South Florida embraces desalination and water reuse for the future

Ashie Akpoji, **Mark Elsner**, **Marjorie G Craig**, **Patti Nicholas** and **Barbara Ross**, South Florida Water Management District, USA

The story of peninsular Florida is all about water. Water links the environment, the economy and the very quality of life. The major industries in Florida are tourism, agriculture and electronics. Florida attractions, such as the large theme parks in the Orlando area, bring millions of visitors to the state from across the USA and around the world.

The state is fully dependent on rainfall to replenish surface and groundwater supplies. A statewide drought in the early 1970s was so severe it prompted Florida's landmark Water Resources Act of 1972, which created the state's five regional water management districts.

The South Florida Water Management District (SFWMD) is the oldest and largest of the five districts (Figure 1). The district is officially an "agency of the state" and has authority delegated from the Florida Department of Environmental Protection as well as from the Florida legislature.

The district's mission is to oversee the water resources in the southern half of the state by balancing and improving water quality, flood control, natural systems and water supply within a 16-county region. A key initiative is restoration of the Everglades, a vast wetlands and US national park.

The region's sub-tropical climate is subject to weather extremes – from multi-year rainfall deficits to sudden and prolonged downpours onto very flat terrain. South Florida averages 52 in (132 cm) of rainfall annually, although almost the same amount is lost to high evaporation and transpiration rates.

By operating 2,200 water structures and 61 pumping stations, the SFWMD has the ability to move water through 2,300 miles of canals and levees within 160 major drainage basins that stretch from Orlando to Key West. At the heart of the system is Lake Okeechobee, a 730 sq mile (1,890 km^2) freshwater lake – the largest in the southeastern USA.

Unlike other regions of the country, about 90% of water used in South Florida homes and businesses comes from groundwater sources, with only 10% coming from surface waters.

Why, then, are there water availability concerns in a state with untapped seawater east and west, seemingly abundant rainfall, a huge natural lake and an extensive and productive underground aquifer system? The core of the problem lies in the timing, distribution, and quality of available water.

More than two-thirds of the annual rainfall occurs in just five months, between June and October. With little available water storage, much of this rainfall is lost to tide.

Together with traditional and alternative demand management programs, efforts are under way to build large-scale environmental restoration projects that will capture, store and more effectively utilize water in the future. These initiatives include the construction of massive reservoirs, water preserve areas and stormwater treatment areas.

In addition, regional water resources are intensely impacted by droughts and hurricanes/tropical systems. For example, during the most recent 2007-2008 drought, Lake Okeechobee set a new record low, and groundwater levels fell to within 10% of historic lows.

By contrast, heavy rains and runoff caused by tropical storm Fay in mid-August 2008 saw the lake level rise more than 2 ft (60 cm) in one week, setting another record for the massive lake.

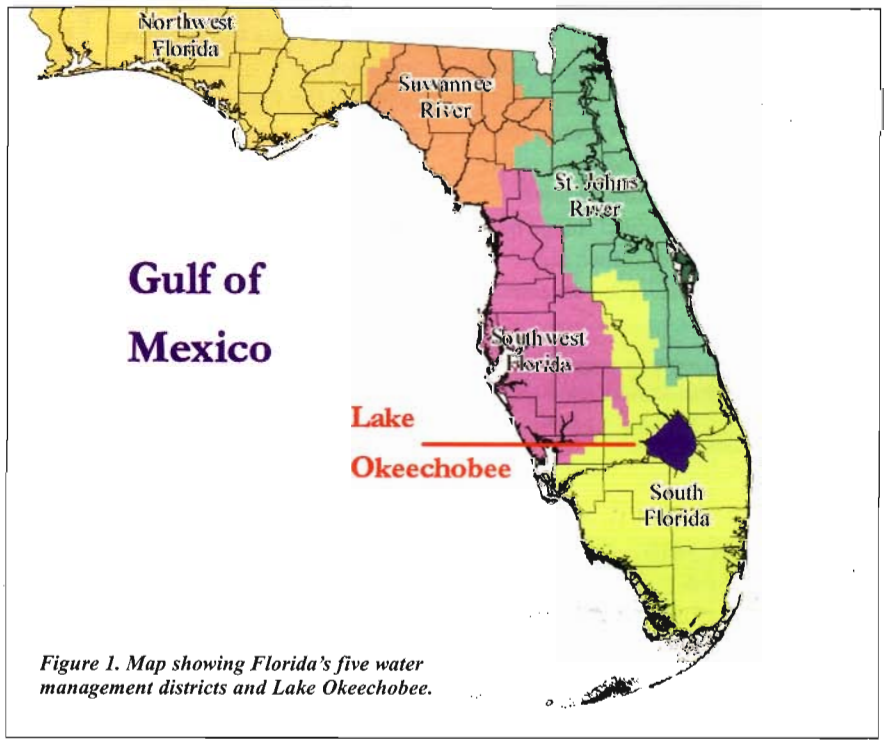

Figure 1. Map showing Florida's five water management districts and Lake Okeechobee.

Projected demands through 2025

Region-specific water supply plans have been developed by the SFWMD to identify water needs and to develop strategies for meeting future water demands. Updated every five years, the water supply plans highlight areas where traditional sources of water will not be adequate to meet future demands. The plans also identify alternative water source options – including desalination, water reuse and conservation to meet projected demands.

Floridians use approximately 6.5 billion gallons (24.6 million m^3) of freshwater every day. With 40% of the state's population and a sizable agriculture industry, South Florida alone consumes 3.4 billion gallons per day (12.9 million m^3/d), more than half the state total.

By 2025, six million new residents are projected to make Florida their home, increasing the state population to more than 24 million people. More than half of the new residents will settle in South Florida – increasing demand to 4.3 billion gallons per day (16.3 million m^3/d) – a 22% increase.

The latest water-supply plan updates concluded that the traditional freshwater sources now being used will be insufficient to meet projected water demands over the next 20 years. However, the water-supply plans further concluded that, with appropriate management and diversification of water supply, there will be sufficient water to meet water needs through 2025, even with a 1-in-10-year drought condition.

What roles do desalination and reuse play?

As the days of cheap and readily available water are behind us, how can water managers and local governments continue quenching the thirst for a renewed environment and an ever-growing population? The most aggressive strategy is to augment supplies through alternative sources, including desalination of brackish and seawater, reclaimed water and reduction of demand through water conservation.

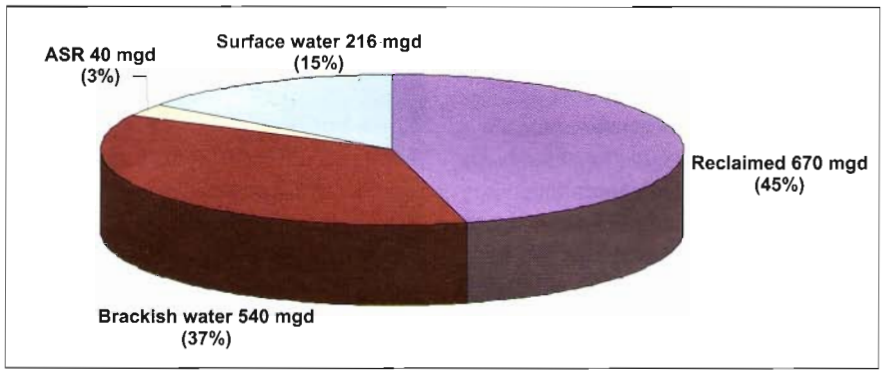

Figure 2. Projected water sources for 2025 in the South Florida Water Management District.

To meet the 900 MGD (3.4 million m^3/d) increase in demand over the next 20 years, the water supply plans identified 314 water supply projects that will produce 1.5 billion gallons per day (5.7 million m^3/d) at a cost of US$ 4.6 billion. Projected sources for South Florida's water in 2025 are shown in Figure 2.

Desalination

Three primary sources of mineralized water are found in the SFWMD: brackish ground water, brackish surface water and seawater. Over the last 10 years, the number and capacity of desalination facilities has doubled.

Currently, there are 31 operating desalination facilities in the SFWMD with a capacity of 206 MGD (780,000 m^3/d), primarily using brackish groundwater. The largest plant is Port St. Lucie-JEA with a capacity of 22.5 MGD (85,000 m^3/d. The current capacity is 20% of the public water supply demand.

By 2012, the number is projected to increase to 37 (Figure 3), including existing plant expansions that will increase the water desalination capacity to about 235 MGD (890,000 m^3/d). Desalination is projected to account for 540 MGD (2.04 million m^3/d) of drinking water by 2025, representing about 37% of the entire public water system capacity.

At present, there are two seawater plants in the Florida Keys producing about 3 MGD (11,300 m^3/d) for peak demand in the SFWMD. Seawater development is expected to contribute about 5% to public water supply by 2025.

There are state and federal regulatory requirement and permits are considered on a site specific basis. A new 25 MGD

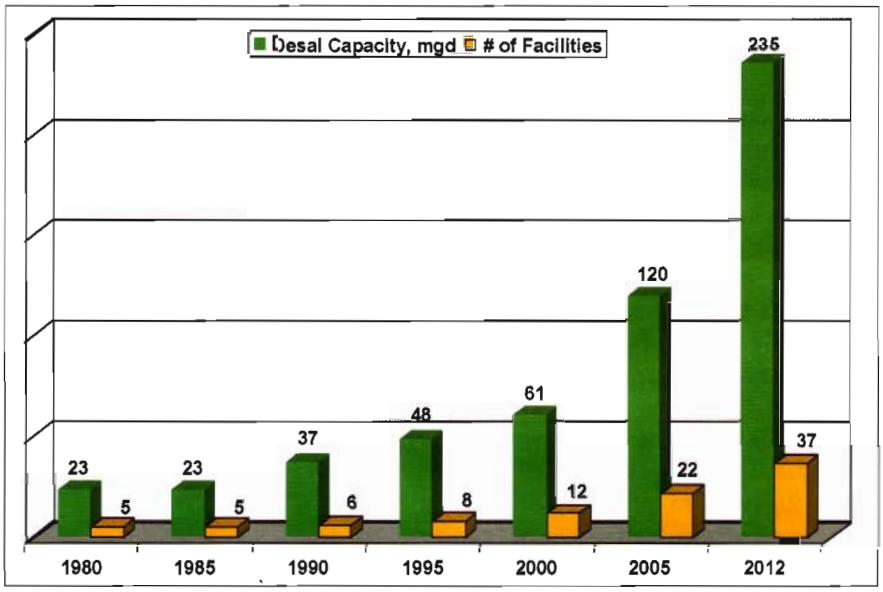

Figure 3. Growth of desalination in the South Florida Water Management District Source: Akpoji et al., 2008

(95,000 m^3/d) seawater RO plant operating in Tampa, Florida, has not reported any environmental concerns from discharging concentrate to the ocean.

The main method of concentrate disposal for the existing RO plants in South Florida is deep well injection. At the current average of 80% recovery, the concentrate generated will exceed 100 MGD (378,000 m^3/d). Increasing recovery efficiencies to 95% will make about 80 MGD (302,000 m^3/d) of new water available, justifying the need for improvements in efficiencies and minimization of waste.

In this regard, the district is currently studying concentrate management technologies appropriate to South Florida. The goal is to improve recovery efficiencies, through membrane design that will also increase energy efficiency and reliability, thus reducing the financial and environmental costs of desalination and water reuse.

Reuse

There are 108 reuse systems reusing over 230 MGD (870,000 m^3/d) of reclaimed water within the district for

- irrigation of residential lots, medians, golf courses and other green space;
- groundwater recharge; and
- environmental enhancement (Figure 4).

Use of reclaimed water is exempt from water-shortage restrictions. The interest in reclaimed water has grown so significantly that many utilities have committed their existing and projected supplies.

Figure 4 shows reclaimed water usage in the district; indeed, some regions have already achieved 100% utilization rates. During the summer of 2007, emergency orders were executed allowing use of reclaimed water to address drought related issues with water supplies.

The water utilities' approach to reuse is changing to implement it strategically in locations to maximize benefits and allow increased withdrawals from the fresh surficial aquifer, including indirect potable reuse.

State actions

To ensure sufficient sources of water and facility capacities are in place to support future land uses, the State of Florida in 2005 undertook significant growth management legislation to strengthen the linkages between land-use and water-supply planning.

To help coordinate land-use decisions with available water supplies, a 10-year water supply facility workplan must be incorporated into a comprehensive plan amendment that addresses intergovernmental coordination, water supply concurrency, assurances that future land uses are based on available water supplies with the identification of alternative water supply projects, conservation and reuse programs to meet future demands.

To support development of alternative water supplies, the legislation also increased funding for local alternative water-supply projects. Over the past three years, the Water Protection & Sustainability Act provided US$ 212 million statewide to develop alternative water supplies, with close to US$ 64 million going to the SFWMD to assist local water users. The SFWMD added US$ 50 million to this cost-share effort to help create even more water capacity.

Over the past 10 years, the SFWMD and the State of Florida have invested close to US$ 170 million to help construct nearly 400 projects, creating about 700 MGD of alternative water supply capacity. Almost half of the funded projects are water-reuse related, and about a quarter of the projects process brackish water sources for potable blending and reverse-osmosis treatment.

During its 2008 session, the Florida legislature passed laws that will result in the elimination of the six ocean outfalls—located along Florida's southeast coast within the SFWMD's boundaries—that are used for effluent disposal. This legislation requires the utilities that currently use ocean outfalls

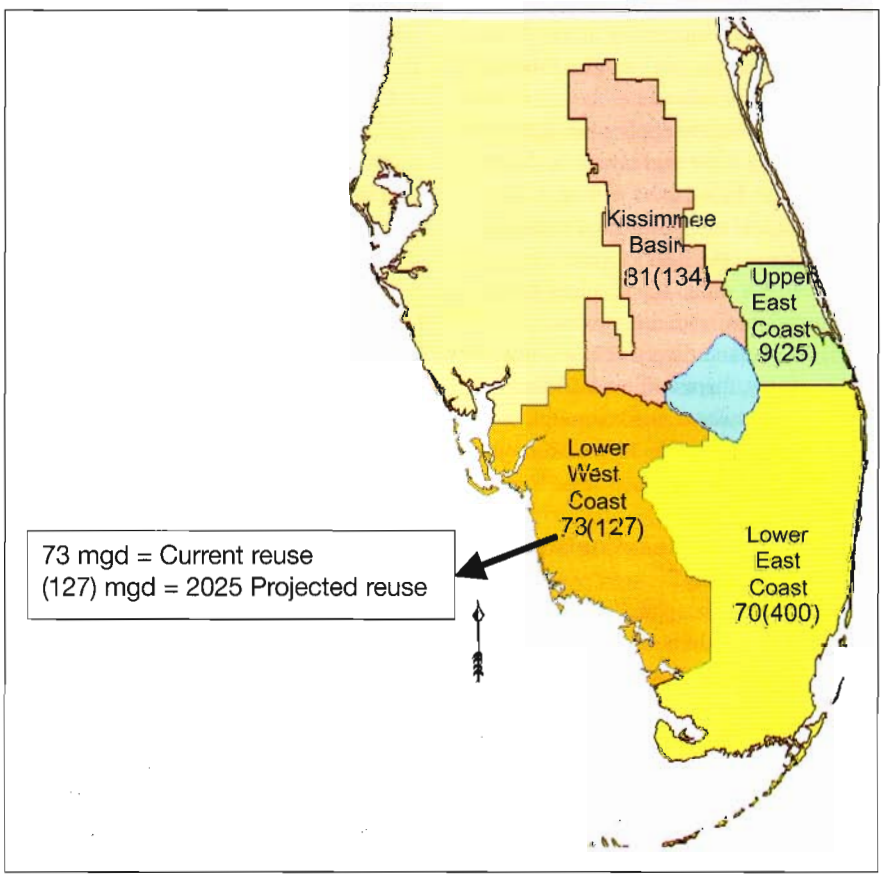

Figure 4. Reuse in 2006 compared with 2025 projected reuse in parenthesis in the District's four planning regions.

Figure 5. A reclaimed water plant producing 10 mgd for wellfield recharge and environmental restoration in South Florida

as a wastewater disposal method to go to advanced wastewater treatment by 2018 and to eliminate the discharges by 2025, unless the method serves as wet-weather disposal to a reuse system. In addition, 60% reuse of the discharge must be implemented by 31 December 2025.

The elimination of ocean outfalls will generate, at a minimum, reuse of 180 MGD (681,000 m^3/d) of the 300 MGD (1.13 million m^3/d) currently discharged to the ocean.

Price comparisons with alternative sources

Historical costs of projects within the district show treatment in increasing order for source waters from traditional sources, the Floridan aquifer, seawater, and reclaimed water. Table 1 shows the cost estimates for different source waters and treatment technologies.

The range of capital and operations and maintenance costs is wide due to site-specific differences that include source-water quality, plant expansions, demand and proximity to supply interconnections from the new water treatment facility.

Conclusion

The hard truth is that the days of limitless and cheap water in South Florida are gone. Planning, investments in alternative water sources, and conservation are required to secure reliability and sustainability of current and future water supplies.

By augmenting supplies through alternative sources – including desalination of brackish and seawater, reclaimed water and reducing demand through year-round water conservation, the SFWMD hopes to continue quenching the thirst for a renewed environment and an ever-growing population.

Realizing that water desalination using RO is energy-intensive, the district also supports studies and projects that use renewable energy to reduce the carbon footprint, operate more efficiently to reduce water use, and manage concentrate to protect the environment. To encourage diversification of water resources, public utilities that use reclaimed water for outdoor irrigation are exempt from water-shortage restrictions.

Reference

Akpoji, A, M E Elsner, and M Craig. 2008. Using Reclaimed Water and Desalination to Reduce the Effects of the 2007/2008 Drought in South Florida. In Proceedings of 23rd Annual WateReuse Symposium, Dallas, Texas, 7-10 September 2008: WateReuse Association.

FDEP (Florida Department of Environmental Protection). 2007. 2006 Florida Department of Environmental Protection Reuse Inventory. Tallahassee, FL.

Table 1. Treatment cost for a 10 million gallon per day facility in South Florida*

Source Water	Treatment	Capital Cost $ million	Annual O&M $ million	Production Cost $/kgal
Surface water	MF/UF	24.4	1.7	1.5-2.5
Surficial Aquifer	Nano	33.6	2.8	2.0-3.0
Floridan Aquifer	RO	48.6	3.2	2.5-3.5
Seawater	RO	64.0	6.2	4.0-5.0
Reclaimed water	Highly Treated	68.0	6.5	5.0-6.0

**Based on the District's 2006 Cost Study +50% to -30% envelope*
MF = Microfiltration; UF = Ultrafiltration; Nano = Nanofiltration