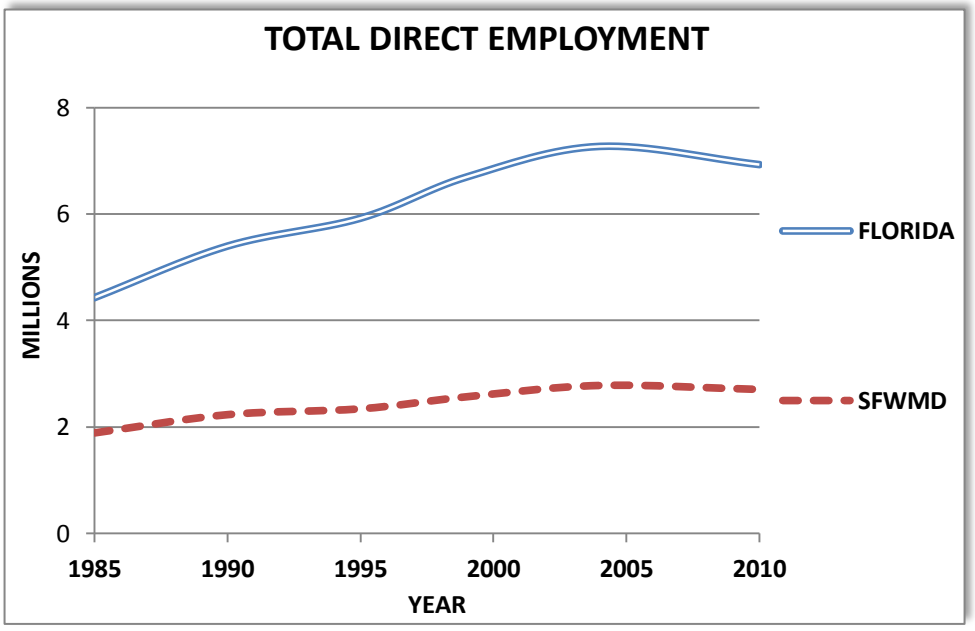


Figure 2-1. Total Direct Employment in Florida and South Florida, 1985-2010

Sources: Florida Statistical Abstract, 1992, 1997, 2001, 2006 and 2011.

Total Employment

Total employment in the South Florida region has tracked similar to the pattern exhibited by the State of Florida (Figure 2-1.) South Florida has continuously represented roughly 40

percent of the state's employment during the period from 1985 through 2010. South Florida's share declined to 38.3 percent in 2004, but has since increased to 39.1 percent. While the number of employees statewide increased by 56.4 percent during this period, South Florida increased by 43.2 percent. Between 2004 and 2010, the number of employees statewide decreased by 4.7 percent while the number of South Florida employees decreased by 2.7 percent.

Agricultural Employment

The agricultural sector comprises the farm and non-farm sources of production, such as fisheries, forestry, dairy and crop production (including – in South Florida – sugar and molasses). Agricultural employment in Florida, statewide, increased steadily up to year 1999, dropped off precipitously in the following five years, and has declined slightly since then. Agricultural employment within the SFWMD followed the statewide trends, but began to level and decline by 1995, about five years earlier than the state as a whole (Figure 2-2). The region also experienced a sharp decline in agricultural employment between 1999 and 2004, losing roughly 29,000 jobs, and has lost another 8,500 positions during the last six years. South Florida comprised roughly 60 percent of the statewide total number of agricultural employees at the time of the original study (1985-1990). This share has declined to about 42 percent, in 2010; however, it still indicates the region is a major driver in the state with respect to agricultural employees albeit at a waning rate of growth. Given that the region's agricultural employment peaked in 1995 and prior to the state as a whole (which peaked in 2000), it is expected that based on current conditions the sector will continue to follow a similar rate of reduction as the State over time. Employment is one facet of the economy, but because of significant changes in technology and crop mix in South Florida, changes in agricultural employment should be construed as the core indicator of the sector.

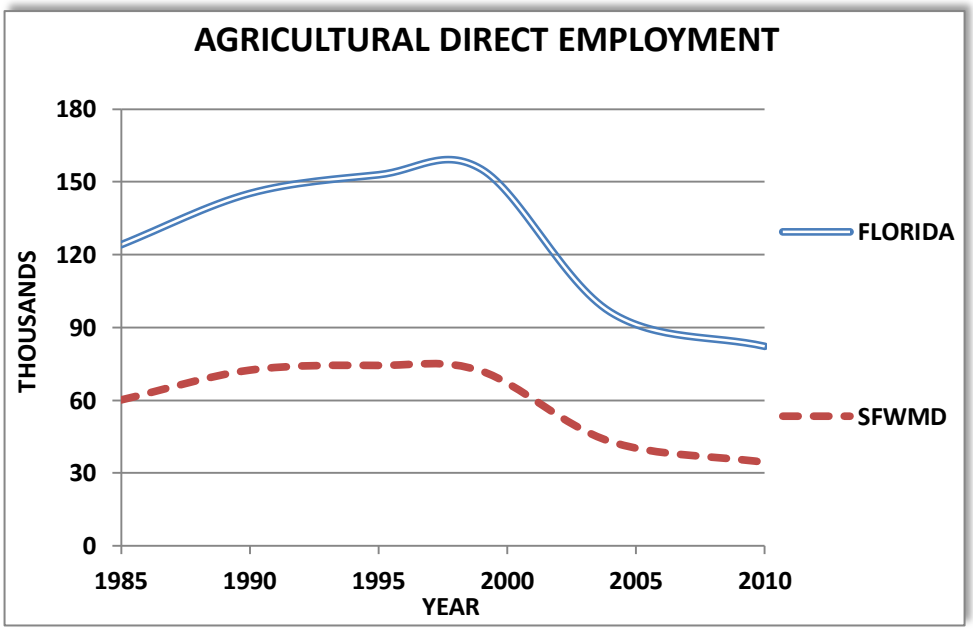


Figure 2-2. Agricultural Direct Employment in Florida and South Florida

Sources: Florida Statistical Abstract, 1992, 1997, 2001, 2006 and 2011.

Non-Agricultural Employment

The non-agricultural sector, with the majority of employees, includes mining (limerock and sand), manufacturing, construction, utilities, retail and wholesale trade, finance, services, and government. Appendix E addresses the growth in employment and the value of all products and services within these sub-sectors from years 1985 to 2010, the most recent year of complete employment data.

The trends in non-agricultural (urban) employment are described in Figure 2-3. In contrast to agricultural employment, the overall trend, both statewide and regionally, is upward. There were dips in non-agricultural employment numbers in the mid-1990s and in the last several years (as part of the larger, national recession and one year of flat population growth). However, in South Florida these declines in non-agricultural employment were less sharp than they were elsewhere in the state. Unlike the declining share of statewide employment in the agricultural sector, the share of statewide employment in the non-agricultural sector represented by South Florida has remained flat at roughly 40 percent. The implication of the diverging trends is that within this region agriculture is contributing less over time, in terms of employment numbers.

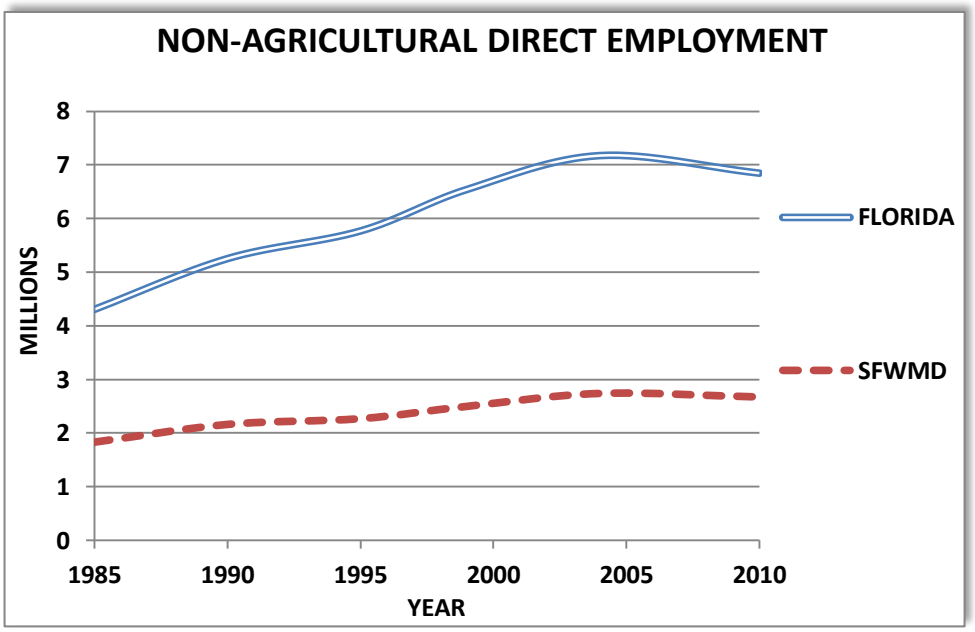


Figure 2-3. Non-Agricultural Direct Employment in Florida and South Florida

Sources: Florida Statistical Abstract, 1992, 1997, 2001, 2006 and 2011

While employment in construction in South Florida has fluctuated to a certain extent corresponding to the national economy, employment in services and in transportation and utilities has shown steady growth in South Florida. Retail trade in the region experienced a marked decline after 1999 (Figure 2-4).

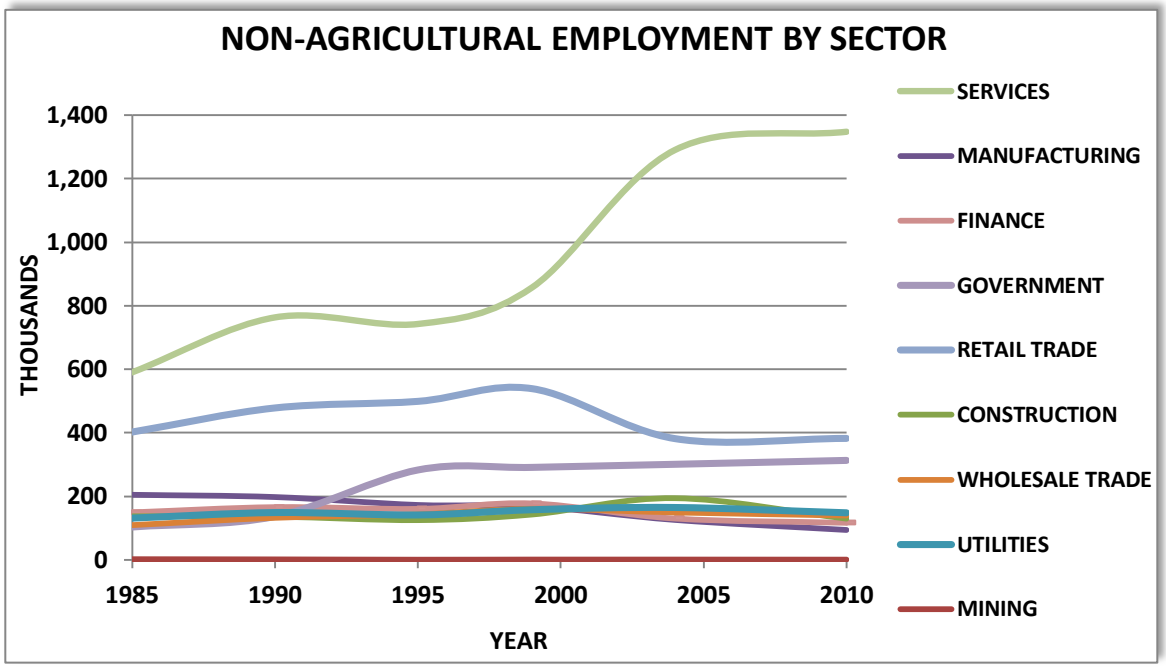


Figure 2-4. Employment in Non-agricultural Sectors in South Florida, 1985-2010

Sources: Florida Statistical Abstract, 1992, 1997, 2001, 2006 and 2011

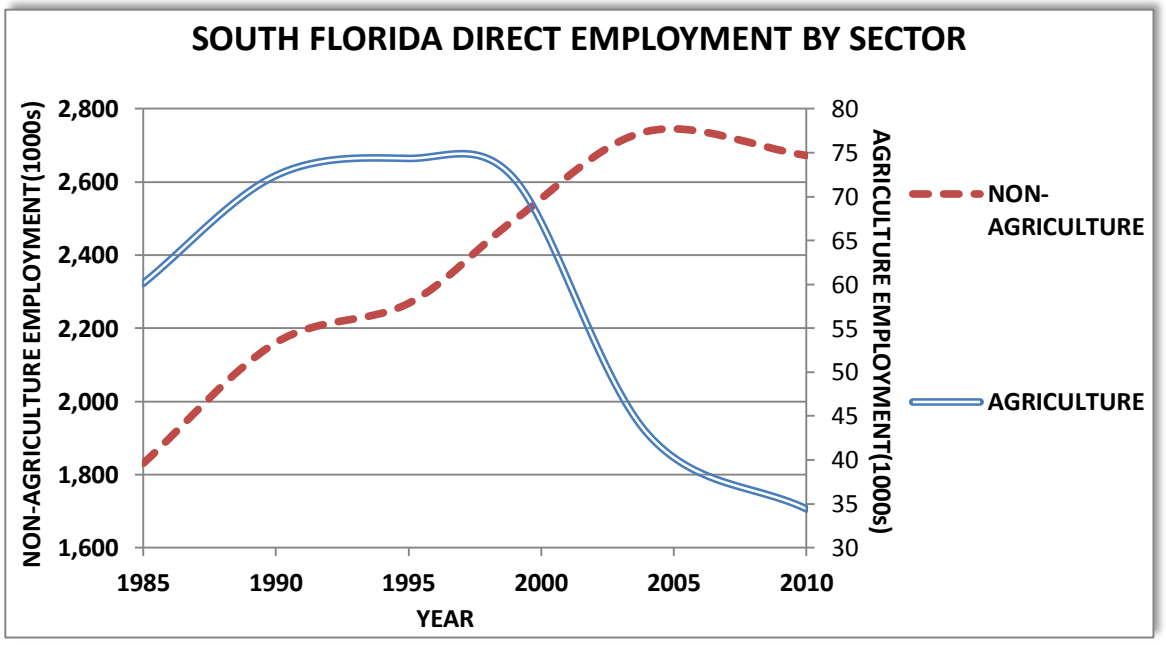


Figure 2-5. Generalized Direct Employment in South Florida, 1985-2010

Sources: Florida Statistical Abstract, 1992, 1997, 2001, 2006 and 2011

Because government employment date was not included from the 1997 University of Florida's Bureau of Economic and Business Research Florida Statistical Abstract, 1994, 1999, 2005 and 2010 government direct employment data for this update was estimated with adjusted IMPLAN output employment data using following methodology. IMPLAN output employment data includes indirect and induced employment; consequently, adjustment was needed to obtain direct employment for the government sector:

(1) Calculating direct employment from BEBR Florida Statistical Abstract with adjustments for 6 counties. [Although SFWMD consists of 16 counties, six of those counties (Charlotte, Highlands, Okeechobee, Orange, Osceola and Polk) have only partial area and/or population in SFWMD. Therefore, those six counties' employment data were adjusted for the portion of the counties within the District boundaries by the percent of county population in SFWMD for non-agricultural sectors and the percent of county agricultural acreage in SFWMD for agriculture sector.]

(2) Calculating average ratio of direct employment from Florida Statistical Abstract data versus employment from IMPLAN output data.

(3) Applying average ratio from (2) to Government employment from IMPLAN output data.

(4) Estimating 1995, 1999, 2004, 2010 direct government employment.

In sum, employment growth in the agricultural sector has lagged behind the growth of other sectors during the past decade in South Florida. Total employment has increased by 43.2 percent during the period 1985-2010, while agricultural employment declined by 42.8 percent during the same period. This pattern is made evident in Figure 2-5, which summarizes the recent patterns in each sector of employment unique to South Florida and highlights the differences in total employment between the agricultural and non-agricultural sectors. Non-agricultural employment was roughly 30 times that of agricultural employment in 1985; this difference increased to about 78 times as of 2010. Figure 2-5 contrasts these trends.

Farm and Non-Farm Income

Appendix D-2 describes farm and nonfarm income for the period ranging from 1985 through 2009. Farm income in the SFWMD (adjusted for District boundaries) doubled from $473 million in 1980 to $1.089 billion in 2009, a 130 percent increase. Total non-farm income grew from $25.3 billion in 1980 to $185.0 billion in 2009, an increase of roughly 632 percent.

Farm income has fluctuated over the past 30 years and declined to nearly 1980 levels (in nominal dollars) after the 2004-05 hurricane seasons. The rate of growth of Non-Farm income rose steadily over this period, albeit its rate of growth diminished in the most recent five to six years (Figure 2-6). In recent decades farm income reached a maximum of 2.41 percent of the total income in the region – in 1985. Farm income declined to 0.37 percent of the total in 2005 and increased to 0.59 percent in 2009.

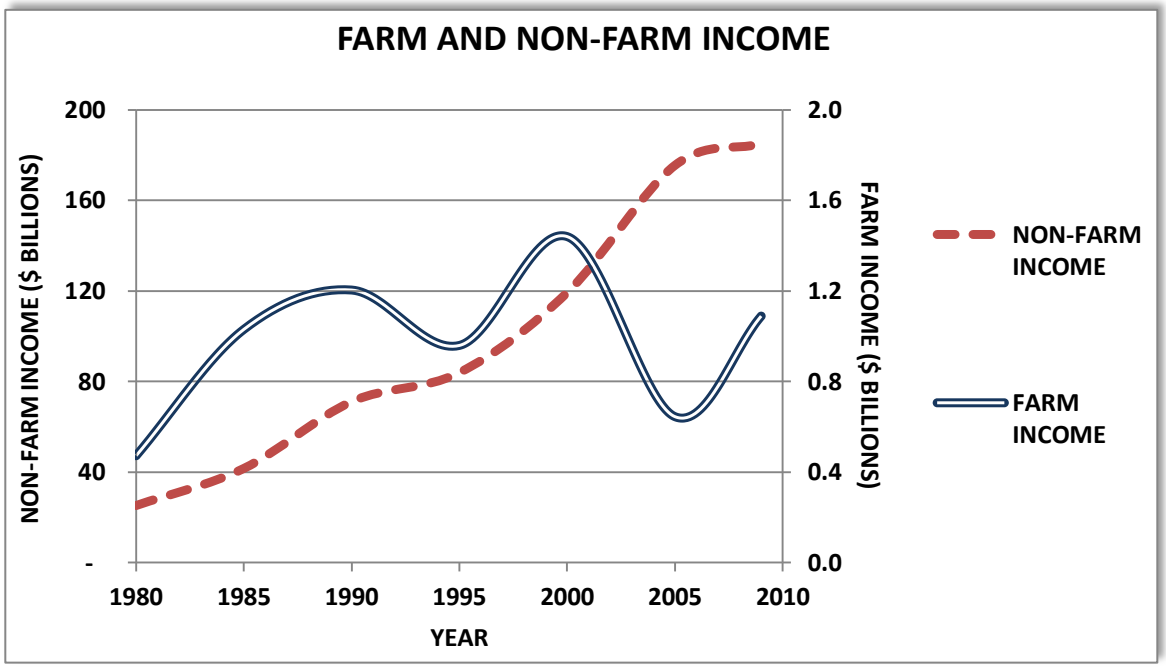


Figure 2-6. Farm and Non-Farm Income in South Florida, 1980-2009

Sources: Florida Statistical Abstract, 1982, 1987, 1993, 1998, 2002, 2008 and 2011

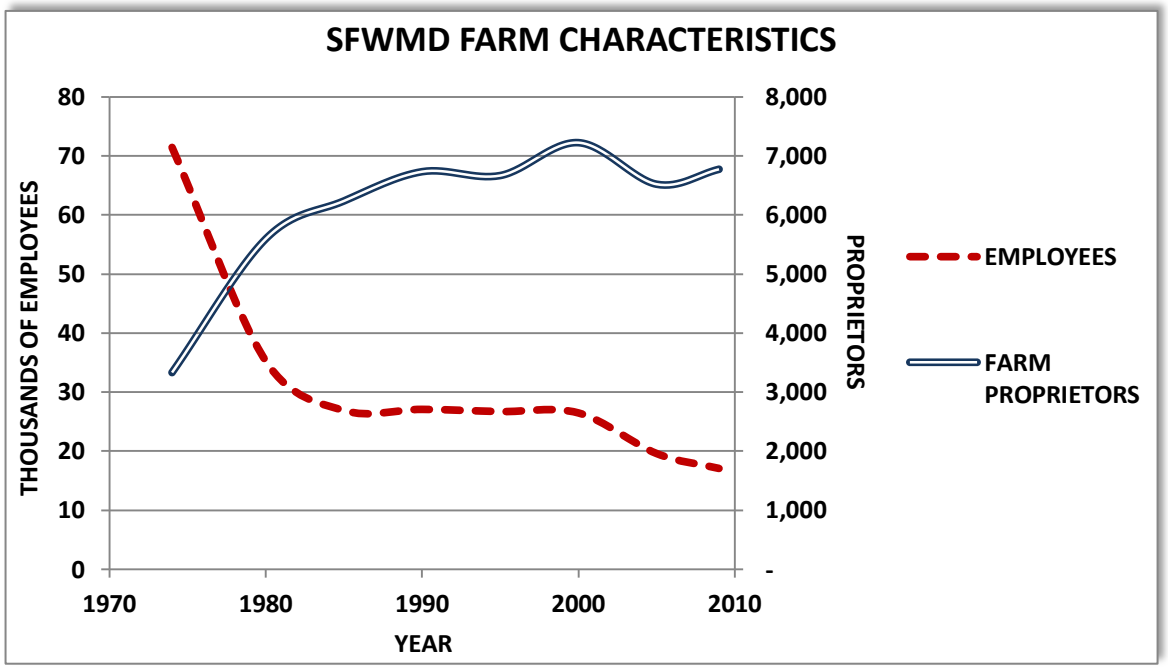


Figure 2-7. Farm Proprietors and Employees, 1974-2009

Sources: Florida Statistical Abstract, 1979, 1983, 1988, 1993, 1997, 2002, 2007 and 2011

The likelihood of farm income exceeding its previous share of total income is slight. Figure 2-7 describes the recent trends in farm ownership and total employees. Changes in the four-county sub-region of Miami-Dade, Broward, Palm Beach and Hendry Counties are responsible for part of these shifts. The total number of farm proprietors has increased since 1970, but the numbers of employees declined sharply in 1980 and 1985 and has not rebounded, signaling a fundamental change in farm structure. The number of employees is about 24 percent of what it was prior to 1980, and although farm sales (and the associated share of the Gross Regional Product) may increase depending upon market prices, it is expected that farm income will not significantly increase over time.

B. Analysis of the Gross Regional Product

As in indicator of the size of the current economy, the following table summarizes the Gross Regional Product (GRP) of the 16 counties of the SFWMD from 2008 to 2010.[15] As with the 1990 study, the Gross Regional Product was chosen as the device to partition the relative contributions of the agricultural and non-agricultural sectors of the local economy (discussed below). Data for this analysis were obtained from the Impact Analysis for Planning (IMPLAN) economic impact modeling software package of Florida (state) and counties. This system enables construction of input-output models and social accounting matrices that represent the structure of a regional economy in terms of transactions among industry sectors, households, and governments. According to the results, the total GRP of the South Florida region decreased from $343.8 billion in 2008 to $300.9 billion in 2010. The GRP is dominated by the economies of Miami-Dade, Broward, Orange, and Palm Beach Counties.

Table 2-2 contrasts the Gross Regional Product (GRP) of South Florida with the Gross State Product (GSP) of Florida. Although the GSP of Florida decreased from $747.8 billion in 2008 to $732.8 billion in 2009, it recovered to $747.7 billion by 2010. However, the percentage of the Florida's GSP generated by the SFWMD decreased from 46 percent (in 2008) to 40 percent (in 2010). This is consistent with the trend regarding the District's share of the State's population.

[15] Gross Regional Product (GRP) is defined in this report as the monetary measure of the value of goods and services produced within the regional economy. It is measured by the difference between gross economic output and intermediate consumption..

Table 2-1. GRP for the SFWMD, 2008-2010 ($ millions)

County	2008	2009	2010
Broward	$82,547	$80,695	$73,508
Charlotte	$11	$10	$12
Collier	$14,233	$13,257	$12,628
Dade	$121,418	$117,561	$103,068
Glades	$179	$201	$277
Hendry	$860	$1,072	$959
Highlands	$1,826	$1,947	$2,006
Lee	$20,589	$19,674	$18,686
Martin	$6,050	$6,031	$6,159
Monroe	$3,959	$3,781	$3,910
Okeechobee	$781	$718	$744
Orange	$15,214	$14,796	$12,759
Osceola	$5,473	$5,283	$5,036
Palm Beach	$64,428	$64,221	$55,934
Polk	$1,367	$1,398	$1,365
St. Lucie	$6,514	$5,765	$5,678
Totals	**$343,788**	**$334,639**	**$300,903**

Sources: 2008 data is from Table 2 in Rahmani et al. (2008) retrieved from http://www.fred.ifas.ufl.edu/economic-impact-analysis/pdf/Florida%20Counties.pdf, 2009 data is from Hodges et al. (2009) retrieved from http://ifas.ufl.edu/reports/economic_impact.pdf, and 2010 data came from IMPLAN 3.0 County-Level Data GRP of the six counties, Charlotte, Highlands, Okeechobee, Orange, Osceola and Polk are adjusted by percent of county population by SFWMD.

Table 2-2. Florida GSP and SFWMD GRP, 2008-2010 ($ millions)

	2008	2009	2010
Florida GSP	$747,770	$732,782	$747,735
SFWMD Percent of the Florida GSP	46%	46%	40%

Sources: http://www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1&isuri=1&acrdn=1, IMPLAN, Years 2008, 2009 and 2010. See Notes for Table 2-1 for sources for specific years.

C. Trends in the Regional Economy

Figure 2-8 represents the Gross State Product of Florida and the Gross Regional Product of South Florida from 1985 (the GRP data point of the 1990 study) through 2010. This study employed 5-year increments to identify any long-term trends and to discount the effects of any particular outliers, such as the recession and housing crisis in 2008. Due to data availability, the authors chose six years of representative data points (1985, 1990, 1995, 1999, 2004 and 2010). 1985 data were taken from the 1990 study (based on the 1988 Florida Statistical

Abstract); the 1990 data were taken from 1994 Florida Statistical Abstract using the 1990 study's methodology to build the dataset.[16] Data for 1995 through 2010 were obtained from the Impact Analysis for Planning (IMPLAN) database for the State of Florida and the associated SFWMD 16-county region.

Methodology to Address Changes in Productivity Reporting

At the time of the 1990 study, the GSP was derived from national level data. The 1994 Florida Statistical Abstract reports Florida's GSP and employment for 1990 by sector and by county. The dollars of GSP per employee of each sector was calculated by dividing the share of the Florida GSP represented by each sector by the number of employees per sector. These state-level values for dollars per employee are used as proxies for dollars per employee at the regional (District) level. The GRP by sector was calculated multiplying the state-level dollars per employee by sector by the employees in each sector in the region. The 1995 data was estimated using IMPLAN Professional version 2.0 and the subsequent years' data were estimated using IMPLAN Professional version 3.0. Through IMPLAN, the research team was able to compile county-level data results, including GRP[17], income, and employment.

In South Florida, there was a nearly linear increase in the GRP from 1987 until the start of the financial collapse, recession and housing crisis in 2008. South Florida exhibited continued growth for about a year after the State as a whole responded to the larger economic forces. However, while Florida's GSP is currently rebounding to the levels last seen in 2007, South Florida, as of 2010, had not exhibited significant signs of recovery. In sum, based on the five-year increment, or point, data depicted in the figures, the SFWMD region was slower to respond, but more affected by the recession.

Accounting for the Fishing Industry Imports

Based on Florida Statistical Abstract's reporting format, the 1990 study divided industry into 10 sectors: Agriculture (SIC 01-09, agriculture, forestry and fishing); Mining (SIC 10-14); Construction (SIC 15-17); Manufacturing (SIC 20-39); Utilities (SIC 40-49), Transportation, Communication and Public Utilities); Wholesale Trade (SIC 50-51); Retail Trade (SIC 52-59); Finance (SIC 60-67, finance, insurance and real estate); Services (SIC 79-89); and Government (SIC 91-97).

In the context of water management in South Florida, the fishing industry is important. However, because of data reporting prior to 1990, fishing could not be extracted from the agriculture sector. From 1995 forward, fishing industry data could be analyzed separately. Table 2-3 demonstrates that in recent years fishing represents between 2.9 percent and 8.1 percent of the GSP, and between 1.9 percent and 6.8 percent of the GRP. To ensure consistency when comparing findings with the 1990 study, the authors have included fishing in the agriculture sector, despite it not requiring any significant freshwater withdrawals for processing, etc.

[16] The 1990 study's methodology derived the Gross State Product from national level data.
[17] Post-1995, IMPLAN state and county-level data were used. Total Value Added, or gross regional product, is the monetary measure of the value of goods and services produced within the regional economy.

Table 2-3. Fishing Share of the Agricultural Sectors of the GSP and GRP, 1995-2010

		1995	1999	2004	2010
Florida GSP	Agriculture	5,504	6,660	6,330	5,406
	Fishing	218	190	400	440
	Fishing share	*4.0%*	*2.9%*	*6.3%*	*8.1%*
SFWMD GRP*	Agriculture	2,452	3,240	2,930	2,336
	Fishing	100	62	141	158
	Fishing share	*4.1%*	*1.9%*	*4.8%*	*6.8%*

Sources: 1995 data are from IMPLAN 2.0 and 1999-2010 data are from IMPLAN 3.0
* Fishing would represent a still smaller share of the GRP, especially if Charlotte County (with only non-coastal acreage within the SFWMD) were excluded.

Findings

Adjusted for District boundaries, the 16-county Everglades region continues to produce about half of Florida's output of goods and services. The South Florida region generated 42.8 percent of the State's economy in 1985, increased to 52.9 percent by 1999 and declined to 42.2 percent by 2010.[18]

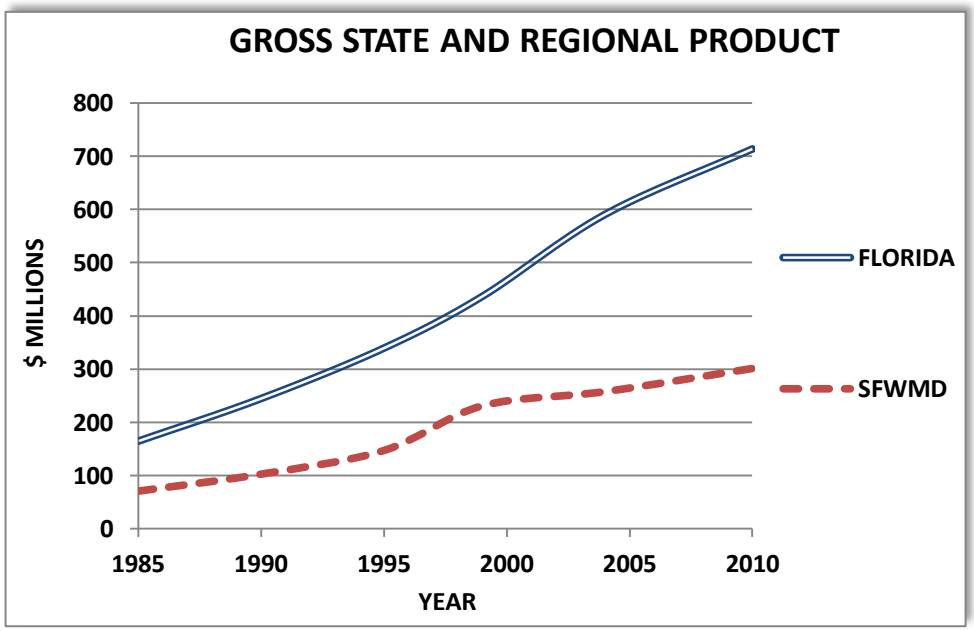


Figure 2-8. Gross Regional Product of Florida and South Florida, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

[18] According to BEA, the 2010 GSP was $747,735. According to IMPLAN for 2010, the results depict the GSP as $713,840. For 2010, the GRP results for the SFWMD region were $301,042, which corresponds to about 40.3 percent and 42.2 percent, for BEA and IMPLAN, respectively. In order to maintain consistency with three years of data (2008, 2009, and 2010) the GSP data (BEA), or 42.2 percent, was used.

The rate of growth of the GRP of South Florida was similar to the rate statewide during 1985-1995. The GRP increased by 45.4 percent and GSP increased by 48.8 percent during 1985-1990, a difference of 3.4 percent. During 1990-1995, the GRP increased by 43.4 percent and GSP increased by 38.8 percent. However, from 1995 to 1999, the rate of growth of the GRP of South Florida was greater than the GSP growth rate. The GRP increased by 57.1 percent, while the GSP increased by 28.6 percent, i.e., the South Florida region was growing at a rate nearly twice as fast as the State as a whole. However, this pattern reversed during 1999-2004 when the GSP increased 35.3 percent and the GRP increased only 11.6 percent. This latter relationship in which South Florida's regional economy is weaker than that of the State has persisted: from 2004 through 2010 the GSP increased by 20.8 percent while the GRP increased by just 16.9 percent.

Figure 2-10 shows the dramatic rise in the value of services statewide, represented by the largest portion of the GSP. The sectors are listed in the legend corresponding to size (as of year 2010). The Services sector exhibits a steady increase during the last 25 years; however, as mentioned above, agriculture has remained relatively flat and was the smallest sector but for mining. Figure 2-11 presents the distribution of the GRP from 1985 through 2010. Similar to the State's economy, services dominate the region and agriculture and mining are the smallest sectors.

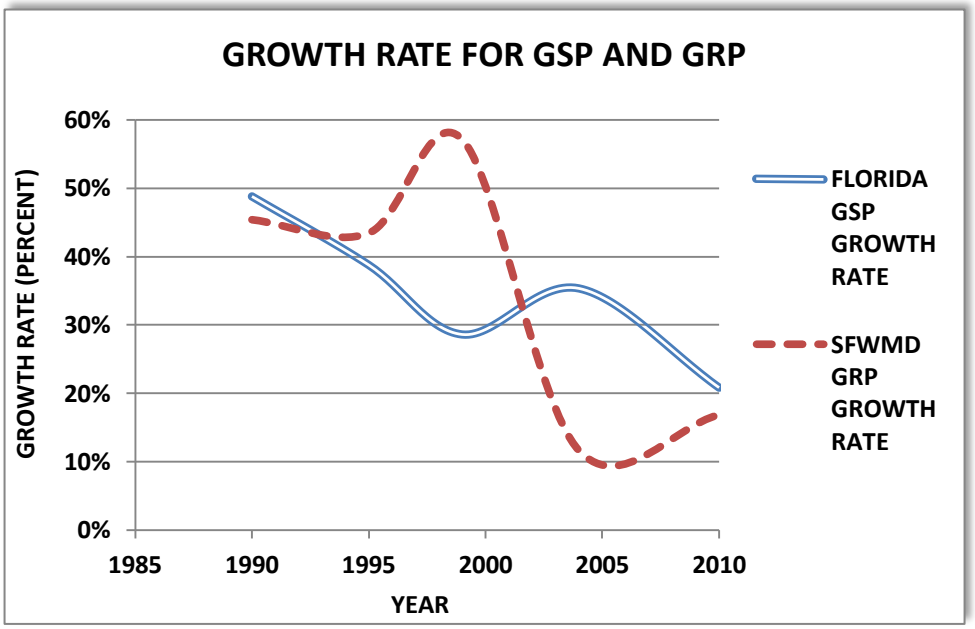


Figure 2-9. Growth Rate for Gross State Product of Florida and Gross Regional Product, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

Figures 2-12 and 2-13 aggregate the non-agricultural sectors at the state and regional levels, respectively. The scale for the non-agricultural sectors is on the Y axis to the left; that for agriculture is on the Y axis to the right. It is important to note that in both instances the range of values (i.e., the scale maximum) for agriculture is 1/100 of that for the non-

agricultural sectors. While the scale for output at the state level is twice that for South Florida, the pattern is identical at the state and regional levels for both generalized sectors of the economy. The non-agricultural sectors, state and regional, continue to grow, although the rate of growth since 2005 has declined. Agriculture, on the other hand, has fluctuated, reaching high points in 1990 and 2000 at both the state and regional levels.

Last, Figure 2-14 documents the relative share of the two generalized sectors. In 1985, agriculture was responsible for about 3.1 percent of the GRP. This share has declined steadily and was less than 1.0 percent in 2010. Conversely, the non-agricultural sectors have increased from 96.9 percent to more than 99 percent of the GRP in the Everglades region during this period.

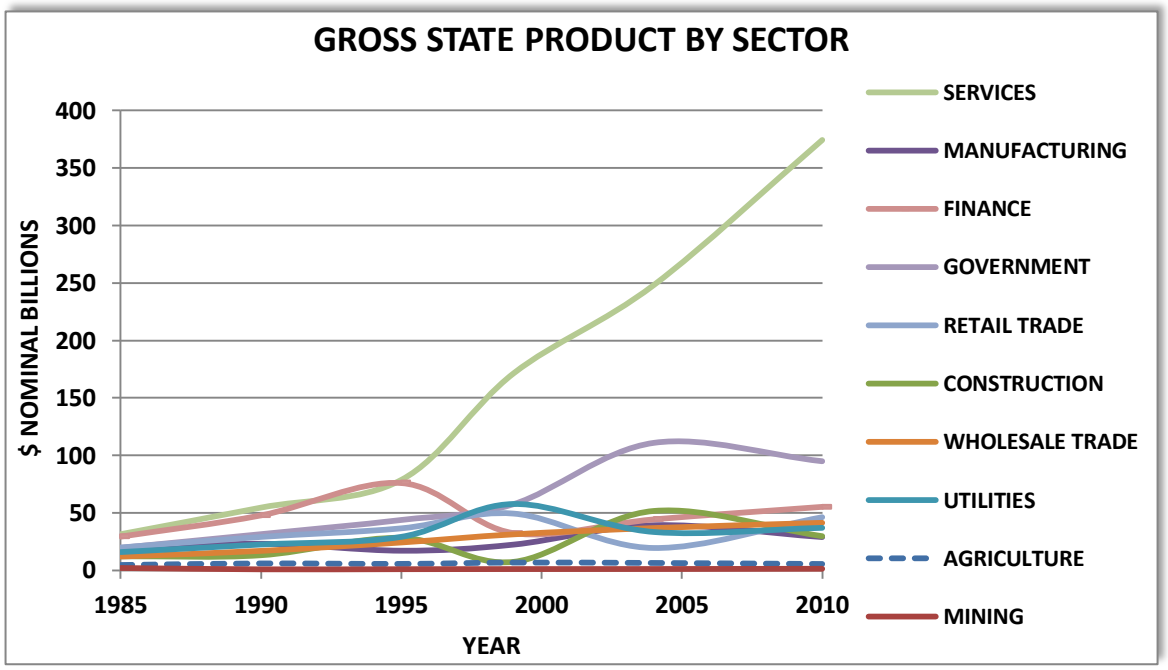


Figure 2-10. Gross State Product of Florida, by Sector, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

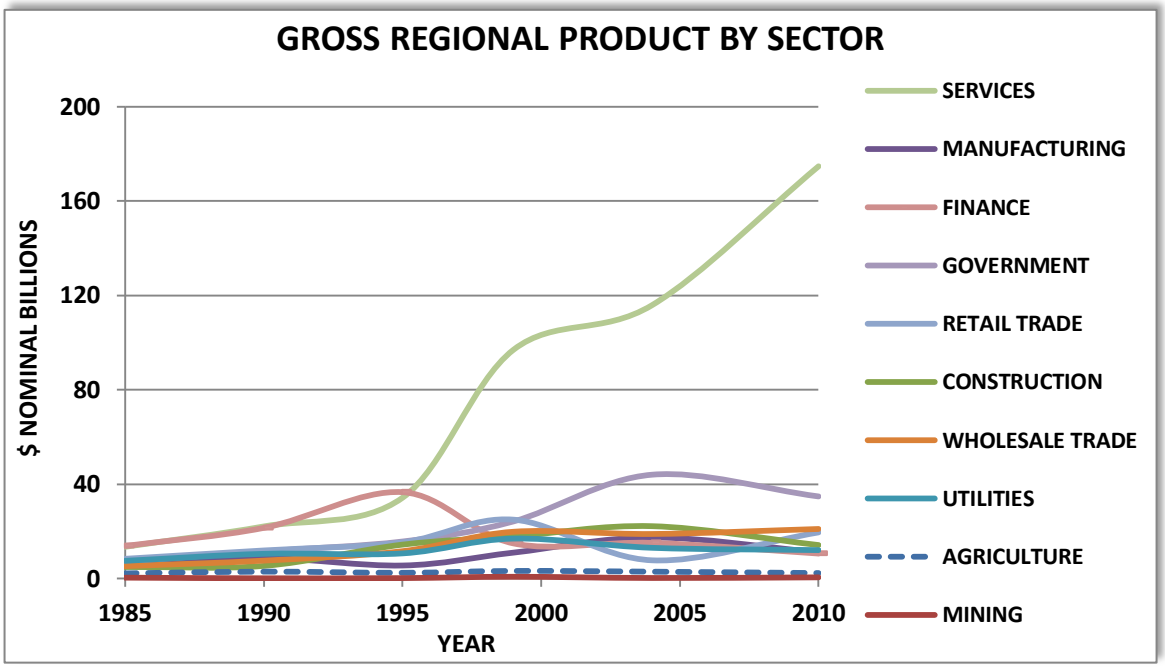


Figure 2-11. Gross Regional Product, by Sector, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

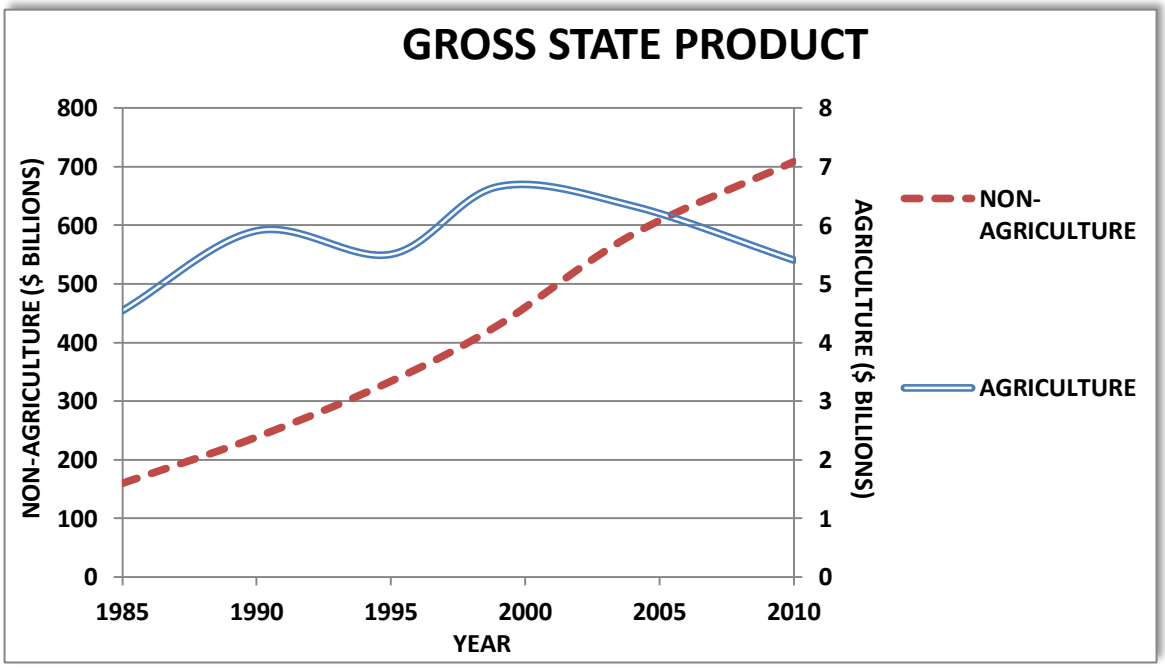


Figure 2-12. Generalized Gross State Product of Florida, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

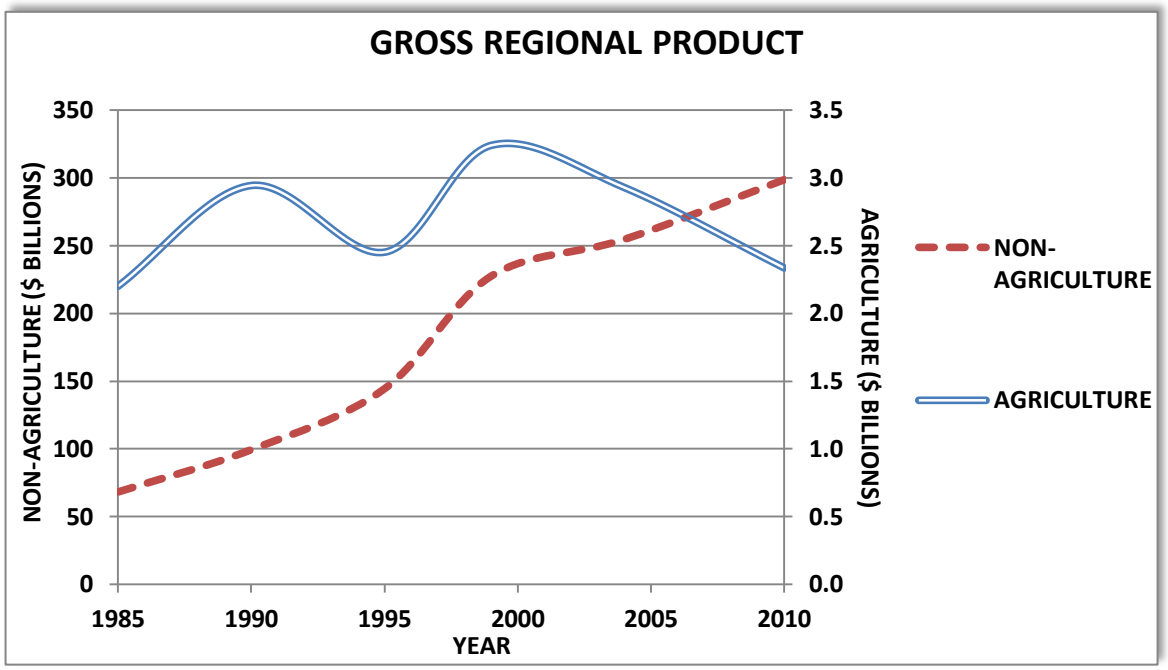


Figure 2-13. Generalized Gross Regional Product, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

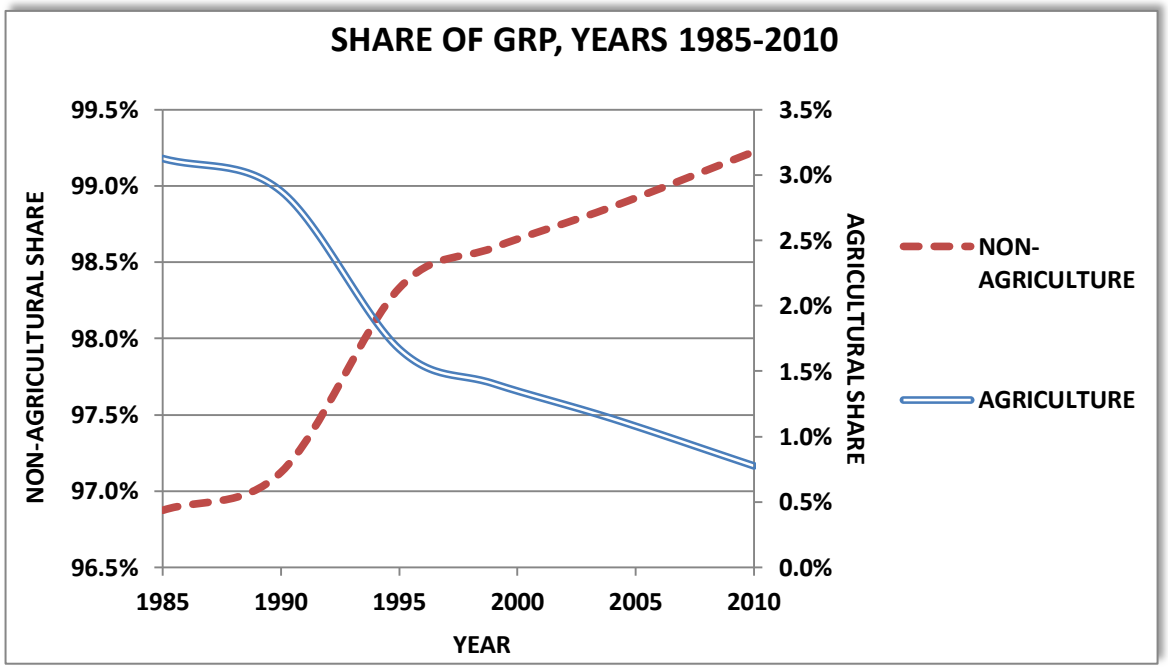


Figure 2-14. Relative Share of the Gross Regional Product, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

Labor Exports and Imports

Similar to the 1990 study, economic base analysis was used to estimate the value of export labor for each sector, which are reported in Appendix E-3. Economic base analysis involves multiplication of the differences in the shares of each sector of the total economy by the total number of employees to estimate the number of export employees. The numbers of export employees are then multiplied by the dollars generated per employee to produce the total value of exports by sector. This methodology follows Bovet (1975) for estimating profit losses and unproductive fixed costs: 1) determine average number of employees per economic SIC class; 2) estimate production workers by multiplying the total employees by the percent of production employees to all employees; and 3) multiply the number of production workers times average annual salary to yield average production payroll. This is then divided by the percent that production payroll is of the value of shipments to estimate the value of shipments.

Figure 2-15 shows the nominal dollar contributions of agriculture to the GRP and agriculture sector's share of exports in the SFWMD region for 1985-2010. Although the agricultural sector's share of total GRP in South Florida was 3.18 percent, agriculture represented 14.1 percent of regional exports in 1985.[19] While the agricultural sector's share of the GRP based on employment remained about 3 percent until about 2000, it declined to 1.27 percent by 2010. The agricultural sector accounted for more than 10 percent of the regional value of exports during the 1980s and reached a recent maximum of 17.42 percent in 1990. However, agriculture's share of export value decreased in the 1990s, declining to only 3.3 percent in 2010.

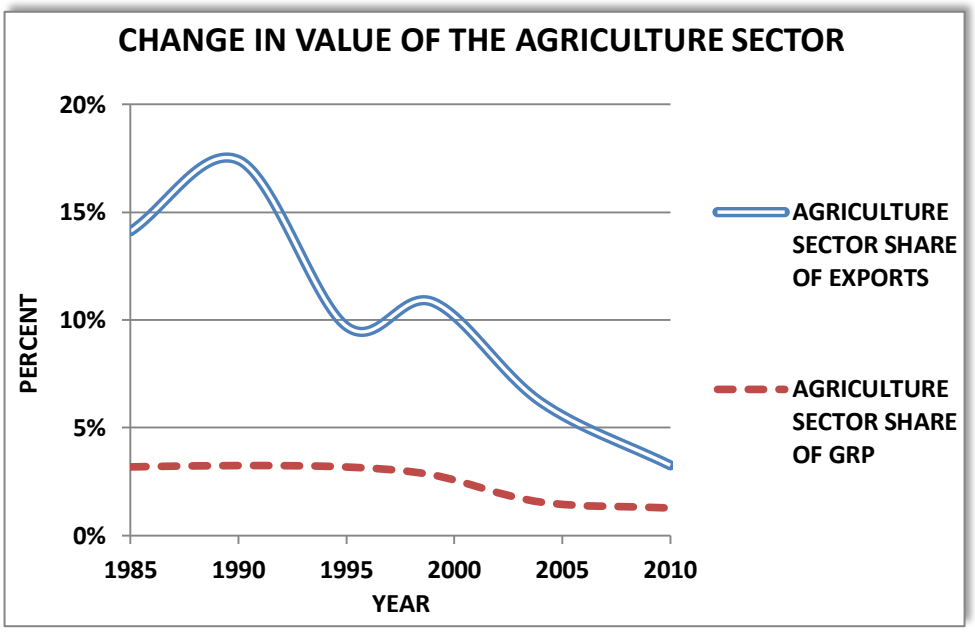
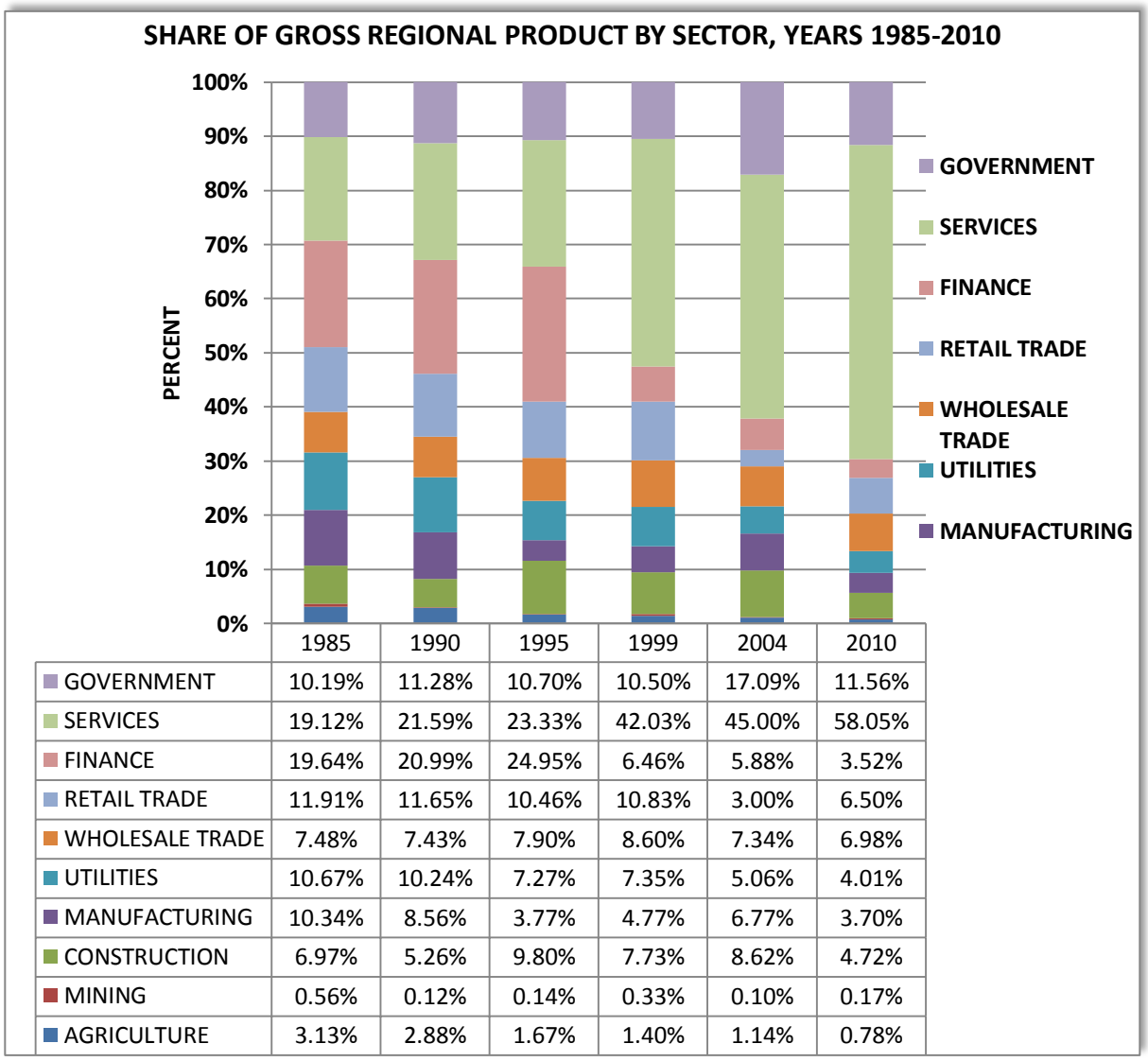


Figure 2-15. Change in Economic Values of the Agriculture Sector, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

[19] The Utilities sector (i.e., power production, transportation, and communications, the output of which is generally consumed) within the region is excluded on calculating exports' share.

Figure 2-16 further translates Figure 2-11 and shows the relative changes in the sectors of the GRP over the past 25 years. Because of the rapid increase in the size of the share of the Services sector in the District (from 19.1 to 58.1 percent), the relative shares of all other sectors are decreasing.



	1985	1990	1995	1999	2004	2010
GOVERNMENT	10.19%	11.28%	10.70%	10.50%	17.09%	11.56%
SERVICES	19.12%	21.59%	23.33%	42.03%	45.00%	58.05%
FINANCE	19.64%	20.99%	24.95%	6.46%	5.88%	3.52%
RETAIL TRADE	11.91%	11.65%	10.46%	10.83%	3.00%	6.50%
WHOLESALE TRADE	7.48%	7.43%	7.90%	8.60%	7.34%	6.98%
UTILITIES	10.67%	10.24%	7.27%	7.35%	5.06%	4.01%
MANUFACTURING	10.34%	8.56%	3.77%	4.77%	6.77%	3.70%
CONSTRUCTION	6.97%	5.26%	9.80%	7.73%	8.62%	4.72%
MINING	0.56%	0.12%	0.14%	0.33%	0.10%	0.17%
AGRICULTURE	3.13%	2.88%	1.67%	1.40%	1.14%	0.78%

Figure 2-16. Sector Shares of the GRP of the Everglades Region, 1985-2010

Sources: 1985 to 1990 data are from Florida Statistical Abstract, 1995 data are from IMPLAN v. 2.0 and 1999-2010 data are from IMPLAN v. 3.0

Sugar and the Agricultural Sector

At the time of the 1990 study, sugar comprised about 36 percent of the total market value of agricultural production in the region, while other crops (dominated by tomatoes) provided about 38 percent of the region's market value, then estimated to be $1.86 billion (1987-88 season), or $3.22 billion in 2011 dollars. The share attributable to sugar and molasses production was $1.14 billion in 2011 dollars. According to the USDA, the market value of

cane for sugar in Florida in 2010 was estimated to be $543 million.[20] However, the direct output of *refined sugar* is estimated to be $1.09 billion, a decline to about 14 percent of the region's agriculture production and a decline of about 4.3 percent in constant dollars.[21]

According to the last USDA Agricultural Census, the market value of agriculture in the South Florida region was dominated by other crops, including nursery and greenhouse (46.7 percent in 2002 and 42.5 percent in 2007).[22] However, there are other important crops grown in the region. Appendix D-1 provides a list of crop output for the region for the years 2002 and 2007. Fruit, tree nuts, and berries accounted for 11.8 percent in 2002 and more than 14.8 percent in 2007 of regional revenues for crops that totaled $5.75 billion in 2002 and $6.3 billion in 2007. Nursery, greenhouse, floriculture, and sod were worth over $0.9 billion in 2002 and $1.0 billion in 2007.

The top three counties for total market value of agricultural products were Palm Beach, Miami-Dade and Hendry in 2002, and Palm Beach, Hendry and Polk in 2007. These top counties accounted for 60 percent and 58 percent of the region's agricultural products in 2002 and 2007, respectively. Among the 16 counties in the District, 12 counties increased agricultural products' market value while market value in four counties (Broward, Collier, Miami-Dade and Monroe) decreased during this period. In particular, the market value of agricultural products in Miami-Dade County decreased almost 45 percent, from $1.16 billion in 2002 to $0.63 billion in 2007.[23] Considering that number of farms in Miami-Dade County increased from 1,846 in 2002 to 2,136 in 2008, the market value (if reported) would have been expected to increase (rather than decrease) between 2002 and 2007.

D. Long-Term Forecast of the Economy for the State of Florida and SFWMD Region

South Florida consistently represented roughly 40 percent of the state's employment during the period between 1985 and 2010. Based on current economic conditions, the agricultural sector will continue to shrink over time. Unlike the declining share of statewide employment in the agricultural sector, the share of employment in the non-agricultural sector has remained relatively flat over time. Due to this diverging trend, agriculture is contributing less in terms of employment numbers, over time. Considering the trend of farm income, it is expected that farm income will not increase significantly over time. Adjusted for district boundaries, the SFWMD region continues to produce about half of Florida's output of goods and services. The District generated 42.8 percent of the State's economy in 1985, which increased to 52.9 percent by 1999, and then declined to 42.2 percent in 2010.

[20] http://www.ers.usda.gov/data-products/state-fact-sheets/state-data.aspx?StateFIPS=12&StateName=Florida
[21] In 2008, US Sugar comprised 33.2 percent of Florida's production (621.3 E3 tons of 1.87E 6 total) and had $361.6 million in sales, i.e., direct output. (Hodges, et al. IFAS/EDIS Publication FE754).
[22] Miami-Dade County's data for Crops, including nursery and greenhouse in 2007 is not counted. It was withheld to avoid disclosure of information about individual farms in 2007 Agriculture Census.
[23] This decline is attributable to the reported value for crops (including nursery and greenhouse), which was $573 million in 2002, but was withheld in 2007 to avoid disclosure of information about individual farms.

Florida State University's Center for Economic Forecasting Analysis (CEFA) performed a forecast assuming a linear growth extrapolation for the period 2010 to 2050, and employed the historical time series data for years 1985 to 2010.

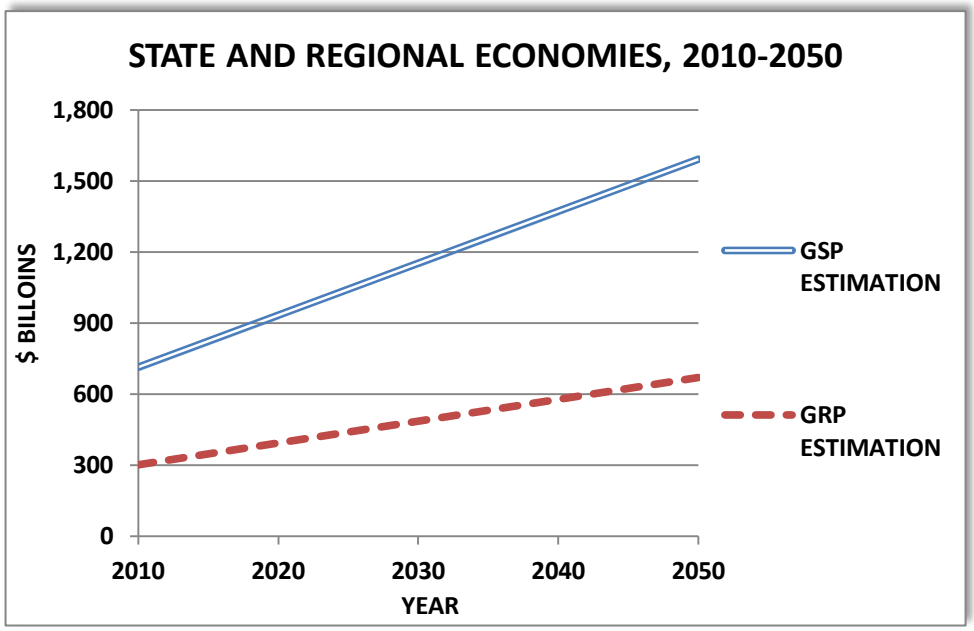


Figure 2-17. Forecast of State and Regional Economies to Year 2050

CEFA estimated the sector-by-sector GSP based on the economic trend from 1985 to 2010, which is presented in the table below. Florida's GSP is estimated to grow by 123 percent between 2010 and 2050. By 2050, the agricultural sector is projected to increase by about 26 percent, which lags behind the total GSP. Agriculture's share of the state's total economy would fall to 0.43 percent. The services sector is expected to increase by 147 percent, from $374.4 billion to $923.3 billion, and the governmental sector is predicted to increase by 127 percent, from $94.9 billion to $215.4 billion. As they are projected to grow faster than the growth of the total GSP, the shares of the services and government sectors are expected to rise. Conversely, yet also based on the historical data, the size of the mining sector is expected to decrease by 82.3 percent from $1.3 billion to $0.23 billion in 2050. The manufacturing sector is predicted estimated to increase by about 59 percent from $28.9 billion $45.9 billion while and the financial sector is predicted to increase by 75 percent from $55.2 billion to $96.6 billion 2050. These sectors are projected to grow at a slower rate than the total GSP and, as a result, the overall shares of these sectors will decline.

Table 2-4. Long Term Forecast of the GSP by Sector, 2010-2050 ($ billions)

Sector	2010	2020	2030	2040	2050
Agriculture	5.41	5.75	6.10	6.44	6.79
Mining	1.27	1.01	0.75	0.49	0.23
Construction	29.60	36.60	43.60	50.61	57.61
Manufacturing	28.86	33.12	37.39	41.65	45.92
Utilities	36.88	45.31	53.75	62.18	70.61
Wholesale Trade	41.26	53.00	64.73	76.47	88.20
Retail Trade	46.13	56.66	67.20	77.74	88.27
Finance	55.16	65.53	75.90	86.26	96.63
Services	374.44	511.66	648.89	786.11	923.34
Government	94.85	124.99	155.14	185.29	215.43
Total	**713.84**	**933.64**	**1,153.44**	**1,373.24**	**1,593.04**

The research team also estimated the regional economy forecast (GRP) based on the team's derived sectoral shares for the years between 1985 and 2010. The following table presents the results in terms of GRP by sector. The share of the agriculture sector would still decrease to 0.38 percent of GRP in the SFWMD region by the year 2050. The respective shares of construction, wholesale trade, services and government sectors in the SFWMD's GRP are forecasted to increase. Based on historical data, the GRP for the mining sector increased from $392 million in 1985 to $514 million in 2010, or an average of $4.9 million yearly. Meanwhile, the rate of growth of the finance sector will be dampened, decreasing 49 percent from $10.6 billion to $5.43 billion.

Table 2-5. Long Term Forecast of the GRP by Sector, 2010-2050 ($ billions)

Sector	2010	2020	2030	2040	2050
Agriculture	2.34	2.39	2.44	2.50	2.55
Mining	0.51	0.56	0.61	0.66	0.71
Construction	14.21	17.93	21.65	25.37	29.09
Manufacturing	11.13	12.68	14.22	15.76	17.31
Utilities	12.07	13.90	15.72	17.55	19.37
Wholesale Trade	21.03	27.33	33.63	39.94	46.24
Retail Trade	19.58	24.05	28.53	33.01	37.48
Finance	10.60	9.30	8.01	6.72	5.43
Services	174.77	239.29	303.81	368.33	432.85
Government	34.81	45.86	56.92	67.97	79.03
Total	**301.04**	**393.30**	**485.55**	**577.81**	**670.07**

Based on the economic trend between 1985 and 2010, both the agricultural and non-agricultural sectors are estimated to increase in nominal values (in constant dollars 2010) but the agricultural sectors' rate of increase will remain lower than the rate of increase of non-agricultural sectors.

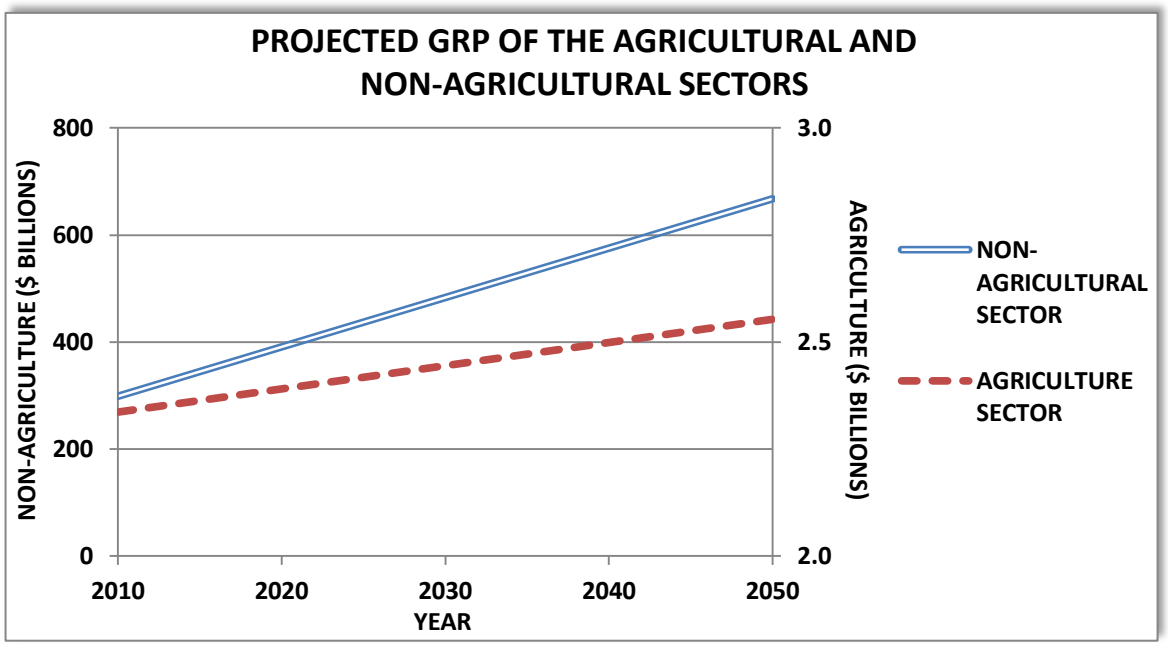


Figure 2-18. Projected GRP for the Agricultural and Non-agricultural Sectors, 2010-2050

Important Points

- *Agricultural employment has declined since 2000 while non-agricultural employment has increased over time.*
- *Employment is greatest in the Services and Retail Trade sectors.*
- *Farm income has been relatively flat over the past twenty years whereas non-farm income has increased.*
- *The regional economy is dominated by the Services, Finance, Government, Manufacturing, and Retail Trade sectors.*
- *Agriculture's share of regional exports has declined.*
- *Sugar's share of agricultural revenues has declined.*
- *The trends in shares of the regional economy suggest that the demand for water by the non-agricultural sectors will increase over time.*

Chapter 3.
Tax Base and the Funding of the South Florida Water Management District

> *Generally speaking, externalities are either related to the volume of water used or are independent of volume. For example, flow-related externalities depend crucially on the amount, quality, quantity, timing, duration and frequency of river flows. . . . Therefore, to mitigate the damaging effects of water supply activities it is often necessary to increase the quantity of flows, modify existing infrastructure to facilitate the delivery of effective flows and potentially change land-use in the catchment.*[24]

Given the responsibility of operating most of the water management infrastructure built by the Corps, the SFWMD depends largely on ad valorem taxes to pay for its operating expenses.[25] The ad valorem tax structure of the SFWMD now consists of three classes of assessments applied to all real estate within the boundaries of the district. The district-wide assessment that supports general operations is currently 0.1785 mills. The second class of assessment is the basin assessment of which there are two: the Okeechobee Basin at 0.1954 mills (covering all of the property within the SFWMD except for Collier County and the mainland portion of Monroe County), and the Big Cypress Basin at 0.1633 mills covering these two remaining areas. (The Big Cypress Basin assessment was established at a lower rate to account for the reduced scale of water management operations and benefits associated with the CSFFCP in those counties.) The third class of assessment, at 0.0624 mills, is also applied within the Okeechobee basin and supports the Everglades Construction project. Revenues associated with basin-specific assessments, however, must be spent within the appropriate basin. The various assessments are added to create the total assessment for the District. The current total millage for the Okeechobee basin is 0.4363 (i.e., 43.63¢ per $1,000 of taxable value) and is applied to real property value, personal property, and centrally assessed value. Thus, in 2012, a $250,000 home in the Okeechobee Basin would pay $87.26 per year, reflecting a $50,000 homestead exemption.

SWFMD Boundary Considerations

The District includes all or parts of 16 counties, i.e., the above millages apply to all unique parcels within the borders of the SFWMD, and within the basins, as appropriate. Ten counties are wholly with the District, and the respective millages are applied to all lots of record and property ownerships in these counties. In these cases, we summed tax information about agricultural and non-agricultural lands county-wide. However, for six counties, only

[24] M. van Bueren and D. MacDonald. "Addressing water-related externalities: Issues for consideration." Paper presented at a Water Policy Workshop convened by the Australian Agricultural and Resource Economics Society, 10th February 2004, Melbourne

[25] In FY2011, ad valorem provided 81.5 percent of the District's revenues (Comprehensive Annual Financial Report).

selected parcels contribute ad valorem to the SFWMD, while parcels external to the SFWMD boundary contribute ad valorem to either the SWFWMD or the SJRWMD.[26]

Methodology

To determine the SFWMD tax base in the six indicated counties, we entered publicly available Florida Department of Revenue (DOR) files containing data about the locations of parcels in all counties and information regarding assessed value, taxable value and use into a Geographic Information System (GIS).

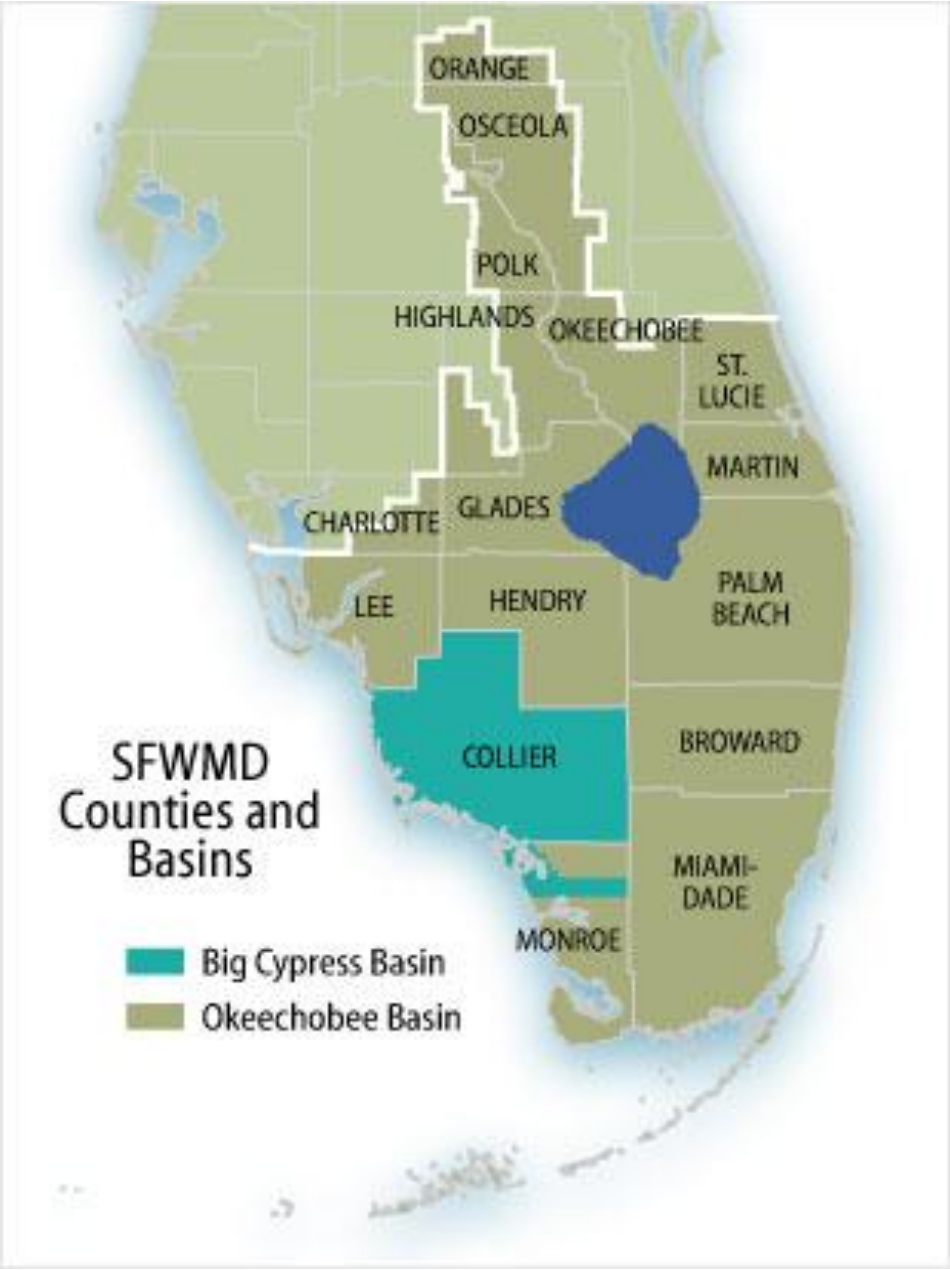


Figure 3-1. Administrative Basins of the SFWMD

[26] Okeechobee, Osceola, Orange, Polk, Highlands and Charlotte counties.

The DOR parcel files are, effectively, parcel maps that include the parcel identification labels assigned by the respective property appraiser offices. Using the GIS, we merged a file describing the boundaries of the SFWMD (available through the Florida Geographic Data Library) with the parcel data file for each of the six counties to select only those parcels within SFWMD. Upon inspection of the boundary regions, we determined that selecting tracts wholly within the District leads to undercounts, i.e., the procedure fails to include parcels that include some land outside the boundary. Intersecting the District boundary with individual county parcel file ensures that no such parcels are excluded. However, the procedure generates records for fragments of parcels that are artifacts of digital processing. To reduce the effect of these extraneous lots (which may result in valuation data for the entire tract being assigned to the fragment), we deleted all records with a lot area smaller than 0.05 acres.[27]

The resulting file was a list with tax/parcel identification (ID) numbers for all lots, by county, within the District. Using database software (ACCESS), we then used the Tax ID list to select those records from the Property Appraiser Name, Address, and Legal (NAL) files with the same Tax ID label. These records include fields with (land) use codes, just or market value, exemption information, sales information and taxable value. We sorted the records by DOR use code and then summed the market and taxable value data for those code values that are agricultural (codes 50-69). These sums, in turn, were subtracted from the district totals for each of the counties to yield the values for non-agricultural properties. The District-limited totals for these counties are reported in Appendix G-1.

A. Property Values and Taxable Values

The 1990 study analyzed the taxable value of agricultural and non-agricultural properties and the ad valorem revenues generated for the years 1980 through 1988. During that time, the taxable value of agricultural lands increased 53 percent while the value of non-agricultural properties increased more than 135 percent. In 1988, the last year complete data were available for that study, agricultural lands in the Okeechobee basin paid $1.61 million in SFWMD ad valorem taxes while urban properties paid $94.78 million, and non-agricultural properties represented 98.3 percent of the tax base of the SFWMD. The study concluded that the continued urbanization of South Florida would exacerbate this disparity in SFWMD revenues over time.

Taxable Values of Property in the SFWMD

Agricultural and non-agricultural lands continue to exhibit a marked disparity in total property values at the district-wide level. In 1988, the total taxable value of agricultural lands was about $3.1 billion, comprising about 1.7 percent of the total taxable value of the district. In 2011, the taxable value of agricultural lands has risen to about $4.3 billion – an increase of about 38 percent. However, during the same period non-agricultural lands increased from about $183.4 billion to $655.2 billion – an increase of more than 257 percent. The taxable value of agricultural lands grew by $1.2 billion over 23 years while the tax base of non-

[27] The criterion of one-twentieth of an acre was arbitrary, and no frequency analysis of lotsize was performed. The intent was to eliminate fragments of parcels along the edges of the District and thereby not distort statistics associated with just, assessed, or taxable values.

agricultural lands grew by $471.8 billion, more than 393 times the value added in the agricultural sector.

The rate of increase in the value of agricultural lands declined from about 6.6 percent per year during the 1980s to about 1.6 percent per year in the last 23 years (a 76 percent decline). In contrast, the rate of increase in non-agricultural lands decreased from about 16.9 percent per year in the 1980s to about 11.2 percent in the following years (a 34 percent decline). In 1988, agricultural properties comprised about 1.68 percent of the total taxable value of the district; in 2011, these lands represented only 0.65 percent of the tax base, a 61 percent decrease in the impact of taxable value.

Appendix G-2 describes that in 2011, agricultural properties are taxed at about 17.8 percent of their just value, reflecting the "classified use" assessment available to land with Department of Revenue codes 50-69. The 1990 study reported that at that time, based on property appraiser interviews, agricultural lands were assessed at 24.8 percent of their market value. If the original study was accurate in this regard, then agricultural lands are assessed at a rate 28.2 percent less than they were 23 years ago. Non-Agricultural lands are taxed at about 79.9 percent of the market value, reflecting in part the effects of the homestead exemption available to residents.

Table 3-1. Percent Change in Taxable Value of Land within the SFWMD, 1988-2011

	PERCENT CHANGE IN VALUE		
COUNTY	**AGRIC.**	**NON-AGRIC**	**ALL PROPERTY**
Broward	30.7	220.9	219.9
Charlotte	34.1	N/A	711.5
Collier	30.7	542.6	531.7
Dade	42.9	239.4	237.5
Glades	82.1	72.0	75.4
Hendry	40.5	63.4	55.6
Highlands	956.0	131.8	237.5
Lee	162.8	324.5	323.6
Martin	-25.8	211.1	195.7
Monroe	N/A	323.6	323.6
Okeechobee	42.2	127.6	111.8
Orange	-14.9	303.6	297.1
Osceola	24.6	416.9	401.9
Palm Beach	69.7	222.7	220.4
Polk	-10.2	210.3	198.6
St Lucie	-38.9	179.6	167.6
TOTAL	**37.6**	**257.3**	**253.6**

Martin, Orange, Polk, and St Lucie Counties lost agricultural value to urbanization or other land use change over the past twenty-plus years. Reductions in agricultural acreage in Lower East Coast counties (Dade, Broward, and Palm Beach) were offset by increases in agricultural land value. The value of agricultural land in Glades County increased to a greater degree than its non-agricultural property and the value of agricultural land in Highlands County increased by more than 950 percent (from $26 million in 1988 to an estimated $270 million in 2011).[28] Figure 3-2 depicts the importance of Miami-Dade, Broward and Palm Beach Counties to District revenues.

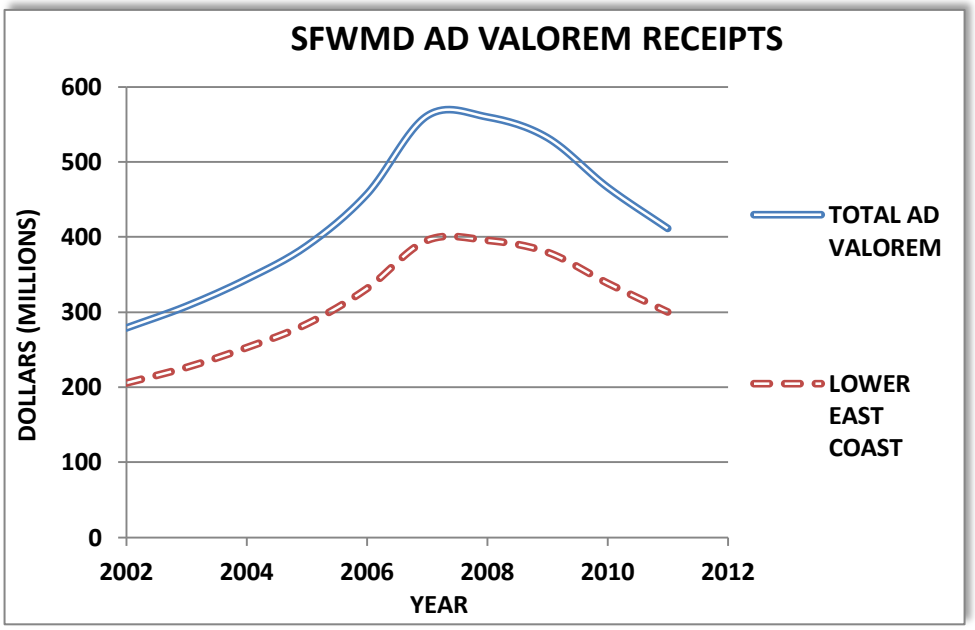


Figure 3-2. Lower East Coast as Share of SFWMD Ad Valorem Receipts, 2002-2011

B. The SFWMD Budget

Data for this breakdown of the District budget comes from the Comprehensive Annual Fiscal Report (Fiscal Year ending September 2011) and the Functional Area Line Item Report. The current partitioning of revenues and expenses is not identical to that provided in the 1990 study.

Revenues

Appendix H-1a summarizes the District's operating budget for the past several years. The budget varied significantly during this period. In FY09 more than $1.97 billion in Certificates of Participation (COPs, an alternative to bonds) ramped up the budget for land acquisition and many capital improvements, several of which are tied to the Comprehensive Everglades Restoration Plan. COPs were a significant component of the budget in FY10 as well. Conversely, the budget in FY12 was reduced markedly relative to prior years, partly because of reductions in the contributions from ad valorem and only nominal issuance of COPs, but

[28] The 1988 determination of value for agricultural lands in Highlands County may have been underestimated.

primarily because of caps imposed by the 2011 Florida Legislature. The average annual budget for FY06 through FY12 (including the COPs) was $1.41 billion.

Excluding the COPs, ad valorem remains the primary source of revenue (Figure 3-3). Ad valorem provided an average of 36.7 percent of the budget over the past 7 years, although this share rose to about 41.9 percent in years without significant issuance of COPs. There were more than $164 million in ad valorem balances in FY12.[29] Including this amount in the ad valorem share of the budget increases the share to 40.8 percent and 47.6 percent in the years without large COPs.

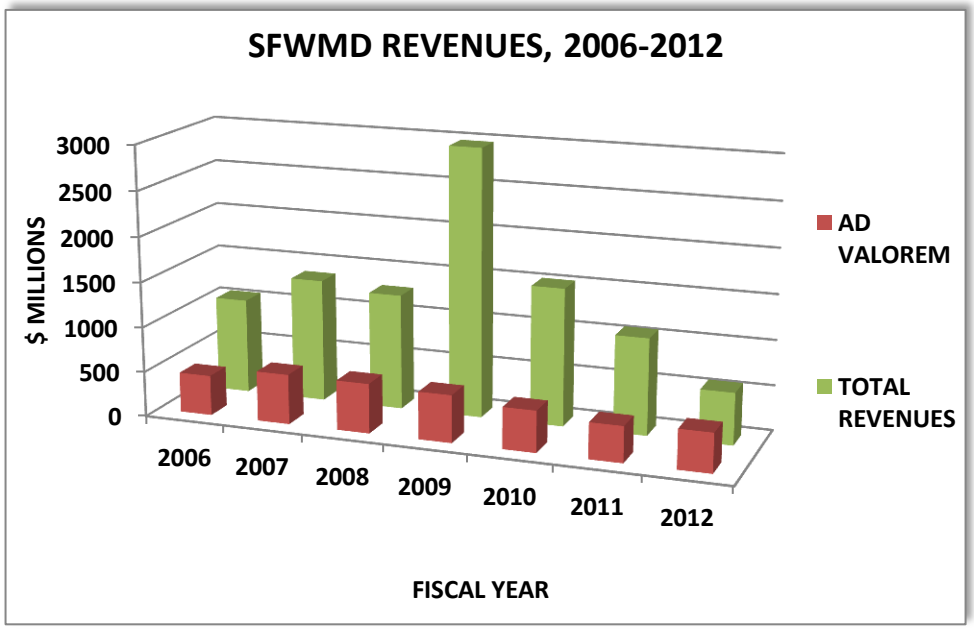


Figure 3-3. SFWMD Revenues, FY 06 – FY 12

During the past seven years, state sources (including trust funds and Forever Florida) average more than $202 million per year, about 16.0 percent of the typical budget. This share reflects FY10 and FY11 in which there were shortfalls in the state budget and widespread agency cutbacks. The following two charts denote the increase in the role of ad valorem in the last two years. The reported percentages discount the contributions of COPs and Carryovers.[30]

[29] SFWMD Proposed Budget, 2012.
[30] Carry-over is the right to use an unspent appropriation beyond the time period for which it was originally granted.

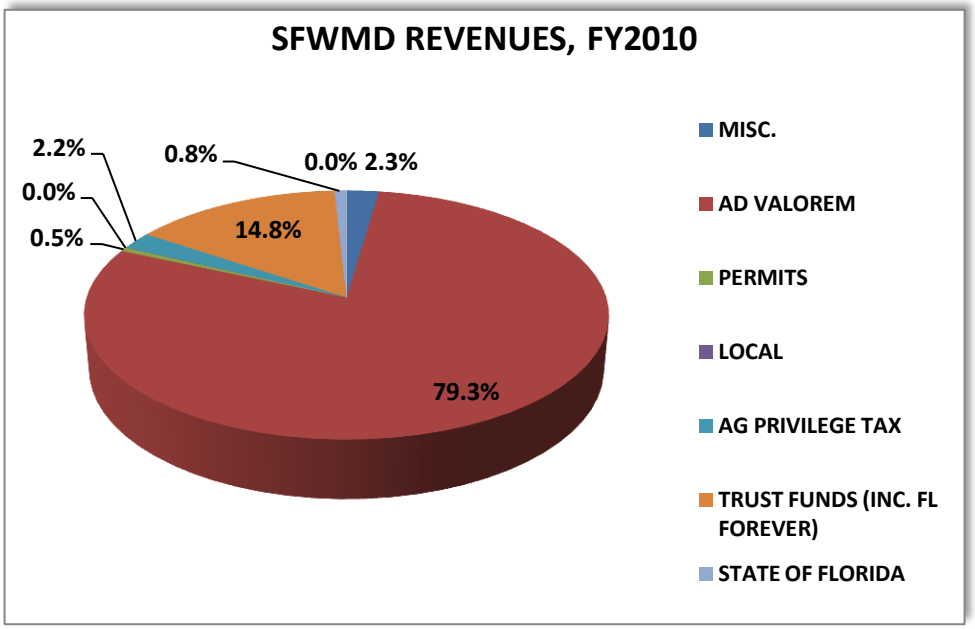


Figure 3-4. SFWMD Revenues, FY 2010, Percent by Category

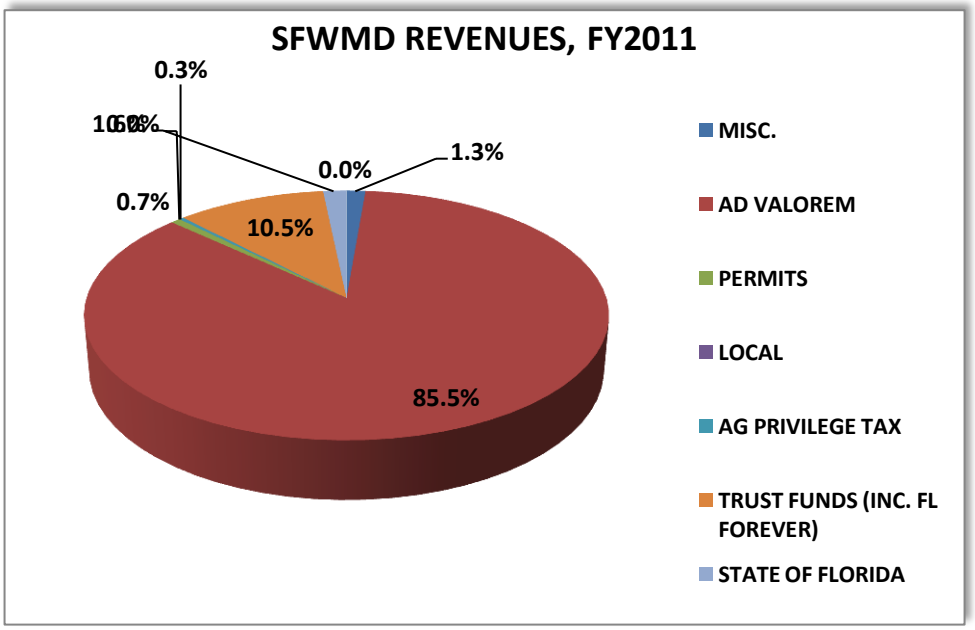


Figure 3-5. SFWMD Revenues, FY 2011, Percent by Category

Expenditures

Appendix H-1b. details expenditures by the District for FY 06 through FY12 (proposed). District-wide expenditures equal revenues each year, although there are program balances and carry-forwards.[31] The District's summary documents merged select categories in FY10 and

[31] Agencies may borrow against future appropriations—the equivalent of a negative carry over.

FY11 and did not report expenditures for Land Stewardship, Modeling and Scientific Support, and Regulation. These presumably were incorporated into Mission Support. Operations and Maintenance (O&M) expenditure programs and associated cost centers remained independent, however.

Expenditures for Operations and Maintenance averaged 15.8 percent of the budget during this time, while Restoration consumed an average of 66.3 percent of the budget. The latter share was inflated in FY 2009 and FY10 by expenditures associated with more than $1.97 billion and $1.11 billion, respectively, in COPS. Discounting those special investments , accelerated by the use of COPS, Operations and Maintenance would comprise about 18.9 percent of the budget, on average. The budget reductions of FY12 raised the O&M share to more than 32 percent of that proposed budget. Restoration, at less than 42 percent of the budget comprised its smallest share in the seven-year period. In sum, O&M has been the second largest category of expenditures by the SFWMD, regardless of the magnitude of the Restoration category or whether other District administrative functions have been merged into Mission Support. O&M is the focus of Chapter 4; portions of the Restoration budget are addressed in Chapter 5.

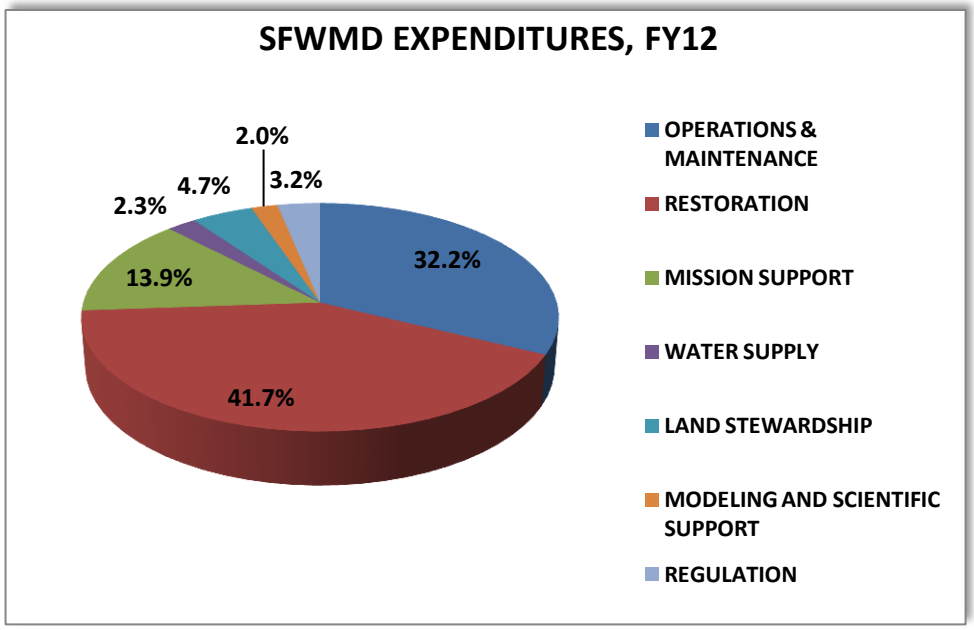


Figure 3-6. SFWMD Expenditures, FY 2012, Percent by Category

Important Points

- *Between years 1988 and 2011, the increase in the taxable value of non-agricultural lands was more than 393 times the change in value within in the agricultural sector.*
- *Agricultural lands now comprise about 0.65 percent of the tax base of the SFWMD.*
- *Based on its current share of ad valorem revenues, agriculture pays less than $3.0 million for all services provided by the District.*
- *Ad valorem remains the largest source of revenue for the SFWMD.*
- *The Agricultural Privilege Tax does not fund all of the Everglades Construction project.*
- *Operations and Maintenance (O&M) remains the second largest category of expenditures by the SFWMD, after Restoration.*
- *With increasing urbanization and planned conversion of agricultural acreage, the share of District ad valorem paid by agriculture will continue to decline.*

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Chapter 4.
Apportioning the Expenditures for and the Benefits of Water Management

> "*Without the federal government there would have been no Central Valley Project, and without that project California would never have amassed the wealth and creditworthiness to build its own State Water Project, which loosed a huge expansion of farming and urban development on the false premise of water that may never arrive. Without Uncle Sam masquerading from the 1930s to the 1970s as the godfather of limitless ambition and means, the seven Ogallala states might never have chosen to exhaust their groundwater as precipitously as they have; they let themselves be convinced that the government would rescue them when the water ran out, just as the Colorado Basin states foolishly persuaded themselves that Uncle Sam would "augment" their overappropriated river when it ran dry.*"[32]

A primary purpose of this study was to quantify the allocation of general expenditures for, and benefits of, water management between the agricultural and non-agricultural sectors in South Florida. This chapter examines operation and maintenance (O&M) and selected capital expenditures, both historical and proposed. The methodology and justification for allocations to each economic sector is provided in this chapter.

A. Hydrologic Basis for Allocating Expenditures and Benefits

The allocation of water management costs in a system can be problematic where interconnected hydrological units serve multiple users. For example, what percentage of the cost of operating a pump station should be attributed to agriculture when water moved to this sector of the economy will, under average conditions, flow downstream to another sector? And how should these costs be included in the tabulation of net benefits and production functions for any particular economic sector? Work on this problem was performed by the SFWMD as early as 1988, but the scope of that review was limited to the O&M of specific projects only within the EAA, and there was no justification for allocation of agricultural benefits of the selected division expenditures. Here, as in the 1990 study, the apportionment of operation and maintenance expenditures in particular is performed based upon the hydrology of the region – the patterns of flow, both passive and actively managed.

The General Approach

Appendix F provides the raw data and derived values to resolve part of the problem. Beginning with calculated rainfall data (corroborated by various SFWMD reports), Appendix

[32] Reisner (1986), page 498.

F-3 documents the various flows among hydrologic units in South Florida. These flows include water supply releases, flood control discharges, drainage, and seepage. The data used were first reported in the 1999 Everglades Interim Report, which documented the flows in the context of the South Florida Water Management Model upon which the Restudy alternatives were based. Newer information is available (e.g., Chapter 2 of the 2012 South Florida Environmental Report). However, it is neither complete nor organized in a manner that allows replication and updating of the 1990 methodology. Most significantly, it includes no information regarding the relationships between the Lower East Coast (LEC) and the Water Conservation Areas (WCAs) and between the LEC and Everglades National Park. Appendices F4-F6 describe the relative shares of water from upstream basins contributing to the Lower East Coast: these shares form the basis for partitioning the expenditures for O&M and for other select district-wide activities.

One significant difference between the 1990 study and this update is a re-consideration of the partition of costs between "urban" and "agricultural." The previous study assigned shares of costs based on flows associated with the LEC and assigned all other (e.g., "non-urban") costs to the agricultural sector. This assignment failed to account for flows specifically to meet hydrological requirements for Everglades National Park, an increasingly significant consideration in the context of restoration. The previous study therefore over-allocated costs to the agricultural sector. As the flows to the Park are now quantified, expenditures towards this end can be estimated consistent with the methodology used, and the allocation between the LEC and the non-urban sector of the regional economy will consequently be more accurate.

Both the 1990 study and this update focus on "field office costs," the expenditures by the District to operate the facilities that in turn are responsible for directly managing the movement of water. The approach taken to apportion field office expenditures was to estimate the percentage of water managed by the field office which becomes part of the water budget of each downstream sector. Appendix F-3 summarizes the flows among hydrological units in south Florida.[33] In the 1990 study, original and separate assessments were made regarding seepage eastward through the Eastern Levee and seasonal discharges from the EAA into the WCAs and Lower East Coast. While the District model incorporated such flows, there was no documentation at that time describing the annual volumes. The hydrological budgets presented in the January 1, 1999 Consolidated Interim Report obviate the need to update those earlier assessments (along with the supporting appendices). Except for the significant difference in the quantity of rainfall as in input to Everglades National Park (6,183 E3 ac-ft/yr in the 1990 study versus 1,709 E3 ac-ft/yr in the 1999 Interim Report), the values used in the studies are proximate and in many instances vary by only a few percent.[34]

[33] "KRB" includes the Kissimmee River, Istokpoga, Fisheating Creek, Taylor Creek, and Nubbin Slough Basins.

[34] The Interim report did not specify the area evaluated for rainfall. The 1990 study used the entire park at 2185 sq mi at 55.5" per year. Even if only the land area (1465 sq mi) were used, at 49.4" (more recent data reported by the Park Service: *http://usparks.about.com/blplanner-everglades12a.htm*) the total would be 3,860 E3 ac-ft/yr, more than twice that reported in the Interim Report. It remains unclear why the rainfall value in recent literature is so much less than prior assessments.

Total and Managed Flow

Two assessments were made: (1) "Total Flow," which relates all estimated average annual flows between hydrologic units to the water budget of each respective unit, and (2) "Managed Flow," which relates only those estimated average annual flows between hydrologic units that require infrastructure and operations to the total annual managed flows through each unit. The unit water budget is the sum of all inflows (including rainfall) entering the unit ("Total Flows To" in Appendix F-3). Managed flows, as defined here, exclude the contributions of on-site rainfall and seepage to total inflow and the contributions of evapotranspiration and seepage to outflow, and thereby reflect flows that are pumped, diverted or discharged and correspondingly require water management infrastructure and operations staff and systems to occur ("Sum of Managed Flows" in Appendix F-5b).

Appendix F-5 details this analysis for both assessments and the results are summarized in Table 4-1. These results provide upper and lower bounds for apportioning expenditures to each economic sector. The "Unit Budget" data indicate the proportion that the flow between each hydrological unit and the Lower East Coast (LEC) is of either the total or managed flow of that hydrological unit. The "LEC Budget" data indicate the proportion that the flow between each hydrological unit and the LEC is of either the total or managed flow of the LEC. These "Unit Budget" percentages then can be translated into shares of field station operating costs. Conversely, the "LEC Budget" percentages reflect shares of the ultimate flows to the urban sector, i.e., the proportion of upstream water management effort at each field station that eventually generates some share of the LEC water budget. In sum, the "Unit Budget" tabulations estimate the percentage of expenditures within the unit to process flows regardless of destination; the "LEC Budget" tabulations estimate the expenditures to process flows directed to the Lower East Coast.

The choice of the LEC as the economic fulcrum derives from the fact that water generally moves from the north and middle of the Okeechobee watershed to either the Park or the LEC. Establishing the share of expenditures unique to the LEC makes it possible to assign the balance to the agricultural sector as the other component of the economy paying for water management services. The separate accounting of flows to support the Park ensures that these flows are not attributed to agriculture (as "non-urban") and thereby corrects the deficiency in the 1990 study mentioned above.

The assumption inherent in this approach is that water management operations are blind to the ultimate distributions of water, and that specific shares of flows between hydrologic units can be tallied and compared to total annual movements. From the perspective of operating expenditures, each unit of water passing through infrastructure managed by a particular station is the same, requiring equal expenditures to manage. From the perspective of a downstream unit, its share of expenditures for operations occurring upstream varies depending upon the total or managed flows through those stations.

Table 4-1. Percent of Lower East Coast (LEC) Water Provided by Upstream Hydrological Units (1995 Base)

	--- Total Flows ---		--- Managed Flows ---	
Unit	Percent of Unit Budget	Percent of LEC Budget	Percent of Unit Budget	Percent of LEC Budget
WCA	20.71	14.03	14.84	11.85
EAA	7.02	4.60	10.53	7.98
LOK	3.44	2.10	4.07	3.26
KRB	1.59	0.97	2.22	1.78

Note: WCA (Water Conservation Areas); EAA (Everglades Agricultural Area); LOK (Lake Okeechobee); KRB (Kissimmee River Basin)

B. The Allocation of SFWMD Operating Expenditures and Benefits

Having developed a means to quantify the contributions of a remote hydrologic unit to the Lower East Coast (and the park), it is necessary to apply these shares of the regional water budget to the District operating budget. For the breakdown of O&M expenditures, hydrological units are affiliated with field stations as follows: WCA with the West Palm Beach station; EAA with the Clewiston station; LOK with the Okeechobee station; and KRB with the Kissimmee station.[35] This study recognizes that management operations for hydrological unit may be governed by more than one station, e.g., LOK is managed by operations at Clewiston and Okeechobee, but the merging of individual office budgets and reapportioning them via a methodology similar to that above would not result in significant differences in final percentages.

Appendix H-3 combines the budget data from Appendix H-2 and the percentages from Table 4-1.[36] As the Ft. Lauderdale, Miami, and Homestead stations are all within the LEC, percentages for these stations were determined by the percentage of urban water use based on withdrawal data for 2005. These were 97.5, 94.2, and 85.0 percent, respectively. Water use data are not developed at the field station level, and Miami-Dade County has two stations. Urban water withdrawals in Miami-Dade are 89.6 percent of total withdrawals and 94.2 percent of the permitted allocations in Miami-Dade are urban (non-agricultural, Appendix B-5). Given the allocations, and the higher of the two values as the percentage for the Miami field station, a value of 85.0 percent for the Homestead station yields the average value of 89.6 percent for county-wide urban withdrawals. This approach recognizes the character and water demand of southern Miami-Dade County as less urban than the northern part of the county.[37]

[35] These assignments are consistent with those used in the 1990 study.
[36] Appendix F-5 provides the derivation of the total and managed flow percentages.
[37] The 1990 study used 17.9 percent for urban demands associated with the Homestead Field Station, assigning an undue share of expenditures to the agricultural sector. No data was provided in the final report of the 1990 study to justify that percentage.

This study recognizes that the West Palm Beach field station has significant responsibilities for managing stage and water supply in Palm Beach and Martin counties, but there was no rational means to partition this role from that of water management in South Florida at large. Therefore, it was included in the context of partitioning flows rather than assigning percentages based on urban and agricultural withdrawals, which in Palm Beach County would have underestimated the urban component of expenditures.

1. Field Office Expenditures

The prior study included referenced arguments made by others for 100 percent allocation of many of the field office expenditures to the agricultural sector because the purpose of the original drainage project (i.e., the major canals) was to promote agriculture in the region and was not directed to foster urban development: those expenditures which are oriented primarily towards managing the infrastructure of the project should attach to agriculture. However, this study recognizes the interconnections of water management for all sectors of the regional economy and the methodology devised for apportioning these costs better reflects actual management and not historical intent.

Appendix H-4 summarizes the expenditures for field stations and related divisions of the SFWMD for FY 2008 through FY2011. The 1990 report used a single year for estimating this expense. However, annual budgets for O&M vary in response to each year's physical requirements (i.e., energy for pump stations activated to move flood waters), general equipment and facility maintenance needs, and the larger constraint of the District's overall budget. Therefore, the average employed in this update should be more reflective of typical expenditures for this purpose.[38] The average annual expenditure over the past several years for the seven field stations is $55.9 million.[39] The West Palm station, at an annual average of $15.1 million comprises about 27.1 percent of the budget for all of the stations. The Kissimmee/St Cloud station absorbs about 7.8 percent of that budget.

The average annual station expenditures were multiplied by the percentages outlined in Table 4-1 and the LEC-specific percentages based on withdrawals. These expenditures were also multiplied by the percentages derived for flows to the ENP. The allocation of expenditures for agriculture was the remainder, after accounting for the urban and Park components. Appendix H-5 provides these results, which are summarized in Table 4-2.

[38] Baumol and Willig (1981) concluded that sunk costs (such as those associated with capital costs of a water distribution system) contribute to creating economies of scale and hence, high barriers to entry (i.e., monopoly profits, resource misallocations and inefficiencies). However, fixed costs (similar to the costs incurred by public goods) do not contribute to barriers to entry and associated misallocation problems. This study did not attempt to examine economies of scale by consolidation of field offices, etc., and associated reallocation of fixed costs. For example, it can be assumed that reallocation of costs associated with pumps would be incremental, or subadditive, in the Baumol sense; however, other fixed costs such as office expenditures might not be reallocated as incremental costs.

[39] The FY2011 expenditures for "Movement of Water" alone was $4.09 million, but that fails to include $9.0 million in "Pumping Operations", and millions of dollars in pump station modification and repair, canal and levee maintenance, etc., all of which are necessary to manage the movement of water.

Table 4-2. Summary of District Expenditures for Field Stations and Related Operations ($ millions)

Alternative		ENP Allocation	Urban Allocation	Agric. Allocation	Agricultural to Urban Ratio
Total Flow	Source Unit-Based	$5.31	$17.39	$33.20	1.91
	LEC-Based	$2.58	$17.87	$35.45	1.98
Managed Flow	Source Unit-Based	$21.80	$9.30	$24.79	2.67
	LEC-Based	$6.63	$16.28	$32.99	2.03
	Average	$9.08	$15.21	$31.61	2.08

The "total flow" and "managed flow" approaches provide upper and lower bounds for urban and agricultural shares of the operation of the major components of SFWMD infrastructure. Three of the four alternatives are similar; the range of expenditures for urban purposes is within ten percent ($16.28 million to $17.87 million). The anomaly occurs when the analysis is restricted to managed flows focused on the ENP. The assignment of $21.8 million in expenditures to the Park derives from the significant volumes delivered to the WCAs as drainage and then to the Park as flood control discharges and environmental water supply.

Including this special case yields an average of $9.08 million in expenditures for the Park, $15.21 million for largely urban purposes, and $31.61 million for agriculture, a difference of $16.4 million per year between the latter two. Excluding the outlying case yields an average of $4.84 in expenditures for the Park, $17.18 million for urban purposes, and $33.88 million for agriculture, a difference of $16.7 million per year between the latter two. The more conservative estimate of $16.4 million per year is used in subsequent analysis.

The ratio of averaged expenditures for the agricultural sector to those for the urban sector is 2.08. From Appendix B-2, the ratio of agricultural water withdrawals to those for urban purposes was 1.22 in 2005. The implication is that field station expenditures result in a disproportional benefit (of greater than 70 percent) to the agriculture sector relative to the amount of water delivered. However, this report recognizes that field station expenditures, as part of the larger O&M budget, deliver functions other than water supply, and the need for different water management services will vary by location in the system.

The average ad valorem component of the District budget in recent years (including the housing bubble and bust) has been $457.3 million. The share of the District's tax base that has agricultural exemptions has dropped to 0.65 percent. Agriculture now contributes only about $2.97 million per year towards the entire District budget but receives a return on that investment of at least $31.6 million in field station expenditures alone. The difference, approximately $28.63 million, is then a subsidy from the non-agricultural sectors of the

economy. While water management functions between economic sectors are linked, the above estimate is based directly upon where water goes and how it gets there, and double-counting is therefore avoided. Only if the agricultural sector were taxed at a rate that generated the additional $28.63 million per year would that subsidy be offset. The approximately $11.3 million per year paid as the Agricultural Privilege Fee do not count towards offsetting these operations costs, and are addressed in the following section on capital projects.[40] If one were to isolate the agricultural share of ad valorem for field stations, its share (at 0.65 percent in 2012) would be just $363,400 and the "return on investment" for this sector would be 87 to 1. The ratio for the non-agricultural sectors would be just 0.27, less than 1.0, i.e., a loss.

In summary, the SFWMD expends between $24.8 million and $35.5 million annually to provide O&M water management functions for agriculture through its field stations. The most likely value is $31.6 million. Based on its current share of ad valorem revenues, agriculture pays less than $3.0 million for all services provided by the District, i.e., operations and maintenance, scientific support, regulation and permitting, etc. Therefore, the annual base subsidy from the non-agricultural sectors for O&M is approximately $28.6 million. Any allocation of expenditures for other functions to benefit the agricultural sector is then a net addition to this amount.

In 1985, agriculture withdrew a total of 1.91 million acre-feet (acre-ft) while non-agricultural uses required 1.326 million acre-ft (Appendix B-1).[41] As of 2005, these withdrawals are estimated to be similar for agriculture, but have increased to 1.55 million acre-ft for the non-agricultural sectors. Based on allocations of expenditures of $31.6 million and $15.2 million respectively, in terms of the direct expenditures for water management, agriculture requires $16.57 of expenditures for each acre-ft withdrawn while the non-agricultural sectors require $9.76 per acre-ft. Thus, based upon the expenditures for operating field stations alone, each acre-ft made available to agriculture requires $6.81 more than when made available to the Lower East Coast. Further, based on its share of ad valorem (a total of $2.97 million per year), agriculture pays $1.55 per acre-ft while the non-agricultural sectors pay $291.62 per acre-ft. These costs do not include the final delivery to the consumer, i.e., the costs of private, internal irrigation systems or municipal treatment and delivery systems (public water supply).

[40] The Agricultural Privilege Tax is restricted in use for the Everglades Construction Project. While expenditures for the Project include land acquisition, design and construction, and ultimately "management," the District budget documents do not isolate or allocate shares of the Agricultural Privilege Tax to hydrological operations.

[41] These are revised values, including the re-assignment of domestic self-supply to the urban sector. The 1990 study used 1.874 million ac-ft for agriculture and 0.934 million ac-ft for non-agricultural purposes.

Table 4-3. Changes in the Relationship of District Expenditures and Revenues per Acre-foot of Water Withdrawn ($ millions).

	--- 1985 ---		--- 2005 ---	
	Agriculture	**Non-Agriculture**	**Agriculture**	**Non-Agriculture**
Direct Expenditures per Acre-Foot Withdrawn	$9.61	$8.08	$16.57	$9.76
Ad Valorem Paid per Acre-Foot	$0.23	$26.90	$1.55	$291.62

Relative to the values of these derived statistics presented in the 1990 report, while the ad valorem paid by the agricultural sector per acre-ft of water for agricultural withdrawals has increased by a factor of more than 6.7 (from $0.23 per acre-ft in 1990 to $1.55 per acre-ft in 2012), the ad valorem paid by the non-agricultural sectors per acre-ft of water withdrawn has increased by a factor of more than 10.8 (from $26.90 to $291.62). The per unit expenditures for making water available for agriculture have increased by more than 72 percent over this period (from $9.61 per acres-ft to $16.57) while the per unit expenditures for making water available for the urban sector have increased by less than 21 percent (from $8.08 to $9.76). To make water available for agricultural withdrawal, total expenditures increased by $13.6 million (from $18.0 million to $31.6 million). The increase for the urban sector was $7.66 million (from $7.55 million to $15.21 million). Agriculture is receiving the same quantity of water it did in 1985 but the water management system is spending significantly more to achieve this than it does to provide more water to the urban sector. Last, the ratio of total expenditures between the two sectors decreased from about 2.38 in 1985 to 2.08 in 2012[42]. Based on this change, the disparity identified in 1990 should have been dampened, but has become exacerbated because of the significant reduction in share of ad valorem contributed by agriculture.

To better reflect the relative sizes of each sector, the subsidy of operations and management expenditures provided by the urban sector to agriculture should be deducted from the GRP attributed to agriculture because these expenditures make available an input (water) to the final product. Further, these monies could have fueled non-agricultural production instead of paying the SFWMD for the management for non-urban needs.

2. Expenditures for Other District Activities

The previous section partitioned only the expenditures associated with the field stations that manage water. Ad valorem revenues support another $401.4 million of District activities per year.[43] Any further partitioning of these expenditures represents direct subsidies as all of the agricultural ad valorem is already accounted for in the previous accounting of field station

[42] This calculation necessarily uses 2005 water use data (the most current), but information from the 2012 budget, rather than applying outdated budget data.

[43] Net of Certificates of Participation and Ad Valorem Balances, ad valorem represents, on average 63 percent of the annual budget.

expenditures. For example, the expense category of "Regulation by the District" averages $18.5 million per year. While regulation is supported by permit fees, revenues from permits and licenses are typically only $2.5 million per year. Consequently, net expenses for regulation are approximately $16.0 million per year.[44]

Permit Administration

Much of the regulatory work of SFWMD relates to the administration of permits. Thus, population, size of parcel served, and type of end use are secondary to the actual paperwork, information storage and maintenance, communications, planning, review, and monitoring attached to individual applicants and permit holders.

The approach taken to apportion these expenditures for regulation was to compare the number of consumptive use permits (CUPs), by sector, after factoring out the management of environmental resource permits (ERPs). ERPs are required to a much greater degree by the non-agricultural sector.[45] Further, ERPs require more staff-time than do CUPs.[46]

The SFWMD reports an average of 2,360 CUPs per year and 2,150 ERPs per year. Based on the above information, there are a total of 169,910 "permit-days" of processing time, of which 43.0 percent is tied to administering CUPs. Forty-three percent of the $16.0 million, or $6.89 million, of the regulatory budget attaches to CUPs. Appendix B-5 describes the distribution by end use for the number of CUPs: for the 2,360 Major General and Individual Permits (issued for a total of 23,930 wells), 47.5 percent are agricultural. Consequently, $3.27 million in regulatory expenditures attach to agricultural CUPs. As mentioned above, the agricultural share of ad valorem is already accounted for, therefore this $3.27 million in the processing of well permits is another direct subsidy.[47]

Alternatively, in FY11, ERPs are budgeted at $12.32 million, CUPs are budgeted at $6.30 million, and "Ag Team Technical Assistance" is funded at $0.23 million. At 47.5 percent, agricultural CUPs would require $2.99 million. The additional (specific) Agricultural Team Assistance would yield a total of $3.22 million. The lesser amount ($2.99 million) is used here.

Other Program Categories

The other major categories of expenditures that could be partitioned include "Mission Support," "Water Supply," and "Modeling and Scientific Support." Budgeted expenditures for these three categories in FY2012 are $104.5 million, although the average expenditures between FY06 and FY12 have been $194.6 million. The FY2011 Functional Area Line Item Report provides details for roughly 240 program areas. Modeling is a key component of

[44] The FY2011 Functional Area Line Item Report indicates a budget of $4.85 million for Water Use Permitting and another $1.45 million in Water Use Compliance, but other expenditures attach to regulation.
[45] For the period June 2011 through May 2012, agricultural ERPs comprised just 4.6 percent of the total applications.
[46] With median process times of about 45 days for an ERP versus 31 days for a CUP, ERPs require 45.2 percent more staff time.
[47] The 1990 study estimated that the urban sector provided a $5.2 million subsidy to agriculture through the regulatory program, but did indicate that this was likely an over-estimate.

planning for water supply and for operations. Expenditures in this category ($15.3 million on average, 2006-2012) could be allocated according to water use (i.e., 55 percent agricultural, 45 percent non-agricultural) or by CUPs (i.e., 48 percent agricultural, 52 percent non-agricultural) – metrics that relate to one of the primary reasons for which modeling is undertaken. Water Supply (at $45.6 million, accounting for $2.6 million for the Big Cypress Basin) could be addressed similarly. On the other hand, allocating expenditures for Mission Support – all of the administrative and executive functions of the District including areas as diverse as Human Resources, the General Counsel's office, contract management, information technology, facilities maintenance, and lobbying – may be based on some measure of benefits obtained as a result of water use such as relative shares of the Gross Regional Budget or of property value (just value, not taxable value). Average expenditures for this category are $127.2 million per year (accounting for $3.9 million for the Big Cypress Basin).

The most conservative estimates as suggested above yield $29.2 million in Modeling and Water Supply expenditures to benefit agriculture and $31.7 million to benefit the non-agricultural sector. For Mission Support, the just value of agricultural lands is 2.86 percent of the District total (Appendix G-2). The shares would be $3.6 million for agriculture and $123.6 million for the non-agricultural sector. The total subsidy to agriculture in these other program categories is no less than $32.8 million.

C. Capital Expenditures

Water resource capital expenditures have had a significant impact on the face of South Florida. Without such expenditures, the water management infrastructure that has reshaped the region's economy and ecology would not be as extensive as it is, and the breadth of agricultural use of land would be greatly reduced. This section allocates the fractions of regional capital investment that have benefitted agriculture and urban development. The first part of this section discusses the Central and South Florida Flood Control Project, funded chiefly with Federal dollars, which made much of South Florida agriculture feasible. Subsequent parts examine other current and proposed capital expenditures of the South Florida Water Management District, funded primarily with ad valorem revenues, the Everglades Construction Project, funded in part with "agricultural privilege taxes," and the Comprehensive Everglades Restoration Project.

Calculations involving discount rates and annualized values use a factor of 6.3 percent. Despite the record low rates for borrowed money over the past two years (and reduced discount rates announced by the Corps) the average discount rates for Federal water supply projects over the past 60 years is closer to 8 percent. The project life of many capital improvements is on the order of 50 years (the CSFFCP is now more than 60 years old); however, select components of the CSFFCP scheduled for repair or modification are less than 30 years old. Consequently, where applicable, this smaller time period was used and the discount factor to generate annualized values was adjusted accordingly.

1. The Central and South Florida Flood Control Project

The Central and South Florida Flood Control Project (CSFFCP) was the culmination of the State of Florida's early drainage efforts (Figure 4-1). Congress authorized the project in 1948 to provide flood protection from Lake Okeechobee, drain land for agricultural use, and manage the water supply for irrigation purposes. These water management functions are inter-related and individual project components serve multiple objectives. The initial CSFFCP featured over 1,300 miles of canals and levees, a dozen high volume pump stations, over 60 spillways, and several hundred secondary structures, the majority of which were designed and constructed by the U.S. Army Corps of Engineers. The project was to allow a more profitable use of 1.57 million acres of existing crop and pastureland and to open 726,000 acres for the first time, including 530,000 acres mostly in the EAA and 128,000 acres east of the perimeter levee. Operation and maintenance for most of the project was turned over to the Central and South Florida Flood Control District (CSFFCD, the predecessor to the SFWMD) after completion of each component.

The Corps was to finance most of the work on the CSFFCP, with the State of Florida contributing from general revenues, and the water management district, then called the Central and South Florida Flood Control District, contributing from its own ad valorem revenues. According to Clark (1978), "These taxes are collected not only in the area most benefitted by drainage but also from the heavily populated areas of the southeast coast." Thus, money collected from the urbanizing southeast coast subsidized other areas that benefit directly from the CSFFCP drainage system. Urban property, much of it on the higher coastal ridge and less subject to flooding, has accounted for the majority of assessed valuations. Thus, at the time of project authorization, urban flood control benefits were secondary, but urban funding was necessary.

Referring to the CSFFCP, Carter (1974) and Blake (1971) suggested that federal expenditures were made solely for the benefit of the agricultural community and that flood control and water supply benefits for the coastal municipalities were afterthoughts and inadvertent consequences of the project. Their logic behind this re-consideration of CSFFCP expenditures and benefits is as follows:

1. Flood control for Lake Okeechobee towns should not be considered a project benefit because the beneficiaries of protection (i.e., homes and businesses) are located in a flood hazard area solely because of their affiliation with agricultural production;
2. Navigation benefits should be considered part of the original drainage aspect of the project because much of the construction consisted of locks and the widening and maintenance of existing drainage canals; and
3. The reported benefits to fish and wildlife through the creation of the conservation areas should be considered non-existent because if the project had not been undertaken, the central Everglades would have remained in its natural state, and populations of the native fish and wildlife would not have been severely impacted. [i.e., given that the estimated number of wading birds in the Everglades ecosystem is ten percent of their levels in the 1930s, the benefits of the CSFFCP may be negative, not positive.]

In sum, since navigational benefits are by-products of drainage efforts, and fish and wildlife conservation was done only to mitigate damages associated with the project, almost all of the project benefits (and assignment of infrastructure costs and operations) should accrue to agriculture.

Figure 4-1. Historical Map of the CSFFCP

The federal government was responsible for 82 percent of the project's initial capital outlay or "first costs," which included land acquisition and construction. [Total costs are defined to include these plus operation and maintenance expenses.] The State of Florida contributed 43 percent of the total non-federal costs and the Flood Control District, using ad

valorem, paid the remainder. Between FY 1950 and 1973, total nominal Federal expenditures for the Project were $292 million.[48] Adjusting annual expenditures by the CPI across the years of construction, Carter (1974) reported that this amount translated into an estimate of first costs equal to $529 million in 1973 dollars. Comparing values across 40 years is problematic, but based upon the annual average of the CPI in 1973 and its value in 2011 the project would cost $2.68 billion (in 2011 dollars). The breakdown for first costs then is $2.20 billion from the Federal government (U.S. taxpayers), $207.4 million from the State of Florida, and $275.0 million from South Florida property owners.

Agriculture clearly constituted a larger share of the tax base of the District across the decades from 1950 through 1980. However, if the project could be built for $2.68 billion in today's dollars, using its current share of the tax base (0.65 percent), agriculture in South Florida would contribute about $1.8 million while urban interests would contribute about $273.2 million. According to Carter (1974):

> *"It is not too much to say that the cost sharing for the $529 million FCD project has favored agricultural interests–and especially the corporate farming enterprises of the Everglades Agricultural Area–in an outrageously unfair way. This seems especially true in light of the other government subsidies available to these enterprises."*

In the 1990 study, agriculture's share of the project was estimated to be about $2.5 million based on agriculture's share of ad valorem in 1988, which was 1.67 percent. Fitting an exponential decay to these two points yields an agricultural share of ad valorem of about 4.63 percent in the early 1960s (i.e., the mid-point of the construction era. This would translate into an average share of about $12.7 million in today's dollars and implies that urban property owners would have contributed $262.3 million. Property tax records for those decades would be necessary to resolve this issue more definitively.

The above capital expenditures for the CSFFCP did not include an estimated $34 million for repairs to revetments on the interior of the Hoover Dike or $15 million for new gate structures and pumps installed shortly after the 1990 study.[49] While done to protect the existing investment, the revetment repairs safely allow increased storage in Lake Okeechobee thereby providing further assurances of water supply for agriculture (the larger consumer). The same argument applies to the gate repairs. Only limited benefits for downstream (urban) supply or flood protection can be claimed for these expenditures.

Herbert Hoover Dike Repairs

The Hoover Dike surrounds Lake Okeechobee and is the successor to the earthen dam that failed in the 1926 and 1928 hurricanes. It is approximately 144 miles long and averages about 35 feet in height and 300 feet in width. The costs of the Dike, separable from the CSFFCP, were about $165 million (1960 dollars). Portions of the Dike have been found to be

[48] The costs as reported in budget documents and not adjusted for inflation or the value of time.

[49] The 1990 study indicated that these federal projects (Lake Okeechobee revetments and hurricane gates) were to have cost between $49 million and $82 million (1990 dollars). The local taxpayer share of these works would have been $11.5 million and the subsidy to agriculture would have been a minimum of $7.3 million based on the historical Corps' allocation of benefits ($12.6 million in 2011 dollars).

at risk of failure and require rehabilitation to ensure flood protection safety and the capacity to employ new lake stage schedules. In addition to the revetment repairs of the 1990s mentioned above, in the past decade the Corps has spent nearly $400 million for the cutoff wall in Reach 1 (the southeast area between Port Mayaca and Belle Glade) and for culverts in Reaches 1, 2, and 3 (the highest area of risk).[50] The estimate for repairs to Reach 1A, a length of 4.9 miles, is $63.82 million.[51] The Corps estimates that it will require approximately $1 billion and another ten years to complete the rehabilitation of Reaches 1, 2, and 3, and estimates an end date of 2022.[52] Completing Reaches 1-3 would lower the current classification of risk and enable different a broader range of lake operations. However, the likelihood of rehabilitating the remaining reaches (4-8) is speculative at the time of this update.

Summary of CSFFCP Expenditures

Total CSFFCP costs, including Hoover Dike repairs, are estimated to be $3.68 billion (2011 dollars), of which South Florida agriculture contributed $12.7 million and urban property contributed $262.3 million. The contribution from federal taxpayers is $3.2 billion and from the State of Florida is $207 million.

Using the Corps' original estimate of 65 percent for agricultural benefits (as reported by Clark), $2.39 billion of the project expenditures can be allocated to agriculture. The annualized value of this investment discounted at 6.3 percent is $150.7 million per year.[53] Allowing the remaining 35 percent, or $1.29 billion, to be allocated wholly to urban benefits yields an annualized value of $81.1 million per year.[54] The annualized value of the cumulative agricultural and urban sector contributions towards these public expenditures is estimated to be $0.86 million and $17.81 million per year respectively. Therefore, the net subsidy to the agricultural sector (from all sources) is $149.84 million per year for the agricultural sector and $63.29 million per year for the non-agricultural sectors.

In the late 1980s, additional federal projects totaled $49 million (Hoover Dike revetments and gate structures, separate from the recent improvements), of which at least $31.85 million were allocated to agriculture. The discounted annual value of these supplemental expenditures in 2011 dollars is $3.45 million (agriculture) and $1.1 million (non-agricultural).

It is possible to partition the State and local shares of the CSFFCP costs. For agricultural purposes, the State of Florida contributed $134.8 million and the CSFFCD contributed $178.8 million. The annualized values are $8.49 million and $11.3 million, respectively. For non-agricultural purposes, the State of Florida contributed $72.6 million and the CSFFCD

[50] According to Andy Reid of the Sun Sentinel, as of July 2012, $360 million have been spent in the past five years.

[51] Herbert Hoover Dike Major Rehabilitation, Martin and Palm Beach counties, Florida, Draft Supplemental Environmental Impact Statement (SEIS), Reach 1a Landside Rehabilitation, June 2010.

[52] The Corps needs to complete another engineering report to finalize engineering solutions and develop more precise estimates for Reaches 1 – 3 (personal communication, Corps staff).

[53] The average discount rate for Federal water supply projects from 1987 through 2012 is 6.33%; the average rate for other types of Corps projects under Section 80, WRDA 1974, between 1974 and 2012 is 6.82%. The values are calculated based on 6.5% and 50 years of project life.

[54] This approach fails to allocate any benefits to the natural system.

contributed $96.38 million, and the annualized values are $4.57 million and $6.07 million, respectively.

The sectors of the South Florida economy contributed to these expenditures through the relative shares of sales tax (State of Florida) and ad valorem (CSFFCD). For example, assuming agriculture paid the $12.7 million in ad valorem as suggested above, its return on investment was about 14.1 to 1. The non-agricultural sectors contributed an estimated $262.3 million in 2011 dollars; the return on investment here is 0.37. In the context of the CSFFCP, The non-agricultural sectors provided a $166.1 million subsidy to agriculture through the CSFFCD.

With regard to the State of Florida's share, the project was subsidized by residents state-wide.[55] At the mid-point of the Project, South Florida held less than 36 percent of the State's population. Assuming homogenous income and household expenditures, South Florida residents contributed a minimum of $74.4 million towards Florida's contribution to the CSFFCP. The rural population in South Florida during the 1960s was no more than 5 percent; perhaps less than 4.5 percent of the region's total. Again, assuming homogeneity of taxable expenditures, the agricultural sector contributed no more than $3.72 million. The return on investment through sales and other taxes is greater than 42.1. South Florida's non-agricultural sectors likely paid $70.68 million in state taxes towards the CSFFCP. The return on investment for these sectors is 1.03, the nominal benefit derived from the support provided by residents elsewhere in Florida. South Florida's non-agricultural sectors provided a $44.6 million subsidy to agriculture through the State's coffers.

2. The Everglades Construction Project

The Everglades Construction Project (ECP) is the capital improvements and operations program that implements the Everglades Forever Act of 1994. The fundamental purpose of the project is to reduce nutrient loading to the Everglades Protection Area, comprised of the Water Conservation Areas and the Everglades National Park. Phosphorus and nitrogen entering the EPA, largely from the Everglades Agricultural Area but also from direct flows from Lake Okeechobee, had been demonstrated to have altered the ecology. The 1988 lawsuit filed by the US Attorney General to protect the Arthur Marshall Loxahatchee National Wildlife Refuge (WCA1) in particular led to a settlement with the State of Florida and the eventual passage of the EFA. The EFA directs that nutrient reduction be achieved in part by "best management practices" – in-field modifications to agricultural practice to reduce nutrient application, improve uptake, and reduce downstream loadings. The EFA also directs that nutrient management of waters discharged to the WCAs be addressed by the construction of artificial and restored wetlands – stormwater treatment areas (STAs). Last, the EFA provides a funding mechanism for the timely construction of the STAs to ensure the terms of the settlement are met. While modifications to the final design and operation of the ECP remain in play as of the drafting of this update, significant funds have been expended since 1996 to acquire land, construct and learn from pilot projects and to construct the first phase of what will be the infrastructure package to resolve the water quality problem.

[55] Florida's population in 1960 was about 4.95 million. South Florida comprised about 35.9 percent of this total.

The ECP is first and foremost a water quality capital improvements project and does not relate directly to water supply. It cannot, however, be easily separated from water supply considerations, given both its component locations and role in the hydrology of the Okeechobee-Everglades watershed. By design, the ECP introduces new storage where there was little (or where it had been removed by previous conversion of land from natural systems to agriculture). Further, by the Court's directive its operation must not worsen hydrological conditions within the EPA and is intended to improve low-flow circumstances. Removal of agricultural lands for the creation of Stormwater Treatment Areas (STAs) (and supporting flow equalization basins) reduces demand for irrigation supply; increased flow to the ECP will contribute some additional flow (via seepage and recharge) to the Lower East Coast. In sum, the ECP has and will continue to affect the overall balance of water demand in South Florida.

At the time of passage of the EFA, the estimates for constructing the ECP were believed to be on the order of $500 million.[56] By 1999 the estimated costs had exceeded $825 million[57] and by 2008 the estimated costs were revised to $836.2 million.[58] The Fourth Biennial Report states the current cost to be $897 million. Capital costs (for Phase 1) and long-term O&M were projected to be more than $1 billion.[59] Further, the anticipated additional expenditures required to achieve the agreed-upon water quality standards are estimated by FDEP and the District to be an additional $880 million, at a minimum.[60] The grand total – if fully implemented – will be between $1.78 billion and $2.04 billon.[61] Cumulative revenues through 2011 were $1.37 billion and the cumulative expense through September, 2016 (FY 15) is projected as part of District budgeting to be $1.99 billion, including Federal contributions of $198.9 million (for the STA-1E/C-51 West Project) and $768.9 in District ECP capital costs, EFA expenditures and debt service.[62]

Unlike the CSFFCP, the majority of the costs of constructing the ECP are borne by Florida taxpayers in general and South Florida property owners, both agricultural and urban.[63] The allocation of taxes to pay for portions of the ECP is framed by the EFA (s.373.4592, Florida Statutes). Agricultural contributions initially were to run for a maximum of 20 years. The contributions, termed the Agricultural Privilege Tax, were never more than $12.3 million per year and could be reduced to a minimum rate provided that BMPs were duly implemented

[56] http://www.oppaga.state.fl.us/reports/pdf/9679rpt.pdf
[57] The USFWS reports that Florida's share of costs was $635 million and the Dept. of Interior was $190 million.
[58] Appendix C, Progress Towards Restoring the Everglades: The Second Biennial Review, 2008.
[59] In 2005, Sano, Hodges, and Degner reported capital costs to be $509.8 million, but total costs (including O&M over 50 years) were $1.01 billion. (FE576, IFAS, University of Florida); the Biennial Report reports expenditures to date (2008) to be $643.1 million.
[60] AP release, July 13, 2012, "A federal judge (Judge Gold) has given clearance to an $880 million Everglades cleanup plan, paving the way for the possible resolution of more than two decades of lawsuit."
[61] Chapter 13, 2011 South Florida Environmental Report.
[62] Appendix 1-5, 2012 South Florida Environmental Report.
[63] Based on the 2012 South Florida Environmental Report, the Federal share of the ECP is less than 10 percent.

and phosphorus loads reduced by specific percentages. The general public's share of the project was 72.8 percent. [64]

The contribution from agricultural lands was effectively capped by law at a total of $240 million over the (then expected) era of construction, regardless of the final costs for the ECP. However, the EFA was amended in 2003 to provide for extended contributions via the Agricultural Privilege Tax beyond 2017, although at a lower rate.[65] In real (constant) dollars, contributions made at the lower rate several years out will be worth far less per year than the original tax.[66] Even at the 2008 estimate of $836.2 million, the urban residents and property owners of the non-agricultural sectors of the South Florida economy would pay approximately $596 million for a project that had no defined water supply benefits for them.[67] While the agriculture of the EAA incurred costs to implement the BMPs, savings in fertilizer applications also accrue, i.e., there may be net costs to agriculture above the Agricultural Privilege Tax, but these are not included here.

Adjusted by the Consumer Price Index (CPI) (in the manner conducted for the CSFFCP), the project costs to date would be $961.4 in 2011 dollars. Appendix G-6 documents the total amounts paid by the EAA and the C-139 "western basins" towards the ECP. Adjusting these payments similarly yields a total contribution of $172.3 million via the EAA Agricultural Privilege Tax.[68] An additional $6.4 million (in 2011 dollars) from the C-139 basin is estimated. Total agricultural contributions then are $178.7 million.

Not all of the balance of Florida's share of ECP costs is paid for by South Florida property owners; part is paid for by the State of Florida, and the balance was to be met with a share of tolls from Alligator Alley and mitigation funds from Florida Power & Light. The District may assess up to an additional 0.1 mil earmarked specifically for the ECP. In FY 2012, the total tax rate in the Okeechobee Basin is 0.4363 mil, of which 0.0624 mil are dedicated to the ECP. Therefore, 14.3 percent of the District's total ad valorem tax base in this basin is directed to resolving this water quality issue.[69] Aside from the District-wide millage of 0.1785 applied throughout the jurisdiction, the ECP surcharge represents 24.2 percent of the specific Okeechobee basin millage (at 0.1954). Nearly one-fourth of the ad valorem paid to manage water within the Okeechobee basin, above that paid for District-wide

[64] Per OPPAGA report 96-79, the EAA and C-139 basins would contribute $134 million of a total of $492, or 27.2 percent. Ad valorem, Alligator Alley tolls, FPL Mitigation and P2000 would contribute 51.0 percent, 12.1 percent, 2.8 percent, and 6.7 percent, respectively.

[65] Chapter 2003-12, Laws of Florida provides that "for the tax notices mailed in November 2014 through November 2016 [the rate] is $25 per acre and for tax notices mailed in November 2017 and thereafter shall be $10 per acre."

[66] At the initial minimum ($24.89 per acre), the tax was equivalent to about $36.71 in 2011 dollars. Future payments will be worth no more than $8.33 in 2011 dollars.

[67] Sano, Hodges, and Degner (2005) used a value of $13.21 per 1000 gallons (based on willingness to pay during shortage) to assign benefits of $112.1 million over 50 years, or $2.24 million per year). It would be possible to use the allocation methods applied to O&M expenditures once discharge volumes are stabilized.

[68] The EAA tax rate is set by law to be a minimum of $24.89 per acre through 2013, declining to $10 acre after 2017. The C-139 Basin is capped at $654,656 per year, with a tax of $4.30 per acre through 2014 and declining to $1.80 thereafter.

[69] From 2008 through 2011, the SFWMD millage for the Okeechobee basin was 0.624 of which the ECP tax was 0.0894, or 14.33 percent. This share is then continuous over much of the project construction.

responsibilities, is being applied to the ECP, a project required primarily to address the water quality impacts of the EAA.

The ad valorem contributions from the entire agricultural sector (EAA and elsewhere) are accounted for in the expenditure allocation analysis in Section B of this Chapter. If the final costs of the ECP were the minimum of previous projects – $1.78 billion – then the contributions from the non-agricultural sectors, the state of Florida and the federal government will total $1.60 billion. As the project is intended to resolve water quality ramifications of drainage (primarily) from the EAA and (secondarily) from Lake Okeechobee, all of these expenditures are assigned to the agricultural sector. Annualized at 6.3 percent, the value is $100.8 million per year.

3. The Comprehensive Everglades Restoration Project (CERP)

The Comprehensive Everglades Restoration Project (discussed in Chapter I) proposes to retrofit and expand much of the CSFFCP. Water supply is a primary factor of CERP's design: "Quality, Quantity, Distribution and Timing." CERP components were to address the capture of some of the estimated 1.7 bgd of water lost to tide that is a byproduct of the current design and management of the CSFFCP, thereby expanding supply for all users, including the restored ecosystem.[70] As the CSFFCP project was intended to provide drainage and modify the landscape, rendering it useful for agriculture and other development, so must CERP be viewed as building upon that premise: water supply and flood protection benefits to existing uses are to be either maintained or improved. [71]

The initial plans contemplated $7.8 billion in expenditures over a 20-year window, cost-shared 50:50 with the State (and the District), supplemented by an estimated $182 million per year in O&M (to be funded by the District). Under that proposal, the District (as the local project sponsor) and the State would have committed approximately $200 million per year together. By 2007, the costs (including land acquisition) had risen to $9.5 billion and would require 30 years to complete. In 2010, the Congressional Research Service, applying the CPI to 2004 data, estimated final costs to be $10.9 billion.[72] A recent report prepared by the Netherlands government indicates costs of $11 billion over 35 years.[73] When it downgraded bonds issued by the District in January 2012, Fitch reported that the costs had risen to approximately $12.5 billion.[74] The CRS (2011) reports an estimated cost of $13.5 billion over fifty years.

Appendix I-1 summarizes Federal and State CERP and restoration-related expenditures through the FY 2012 appropriations requests. Federal contributions specific to CERP

[70] Of "new water," CERP is expected to deliver 80 percent to the natural system as part of "getting the water right" and the remaining 20 percent is for agricultural and non-agricultural supply.
[71] By law, CERP does not modify drainage or flood control characteristics of the CSFFCP, but does improve water supply as well as natural system deliveries.
[72] This estimate was affirmed in the review of the "Yellow Book" costs in Progress Towards Restoring the Everglades: The Second Biennial review, 2008. *http://www/nap.edu/catalog/12469.html*
[73] http://www.nga.gov/education/classroom/dutch/dutch_supplements.pdf
[74] http://seshippingnews.typepad.com/south_east_shipping_news/2012/01/fitch-downgrades-florida-water-districtin-the-event-of-non-appropriation-the-district-must-surrender.html

(through funding of the Corps and the DOI) total $967 million. The State of Florida (through DEP and the District) has spent $3.34 billion, a significant share of these costs for land (Figure 4-3). Adjusting for inflation over the past 12 years yields $1.03 billion and $3.57 billion, respectively. Annualized, the federal share is $64.9 million per year while Florida's share is $224.9 million (shared between the State and the District), a total of $289.8 million per year.

While ad valorem contributes to the District share of expenditures for CERP (including paying the interest on Certificates of Participation), State of Florida investments derive in part from documentary stamps tax and general revenue. Documentary stamps ("doc stamps"), contributing to the Water Management Lands Trust Fund, Florida Forever, and the Save Our Everglades Trust Fund, apply to real estate transactions. Consistent with the allocation of ad valorem, doc stamps reflect both the sales price (which is proportional to assessed value) and the numbers of transactions. The non-agricultural sector has both greater value and a greater frequency of transactions (if only to accommodate new growth).

General revenue derives from the state sales tax, currently 6 percent. Assuming similar personal or family expenditures among all residents in the region, then tax revenues should be proportional to population. In 2010, the agricultural population of the District was no larger than 5.2 percent of the total. Consequently, the urban sectors are contributing at least 94.8 percent of the State share of CERP paid from General Revenue (sales taxes) and more than 99.3 percent of the share paid through doc stamps.

Last, with regard to the federal share of CERP, income taxes provide the primary source of revenues for appropriations to the Corps and partner federal agencies. Conservatively, assuming similar incomes for both sectors, federal income tax revenues would also be proportional to population. Data reported in Chapter 2 suggests that corporate taxes and employment income are dominated by the non-agricultural sectors.

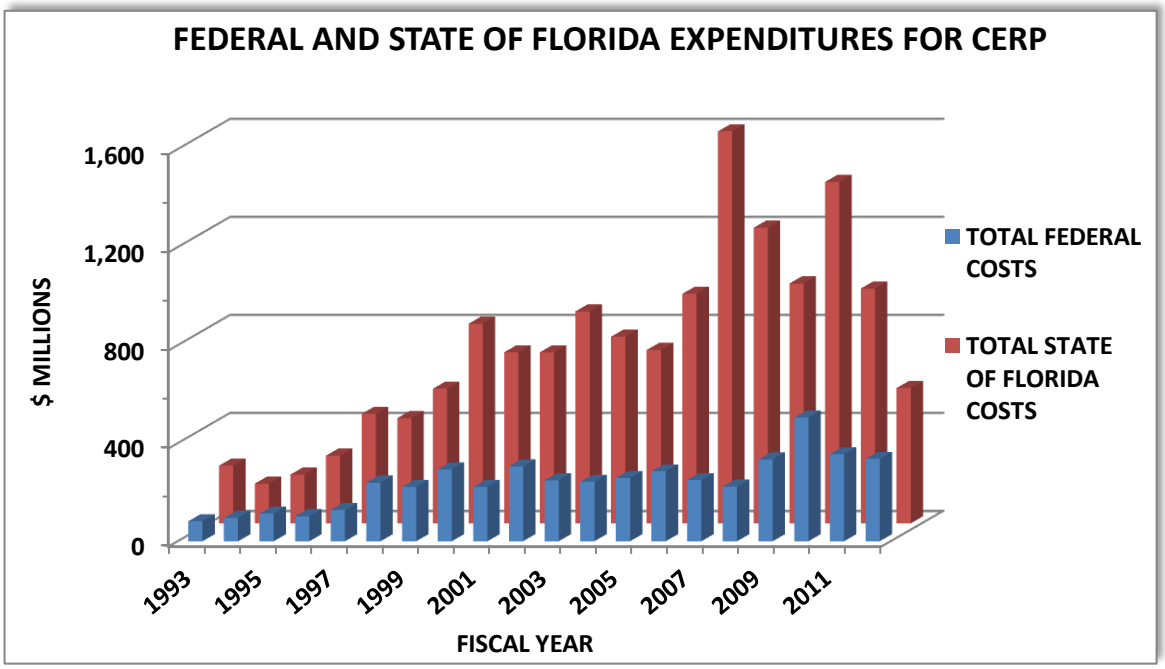

Figure 4-2. Federal and State Expenditures for CERP, 1993-2011

Figure 4-3 identifies the magnitude of CERP relative to ongoing state and federal expenditures over the past 15 years. CERP expenditures did not begin until 2001 and were at a maximum of about $600 million in 2007. Non-CERP expenditures (state and federal combined) exceeded that amount every year since 1998.

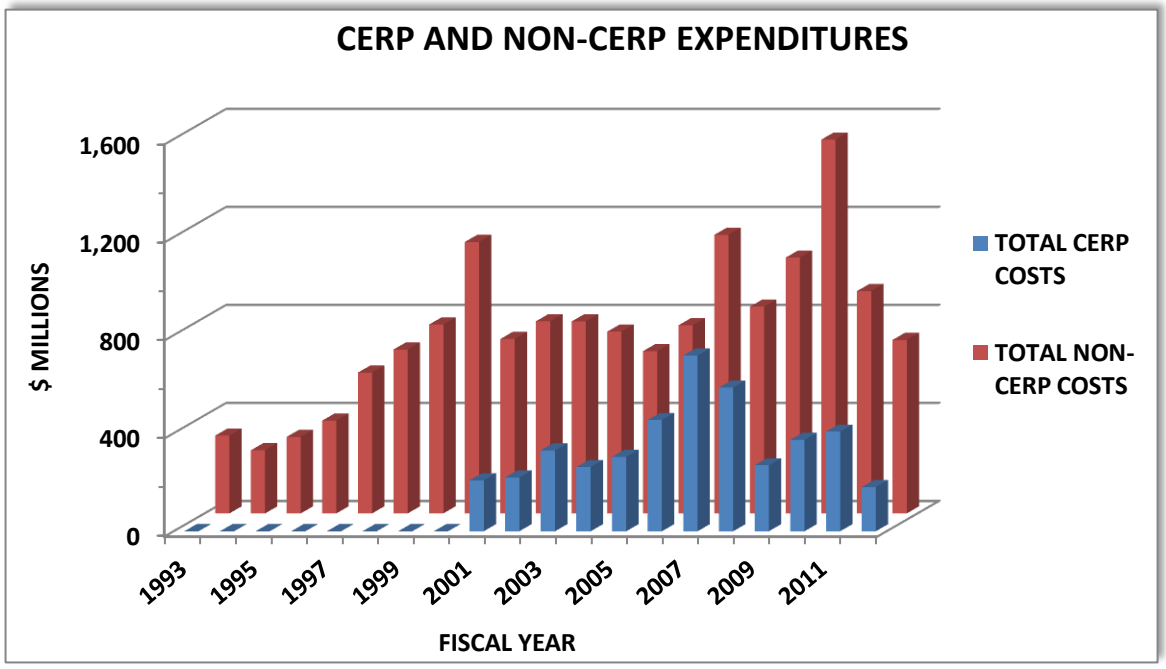

Figure 4-3. Total CERP and Non-CERP Expenditures, 1993-2011

Table 4-4. Project Category and Funding Allocated among CERP and All South Florida Restoration Projects and Activities, Fiscal Years 1999-2006 (millions of 2011 dollars)

	--- CERP Projects ---		--- All Projects ---		
Type of Project	**Federal**	**State**	**Federal**	**State**	**Total**
Land Acquisition	0	1995.7	316.2	2,537.4	2,853.6
Project Construction	0	28.7	932.5	1,253.1	2,185.5
Support Activities*	380.9	213.9	1,268.6	1,586.5	2,855.2
Totals	$380.9	$2,238.2	$2,517.3	$5,377.0	$7,894.2

* Support activities include RECOVER efforts, adaptive assessment and monitoring the Interagency Modeling Center, program coordination, and science- and mission-related activities that indirectly benefit the restoration, such as invasive species control. In addition, for the USACE and SFWMD, support activities include some funding for project design, pilot project design, and feasibility studies.

Source: GAO (2007)

The funding allocation described above does not address the purposes or beneficiaries of specific projects. If all of the expenditures to date could be ascribed to the two economic

sectors based upon the share of water supply benefits as calculated in the discussion regarding the allocation of field expenditures (rather than using the historical 65:35 allocation of benefits defined by the CSFFCP) the breakdown would be as follows:

Table 4-5. Conceptual Assignment of Annualized CERP Expenditures through 2011 based upon Water Use (millions of dollars)

Funding Source	Agricultural	Non-Agricultural
Federal	36.6	16.2
State of Florida	127.2	16.2
Totals	163.8	32.2

The significant subsidy via the State of Florida is a consequence of the contributions of ad valorem, sales tax and doc stamps revenues from the urban sector. However, the allocation of CERP highlighted in Table 4-5 is rooted in the methodology of the 1990 study and ignores aspects of the funding stream, the initial prioritization of projects, and the investment in projects that strictly (or primarily) benefit the natural system. As such it represents an upper bound for this subsidy to both the agricultural and non-agricultural sectors. Much of the funding to date has been directed towards land acquisition and environmental restoration, and the benefits of (constructed and operated) projects have yet to be realized. Most significantly for the purposes of this update (i.e., linking expenditures to water use and the economy), none of the projects completed as of 2012 provide direct agricultural water supply benefits. Further, several projects that are underway provide non-agricultural water supply benefits only indirectly. Restoration efforts such as Picayune Strand, C-111 Spreader Canal, Loxahatchee River Watershed, and the Biscayne Bay Coastal Wetlands projects may improve water supply conditions in the lower east and lower west coasts by (1) eliminating demand associated with future development, (2) increasing water tables in the vicinity of the projects and (3) contributing to aquifer recharge. However, the primary purpose of these projects is not water supply, and long-term studies or site-specific modeling would be needed to determine the scale of water supply benefits, if any.

While most CERP projects have multiple benefits, select projects can be allocated by purpose within the South Florida economy. For example, the Fran Reich Preserve (Site 1 Impoundment, $54.0 million) can be assigned in large part to Lower East Coast water supply. The annualized subsidy to the non-agricultural sector for this project is about $3.4 million per year. Conversely, lands acquired for the EAA Storage Reservoir can be assigned to water supply and flood protection for the agricultural sector. There are several components to the project, but a minimum expenditure has been $112.4 million.[75] The implicit subsidy is $7.1 million per year. The Taylor Creek – Nubbin Slough STA is a water quality project that

[75] The DOI provided $99,434,312 in federal Farm Bill funds for the acquisition of these lands and the SFWMD provided $12,939,906. (http://www.saj.usace.army.mil/Divisions/Regulatory/DOCS/interest/SFERC/CompartmentsB-C/FEIS_Chap-1.pdf)

addresses agricultural impacts only.[76] At $138.7 million ($168.1 in 2011 dollars, via land acquisition and construction from FY05-09), the subsidy is $10.6 million per year.[77] CERP includes projects to improve the quality of urban stormwater – the C-9 and C-11 Improvements are good examples – but these have not yet been constructed.[78]

4. Other SFWMD Capital Projects Relating to Water Supply

Prior to CERP, the SFWMD has been responsible for various capital improvements needed to support the multi-objective functions of the CSFFCP, including water supply. Some of these projects have been through multiple phases of planning and development. For example, in the 1990 study, Nicodemus Slough (the west side of Lake Okeechobee) was identified as a project to benefit water quality and supply for agriculture.[79] The initial costs were $1.68 million, later revised to $3.26 million ($5.6 million in 2011 dollars). In February 2011, District staff recommended a 16,000 acre project requiring $4.9 million to design and construct, a 10-year land lease at up to $2.1 million per year, and O&M costs of $0.4 million per year. The total contract was proposed not to exceed $28.6 million.

Other projects have long since been implemented as part of general operations, including the repowering of the S-6 pump station ($2.0 million); S-5a parts upgrades ($0.15 million); the "Modified Hendry County Plan Project" ($8.5 million); Okeechobee gate replacement ($1.46 million) and the Clewiston Field Station Building upgrades ($0.25 million). The 1990 study identified $11.6 million to be expended within the Okeechobee basin for agriculturally-oriented projects between 1989 and 1994. The Bolles and Cross canals improvements, initially budgeted at up to $4 million, have been absorbed into CERP, Everglades Agricultural Area. In neither 2010, 2011 nor 2012 was there a discrete budget line for this capacity project.[80] In current dollars, these projects sum to $19.9 million, excluding the Hendry Plan and the Final Scope of the Nicodemous Slough project, these latter projects result in total expenditures of $63.1 million.

The 1990 study considered the contribution of the agricultural sector to the entire capital improvements budget, and the value of those projects clearly addressing agricultural water supply or water quality improvement and estimated the annualized value of the subsidy to be

[76] http://www.sfwmd.gov/portal/page/portal/common/newsr/lonew/tcns_proj_feat.pdf

[77] Other projects with water supply benefits are pending: the Lake Okeechobee Aquifer Storage and Recovery (ASR) project would have provided water supply benefits to agriculture (with secondary benefits to the urban sector), but other than pilot facility the project has not moved forward. The Hillsboro and Caloosahatchee Pilot ASRs are in place as part of the regional ASR study.

[78] $190 million were expended for the 7,000 acre Southern Gardens purchase that will have water quality benefits for the EAA. However, the project will also yield (undetermined) environmental benefits and consequently was not included in the allocation of expenditures that subsidize agriculture.

[79] Nicodemus Slough is intended to allow for flooding generated by raised lake levels. The primary reason for raised levels is to increase supply for irrigation. Given that agriculture in the region consumes more water than the Lower East Coast, expenditures related to expanded storage must be apportioned similarly. [A 1989 SFWMD memo indicated that Lake-supplied Lower East Coast water was about one-sixth the volume supplied to the EAA.]

[80] Page 4, Appendix 1-4, 2012 South Florida Environmental Report; Appendix 7, 2010 and 2010 South Florida Environmental Reports

just $1.0 million in 2011 dollars. The annualized value of the various projects identified above exceeds $2.2 million, all of which is net subsidy.

SWIM Plan Expenditures

The Surface Water Improvement and Management Program was the State of Florida's framework to prioritize the cleanup, restoration and long-term management of priority water bodies. Lake Okeechobee was one of the priorities for the SFWMD. The Lake had been impacted significantly by agriculturally-generated nutrient loading from the Kissimmee River, the Taylor Creek and Nubbin Slough basins, and the EAA (from historical backpumping). Through 2002 the District had expended a total of $27.96 million.[81] These were legacy expenditures from a more comprehensive program (adopted by the District) that had been expected to require $120 million between 1990 and 2000, of which the EAA would have been required to contribute a maximum of $40 million.[82] The balance was to have been split evenly between Preservation 2000 monies and District revenues. An additional $30 million in water quality improvement costs were to be born independently by the EAA.

SWIM funding for other priorities and program elements was largely eliminated by FY 97; however, post-1990, the SWIM program expended $35.4 million (2011 dollars) on Lake Okeechobee.[83] These included state general revenues (passed primarily through the DEP) and local resources. Discounted over the life of the program (less than 25 years), the subsidy is $2.85 million per year.

5. Summary of Capital Expenditures

The costs of supporting agriculture include the apportioned share of capital projects and land acquisition costs plus subsidies from the urban sector. The subsidies relating to SFWMD programs are net – the balance of funding was described in the section addressing O&M expenditures, and the other programs are in addition to that. The summed subsidies are employed in the calculations of the relative costs of water.

The 1990 study identified a $117.2 million (annualized) subsidy for agriculture and a $45.7 million subsidy for the urban sector. These amounts are $201.7 million and $78.7 million, respectively, in 2011 dollars. Largely because of the Everglades Construction Project and the nominal funding provided by the agriculture towards CERP, the subsidy to agriculture has increased significantly, by more than $276 million per year, or 137 percent. The subsidy to the non-agricultural sectors increased by $18.1 million, or about 23 percent.

[81] Expenditures were $2.12 million prior to 2000, $16.96 million in 2001, and $8.88 million in 2002, SWIM Plan Update for Lake Okeechobee, 2002.

[82] With reference to the first draft of the SWIM Plan, it was estimated that 40,000 acres of the EAA would be needed for filtration with an estimated total cost of $200 million. The acreage set forth in the adopted SWIM Plan (September 1990) was 75,700 acres and the costs of acquisition and management may be assumed to rise proportionally. Estimates in 1990 were as high as $500 million.

[83] The Lake Okeechobee Protection Act (s.373.4595, F.S.) adopted in 2000 replaces the SWIM program for the lake.

Table 4-6. Summary of Annualized CSFFCP and SFWMD Subsidies to Agricultural and Non-Agricultural Sectors ($ millions)

Item	Agricultural	Non-Agricultural
CSFFCP Infrastructure (Net)*	$ 149.8	$ 63.3
Other Federal Projects**	3.9	1.1
ECP	92.8	0.0
CERP (State and Federal Merged)	17.7	3.4
SFWMD Capital Projects	2.2	---
SWIM (LOK)	2.7	---
SFWMD O&M	28.6	---
SFWMD Regulatory	3.2	---
Other SFWMD Functions	32.8	---
Totals	**$333.7**	**$ 67.8**

* Including current Hoover Dike repairs.
** Including older Hoover Dike and Gate repairs.

Were one to exclude any consideration of CERP as a subsidy to the South Florida economy and its use of water resources the totals would be $316.0 million for agriculture and $64.4 million for the non-agricultural sectors. Under this scenario – a lower bound – in constant dollars the total subsidy to the agricultural sector through the CSFFCP and the SFWMD would have increased by $114.3 million per year while the subsidy to the urban sector would have decreased by $14.3 million per year.

Including the specific projects identified as complete and allocable to either sector yields $333.7 million and $67.8 million for the agricultural and non-agricultural sectors, respectively. Should CERP be completed, the above summary of subsidies should be revisited to reflect final expenditures and the appropriate assignment of water supply and water quality benefits to the respective sectors (including the natural system).

D. Discussion of Selected Benefits Attributable to Water Management Infrastructure, Operations, and Maintenance

The thrust of this update is to highlight the changes in scope of subsidies and externalities relating to water use. The 1990 study did include a section reflecting upon the benefits (i.e., the added value) of water management, and viewed these separately from the District and other expenditures attributed to the agricultural and "urban" sectors. Neither the 1990 study nor this update is a benefit-cost analysis or a determinant of net economic value, and benefits highlighted below are not included in the assessment of the full costs of water in Chapter 7.

The benefits of water management are not simply the returns on invested ad valorem tax dollars as described above. The costs for managing specific volumes of water are typically a fraction of the value of these volumes in the context of its ultimate use, i.e., the value of managing water, an input to production, agricultural or urban, is small compared to the value

of the output of that production. Water, while critical, is then one of numerous factors generating value within the sectors of South Florida's economy. Water management in South Florida, including drainage, flood control, and water supply, has made investment in both urban and agriculture property possible. As stated earlier, while the value of agricultural land has not increased dramatically the market value of crops, however, has increased. In the urban sector, property values have increased significantly and the value of protecting water supplies is another important benefit.

1. Property Value Benefits Associated with Water Management

The 1990 study determined that a log-linear relationship best described increase in property value over time, and used the available property data for 1965 and 1980-88 to estimate taxable property values for 1950 and for 1974. Just or market value would be the better proxy to measure property value benefits, but the earlier data is not readily available. This update adjusts the previously estimated values for inflation (Table 4-6).

Based on the adjusted values, the value of agricultural properties increased roughly 40 percent over the construction of the CSFFCP, and has since declined in constant dollars to a level about 28 percent less than 1950. This decline is attributable in part to reduced acreage but also changes in taxation. The population of the area now covered by SFWMD has increased from an estimated 838,000 in 1950 (i.e., the beginning of the flood control project) to more than 7.6 million in 2011, an increase of 815 percent. Based on the estimated value of $16.8 billion in 1950, the taxable value of non-agricultural lands has appreciated by 3,800 percent.[84]

Table 4-7. Estimates of Taxable Value of Property in the SFWMD (2011 $ billions)

Year	Agricultural	Non-Agricultural	Total
1950	5.6	16.8	17.4
1965	7.9	80.0	87.9
1974	7.8	153.8	161.6
1980	5.5	212.7	218.2
1988	5.9	348.7	354.6
2011	4.3	655.2	659.5

The change in taxable value of non-agricultural land for the period 1950-2011 is $638.4 billion (2011 dollars). Total property value benefits for that period are $642.1 billion, implying that urban benefits account for 99.4 percent of total property value benefits. The same calculation for the taxable value of agricultural property indicates a loss of $1.3 billion based

[84] However, since the completion of the project in the early 1970s the population has increased by a factor of about 2.9 while non-agricultural properties have increased in value by a factor of about 4.3. The 1950 estimates may be in error, and the CPI may not be the best device for rectifying data that old.

on a value of $5.6 billion in 1950. It is important to recognize that this loss is for taxable value, not market value.

Despite increases in agriculture acreage and productivity, the taxable value of these lands has decreased by more than 23 percent in constant dollars. Not only is the land under-assessed (in terms of market value), but its rate of growth in assessment has not kept pace with that of non-agricultural properties.

2. Agricultural Production Benefits Associated with Drainage and Flood Control

Drainage has been the primary factor in promoting development throughout south Florida. Without lowered water tables, only the coastal ridge would have supported urban uses, and agriculture would have been limited to the relatively narrow band of land (3-5 miles wide) west of the ridge that historically remained subject to seasonal flooding. Drainage, then, has made possible the urban use of marginal agricultural land and the agricultural use of freshwater wetlands. Urban property values and the market value of the altered natural landscape have increased dramatically in response to these shifts.

Detailed data on the changes in total agricultural acreage post-1950 is incomplete. For example, the table notes to the USDA Agricultural Censuses of 1950 through 1964 reflect acreage reporting was subject to problems in tract ownership across county lines (Glades County in particular). However, the following chart illustrates the general impact of the CSFFCP on the South Florida counties directly affected by it (Dade, Broward, Palm Beach, and Hendry).

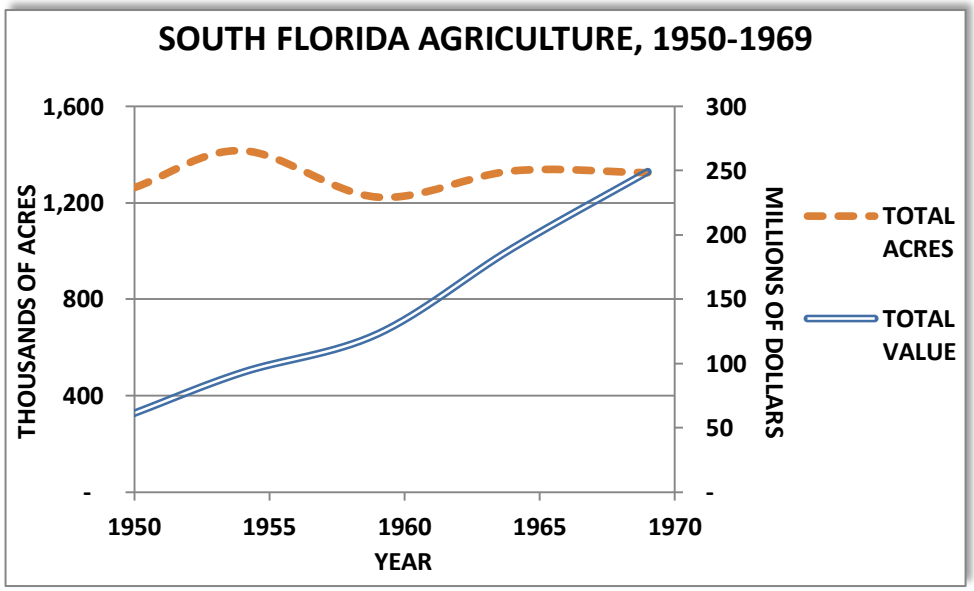

Figure 4-4. South Florida Agriculture Acreage and Market Value, 1950-1969

While the agricultural acreage in these four counties fluctuated over the course of the twenty years of completing the CSFFCP (in part due to the definition of farms and in part because of evolving land use), the market value of production increased more than 306

percent. Further, the value of agricultural production per acre increased in nominal dollars from $48.54 to $188.11, or from about $453 to $1,153 in 2011 dollars.

Acreage in sugar (primarily Palm Beach and Hendry Counties) increased from 38,500 (prior to the CSFFCP) to over 421,000, an increase of over 993 percent, declining to roughly 384,000 in recent years attributable in part to sugar land purchases for restoration. Data on shifts in other major agricultural uses throughout the entire region were limited to information collected by Clarke (1978) for years between 1947 and 1974: pasture beginning at 455,000 acres increased by 117 percent to nearly 986,000 acres; truck crops increased by 3 percent (after reaching a peak in 1969 of a 47 percent gain); and citrus increased by over 375 percent. The present value of the increase in non-sugar agricultural benefits for the period from 1947-74 is $14.1 billion. Including the estimated value of the increase in sugar acreage during 1974-89 resulted in total production benefits worth more than $17 billion (2011 dollars). The following table describes the current mix of agriculture in the Lower East Coast, served by the CSFFCP. While the CSFFCP provided for the expansion of agriculture, total acreage has declined in recent decades because of development and the use of land for STAs.

Table 4-8. Agricultural Acreage in the Lower East Coast, 2010

Crop	Acres
Sugarcane	384,100
Vegetables, Melons, Berries	82,350
Citrus	31,628
Other Field Crops	15,079
Greenhouse, Nursery	14,270
Other Fruits, Nuts	8,302
Sod	7,775
Total	**543,684**

The 1990 study summarized an assessment done by Clarke (1978), contrasted her results with estimates provided by the sugar industry itself and concluded conservatively that 28.5 percent of the lands in sugar could be attributed to the CSFFCP and other price and technical support, and that of the remainder 47.5 percent could be attributed to the embargo, and about 24.0 percent was in response to crop demand and the EAA's ability to support agriculture. While the 1990 study reported sugar and molasses revenues of $663.26 million for 1988, more recent information suggests that the industry revenues over the past decade average about $450 million per year. Consequently, about $128 million in sugar industry revenues can be attributed to the CSFFCP and price supports.

Examined from another direction, the United States Fish & Wildlife Service (USFWS) estimated that the EAA growers have derived a net benefit of $390 per acre-ft delivered (2011 dollars). The estimate was based on 1976 Federal costs of $10 for supplying an acre-ft through the CSFFCP and crop benefits, presumably defined as profit, of $110. Water withdrawals for agriculture in Palm Beach and Hendry counties were about 1.18 mgd, or 1.32 E6 acre-ft in 2005. Net benefits to all growers are estimated to be $514.7 million (2011

dollars). Significant agricultural production benefits may be attributed to the CSFFCP and that the sugar industry has received about 40 percent of this gain.

Economic Impacts of the CSFFCP on Agriculture

In its 1948 Report to Congress, the Army Corps of Engineers estimated that benefits to land use (as agricultural productivity) would account for 65 percent of total project benefits. Flood control benefits also would accrue to the agricultural sector and to the population living near Lake Okeechobee, and the remaining 35 percent of benefits would be in flood control for others (i.e., downstream), navigation, and fish and wildlife.

The majority of the project's water control works is located adjacent to and provides the most benefit to the area just south of Lake Okeechobee (the EAA). As this is where sugarcane is predominantly grown, it could be argued that a large portion of the project's costs and benefits could be allocated to the sugar industry. Still, many acres of vegetable, citrus, and pasture benefitted as a result of drainage. Clarke (1978) estimated the minimum benefit received by each of the five major agricultural sectors in the area (vegetables, sugarcane, citrus, new pasture, and improved cattle pasture) as follows:

Benefits per sector = (the number of acres opened to production by the CSFFCP)*
(the average profit per acre per sector)

Based on the results for each sector, sugarcane received at least 21 percent of the total benefits. If 21 percent of the costs over the period between 1948 and 1978 were allocated to sugar, the benefit-cost ratio for that sector would be 3.7 to 1.

Carter determined the overall benefit-cost ratio of the project to be 2.05 to 1 in 1948 and to be 5.3 to 1 in 1973; however, the economic sectors benefit unevenly. Using the latter, more recent, ratio suggests total project benefits on the order of $13.4 billion (2011 dollars), of which about $8.7 billion would be allocated to agricultural enhancement. Based on an estimated total ad valorem tax stream from agriculture of $120 million during 1950-2011 (including $59.9 million contributed prior to 1989), the private profit to public expenditure ratio of the CSFFCP for agriculture is over 72 to 1. Conversely, using a non-agricultural tax ad valorem stream of $8.6 billion (including $3.1 billion prior to 1989), this ratio for the urban sector is less than 0.6 to 1. In the light of subsequent patterns of development and population growth, the Corps' allocation schedule (65 percent agriculture; 35 percent other) would be treated differently today.

3. Benefits Associated with Water Supply

Improved water supply for both agricultural and urban uses has been an objective of water management in South Florida. Historically, storage in Lake Okeechobee reduced the risk of failure for agricultural concerns while storage in the Water Conservation Areas maintained the minimum stages necessary to prevent further saltwater intrusion of coastal wells. The overall freshwater content of the Biscayne Aquifer is able to meet fully the current and near future demand for water, however, several older wellfields are located in areas

subject to intrusion as a result of either prolonged drought or reduction in freshwater head from pumping, drainage, and systematic dewatering of the region.[85]

The 1990 study included Broward County's then current estimate for the cost of developing two new wellfields with a total capacity of 130 mgd, which would have cost $0.91 million per mgd supplied (2011 dollars). In 2005, the non-agricultural use of groundwater in Dade, Broward, and Palm Beach counties was 1037 mgd (Appendix B-3b). At that unit cost, replacing the region's wellfields, assuming similar well sizes, pumps, and land acquisition costs, would be $946 million. In its 2005 LEC Water Supply Plan Update, the SFWMD identified numerous projects, some of which included water supply alternatives such as reverse osmosis, the use of reclaimed water (irrigation), and canal recharge. The costs of these alternatives varied significantly, and only a few – those expanding the capacity of existing facilities – were less than $1 million per mgd. Costs for new facilities ranged from $1.5 million per mgd to more than $7.3 million per mgd (the Ft. Lauderdale "Prospect Floridan Water Supply/Treatment Facility"). These estimates are consistent with the 1990 study that concluded that supply alternatives cost between 4-6 times that of conventional groundwater. Assuming there are no new economies of scale, if the majority of the area's potable water were to be generated by desalinization at a cost of $2.5 million per mgd then the added costs for the region could reach $2.6 billion.[86] However, the water supply characteristics of the existing CSFFCP – existing infrastructure – obviate the need for expenditures of that magnitude and only the increment of new supply would be subject to those unit costs.

Table 4-9. Typical Costs of Alternative Water Supply

Different Alternatives	Associated Costs
Expansion of existing facilities	< $1 million per mgd
New Facilities	$1.5 million - $ 7.3 million per mgd
Desalination	$2.5 million per mgd

The population of south Florida alone (Monroe, Dade, Broward, and Palm Beach counties) is expected to increase to about 6.58 million by the year 2030, a 16 percent increase. The demand (and competition) for water, despite imposed conservation measures, may be expected to continue to rise. Should the existing framework of water management fail in terms of adequately protecting urban supplies, the added costs in the near future could exceed $940 million per year and total expenditures for potable supply could exceed $2.6 billion.

[85] This statement ignores the effects of any rise in mean sea level on either the water table or the boundary of the freshwater – saltwater interface.
[86] Based on projected demand.

Important Points

- *Surface hydrology can be used to estimate shares of expenditures for water management.*
- *The SFWMD expends roughly twice as much to ensure water supply for agriculture than it does to support the water supply for the LEC.*
- *Based on its share of ad valorem, agriculture pays $1.55 per acre-ft of water withdrawn while the non-agricultural sectors pay $291.62 per acre-ft.*
- *The subsidy from the non-agricultural sectors to agriculture for SFWMD O&M expenditures is $28.6 million per year.*
- *Subsidies to agricultures for all SFWMD programs total $64.6 million per year.*
- *The net subsidy to agriculture provided by the Everglades Construction Project is estimated to be $92.8 million per year.*
- *The disparity between the agricultural and non-agricultural sectors in the District expenditures and the ad valorem paid per acre-foot of water will increase over time.*

Chapter 5.
Selected Federal and State Subsidies Affecting Water Use

> *"But these problems pale into insignificance compared with the impact of subsidies. The World Bank reckons governments subsidize environmentally and economically harmful activities to the tune of about $1.2 trillion a year: $500 billion on cheap fossil fuels; $300 billion on cheap or free water; $400 billion on fishing and farm subsidies . . . "*[87]

Following the determination of how much each South Florida economic sector pays towards capital and operating expenditures, the next goal of this study was to examine the broad range of direct subsidies that contribute to the economic feasibility of agriculture in South Florida and therefore its demand for water. These subsidies represent additional resources from the general public, both nationally and of the State of Florida, without which agriculture may not be competitive, either regionally or globally. As the above quote highlights, farm and water subsidies are both large in scope and potentially damaging to both the environment and the economy.

Subsidies, particularly the federal sugar program, have had a significant impact on the face of South Florida. Without such expenditures, the composition of the agricultural sector, i.e., the absolute areas (and quantities) of the crops grown and their relative shares of total market value, would be substantially different. Subsidies include quotas, price supports, direct payments, discounted loans, and technical assistance. For fair evaluation of the value of water, major subsidies must be identified and accounted for within the GRP.

Data regarding federal expenditures were accumulated via contact with those agencies and programs that were identified as contributing to deterioration of Everglades wetlands in an early report to the USFWS (Diamond, 1986). The first section of this chapter discusses the Federal Sugar Program. The second section examines other federal programs that contribute to the sustainability of agriculture in South Florida. A brief discussion of State of Florida programs follows.

A. The Federal Sugar Program

Government provides various programs to assist farmers, which in turn provide market stability and increased reliability (as volume) of food supply. These programs have benefitted sugar crops, in particular, through various industry-protective measures. In terms of annualized total expenditures in South Florida, the sugar subsidy program ranks a close second to the CSFFCP. Regardless of their respective environmental impacts, the water management project is multi-purpose while the sugar subsidy program benefits a single industry. While the federal support program operates nationally and supports production of

[87] The Economist, Volume 403, Number 8789, June 16, 2012.

both beet and cane sugar in several states, it has been suggested that sugar production in Florida specifically could not function without it. Consequently, the assessment of the industry in this update is strictly within the context of its demand for water and water management and the costs to South Florida residents. This update does not address the need for the program or its value to the region's economy.

The Sugar Subsidy Program

The Sugar Act of 1934 was designed to assure an adequate supply of sugar to consumers at reasonable prices and to protect the welfare of the industry. Two key provisions were that the Federal government would stabilize prices so that profits could be guaranteed and that each farm was assured a share of the market. While the act has effectively protected the industry, U.S. consumers have continuously paid many times above the world market rate throughout the duration of the program. For example, when the Sugar Act expired in 1974, U.S. prices dropped to world market prices. Based on an interview with US Sugar, Clarke (1978) indicated that the effect of supports was to maintain prices between 10 and 15 percent above base value. A mean value of 12.5 percent generates industry benefits above government costs worth $838,013 in 1976 dollars, or $3.26 million in 2011 dollars.

The sugar subsidy program consists of both market supports and import quotas. Section 902(a) of the 1985 Food Security Act requires the President to use all authorities to permit the Secretary of Agriculture to operate the sugar program established in Sec. 201 of the Agricultural Act of 1949 (7 U.S.C. 1446) by preventing the forfeiture of sugar to the Commodity Credit Corporation. The last Farm Bill to pass (The Food, Conservation, and Energy Act of 2008) renewed the program; the 2012 Senate has approved a bill preserving the sugar program.

The market support aspect of the program consists of a minimum loan rate and a market stabilization price. In the 1990 study, the average retail price of 39 cents a pound broke down as follows:

a) 18 cents for the government price support;
b) 4 cents for the market stabilization rate, which covers transportation, handling, and *loan interest* (emphasis added);
c) 1.5 cents for market price above support totals;
d) 8 cents for refining costs plus profit; and
e) 7.5 cents for marketing, transportation, and retail profit.

The subsidy supports the interest on the loan itself; ***loan interest is not paid for by industry profits.*** This arrangement has not been modified in the intervening years although the consumer price for sugar has risen to 68.30 cents per pound (2011).[88] As the price support has not increased above 18.5 cents, the additional 28.8 cents is distributed among (c) through (e).[89]

[88] Table 6--U.S. retail refined sugar price, monthly, quarterly, and by calendar and fiscal year, *www.ers.usda.gov/briefing/sugar/data/Table06.xls*
[89] In constant dollars, the 1990 retail price would be about 67.1 cents per pound.

The 2008 farm bill increased sugar loan rates by 4% to 5% in stages, through FY 2012. For the 2010 sugarcane that was harvested and processed during FY 2011, the national average loan rate was 18.5¢/lb for raw cane sugar. While the loan rate has varied by crop year from 2007 to 2012 (Table 5-1), Florida has had almost constant loan rates around 18 cents during the past six years.

Table 5-1. Loan Rates of Raw Cane Sugar and Minimum Price Support for Sugarcane in Florida (2005-2010)

	Crop Year					
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Loan Rate (¢/lb)	17.86	17.93	18.07	18.07	17.92	18.21
Minimum Price Support ($/ton)	27.94	27.63	27.93	27.98	29.03	27.37

Source: United States Department of Agriculture Farm Service Agency (USDA-FSA), *http://www.fsa.usda.gov/FSA/newsReleases?area=newsroom&subject=landing&topic=pfs&newstype=prfactsheet&type=detail&item=pf_20110328__insup_en_sugar03.html*

The 2008 Farm Act provides for USDA to make loans available to processors of domestically grown sugarcane at set loan rate levels for FY2009-13.[90] The USDA's Commodity Credit Corporation (CCC) oversees the loan program. Loans are taken for a maximum term of 9 months and must be liquidated along with interest charges by the end of the fiscal year in which the loan was made. Unlike most other commodity programs, the sugar program makes loans to processors and not directly to producers. To qualify for loans, processors must agree to provide payments to producers that are proportional to the value of the loan received by the processor for sugar sugarcane delivered by producers. USDA has the authority to establish minimum producer payment amounts. The loans are made up-front based on projected production with the sugar itself used as collateral. Interest rates are set by the Treasury on the first business day of each month and the rate is fixed throughout the loan. The loan rate for raw cane sugar in FY 2012 is 18.75 cents per pound.

Failures of the Sugar Loan Program

Aside from the environmental impacts of production (discussed in Chapter 6), the economic impacts of the sugar loan program are highlighted when there are direct failures. There have been several occasions on which Florida sugar processors have defaulted on their loans. Since 1976, the CCC acquired collateral from Florida during 1985-86 and most recently in 2000-01.

The loans are nonrecourse. When a loan matures, USDA/CCC must accept sugar pledged as collateral as payment in full in lieu of cash repayment of the loan, at the discretion of the processor. "In-process" sugar and syrups must be converted into raw cane at no cost to the CCC before being eligible for forfeiture.[91] The CCC tracks how much sugar it would have to sell back to the marketplace when prices are so low as to cause forfeiture. By law, the sugar

[90] http://www.ers.usda.gov/briefing/sugar/policy.htm
[91] The processor is not required to notify USDA of the intention to forfeit the sugar under loan.

program must be managed, to the extent practicable, so there are no costs to taxpayers. However, when forfeitures occur the government loses money (a cost to taxpayers) because the dollars lent on the collateral are priced at the established loan rate which in turn is at a higher rate than the price CCC could obtain on the open market.[92]

For example, reports differed as to the impact of the 1985-86 default, which involved 862 million pounds according to CCC records. Womach (1987) stated that the Commodity Credit Corporation ended up owning sugar for which it had loaned $107.6 million. Most of that sugar was sold to China at 4.75 cents a pound and some was sold domestically for ethanol at 3 cents a pound. The total loss translated to $83 million. An assessment published in the Ft. Lauderdale Sun-Sentinel (21 August 1989) stated that five processors defaulted on $154 million in sugar loans (for 870 million pounds) and that the Federal government sold the sugar one year later at a loss of $77 million. Taking the average of the two estimates, at $80 million, and the reported 862 million pounds yields an estimated loss of 9.3 cents per pound. In today's dollars, the 1985-86 forfeiture was worth more than $164.2 million. The most recent default involved 589.8 million pounds, also over a two year period. CCC data indicates the economic loss was more than 32 cents per pound and the net loss was $188.7 million.

These occasional failures of the loan program must then be included in estimating the subsidy to sugar. In terms of historical Sugar Act payments for deficient yields and abandonment of acreage, Clarke (1978) estimated that there were $224.5 million in 1976 dollars (or $887.5 million in 2011 dollars) paid during 1947-1975. Combined with the more recent occurrences, these Florida forfeitures equal $1.24 billion, an average of net loss to taxpayers nationally of $20 million per year.[93] This amount is not a subsidy from the urban sector (unless one evaluates South Florida's share of the national tax revenues that cover the loss), but a sum that must be deducted from agriculture to reflect dollars that would not otherwise flow within its share of the regional economy.

Costs to Consumers

In 1974 when the Sugar Act expired, U.S. prices dropped to world market prices. Based on an interview with US Sugar, Clarke (1978) indicated that the effect of supports was to maintain prices between 10 and 15 percent above base value. A mean value of 12.5 percent generated industry benefits above government costs worth $838,013 in 1976 dollars or $3.26 million in 2011 dollars.[94]

Global impacts of the sugar program to sweetener users were estimated at $2.0 billion in 1986. During the period 1981-86, U.S. sugar producers were afforded guaranteed prices over three times the world price. However, in 1988, a U.S. Department of Commerce analysis of import restrictions suggested that the program costs U.S. consumers alone about $3 billion per year (including induced impacts). These costs benefitted about 12,600 growers in the domestic (national) industry, which translated into an estimated $238,000 per grower (more

[92] Farm Service Agency, USDA, personal communication (March, 2012).
[93] Reviewing just the period of 1985 through 2011, there were $359 million in losses, or $14.1 million per year.
[94] In 1999, the University of Iowa estimated that loss of the program would increase global prices by 13.2 percent.

than $452,000 per grower in 2011 dollars).[95] At the time of that report, the program cost consumers about $12 per capita, or nearly $46 million per year for South Florida residents (more than $87 million in 2011 dollars). The Department of Commerce report identified the program had the following effects on the national economy:

- maintained the domestic price at several times the free-market level;
- costs consumers $3 billion per year;
- encouraged a 40 percent per year increase in the imports of sugar-containing products competing against domestic goods;
- caused a 40 percent reduction in the domestic refining industry; and
- displaced an estimated 12,000 jobs because imports containing world-price sugar captured U.S. markets and encouraged offshore investment.

More recently, the program was estimated to benefit cane growers (nation-wide) by $307 million (1999 dollars).[96] At fifty percent of production of domestic cane, Florida growers benefit by $207.3 million (in 2011 dollars). In the referenced study, the cost to domestic sweetener consumers has been re-calculated to be $1.9 billion, or $2.56 billion in 2011 dollars. Based on a domestic population of about 281 million persons in the year 2000 (when that analysis was conducted), the costs per capita were $9.11 per year (in 2011 dollars). For South Florida residents, the elevated costs of sweeteners attributable to the program are $59.8 million per year.[97]

In a 2008 assessment of prices for raw sugar, the USDA found that in constant dollars, world prices fluctuated between 8 cents and 20 cents per pound, averaging about 14 cents, while U.S. prices have declined steadily from about 38 cents a pound (in 1982) to about 22 cents a pound in 2007, with an average of more than 28 cents per pound. The prices may be converging, but domestic prices remain on the order of 9-10 cents above that of the global market.[98] Even if a loss of Florida production were to occur and global prices increased by the suggested 10-15 percent, domestic prices (if steady) would remain 6-7 cents above that price. Based on Florida's production of 1.87 million tons and the conservative price differential of 6 cents per pound, Florida growers' share of the cost to consumers nationally is then about $224.4 million. The District's population's contribution to this benefit is $5.68 million.

Industry Loan Savings

The 1990 study compared the Sugar Loan, Prime, and Treasury bill rates for three years (1986-1988). The Sugar Loan rate is set by the CCC, which receives the money for its programs from the Treasury. Since the federal government runs on a deficit, the Treasury must borrow money to fund the program. Treasury bills are the short-term instruments that make up a large portion of the national debt. Thus, it is safe to assume that this is the cost of the CCC loan funds. The Prime Rate is the rate quoted to a bank's most credit worthy customers and the difference between the average Prime Rate and the average Sugar Loan

[95] These impacts reflect both cane and beet growers nationally.
[96] Beghin, et.al. "The Cost of the US Sugar Program Revisited." Center for Agricultural and Rural Development, Iowa State University, 2001.
[97] Based on a regional population of 6.56 million in 2000.
[98] In 2011 prices surged. The domestic price rose to 56.2 cents a pound while global prices increased to 31.7 cents per pound.

rate at that time was 1.826 percent and the difference between the Sugar Loan rate and the T-Bill rate was around one-half percent. As the interest rate for sugar loans increases, the amount saved (i.e., the relative value of the subsidy) declines. It must be re-emphasized that the interest paid is covered by a portion of the market stabilization price (MSP). Based on production of 1,517 thousand tons, the value of the MSP was $121.4 million in 1988. Interest paid was 6.0 percent of the MSP. The interest saved annually during 1986-88 was $5.4 million in 2011 dollars.

However, it is unlikely that a farm would be able to acquire funding at prime rate, especially loans which are collateralized against projected production (i.e., the justification for the CCC program). For agricultural loans commercial banks charge rates between one and two percent above the prevailing prime rate. This surcharge reflects the increased risk of agriculture versus other industries. If one percentage point is added to the average difference between the Prime Rate and the Sugar Loan rate, it can be conservatively determined that sugar growers are able to acquire loans from the government at approximately 3 percent points below that which could be acquired on the open market. Assuming that all loans are made for six months, the average sugar loan rate for each calendar year can be applied to the total amount loaned for that year to determine the approximate amount of interest paid. The savings in interest payments is one-half the difference in rates (1.5 percent).

Florida Sugar Production

Approximately 400,000 acres of sugarcane are harvested annually in Florida, producing approximately 1.5 million tons of sugar.[99] Florida's production expanded significantly since 1960 when the U.S. ceased importing Cuban sugar: between 1960 and 1975 there was nearly a six-fold increase in sugar acreage. Planted acreage grew by another 54 percent during 1975 to 1988. Acreage and harvest have declined by about 5 percent in recent years, in part due to conversion of acreage to STAs in the context of the Everglades Construction Project. Figure 5-2 shows the overall growth in production from 1950-2010.[100]

Sugar remains the dominant crop in the EAA with more than 374,000 acres planted (of about 512,000 total acres). Acres harvested have historically been about 96 percent of acres planted. The number of farms, particularly large ones, increased concurrently with regional production, and the size of individual farms increased as well. Sugar acreage in Florida increased from 257,584 acres in 1973 (136 farms averaging 1,894 acres each), to 383,400 acres in 1985.[101] In 2007, 108 growers cultivated 378,587 acres in 2007, implying that farms now average 3,505 acres each.[102] This equates to an 85.1 percent increase in the average individual farm acreage during years 1973-2007.[103]

[99] *http://edis.ifas.ufl.edu/pdffiles/SC/SC03200.pdf*; SFWMD data suggests the acreage to be 384,100.
[100] Missing data were interpolated.
[101] Florida Statistical Abstract, 1987
[102] Florida Statistical Abstract, 2011
[103] The next agricultural census will be the 2012 report, not yet available.

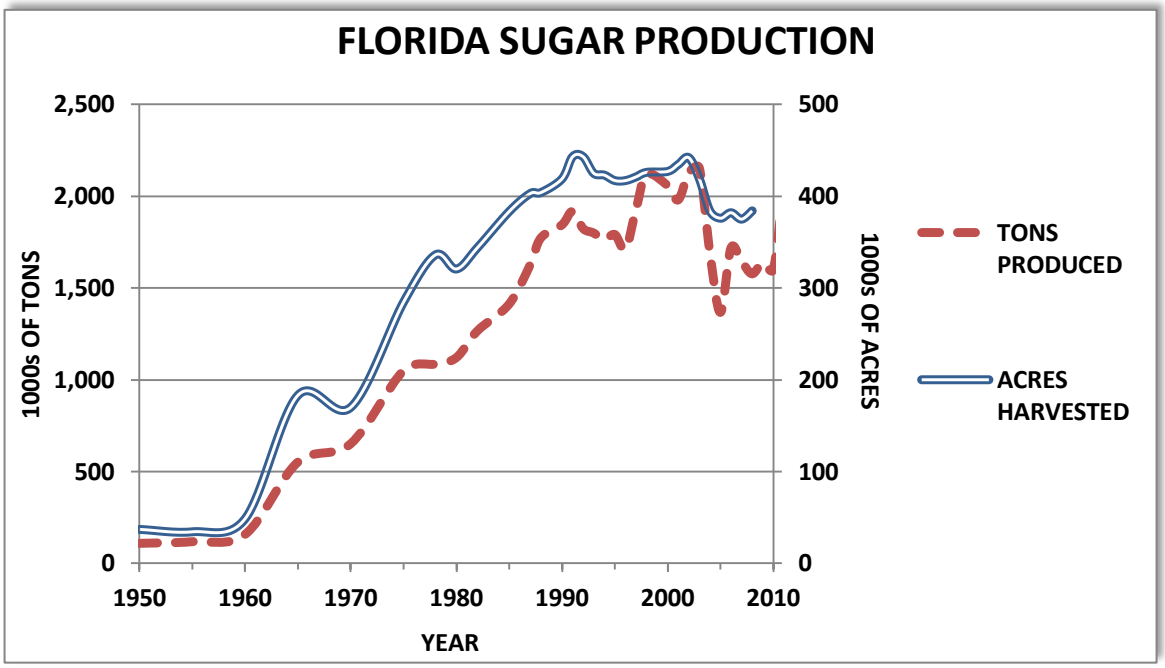

Figure 5-1. Sugar Production in Florida, 1950-2010

Several factors contributed to the growth of the industry. Clarke (1978) estimated that 66 percent of the increase in acreage in sugar is attributable to the embargo of Cuban sugar. With regard to the CSFFCP, Smokey Knecht (then representing U.S. Sugar) indicated that the probable growth in the industry would have been about 25 percent over the thirty years in the absence of the CSFFCP and (unspecified) related federal support.[104] U.S. Sugar also indicated that a third of acreage then in production would have occurred without the CSFFCP. An additional one-third of current growers would have improved their property to produce sugar cane, but yields would only be one-half of current production. Thus, about 50 percent of the area's activity [33% plus 33%/2 = 50%] would have occurred without the project. Without the CSFFCP, conversion from lower valued truck crops and the formation of additional drainage districts would have been needed to provide the acres supportable by the change in market demand.

In 2005, agricultural water use in Palm Beach and Hendry Counties (the EAA) totaled 1,178 mgd, more than 60 percent of all agricultural use in the District and nearly 30 percent of all water withdrawn. The District LEC Water Supply Plan Update noted that the gross irrigation demand for sugarcane alone was more 436.6 mgd, or 37 percent of all agricultural demand in those two counties. This demand is predicted to increase to as much as 1,097 mgd

[104] By 1940, before the CSFFCP, the Soil Conservation Service produced evidence that 28 percent of the Everglades Drainage District was no longer fit for any known type of agriculture and another 22 percent was of doubtful value.

during a 10-year drought.[105] If the US Sugar estimates of industry scale without the CSFFCP are correct, then the project is responsible for about 208 mgd.[106]

Sugar, which was the seventh most valuable crop in Florida in 1960, was second to oranges by 1985 (7.3 percent versus 16.1 percent of all agricultural cash receipts). During the early 1980s, Florida surpassed Hawaii to become the largest cane producer in the U.S. and accounted for 43 percent of total cane sugar production. Florida produces more than 20 percent of total sugar (from both beet and cane) produced in the United States annually.[107] In 2006, Florida still ranked first nationally in value of sugar produced from sugarcane – approximately $425 million, 50 percent of the total U.S. value of sugar from sugarcane. In 2008, Florida accounted for 13.9 million tons harvested, followed closely by Louisiana with 13.7 million.[108] From 2006-08 Florida produced approximately 1.87 million tons of raw sugar per year; Louisiana produced roughly 1.37 million tons. Between the price support program and the CSFFCP, an estimated $202.5 million in receipts were generated in 2006 that would not otherwise occur.[109]

Value of the Sugar Industry

There are several means to address the impact of the sugar industry on Florida and, ultimately, its demand for water and its competition for the resource. For example, the 1990 study reviewed a report that was financed by the Florida Sugar Cane League (Mulkey and Clouser, 1988). Based on 1985 production data, that multiplier effect study indicated that sugar farmers contribute an estimated $1.6 billion to the state economy ($3.04 billion in 2011 dollars). However, the 1990 study found the Mulkey methodology flawed because the selected multipliers reflected the impact of the refined (not raw) sugar industry on downstream uses and most of the refining does not take place in Florida. With regards to this point, Mulkey and Clouser noted that the sugar industry is defined as production up to and including the transportation of raw sugar. Thus, the value of raw sugar, i.e., sales to refineries, should not be used as the base of the multiplier. The value of raw sugar should accrue to the milling industry, not the growers, as the two are rarely synonymous. At the time of the 1990 study, the output multiplier for raw sugar production from the Regional Input-Output Modeling System (RIMS II) (Bureau of Economic Analysis, U.S. Department of Commerce) was 1.6167. This was the number for the four-county producing region, which is where the benefits must be evaluated in the context of local water use. In current dollars, the estimated economic impact of the sugar growing industry in South Florida, based on direct sales to the mills, was $1.21 billion while the economic impact of raw sugar marketing was $2.09 billion. The value of the industry to South Florida was overstated in that study by 31 percent.

[105] SFWMD LEC Water Supply Plan (2006).
[106] There is approximately 11,946 acres of cane (and 20.8 mgd of demand) outside of the EAA and not explicitly dependent upon the CSFFP.
[107] http://edis.ifas.ufl.edu/pi207
[108] http://business.highbeam.com/industry-reports/agriculture/sugarcane-sugar-beets
[109] Based upon a 47.6 percent share of the region's sugar production allocable to the CSFFCP, i.e., EAA only.

More recently, Institute for Food and Agricultural Sciences (IFAS), University of Florida, assessed the implications of the departure of US Sugar as a result of the 2008 proposed purchase of the corporate assets, including roughly 187,000 acres of farmland. [110] The study isolated the sugar operations from other corporate activities and estimated its economic impact. The direct output was valued at $361.6 million; the value added was determined to be $377.5 million. Based on its share of raw sugar output, US Sugar represents about 34.9 percent of total sugar production in Florida. Therefore, the industry's direct output is worth an estimated $1.04 billion and the value added is $1.08 billion. Combined, the impact is then $2.12 billion, which is within 1.5 percent of the above, revised, estimate.

Table 5-2. Value of Agricultural Products and Sugarcane in Florida, 1987-2010 ($ thousands)

Year	Value of Agricultural Products	Value of Sugarcane	Sugar Share of Market
2007	7,785,228	426,600	5.5%
2002	6,242,272	536,649	8.6%
1997	6,004,554	445,855	7.4%
1987	4,351,383	401,391	9.2%
Average	**6,095,857**	**452,624**	**7.5%**

Source: Value of Sugarcane in Florida from USDA Summary Data (1987-2010) and Market Value of Agricultural Products in Florida from the Agricultural Census (1987-2007).

According to the USDA summary data from 1987 to 2010, but for a few years the annual value of sugarcane in Florida has remained between $0.4 billion and $0.5 billion. [111] The average has been $443.3 million. The first column of the above table, the market value of all agricultural products in Florida, describes an increasing trend. Consequently, the weight of sugar industry in Florida has decreased over time, from 9.2 percent in 1987 to 5.5 percent in 2007. Between 1987 and 2010 the average has been less than 7.5 percent. Appendix D-1 describes the market value of crops in SFWMD in 2007 to be $3.6 billion. Sugar's share of the regional value of agriculture was under 11.9 percent.

B. Other Federal Programs

In addition to the sugar subsidy, the Federal government has spent other monies in support of the industry and related services, such as worker housing and agricultural research and experiment stations. The South Florida Ecosystem Restoration Task Force "Cross-Cut Budget" documents address the breadth of some of these programs; many do not impact water use and many are directed at remedies or adaptation to the negative consequences of the CSFFCP and past federal and state initiatives.

[110] EDIS Document FE754, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL, October 2008.
[111] See Appendix D-3 for complete data.

Federal monies have tended to be given disproportionately to larger corporate entities. Carter (1974) reported that in 1969 there were $5.094 million in total federal subsidy payments to the area. The US Sugar Corp. received 1/5 of this total despite having only 37,400 acres in cane production (5.15 percent of all EAA acres, but 23.4 percent of all acres in cane). US Sugar received an additional $2.5 million of improvements to the local drainage district via the Soil Conservation Service. In this dated example, 50-75 percent of the benefits accrued to US Sugar while 73 percent of the costs were born by federal taxpayers.

USDA Support

The USDA maintains a research unit at Canal Point, the primary task of which is to improve sugar production. Clarke (1978) reported a total of $8.22 million (1976 dollars) in expenditures over the period between 1947 and 1976. These expenditures averaged approximately $1.08 million per year (2011 dollars). Appendix J-3 provides more recent data. For the period between FY2000 and FY2012, the average has been $2.75 million per year.[112] The direct contribution to benefit the industry has increased by $1.67 million (a 154.6 percent increase). As this program is funded through the federal government and South Florida residents comprise 2.6 percent of the US population, the regional contribution is about $71,000 per year.

Cooperative Extension Services (CES)

USDA provides a series of agricultural educational and information programs through its county level Cooperative Extension Offices. The programs include agricultural production techniques, pest management practices, home economics and nutrition, support for 4-H youth organizations, commercial and sport fishing, and energy conservation for businesses. In 1990, approximately $5.5 million in federal monies were distributed within the SFWMD through the Institute for Food and Agricultural Sciences (University of Florida). Appendix L-1 summarizes these expenditures by county for 2009-2011. Adjusted for county populations within the SFWMD, federal contributions now average $9.60 million per year and these are matched by local (county) funds averaging $8.57 million. The program total is $18.17 million per year.

Well under 360,000 residents within the District are employed or reside on agricultural lands.[113] Assuming similar federal income tax contributions and that Florida is neither a net benefactor nor subsidizer of the program, the agricultural sector supports no more than $450,000 of the federal receipts. The county shares are generated via ad valorem: at 0.65 percent taxable value agriculture contributes no more than $56,000 toward the local match. Agriculture's total investment via income and property taxes to support the "Partners in Progress" program is estimated to be less than $0.51 million. While the non-agricultural sectors benefit indirectly from the productivity enhancements fostered by the program, the subsidy (passed through federal and local government) is $17.66 million per year.

[112] The 2012 Cross-Cut Budget indicates an average of $5.0 million in ARS spending, FY02-FY12, which includes $0.8 million in funding in 2012 for the Ft. Pierce Research Unit, $0.6 million for the Miami Unit, and $2.6 million for the Ft. Lauderdale Unit.

[113] This number includes the populations of Pahokee and South Bay; Glades, Hendry, Highlands and Okeechobee counties; and one-half the population of Osceola and Orange counties.

Federal Crop Insurance Corporation (FCIC)

Apart from the sugar program, crop insurance provides coverage for up to 65 percent of all losses resulting from insects and climatic extremes. Policies are sold at a discount of 30 percent off of the estimated premiums required to pay out all claims in a given year, i.e. the government charges only 70 percent of the anticipated direct costs. Program administration consumes approximately 20 percent of the collected annual premiums. Nationwide, the government pays between 30-46 percent of the program expenditures, depending on claims paid each year. In recent years within the SFWMD the program's loss to income ratio has averaged 1.43 (Appendix J-2).

Table 5-3. Select FCIC Payments in South Florida ($ millions)

Year	Total Premium	Total Indemnity Paid	Indemnity to Premium Ratio
1990	5.50	13.88	2.52
2000	51.90	71.02	1.37
2010	61.19	34.24	0.56

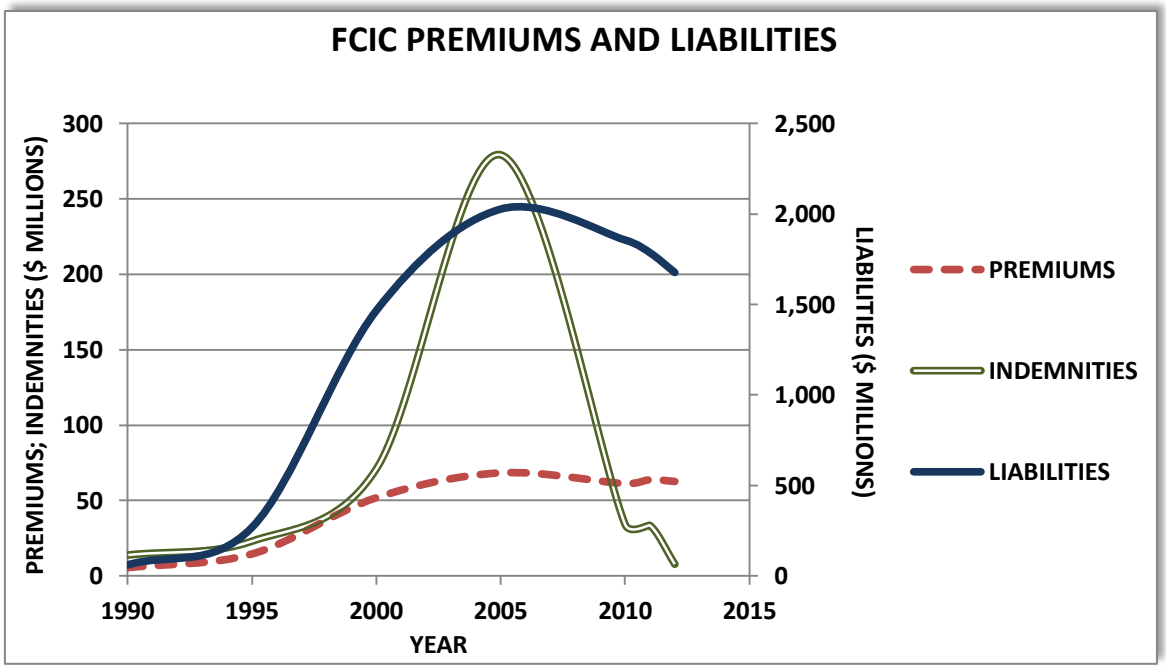

Figure 5-2. Characteristics of the FCIC Program in Florida, 1990-2012

Premiums for the sixteen counties (not adjusted for acreage) totaled only $5.5 million in 1990, increasing to $63.7 million in 2012. Indemnities varied during this period, including a total of $279.1 million in 2005 following the 2004-05 hurricane seasons. The average of the total annual premiums paid since 2000 is $61.6 million. Conversely, for the same period, the average of the total indemnities paid to the region is $85.2 million per year, a ratio of 1.38.

Average net returns to program participants in the SFWMD for the period 2000 through 2012 are $23.5 million per year. Appendix J-2 notes that premium discounts were provided in 2000 ($4.71 million) and that additional (unspecified) subsidies were provided that average $41.5 million per year. Since 2000, the average total subsidy to the region from taxpayers nationally under this program may be as much as $66 million per year. South Florida's share would be about $1.62 million of which the non-agricultural sector pays about $1.54 million per year.[114]

Other USDA Programs

Separate from loans made for sugar, Appendix J-1a summarizes the various other government payments to agriculture for the years 1992 through 2007. These payments include the Conservation Reserve and Wetlands Reserve Programs and other activities under the Natural Resource Conservation Service (NRCS), intended to foster habitat and reduce impacts to surface waters. However, disbursements for these programs are often not fully reported. In 1997, for those counties with reports, Conservation Reserve and Wetlands Reserve payments were about $165 million, less than 14 percent of the total. In 2002, at a reported total of $565 million, the share of conservation funding was 23.5 percent. In 2012, the NRCS was funded (District-wide) at $63 million, including the following allocations:

- $5.8 million for Environmental Quality Incentives Program;
- $9.2 million in the Wetlands Reserve Program (2011 data);
- $3.2 million for the Grassland Reserve Program;
- $0.1 million for the Wildlife Habitat Incentives Program; and
- $4.4 million for the farm and ranch Land Protection Program.

At the national level, farm and commodity programs are budgeted at nearly twice that of conservation programs.[115]

Adjusted for agricultural acreage within the SFWMD, the average has been $4.48 million per year (in nominal dollars). The average annual disbursement is $5.11 million in 2011 dollars. Assuming that 75 percent of the disbursements do not support conservation objectives, the average funding to support agriculture is $3.83 million per year and the contribution from South Florida residents is more than $96,000 per year.[116]

Reported Commodity Credit Corporation (CCC) Loans for crops other than sugar totaled $985 million in 1992 and $154 million in 2007. No loans are reported within the SFWMD in 1997 and 2002; data are not available for intervening years. The 1992 loans would be worth $1.58 billion in 2011 dollars; the 2007 loans are worth $167 million in current dollars. Assuming no loans in any of the intervening years, the total would be $1.75 billion over twenty years, i.e., an average of $87.4 million in loans per year. At a rate of savings in interest of 2 percent per annum, the savings to agriculture are $1.75 million per year.

[114] This update has not explored to what extent these payments lower the costs of foods consumed locally.
[115] USDA FY2012 Budget Summary and Annual Performance Plan.
[116] The estimate provided in the 1990 study was $3.35 million per year, or $5.76 million per year in 2011 dollars. The range of programmatic support may have declined by $0.65 million per year.

Rural Electrification Administration (REA)

Because the availability of power makes settlement and more intensive use of wetlands possible, the REA was reviewed in the 1986 USFWS study and included in the 1990 study as a federal assistance program that supports agriculture and therefore water use. The Glades Electric Cooperative, based in Moore Haven, borrowed money from both the REA and the National Rural Cooperative Financing Corporation (NRCFC) to extend electric service into rural areas. The Cooperative borrowed a total of $21,988,948 as of September 30, 1989, 70 percent of which came from the REA at a guaranteed loan rate of 5 percent. The other 30 percent came from the NRCFC, at a loan rate between 8 and 14 percent, yielding an average debt interest rate of 6.8 percent. At the time, savings of about 3.2 percent were obtained versus borrowing from commercial banks that were lending at the prime rate. Assuming that the NRCFC loan floated with the prime, the savings derived primarily from the guaranteed loan. Those savings translate into $847,700 for the outstanding debt.

C. State of Florida Subsidies

While most of the operating subsidies for agriculture and therefore its use of water are provided by the Federal government and the SFWMD, the State of Florida does contribute as well. State University System funds support IFAS and the agricultural experiment stations operated in conjunction with the USDA (discussed above) and the various Fire Control Districts (Florida Division of Forestry). While the latter had been included in the 1990 study, the specific impact on agriculture and water use cannot be assessed.

State Land Leases

One significant role of the state is the leasing of state-owned lands in the EAA to agricultural concerns. A total of 13,953 acres, representing about three percent of the EAA acres planted in sugarcane, are leased to seven growers (Appendix L-2). Based on the current market value of raw sugar ($967 million) and the percent that state lands represent of the total planted acreage (three percent), state lands generate about $29 million in industry revenues. The leases expire between 2015 and 2018 and are expected to be renegotiated and extended. While the rent varies slightly over time according to an index developed by the State, the annual consideration of the leases for the current year was $4.004 million, or an average of about $287 per acre per year.

In 2012, the average market value, as determined by the Palm Beach County Property Appraiser, of the 428 private agricultural tracts in the EAA that are 320 acres or larger is $3,472 per acre. However, in consideration of use, market characteristics, brokers' fees, transaction costs, closing costs and the time of money, Florida property appraisers assign market or just values anywhere from 15-25 percent below fair market value. Further, such adjustments would not reflect improvements like internal drainage systems unique to the EAA. With a nominal 25 percent adjustment for such typical improvements, EAA lands would sell very conservatively for $4,629 per acre. At current lending rates for property (i.e., 4.5 percent or less) annual payments over 30 years would be about $284 per year, effectively the same as the state's rent.

While the rent paid compares favorably with the $284 per acre estimated to be the average return to owned land for growers using private land, many of these acres are on deeper soils nearer to Lake Okeechobee that are both more productive and are likely to be productive for a longer time and hence should rent for more money. In 2012, the assessed value of these lands is between $500 and $1,500 per acre, and the average assessed value is about $712 per acre. The just value, however, for most of these properties (DOR Class 51) is now larger the $5,000 per acre. In 2011, the median value of over 210 such properties was more than $22,100. Even at 3.5 percent and payments made monthly (and lowering total payments), annual payments for principal and interest would be more than $1200. The State of Florida may be subsidizing these lands at a rate of about $913 per acre per year. If this difference were applied to all lands under lease the subsidy would be worth as much as $12.7 million per year.[117]

Recent transactions between state agencies and the private sector in the EAA have averaged $7,351 per acre. These transactions are required by law to be at fair market value, and therefore are assumed to be more reflective of the land's value than the adjusted appraiser's estimates. Annual payments based on such values at 4.5 percent would be more than $447 per acre per year, or $160 more than current rent. At that rate, the state subsidy would be worth $2.23 million. Assuming the real worth of the state's land (as measured by strictly private transactions) lies between the two valuations, the state subsidy is conservatively estimated to be $1.13 million per year.

Table 5-4 reflects the change in the value of this subsidy when alternative interest rates are used. At 5.6 percent, the average rate over the past decade, the subsidy is $1.82 million. This past decade includes rates among the lowest in post WW-II history. However, the average (mean) rate between 1980 and 2012 (including the extremely low rates since the burst of the housing bubble) is nearly 8.2 percent. At this rate, the subsidy would be $3.54 million.

Table 5-4. Annual Value of Lease Subsidy ($ millions)

	Land Value per Acre	Interest Rate 4.5%	5.6%	8.2%
Palm Beach County Just Value	$3,472	-1.03	-0.63	0.37
Nominal Market Value	$4,629	-0.04	0.50	1.83
Mid-point of Nominal Market and Average Sales Price	$5,990	1.13	1.82	3.54
Recent Average Sales Price	$7,351	2.29	3.15	5.25

The 1990 study raised the question whether rents paid for state leases adequately offset the costs to address the externalities of production from these acres. To resolve the question, a conservative estimate of $120 million for implementing the adopted SWIM Plan (September 1990) served as one proxy for these externalities. Based on total agricultural acreage in the

[117] The median value of DOR Class 53 lands was $3,740 per acre. At 4.5% the payments and interest would be about $228 per year.

EAA of 512,000 acres (not just sugar) and a ten year plan, total SWIM expenditures would have averaged over $234 per acre or about $23.44 per acre per year of which the state's share (one-third) was to be about $7.81. The study concluded that 3.7 percent of the rent collected would be spent by the state to compensate for the externalities of production. This amount represented an additional subsidy of $114,573 per year (i.e., about $197,000 per year in 2011 dollars). However, the projected final project costs for SWIM implementation were revised to be more than $500 million, or $97 per acre per year. If the rents remained constant, then as much as 15.4 percent of the EAA rent would be diverted towards cleanup. In the aggregate, the state was expected to receive about $31 million in rent during the 1990s. The state's share of SWIM costs (for acquisition) would be about $40 million. Consequently, the monies received by the state from its lands in the EAA would account for about 78 percent of the (then) planned state land acquisition expenditures in the EAA to address water quality. The remaining 22 percent ($15.5 million in 2011 dollars) would be a subsidy to agriculture.

State Supported Research

Integrated with IFAS activities, other sponsored research funds are directed to the Everglades Agricultural Experiment Station (Belle Glade). Lacking any detailed data, the 1990 study took a 5.3 percent share of the total Experiment Station annual budget. While the 2007 Annual Report did not include any budgetary information, the average expenditure for the Everglades Station over the past five years has been $0.78 million. Sixty-nine percent of the FY09 research budget was via federal agencies (with 58 percent of that coming from the USDA) and 10 percent came from the state. Significant other funding (71 percent of the $85.3 million sponsored research program) goes to various academic departments that may use the Belle Glade facility.

D. Summary of the Annualized Impact of Subsidies

The subsidies reviewed are a resource to agriculture by providing monies which the industry would otherwise have to provide itself. In instances where an industry is marginal, subsidies make the difference between remaining in business or closing. Table 5-4 lists the programmatic subsidies to agriculture in South Florida that must be deducted from agriculture's share of the GRP. The total is $128.4 million. Because these subsidies are funded by the entire tax base (federal and state), the GRP associated with South Florida's urban population should be increased by a similar quantity based on its share of the relevant populations, i.e., these funds would generate non-agricultural goods and services. This was not done, however, because the sum represents a fraction of the region's non-agricultural GRP.

Table 5-5. Summary of Selected Annualized Federal and State Subsidies to Agriculture ($ millions)

Item	Annual Subsidy
Annualized Sugar Loan Losses	5.50
Sugar Loan Interest Savings	5.40
Price Support Benefits*	5.68
ASCS Payments	1.75
FCIC Net Returns	23.50
USDA Research	2.75
NRCS Programs	3.83
CES Programs	17.66
State Rent Subsidies	1.13
State-supported Research	0.78
Total	**67.98**

***** Local share only, the national program provides $224 million in price supports.

Thus, at least $68 million flows into the agricultural sector, most of it to the EAA. Given that the market value of agriculture in South Florida is about $3.60 billion (2007 Agricultural Census), subsidies equal 1.9 percent of the wholesale value. A minimum of $20.2 million in subsidies support sugar production with a market value of $967 million. Thus, subsidies represent about 2.1 percent of the market value of the sugar crop. Based on harvested area of 384,000 acres, the subsidy translates into $53.11 per acre, a reduction of 9.0 percent from that support as estimated in 1990. At the typical costs reported by IFAS of about $637 per acre, subsidies offset about 8.3 percent of the cost of production.

Important Points

- *Sugar (acreage) and production have declined and the industry now represents less than 6.0 percent of Florida's crops and 12.9 percent of EAA crops.*
- *Sugar benefits from at least $16 million per year in direct Federal support.*
- *Agriculture benefits from $68 million per year in Federal and State programs.*
- *Agriculture in the EAA benefits from about $1 million in below market land leases.*

Chapter 6.
Selected Externalities of Water Use in South Florida

> *The goal of managing externalities is not to eliminate them but to take account of the spillovers when making resource allocation. This can be done either by using economic instruments that aim to 'internalise' the externality into water users' decision making (for example, property rights, taxes or subsidies) or by using regulatory and education approaches. . . .A first-best solution would require water to be priced to include externality impacts, which may involve 'tagging' the water as to when and where the water was extracted and when and where the water was used and finally disposed of in the environment. This approach would send clear signals about the impact each kilolitre of water has along the water cycle. Despite the elegancy of this solution, it is doomed to failure due to the intensive information requirements and administrative logistics. Operationally, a better strategy is to use a suite of pricing, regulatory and other mechanisms that collectively result in the efficient management of externalities. .*[118]

Following the determination of how much each South Florida economic sector pays for capital and operating expenditures and the magnitude of direct and indirect programmatic subsidies, the next goal of this study was to examine the economic impacts, or externalities, associated with the allocation and use of water.

An externality is said to exist whenever an output of one economic agent appears as an input in the consumption or production vector of another agent without accompanying payment. Ideally, water resources should be examined in a full general equilibrium context, where all positive and negative externalities would be taken into account and internalized. The costs imposed by certain uses, such as congestion from too many viewers of scenery, are reciprocal without any real income or utility redistribution, and there is no damage to the scenery. The nature of externalities occasioned by mining or pollution is different in that it is unidirectional, there are attendant utility redistributive effects, and the characteristic of the environment is altered (Krutilla and Fisher, 1985). Nondestructive uses of amenity resources do not foreclose any future options that are not reflected in the opportunity returns foregone by precluding destructive use. However, when the use of a resource results in society giving up the chance to use the resource for some other purpose, the resource becomes an economic good and opportunity costs attach.

Both the quantitative uses of water and resulting qualitative alterations to water may have externality costs associated with them. First, withdrawal and consumption of water results in less water available for downstream users. Insufficient supply for the subsequent user could necessitate the development of supplemental or more costly alternative supplies. In South Florida, diversion and consumption of water has had negative effects on receiving bodies such

[118] M. van Bueren and D. MacDonald. "Addressing water-related externalities: Issues for consideration." Paper presented at a Water Policy Workshop convened by the Australian Agricultural and Resource Economics Society, 10th February 2004, Melbourne

as Everglades National Park, Florida Bay, and the Caloosahatchee River. At the two latter locations, reduced freshwater supply has contributed to conditions of hyper-salinity, ecosystem changes, and reduced productivity. Second, the use of water, whether for agricultural or urban ends, may result in degradation of water quality whenever inadequate measures are taken to restore it. This is not a condemnation of human use, but simple recognition of the chemistry of water. Pollutants in water impose varying degrees of damage or limitations on subsequent users, depending on the specific pollutant, its concentration, and the intended use. In an industrial context, for example, water for diluting wastes may have economic value in that it reduces the damages associated with ecosystem exposure to undiluted discharge or disposal. The most direct method of estimating the value of dilution water would be to estimate the damages associated with differing water quality levels. The benefits of dilution water that upgrades water quality could then be defined as the reduction in damages.[119]

Water Quality and Impacts to South Florida Ecosystems

In South Florida, the soils and topography were such that the quality of historical flows of water through the Everglades was relatively pure, i.e., with low levels of nitrogen, phosphorus, and dissolved organics. Because of nutrient uptake in various wetland systems within the historical Everglades, concentrations of dissolved nitrogen and phosphorus entering the Park had been less than that of rainwater. While these wetlands (e.g., the Water Conservation Areas and the pre-drainage EAA) exhibited a high degree of nutrient uptake, there is evidence that these soils have a limited capacity for nutrient removal and sequestering. Water table drawdown and field practices resulting in the loss of muck soils clearly impacted the total soil volume available for nutrient uptake and mineral accretion. In addition, agriculture in South Florida raised the concentrations of these contaminants by the oxidation of organic soils (and resulting release of stored nutrients) and by use of fertilizer above the rates of uptake by crops. Other contaminants include insecticides and fungicides, considered necessary to address some of the biological challenges to agriculture in a sub-tropical climate. Urban areas contribute to elevated nutrient levels primarily from suburban runoff of excess fertilizer and pet waste, which has been backpumped in certain basins for flood protection and drainage.[120] Other contaminants, such as heavy metals and organics, enter surface and groundwaters from disposal of industrial wastewater and nonpoint runoff from streets and storage areas. Thus, a wide range of contaminants and pollutants enter the regional water network from all manner of human use.

The consequences of these elevated levels of contaminants and pollutants have been evidenced by eutrophication in the region's interior wetlands and estuaries. This cultural eutrophication is in addition to changes in wetlands and related ecosystems attributed to alterations to hydrology, although it is difficult to separate the effects of each except in controlled experiments. Eutrophication, and the resulting shifts in species composition, can have significant impacts on the uses of South Florida wetlands. Some of these impacts can be assigned monetary value and can therefore be included in the economic analysis of water use.

[119] Note, dilution of wastes is not the only means of mitigating damages – quality can be maintained through treatment of and reduction of wastes entering the stream.

[120] Domestic wastewater (on-site treatment and disposal systems), except in the Florida Keys, is no longer a major source of nutrients to urban runoff.

Displacement of Everglades Wetland Communities

At the time of the 1990 study, the USFWS estimate of the rate of degradation of wetlands in the Water Conservation Areas from agricultural drainage from the EAA was estimated to be six acres per day. Degradation, then quantified by the USFWS and the SFWMD, primarily reflected shifts from sawgrass to cattail communities and these were attributed to higher nutrient levels. Based on USFWS assessments, the report stated that 24,000 acres had already been impacted. Further, because nutrient levels of field discharges were still high – the Everglades Forever Act was more than four years distant – approximately 66,000 acres (throughout the WCAs) were expected to become degraded over the next thirty years, i.e., a total of about 90,000 acres would be degraded and potentially affect recreational use (and economic value).

While water quality was the dominant theme for that specific assessment, both water quality and hydrology affect the structure of vegetation communities of the WCAs. The 1999 Everglades Interim report concluded that more than 129,000 acres in the WCAs would exhibit hydrological improvement as a result of the Everglades Construction Project, but more than 48,600 acres would be negatively affected by it.

Regardless of the hydrological improvements to the Rotenberger Wildlife Management Area (WMA) and WCA-3 from enhanced sheetflow, that report indicated continued degradation from phosphorus loading and predicted localized conversion of cattails for another 583 acres near the points of ECP discharge in WCA-2 alone. For WCA-1, the USFWS reports that as of 2009, 68 percent of the Refuge, or more than 97,800 acres, had been infested with invasive species and, in 2010, 21,000 acres were burned to limit further encroachment by cattails.[121] In 2009, the Corps of Engineers evaluated the spread of cattails in WCA-3 based on trends between 1995 and 2003 and phosphorus loading through the S-9 Pump Station. The Corps concluded that 29,400 acres were "primed" for near-term conversion and that various alternatives to the Broward County Water Preserve Project would only serve to reduce the conversion, but not reverse the pattern. In sum, several tens of thousands of acres are poised for the ecological manifestation of degradation of water quality. Last, efforts to eliminate and possibly reverse the impacts of water quality and hydrologic modification remain approximately two decades away: full implementation of the EFA to achieve water quality standards in the WCAs may not occur until 2029, pending the implementation of the outcome of recent negotiations between the State of Florida, the USEPA, and the federal courts, and CERP is scheduled to be completed even later.

The 1990 study contemplated the economic effects of a total of 90,000 acres impacted primarily by water quality through 2020. The above agency reports suggest that a minimum of 51,000 new acres are already dominated by cattails, and based on the assessment of 24,000 acres affected prior to 1989, that the rate of conversion since declined to about 3.4 acres per day. However, the Fourth Biennial report references studies that document that the minimum impacts measured through 2004 are about 20,670 acres in WCA-2 and 79,800 acres in WCA-

[121] USFWS, ARM Loxahatchee NWR 2010 Annual Narrative.

3, a total of more than 100,000 acres.[122] Based on the current monitored (not calculated) rate of 2.1 acres per day, the total in 2012 would now be about 104,600 acres. Without a more robust means to project a new estimate for the number of additional acres expected to become degraded under current and proposed water management plans, the minimum estimated total area impacted after twenty years (i.e., in about 2030) will be more than 112,200 acres.[123]

In sum, the use and management of water by both agriculture and the urban sector of South Florida have impacts on the ecological character of the WCAs as well as nearshore waters. Changes in ecological character may negatively affect productivity (yield), usability, or the general attractiveness of the areas impacts. The 1990 study examined the indirect impacts of water use upon recreation, commercial fishing, and tourism. This update expands upon these three subjects without attempting to definitively quantify the correlation between affected habitat and the degree of resource use or enjoyment.

Other Anthropogenic Impacts to the WCAs

In addition to conversion of sawgrass communities to cattails, the "ridge and slough" and tree island components of the Everglades habitat mosaic have been subject to loss because of hydrologic modification and land conversion, again attributable to the transformation of the Everglades ecosystem to support agricultural and non-agricultural uses. The Fourth Biennial Report suggests that the ridge and slough system, which once may have comprised as much as 1.5 million acres, has been reduced to between 22 and 55 percent of its historical extent.[124] At a conservative 22 percent, an estimated 330,000 acres have been impacted, although part of this gross acreage is addressed by the nutrient-driven habitat conversion discussed above.

The Report also quoted Ogden (2005), who noted the habitat's importance: the landscape represented "a principle center for primary and secondary production and inter-annual survival of aquatic organisms" in South Florida's freshwater wetlands. Tree islands, a component of the ridge and slough system, declined an estimated 73 percent between 1940 and 2004. Beyond changes in spatial extent, the Report did not specify the degree of loss of ecosystem functionality but noted the correlation with loss of wading bird nest habitat: snail kite populations have declined by roughly two-thirds since 1994. Wading birds are the focus of wildlife viewing by residents and visitors and therefore habitat loss affects the usability (and economic value) of these areas.

The Everglades ecosystem is also beset by loss in economic value associated with widespread elevated levels of mercury, affecting human consumption of fish and the health of bird and other wildlife populations, which are viewed by residents and tourists. Mercury has

[122] The Fourth Biennial Review of Everglades Restoration affirmed that the rate of cattail growth remained 6.5 acres per day through 1995, and declined to about 2.1 acres per day between 1995 and 2003, with further slowing since, but the current rate has not been specified.

[123] Based on a straight-line decline to zero, 1.05 acres per day for twenty years yields 7,665 additional acres before system equilibrium. An exponential decay between 2012 and 2030 results in cumulative impacted area of 107,535 acres, but this ignores the Corps' prediction of another 20,400 acres.

[124] "As of 2005, 28 percent of the original ridge-and-slough landscape was considered degraded, and another 27 percent had been drained and lost to urban or agricultural land uses (McVoy et al., 2011). Harvey et al. (2012) identified a smaller surviving percentage—about 22 percent—in those areas bounded by WCA-2, WCA-3, and Everglades National Park." (Page 113 of the Report)

both local and global sources, but the circumstance is worsened by sulfate (primarily a byproduct of agricultural production), which accelerates the bio-methylation of mercury entering the system. The Fourth Biennial Report references work by Osborne (2011) that indicates cattail conversion itself accelerates mercury cycling. An estimated 1 million acres in South Florida have elevated mercury levels. While mercury levels in the STAs declined from concentrations well above 1.0 ppm observed prior to 1994, levels remain above the EPA's recommended criterion of 0.3 μg/g. Health advisories restricted the consumption of sportfish in the WCAs in the 1990s. Current Florida Department of Health guidelines suggest that in WCA-2A, for example, women of childbearing age and children should not consume largemouth bass 14 inches or more, and others should limit consumption of redear sunfish, spotted sunfish, butterfly peacock and largemouth bass under 14 inches to one meal per month and limit consumption of warmouth and bluegill to no more than one per week. These limitations affect recreational value as well as consumer costs where the loss of such fish in the local diet necessitates replacement with more expensive sources of protein.

Methodology

The 1990 study underestimated the externalities it reviewed in that it looked forward thirty years from the time of the study, but failed to include the roughly twenty years of impacts that had occurred prior. This update includes estimations of acreage impacted (based on the late 1980s estimate of about 24,000 acres), applies that share of acres to the 2011 economic impact, and then multiplies the impact by a factor to reflect the difference between the Consumer Price Index for the reference year and 2012. Looking forward, this update assumes that implementing the Long Range Plan for STA expansion and related activities (i.e., preventing further degradation) will require the nearly 20 years anticipated by the recent EPA-approved proposal.

This approach assumes that new impacted acres (due to nutrients and vegetation community alteration) will taper off to zero by 2030. The approach taken then accumulates economic impacts for a period of sixty years (1970-2030), at which point impacted acres may have reached their maximum extent and after which "restoration" or reduction in impacted acres is assumed to occur. The period of recovery is taken to be thirty years, one half the period of degradation. During this latter thirty years no new acreage is impacted, but lost economic activity associated with the residual cattail and other non-native dominated communities continue to be an externality of water use until such time as recovery is fully complete.

In sum, impacts accrue between 1970 and 2060, but reach a maximum value at 2030. The value of each year's impacts is adjusted by the CPI for all years prior to 2012 and is discounted at 3.5 percent annually for all years between 2013 and 2060.[125] As in the 1990 study, the use of impacted acres is taken to be 50 percent of unimpacted habitat.[126] The rate used to annualize cumulative or total values is 6.3 percent.[127] The following table describes

[125] Various reports and texts regarding ecological economics argue forcibly for a zero discount rate for future environmental services.
[126] The actual share of residual ecological value remains unknown, but is greater than zero and less than unity.
[127] At 90 years, the factor is simply multiplied by the cumulative economic impacts.

the relative annual values for a *hypothetical* impact to $2 million worth of recreational use in 2012 ($1 million in lost use using the 50 percent factor).

Table 6-1. Relative Impacts of Hypothetical $2 million Loss, 1970-2060 (2011 dollars)

Average Undiscounted Loss per Year	Average Discounted Loss per Year	Annualized Value of Cumulative Losses
$74,066	$63,281	$362,791

The average discounted loss is about 85 percent of the undiscounted loss. While the adjustment for inflation increases the values of losses incurred prior to 2012, the discounts (which are geometric) result in only modest additions (e.g., one half of the undiscounted amounts) to cumulative losses beginning in about 2021. The discount rate would need to be 1.11 percent to generate an annualized value of cumulative impacts equal to the average discounted loss per year.

A. Impacts to Recreation

The use of natural areas for recreation represents non-producible amenities[128] and services entering directly into the utility functions of individuals in final consumption. If a natural area is characterized by rare attributes that enhance recreation or related amenity services, the range of substitutes may be both exceedingly narrow and grossly imperfect (Krutilla and Fisher, 1985). Sites that are unique and draw users from afar, or those that are near urban areas (e.g., the Everglades), will have higher values reducing the range of substitutes further (Bramhall and Mills, 1966). Natural lands have become increasingly important in providing these amenity services to a society that has exhibited an increasing demand and therefore increased value.

In addition to the direct utility for the above described users, non-user values also may be identified: 1) option values that deal with consumers' willingness to pay for the resource at a later time; 2) existence values that are attributed to consumer knowledge of the resource; and 3) bequest values that reflect willingness to pay to save the resource for the enjoyment of future generations. All of these values, user and non-user alike, may be subject to externalities.

Appendix M outlines the value (as expenditures) for the recreational and tourism use of South Florida ecosystems. Recreational uses of South Florida freshwater wetlands and adjacent natural systems include fishing, hunting, camping, birdwatching, and hiking.

[128] These amenities include those such as may be provided by the chemistry of time and other biological processes that are not capable of replication by man.

Park Visitation

Appendix M-1 summarizes the areas of the key recreational units in South Florida. The total recreational space affected directly by water management is over 3.2 million acres (including the Big Cypress Addition). Figure 6-1 describes the use of several of these major recreational resources. Based on the degree of degradation related solely with nutrient loading discussed above, approximately 6.2 percent of the Conservation Areas and National Wildlife Refuge is degraded, 3.7 percent of the area of the Conservation Areas and the Big Cypress is degraded, and 3.0 percent of the area of the Conservation Areas and the National Park is degraded. These percentages are intended to characterize the share of the resource that may now be limited in providing recreational and other values to users.

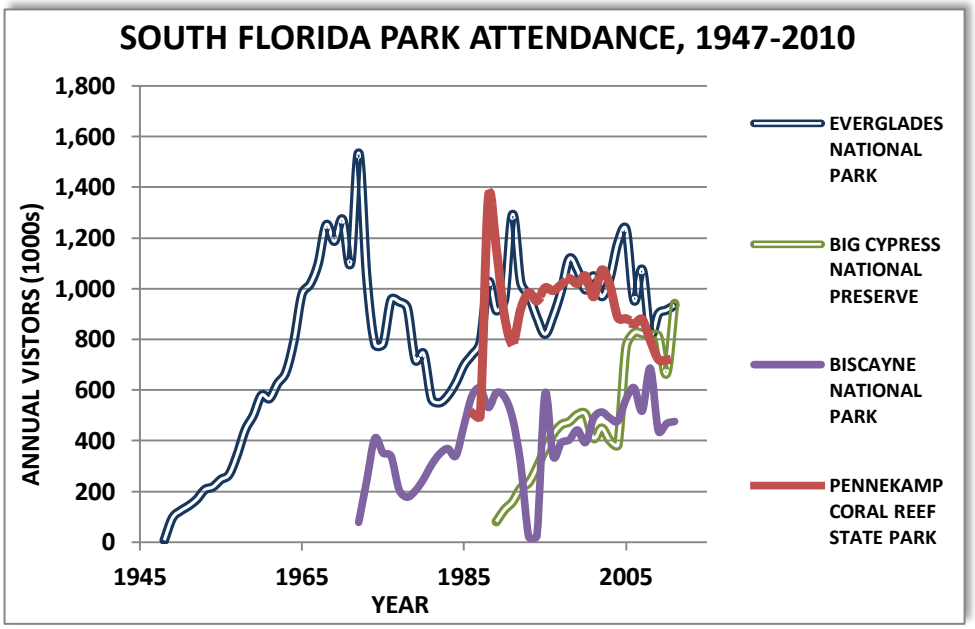

Figure 6-1. Visitation to Area Parks, 1947-2011

Figure 6-2 describes visitation at the three national facilities and Coral Reef (Pennekamp) State Park. While the trend over the period 1989-2010 for the total of major area park visits is increasing it does so at a slower rate than population. This trend must be viewed in the context of the significant increase in tourism that has occurred during the past three years (discussed below). Since the 2008-10 recession, tourists to just Palm Beach, Broward and Miami-Dade Counties increased roughly seven percent to 29.4 million in 2011. However, this increase is not evident in the gate counts at the major resource-based parks.

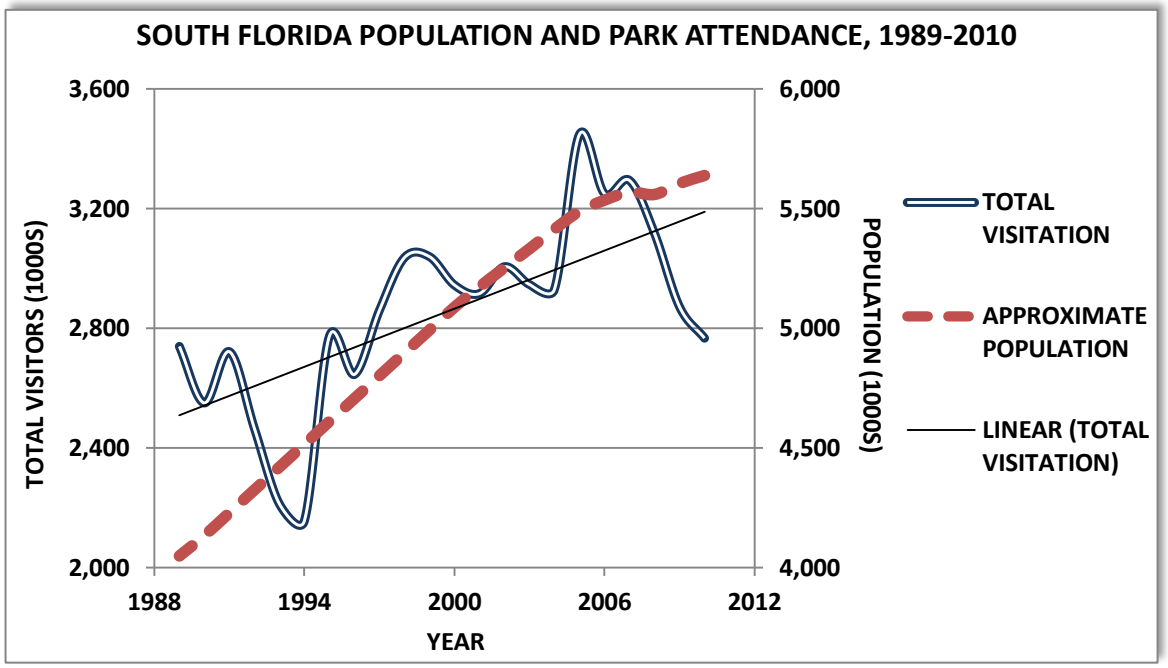

Figure 6-2. Park Usage and Population Growth

There are numerous other factors contributing to the decline in visitation rates, including demographics, cultural shifts regarding hunting and fishing, and changes in choice for recreation (including growth in indoor activities). This specific decline is not matched, however, by proportional reductions in visitation to either the Big Cypress National Preserve (a separate watershed) or the Everglades National Park where the average numbers of visitors since 1990 have been more than 502,000 and 1 million, respectively. [129] While the number of visitors at the Park has fluctuated between 0.82 million and 1.2 million (i.e., 1 million plus or minus about 20 percent) and declined by about 2.5 percent in the last several years, usage at Big Cypress has increased significantly from an average of about 360,000 between 1990 and 2005 to more than 800,000 annually since then (greater than a 120 percent increase). Visitation at the JW Corbett WMA, also outside of the EPA, increased nearly 60 percent since 1987. In sum, visitation has increased to those natural areas less impacted by either (a) nutrient pollution (water quality) or (b) invasive species exacerbated by reduced hydroperiods (water availability), but visitation elsewhere has remained relatively flat, despite the growth in regional population. The implication is that parks affected by changes in Everglades hydrology are exhibiting some sign of reduced visitation. The economics of park visitation are embedded in those of tourism, for which several studies have been undertaken, and are addressed in Section B, below.

Recreational Fishing and Hunting

One measure of area resource-based recreation is the documented number of users, defined here as unique visits. Current usage for the WCAs is about 853,000 annually. The 1990 study assessed the apparent reduction in use of the WCAs between 1970 and 1990. If

[129] The sharp decline in visits to Biscayne National Park in 1992-93 is attributed to Hurricane Andrew (August 1992).

the earliest usage estimates were accurate, there was reduction of nearly 11 percent in usage during a period when the District population grew by more than 96 percent.[130] Using the ratio of the number of visitors to the District population as in index, the ratio dropped from 0.28 in 1970 to 0.13 by 1990, a 54 percent reduction in average use. Thus, a 3.3 percent loss of native habitat was correlated with an 11 percent net loss in actual use and a 54 percent loss in expected (District-<u>wide</u>) use and related revenues.[131] Between 1990 and 2010, a period of 46 percent growth in District population, the index declined to 0.11, a 13 percent reduction.

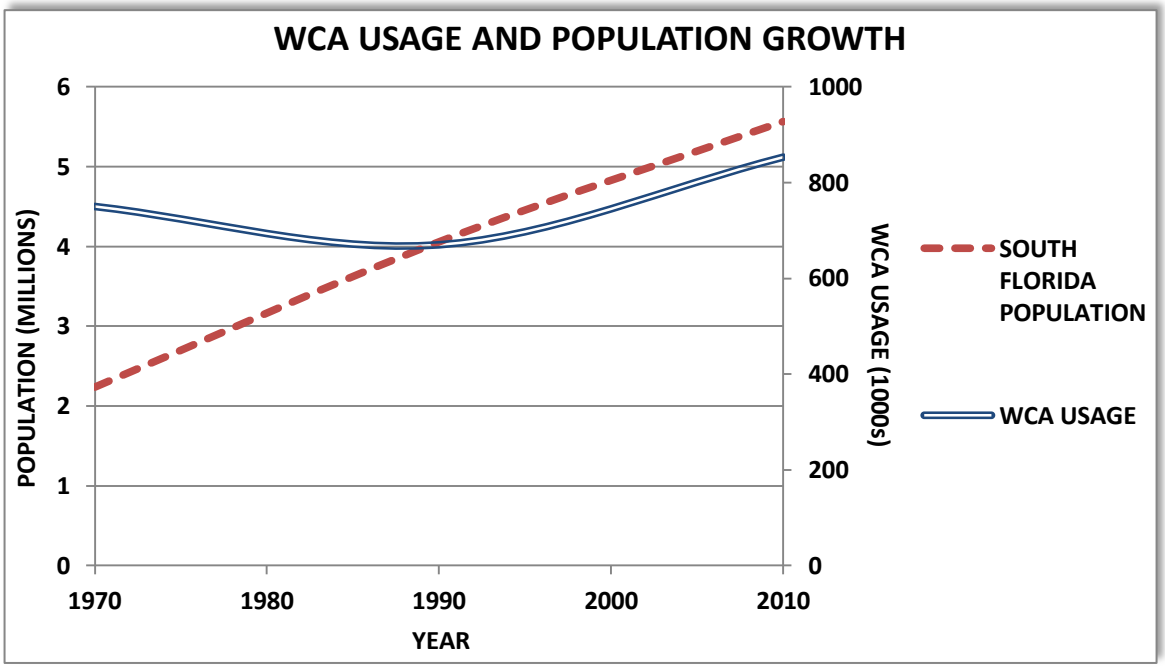

Figure 6-3. WCA Usage and Population in South Florida, 1970-2010

In toto, the usage of the WCAs increased less than 14 percent between 1970 and 2010 while the tri-county population increased by 149 percent (and the District population increased by more than 187 percent). The tri-county and District-based usage indices declined by 54 percent and 60 percent, respectively. Figure 6-3 describes these changes.

[130] The population of Dade, Broward and Palm Beach Counties grew by more than 81 percent during these two decades.

[131] Using the population of only Dade, Broward and Palm Beach Counties, the index declined from 0.34 in 1970 to 0.17 in 1990 and then to 0.15 in 2010.

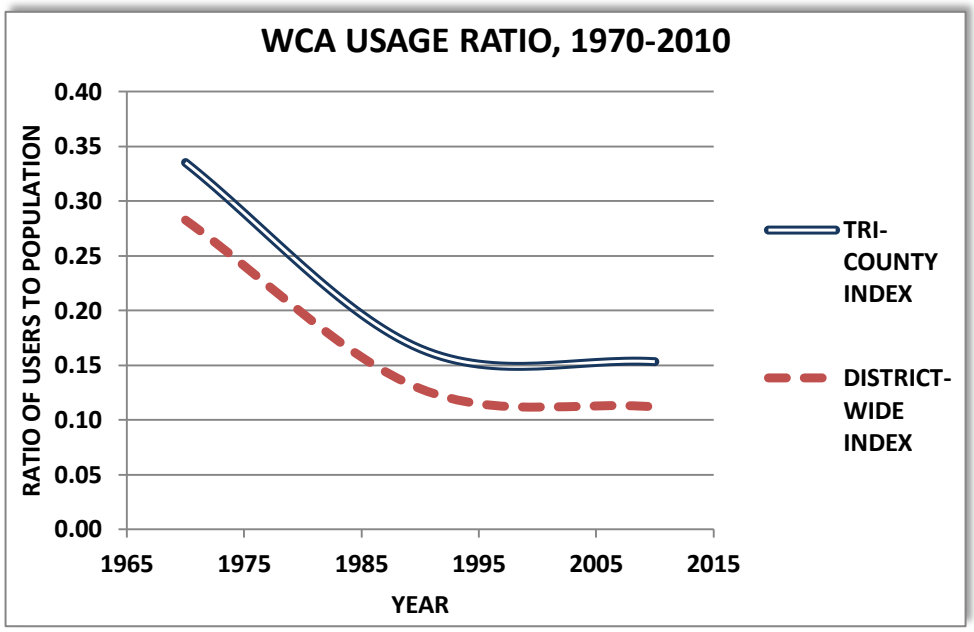

Figure 6-4. WCA Usage and Population in South Florida, 1970-2010

Another indicator of recreational use is the number of residential licenses for hunting and freshwater fishing. FWC data for the past seven years indicates a steady decline in licenses used to access the resources of the WMAs in South Florida. Data were not readily available to characterize the numbers of licenses issued prior to 2004; however, the trend is well-defined (Figure 6-3). In sum, total recreational usage of South Florida terrestrial habitats has increased, although at a slower rate than population growth. Usage of the WCAs, however, is comparatively flat despite population growth, proximity, and access. Based on the 14 percent increase described above, the average annual rate of growth in patronage is just 0.33 percent, contrasted with the 2.32 percent growth in population and potential users of the resource. As recently as 2004 the number of licenses sold was about 10.3 percent of the District's population. By 2010, the license-holding public declined to 7.4 percent of the population. Further, for the tri-county area of Palm Beach, Broward, and Miami-Dade, this statistic declined from 3.2 percent to 2.8 percent over the same period.

If the decline in licenses were a reflection of a change in the public's use of WMAs and other regional resources affected by declines in ecosystem quality, then loss of license revenue would be an externality of water use and management. In 2011, FWC receipts for residential licenses totaled $23.7 million. Residential hunting and fishing licenses issued in the District comprise 49.7 percent of the statewide total; South Florida residential licenses yield about $11.8 million in state receipts. Licensing has declined at an average rate of 3.62 percent per year. The reduction in state receipts is an estimated $427,000 per year. This estimate is conservative in that it reflects the raw decline in numbers and does not include any factor to address the difference between the number of licenses sold and those that would be sold had licensing kept pace with population.[132]

[132] For the period between 2004 and 2011 the area's population grew by 7.71 percent. Relative to the expected visitation, net losses then are 11.33 percent or $1.34 million for FY 2011.

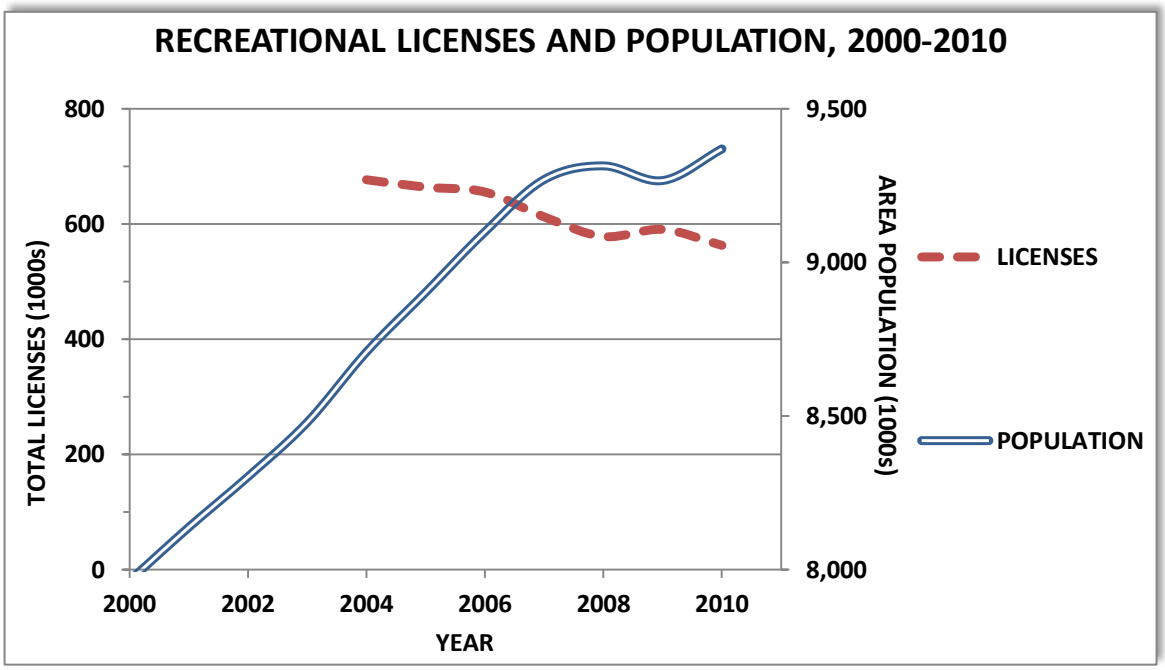

Figure 6-5. FWC Licenses Issued and Population Growth

The Value of Resource-Based Recreation

The following table shows the economic impacts of fish and wildlife recreation in Florida, statewide, in 2011. Among the four categories, wildlife viewing generated the largest sales and economic impacts (39 percent of the total). However, saltwater fishing supported more jobs (54,516) than did wildlife viewing (51,380).

Table 6-2. Economic Impacts of Fish and Wildlife Recreation in Florida (2011)

Category	Retail Sales ($ millions)	State and Local Taxes ($ millions)	Economic Impact ($ millions)	Jobs
Hunting	$447.1	$49.2	$780.1	10,675
Freshwater Fishing	$1,536.2	$143.7	$2,630.6	24,802
Saltwater Fishing	$3,329.8	$345.8	$5,692.0	54,516
Wildlife Viewing	$3,456.6	$351.0	$5,784.3	51,380
Totals	**$8,769.7**	**$889.7**	**$14,886.9**	**141,373**

Source: Florida Fish and Wildlife Conservation Commission (2011) Economics of Fish and Wildlife Recreation

Analyses of recreation (independent of tourism) that are specific to South Florida vary in scope and conclusion. Based on direct expenditures for freshwater fishing and estimates of the population that fishes, the 1990 study suggested that recreational freshwater fishing (only) in the interior ecosystems of South Florida (excluding Lake Okeechobee) is worth between

$69.2 million and $112.9 million (in 2011 dollars).[133] Based on a user survey and 2006 USFWS data, Fedler (2009) suggested that residential (non-visitor) freshwater fishing in the 13 core counties of the District was worth $205.9 million per year (including $111 million for travel and access expenditures) while saltwater fishing was worth more than $516.8 million per year (including $312.9 million for travel and access). Mather estimated that the *total economic value* of hunting (only) in the 16-county region was $175 million per year.[134] Drawing from different surveys, these estimates suggest that the region is responsible for at least 13 percent of the state-level estimate of economic impact: 22 percent for hunting, 13 percent for freshwater fishing, and 16 percent for saltwater fishing. Using 13 percent as a conservative share, the District generates at least $1.14 billion in direct economic impact and perhaps as much as $1.94 billion in total economic value for all resource-based recreation.[135] The region's share of state and local taxes associated with these expenditures is estimated to be at least $115.7 million annually.

There are no hunting or similar resource-consumptive uses in the area's national parks, but other uses are permitted.[136] Regardless of use constraints, the average annual visits to the major parks are 3.18 million per year and these are supplemented by more than 0.86 million in visits to the various WMAs (including a minimum of 0.54 million to the Everglades WMA) and 0.32 million to the WCA-1. Estimated total usage is 4.26 million visits per year, and the WCAs support 20.2 percent of these visits. Consequently, in recent years the WCAs conservatively generate $230.1 million in direct economic impact, $391.7 million in total economic value, and $23.3 million in state and local taxes per year.[137]

Estimates of Impacts to Resource-Based Recreation

The 1990 study offered several approaches to bounding the loss in recreational value due to then-current and projected additional loss of habitat. Using the then-applicable discount rate of 8 percent (i.e., yielding smaller future values over time), the study estimated annual direct losses of $85,276, or $146,737 in 2011 dollars. Borrowing values from a complementary study Kissimmee River restoration generated a total economic value of $327,625, or $565,856 in 2011 dollars.

While the total area of the WCAs is 867,400 acres, the Refuge and the Everglades and Francis Taylor WMAs (i.e., the areas accessible for recreation) total only 819,231 acres. Based on the conservative cumulative estimate of 112,200 impacted acres in the WCAs, 13.7 percent of the system will have been degraded by 2030. On average, for the period between 1970 and 2030, (i.e., pre-restoration), each year of degradation implies a loss of 0.23 percent

[133] The lower value reflects actual expenditures for park admissions, licenses and fees, and freshwater fishing gear. The higher value is an extrapolation of expenditures for hunting and camping based on the percentage of the population engaged in these activities at the J.W. Corbett Wildlife Area.
[134] Total economic value includes indirect and induced impacts. Based on the relationship between total and direct economic value for recreation in South Florida, direct impact for hunting may be about $103 million.
[135] It is unclear if the FWC tabulations reflect hiking, nature photography and the like.
[136] Hunting is a permitted use in the Big Cypress National Preserve.
[137] Direct expenditures for fishing and hunting in the WCAs may be a minimum of $172 million.

of the ecosystems that support these uses.[138] This loss may be equivalent to as much a 0.91 percent loss of expected use per year:

$$\frac{\text{(54.5 percent loss in } \textit{expected} \text{ use)*(0.23 percent loss in habitat per year)}}{\text{(total of 13.7 percent loss in habitat)}} = \text{0.91 percent loss of } \textit{expected} \text{ use per year}$$

This expected loss is an underestimate as the 54.5 percent loss is based on conditions as of 2012. Should the recent trend in use continue, the reduction in expected use would be larger in 2030. The incremental *expected* annual loss is then estimated to be $2.09 million in direct impact, $3.56 million in total economic value, and $0.21 million in state and local taxes. This amount should be taken as a lower bound on the economic impacts of habitat loss or alteration specific to nutrient loading as the losses due to hydrological modification and mercury contamination are not included.

Alternatively, using the current economic value of $230.1 million per year for the WCAs and applying the methodology outlined above reflecting the combination of CPI and discounted future values for the period between 1970 and 2060 yields average discounted losses of $7.28 million per year.

A third estimate is provided employing the estimated economic impact developed just for recreational freshwater fishing: given that the WCAs comprise more than 85 percent of the total acreage of (freshwater) Wildlife Management Areas and Public Use Areas in the District, the economic impact of freshwater fishing may be largely imputed to the WCAs. At nearly $206 million per year within the entire District, the WCAs may be worth $174 million per year. Total losses over 60 years as a result of habitat impact are estimated to be $377 million in 2012 dollars, adjusted for the CPI and for inflation between 2012 and 2030. The average annual loss in value is $6.29 million per year.

Offsets to Predicted Impacts

The 1990 study applied a 50 percent loss in usage, i.e., that all recreational use is not displaced with habitat conversion. While no new uses are occurring in the WCAs, waterfowl hunting is a new regulated use within the STAs. Appendix M-6 reports more than 10,300 visits in the most recent season (September 2011 – January 2012). No data was found on the economics of local waterfowl hunting specifically. However, in a 1999 review of eleven studies of wetland values for hunting in general the USDA reported a median value of $1,031 per acre.[139] If applied to the roughly 45,000 acres of effective area in existing STAs, waterfowl hunting may be worth $46.4 million, assumed to be total economic value. Annualized at 6.3 percent, this specific value would be equal to $2.92 million per year, an offset to the above tabulated losses.[140]

Freshwater system recreational losses may be offset by continued or expanded recreational use of altered habitat, however, National Refuge and National Park ecologists

[138] Using the total acreage of WCA-1 and the Everglades WMA, 682,402 acres, and sixty years of impacts (1970-2030).

[139] Economic Research Service/USDA Wetlands and Agriculture: Private Interests and Public Benefits / AER-765

[140] Ibid, the lowest value reported in the study was $18, implying hunting in the STAs may be worth as little as $360,000, or $23,400 per year.

suggest that the diversity and overall populations of species key to these recreational uses will decline in response to environmental degradation. On the other hand, based on recent trends this analysis does not consider that recreation use (and related expenditures) will increase with population growth or that the increase in habitat degradation will result in a disproportionately greater loss of dependent species should the total degraded habitat reach some critical threshold.

B. Impacts to Regional Tourism

South Florida is well-known for its tourism, which generated about 20 percent of the Gross Regional Product in 2007. Visitation statewide increased 39.7 percent from 58.9 million in 1999 to 82.3 million in 2010, and tourism spending, which reflects tourism and recreational taxable sales, increased similarly – 32.8 percent from $47.2 billion in 1999 to $62.7 billion in 2010. State sales tax revenues from tourism increased 35.7 percent during the same period (Table 6-1).

According to the Alpert and Stronge (2009), about 101 million tourists visited the 16-county Everglades watershed and spent $76.2 billion. In 2006, thirty-six percent of all state and national park visitors in Florida visited parks in the greater Everglades region, and an estimated 5.5 million tourists engaged in recreational activities during their visit to the region in 2007. On average, these tourists spent $187.13 daily on lodging, dining, recreation, entertainment, shopping, and local transportation. If one day of these expenditures were assigned to each reported instance of Everglades-based recreation, the expenditures amount to about $935 million. Further, every dollar spent by tourists in Florida translates to an additional 97.5 cents of indirect and induced impacts or production. Therefore, the $935 million in direct spending results in an additional $911.6 million to the GRP. The authors also estimated that Everglades-centered tourism created 17,799 jobs in 2006. As a result of these jobs, labor earnings in Florida were increased by $561 million.[141]

According to Cook (2011), total visitor spending in 2008 within Miami-Dade, Monroe, and Collier Counties was $119 million, including $8 million spent inside the Everglades National Park. While tourism per se was not measured, the study identified that 83 percent of the visits to the Park were from outside the three counties, 96.4 percent of all visitor spending was associated with these trips, and 97.3 percent of visitor spending was associated with these trips made primarily because of the Park. Non-local visitor spending therefore totaled $114.9 million. The greatest proportions of expenditures were for lodging (42 percent) and restaurant meals and bar expenses (19 percent).

[141] Alpert and Stronge, 2009, The Economics of the Everglades Watershed and Estuaries http://drivecms.com/uploads/riverofgrasscoalition.com/1022369245The%20Economics%20of%20the%20Everglades%20FINAL%20REPORT.pdf

Table 6-3. Economic Impact from Tourism in Florida (1999-2010)

Year	Visitors (millions)	Tourism Spending ($ billions)	Sales Tax Revenues from Tourism ($ billions)	Directly Employed by Tourism
1999	58.9	47.2	2.8	826,200
2000	72.8	50.9	3.1	842,900
2001	69.5	50.8	2.9	864,500
2002	73.9	51.1	3.0	862,900
2003	74.6	51.5	3.1	874,700
2004	79.7	57.1	3.4	920,700
2005	83.6	62.0	3.7	948,700
2006	83.9	65.0	3.9	964,700
2007	84.5	65.5	3.9	991,300
2008	84.2	65.2	3.9	1,007,000
2009	80.9	60.9	3.7	973,800
2010	82.3	62.7	3.8	974,700

Source: Visit Florida Research (2011), Visitor Stats

Applying Cook's conclusions regarding the share of regional visits made primarily because of the Park, there was $53.7 million in non-local visitor spending attributed directly to the Park, which in turn supports 788 jobs in the area and generates $83.2 million in output (sales revenues), $28.6 million in labor income, and $48.7 million in value added. Everglades National Park itself employed 327 people in FY 2009 with a total payroll including benefits of $22.1 million. Including secondary effects, the local impact of the Park's payroll was 431 jobs, $26.3 million in labor income, and $34.0 million total value added.[142] In principle, non-local visitors contributed to 97.3 percent of these Park payroll impacts.

Based on Cook's reported numbers for Park re-entries, there were about 665,500 unique person-trips to the Park in 2008. Twenty-one percent of all visitor groups indicated the Park was the primary reason for their visit to the area, suggesting that about 140,000 individual visitors arrived because of the Park. The 1990 study, using data regarding the primary reasons for travel, sales of hunting and fishing licenses, and county-specific visitor estimates, concluded that between 273,000 and 333,000 non-local visitors came to the Everglades region specifically to experience the resources of the WCAs, the National Park and Big Cypress. If Cook's allocation is correct then there are roughly 160,000 tourists arriving primarily for the WCAs and Big Cypress. Assuming the same ratio for tourists as among all visitors, there are approximately 60,000 tourists each year in the WCAs and about 100,000 at Big Cypress.

[142] Cook, 2011, "Impacts of Visitor Spending on the Local Economy: Everglades National Park, 2008"

The DEP reports total direct economic impact of the Pennekamp Coral Reef Park alone to be more than $32.7 million.[143] This park attracts 29 percent of the visitors to the major state and national parks in the area: assuming no visitor attends more than one major park per day the regional total would be $113.4 million. The DEP estimates do not reflect secondary effects. In sum, Everglades Park may contribute $52.7 million, Pennekamp another $32.7 million, leaving $27.0 million in tourist expenditures specific to the WCAs and Big Cypress. Applying the above shares suggests $10.1 million in tourist expenditures for the WCAs and about $16.9 million for Big Cypress.

Estimates of Impacts to Tourism

Despite the positive economic impact in the region associated with tourists to the area's major parks, habitat degradation may have affected both the numbers of tourists and their expenditures.

The 1990 study estimated that habitat impacts generated discounted losses in daily expenditures by tourists to be $123,813 in 2011 dollars. The annualized, discounted loss associated with all visitors to area resources was stated to be $386,323 in 2011 dollars.

Data for 2002 indicates (statewide) the weighted average of expenditures for air and car visitors is $126 per day or $671 per trip.[144] These translate into $157 and $839 per day and per trip, respectively in 2011 dollars.[145] Cook's weighted estimate for differing classes of overnight visitors to the Park was $139 per day, $145 dollars in 2011. The more conservative values are used. Examining tourists as recreational users above and using the same rate for loss of habitat implies a loss of over $1.04 million per year:

(0.5)*($839 per tourist per trip)*(273,000 tourists)*(0.91 percent loss in expected use per year)
= $1,042,164 per year[146]

Should we restrict the impacts to the WCAs (i.e., the estimated $10.1 million in tourist expenditures), then cumulative, discounted, externalities are $0.32 million per year. As the WCAs attract about one-sixth of all resource-focused tourists, the average annual externality to the greater system may be as much as $1.92 million.

Tourist Development Taxes

Tourist development taxes in the Okeechobee basin are reported in Appendix M-9. These revenues totaled more than $312.6 million in 2009, but fluctuated during the past fifteen years (Figure 6-6). Since 2000, the average revenues have been $273.8 million per year.

[143] The State Park System Direct Economic Impact Assessment for FY2010/11.
[144] http://search.comcast.net/?cat=web&con=homepage&q=expenditures+per+visitor+Florida+2010
[145] The 1990 study incorporated weighted values of $98 per day and $969 per trip (2011 dollars) – trips have become shorter.
[146] In contrast, the 1990 study included hypothetical economic losses totaling $145 million per year (2011 dollars) associated with ecosystem collapse due to the continued spread of *Melaleuca quinquenervia* in South Florida. This update only explores losses that can b reliably documented.

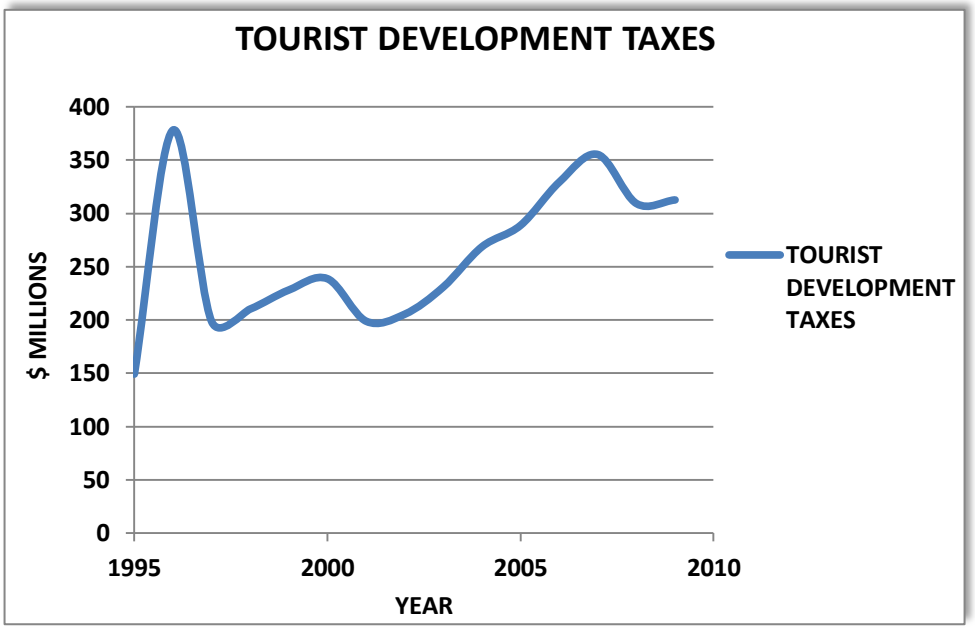

Figure 6-6. Tourist Development Taxes, 1995-2009

Accepting the 2009 estimate of 101 million tourists (which includes internal visits and visits to Collier County) and the conservative estimate of 273,000 tourists specifically visiting to access the major South Florida interior ecosystems, then these visitors are responsible for 0.27 percent of all tourism expenditures, which includes bed taxes. The amount of taxes attributed to these tourists is $740,000 per year. The loss associated with the reduction in habitat is then $6,734 per year. The 1990 study estimated that habitat impacts resulted in losses of tourist development taxes to be $3,579, or $6,159 in 2011 dollars. More local governments have adopted bed taxes since 1990.

Should the externalities of water management and use result in the loss of all 3.2 million visitors, the proportional loss of tourism development taxes would be $8.7 million per year.

C. Commercial and Recreational Fishing Impacts

Indications of externalities (and other factors) to coastal resources may be reflected by changes in the numbers of boats, the numbers of commercial and recreational licenses for saltwater and freshwater fishing, and reported harvests of saltwater and freshwater species.

Registered Boats

The numbers of registered boats in the region for the period 1990 through 2011 are reported in Appendix M-3. Registrations and boat usage increased with population until 2007, although the number of boats declined by about 12 percent since. The change in the historic trend includes the effects of the financial crisis beginning in 2007-2008, but that may not be the only factor (Figure 6-7).

The impact of the statewide net ban is discussed below, under Commercial Fishing. While the ban is a commercial and not a recreational fishing issue, the boat registrations described here include both classes of craft. The rate of increase in registrations declined after 1996 (the year the ban went into effect), but there was no net decrease in the region. The data indicate that registrations were flat or declining as of 2005, prior to the financial crisis, suggesting that conditions or opportunities for the use of craft (e.g., quality of fish stocks) may have been compromised. The percentage of registered craft that are in commercial use has been relatively constant, between 3.0 percent and 3.2 percent of the total.[147]

Assuming that water management affects water quality in the broadest sense (both pollutants and salinity), water use in South Florida may be responsible for a decline in boater activity. The externalities would include lost state and local revenue tied to registrations and reduced local sales tied to boating. Registrations have declined by about 46,800 over the past five years (an average of 9,360 per year). Vessel registration fees are tied to boat length, varying from $23 for craft less than 16' to $85 for craft less than 40'. Using the average of $54 per registration indicates an externality of lost state revenues of more than $505,000 per year. All of the coastal counties of the SFWMD, except for St. Lucie, attach a surcharge ranging from 40-50 percent of the state's fee. These counties represent 72 percent of vessel registrations. Assuming uniformity in decline across the District, about $182,000 per year in local revenues are lost. The State also charges a $50 fee for commercial craft. Losses for this charge are another $14,000. Total losses are estimated conservatively at $701,000 per year.

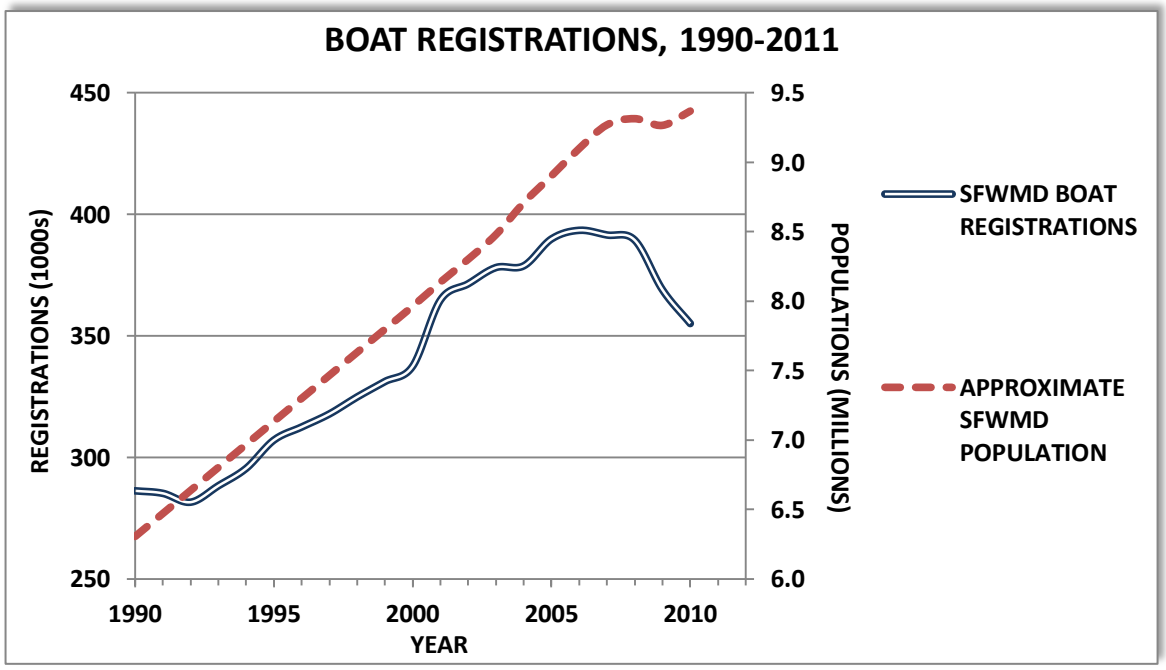

Figure 6-7. Boat Registrations and Population Growth

[147] FWC, Calendar Year Vessel Statistical Reports, 1990 through 2011.

Commercial Fishing

Commercial saltwater fish and shellfish landings for the region are reported in Appendix M-8. The total landings in 1987 were 59.7 million pounds and were worth an estimated $96 million. Data for 2010 indicate an uptick in landings (at 36.1 million pounds) following several years with total catch of between 21.9 and 27.4 million pounds (Figure 6-2). Monroe County, at the hydrological terminus of the Everglades system, accounts for over 37.5 percent of this value.

Mather (2010) tabulated dockside value by species and reported total dockside value equivalent to $93.1 million in 1986 for 54.7 million pounds and $53.7 million in 2008 for 28.0 million pounds, a decline of $39.4 million.[148] While dockside prices for individual species have varied over time, Mather's approach simplifies the challenge of estimating the contribution of fisheries to the regional economy. For the period 1986-2008, Mather reported a 49 percent decline in catch and a 42 percent decline in value (Figure 6-8). While some of this reduction has been attributed to overfished stocks and the net ban imposed in 1996, water quality (especially salinity alteration), has been referenced as a primary cause for decline.[149] Stormwater runoff from the Lower East Coast would ultimately affect Palm Beach, Broward, Dade, and Monroe Counties. Waters from the Kissimmee River basin and Lake Okeechobee would affect Lee and St. Lucie Counties through C-44 and C-43 discharges, respectively; Collier County would be affected by littoral movement from the Caloosahatchee estuary.

The 1990 study examined commercial fish harvest between 1980 and 1987, and total catch declined nearly monotonically during that period.[150] While dockside value fluctuates in accordance to the distribution and price of the fish caught, total catch, which includes both shellfish and finfish, reflects the productivity of coastal ecosystems. This parameter, however, is influenced by many factors external to the system of South Florida, including overfishing elsewhere, the quality of runoff from contributing watersheds, local pelagic water quality and temperature, etc., and there is no single linear relationship between any such factor and the reduction in harvest. Further, impacts of the net ban (taking effect in 1995) are not apparent in the harvest data for South Florida. Figure 6-8 indicates that the relative increases and decreases in catch for these classes are not uniformly parallel, but that the overall size of the harvest has declined sharply.

The 1990 study did not tabulate the annual loss of nearshore fisheries, but identified the loss associated with ecosystem collapse. An approach to the problem could include the changes in discharge to the coast that are a consequence of water management focused initially on drainage, flood protection, and water supply. Discharge to tide from the Lower East Coast and Lake Okeechobee, exclusive of unmanaged groundwater flow, is 4,514 E3 acre-feet per year. Discharges under CERP, intending to capture flow to tide that is

[148] These estimates were developed applying 2009 dockside values, by species, to the historical and current catch.
[149] Mather (2010) also addressed the change in landings and dockside value after 1996 to eliminate the effects of the net ban. Declines in catch and value were approximately 49 percent each for the period 1996-2008.
[150] Florida Statistical Abstract, 1981-1988

disruptive, may be about 3,085 E3 acre-feet per year.[151] The suggested relationship then is approximately a 49 percent decline in harvest that is concurrent with a 32 percent increase in discharge above background or desired levels.

Of the difference of about 1,429 E3 acre-feet, the LEC comprises about 662 E3 acre-feet or 46.3 percent and the ENP share is 1.5 percent. One can then allocate the share of decline among the sectors: of the $39.4 million decline, $18.22 million may be attributed to agriculture and $16.17 million may be attributed to the drainage and flood protection needs of the non-agricultural sectors of the Lower East Coast.[152] As of 2011, the net annual externality of agriculture (all, not just the EAA) is about $2.05 million per year.

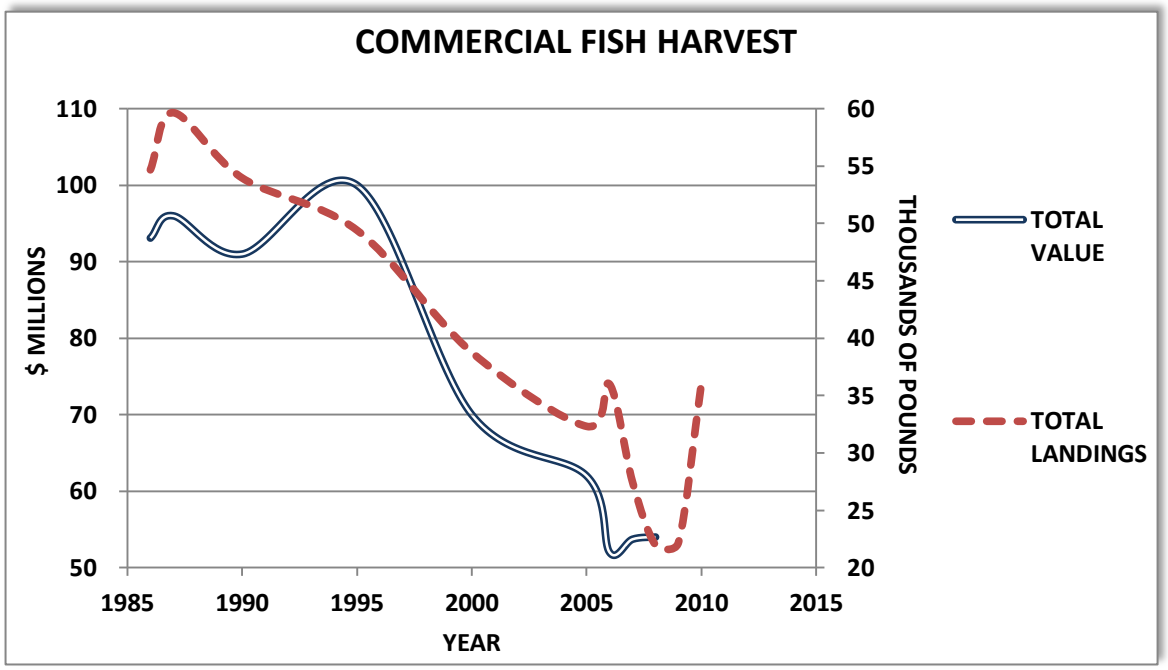

Figure 6-8. Seafood Landings and Value, 1986-2010

Alligator Products

The 1990 study reported commercial trade in alligator products in South Florida to be between $2 million and $3 million per year and conservatively estimated annualized losses due to habitat loss at about $26,000 per year. Based on retail value of about $3,000 per animal (1989 data),[153] the retail value of alligators harvested in South Florida may have been worth as much as $3.3 million per year until about ten years ago. However, harvest in recent years is about one-fifth of what it had been (Appendix M-6b), i.e., perhaps yielding just $660,000. The

[151] Average pumped flow in the region is 3,680 ac-ft per year. The sum of all discharges through the LEC, St Lucie and Caloosahatchee under CERP is 2,927 E3 acre-feet, but these include 482 E3 acre-ft as environmental water supply.

[152] If these impacts are correct, the loss of environmental value attached to LEC discharges may exceed the scope of externalities associated with agricultural discharges to the WCAs. However, the annualized costs of the ECP, not including operations, greatly exceed either. In sum, the externality that EAA and LOK discharges impose on the WCAs is assigned as a subsidy to agriculture.

[153] http://myfwc.com/media/310212/Alligator_IFASvm52.pdf

value of alligator production (Statewide, including farmed) in Florida was $2.6 million in 2010,[154] so the estimate of $660,000 for native harvest in the region is reasonable. At a rate of loss of 0.91 percent per year, losses associated with habitat degradation would be about $6,000 per year.

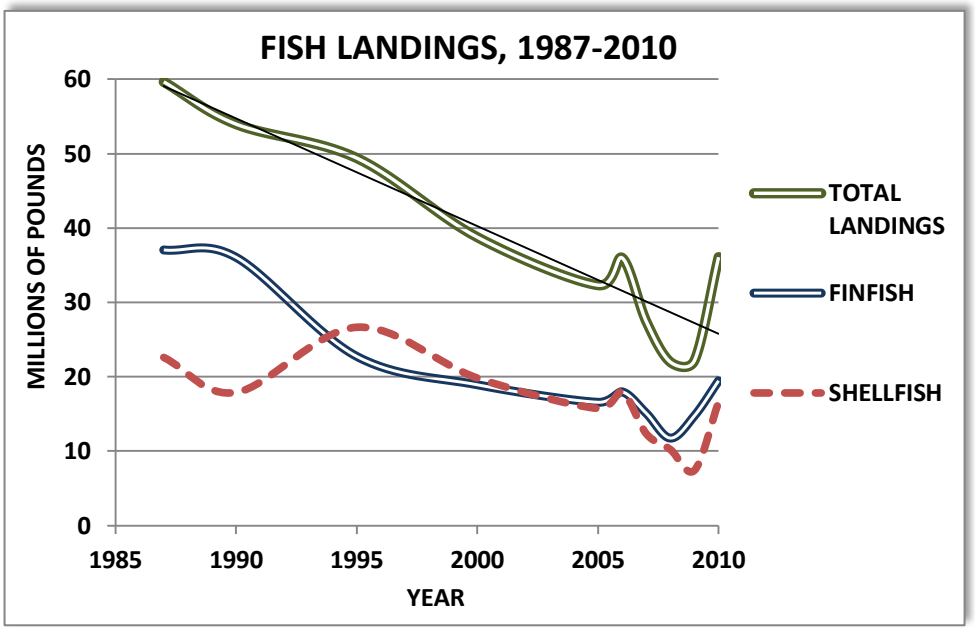

Figure 6-9. Total Seafood Landings, 1987-2010

D. Summary of Externalities

Appendix M-9b updates the findings of the 1990 study and includes a column of data that describes the annual impact of the (then) current losses plus the anticipated losses associated with 30 additional years of impacts. The values overstate the anticipated ("cumulative") losses because the rate of cattail conversion has declined. However, the period of losses is anticipated to now extend until 2060 rather than 2020, i.e., forty additional years, at minimum, albeit at a decreasing rate.

[154] http://www.agmrc.org/commodities__products/aquaculture/alligator-profile/

Table 6-4. Estimated Annual Values of Selected Externalities of Degraded Habitat (*1990 Report*, 2011 $ millions)

Impacted Function	Current Annual Loss	Annualized Future Cumulative Losses (Discounted)	Maximum Total Annual Impact
Recreational			
Fishing & Hunting	0.25	0.16	0.41
Tourism	0.64	0.43	1.06
Bed Taxes	0.01	0.01	0.01
Okeechobee Fisheries*		1.46	1.46
Okeechobee User Value*		0.55	0.55
Commercial			
Okeechobee Fisheries*		0.42	0.42
Offshore Fisheries*		3.19	3.19
Alligator Harvest	0.07	0.05	0.12
Totals	**0.97**	**6.27**	**7.22**

* These functions are affected by urban stormwater discharges also; not 100 percent of the losses can be attributed to agriculture.

Note: Okeechobee User Value, and Okeechobee and Offshore Fisheries calculated at 3.5 percent of the annual value of the subject, i.e., the annualized value of the annual yield.

For comparison, in this update, revised tabulations based upon new data indicate that direct annual losses in 2011 as a result of degradation of habitat associated with water use and water management include the following:

Table 6-5. Revised Estimated Values of Selected Externalities in 2011 ($ millions)

Category	Annual Loss
WCA-Based Recreation	2.09
Tourist Expenditures	1.04
Bed Taxes	0.01
Commercial Alligator Trade	0.01
Hunting and Fishing Licenses	0.47
Boating Registration Fees	0.70
Commercial Fisheries	2.05
Totals	**6.37**

For purposes of further analysis in this update the conservative value of $6.37 million in direct economic impact is used. The value is less than two percent larger than previously estimated using different data sources and approaches to the problem of quantifying externalities. However, the user value of South Florida ecosystems, measured by "willingness-to-pay" and measured by surveys, may be anywhere from 1.5 times to 3.6 times greater than direct expenditures. The indicated recreational losses are underestimated because conservative values were used for known or derived direct expenditures.

Important Points

- *The habitat and recreational value of an estimated 105,000 acres of the WCAs has been reduced by nutrient-rich discharges.*
- *Recreational visits and tourists to impacted areas have remained flat (relative to expected use) while unimpacted areas (i.e., outside the WCAs) have seen increased usage.*
- *Externalities include reductions in bed taxes, sales of hunting and fishing licenses, and boating registration fees.*
- *Losses in the value of freshwater-based outdoor recreation and saltwater fishing are conservatively estimated to be about $2 million each.*

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Chapter 7.
Discussion and Conclusions

> "*But the tragic and ludicrous aspect of the whole situation is that cheap water keeps the machine running . . . . The effect of everything, according to the economists, is that a few thousand farmers will, over the course of fifty years, receive a billion and a half dollars' worth of taxpayer generosity that was never supposed to be theirs.*"[155]

> *" . . . natural resources issues spark contentious debate precisely because they strike at core values of fairness, equity, and even aesthetics. Honest, fair-minded people can have honest, well-founded discussions over priorities and programs."*[156]

Chapter 1 introduced the context for water management in South Florida and discussed how it has become a necessity for the region's economy. Chapter 2 characterized the regional economy in terms of its dominant sectors and trends in both employment and outputs. Chapter 3 examined how water management is funded, while the role and financial share of various economic sectors with regard to infrastructure and water management operations was the subject of Chapter 4. Chapter 5 outlined the extent of the non-local subsidies and Chapter 6 estimated the economic impact of selected externalities associated with continued loss of native habitat due to water use. The subject of this chapter is to examine the existing pattern of costs and benefits and the requirements of long-term natural resource protection.

A. Summary of Findings

The major findings of this update relate to the following subjects:

- the patterns of water use;
- the allocation of SFWMD expenditures for water management;
- the nature and magnitude of other programs that directly or indirectly subsidize agriculture and its use of water;
- externalities of water use in the region; and
- the relationships of economics and demographics to the agricultural and non-agricultural sectors of the regional economy.

The 1990 study concluded that South Florida agriculture, particularly the EAA and much of Southern Dade County, operated at the expense of South Florida's urban community and of taxpayers nationally. The EAA unfairly benefits from the existing taxing structure that supports the SFWMD and its operations. Internalization of the externalities of agricultural use of water and accounting for the subsidies indicated in the update result in significant changes in the relative costs of water to each sector. The opportunity costs allocating water to

[155] Reisner (1986), pp 500-501.
[156] Feldman, 1991. page ix.

agriculture are high, especially in the context of the need to protect and develop municipal water supplies.

Water Use

The 1990 study predicted that agricultural consumption would remain steady or decline in response to improvements in irrigation efficiency and a decrease in total acreage in production. While agricultural withdrawals in 2005 are effectively the same as they were in 1985, demand did rise by 566 mgd (in 2000), an increase of 29 percent. It is possible that the decline in agricultural use in 2005 is an anomaly, attributable in part to the 2004-2005 hurricane season and lost production.[157]

As of 2005, agricultural irrigation remained the largest user of freshwater, accounting for more than 87 percent of all surface water consumption (which is governed most directly by water management infrastructure), 26 percent of groundwater, and (according to the USGS) 55 percent of all freshwater. More than 47 percent of all major general consumptive use permits are for agricultural purposes.

While the non-agricultural sector's share of freshwater withdrawals has increased since the 1990 study, these uses yet make up less than 45 percent of freshwater use.[158] Non-agricultural consumption, including public supplies, recreational irrigation and all industrial withdrawals, especially in the southeast counties, continues to rise with population growth. Conservation measures and mandatory restrictions may dampen the rate of increase in non-agricultural water use, but annual withdrawals for these purposes will likely exceed agricultural use in the next twenty years. Further shifts in the agricultural sector away from row crops towards greenhouse and nursery operations will intensify of this reversal in dominance of use.

The region's hydrology remains tightly interconnected. The EAA, for example, contributes between 4.6 and 8.0 percent of the total inflows to the Lower East Coast. This update included allocations to the Everglades National Park and between the LEC and the Park, thereby providing a better estimate of water managed for the use by the agricultural and non-agricultural sectors.

The Regional Economy

The region's population grew by more than 47 percent since the publication of the previous study. The population of the four urbanized counties of southeast Florida is expected to increase by about 900,000 persons in the next twenty years, while the population of the predominantly agricultural portions of the District is expected to increase by about 24,000 persons. The District's population and associated economy will continue to urbanize.

[157] If the as-yet-to-be-published 2010 USGS reports bear this out (that 2005 demand was an exception), then the differences in unit and average marginal costs for the agricultural and non-agricultural sectors (discussed below) will be exacerbated.

[158] Based upon USGS District totals; these percentages do not agree fully with USGS information summed at the county level.

The non-agricultural sector has increased its relative share of employees, income, and the Gross Regional Product. Since 1980, farm income grew by 130 percent while non-farm income grew by roughly 632 percent. Farm employment declined since the previous study and agriculture's share of the GRP declined from about 3 percent to currently less than 1 percent. Sugar production, concentrated in the EAA and long the dominant component of the agricultural sector in South Florida, now contributes less market value than do nursery and greenhouse producers. Farm income may have reached its maximum share of the regional total – 2.4 percent – around 1985; however, by 2009 farm income declined to less that 0.6 percent of total regional income.

The Gross Regional Product is estimated to be about $301 billion in 2010. Agriculture's share of the GRP was determined to be about $2.3 billion (including fishing, which is not a significant user of water), an increase of about $0.1 billion over the past twenty-five years. However, relative to 1985, the agricultural share of the GRP decreased from about $4.5 billion to $2.3 billion in constant dollars, about a 49 percent decrease. Agriculture's share of the GRP is now less than 0.8 percent of the total impact of the regional economy, a 27 percent decline since the 1990 study. Conversely, the non-agricultural sectors' share of the GRP increased from $68 billion to $299 billion, an increase of $230 billion. Relative to 1985, the non-agricultural share increased about $161 billion in constant dollars (or 116 percent).

Although the share of the agriculture sector has decreased to 0.8 percent when compared with the 1990 study, agriculture still plays an important role in Florida's economy. Each year, farms, ranches, nurseries and other agricultural businesses contribute significantly to the SFWMD regional economy. As cited in Chapter 2, citrus production makes up the bulk of the agricultural industry in Florida, with about 75 percent of the U.S. oranges and accounting for about 40 percent of the world's orange juice supply.[159] In addition to citrus products; sugarcane, celery, tomatoes and strawberries contribute to the economy in Florida. Jobs that stem from the agriculture industry include farming, interstate and intrastate truck driving, food product manufacturing, beverage manufacturing, etc. For example, in 2010, food product manufacturing hired 17,280 people and produced $7.5 billion (including indirect and induced impacts) in the 16 counties of the SFWMD.

Property Values and Tax Base for SFWMD

The 1990 study predicted that the share of ad valorem from agricultural lands would decline in response to a decrease in total acreage in production and rapidly increasing values for non-agricultural property. Agriculture's share of ad valorem supporting the SFWMD declined from about 1.7 percent of the total tax base in 1990 to the current total tax base of 0.65 percent. The nominal (then current) taxable value of agricultural lands (i.e., unadjusted for rises in consumer prices) increased by 38 percent over the past 23 years. In contrast, the nominal taxable value of non-agricultural properties increased by more than 257 percent. If the change in the consumer price index for this period were applied to property values, the taxable value of agricultural lands actually declined by more than 27 percent.

[159] Economy strengths in Florida, Florida quick facts retrieved from *http://www.stateofflorida.com/Portal/DesktopDefault.aspx?tabid=95*

Based on the documentation at the time, the 1990 study concluded that agricultural lands were taxed at about 25 percent of their "market value."[160] In 2011, reflecting the use of statutorily provided exemptions and the nature of the appraisal process, this rate was determined to be less than 18 percent of its "market value." If agricultural property were taxed at its "just" value (i.e., no exemptions), its share of the District tax base would still be less than 3.7 percent.

With regard to the entire capital and operating budget of the SFWMD ($565.8 million, excluding the Big Cypress basin), agriculture paid approximately $3.0 million in ad valorem taxes, or less than 0.6 percent of the total. The total Okeechobee Basin millage of 0.4363 is 54.4 percent of the statutory cap of 0.8 mills. Total SFWMD revenues could be enhanced by nearly 49 percent if the maximum millage were levied.

In the EAA specifically, agriculture pays less than $432,000 dollars in SFWMD ad valorem taxes (based on the appraised value of the existing soil classes and industry buildings such as mills). Based on the change in housing prices in the EAA since 2000, the District ad valorem revenues from cities in the EAA are approximately $206,000.[161] Assuming complete dependence of these cities on agriculture, then the EAA community pays about $638,000 each year, or less than 13 percent of all agriculturally-derived SFWMD revenues.

In sum, non-agricultural property owners pay more than 99 percent of the costs of operating and maintaining South Florida's water management infrastructure. The total taxable value of non-agricultural lands may be expected to continue to increase relative to agricultural land as the region's population grows and some agricultural properties become developed.

Allocation of SFWMD Expenditures

The 1990 study indicated that the SFWMD expended about 71 percent of its operations and maintenance (O&M) budget to provide water and water management services for agriculture. In 2011, this share declined to 56 percent. The decline is largely attributable to a correction provided in this update that allocated $9.1 million in O&M expenditures in 2011, to address the hydrological program for the Everglades National Park. To provide comparison, if the error had been perpetuated the share would have increased to 73 percent. For the approximately $3 million in ad valorem taxes paid by agriculture (district-wide), agriculture properties concentrated in Palm Beach County and secondarily in Miami-Dade County receive an estimated $31.6 million in O&M expenditures. Indirect subsidies for other District activities include a minimum of $3.2 million within the regulatory and permit programs and $32.8 million is various planning and support initiatives.

The Everglades Construction Project and the Long Term Plan to achieve statutory water quality objectives in the Everglades Protection Area have effectively displaced the SWIM initiative that was reviewed in the 1990 study. For consistent comparisons to be made

[160] Market Value here is defined as agricultural land, and not as its potential market value in some other land use, i.e., "highest and best use."

[161] The median values of homes in the four EAA cities increased from about $65,000 in 2000 to $101,000 in 2012. With the additional homestead exemption (and assuming all units are owner-occupied), then the average taxable value has increased by about $11,000 per home, or about 17 percent.

between the 1990 study and this update, the federal financial contributions to the Project were excluded: current local costs are currently nearly $769 million. Florida Statutes provide for agricultural privilege taxes through November 2013.[162] Unless the legislation is modified and the provision extended, agricultural payments (including BMP incentive credits) will not exceed $230 million. The remaining balance of at least $539 million can be considered a subsidy from the non-agricultural sector.

Allocation of CSFFCP and CERP Expenditures

The bulk of the CSFFCP was paid for by taxpayers nationwide. Based on construction records from the 1950s and 1960s, the project is estimated to have cost $2.68 billion in 2011 dollars, with the equivalent of $2.20 billion provided by the Federal government, and about $207 million from general revenues contributed by the State of Florida. Because these contributions derive primarily from sales and income taxes, the more highly populated urban centers contributed a disproportionately larger share. Local taxpayers (i.e., within the SFWMD) paid about $275 million, of which agriculture (District-wide) contributed no more than $13 million. The local subsidy from urban taxpayers strictly for the CSFFCP, not including operations and maintenance expenditures, was estimated to be over $152 million during the period from 1949-73.[163] Repairs to the Hoover Dike, which is a component of the CSFFCP but not a part of CERP, have cost $400 million to date, and are anticipated to require $1 billion through project completion. Including this additional Federal investment, the CSFFCP program subsidy to the South Florida economy (annualized) is $149.84 million per year for the agricultural sector and $63.29 million per year for the non-agricultural sector. The majority of the contributions associated with the CSFFCP, however, includes sunk costs and are independent in time and source from the current ad valorem, sales, or income taxes paid by South Florida property owners.

Because of the income-based taxing structure and population-proportional bond purchases used to fund the federal share of these projects, urban taxpayers will continue to provide a subsidy to agriculture for any future federal projects. Further, because of the ad valorem basis for the District, should federal policy emphasize increasing the local match in federally-sponsored projects, non-agricultural property owners will be responsible for a larger fraction of total project costs.

Other Subsidies

Federal programmatic subsidies, i.e., net receipts or benefits, not loans, are at least $66.1 million per year. This sum does not include the amortized value of past investments such as the local drainage improvements on 32,000 acres provided by the Soil Conservation Service in 1969 (now worth more than $15.1 million), or the historical direct Sugar Act payments that ended in 1975 but would be worth an estimated $887.5 in current dollars. The most significant State of Florida subsidy is the continued below-cost leasing of public lands to EAA agriculture (estimated to be $1.1 million below market value) which enable $13.2 million

[162] Section 373.4592(6), Florida Statutes.

[163] This is a conservative estimate as a more complete documentation of federal expenditures (Clarke, 1978) indicates that total federal costs through 1976 were at least 4 percent greater than the estimates developed above.

in industry revenues and contribute to at least 3.6 percent of the discharges. Including a conservative estimate of $0.8 million in state-managed research, the total direct subsidies (Federal and State, exclusive of the SFWMD) are estimated to be $68.0 million annually.

Within the District, analysis of all subsidies yields $67.3 million annually in current water management effort and a minimum of $6.4 million per year in habitat impacts, i.e., a minimum of $73.7 million in direct subsidy from non-agricultural taxpayers and natural resource users of South Florida to the agricultural sector. Historical SFWMD activities to address externalities, such as the dairy buyout in the Kissimmee valley to improve conditions in Lake Okeechobee, are not reflected in this total. Excluding the CSFFCP and CERP, annual federal, state and District subsidies to agriculture total $135.3 million. The annualized value of subsidy associated with the benefits of ECP infrastructure to agriculture is at least $92.8 million.

Externalities of Agricultural Discharges

EAA discharges and Lake Okeechobee releases have been determined to be responsible for the degradation of approximately 104,000 acres of wetlands in the Water Conservation Areas. These impacts include quantified shifts in the periphyton and macrophyte communities (especially near inflow structures) that are correlated with higher levels of nutrients, primarily phosphorus. While significant reduction in the recreational and commercial value of these lands has not been documented beyond anecdote and the data-based conclusions made here regarding visitor use and declines in fishing, until such time as the Everglades Construction Project and "Long Term Plan" are fully implemented and prevent discharges that generate imbalances in local flora, the long-term trend is that further degradation and corresponding loss of habitat can be expected to occur.. At some point, reduced habitat necessarily translates into verifiable losses of recreational and commercial opportunities and their related economies.

Based on the percentage of degraded habitat for specific end-uses such as fishing or general ecosystem values that persists for the period between 1970 and 2060, about $6.4 million in direct annual losses can be expected to occur. Select studies of hunting and fishing indicate that the total economic value of these externalities is estimated to be $10.8 million per year. While tabulated differently than in the 1990 study, these estimates are consistent with those made in the previous study.

Conclusion

Excluding the CSFFCP and CERP, the total direct annual subsidies from state and federal sources to South Florida agriculture are $229 million, and the net annual externality of habitat loss related to agricultural water use and discharge is a minimum of $6.4 million. Direct local support of agriculture (through the vehicle of the SFWMD) is at least $161 million per year. Net, indirect subsidy of the non-agricultural sector via Federal and State investment appears to be worth about $68 million per year. The same investment sources contribute an additional $171 million per year, net, to the agricultural sector.[164]

[164] The estimated subsidies reflect the transfer of funds through the structured costs-sharing of programs based upon water use. Each sector of the regional economy benefits from its investment in water management and supporting programs uniquely, and both sectors depend upon each other's outputs.

Table 7-1. Summary of Subsidies and Externalities ($ millions).

	Agricultural	Non-Agricultural
SFWMD O&M Subsidies	28.6	
SFWMD Programmatic Subsidies	38.7	
SFWMD Capital Projects, including ECP	95.0	
Federal and State Programmatic Subsidies	68.0	
CERP	17.7	3.4
CSFFCP and Related Projects	153.7	64.4
Externalities	6.4	
Totals	**408.1**	**67.8**

1. Water Consumption and the Gross Regional Product

Water use in both the agricultural and non-agricultural sectors has increased since the 1990 study. However, the dynamics of the regional economy have been such that while the agricultural sector has grown in the intervening years, its rate of growth and its absolute change in size (in constant dollars) is small in comparison to the non-agricultural sector.

The 1990 study reported that agriculture generated approximately $1,046 of gross domestic product per acre-foot of freshwater withdrawn. This estimate was consistent with a similar evaluation conducted statewide by Lynne (1984) and more encompassing than the strict market value of crops per unit of water use in the EAA prepared by the USFWS.

Based on updated information regarding both water use and the Gross Regional Product for 1985, this parameter is now estimated to be $1,028 per acre-foot ($1.15 million per mgd) for agricultural use. Similarly, the 1990 study reported a value of $94,782 of GRP per acre-foot for non-agricultural use, and this value has been recalculated to be $45,898 ($51.43 million per mgd). Thus, the relative contributions of the sectors to regional economy per unit of water use were less disparate than indicated previously.

However, in 2005, the last year of complete data for water use, the values for the agricultural and non-agricultural sectors were $1,370 of GRP per acre-foot (or $1.54 million per mgd) and $145,852 of GRP per acre-foot (or $163.43 million per mgd), respectively.[165] The adjusted ratio of the two was 44.6 in 1985 (i.e., the urban sector generated more than 44 times the GRP per unit of freshwater use than agriculture). In 2005, this ratio was more than 106.5, implying that over the last twenty years for the amount of water used, the relative value of urban uses more than doubled with respect to the agricultural contribution. On average, for each unit of water withdrawn, the non-agricultural sectors of the regional economy generate more than 106 times the value of agriculture.

[165] Assuming no significant change in water withdrawals by each sector between 2005 and 2010, the GRP (based on the year 2004) per ac-ft is estimated to be $1,092 and $171,087 for the agricultural and non-agricultural sectors, respectively.

Agriculture increased its impact upon the GRP per unit of water used by about 33 percent during this period while the urban sectors increased their collective impact by about 218 percent. However, adjusting for inflation with the consumer price index, the dollars of GRP generated per acre-foot (GRP/ac-ft) for agriculture decreased by more than 26 percent (from about $2,149 in constant dollars). In contrast, the non-agricultural, or urban, sector increased by more than 75 percent (from about $95,926 in constant dollars).[166]

From a marginal water use perspective, the District-wide rate of change (Δ GRP / Δ mgd) during the period between 1985 and 2005 was -347 for agriculture and 804 for urban uses.[167] Adjusted for inflation these rates of change are 522 and 698, respectively: the marginal value of water is increasing more rapidly in the urban sector. The effects of the financial and housing crisis of 2008-2010 are not reflected in these values. However, the disparity between sectors is so large, and market conditions in 2012 are improved relative to the core of the crisis, and thus it can be assumed that the relationship between each sector's shares of the GRP and use of water will continue to diverge. In sum, despite the significant efficiencies in GRP per use of water exhibited by the agricultural sector over the past 20 years, the non-agricultural sectors have accelerated their collective share of the GRP and contribute more total value to the GRP per unit of water withdrawn.

The Unit Cost for Water in South Florida

The 1990 study estimated the water supply costs for Palm Beach County agriculture (EAA) through various means, including partial enterprise budgets (see Marginal Costs, below). For purposes of comparison, the report concluded the total costs in 1990 for EAA agriculture to be $32.6 million (including ad valorem; 2011 dollars) and unit costs to be $62,142 per mgd. The total costs in 1990 for non-agricultural users in southeast Florida were estimated to be $519.4 million, and, based on freshwater withdrawals of 674.27 mgd, the unit costs to be $770,314 per mgd (2011 dollars).

More recent crop enterprise budget costs specific to sugarcane indicate total costs of $99.61 per farm acre (2011 dollars), including ditch maintenance, pumping and water control, and all taxes – water management, drainage districts, and special assessments unique to the C-139 basin or the EAA.[168] The 2011-12 Draft Update to the LEC Water Supply Plan estimates that as of 2010, there are 384,100 acres in sugar and 543,684 total acres in agriculture.[169] Taking the sugarcane water costs as a proxy (sugar comprises more than 70 percent of the LEC agricultural acreage), costs for agricultural water throughout the LEC are approximately $54.16 million. At the estimated agricultural usage of 1,938.7 mgd in 2005, the average costs throughout the planning area are estimated at $27,936 per mgd. Specific to Palm Beach County, however (both coastal areas and the EAA), total costs are approximately $41.3 million, but unit costs are $52,114 per mgd.

[166] Assuming no significant change in water withdrawals by each sector between 2005 and 2010, in constant dollars the GRP (based on year 2004) per unit of water consumed declined by more than 47 percent for agriculture but increased by more than 83 percent for non-agricultural uses.
[167] See Appendix N. The rate of change in GRP from 1985 to 2010 is positive, however, agricultural water use declined by 2.1 mgd, or -11 percent, for the same time period, hence, the rate of change is shown as negative.
[168] Roka, Baucum and Alvarez, EDIS Document SC088, University of Florida.
[169] The update appears to discount the full extent of acreage in the EAA, 730,000.

Current costs at the tap for urban residential consumers of the three major counties of the Lower East Coast are estimated to be $1.32 billion.[170] At the rate of use of 892.6 mgd for public supply, the unit costs are $1.48 million per mgd.[171] Based on these estimates, water delivery costs for EAA agriculture may have declined about $10,000 per mgd in constant dollars (a 19 percent decrease), while non-agricultural users may be paying as much as $710,000 more than in 1990, a 92 percent increase.

The Average Marginal Cost for Water in South Florida

The average marginal cost of water is defined as the change in cost per change in unit consumption over time. The 1990 study evaluated the average marginal cost for the period from 1977 through 1985 for Dade, Broward and Palm Beach Counties, for which adequate public supply and sugar production cost data were available. The study tallied the on-site costs for water users, which for agriculture included electricity and fuel for pumps, plus the ad valorem paid to the District, and for the urban sector included the typical price paid at the tap plus the ad valorem to the District. Utility costs were assumed to include all operations, maintenance, and debt service costs associated with public supply. The cost to the agricultural sector would have been underestimated as equipment costs (pumps) and internal canal maintenance were not included, and the urban sector costs did not reflect non-residential use. Given these limitations, the 1990 study concluded that the average marginal costs to agricultural and urban sectors were about $166,100 and $885,900 per mgd, respectively (2011 dollars).

Water-related costs specific to the EAA in Palm Beach County in 1985 were based upon water use of 524.6 mgd. Assuming no change in internal costs to develop and deliver water, at current rates of use (792.5 mgd) this amount should be $47.8 million in 2011. Based on the taxable agricultural land value in Palm Beach and Hendry Counties of about $963.7 million, the EAA ad valorem for water management is estimated to be $0.42 million. The total costs are therefore estimated to be $48.2 million. For EAA agriculture, the net change in costs is about $15.6 million. Based on a net increase in agricultural water use in Palm Beach County of 118.24 mgd, the average marginal costs unique to the EAA are estimated to be less than $132,104 per mgd, a 20.5 percent decrease over time.

For non-agricultural consumers the net change in costs between 1985 and 2010 (in 2011 dollars) is about $800 million. Based upon a net increase in non-agricultural water use of about 673 mgd, the average marginal cost for the urban sectors has been $1.19 million per mgd, an increase of 34.2 percent.

In summary, unit and average marginal costs for EAA agricultural use of water have declined while unit and average marginal costs for non-agricultural users in Dade, Broward

[170] Based on the average of basic residential rates in Miami, Ft. Lauderdale, and West Palm Beach of $42 for 9 ccf per month (including meter fees) and an estimated 2,563 thousand households, plus $29 million in ad valorem for SFWMD operations. However, this component accounts for only about 575 mgd of the USGS estimate of 936 mgd for the Lower East Coast, i.e., the residential costs may be 63 percent greater. Commercial use increases the total costs by another 5.3 percent. Total sector-wide costs are then $2.9 billion.
[171] This calculation reflects all public supply use, including commercial. The unit costs would be less if based solely on residential use.

and Palm Beach Counties have increased since the 1990 study. To the extent that these costs can be compared over time within differing parts of the Lower East Coast, the average marginal cost to the non-agricultural sector in the Lower East Coast is now about nine times that for the EAA, significantly greater than the ratio of 5.3 estimated by the 1990 study for the period 1977 through 1985. While this concept of average marginal cost is best applied in the context of efficiencies and the individual user or purchaser of water, this update has employed the concept of expenditures for water management instead, reflecting the perspective of the public enterprise providing water and its management.

The Full Costs of Water in South Florida

A key finding of the 1990 study was the magnitude of the change in the average marginal costs of water when the various subsidies and externalities associated with water management and use were taken into account. The factors affecting the indicated changes included O&M subsidies, programmatic subsidies, infrastructure subsidies and externalities affecting recreation, commercial and recreational fishing, and tourism. Three incremental scenarios were evaluated:

(a) the O&M subsidy with the externalities affecting use of habitat;
(b) the above (a), with all other federal and state programmatic subsidies; and
(c) the above (b), with the subsidy provided via the CSFFCP.

The 1990 study adjusted each sector's share of the GRP by the percentage that subsidies and externalities represented of the sector's base costs for water supply. In 2011 dollars, the previous study determined that the average marginal costs for agricultural use increased from $0.17 million per mgd to $4.34 million per mgd when these factors were incorporated. Conversely, the average marginal costs for urban water supply increased from $0.89 million per mgd to $1.07 million per mgd. The average marginal cost for agriculture exceeded that for the urban sector with the inclusion of just the O&M (water management district) subsidy and the recreational and tourism externalities, i.e., scenario (a).

This update revises these calculations to reflect the changes in the constitution of subsidies and reports the impact on both the unit costs and the average marginal costs. An additional scenario – subsidies only, not including externalities – is included. With regard to unit costs, the costs for the non-agricultural sector exceed those for agriculture in all cases. They do, however, decline by more than 12.7 percent when all factors are addressed. The base costs in the Lower East Coast for non-agricultural water use are large and therefore accounting for subsidies and externalities has a nominal effect. Conversely, the full costs of water in the agricultural sector increase by more than $514,880 and are more than ten times the base costs. The ratio of non-agricultural to agricultural unit costs changes from 28.4 (base) to less than 2.3, reflecting a significant shift towards equity should subsidies and externalities be addressed.

With regard to average marginal costs, those costs for the non-agricultural sector become less than that for agriculture when all operating and programmatic subsidies are accounted for. The average marginal cost decline for the non-agricultural sector until the subsidies associated with the CSFFCP are incorporated. Average marginal costs for the non-agricultural sector decline by 20.9 percent as full cost accounting is applied. Conversely, the average marginal costs for agriculture increase by a factor of 27.1. The ratio of non-agricultural to agricultural

average marginal costs changes from 9.0 (base) to 0.26, a reversal in the relative average marginal costs over time were subsidies and externalities addressed through policy shifts.

Table 7-2. The Effect of Subsidies and Externalities on the Unit Costs of Water in South Florida ($ per mgd Withdrawn)

	Agricultural	Non-Agricultural
Unit Costs (1990, in 2011 dollars)	*$ 62,142*	*$ 770,314*
Unit Costs (2011)	$ 52,114	$ 1,478,826
Unit Costs Adjusted for O&M Subsidies	$ 96,240	$ 1,439,648
Unit Costs Adjusted for O&M and Programmatic Subsidies	$ 222,814	$ 1,327,269
Unit Costs Adjusted for O&M and Programmatic Subsidies and Externalities	$ 230,852	$ 1,320,132
Unit Costs Adjusted for O&M and Programmatic Subsidies, Externalities, and Infrastructural Subsidies	$ 567,003	$ 1,291,116

Notes: Unit Cost 1990 (in 2011 dollars) is for reference only.

Table 7-3. The Effect of Subsidies and Externalities on the Average Marginal Costs of Water in South Florida ($ per mgd Withdrawn)

	Agricultural	Non-Agricultural
Average Marginal Costs (1990, in 2011 dollars)	*$ 166,143*	*$ 885,982*
Average Marginal Costs (2011)	$ 132,104	$ 1,188,707
AMC Adjusted for O&M Subsidies and Externalities	$ 427,859	$ 1,136,746
AMC Adjusted for O&M and Programmatic Subsidies	$ 1,276,218	$ 987,697
AMC Adjusted for O&M and Programmatic Subsidies and Externalities	$ 1,330,091	$ 978,232
AMC Adjusted for O&M and Programmatic Subsidies, Externalities, and Infrastructural Subsidies	$ 3,583,136	$ 939,747

Notes: AMC (1990, in 2011 dollars) is for reference only and reflects the period from 1977 to 1985. AMC (2011) reflects the period from 1990 through 2011.

The Surplus Value of Water in South Florida

In addition to the average marginal cost for water, the 1990 study reviewed the limited data then available regarding "willingness-to-pay" as a means to measure the marginal and consumer surplus value of water. The consumer surplus is defined to be the difference

between the total utility and the total market value of a product or resource, and the study suggested that the surplus was a proxy for the opportunity cost of water.[172]

Original research at the time suggested the surplus value for publicly supplied water to be between $437 million and $688 million (2011 dollars). The 1990 study calculated that the surplus value of water within the EAA would be approximately $192 million and that the surplus value unique to sugar production was greater than that for other crops, otherwise there would have been significant displacement of sugar. Because the surplus value for public supply was greater than that for agricultural production, if there were a market for water some portion of it could be transferred to the LEC, resulting in regional economic gain, perhaps avoiding the development of more costly alternative supplies. The report noted that while surplus values that accrue to the consumption of goods and services are not counted towards the GRP, surplus resulting from production is tallied as it is part of the generation of wealth. Consequently, agricultural discharges to the Water Conservation Areas can be viewed as components of producer surplus.

B. Implications of the Findings for the Region

The aforementioned findings point to several long-term implications for the region's citizens and institutions in terms of 1) the tax structure and the costs of water management; 2) environmental impact and the range of externalities; and 3) the regional economy. Each of these issues is discussed below in the context of either no change to the existing system of water use and funding, or a shift to a fair share approach to funding water management and internalizing recognized externalities.

1. Ad Valorem and the Costs of Water Management

The existing funding structure for the SFWMD, which relies heavily upon ad valorem tax, guarantees that non-agricultural property owners will continue to pay an increasingly greater share of the costs of water management. Even conversions of agriculturally productive land to rural or very low density residential land use (thereby raising its appraised value while potentially retaining agricultural exemptions and its agricultural identification) would not alter this trend. Current policies to minimize the use of Certificates of Participation (COPs) for capital projects and State general revenues for environmental and water management purposes ensure an increasing dependence on ad valorem. It is expected that with consolidation of authority (and budgeting) through the Department of Environmental Protection and the Governor's Office, the District's millage will not be increased in the near term.[173] Based on the analysis and results from the 1990 study and current research, it is evident that the net subsidy transfer from urban users to agriculture will continue to increase over time. This had been predicted as well by Carter (1974). A taxing mechanism that was reasonably fair when agriculture dominated the landscape and represented a far greater share of both the property

[172] The 1990 study subtracted the costs of water delivery from the various estimates of "willingness-to-pay" so that the value of water for municipal (or agricultural) use could be compared to the value of in-stream use.
[173] If the millage were increased to pay for new capital projects and to satisfy the demand for more intensive operations and related District functions, urban property owners would simply pay more total dollars.

tax base and the gross regional product is no longer equitable in the context of South Florida in the 21st century, its strained water resources, and its transformative capital projects to restore the Everglades.

As one option or scenario, had the Everglades Agricultural Area been subject to a Flood Control District (FCD) tax consistent with fair cost principles, the outlook might have been different. If, under those circumstances, all of the land had not been brought into production, the land owners perhaps would have demanded that the uncultivated land be bought by the state, consolidated through land swaps into a single large tract, and diked off for reflooding and conservation management. As it was, the FCD tax on the uncultivated land was minimal and nothing was done to manage the EAA differently.

Taxing Alternatives

Portions of the EAA are comprised of a number of drainage and water control districts ("298 Districts," referring to the chapter of the Florida Statutes governing them). For those properties served, the overwhelming majority of taxes paid for water management (between 95 and 99 percent) are in support of such districts whose sole purposes are drainage, flood control, and water supply. Thus, only a small fraction of the monies paid for water management by agriculture are in support of SFWMD operations, i.e., the larger system which feeds the local districts.[174]

The special taxing district established in 1989 for the EAA (the Everglades Protection District) charges property owners $5 per acre, and (according to the Protection District's website) has raised roughly $27 million for water quality research and related property improvements. [175] While the ultimate value of this self-imposed tax for environmental protection has been debated, the use of a secondary taxing district within the SFWMD to support efforts to improve water quality has broader applications, as it represents one means to balance some of the inequities identified in this study and to be a vehicle by which agriculture could internalize externalities. [176]

Such a special taxing district could be restructured (or second one created) to achieve water quality performance standards, in addition to the generation of research funds, i.e., the tax could be indexed to changes in the quality to discharges to state waters on an annual or seasonal basis. This approach has been considered in the past by SFWMD but was considered politically unrealistic. Given the willingness of the EAA to tax itself, such an approach to internalizing water quality impacts appears more feasible. A stormwater utility could also serve this purpose. Such utilities may be established in Florida and an estimated 154 local governments have done so as of 2012. Most of these assess property owners according to land use, impervious surface and the expected quantity and quality of runoff. Again, the value

[174] A search of the Palm Beach County Property Appraisers website and tax details indicated that SFWMD ad valorem was typically 7-10 percent of the non-ad valorem taxes paid to the Everglades Protection District and 1-4 percent of the non-ad valorem paid to the respective water control district.

[175] This District is independent, and is not related to the ad valorem assessed by the SFWMD for the Everglades Construction Project.

[176] At the time it was imposed, Florida's conservation community had gone on record stating that it was a stall tactic preventing stronger action from being taken or was a means to purchase expert witnesses for litigation against stricter water quality standards.

of the tool is in reducing externalities, which could be achieved by improving water quality to the point where habitat impacts are ameliorated or to compensate affected parties for loss of use.

The challenge remains to accurately assess the externalities of continued water quality degradation. The annualized impacts to the habitat ($1.36 million) represent a minimum value of the range of externalities values. Based on earlier studies of recreational use of Lake Okeechobee and area freshwater fisheries, the 1990 study suggested that the "willingness-to-pay" may increase this amount by a factor of 3.6.

2. Environmental Impacts and Related Externalities

South of Lake Okeechobee, the largest environmental impact of the seasonal exports of nutrient-rich water has been the conversion of more than 58,000 acres of native sawgrass and open marsh habitat in the Water Conservation Areas to cattails at an estimated (but declining) rate of continued degradation of about 850 additional acres each year. Studies by both the SFWMD and the USFWS point to elevated nutrient concentrations along the perimeters of the Conservation Areas and movement towards the interiors. Degradation within the interiors has been buffered in part to date by the processes of nutrient uptake and sequestering of phosphorus in marl sediments (i.e., areas appurtenant to discharge points are functioning as "mixing zones"). There have been recognized shifts in the periphyton communities of the other Water Conservation Areas (especially near inflow structures) which are correlated with higher levels of nutrients, primarily phosphorus. As these systems become saturated, further degradation may be expected and community shifts may accelerate.

The ecological impacts associated with the timing of water releases was not developed in this study, however, the impacts of the practice of exporting floodwaters from the EAA into the Conservation Areas, and ultimately the Park, has been documented to be a major factor behind a minimum loss of 80 percent of all wading bird populations in the National Park. The cumulative impacts of the loss of wetlands elsewhere in the larger Everglades ecosystem is another key factor, although Ogden (1988) stated that the largest declines coincided exactly with changes in the water delivery schedules. It has been estimated that about 40 percent of the population loss has been attributed to loss of (peripheral) wetland acreage while about 60 percent of the loss has been attributed to water management and water quality. Ogden (1988) referenced Loftus who had estimated that fish and macro-invertebrates populations were 30 percent lower in the areas of the Shark Slough most impacted by declines in the water table coupled with higher peak stages. Maintaining the practice of storing significant of volumes nutrient-rich waters in the Conservation Areas in conjunction with the timing required to maintain stages suitable for the existing crop mix has resulted in the continued decline of these species.

A consequence of these losses appears to be reduced recreational activity (and expenditures), relative to expected use. This conclusion is based primarily upon a leveling of user-events in the WCAs despite the continued, significant increase in regional population. While the STAs have expanded the opportunities specifically for duck-hunting, degradation of historical habitat in the WCAs has diminished opportunity for fishing, and perhaps hunting. In contrast, increased use in wildlife areas outside of the WCAs has reflected population growth.

Until such time as the Everglades Construction Project succeeds in preventing further degradation, expenditures per user in impacted areas may increase (i.e., more hours spent on-site), but total expenditures can be expected to decline in real dollars.

While the Everglades National Park represents the least-affected ecosystem (as far as water quality) with good access, visitation to the Everglades National Park has been relatively flat despite significant increases in regional tourism (following the limited recovery from the 2008-10 recession). However, any significant damage to the park, i.e., loss of several wading bird species, crocodiles, or major reductions in any of the system's unique habitat, will ultimately result in visitor loss as well.

The Effect of Internalizing Externalities

The 1990 study examined the financial feasibility of the CSFFCP in the context of the externalities that were never included in the project justification. Reflecting public expenditures through 1976, Clarke (1978) had determined that environmental damages from agriculture in the EAA worth $312.7 million per year (2011 dollars) would have rendered the CSFFCP economically infeasible (i.e., environmental impacts greater than that amount would yield no net project benefits). However, when Federal assistance was excluded (e.g., Sugar Act payments through the termination of that program), it would have required only $137.6 million per year in environmental impacts to cause the project to become infeasible. These calculations assumed that only 21 percent of the CSFFCP benefits were attributed to sugar production.[177]

Building upon that earlier analysis, the 1990 study used the Corps' determination that 65 percent of the benefits of the CSFFCP could be assigned to agriculture and that sugar (then) represented about 76 percent of agricultural revenues in the EAA to derive the following findings:

1. Without any subsidies, the net benefits of EAA sugar production were $90 million per year (1990 dollars).
2. When subsidies and externalities were included as costs (but without the CSFFCP), the EAA net benefits were about $48.63 million per year.
3. When infrastructure subsidies were included as costs (but without subsidies and externalities), the EAA net benefits were reduced to about $19.6 million per year.
4. When all subsidies, externalities, and infrastructure were included as costs, EAA net benefits were –$21.75 million per year, i.e., the benefits were negative.

This update does not isolate the sugar industry for the purpose of defining the magnitude or impact of specific externalities or programmatic subsidies, so the above estimates of net benefits have not been extrapolated to reflect the sugar's share of EAA revenues in current (2011) dollars. Further, it is unclear how (or whether) other aspects of the CSFFCP were evaluated in the context of a defensibly complete benefit-cost analysis. While the economy and landscape of South Florida were not radically different in 1989-90 than they were in 1978, an

[177] Had all of the benefits of the project been attributed to the sugar industry alone, the net benefits of the EAA would have decreased to about $86.5 million and $10.3 million, with and without Federal assistance, respectively.

assessment of the CSFFCP's system-wide flood control and water supply benefits in 2011 would require data and analysis not contemplated by the scope of this update.

However, the previous study did propose that internalizing a combination of programmatic and capital investment subsidies and externalities would render the CSFFCP economically infeasible from the narrow perspective of one beneficiary: it would not operate without that support, and this conclusion was born out through the discussion presented under "Florida Sugar Production" in Chapter 5. Rather than revisit the issue from the same angle, this update examined the effects of internalizing externalities on the unit and marginal costs of water and determined that for agriculture the impacts would be significant. Further, the update affirmed earlier conclusions that the average marginal costs for withdrawn water are larger for agriculture than for non-agricultural purposes once O&M and other programmatic subsidies are included. Including externalities simply exacerbates this outcome. When comparing the effect of subsidies and externalities on the unit costs for agriculture, the difference is more than $178,000 per mgd. At the current (2005) use of water for agriculture – 1,908 mgd – the result is $341 million per year, i.e., when transformed into the value of water (rather than the value of crop sales) subsidies and externalities are worth $341 million per year across the entire region.

For EAA sugar alone, the change in the value of water is $57.7 million (about six percent of the industry revenue). SFWMD planning data suggests that the average demand for water for EAA sugar is about 892 gallons per day (9E-4 mgd) per acre. The net effect on costs is then $161 per acre, or 25.2 percent of production costs (at $637 per acre) and 59.5 percent of net returns (at $270 per acre). While the increase in costs does not exceed net returns, this change with respect to the sugar enterprise budget may render production infeasible with regards to land, management and risk.[178]

The current proposal for Everglades cleanup will consist of the nearly 60,000 acres of existing STAs, an additional STA of 6,500 acres and a total of about 19,000 acres of flow equalization basins (including a 1,000 acre mine pit), with a final cost of $880 million. Detailed long-term management costs have not yet been developed and vetted. While the annualized costs of this investment have been incorporated in the analysis conducted in Chapter 4, the management of an area more than 40 percent greater than the existing system of STAs represents a new cost independent of the capital costs referenced. Further, the reduction in EAA acreage means that the agricultural sector will contribute fewer ad valorem dollars than it now does, other conditions relating to property taxation remaining the same. Unless alternative financing is explored, non-agricultural property owners can expect an even larger share of these perpetual management costs.

[178] Based on the IMPLAN economic models for the region, a 30 percent increase in agricultural costs (e.g., internalizing externalities or compensating for loss of subsidies) would result in more than a $31 million loss in revenue.

The prime beneficiary of the expansion of scope of the ECP and resulting improvement in water quality is the EAA: growers may be brought into compliance with state water quality regulations and a Federal court order and thereby be permitted to continue to operate. Water quality benefits to the LEC are negligible (i.e., the existing use of STA-1E); the remaining benefits are the maintenance (but unlikely expansion) of recreation, tourism, and minor commercial harvesting of alligators. The value of the cleanup to the urban sector is the prevention of annualized losses, currently estimated to be about $6.4 million. At current Federal water-related project discount rates, a capital project would need to be worth about $102 million to generate such benefits. Even if the second phase of the project were never built, non-agricultural property owners are assured of contributing nearly $600 million, excluding the annual costs of O&M. On the other hand, the EAA has paid a total of about $179 million over the past 16 years (an average of about $12 million per year) to maintain about $1.5 billion in direct sales of produce, including over $967 million per year in direct sales of sugar.[179]

The loss in agricultural production would have ramifications for the regional economy, discussed below. As the project is currently structured, the annual benefit to one-time cost ratio of the Everglades cleanup for urban payers is 1.03; for agriculture it is 18.3. Urban-oriented benefits are about 5.2 percent of all benefits ($40.5 million of a total of $772 million), and these exist only because the prevention of avoidable losses caused by agricultural impacts is labeled a benefit.

Leasing Considerations

At the time of the 1990 study, the law provided that the EAA lease revenues be used to support cleanup of Lake Okeechobee and the Everglades by granting these monies to the SFWMD to administer for those purposes. Currently, the Trustees of the Internal Improvement Fund (Governor and Cabinet) are authorized under subsections 253.01(1)(c) and 253.01(2), F.S., to spend the $4.0 million in annual lease revenues to acquire, manage and conserve State-owned lands, but there is no constraint to expend these monies in South Florida. Were the funds re-directed towards environmental management in the region it could be taken to be further expenditure of state monies on agriculture in general and a subsidy to other area growers in particular.[180] However, the outcome (improved water quality, for example) would offset the externality of habitat degradation associated with the State's own properties.

3. Water Use and the Regional Economy

It remains clear that water is an undervalued resource for all end-uses in Florida. Agricultural currently consumes about 55 percent of all water, generates less than one percent of the GRP, and pays less than 0.7 percent of the regional costs for managing the resource. To the extent that the negative considerations outlined above are not incorporated into the value

[179] Even if extended as a financing vehicle, EAA Agricultural Privilege Tax contributions may be anticipated to decline by about 6.6 percent as 25,500 acres of a total of 389,000 acres now in production in the EAA will be redirected towards the ECP.

[180] Because the lease rates per acre are nearly the same as that paid by growers on private land there is no means to capture any differential associated with the externalities from these lands.

of irrigation water, these numbers overestimate the true value of water for that end-use. The 1990 study recognized that agriculture improved its efficiency of water use between 1977 and 1985 and the industry has continued to do so through 2005, using no more water than it did over a decade ago. However, this may imply that agriculture substituted more labor and capital, part of which was in the form of subsidies, for water. Increasing the efficiency of use within the urban sector has only recently begun in response to drought and regulatory measures.

Agriculture and the Regional Economy

In general, agriculture will continue to diminish in relative economic value within the regional economy: smaller farms in Dade, Broward, and Palm Beach Counties continue to be developed. Florida growth management law no longer ensures that lands specified as agriculture in the counties' comprehensive future land use plans will maintain that designation for any planning horizon. Consequently, it is the role of Florida agriculture in its national context which will govern its scale and longevity in south Florida. Portions of agriculture will remain significant in South Florida for two reasons: 1) it remains the second most important winter vegetable area of the nation, and 2) it continues to supply roughly 20 percent of all sugar consumed in the U.S. Miami-Dade County supplies a diminishing but significant fraction of tropical orchard specialties and other citrus such as lemons and limes. Given the nature of the (localized) externalities associated with it, the question is whether a substantial reduction or elimination of all or any part of agriculture in South Florida will result in significant long-term impacts to the regional economy.

Independent from CERP, agriculture in the District receives more than $247 million in infrastructure and land related subsidies, based primarily on the 65 percent allocation of benefits estimated by the U.S. Army Corps of Engineers. It also receives over $135.3 million in subsidies related to operations and agricultural practices. It should be recognized, however, that the existing infrastructure of water management at this point is a sunk cost. The only opportunities for internalizing the effects of subsidies and externalities lie in the ad valorem tax structure, the location and use of future infrastructure, and the subsidies themselves. Revising operations and schedules, and modifying or using existing infrastructure to re-allocate water may also serve this end.[181]

Based on data from the SCS (now the NRCS) and the industry review conducted by Clarke (1978), between 28 and 50 percent of agricultural output would not exist without water management, i.e., without about $153 million in infrastructural subsidies, agriculture's share of the GRP could be as little as $1.68 billion and as little as $1.1 billion in southeast Florida. The value of the sugar industry (based on market value and including multipliers) could be as little as $271 million.

[181] The 1990 study suggested that (then) existing pumps could move water in western Miami-Dade County towards municipal wellfields (preserving higher-valued uses) instead of towards the Frog Pond, a nearby agricultural region. The Frog Pond has since been incorporated into Everglades restoration efforts and wildlife management, i.e., the externalities of agriculture in Miami-Dade County have been eliminated not by increasing industry costs but by increasing public sector costs.

While sugar and other crops consume less water on an annual basis than do native wetlands, providing adequate volumes during the dry season and protecting them from drought generates conflict of use. Examining the GRP per unit of water withdrawn, non-agricultural uses (including tourism) generate over 84 times more value than does agriculture. Foregoing less than 1.5 percent of the economy (and a declining share of the region's exports) may not be feasible given the nature and timing of crops grown. However, adjusting the total acreage and mix of crops may be possible by internalizing all costs, including environmental and opportunity costs, and then allowing the remaining industry to compete with national and international markets.

If all of the private land estimated to be used for nutrient reduction under the ECP comes from sugar (and some is now in other crops), less than 1.4 percent of the national source for raw sugar would be affected. The implication is that the industry will not be significantly affected nor will the role of U.S.-produced sugar in the context of the world market be threatened.

Opportunity Costs of Water

It cannot be argued that allocating more water to either agricultural or non-agricultural urban uses will result in greater productivity, e.g., that providing twice the current withdrawals will double output. However, inefficiencies in use make additional allocations and expenditures necessary.

Water conservation practices have advanced significantly in the past two decades, in response to increased water costs as well as numerous and substantive shortages in supply. Such measures now address both domestic water use as well other large users of freshwater, including municipalities (parks, medians, etc.) and agriculture. Consequently, when we consider efforts to increase water supplies to support continued population growth, reallocation of existing supplies from lower-valued to higher-valued uses remains an unexplored alternative. High-cost new supplies have little economic justification when lower-value water uses still predominate in the region. The marginal value of water was not analyzed in detail in this update. However, it is apparent that in South Florida non-agricultural uses are higher-value uses and the analysis of the GRP per unit of water withdrawn bears this out. The impact of reduced water supplies to the non-agricultural sector, then, should have a greater impact on the regional economy (i.e., jobs and income) than the agricultural sector.

Alternative public supply sources are costly. Despite improvements in technology and efficiency, reverse osmosis and desalinization methods produce potable water at a delivery cost of at least 2.5 times the average price for municipal water in South Florida. Conservation is cheaper than the expansion of existing or the development of new sources; however, returns on investment in conservation will decline as the share of residential and commercial units that have not been upgraded continues to shrink. Thus, the framework for water supply decisions will become bounded by the costs for alternative supply versus the costs and benefits of re-allocating among existing uses.

The average marginal cost of water is higher for agriculture than for urban uses when subsidies and externalities are included in the costs. In addition, the sum of the surplus value of water to the urban area of South Florida and the local (District-based) programmatic subsidies is greater than the production costs for sugar. Thus, the opportunity costs of allocating water to agriculture are high. It is not economically efficient at the regional level to develop costly public supplies where lower-valued uses, such as agriculture, could address at least a portion of this need with less funding support.

Finally, long-term diversion of water to agriculture in conjunction with lowering of regionwide water tables to make both agriculture and urban development feasible has resulted in additional costs to urban consumers.[182] Excluding global or regional climate issues, such as more frequent droughts, interior agriculture is partly responsible for these costs because of the quantities of water consumed by irrigation and wasted by diversion. Per unit withdrawn, agriculture currently pays less than 4 percent of the cost of delivering water to the residential tap and its average marginal cost is about 11 percent of non-agricultural uses. Thus, while making more water available for urban consumption would not necessarily result in an expansion of the urban GRP, inappropriate scheduling and excessive diversion of water for agriculture has resulted in short-term and long-term costs to non-agricultural water users and taxpayers, and thereby has led to inhibited or constrained alternative productive uses.

C. Conclusions

Pat Tolle, formerly the spokesperson for the Everglades National Park, once said, "Other parks were set aside to protect some geographical feature – a forest or a river canyon. This [the Everglades National Park] was set aside purely to protect a delicate ecosystem whose heart, its lifeline, is the water." This concept is transferable to the larger system, the entire Kissimmee-Okeechobee-Everglades watershed upon which both agriculture and the urban community place demands. ***Patterns of water use which protect the Everglades watershed are those which will ultimately sustain all economic sectors dependent on it, maximizing the economic value of the region.*** Allocations of water within the system that do not fully reflect the economics of use will further erode the resource base on which all interests, especially agriculture, depend. Last, the Everglades has intrinsic ecological importance having been recognized by its designations as an International Biosphere Reserve, World Heritage Site, and Ramsar Wetland of International Importance; its value can be sustained or enhanced only through appropriate management of the water throughout the system of which the Park is part.

<u>Options to Adjust the Allocation and Cost of Water</u>

Until CERP is fully implemented and extensive alternative supplies developed as contemplated in local governments' 10-year water supply work plans, South Florida's water supply is no longer sufficient to meet all near term water demand. Further, regardless of abundance, the region's integrated system of drainage, flood control, supply, and natural systems maintenance and restoration dictates continued reliance on active management. Such

[182] Broward County invested $69 million ($119 million in 2011 dollars) for two wellfields needed to avoid saltwater intrusion, not solely expansion of supply.

management requires sufficient funding. While prior to and after the 1990 study, the District budgets generally expanded annually, this condition has reversed and there is no immediate taxpayer or citizen pressure (or political will) to change the status quo.

Given this new constraint on water management, two questions remain: 1) What is the optimal allocation of water? and 2) What are the optimal distributions of revenues and expenditures for water management to produce this allocation? These questions cannot be answered in the absolute by this update; however, a shift in the relative cost of water to fairly account for both subsidies and the externalities of agricultural use can contribute economic signals that may move the system towards more optimal allocations of water and its management costs. This shift can be addressed through several means. The following list is not exhaustive, but represents an array of potential options or solutions in achieving a water cost balance among agricultural and non-agricultural users:[183]

1. Collect pertinent taxes, surcharges, or fees, or lift established subsidies on agricultural consumers of water in order to reach parity among agricultural and urban water customers. The revenues must be adequate to cover the annual impact of all externalities and would need to be spent entirely on mitigating them;[184]
2. Employing market-validated just value for agricultural assessments, rather than the currently suppressed taxable values;
3. Establish a supplemental user charge proportional to the direct, variable costs of supplying water for all consumers;
4. Categorize and assign the primary beneficiaries of various District administrative functions, including operations, research, legal, etc.;
5. Establish a user charge for all significant externalities where their value can be readily estimated and the source of impacts explicitly identified;
6. Evaluate and remove nonessential crop subsidies or insurance (i.e., direct federal and state expenditures);
7. Define administrative sub-basins and establish different millages to enable the re-apportioning of the local (District) share of costs of all future infrastructure to the agricultural and non-agricultural sectors proportional to the benefits received;
8. Alter the permitted allocations of water (and the capital, operating and maintenance, and administrative costs associated with the allocation). Establishing minimum flows and supplies to the lower east coast which greatly minimize the risk of wellfield loss may result in reduced need for the development of alternative sources. Greater competition within the agricultural sector during dry periods may result in more efficient allocation based on minimum irrigation requirements; and
9. Evaluate the prioritization or reallocation, of water use, e.g., assuring that long-term municipal, conservation area, and national park requirements for supply and timing are fully met before those of agriculture, will result in stable supplies and costs for urban use but increased costs for agriculture. Significant cost increases may result from less reliability in crop production. These increased costs can be offset by increases in

[183] The list of options does not attempt to adjust how past capital projects have been or continue to be paid for.
[184] Because ad valorem taxes are linked to land value and not explicitly to parcel area or its specific contribution to any particular externality, direct and indirect user fees may be preferable to ad valorem taxes or other fees based on property use.

efficiency of water use and other production components or by simply passing on the charges to the consumer.

The authors emphasize that certain measures are far easier to implement than others. Despite the political hurdles involved, modifying or eliminating one or more programmatic subsidies is a feasible proposal with immediate impacts. Conversely, externalities are not easily addressed. For example, were EAA agriculture to employ additional operational measures to remedy externalities, the benefits may be minimal and realized only in the longer term. Compensation to affected parties would be more direct, but accurate quantification and allocation might be both complex and problematic. In sum, the manipulation of subsidies, both direct (such as payments to growers) and indirect (such as the hidden benefits of water management) will generate larger improvements in equity more quickly.

It is important to recognize that any of these measures is likely to cause an increase in the cost of agricultural output, some of which must compete in national and international markets. The implication is that the resultant cost is a more accurate measure of the value of the crop plus the costs of sustaining adjacent ecosystems on which a portion of the non-agricultural economy depends. Also, the above list is not intended to foster the notion that "user fees," i.e., (1) and (3) are the appropriate tools for resolving all socio-economic agenda, especially those involving shared natural resources. In this instance, the tools address a means to minimize externalities, not a means to pay for the delivery of a service.

The existing system of allocation (and funding) makes it more costly to maintain the natural system of the Conservation Areas and the Everglades National Park (i.e., the Everglades Protection Area). Given the evidence that the reduced overall volumes of water and insufficiently long (and historically untimely) hydroperiods in these units have impacted habitat and wildlife populations, efforts to compensate or counter these losses require additional set-aside lands and operational programs to account for water that is used by agriculture. Re-allocating water to enhance the natural system (assuming adequate quality) may prevent further economic losses and generate new gains related to tourism, recreational use, and possibly commercial fishing. In a system designed to maximize total benefits (all users), transfers of water imply changes in economic activity and such transfers occur when total income may be increased.

The ultimate benefits of realigning expenditures for water management and the resultant adjustments to the scale and nature of agriculture in South Florida should include a reduction in impacts to the Everglades ecosystem, increased opportunity for further restoration, and increased security for municipal supplies that are both highly valued and generate more economic value per unit of use.

Benefits also may accrue to vicarious consumers (who derive satisfaction from knowing that special species or environments exist and are therefore willing to pay to protect them), option demanders (who value the option of future enjoyment, either for themselves or future generations), and those who may benefit from expanded recreational and commercial opportunities. These categories include members within all sectors of the regional economy, including agriculture, even although the nature of agriculture may need to be altered to achieve said benefits. When evaluating preservation and restoration benefits, the value of

environments that have identified qualities for research (e.g., the National Park or the Loxahatchee National Wildlife Refuge) must be added to the above three values.

End Uses and the Value of Water

Measured via the Goss Regional Product, the value of water is clearly greater for non-agricultural uses. As supplies become short, or the regionwide costs to provide the resource become great, maximizing the regional economy will require re-allocation of the resource.

Despite perceptions that water supply was adequate for the (then) foreseeable future, the 1990 study suggested that alternative supplies, such as desalinization, reverse osmosis, and the use reclaimed water would be examined more closely as the urban demand for high quality potable water and municipal irrigation water increased in response to population and economic growth. The District's Water Supply Plans and local governments' 10-Year Water Supply Work Plans all identify and include consideration of alternative sources as part of the mix of supply. If the total cost of reallocating water from agriculture is lower than the cost of the above technological solutions, transfer is the appropriate response.[185] This cost of reallocated water must reflect the reversal of externalities of use or it will be overvalued. In the long run, as increases in energy costs drive up the capital and operational costs of desalinization and reverse osmosis, reallocation should be the more economically efficient means of securing urban supplies, maintaining recreation, and scaling the size and impact of agriculture in the region to reflect the real value of the water resources consumed.

It is evident that South Florida's economy depends more strongly on services, tourism, and trade, all of which rely on an attractive and functional environment that requires adequate supplies of water of acceptable quality. These end uses should have priority for reallocations: impacts to "image" associated with tourism and business cycles may require more time to recover than a growing season. However, caution is offered in this regard: shifting water from heavy users, like agriculture and mining, to services may not be efficient for several reasons:

1) all economic sectors are interconnected;
2) non-market values attached to agriculture may be significant to other sectors such as tourism, although agro-tourism appears less significant in South Florida than in the northern and central portion of the state; and
3) where the economic value of water itself is equal across sectors, those sectors using more labor and capital per unit of output will always display higher dollar value per unit of water (thus, the marginal value of labor, capital, and other resources should be evaluated independently from water to determine the critical factor governing efficiency.

Without further analysis of the degree of integration of agriculture into the regional economy and the marginal value of other factors of the production process, valid statements about the highest and best use of water may not be made.

[185] Including lost total economic value of crops and any expense associated with the transferred water.

Water and Its Management as Public Goods

A public good is one in which each individual's consumption leads to no subtraction from any other individual's consumption of that good. Large quantities of relatively pure water, such as the surface waters of Florida's interior and its dependent ecosystems ordinarily would meet that description. However, goods vary in their degree of being public, and they shift between their public and private characters as capacity constraints (1) become effective with sufficient growth in demand, or (2) become relaxed as additional investment in capacity is made to relieve excess demand. These conditions apply where the facilities *are not irreproducible assets.*[186] It can be readily argued that the Everglades (certainly the National Park) is considered an irreproducible asset. The 1990 study and this update have pointed out that condition (1) is in effect, historically during South Florida's dry season and particularly during its droughts. The shift from public towards a private good also is reflected in selected externalities of agricultural water use. These externalities subtract from downstream uses associated with water of high quality and delivered so as to emulate the historical hydroperiod (e.g., recreation and commercial fishing).

Water management itself, as a service provided by a public agency to meet the needs of various end-users, including the environment, can be defined as a public good. However, for the decades prior to the completion of CERP, water management will have contributed to the taking of biotic and abiotic resources, such as Everglades soils and the base of the Everglades food chain, largely in response to drainage and a pattern of ill-timed discharges. Further, the consumption of water management effort (i.e., capital and operations and maintenance expenditures primarily for agricultural benefit) may have resulted in less capital and manpower resources for non-agricultural needs, such as stormwater management. Thus, water management has become more private in nature. CERP and related investment in land and infrastructure will expand both system and SFWMD's ability to manage storage and quality for all end-users, and thereby make the resource of water management more public.[187]

Employing administrative vehicles that compel all users to bear their respective full costs of management (and the costs of use – their externalities) would reverse the pattern of treating South Florida water and its management as private goods and improve the conditions of the commons. Doing so should better optimize allocation, thereby providing water of appropriate quality and hydroperiod for the natural ecosystem and its users as well as for supplies to meet the requirements of the agricultural and non-agricultural economies.

Climate Change and the Future Disposition of Water in South Florida

Climate change and associated sea level rise was a substantive issue even at the time of the 1990 study.[188] Neither that report nor this update were charged to explore the effects of climate change or sea level rise on either the demand for water or their implications for water management and changes in its purposes or costs. However, agencies such as the Corps and

[186] Emphasis provided by Krutilla and Fisher in their 1985 Resources for the Future report.
[187] Public Goods Condition (2), however, is dependent on the resource not being an irreproducible asset. Use of interior wetlands recognized for their unique habitat and species to provide this additional capacity would violate condition (2), and water management would continue to exhibit the character of being a private good.
[188] The FAU-FIU Joint Center prepared a model and simulation study of the issue for the US EPA in 1988.

the SFWMD as well as the South Florida Regional Planning Council and the Southwest Florida Regional Planning Council have instituted policy and planning programs to examine the impacts of sea level rise in particular on infrastructure, land use, coastal resources, and water supply.

Definitive values for the absolute change in sea level at particular points in time have not been established, and various models have generated and range of estimates from fractions of a meter to several meters over a period from 30 to 100 years. Despite the lack of a firm dimension, scenarios explored have included the spatial extent of South Florida inundated at "base" sea level values, the area subject to storm surges associated with tropical events of varying intensity, the value of properties subject to (modified) storm surge and the demand for flood protection, and the integrity of the Biscayne and Chokoloskee Aquifers.

Significant increases in sea level could have dramatic effects on how water is managed and stored, especially where there is a localized or sub-regional need to maintain or increase the freshwater hydraulic head. An economic assessment of water use would need to account changes in where freshwater is directed and the role of existing and proposed water management infrastructure in supporting these movements.

D. Recommendations for Further Study

Preliminary work done by the FAU-FIU Joint Center in 1988 for the US EPA explored the relationship between the region's water budget and its environmental productivity; this update expands the scope of the economic information to be applied to the issue. Research that explores the region's environmental and economic relationships more deeply and links them to water allocation should be the next step in ensuring fair pricing of water management services while respecting the interconnections, both economic and hydrologic, of the two sectors. For example, select subsidies to agriculture such as those through the Cooperative Extension Services and the USDA have yielded reductions in water demand and non-point pollution. Therefore such subsidies have indirect benefits as far as improving water supply (or its reliability) for potential non-agricultural use and reduced contributions (i.e., through ad valorem to resolve regional water quality problems).

However, despite twenty years of evolving regulation (including amendments to the State Constitution) to address the environmental impacts of water use, the agricultural sector has not fully internalized the externalities of its impacts on the environment and the allocation of expenditures to address the issue exacerbates previous inequities. The values of these subsidies and externalities were determined by the scope of available data, much of which is secondary in nature, and refinements to the methodologies developed for the previous study. Original and more complete information about the following subjects would be necessary to produce a more definitive study on the economics of water use in the region:

a) the expenditures by local governments and the private sector for all water-related infrastructure;
b) the effectiveness of ad valorem as a means to fund water management;
c) enterprise budgets for major elements of the agricultural and non-agricultural sectors (to quantify the role that water plays in the variable costs of select operations); and

d) water use itself (including distribution and use of reclaimed water; treated and untreated discharges; price structure for supplies, and the elasticity of use with respect to costs).

A separate but related research challenge would include the following tasks:

e) summarizing the expenditures and exact nature of the impacts of all governmental programs affecting the demand for water by both the agricultural and non-agricultural sectors (including indirect impacts);
f) determining the costs of modifying such programs, and quantification of benefits of such modifications; and
g) assessing the political feasibility and opportunity of carrying out any fundamental changes to programs affecting water demand, management costs, or pricing.

Data regarding water use – net consumption – particularly by agriculture are poor, and therefore details about water use, water withdrawals, and water consumption at the larger scale remains inconclusive. A model that links the region's hydrological budget to its economy, and more specifically, water allocation to the value of urban supply, the enhancement of environmental value, and agricultural output, is needed.

CERP is intended to yield environmental improvements. As these become quantified (e.g., the acreage of stabilized ecological communities, increases in populations of listed species, and documented increases in recreational use, hunting, fishing and tourism), the economic impacts of the investment should be tabulated. These findings will enable a better partition of the costs and benefits expanded water supply for the agricultural and non-agricultural sectors of the economy of South Florida.

Further, subsection 373.036(7), F.S., requires the annual South Florida Environmental Report (SFER) to provide an estimation of "costs" to maintain water quality in the Everglades region in an effort to satisfy the annual reporting mandates required by federal and state regulations and permits.[189] However, the economic analysis of "benefits" determination is a more complicated process. The estimation of economic benefits involves making choices with respect to how water will be used and who will use it. Because people value water for different reasons, there are highly variable monetary values allocated to water. Assigning a monetary value can be very complicated because of scale economies and ecological interaction issues. Therefore, economists employ both direct and indirect valuation methods, either via market or non-market mechanisms, as a way to estimate economic value of water. Economic valuation methodologies include: the user's willingness to pay (WTP) to use, or protect, an ecosystem service, the payment for ecosystem services (PES) programs that compensate landowners for conserving land, and avoided costs to society due to protection activities, among others.[190] One can analyze the value of water through its direct use, as in this study

[189] Chapter 2005-36, Laws of Florida

[190] The EPA (2012) report concludes that, by using cost comparison analysis, watershed protection is less expensive than building new infrastructure for water purification needs. They also suggest that intact wetlands store and capture excess water and are therefore expected to be more resilient to the anticipated effects of climate change. Further, they assert that conservation development preserves open space, while maintaining landscape connectivity and increasing outdoor recreation.
http://www.lcbp.org/PDFs/2012economic_benefits_factsheet2.pdf

(e.g., sector outputs), in socio-ecologic use (e.g., water storage and flood control), and in non-use (sustainability).

Areas of further water resources research in the Everglades region should address optimal size, or scale economies, with regard to water supply and management organizations. Cost models should consider economies of scale and network density, both for public supply (e.g., distribution pipe lengths, etc.), and for agriculture (e.g., service sub-districts). Such models should incorporate water quality considerations – the externalities related to altered hydroperiods and stormwater discharge addressed here are partial. Further research should be cross-disciplinary, including but not limited to expertise in: hydrology, computer simulation and modeling, sociology, ecology, and particularly economics, land use and land policy planning.

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