

Climate Trends, Resilience Challenges, and Broward Next

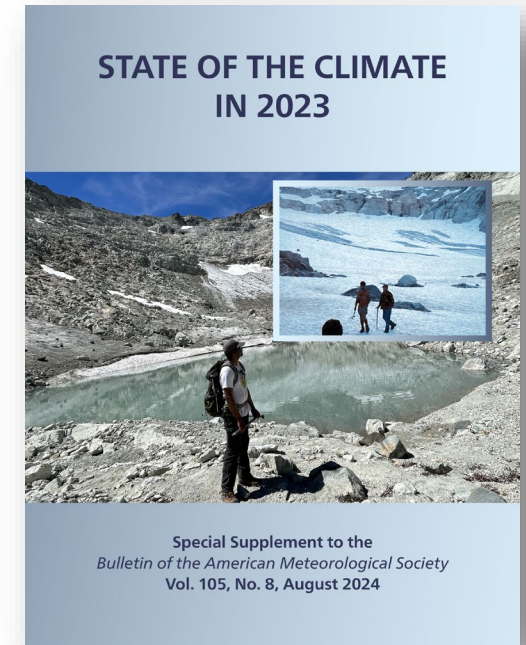
Presented to the Broward
Planning Council

October 17, 2024

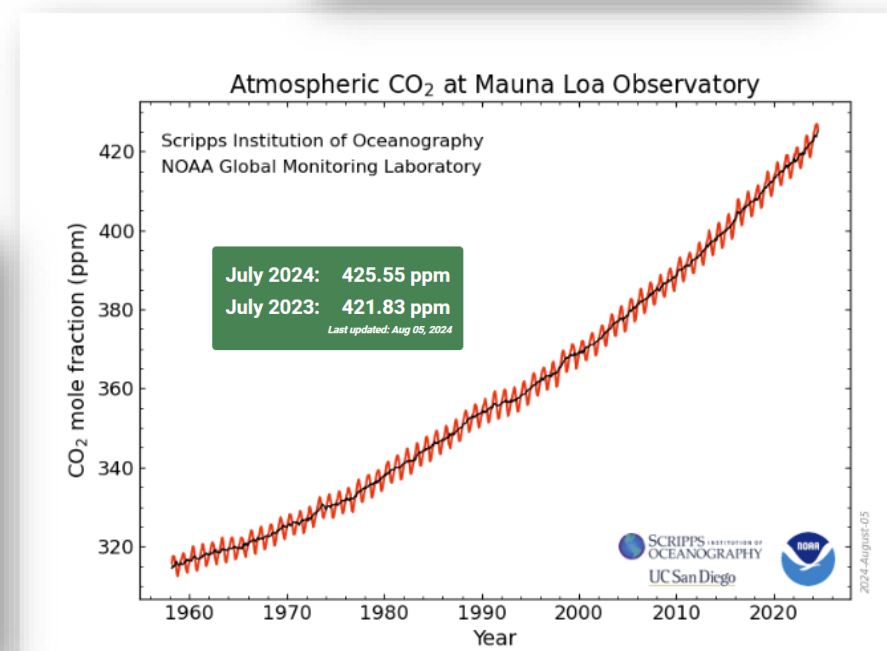
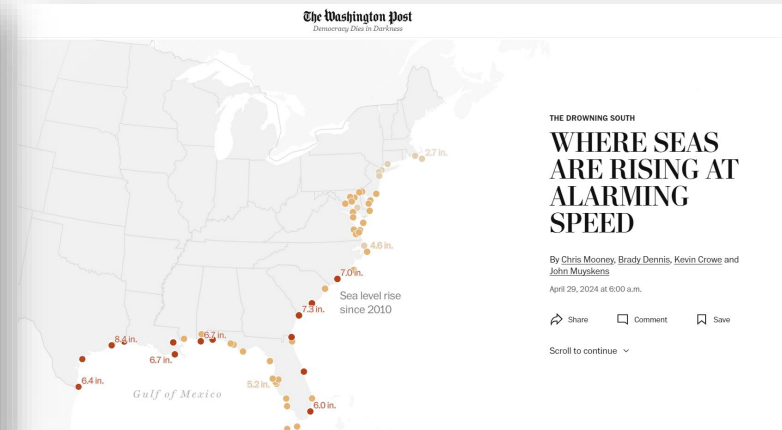
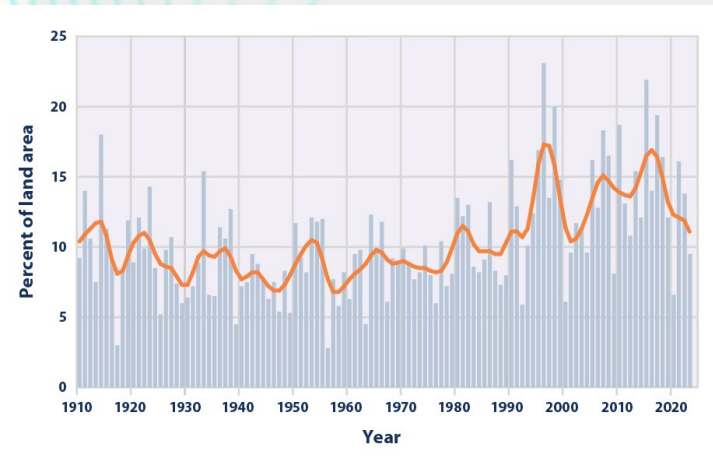


Global Climate Trends

- Greenhouse gas concentrations, global temperature across land and oceans, global sea level and ocean heat content all reached record highs in 2023
- The rate of sea level rise increase over the last 10 years is more than twice the rate from 1993 to 2002.



Extreme One-Day Precipitation Events in the Contiguous 48 States, 1910–2023

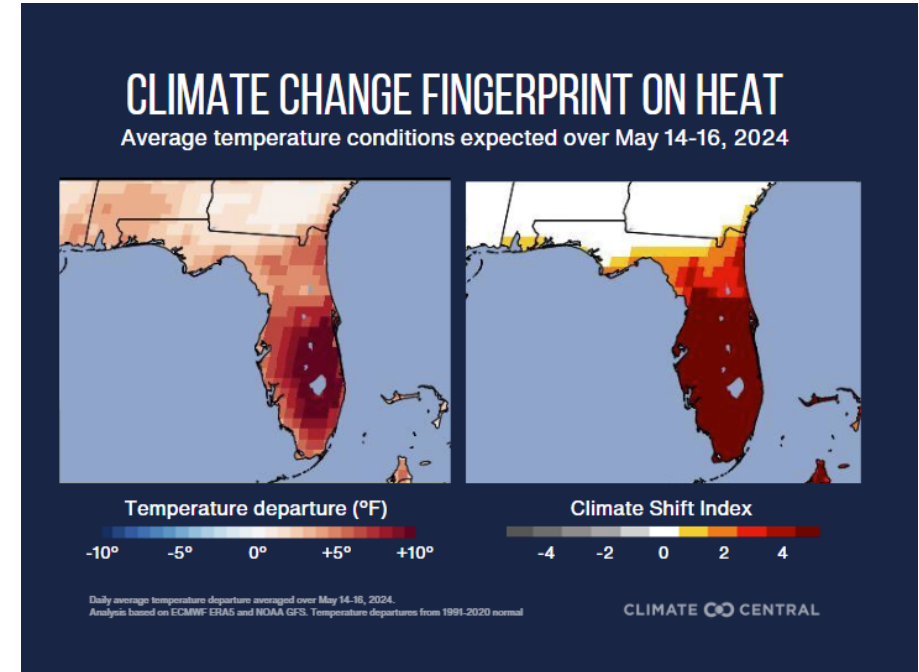
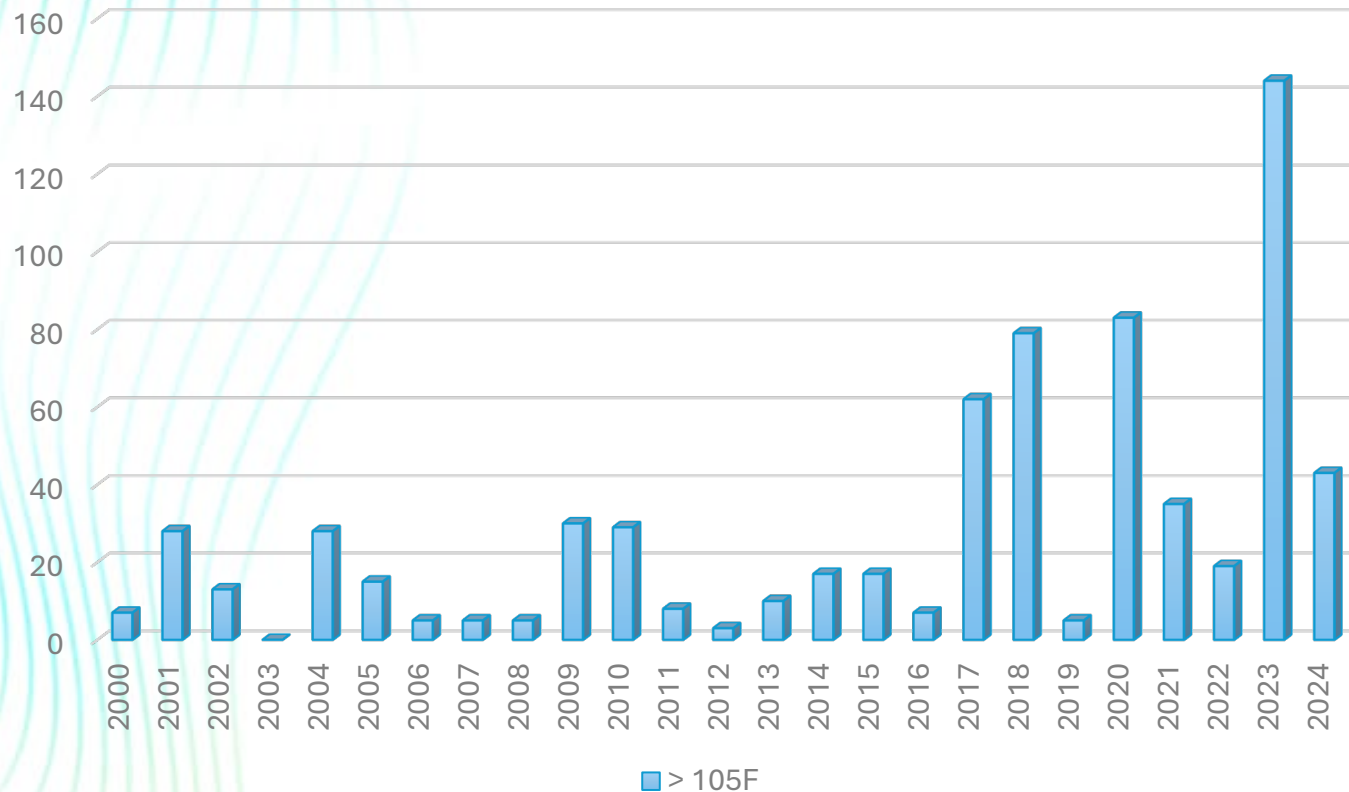


Local Climate Trends - Heat

Climate Shift Index Alert - May 13, 2024

Dangerous, early-season heat in Florida made five times more likely by climate change

Hours Above Heat Index Thresholds



7 NEWS MIAMI News ▾ Investigations ▾ Weather ▾ Sports ▾ Entertainment ▾ ... Watch 87° ☀

BREAKING

South Florida faces record spring temperatures; health officials urge caution

BY CAROLINA BORGES, ALEX BROWNING, VANESSA MEDINA, RUBÉN ROSARIO

MAY 15, 2024

Share f t e

Extreme Rainfall and Compound Flooding

Rank	Precipitation (in.)	Date
1	8.42"	12 April 2023
2	6.99"	6 June 2017
3	6.72"	3 October 2000
4	6.51"	3 June 2022
5	6.39"	12 June 2024
6	6.05"	15 November 2023
7	5.97"	4 November 1998
8	5.96"	8 November 2020
9	5.38"	27 May 2003
10	4.69"	7 June 1999

■ Last 5 years

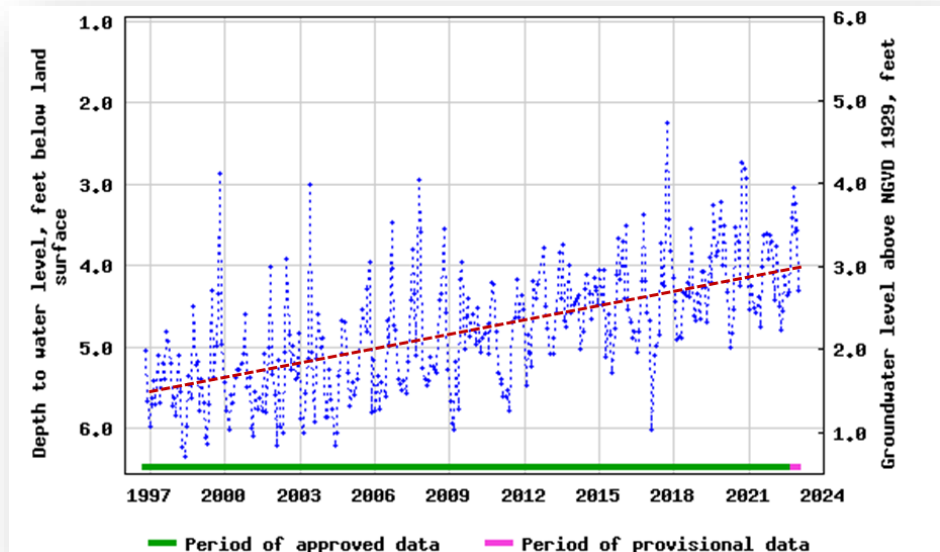
Hollywood – June 2024

‘Catastrophic flash flooding possible’ with heavy rain falling on still-flooded South Florida

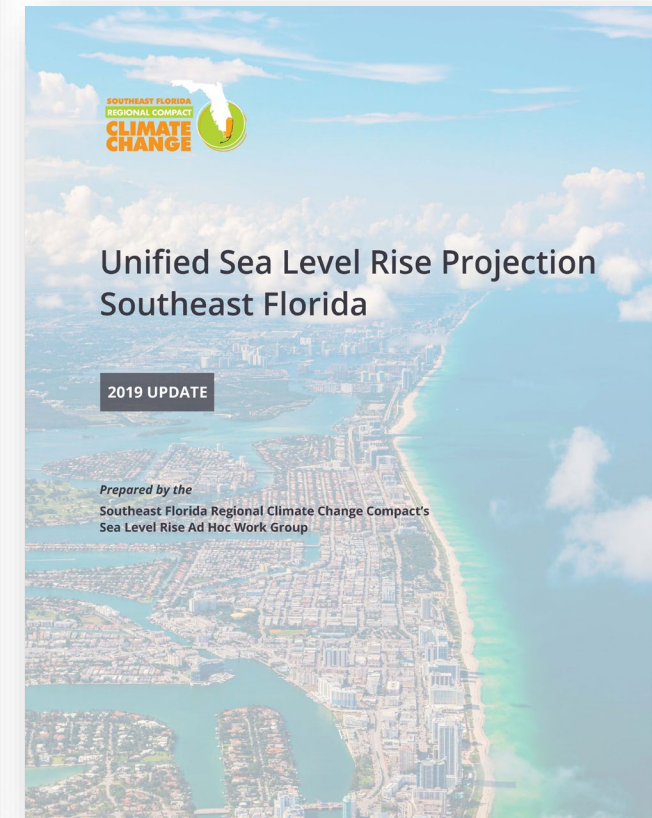
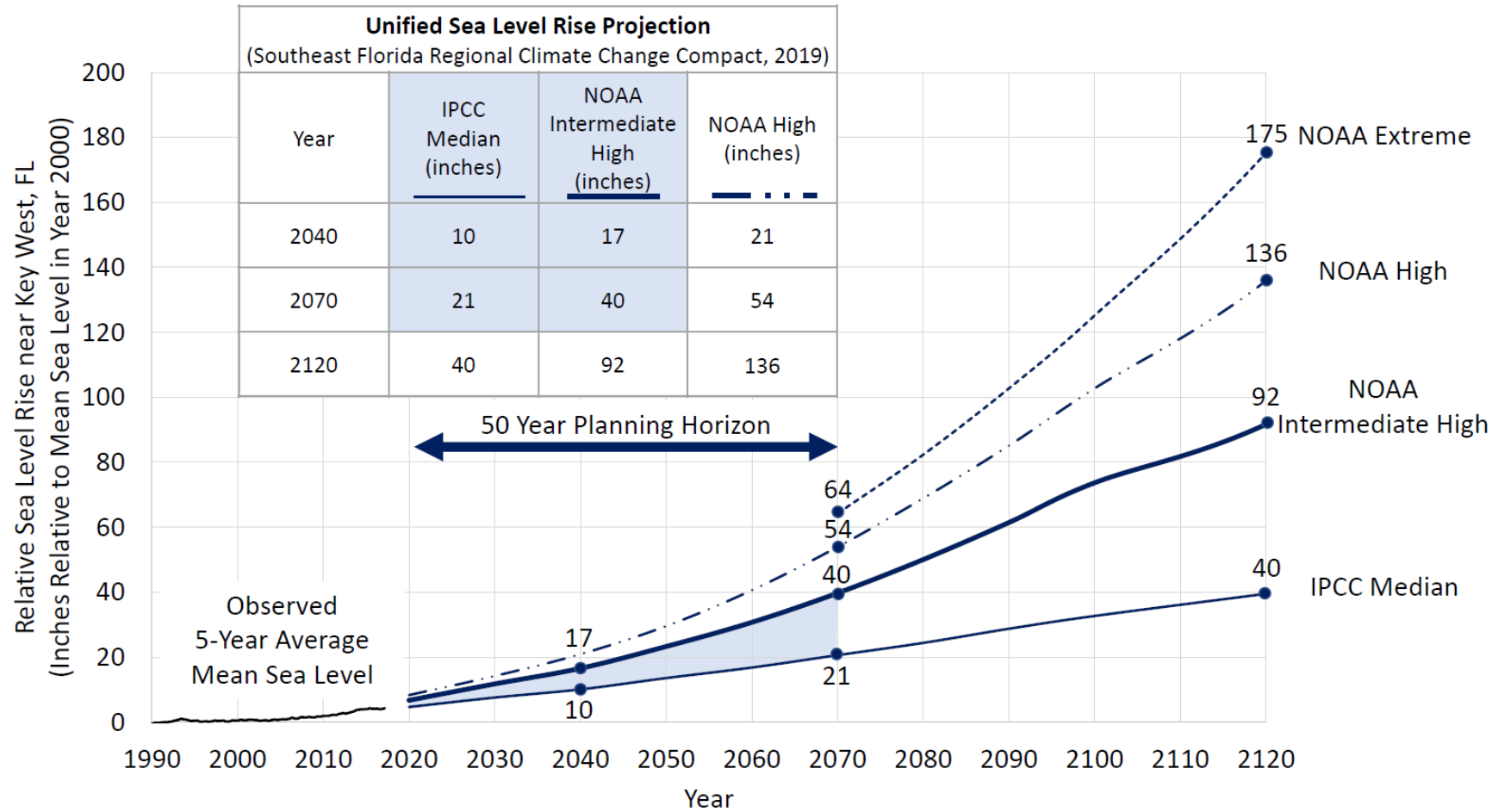
By Elizabeth Wolfe, Robert Shackelford, Mary Gilbert and Taylor Galgano, CNN
 5 minute read · Updated 7:37 PM EDT, Thu June 13, 2024



Groundwater Table Rise



2019 Regional Sea Level Rise Projection (Reaffirmed)



Observations vs. Projections

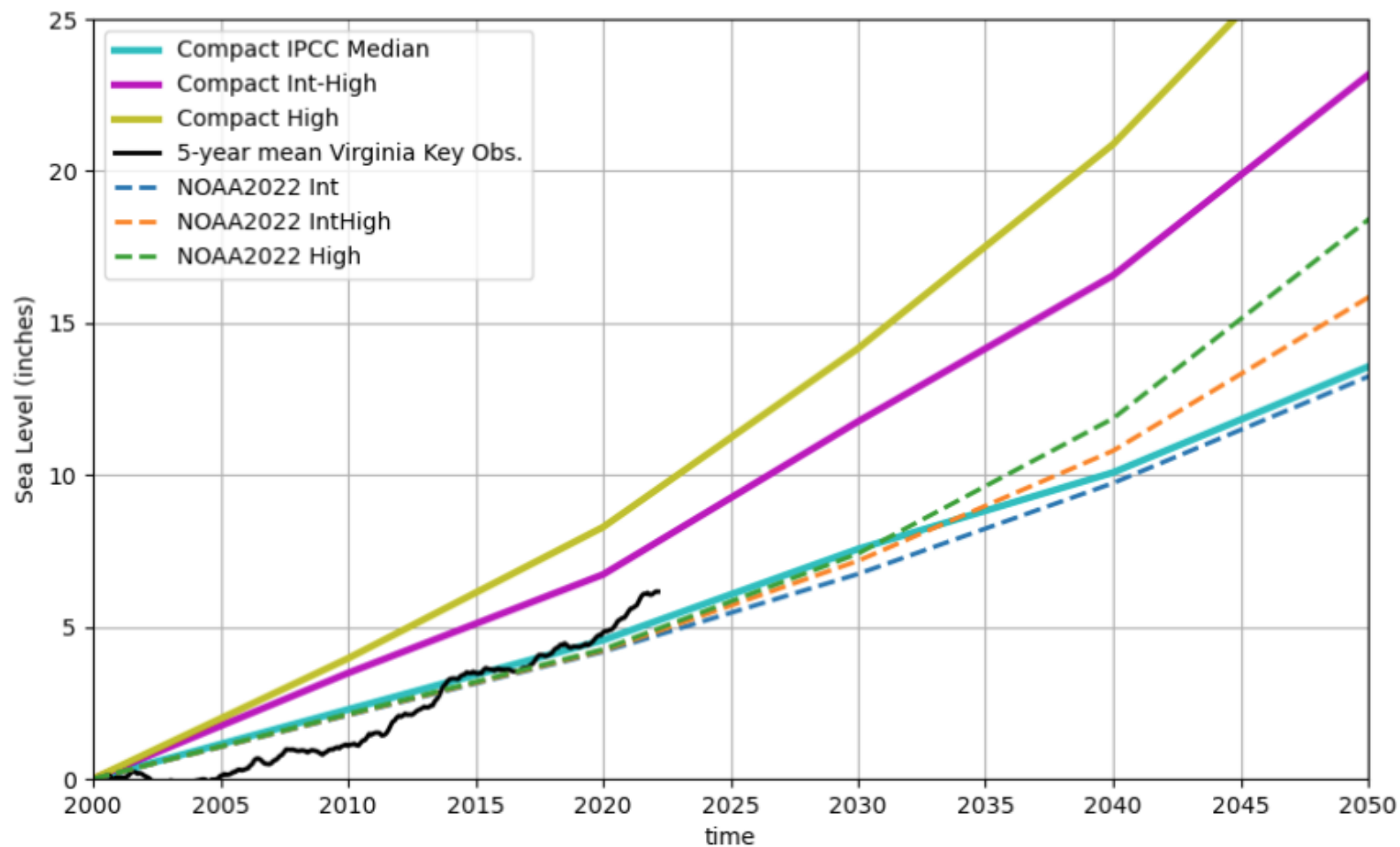


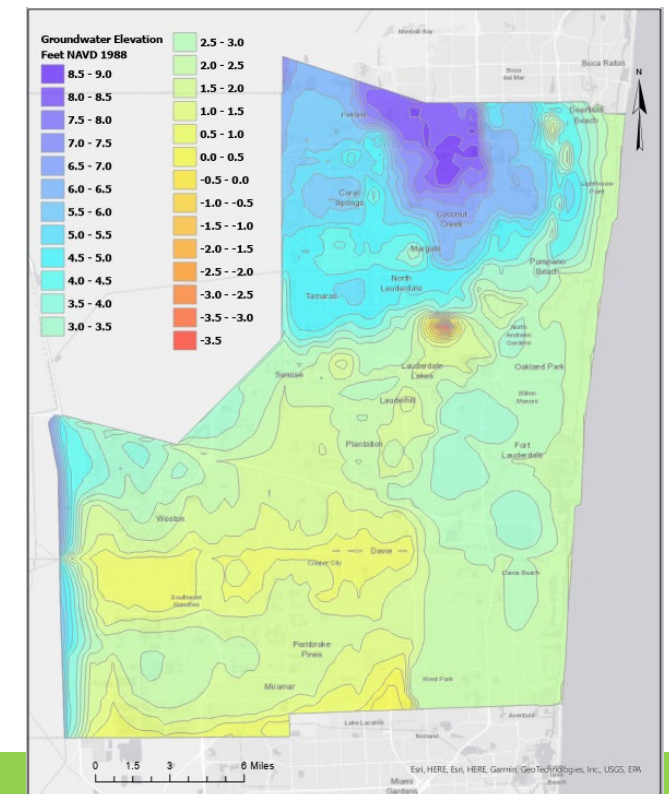
FIGURE 4: Comparison of 5-year average sea level at the Virginia Key (Miami-Dade County) tide gauge (anchored at the end of the 5-year period) with Compact 2019 projections and the NOAA 2022 scenarios.

Actions: Updates to Resilience Standards

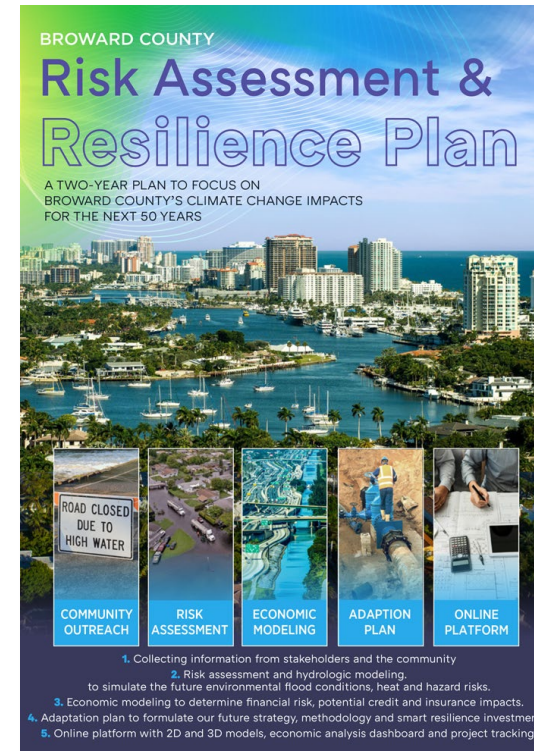
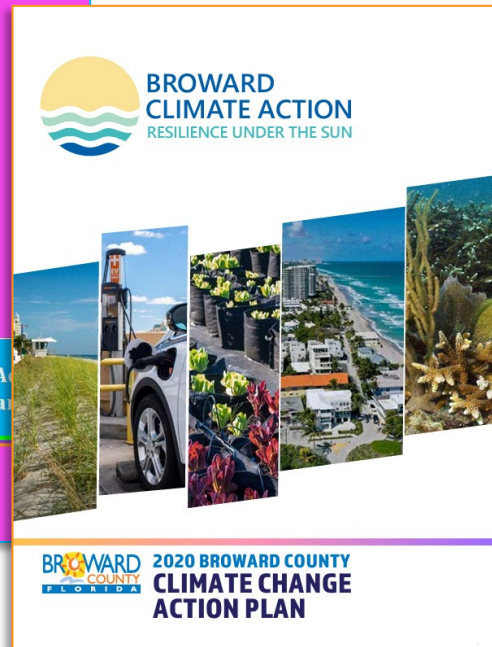
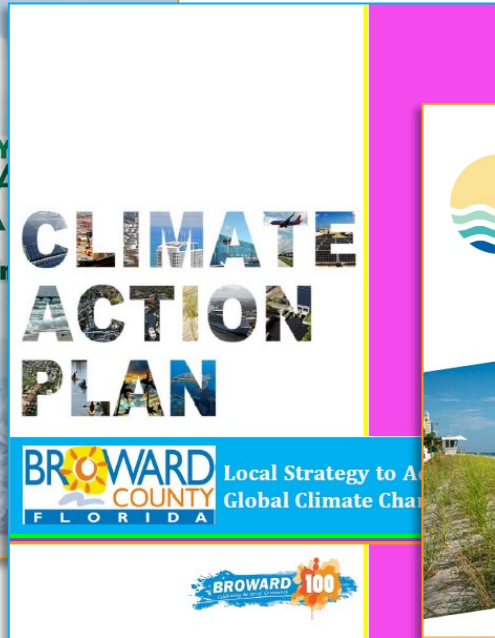
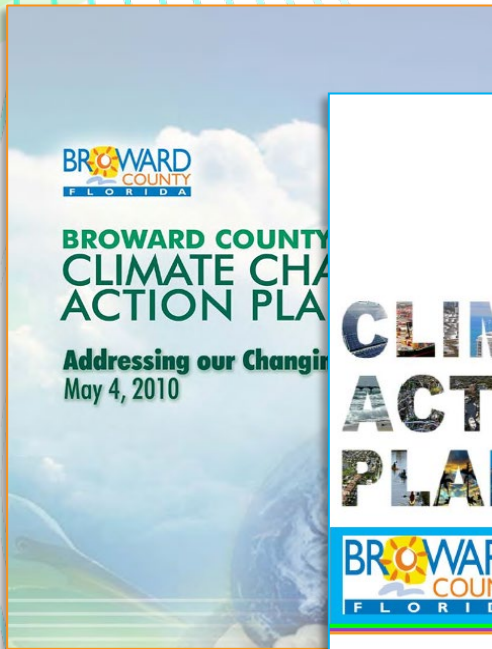


Future Conditions
Groundwater Map – 2024

- Sea Level Rise Projection - 2012, 2015, 2019
- Priority Planning Area Map - 2012, 2015, 2020
- Future Conditions Map Series - 2017
- Resilience Standards
 - Drainage infrastructure – 2017, 2024
 - Tidal flood barriers - 2020
 - 100-Yr Flood elevations – 2021, 2025*
- FEMA Flood Maps – July 2024 (90K new parcels)



Broward County Policy and Planning



BROWARD COUNTY RESILIENCE PLAN

A coordinated community-wide Resilience Plan focused on infrastructure improvements and redevelopment strategies

The CCAP consists strategic actions that will increase the resiliency of Broward County's community to the effects of climate change.



Climate Action Plan Update

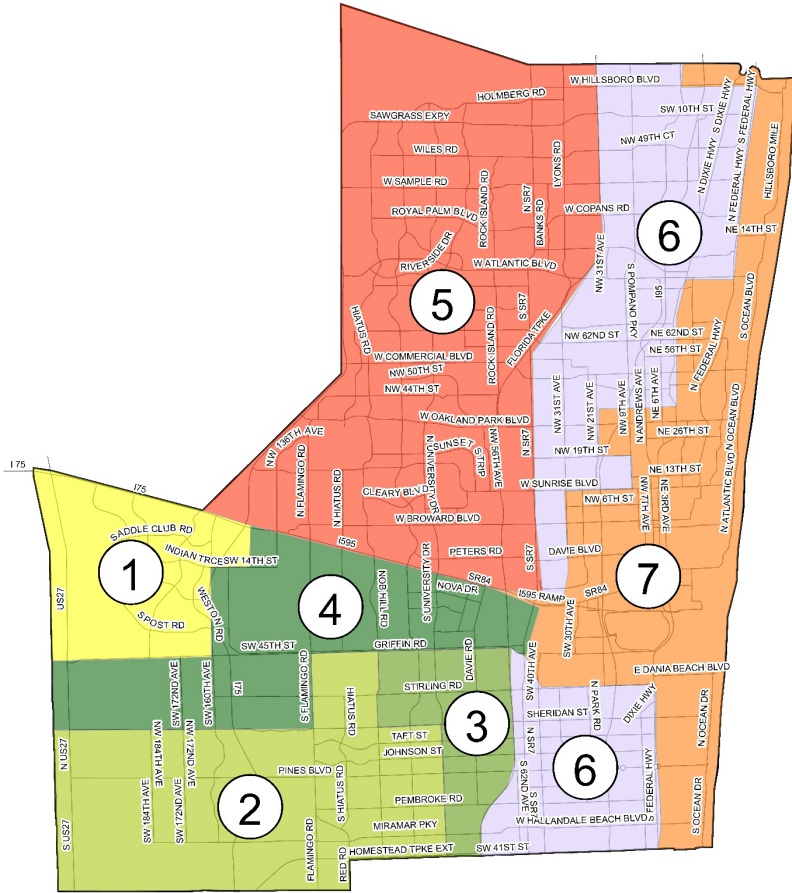


Current
CCAP



- Pursue Net Zero Target
- Promote the transition to zero-waste and encourage a circular economy
- Maximize value from transportation-related studies.
- Implement the County-wide Resilience Plan.
- Incentivize innovation in green infrastructure
- Develop a strategy to prioritize those in Broward County experiencing a high energy burden
- Proactive reduce risk through planning
- Invest in technology and automation for water management

Initial Adaptation Approach



Zone	Preliminary Strategy
1	<ul style="list-style-type: none"> • Explore Pre-storm operations to gain storage ahead of storm. • Manage discharges to allow other areas to drain.
2	<ul style="list-style-type: none"> • Explore Pre-storm operations to gain storage ahead of storm. • Manage discharges to allow other areas to drain. • Maintain beneficial site storage.
3	<ul style="list-style-type: none"> • Add conveyance improvements, probably based on energy. • Identify storage opportunities.
4	<ul style="list-style-type: none"> • Maintain beneficial site storage. • Target flooding spots based on cost of damages. • Explore Pre-Storm Operations to gain storage.
5	<ul style="list-style-type: none"> • Identify storage to reduce runoff. • Manage storage ahead of the storm.
6	<ul style="list-style-type: none"> • Minor opportunities for storage. • Improve gravity-based conveyance. • Add energy.
7	<ul style="list-style-type: none"> • Manage and protect coast. • Add artificial and natural barriers. • Incorporate energy-based conveyance improvements.

Suites of Adaptations were developed incorporating three adaptation zones

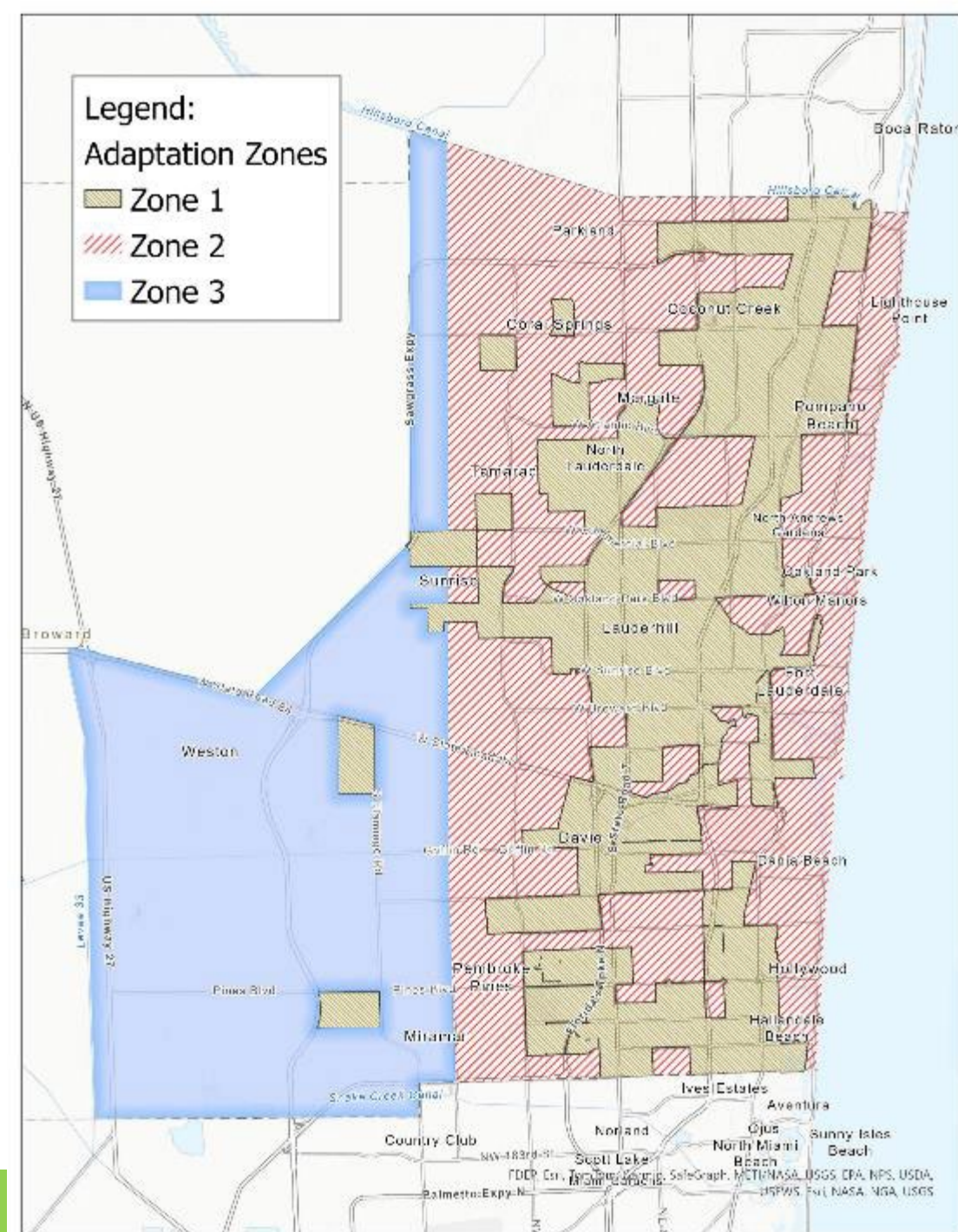
Zone 1 – Highest Vulnerability Areas

Zone 2 – Coastal

Zone 3 – Inland

Six Suites of Adaptations were evaluated using the Hydraulic & Hydrologic Model to define the adaptation plan components and sequence

A seventh suite was defined to address gaps in the simulation and after receiving feedback from stakeholders.



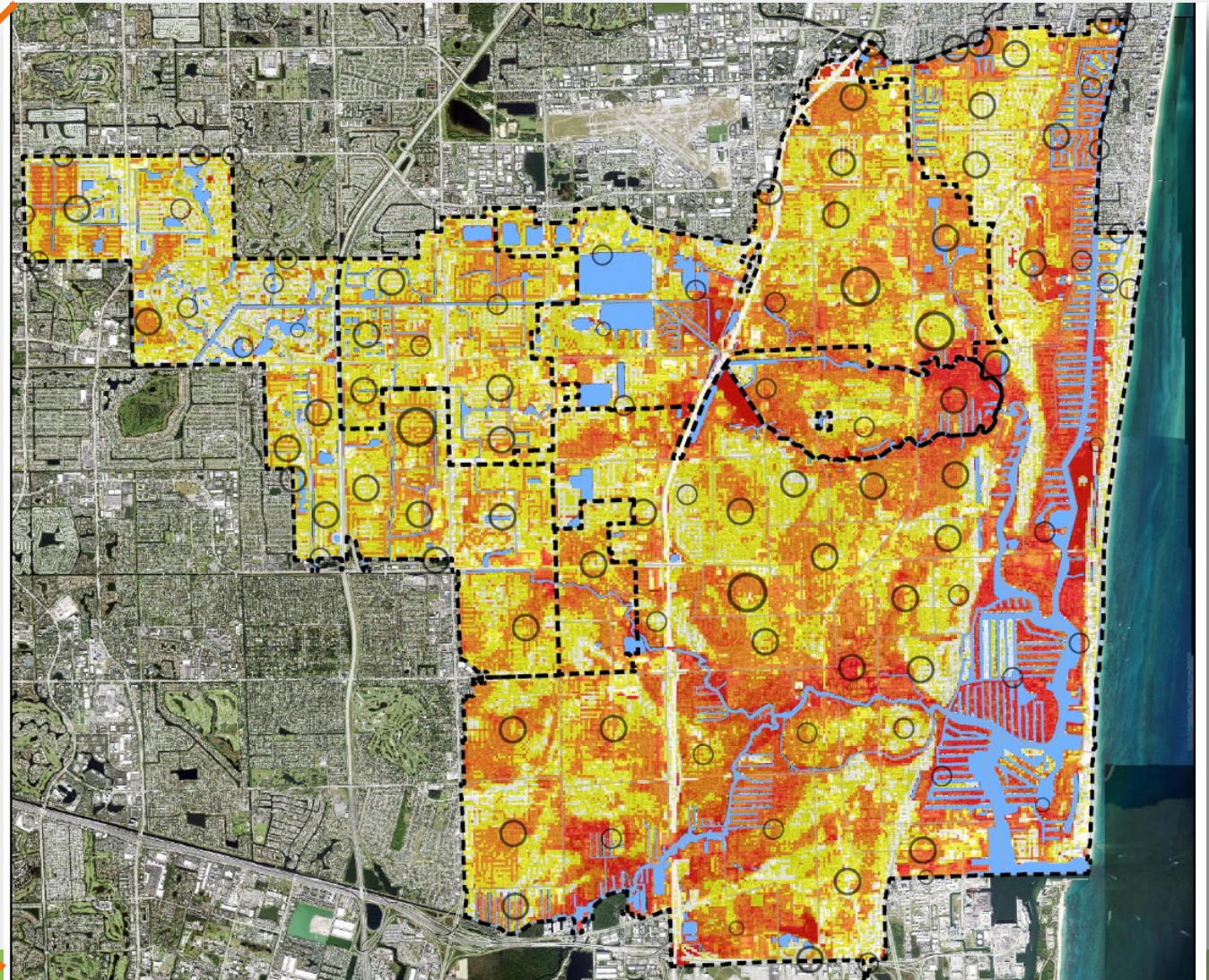
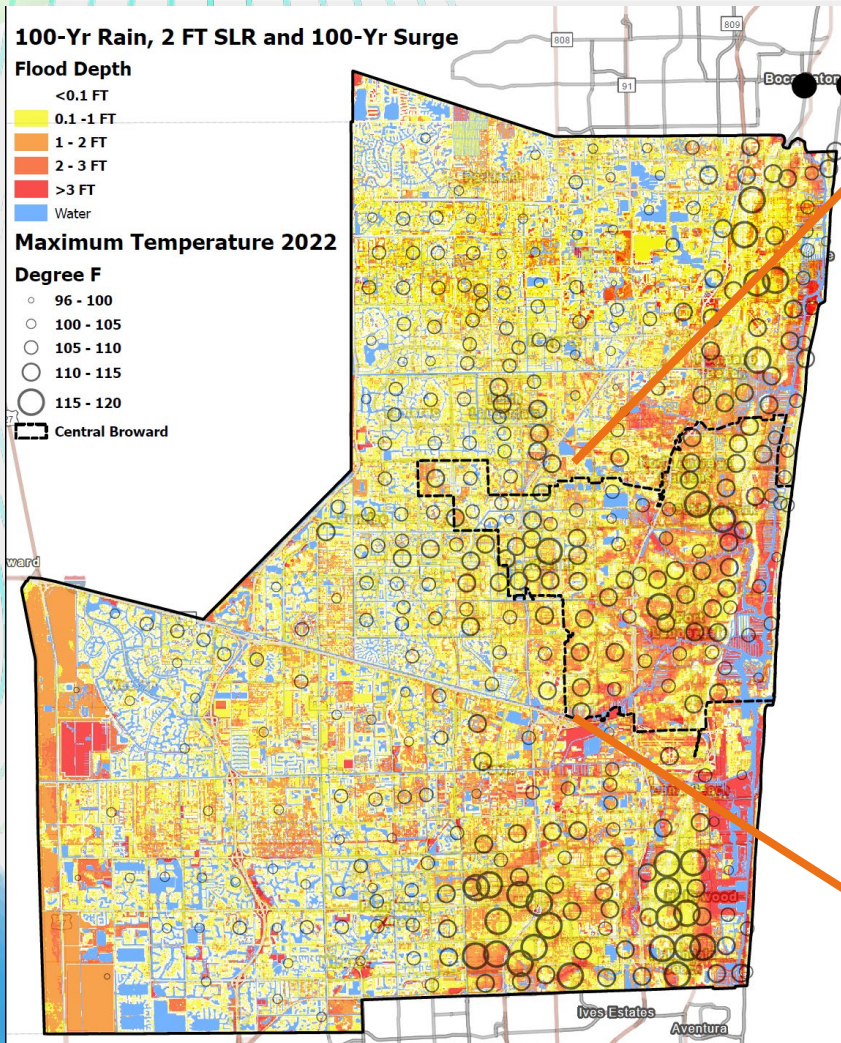
Adaptation Strategies Evaluated

- Storage
 - Above ground storage (large)
 - Recovering underground storage
- **Green Infrastructure**
- Reducing Impervious area
 - Adding localized surface storage
- Conveyance
 - Improving existing conveyance structures (canals, culverts, etc.)
 - Additional Pumping
- Barriers
 - Property level seawalls
 - Nature-based and/or engineered structures
 - Large scale levees and other close out structures

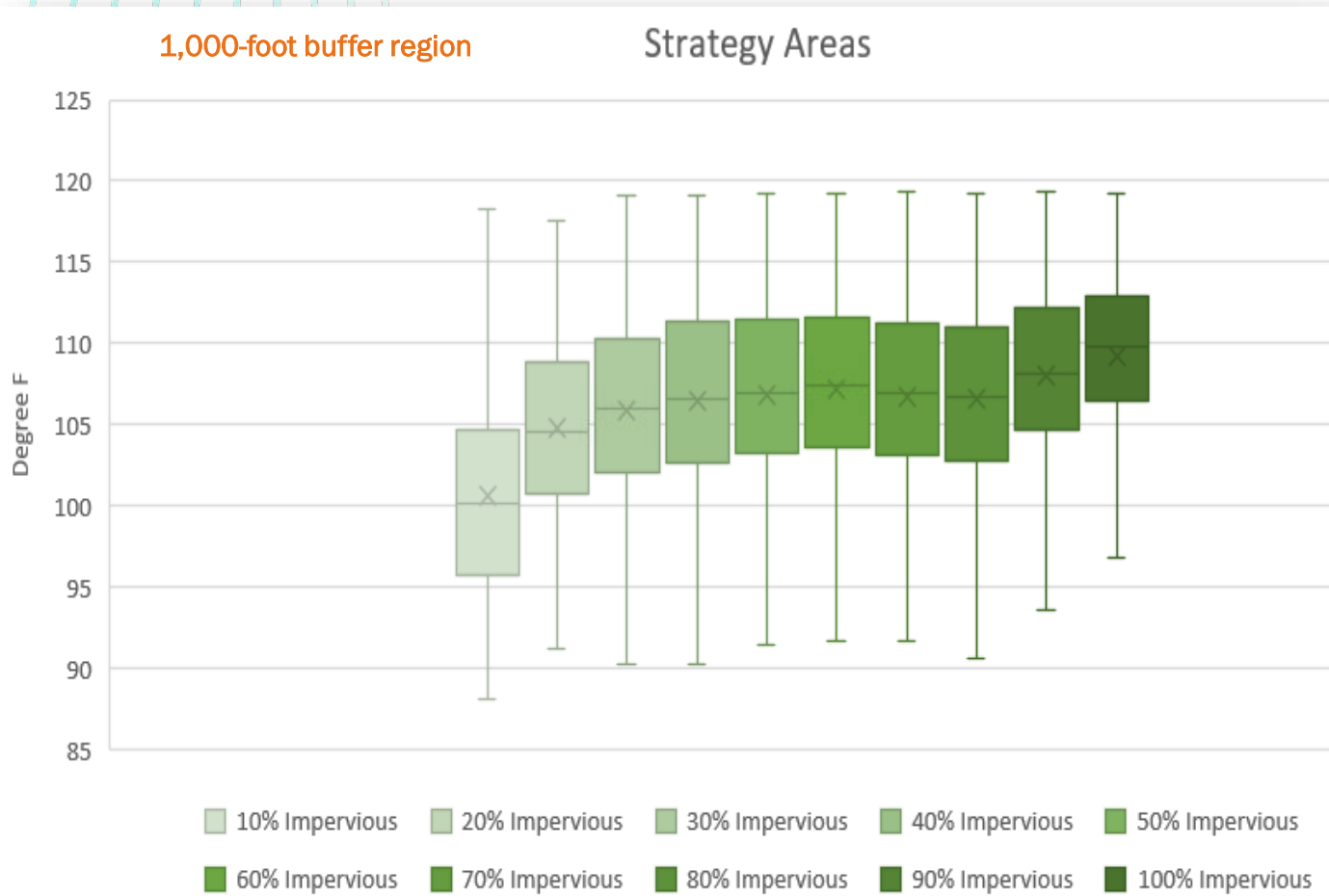
This adaptation strategy is linked to the development of Green Infrastructure. Most Green Infrastructure solutions are based on the idea of increasing infiltration by reducing impervious area. Infiltration can only be increased if there is available ground storage to receive rainwater.



Intersection of Flood and Heat Risk



Correlation between Pervious Areas and Land Surface Temperature



- Potential 10° F difference between pervious and impervious area

Soak Up the Rain with Green Infrastructure

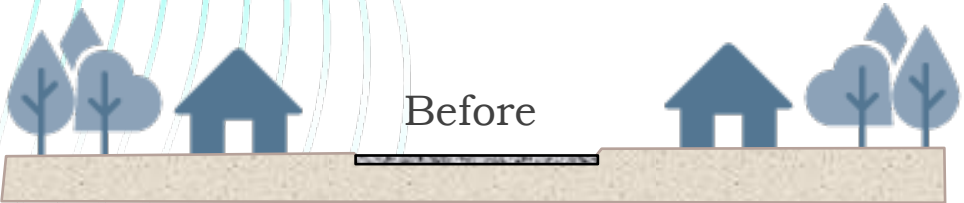
www.epa.gov/soakuptherain

Learn more. Take Action.

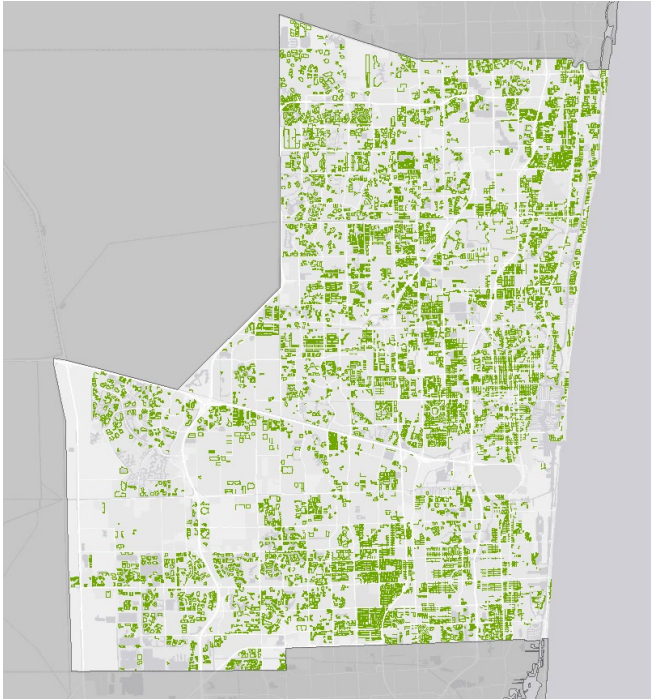
Poster created by U.S. EPA Office of Wetlands, Oceans and Watersheds.

Green Infrastructure – One-way roads/swale recovery

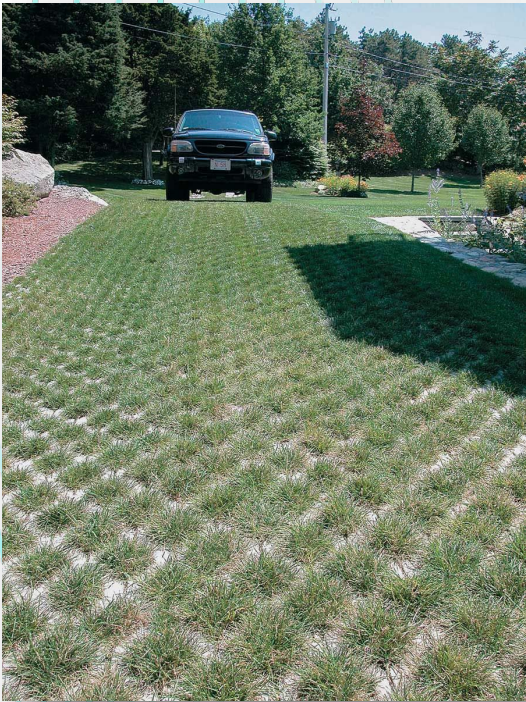
All local roads in the County were reviewed to analyze the potential conversion from two-way roads to one-way road.



Converting
1,760
Miles of two-way roads to one-way road plus swales



Additional Infrastructure Adaptation Strategies



Increased Pervious



Swales



Canal Operational Improvements

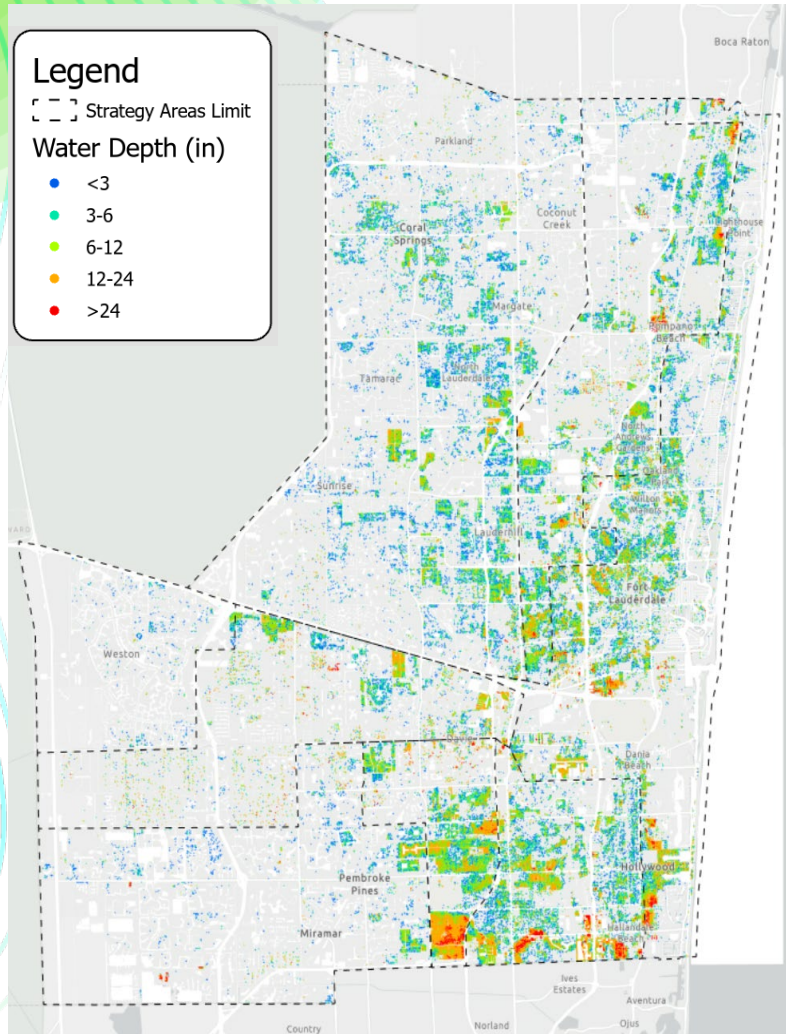


Bio Swales

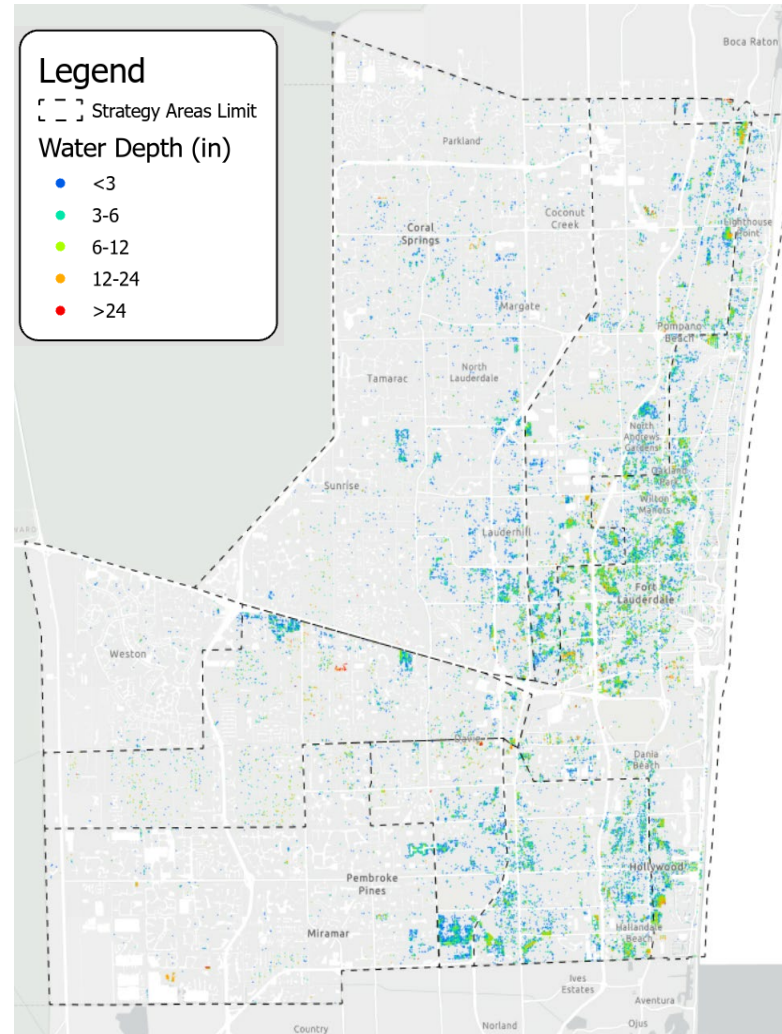


Stormwater Storage

Full Adaptation Suite – 2ft SLR, 100-yr Rain, No Surge



Base Scenario Structures Water Depth (inches)



Adaptation Strategy Structures Water Depth (inches)

Distribution of Structures by Flood Depth Impact

Flood Depth (in)	BASE (NO ADAPTATION)	ADAPTATION
<3"	28,209	13,982
3"-6"	32,056	12,252
6"-12"	38,166	8,949
12"-24"	25,254	2,607
>24"	33,757	169
TOTAL	157,442	37,959

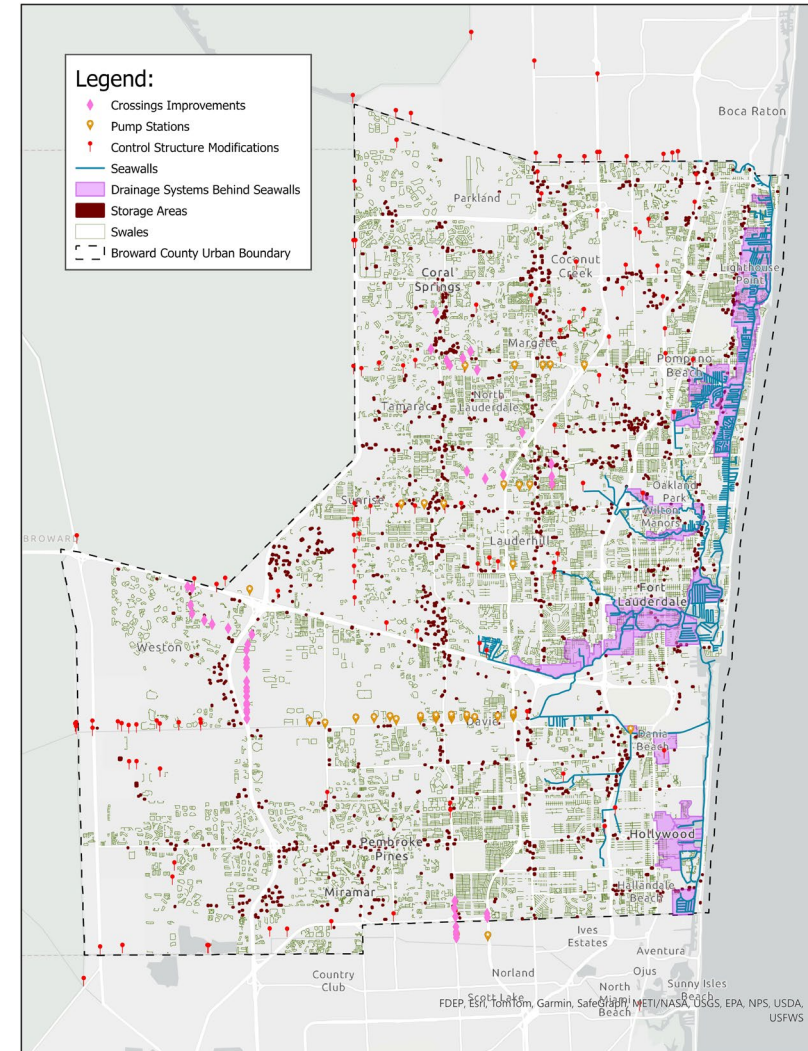
76% Reduction

Scenario

Rain	SLR	Tidal
100-yr. 3d	2 ft	King Tide, No Surge

Full Suite of Adaptations – 2- and 3-foot Sea Level Rise, through 2070

- Tier 1
 - Pumping stations
 - Culvert improvements
 - Storage areas
 - Control structures
 - Two-way road conversions (swales)
 - 5-ft. sea walls
- Tier 2
 - Drainage systems
 - Seawall elevated to 7 ft.



190+ Miles
enhanced
Seawalls

169
Controls
Structures

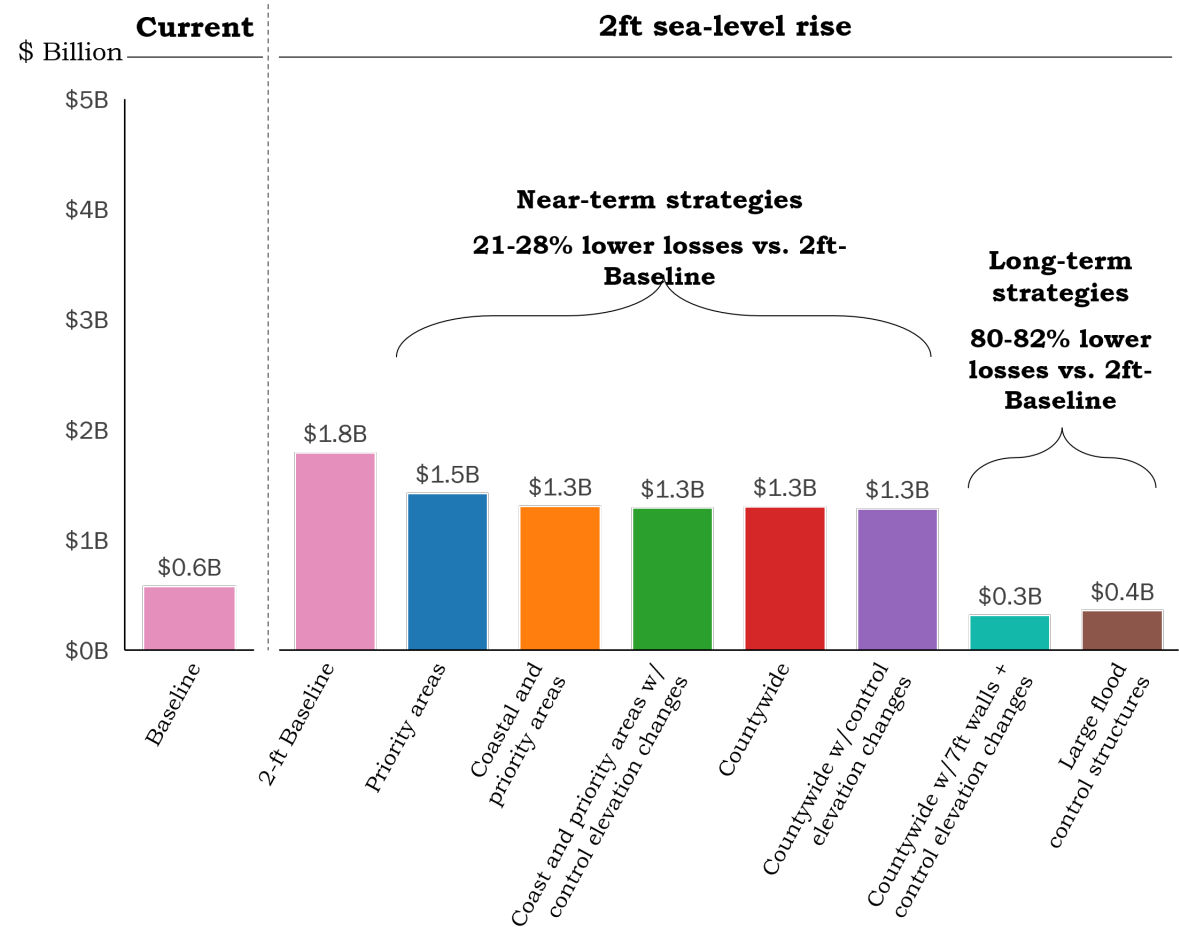
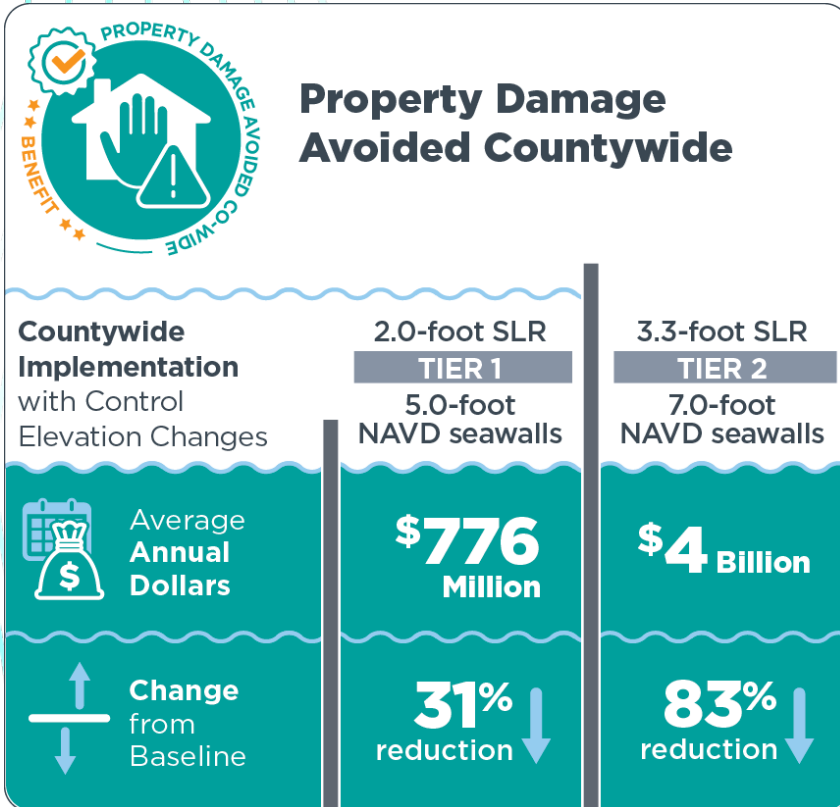
28
New Pump
Stations

50
Upgraded
Crossings

1,247
Acres-ft of
storage

Reduces Direct Property Losses & Protects Property Value

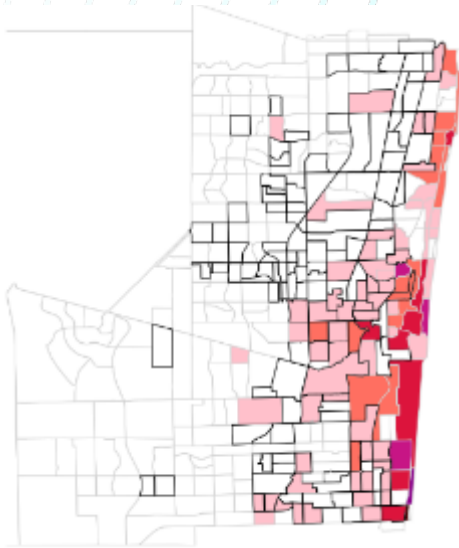
Avoided residential damages relative to baseline (\$M)



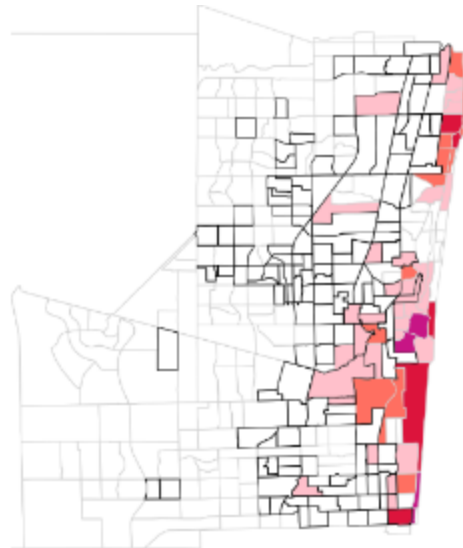
Tier 1 and Tier 2 reduce property damage across much of Broward County

Annual average damages to residential assets as share of property value across the county

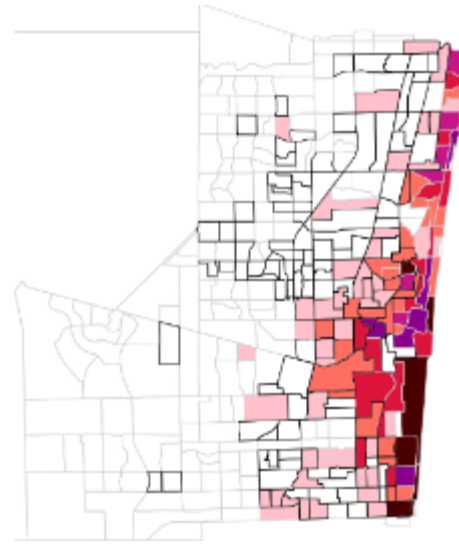
Baseline – 2ft



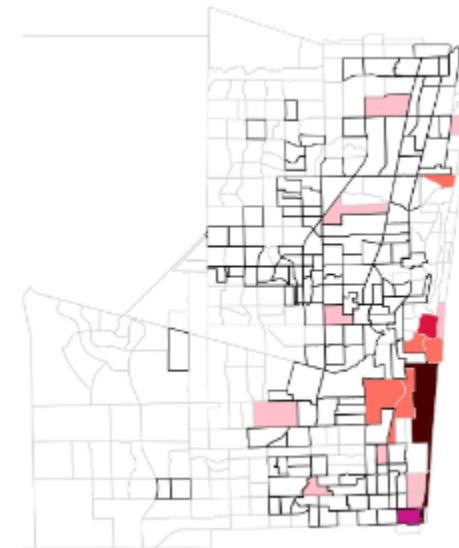
Countywide adaptations w/
control elevation changes –
2ft



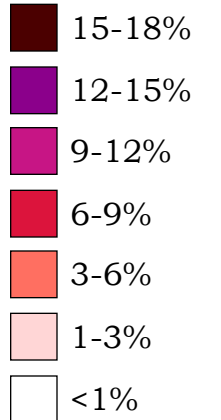
Baseline – 3.3ft



Countywide adaptations w/
control elevation & 7ft
seawalls- 3.3ft



Damages as
share of
property
value:



Areas outlined in black relate to zone 1

Benefits of higher property values across the County are evident under both Tiers

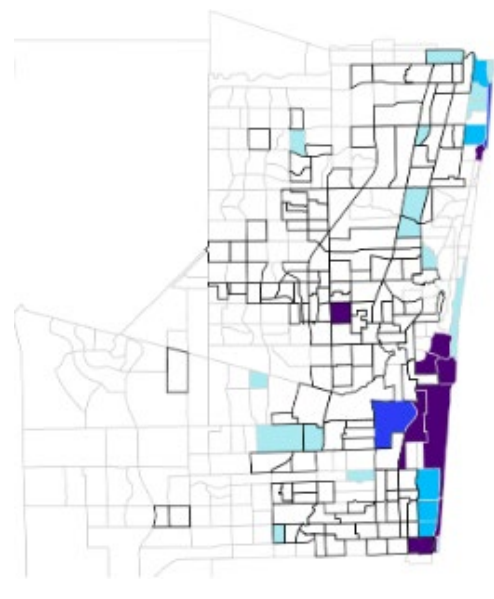
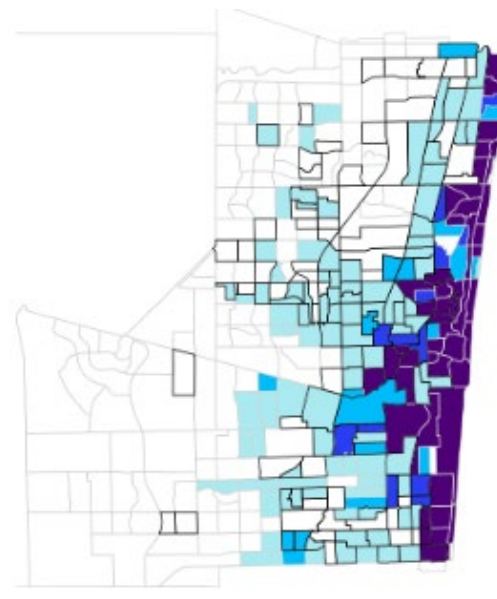
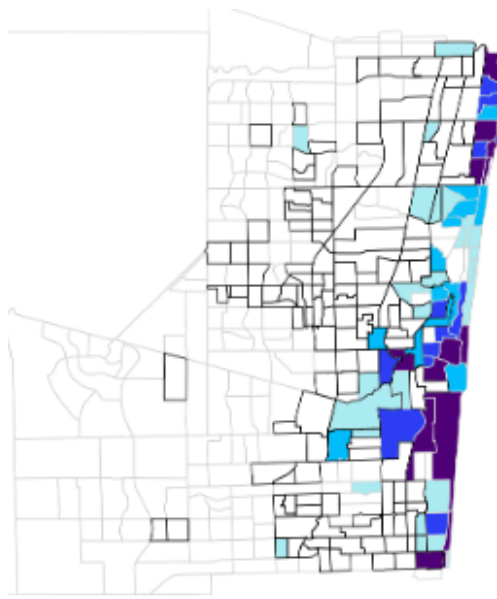
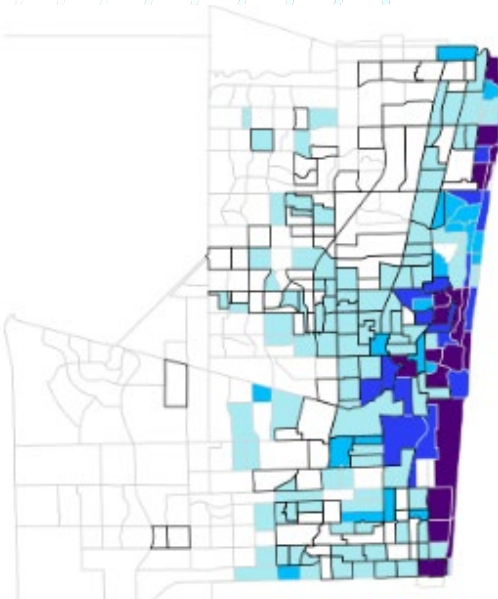
Real estate value losses across the County (\$M losses)

Baseline - 2ft

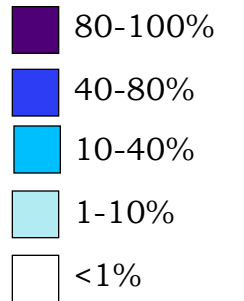
Countywide adaptations w/
control elevation changes -
2ft

Baseline - 3.3ft

Countywide adaptations w/
control elevation & 7ft seawalls-
3.3ft



Property value loss as share of total building value, %



Areas outlined in black relate to zone 1

Benefits of reduced flood insurance premia across the County (Assumes all policies remain in place)

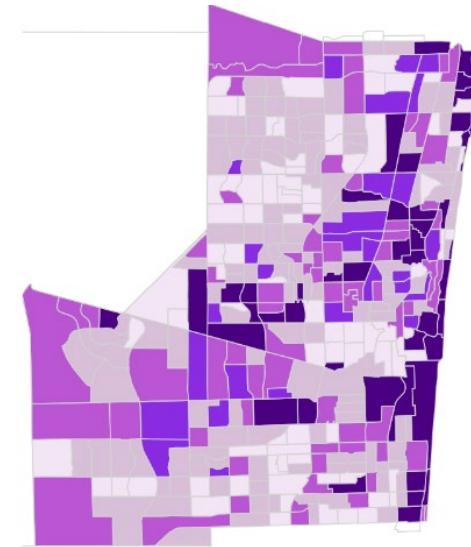
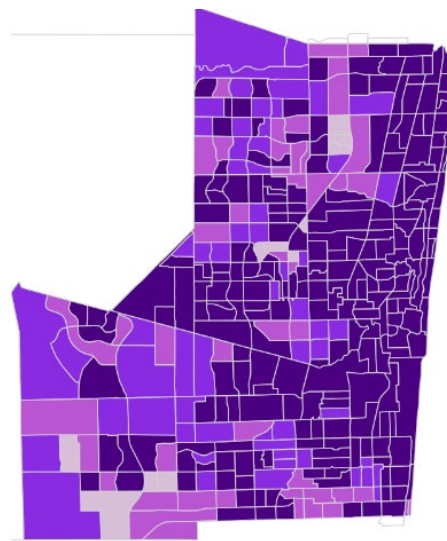
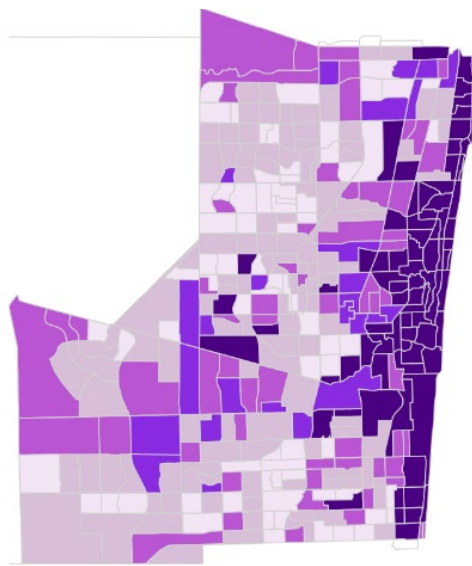
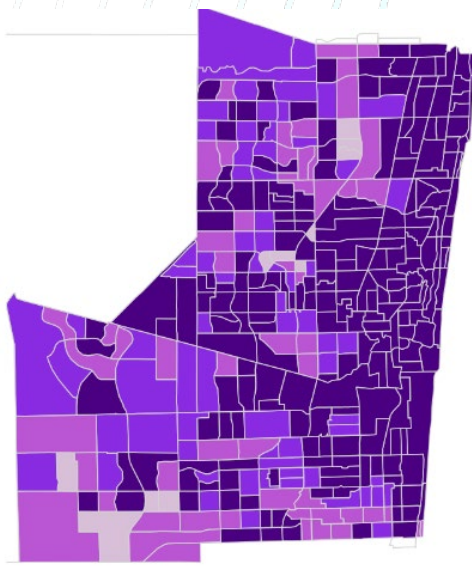
Single-family home premiums (\$ premium cost) adjusted for risk

Baseline – 2ft

Countywide adaptations w/
control elevation changes –
2ft

Baseline – 3.3ft

Countywide adaptations w/
control elevation & 7ft seawalls-
3.3ft



Average premium for single-family home:

- >\$1,600
- \$1,200-\$1,600
- \$800-\$1,200
- \$400-\$800
- Up to \$400

Scenario Viewer

RESILIENT BROWARD Storm Viewer (Development Version)
Find address or place

<p>2a. Rainfall Amount ⓘ</p> <div style="display: grid; grid-template-columns: 1fr 1fr; gap: 5px;"> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">5-yr</div> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">25-yr</div> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">50-yr</div> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">100-yr</div> </div>	<p>2b. Rainfall Amount ⓘ</p> <div style="display: grid; grid-template-columns: 1fr 1fr; gap: 5px;"> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;">5-yr</div> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;">25-yr</div> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;">50-yr</div> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;">100-yr</div> </div>		
<p>3a. Storm Surge ⓘ</p> <div style="display: grid; grid-template-columns: 1fr 1fr; gap: 5px;"> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">20-yr Storm Surge</div> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">100-yr Storm Surge</div> </div>	<p>3b. Storm Surge ⓘ</p> <div style="display: grid; grid-template-columns: 1fr 1fr; gap: 5px;"> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;">20-yr Storm Surge</div> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;">100-yr Storm Surge</div> </div>		
<p>4a. Adaptation Scenario ⓘ</p> <div style="display: flex; gap: 5px;"> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">None</div> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">Countywide</div> </div> <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center; margin-top: 5px;">Countywide w/ large surge barriers</div>	<p>4b. Adaptation Scenario ⓘ</p> <div style="display: flex; gap: 5px;"> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;">None</div> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;">Countywide</div> </div> <div style="background-color: #008000; color: white; padding: 5px; text-align: center; margin-top: 5px;">Countywide w/ large surge barriers</div>		
<input checked="" type="checkbox"/> Compare two scenarios		<p style="font-size: small;">2.0 ft SLR / 25-yr Rainfall / 20-yr Storm Surge / Variable GW</p> <p style="font-size: x-small;">FDEP, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USEFWS</p> <p style="font-size: x-small;">Powered by Esri</p>	<p style="font-size: small;">2.0 ft SLR / 25-yr Rainfall / 20-yr Storm Surge / Variable GW</p> <p style="font-size: x-small;">FDEP, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USEFWS</p> <p style="font-size: x-small;">Powered by Esri</p>

Neighborhood Level Navigation

RESILIENT BROWARD Storm Viewer (Development Version)

NO ADAPTATIONS WITH ADAPTATIONS

Find address or place

1a. Rainfall Amount	1b. Rainfall Amount
5-yr 10-yr	5-yr 10-yr
25-yr 100-yr	25-yr 100-yr
2a. Sea Level Rise	2b. Sea Level Rise
Current SLR 2.0 ft SLR	Current SLR 2.0 ft SLR
3.3 ft SLR	3.3 ft SLR
3a. Storm Surge	3b. Storm Surge
No Surge 100-yr Storm Surge	No Surge 20-yr Storm Surge
	100-yr Storm Surge
4a. Groundwater Conditions	4b. Groundwater Conditions
Saturated	Saturated

Scenario RP49

Flooding Depth

- < 6 in
- 6 in - 1 ft
- 1 ft - 2 ft
- > 2 ft

Implementation through Broward Next

Apply the Countywide Resilience Plan and Scenario Viewer in Review of all Land Use Proposals: Evaluate all land use proposals for future flood risk and assignment of water management needs.

Enhance Green Streets Requirements: Promote the conversion of selected neighborhoods from 2-way roads to 1-way roads with green infrastructure.

Identify Resilient Growth Priority Areas: Study and identify priority areas for development/redevelopment that advance the County's resilience goals. Might include areas of lower flood risk, connected to desired infrastructure and community services.

Reduce Impervious Cover: Provide incentives for property owners to convert impervious area to pervious area on private property for purposes of drainage.

Increase Stormwater Storage/Management Requirements: Increase required onsite storage capacity requirements on land being developed or redeveloped.

Green Development Incentives - Facilitate development incentives and variances for providing additional storage at new developments and redeveloped properties if a "net benefit" to the community would be achieved, such as additional density bonuses for enhanced stormwater management or green infrastructure.

Implementation through Broward Next

Discourage Large Surface Parking Lots: Provide incentives and/or regulations for property owners to replace asphalt parking lots with parking garages or other alternatives.

Adaptively Manage the County's Seawall Ordinance: Revisit minimum elevation requirements for tidal flood barriers as sea levels rise. Prepare an updated seawall ordinance to upgrade seawalls from the current 5.0 feet to 7.0 feet NAVD - or appropriate flood protection levels - based on sea level rise trends and projections.

Resilient Complete Streets Design Standards: Incorporate resilience standards into complete streets projects and standard designs, including bioswales, permeable paving, planted areas, street trees, lighter/reflective paving, and shade structures through resilient complete streets design standards (see NACTO urban street design guide as a reference).

Resilience through Overlay Districts: Explore the use of overlay districts to further resilience as part of land use development requirements, particularly in furtherance of green infrastructure to address the combined heat and flood risk in priority areas.



Questions?