The Emerging Role of Regional Water Management Districts in Hurricane Preparedness, Response, and Recovery

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South Florida Water Management District

The Emergency Management Division of the Department of Community Affairs is the agency responsible for statewide planning and implementation of hurricane preparedness, response, and recovery plans for Florida. This responsibility is laid out in Florida Statutes, Chapter 252. In that law, the Division of Emergency Management is charged with authorizing "the creation of local organizations for emergency management in the political subdivisions of the state, and to authorize cooperation with the Federal Government and the governments of other states" (Ch. 252.32 F.S.). The Statutes also say it is "the policy of the state that all emergency management functions of the state be coordinated to the maximum extent with comparable functions of the Federal Government, including its various departments, agencies of other states and localities, and private agencies of every type, to the end that the most effective preparation and use may be made of the manpower, resources, and facilities of the nation for dealing with any emergency that may occur" (Ch. 252.32 (2) F.S.).

Water management in Florida is administered through Chapter 373 F.S., which established five hydrologically distinct water management districts (Figure 1). These five regional agencies are charged, among other responsibilities, with managing water and related land resources; promoting the conservation, development and proper utilization of surface and groundwater; preventing damage from floods, soil erosion, and excessive drainage; minimizing degradation of water resources caused by the discharge of stormwater; maintaining the navigability of rivers and harbors, and promoting the health, safety, and general welfare of the people of this state (Ch. 373.016 F.S.).

The purpose of this paper is to describe the emerging role of the water management districts in the state emergency planning process. This will be accomplished by describing how one district, the South Florida Water Management District (SFWMD), has changed its traditional role of single-purpose flood control, operating independently of the state emergency planning process. Its current role includes a seat in the State Emergency Management Operations Center, being a member of a statewide task force developing a disaster recovery plan, and being an agency attempting to coordinate hurricane preparedness, response, and recovery within its 16 county area.

Overview of the south florida water management district

Physical description

The South Florida Water Management District is a regional agency responsible for water resources throughout all or part of Florida's 16 southernmost counties. It is one of five such agencies created by state legislation in 1972 and is the largest both in land area and population. The District covers 17,930 square miles ranging from the southern portions of the city of Orlando to both the Gulf and Atlantic coasts including the City of Miami through the Florida Keys (Figure 1). The present resident population in the region approaches 5 million with over 60% residing in Dade and Broward Counties (the Miami consolidated statistical metropolitan area).

The District is in a tropical and subtropical climatic zone. It is characterized by two distinct seasons, wet tropical weather in the summer and a dry temperate climate in the winter. The average rainfall is 54 inches with 36 inches falling from May through September. These concentrated periods of rainfall and level terrain produce a continually swampy, flooded condition that for a long time made South Florida an undesirable region for human settlement (Fernald and Patton, 1984).

The geography of the South Florida Water Management District is dominated by the Kissimmee-Everglades system (Figure 2). The region is characterized as low and flat with extensive wetlands seasonally inundated except where drained by canals. The largest wetlands are the

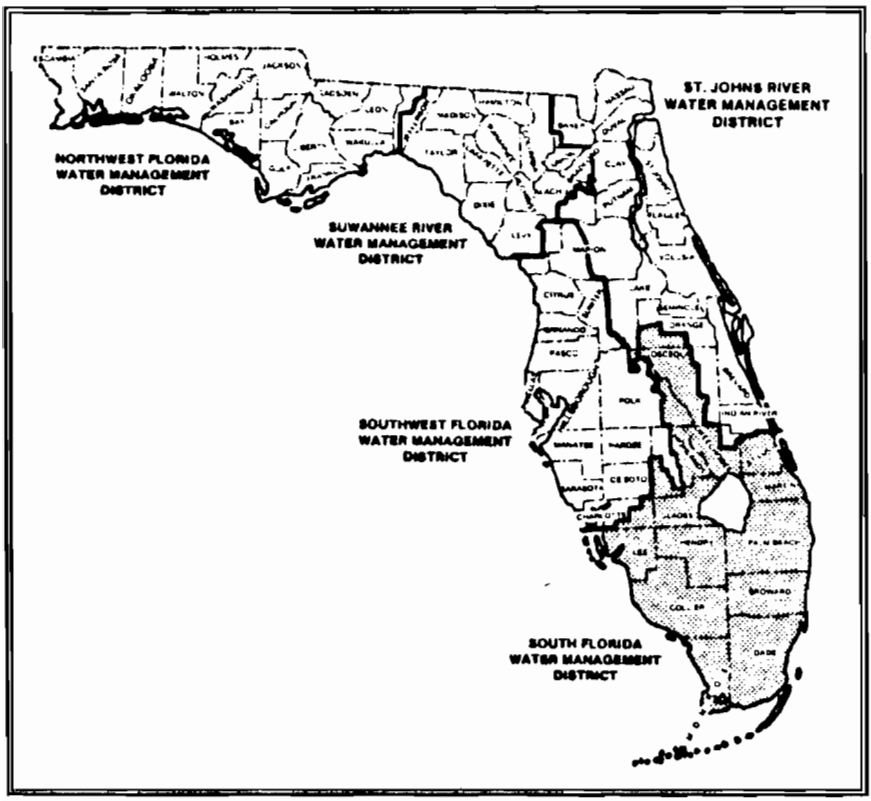

Figure 1
Water Management Districts

Everglades and the Big Cypress Swamp. Most of the surface water flow moves through marshes or through broad sloughs. The southeastern part of the district has a large network of regulated canals used to control water movement during periods of high and low water (Fernald and Patton, 1984). Many natural communities are found in the South Florida region. These range from the more predominant Pine Flatwoods, Saw Palmetto Prairies and Prairie Grasslands in the central part of the District

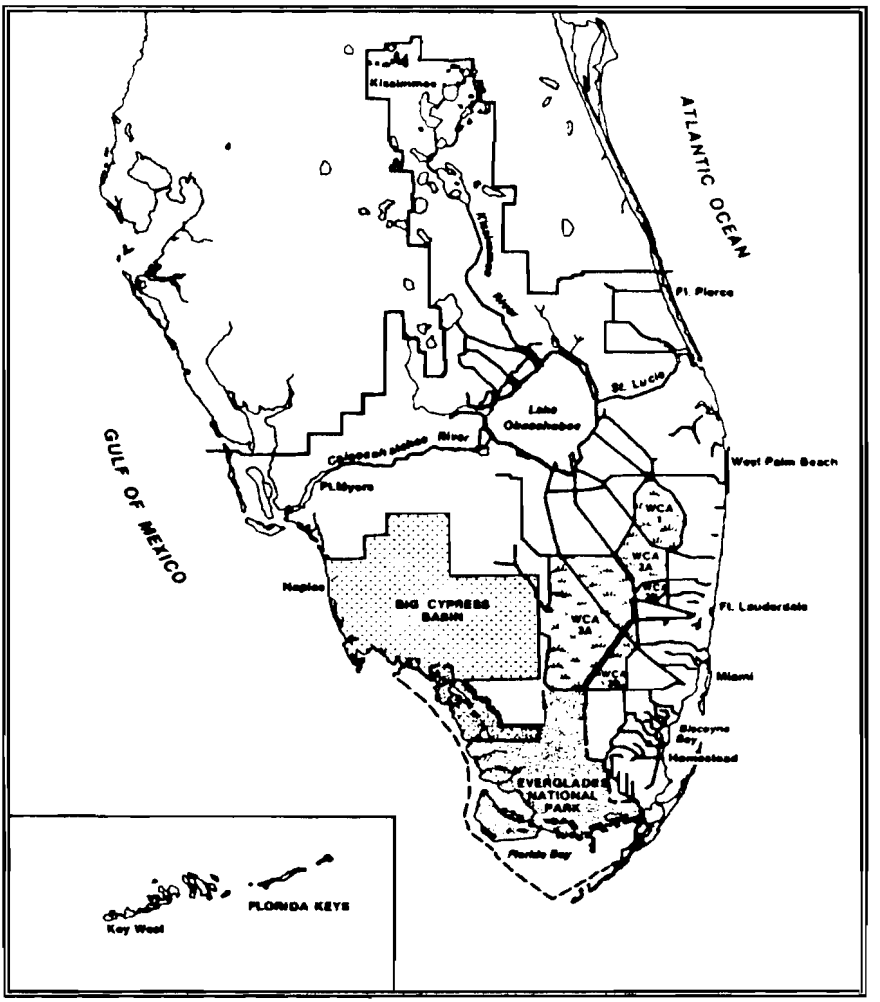

Figure 2
Major Political and Geographic Features
South Florida Water Management District

to the Everglades Marshes, Sloughs and Tree Islands and Prairie Marshes on Marl to Mangrove and Cypress Swamps in the southern portions of the District.

Historical overview

The South Florida Water Management District originally began as the Everglades Drainage District in 1907, legislatively created to design and construct an Everglades drainage project. During 1913-1927, 440 miles of levees and sixteen locks and dams were constructed. Hurricanes in 1926 and 1928 (with fatalities of 372 and 2,300 persons, respectively) were instrumental in the subsequent creation of the Okeechobee Drainage District in 1929. This District improved flood control by constructing major levees, control gates, and floodway channels along the shores of Lake Okeechobee.

In 1948, following a major hurricane in 1947, the Central and Southern Florida Flood Control Project was authorized by the U.S. Congress. The project was to provide flood protection and an adequate water supply; prevent saltwater intrusion; encourage agricultural and urban development; and preserve fish and wildlife. The Central and Southern Florida Flood Control District (CSFFCD) was established in the same year by the Florida legislature to act as local sponsor for the project that would consist of a series of canals, levees, water retention areas, pump stations and water control structures engineered and constructed by the U.S. Army Corps of Engineers. By 1965, 17 years later, the project was only 40% complete and had cost $174 million (SFWMD, 1988).

A serious drought in 1971 was the impetus behind broadening the authority and responsibility of the CSFFCD to include the regulation and control of water supplies with the passage of the Florida Water Resources Act in 1972. This expanded scope subsequently was incorporated into the 1976 designation of the agency in its current title as the South Florida Water Management District. The District now owns and operates a system of over 200 water control structures, 25 pump stations, and over 1,400 miles of primary canals. To move water in this flat region, 25 pump stations (total capacity of 20 trillion gallons/per

day) are used. To operate and maintain this system, the District uses seven field stations and a staff of approximately 500 employees.

The operation and maintenance of this multi-purpose system is one of the foremost goals of the agency. Year round activities attend to the system in preparation for major storm events. These activities include structure and machinery maintenance, aquatic plant control and canal and levee maintenance. The dry season (November through May) is the high maintenance period in which water control gates are sandblasted and painted and hydraulic lifting cylinders are overhauled, internal machinery components are inspected and/or replaced. Repowering of pump stations is also undertaken to ensure the system's reliability (South Florida Water Management District, 1990).

During the summer, the importance of maintaining conveyance capabilities in the canals is of paramount importance since this is also the wet season. This is the season of intense aquatic plant maintenance (mechanical, chemical, and biological) aimed at keeping the canals and lakes unobstructed. Other activities such as erosion control, shoal removal, and mowing operations ensure system readiness in the event of a major storm or hurricane. In these activities, the District uses over $32 million and uses 642 pieces of equipment ranging from trucks to forklifts and draglines to air boats. The southern portion of the system (extending from south of Lake Okeechobee to Homestead) is run by a 250-mile microwave system with 18 stations, 55 remote multi-sensor units and 250 sensors. The system, in the form of a loop, is interconnected by VHF radio and the microwave loop. The telemetry system transmits information on water levels, wind velocities, rainfall, water temperature, and salinity levels at coastal structures. This system also can remotely open or close water gates, precluding the necessity for manual operation. In addition, the District tests its field operation units annually for their readiness in the event of a hurricane through field exercises.

The agency presently employs approximately 1,450 persons. Its 1992 budget stands at $268 million, fueled predominantly by ad valorem taxes. Its field offices are located in Clewiston, Homestead, West Palm Beach, Miami, Okeechobee, Kissimmee, and Fort Lauderdale. The agency also

has smaller offices in Fort Myers, Miami, and Kissimmee as well as a Big Cypress Basin office in Naples.

Recent internal activities

Traditionally, the District primarily had responded to hurricanes through its operational units. Over the past two years, the District has been attempting to strengthen its hurricane procedures both within the agency and between its external contacts at the local, regional, state, and federal levels. At the internal level, an interdepartmental hurricane task force was created to assess the agency's proposed hurricane procedures. Through that process, the other parts of the agency not directly tied to the structural water works were incorporated into a comprehensive procedures manual. As a result of this effort, all District staff now clearly understand their roles in each of the hurricane phases of preparedness, response, and recovery.

At the same time that the overall procedures manual was being created, a hurricane task force was identified and its role delineated. The task force is comprised of each departmental director (or substitute). The new procedures called for this task force to convene when the staff meteorologist determines that a tropical storm or hurricane has the potential of hitting South Florida within five days. At this time, field and pump stations are notified to cease all routine operations and to begin storm response procedures with the headquarter's staff. This task force is expected to "weather" the storm in the District headquarters in West Palm Beach with its communications staff and its 24-hour control room personnel.

Recent local activities

At the local level, the District has assigned staff members to be located in strategic Emergency Operations Centers (EOC's). At present, 10 of the District's 16 counties have such personnel assigned. These "intergovernmental representatives" are assigned the task of becoming familiar with both District operations and the operations/logistics and personnel of their assigned EOC's. To ensure communications between the Agency headquarters, the field stations and the EOC's, District staff has been

issued cellular phones and verification of radio frequencies and phone lines have been clarified between field personnel and the EOC's. Also at the local/regional level, the District is hoping to participate in full-scale hurricane drills with the county governments.

Recent state activities

At the State level, the District has been working the Department of Community Affairs on several topics. During the hurricane season of 1990, the District coordinated with the other four water management Districts and established a District representative in the State Emergency Operations Center. During that same year a District representative participated in a state-wide hurricane drill and another representative participated in the mobilization of the State EOC during Tropical Storm Marco from October 9-12, 1990. The South Florida Water Management District staff is also representing all the water management districts on a State Disaster Recovery Plan Task Force. This task force is assisting the Division of Emergency Management in the development of such a plan. At present three "scenarios" are being pursued as to the logistics and practicality of the plan design. The alternative plan models have been described by Thurber (1991) as: (1) building upon the current system of emergency management already in place (e.g., through use of each county EOC); (2) creating regional recovery centers that would represent areas greater than each specific county's jurisdiction; and, (3) a combination of (1) and (2).

Recent—federal Activities

At the federal level, the District held a training seminar for its engineers on the procedures and forms necessary for disaster assistance from the Federal Emergency Management Agency (FEMA). A representative from the Division of Emergency Management, Florida Department of Community Affairs conducted the seminar. In addition, last year the District began registering its water control structures with the U.S. Army Corps of Engineers for use in a disaster-related rehabilitation program. Although the documentation necessary to register these structures is laborious and time consuming, it is hoped that many of these structures

can be registered in time for the 1991 hurricane season. Registered structures would then be eligible for 80% funding for repairs from the federal government.

Hurricane/rainfall events in south florida (urban-area)

Hurricanes or extreme rainfall events are no strangers to South Florida. Records as far back as September 18, 1926 record the category 4 hurricane that struck Miami and passed over Lake Okeechobee inundating the town of Clewiston. Table 1 depicts a chronology of 'notable' hurricanes that have struck the South Florida Water Management District region since the early 1900s. Table 2 lists the historic incidence of both hurricanes and tropical storms for the District. Table 3 shows the accompanying rainfall for these storm events. It should be noted that extensive rainfall is often not associated with hurricanes or tropical storms. Numerous records of 18-20 inches of rainfall in a 3 day period exist in South Florida independent of a tropical storm or hurricane. A recent example of such extremes was the 12-14.6 inches of rainfall that fell on the Hollywood, North Miami area in October of 1991. This rainfall event was the result of a stalled front, not a hurricane or tropical storm.

Figure 3 graphically portrays the contribution of hurricanes and tropical storms compared with annual precipitation. Figure 4 elaborates on this information by depicting, by year, the hurricane/tropical storm percent contribution to annual rainfall between 1919-1978. The data demonstrate that the rather erratic nature of annual rainfall in South Florida is often independent of the occurrence of a hurricane.

The probability of a hurricane strike in South Florida is the highest nationally (Figure 5 and Table 4). The All-Industry Research Advisory Council (1989) reports that Dade, Broward, and Palm Beach Counties have an annual probability of 10% of being struck by a hurricane. Table 5 shows the historical and probably return period by storm category for Broward and Dade Counties.

Table 1
Floods in South Florida, 1900-1986

Date	Event	Remarks
1926	**September**—Category 4 hurricane moves inland at Miami and passes over Lake Okeechobee. Clewiston is swept by floodwaters from the lake.	• 13-foot storm surge in Biscayne Bay. • 372 persons drown in Clewiston. • Sanibel and Captiva Island inundated. • Damages total $115 million statewide.
1928	**September**—Hurricane moves inland at Palm Beach and passes over Lake Okeechobee. A 12-foot wind-generated tide sweeps Belle Glade.	• 2,300 persons drown in Belle Glade. • Damages total $26 million • Precipitates construction of Herbert Hoover Dike at Lake Okeechobee.
1935	**September**—"Labor Day" Hurricane sweeps the Florida Keys.	• 300 fatalities reported. • 18-foot storm surge and 36-foot breakers are recorded. • Extensive damage to structures/roads.
1945	**August**—Tropical storm causes major flooding in Tampa Bay area. **September**—Hurricane moves inland near Miami.	• 4 fatalities reported. • $54 million in damages. • Evacuation prevents heavy loss of life.
1947	**September and October**—2 hurricanes cross South Florida. **January to December**—Miami receives 102" rainfall (58" is annual norm). Flooding along Kissimmee River.	• 17 fatalities reported. • $59 million in damages. • 5 million acres flooded in South Florida. • Saturated ground creates a "sheet-flow." • 20-40 miles wide. • $9 million in damages. • 600,000 acres flooded.

Table 1
Floods in South Florida, 1900-1986

Date	Event	Remarks
1948	**September**-Hurricane crosses South Florida.	• 6-foot storm tide at Key West. • Islamorada and U.S. 1 flooded. • 11-foot storm tide at Ft. Pierce. • 500 homeless in Stuart. • Damages total $45 million.
1960	**September**-Hurricane Donna (Category 4) crosses the Keys/moves inland at Ft. Myers.	• 13-foot storm surge at Islamorada. • 13 fatalities reported. • Tampa receives 14" rainfall in 2 days. • Damages total $305 million. • U.S. 1 flooded in 6 locations.
1979	**May**—Hurricane David moves up Florida's east coast. **September**—Hurricane Frederic hits Florida's west coast.	• $1 million in damages. • $4 million in damages.
1984	**October**-Gale force winds along the east coast. Heavy rains of up to 7" accompanied the storm over the southern half of Florida. Extensive coastal flooding and beach erosion with numerous structures damaged or destroyed. Fishing piers and seawalls damaged or destroyed. Damage confined to the seashore except where heavy rain in the south caused local flooding.	• 1 fatality reported. • 8 southeastern Florida counties affected.

Table 1
Floods in South Florida, 1900-1986

Date	Event	Remarks
1985	**July**—Tropical Storm Bob moved across South Florida from Fort Myers to just north of Palm Beach. **August**—Hurricane Elena moved up Florida's west coast.	• Rainfall amounts ranged up to 13" at Naples. • Tides 3 to 5 feet above normal isolated Sanibel Island and Marco Island and flooded streets in Naples and Everglades City. • Several beaches suffered erosion from Port Charlotte to Marco Island. • Tides 3 to 5 feet above normal from Sarasota to Pensacola. • A storm surge of 10 feet was reported at Apalachicola. • Rainfalls ranged from 2" at Key West to 11" at Apalachicola. • 6 tornadoes were spawned.
1987	**December**—Monroe County-Key West Heavy Rain. **October**—Hurricane Floyd—South Florida and the Keys.	• Heavy rain, 6.6", caused flooding of streets with up to 2 feet of water on the roadways. • Most of the rain fell between 5 am and 7 am EST. • Rainfall of 2-4" was reported across Southern Florida with a band of 5-9" from Naples to Lake Okeechobee to Fort Pierce.

Source: Hazards Analysis (draft) Division of Emergency Management, Department of Community Affairs. Tallahassee, FL October 1990.

Potential Hurricane Damage

Potential damage in South Florida resulting from hurricanes has risen sharply. One study (All-Industry Research Advisory Council, 1989) has cited coastal property exposure increases of 70% between 1980 and 1988 for coastal Florida. The three South Florida counties of Dade, Broward and Palm Beach account for 45% of Florida's total property exposure. Broward County's insured coastal property exposure increased from $50 billion to $84 billion between 1980-1988 while Dade County's exposures

Table 2
Hurricanes and Tropical Storms
In the South Florida Water Management District

Hurricanes		Tropical Storms	
1919	Sept 9-10	1925	Nov 30-Dec 1
1920	Sept 25, 29-30	1926	Sept 15-17**
1921	Oct 24-25	1928	Aug 12-14
1924	Oct 19-21	1930	Sept 8-10
1926	July 26-28	1932	Aug 29-31
1926	Oct 20-21	1934	May 26-28
1928	Aug 7-9	1934	July 22-23
1928	Sept 16-17	1936	June 13-15
1929	Sept 27-29	1936	Aug 21-22
1933	July 29-Aug 1	1937	July 28-30
1933	Sept 1	1937	Aug 29-31
1933	Sept 4-6	1938	Oct 13-17**
1933	Oct 3-5	1940	Aug 2-3
1935	Sept 2-5	1941	Sept 15-17
1935	Sept 28-29	1941	Oct 17-21
1935	Nov 4-5	1945	Sept 3-5
1936	July 29-30	1946	Nov 1-2
1939	Aug 11-13	1947	Aug 19-20
1941	Oct 6	1947	Sept 22-23
1944	Oct 16-19	1947	Oct 5-6
1945	June 21-24	1951	Oct 1-3
1945	Sept 14-16	1952	Feb 2-3
1946	Oct 7-8	1953	Aug 27-31
1947	Sept 17-18	1953	Oct 3-5
1947	Oct 11-12	1953	Oct 7-10
1948	Sept 21-23	1959	June 16-20
1948	Oct 4-5	1960	Sept 21-25
1949	Aug 26-28	1962	Aug 24-26
1950	Sept 3-6	1964	June 5-6
1950	Oct 15-18	1967	Sept 7-8

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Hurricanes and Tropical Storms
in the South Florida Water Management District

Hurricanes		Tropical Storms	
1951	May 17	1968	June 2-6
1959	Oct 16-19	1968	June 17-20
1960	Sept 9-11	1968	Aug 9-10
1964	Aug 26-28	1969	Sept 6-7
1964	Sept 9-11	1969	Oct 1-4
1964	Sept 27-28*	1970	Sept 13-15
1964	Oct 5-6*	1970	Sept 26-27
1964	Oct 14-15	1971	Aug 10-12
1965	Sept 7-9	1972	Sept 4-6
1966	June 8-9	1974	June 24-28
1966	Oct 2-5	1974	Oct 6-7
1968	Oct 16-19	1975	June 26-27
		1976	Aug 17-19

*Hurricane "Hilda" passing and returning.
**Two storms overlapped.

Source: Brandes, 1981.

Table 3
Tropical Cyclone Rainfall—All South Florida Stations
(in inches)

Dates	Annual Total Rain	Hurricane Rain Total	Tropical Storm Rain Total	Hurricane + Tropical Storm		
				Total	% Annual	% Seasonal
1919	55.02	0.92	0.00	0.92	1.7	3.2
1920	54.49	1.67	0.00	1.67	3.1	5.1
1921	47.13	2.86	0.00	2.86	6.1	9.6
1922	58.81	0.00	0.00	0.00	0.0	0.0
1923	49.41	0.00	0.00	0.00	0.0	0.0
1924	63.64	6.24	0.00	6.24	9.8	14.3

Table 3
Tropical Cyclone Rainfall—All South Florida Stations
(in inches)

Dates	Annual Total Rain	Hurricane Rain Total	Tropical Storm Rain Total	Hurricane + Tropical Storm		
				Total	% Annual	% Seasonal
1925	58.36	0.00	3.56	3.56	6.1	12.6
1926	61.90	3.29	6.53	9.82	15.9	24.0
1927	39.64	0.00	0.00	0.00	0.0	0.0
1928	57.78	8.18	3.16	11.34	19.6	25.9
1929	59.59	4.33	0.00	4.33	7.3	10.0
1930	66.84	0.00	2.61	2.61	3.9	6.9
1931	48.04	0.00	0.00	0.00	0.0	0.0
1932	53.16	0.00	3.72	3.72	7.0	11.1
1933	59.72	12.34	0.00	12.34	20.7	29.9
1934	54.81	0.00	2.74	2.74	5.0	8.5
1935	51 .57	6.53	0.00	6.53	12.7	17.6
1936	63.27	1.07	6.76	7.83	12.4	20.5
1937	56.53	0.00	2.68	2.68	4.7	7.6
1938	40.82	0.00	3.02	3.02	7.4	10.3
1939	54.14	1.75	0.00	1.75	3.2	4.4
1940	58.01	0.00	1.34	1.34	2.3	3.7
1941	60.24	0.53	4.12	4.65	7.7	13.4
1942	52.32	0.00	0.00	0 00	0.0	0.0
1943	49.06	0.00	0.00	0.00	0.0	0.0
1944	45.73	5.35	0.00	5.35	11.7	16.1
1945	53.65	11.00	2.56	13.56	25.3	31.7
1946	51.13	1.48	1.57	3.06	6.0	9.1
1947	78.10	8.23	4.58	12.81	16.4	24.3
1948	58.46	10.03	0.00	10.03	17.2	24.7
1949	53.81	4.53	0.00	4.53	8.4	11.0
1950	45.88	9.56	0.00	9.56	20.8	28.3
1951	50.09	0.19	4.72	4.91	9.8	14.0

Table 3
Tropical Cyclone Rainfall—All South Florida Stations
(in inches)

Dates	Annual Total Rain	Hurricane Rain Total	Tropical Storm Rain Total	Hurricane + Tropical Storm		
				Total	% Annual	% Seasonal
1952	52.82	0.00	1.57	1.57	3.0	4.4
1953	65.52	0.00	8.81	8.81	13.4	19.1
1954	57.22	0.00	0.00	0.00	0.0	0.0
1955	42.99	0.00	0.00	0.00	0.0	0.0
1956	42.68	0.00	0.00	0.00	0.0	0.0
1957	62.76	0.00	0.00	0.00	0.0	0.0
1958	60.28	0.00	0.00	0.00	0.0	0.0
1959	73.45	3.44	7.86	11.30	15.4	23.5
1960	65.60	5.14	4.20	9.34	14.2	20.3
1961	39.44	0.00	0.00	0.00	0.0	0.0
1962	51.66	0.00	0.92	0.92	1.8	2.4
1963	52.23	0.00	0.00	0.00	0.0	0.0
1964	50.12	5.03	1.96	6.99	13.9	21.8
1965	50.04	1.77	0.00	1.77	3.5	4.7
1966	60.49	4.65	0.00	4.65	7.7	11.7
1967	46.61	0.00	0.36	0.36	0.8	1.0
1968	61.03	3.10	9.26	12.35	20.2	27.9
1969	65.18	0.00	2.92	2.92	4.5	6.8
1970	50.37	0.00	1.60	1.60	3.2	5.7
1971	46.21	0.00	0.96	0.96	2.1	2.8
1972	52.18	0.00	0.33	0.33	0.6	1.1
1973	52.22	0.00	0.00	0.00	0.0	0.0
1974	49.62	0.00	6.94	6.34	14.0	18.4
1975	45.37	0.00	0.53	0.53	1.2	1.6
1976	47.25	0.00	2.34	2.34	5.0	8.2
1977	48.48	0.00	0.00	0.00	0.0	0.0
1978	52.55	0.00	0.00	0.00	0.0	0.0

Source: Brandes, 1981.

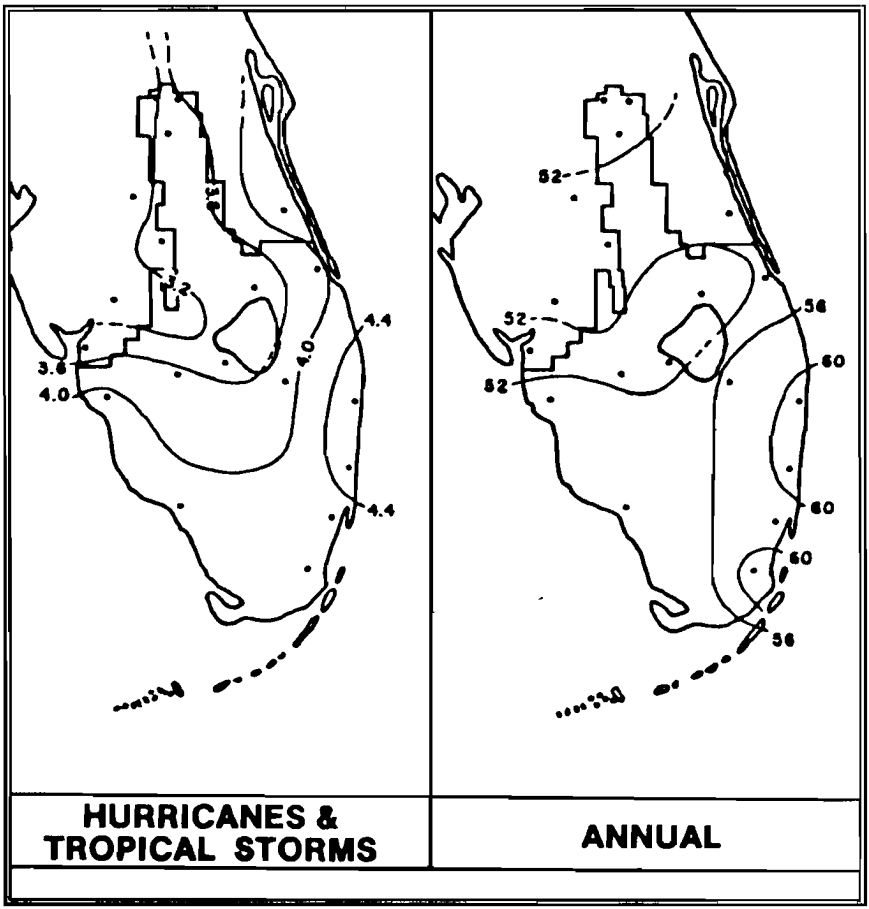

Figure 3
Mean Rainfall in Inches, 1919-1978
SFWMD

Source: Brandes, 1981.

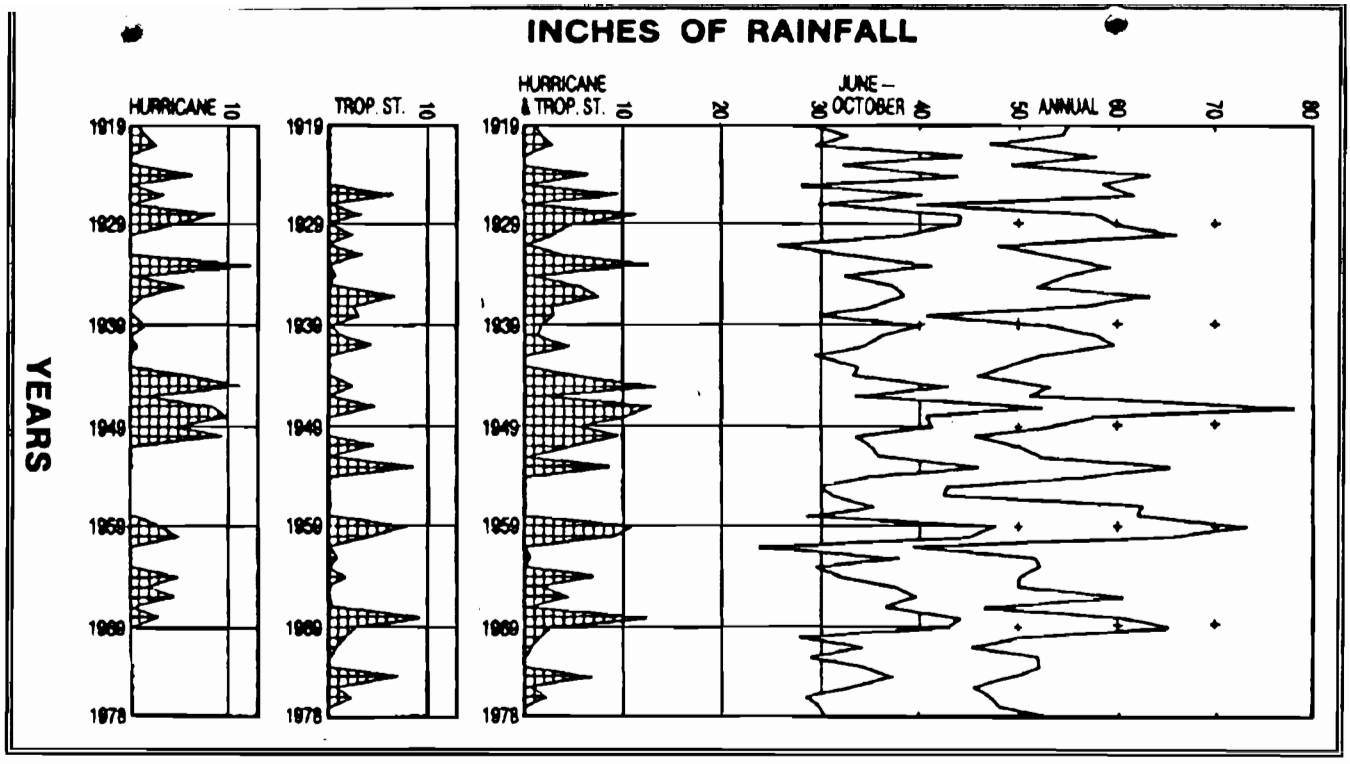

Figure 4
Inches of Rainfall
Source: Brandes, 1981.

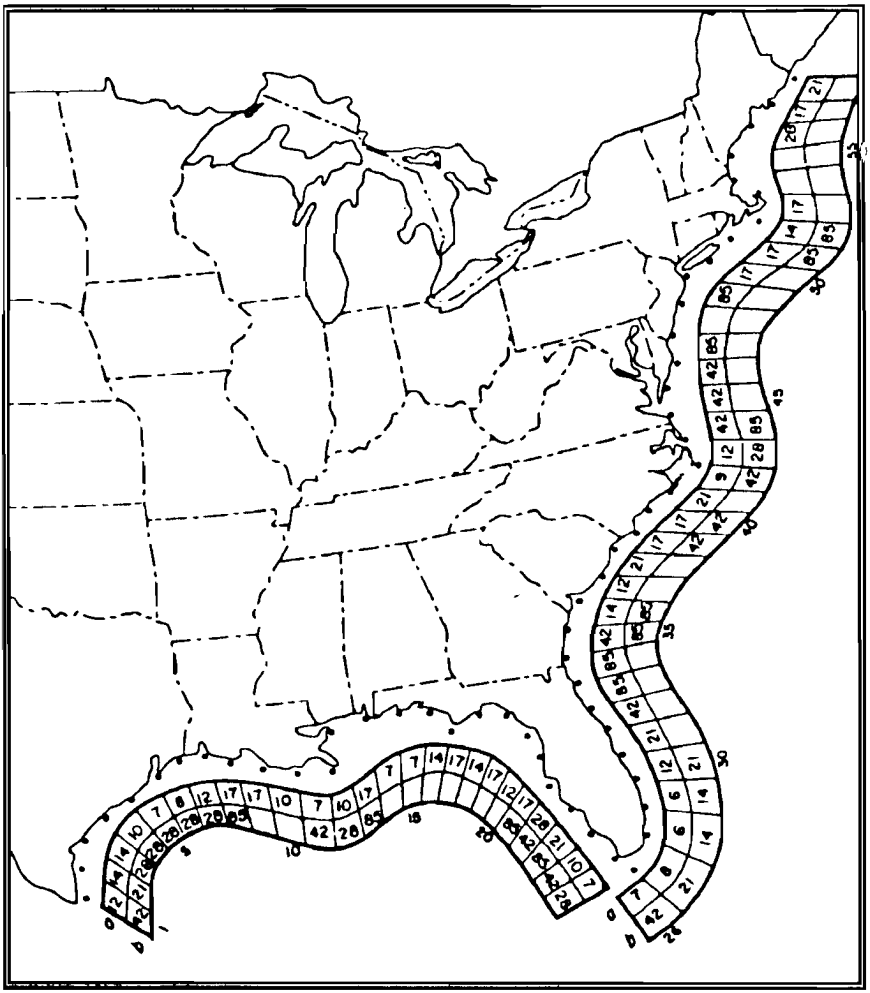

Figure 5
Probability of a Hurricane Strike
Source: Simpson and Riehl, 1981

Table 4
Number of Hurricanes (Direct Hits) Affecting US and Individual States According to Saffir/Simpson Hurricane Scale

Area	Category Number					All	Major Hurricanes (3+)
	1	2	3	4	5		
Texas	9	9	8	6	0	32	14
Louisiana	5	5	7	3	1	21	11
Mississippi	1	1	4	0	1	7	5
Alabama	4	1	4	0	0	9	4
Florida	16	14	15	5	1	51	21
(Northwest)	9	6	5	0	0	20	5
(Northeast)	1	7	0	0	0	8	0
(Southwest)	5	3	5	2	1	16	8
(Southeast)	4	10	7	3	0	24	10
Georgia	1	4	0	0	0	5	0
S. Carolina	6	4	2	*1	0	13	3
N. Carolina	10	3	7	*1	0	21	8
Virginia	1	1	*1	0	0	3	1
Maryland	O	*1	0	0	0	1	0
New Jersey	*1	O	O	O	0	1	0
New York	3	0	*4	0	0	7	4
Connecticut	2	*1	*3	0	0	6	3
Rhode Island	O	*1	*3	0	0	4	3
Massachusetts	2	*1	*2	0	0	5	2
New Hampshire	*1	O	O	O	0	1	0
Maine	4	0	0	0	0	4	0
U.S. (Texas to Maine)	49	33	41	13	2	138	56

* Indicates that all hurricanes in this category were moving in excess of 30 miles per hour.
Source: Neumann et al., 1981.

Table 5
Hurricane Frequencies

Area	Category Number					All	Major Hurricanes (3+)
	1	2	3	4	5		
Number of Hurricanes by Storm Category							
Broward	14	12	11	8	1	46	20
Dade	14	9	14	9	1	47	24
Probable Return Period by Storm Category (in years)							
Broward	7.1	8.3	9.1	12.5	100	2.2	5.0
Dade	7.1	11.1	7.1	11.1	100	2.1	3.7

Source: South Florida Regional Planning Council, 1987.

increased from $73 billion to $112 billion over the same time period. "Insured exposure" is defined as "the sum total of liabilities insurers have at risk or the value of the insurance coverage provided on structures and their contents" (All-Industry Research Advisory Council, 1989). When looking at potential storm damages, a worst case scenario of a Hurricane Hugo hitting the Miami area at high tide results in estimates of $9 billion (All-Industry Research Advisory Council, 1989). The South Florida Regional Planning Council (1987) reports a similar figure for Dade County in a category 5 storm. Dade County's 1990 population was 1,937,094 and is expected to reach 2,280,200 by the year 2010 (Smith and Bayya, 1989). Broward County estimates for economic losses from a category 1 to 5 range from $200 million to $8 billion (South Florida Regional Planning Council, 1987). Population changes between 1990-2010 for that county are estimated to be from 1,280,875 to 1,666,632, respectively (Smith and Bayya, 1989).

Conclusions and recommendations

From the aftermath of Hurricane Hugo which struck in the fall of 1989, it was apparent that few states, if any, were prepared fully to deal with the entire extent and ramifications of such a storm. Florida was no exception. The State Emergency Planning Agency (DCA) is still in the process of developing its statewide disaster recovery plan. During this period however, the Florida water management districts have taken the initiative in promoting the state's recognition of their vital role in hazard mitigation, preparedness, response and recovery. In 1990, the water managements were added to the State Emergency Operations Center as active participants in the mobilization of that center. This progress has been made despite the fact that water management districts are not mentioned in county emergency plans as pertinent players in the emergency management field. In fact, water management district canals or flood control structures are absent from the lists of primary county structures such as roads and bridges listed in most county plans. There is still much to be accomplished before water management districts are integrated fully into local, regional and statewide disaster planning.

Because the water management districts are by definition regional agencies, they have been functioning in a multi-county context since their inception. This "regional" perspective has been championed by the South Florida Water Management District through its use of field stations which operate and maintain the CSFFCD project works in functional regions not bounded by political boundaries. Because many water management issues cross political boundaries, the District has also assigned "local governmental representatives" to each county to help coordinate District activities with the affected county(s). This framework, which also includes coordination with the County EOC's, assists in planning for and implementing regional solutions. Training sessions, workshops and intensive coordination is needed to educate all sides as to the prescriptive actions of all affected entities. Coordinated drills between counties and District staff also is needed greatly.

As with most natural disasters, hurricanes or tropical storms tend to across municipal, county, state, and national boundaries. Managing

natural resources from a regional standpoint has its merits in light of economies of scale and relative homogeneity of terrain and climate. This approach, which fostered the 5 hydrologically-delineated water management districts has been successful in facilitating a system-based approach to planning rather than one that is politically segmented. The recent attempts by the Florida Division of Emergency Management to draft a statewide recovery plan from a regional perspective deserves merits and should be pursued further. The concepts of regional recovery centers and regional staging areas coordinated through the State Emergency Operations center is both needed and preferred (Thurber, 1991). Such a regional perspective can take advantage of greater area-wide planning, and can harness additional regional agencies, such as the water management districts to help solve regional problems. This regional perspective is needed so that all involved agencies can be identified, coordinated, and provided opportunities to reach solutions which maximize the health, safety, and welfare of all citizens of Florida. The South Florida Water Management District needs assistance from all levels of government to improve its readiness ability. Likewise it extends its expertise and abilities toward its communities, counties, and coordinators in working toward these goals.

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