Water and Climate Resilience Metrics Initiative at the SFWMD

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Water and Climate Resilience Metrics

Goals

- Track and document trends and shifts in water and climate data monitored by the District.
- Support long-term term planning by incorporating trends into future scenario formulation.
- Advances the District's resiliency goals by informing infrastructure investments and operational decisions of ensuring flood protection, water supply, and ecosystem restoration mission elements under current and future climate conditions.

Phase I

Initiated in 2020, focused on implementing an initial set of priority metrics and automating the trend analyses of metrics data stored DBHYDRO.

Phase II

Initiated in 2025, focuses on refining and expanding the assessment of changing water and climate conditions.

Water and Climate Resilience Metrics

Climate Metrics
Indicators that reflect the primary drivers of observed changes in climate conditions and influence the hydrological cycle.

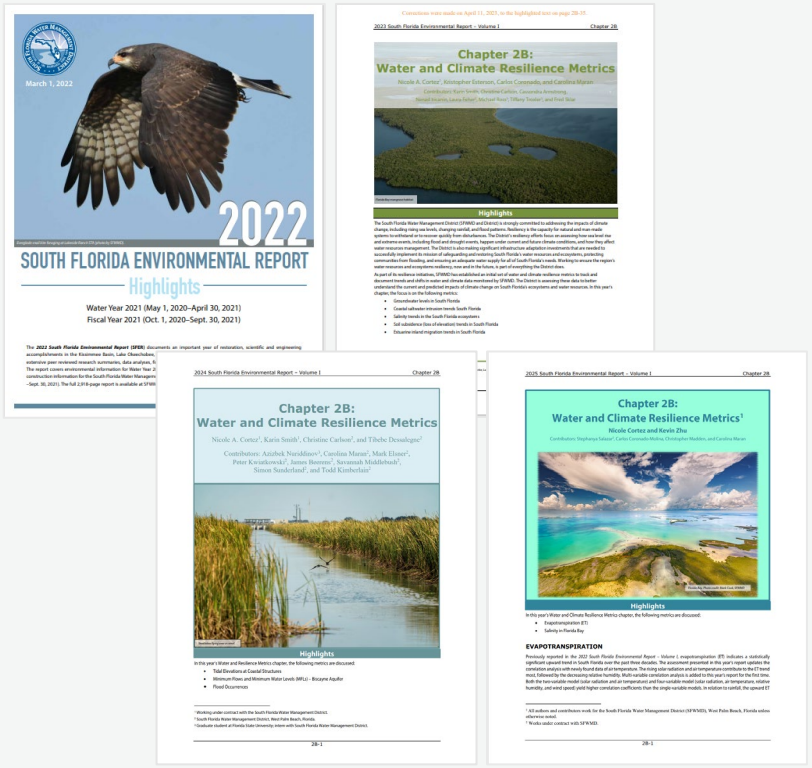
Resilience Metrics
Indicators that represent the observed effects of changing climate conditions. These may be managed or mitigated through water management operations and/or by implementing adaptation strategies.

Phase	METRIC	CATEGORY	TREND ANALYSIS	AUTOMATION
I	Rainfall	Climate	✓[1]	✗
I	Evapotranspiration (ET)	Climate	✓	✓
I	Tidal Elevations at Coastal Structures	Climate	✓	✓
I	High Tide Events (Limited Flood Control Capacity Events)	Climate	✓[2]	✗
I	Groundwater Levels/Elevations/Stages	Resilience	✓	✓
I	Saltwater Intrusion/ Saltwater Interface – Chloride Levels	Resilience	✓[1]	✓
I	Minimum Flows and Minimum Water Levels (MFLs) – Exceedances/ Violations	Resilience	✓	✓
I	Flooding Events	Resilience	✓	✗
I	Water Temperature	Resilience	✓	✓
I	Dissolved Oxygen (DO)	Resilience	✓	✓
I	pH	Resilience	✓	✓
I	Specific Conductance	Resilience	✓	✓
I	Estuarine Inland Migration – Everglades	Resilience	✓	✗
I	Soil Subsidence	Resilience	✓	✗
I	Salinity in the Everglades and Biscayne Bay	Resilience	✓	✗
II	Drought	Climate	✓[2]	✗
II	Freshwater Lens	Resilience	¤	¤
II	Stormwater Volume and Flow	Resilience	¤	¤
II	Algal Blooms	Resilience	¤	¤
II	Atlantic Multidecadal Variability (AMV)	Climate	¤	¤

✓ Trend analysis and/or tool automation were completed for the metric.
✗ Trend analysis and/or automation were not completed for the metric.
¤ Trend analysis and/or automation are pending development for the metric.
[1]Updated analysis pending publication March 1, 2026.
[2]First analysis pending publication March 1, 2026.

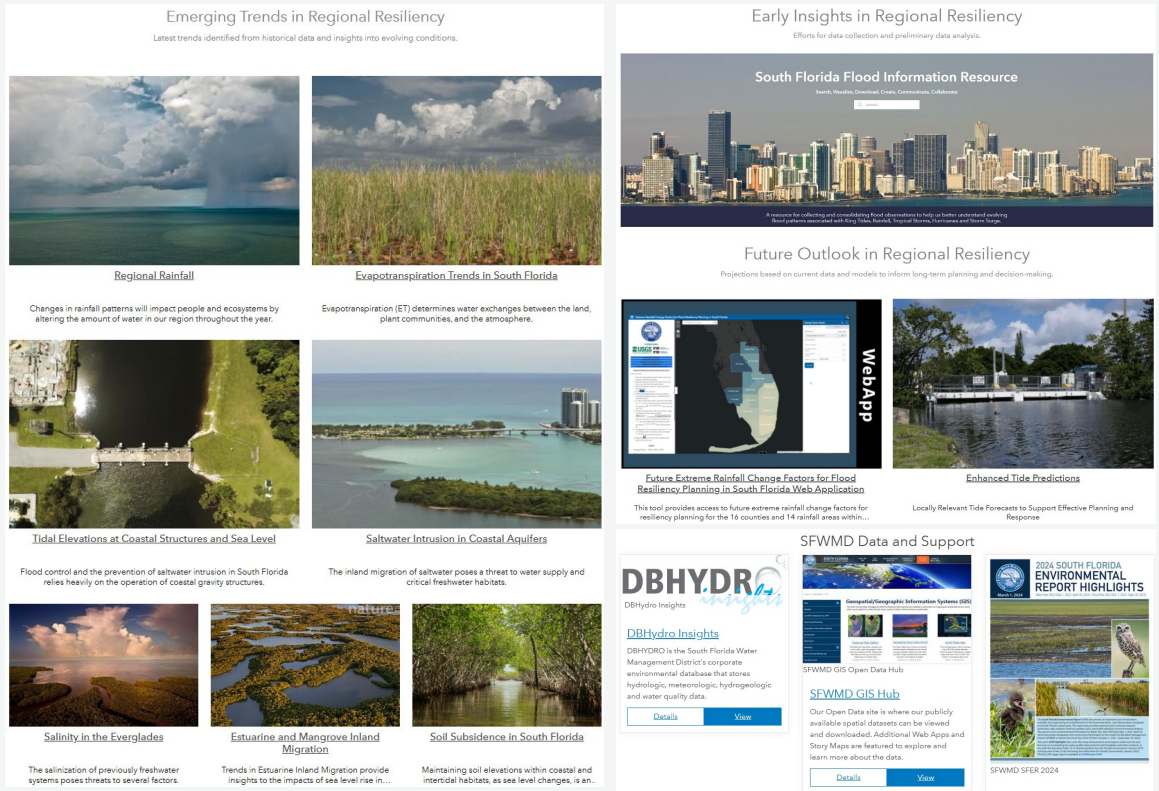
Water and Climate Resilience Metrics

Technical Reports



sfwmd.gov/SFER

Online Resources

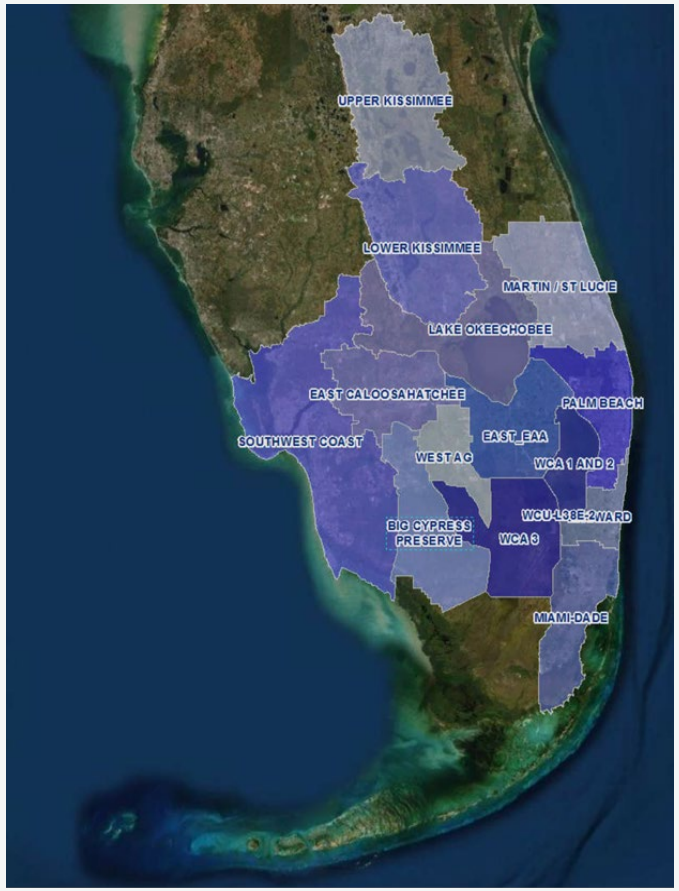


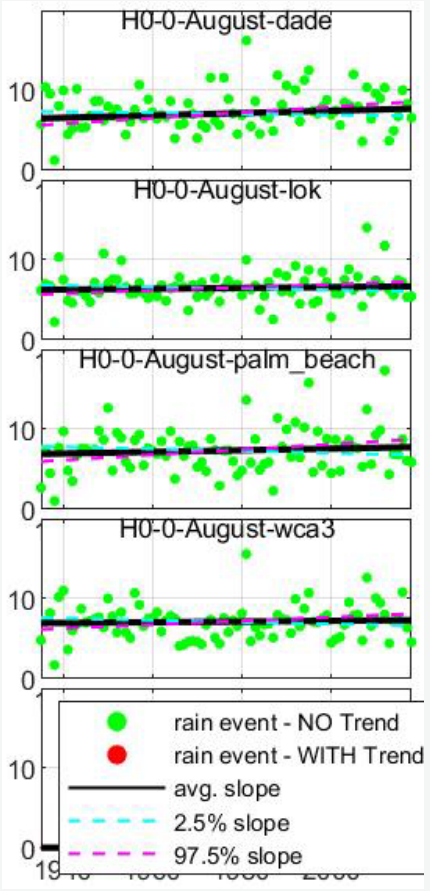
sfwmd.gov/ResilienceMetricsHub

Rainfall Trend Analysis

Strategy

1. Spatially interpolate rainfall using Thiessen-10 method on the "super grid" (2x2 rainfall binary file).
2. Calculate continuous regional rainfall daily time series for the 14 management basins.
3. Calculate monthly, seasonal and annual rainfall time series for each basin.
4. Perform Frequency Analysis for 1-, 3- and 5-day maxima for each basin.
5. Perform trend analysis on the time series resulting from steps 3 and 4.





Rainfall Trend Analysis results for August and POR 1935-2018

Rainfall Cluster Analysis

MATLAB Executable

Created by Dr. Alaa Ali (Technical Lead for Rainfall).

Variables

1. Peak Over Threshold
   4.0 to 9.0 inches
2. Minimum Data Points for Period of Record (POR)
   5 or 10
3. Minimum Data Locations to Form a Cluster
   5 (~5 mi^2), 7 (~10 mi^2), or 10 (~20 mi^2)
4. Trend Analysis Significance Level
   0.01, 0.05, or 0.1

Data points in POR x Data locations to form cluster x Significance level

5 x 5 x 0.01	1	1	1	2	6	11	15	10
5 x 5 x 0.05	1	1	1	2	6	11	15	10
5 x 5 x 0.1	1	1	1	2	6	11	15	10
5 x 7 x 0.01	1	1	1	2	6	11	11	7
5 x 7 x 0.05	1	1	1	2	6	11	11	7
5 x 7 x 0.1	1	1	1	2	6	11	11	7
5 x 10 x 0.01	6	6	8	7	10	14	16	8
5 x 10 x 0.05	6	6	8	7	10	14	16	8
5 x 10 x 0.1	6	6	8	7	10	14	16	8
10 x 5 x 0.01	1	1	5	6	10	5	6	2
10 x 5 x 0.05	1	1	5	6	10	5	6	2
10 x 5 x 0.1	1	1	5	6	10	5	6	2
10 x 7 x 0.01	1	1	5	8	6	6	3	1
10 x 7 x 0.05	1	1	5	8	6	6	3	1
10 x 7 x 0.1	1	1	5	8	6	6	3	1
10 x 10 x 0.01	6	7	9	11	11	4	3	1
10 x 10 x 0.05	6	7	9	11	11	4	3	1
10 x 10 x 0.1	6	7	9	11	11	4	3	1
Peak over threshold (in)	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**

Total number of clusters for different variables.

Rainfall Cluster Analysis

Name	Peak over threshold (in)	Results: Clusters	Results: Trend	Cluster with trend				Cluster with trend			
				Cluster number	Cluster location	Data points	Observed trend (avg slope)	Cluster number	Cluster location	Data points	Observed trend (avg slope)
5 x 10 x 0.05	4.0	6	2	2	Lower East Coast	1297	4.81	6	Upper East Coast	745	4.84
5 x 10 x 0.05	4.5	6	2	2	Lower East Coast	842	5.3	6	Upper East Coast	505	5.4
5 x 10 x 0.05	5.0	8									
5 x 10 x 0.05	5.5	7									
5 x 10 x 0.05	6.0	10	2	4	Near LO	20	7.31	6	Near LO	27	6.64
5 x 10 x 0.05	6.5	14	2	11	Near WCA12	35	7.45	14	Near WEAA	50	-8.51
5 x 10 x 0.05	7.0	16	1	7	Near MSL	25	-7.82				

Persistent clusters

- Represent zones of stable hydrological behavior over time.
- Consistently exhibit elevated rainfall exceedances across thresholds and years.
- Should be prioritized for resilience infrastructure (base-level infrastructure investment and long-term risk planning).

Emerging clusters

- Represent dynamic hotspots where rainfall intensity increases during extreme weather events.
- More prominent in the updated period (2035–2024) and for higher thresholds (5.00 and 6.00 in).
- Demand heightened attention in both climate adaptation strategies and emergency response planning (significant challenges to unprepared infrastructure systems).

Rainfall Cluster Analysis

Name	Peak over threshold (in)	Results: Clusters	Results: Trend	Cluster with trend				Cluster with trend			
				Cluster number	Cluster location	Data points	Observed trend (avg slope)	Cluster number	Cluster location	Data points	Observed trend (avg slope)
5 x 10 x 0.05	4.0	6	2	2	Lower East Coast	1297	4.81	6	Upper East Coast	745	4.84
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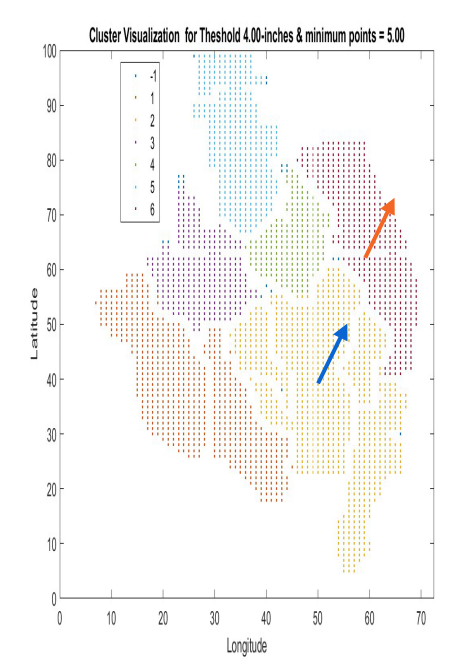
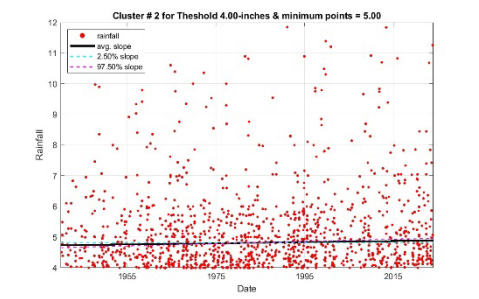
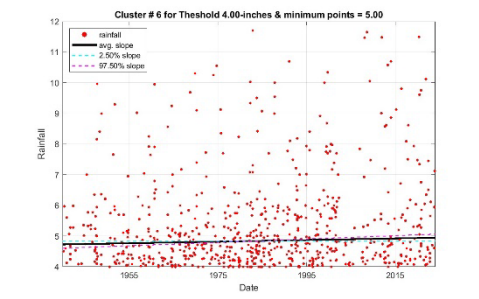
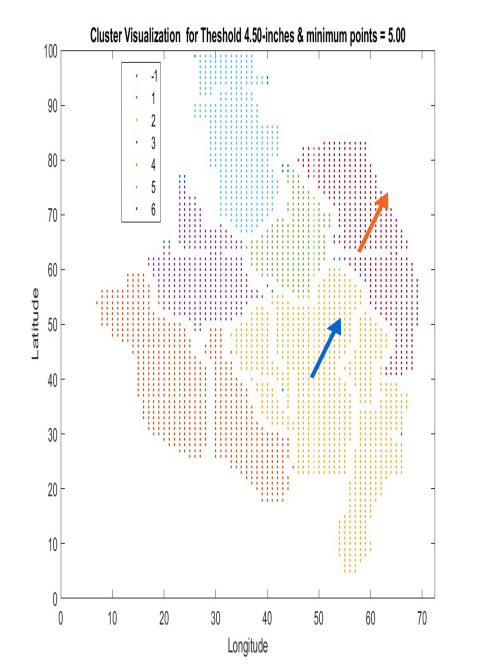
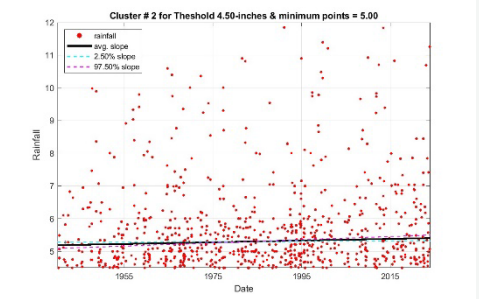


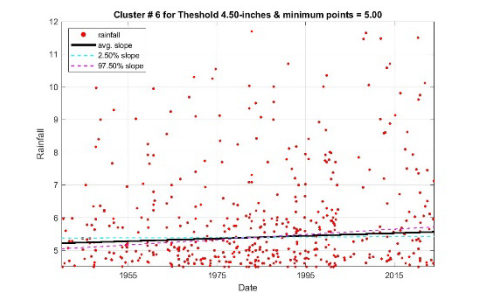




Rainfall Trend Analysis results for POT 4.00 inches and POR 1935-2024



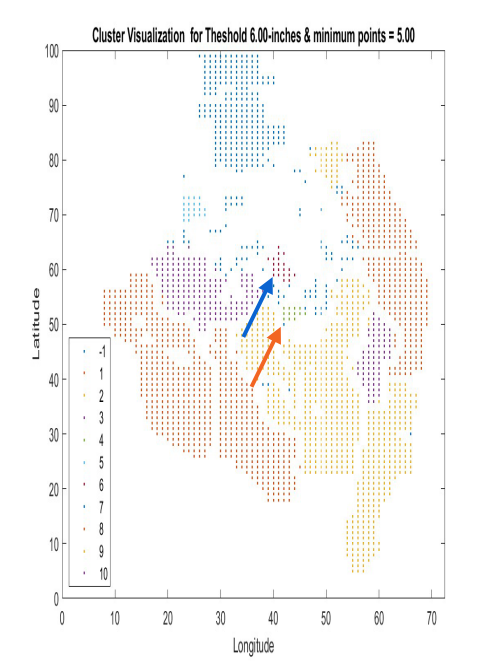


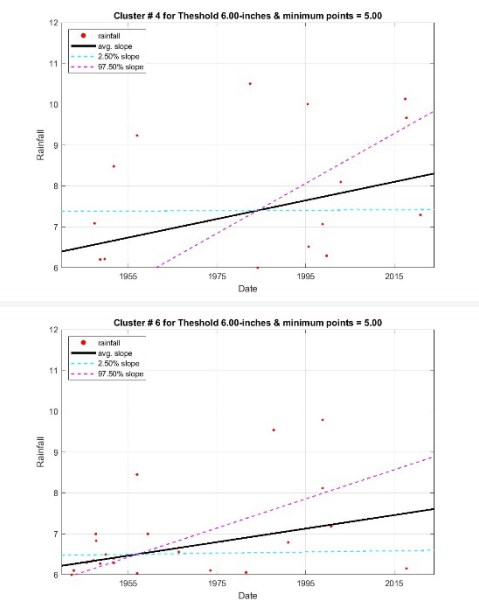


Rainfall Trend Analysis results for POT 4.50 inches and POR 1935-2024

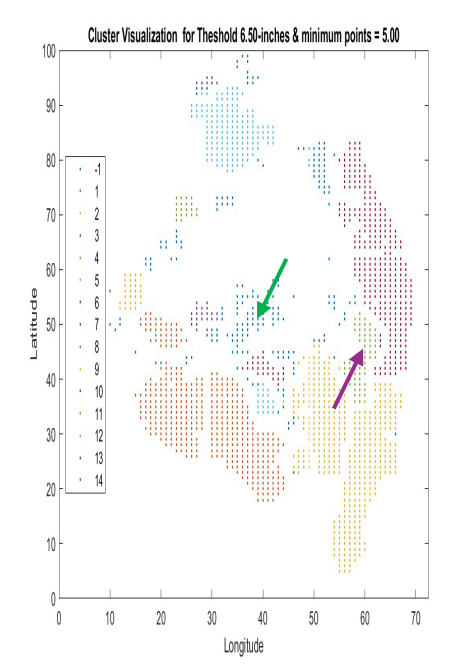
Rainfall Cluster Analysis

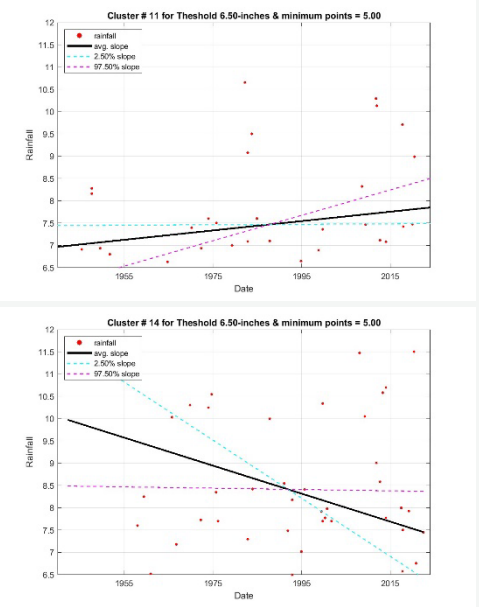
Name	Peak over threshold (in)	Results: Clusters	Results: Trend	Cluster with trend				Cluster with trend			
				Cluster number	Cluster location	Data points	Observed trend (avg slope)	Cluster number	Cluster location	Data points	Observed trend (avg slope)
5 x 10 x 0.05	6.0	10	2	4	Near LO	20	7.31	6	Near LO	27	6.64
5 x 10 x 0.05	6.5	14	2	11	Near WCA1	35	7.45	14	Near WEAA	50	-8.51





Rainfall Trend Analysis results for POT 6.00 inches and POR 1935-2024





Rainfall Trend Analysis results for POT 6.50 inches and POR 1935-2024

Summary

Water and Climate Resiliency Metrics

- The Initiative provides a framework for understanding how water and climate data are changing across the District.
- Phase I built the foundation with initial metrics and automation.
- Phase II refines, expands, and adds new metrics.

Rainfall Trend Analysis

- Temporal and spatial trends have been identified for rainfall.
- First analysis identified trends across 14 rainfall areas.
- Cluster analysis revealed trends across persistent and emerging rainfall zones.

Any questions?

Thank you