

# IT TAKES A VILLAGE TO SAVE THE VILLAGE

## *Adventures in Vulnerability Assessment with a Focus On Flooding and Stormwater*

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NEMAC+FernLeaf

Florida Stormwater Association  
Annual Conference  
June 2021

# PRESENTATION OUTLINE

- Two Types of Vulnerability Assessment in Florida
- Adventures in Water-Focused Vulnerability Assessment
- All Threats Vulnerability Assessment Adventures
  - Assessing Water Threats
  - Community Assets
  - Social Vulnerability
  - Future Change
- Adaptation Strategies
- Lessons Learned

# VULNERABILITY

“The quality or state of having little resistance to some outside agent”

-Merriam-Webster Dictionary

*(online at <https://www.merriam-webster.com/dictionary/vulnerability>)*

# Florida Vulnerability Assessments: The Two Buckets



<b>Water-Centric Vulnerability Assessment</b>	<b>All Threats Vulnerability Assessment</b>
Usually springs out of a Stormwater Master Plan or Watershed Management Plan	Considers All Climate Threats, Including Water Threats
Usually leverages an in-depth modeling effort for surface and/or groundwater resources	Sometimes leverages an in-depth modeling effort for surface and/or groundwater resources
Until recently, (poor) water quality was not normally considered	Until recently, (poor) water quality was not included as a threat
Tends to be infrastructure focused, but that is changing	Menu focused – broad array of strategies for adaptation
Non-water threats are not considered or only lightly considered	Water is just one threat type but generally plays a prominent role
Stormwater or water resources manager	Sustainability or resilience manager

# Water-Centric Vulnerability Assessments

- **Started with a strong focus on sea level rise**
- **You can take this journey in steps**
- **It is relatively inexpensive to include future scenarios in Stormwater Master Plans, Watershed Management Plans, and Watershed Models**
- **Some of our Water Management Districts are preparing rainfall datasets from Global Climate Models – this would make this type of plan easier for local governments**
- **We need to work on Water Quality Models that provide information on future conditions**
- **In Florida, at the end of the useful life of a stormwater asset designed in 2021, the design storm used to size it will be based on hydrologic data that is almost 100 years old unless we update our cookbooks now**

# Warnings About the “All Threat VA Adventure”

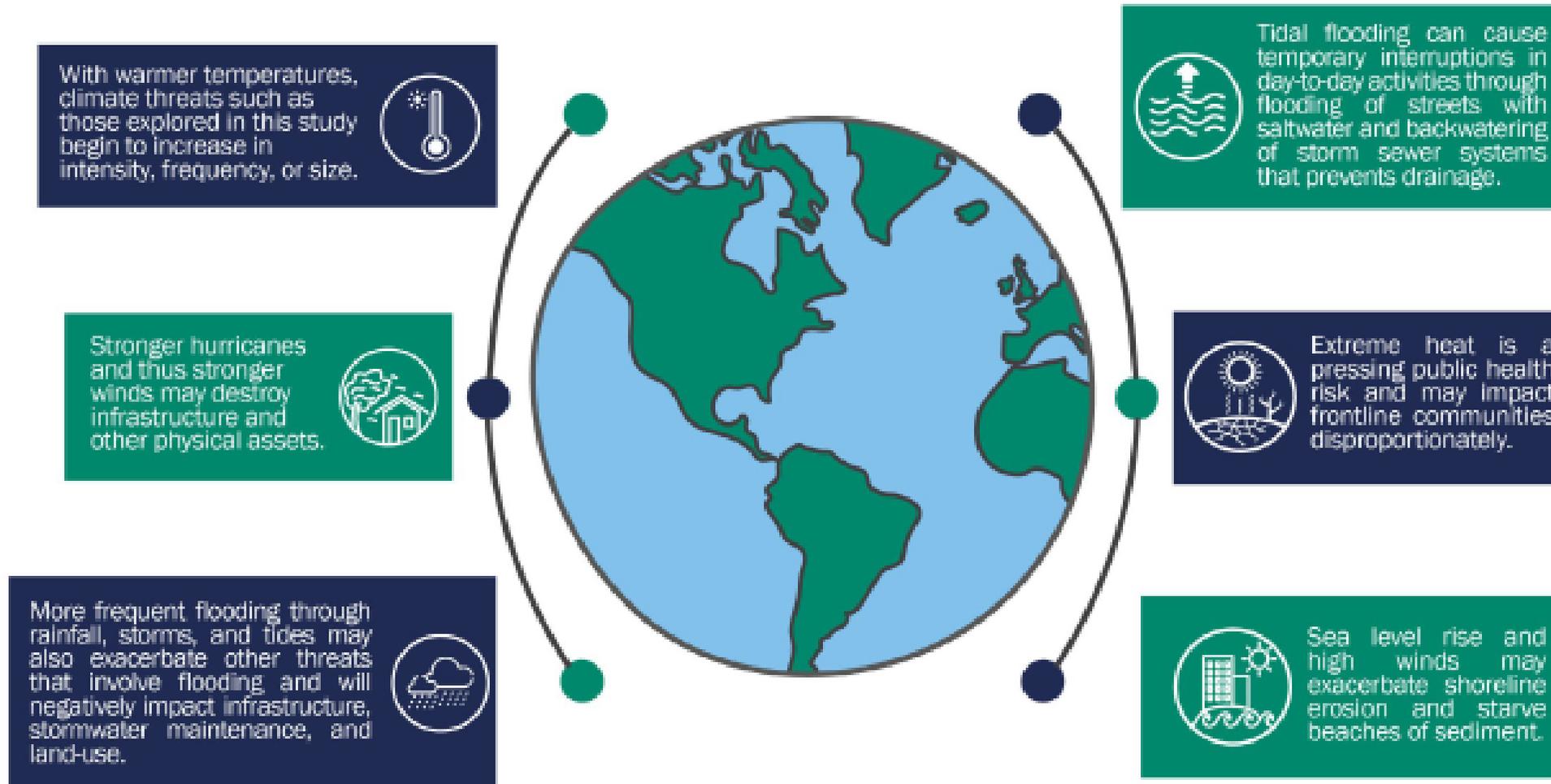
- **The nomenclature is different than our nomenclature in the stormwater arena, but many of the scientific principles are the same (will feel familiar)**
- **You will need to work with a broad array of professionals, personalities, and opinions**
- **A broader AND deeper team is needed**



# Climate Change Impacts 101

Excerpt:  
Executive Summary,  
Coastal Resilience Partnership  
CCVA  
(Brizaga)

Climate is the usual weather conditions expected for a location. Climate change is the change in those usual weather conditions, such as how much rain a location will receive or the average temperature. Increased greenhouse gas emissions by humans is causing changes in our climate on a global scale.



# What are threats or hazards?



Major hazard events or chronic disruptions that negatively impact community assets (e.g. people, infrastructure, services, resources)



Can have the potential to be influenced by changing conditions, resulting in increased frequency or severity in the future



Influenced by stressors

Climate threats are the result of both climate and non-climate stressors

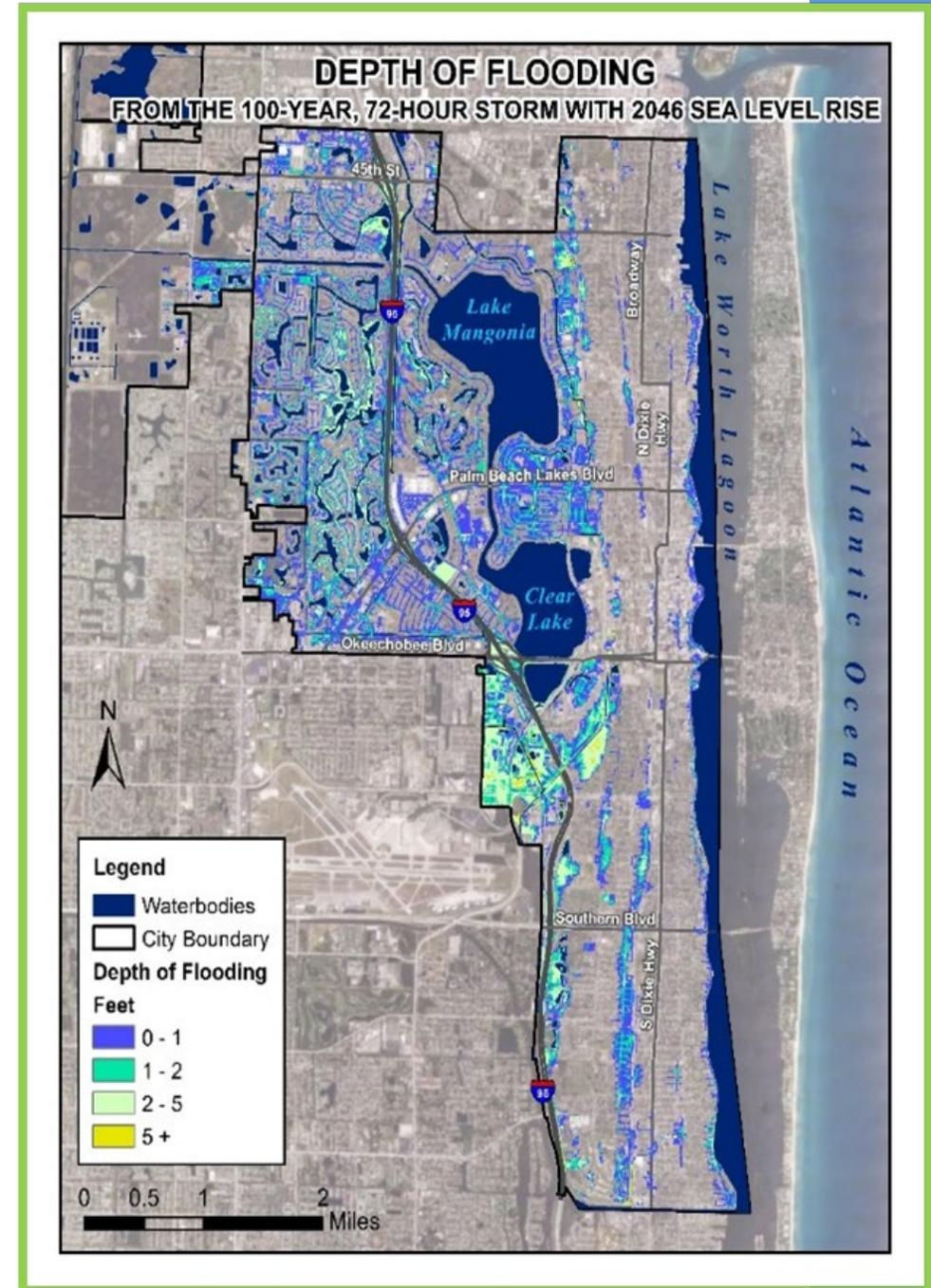


Impact communities in spatially explicit areas, or impact communities as a whole



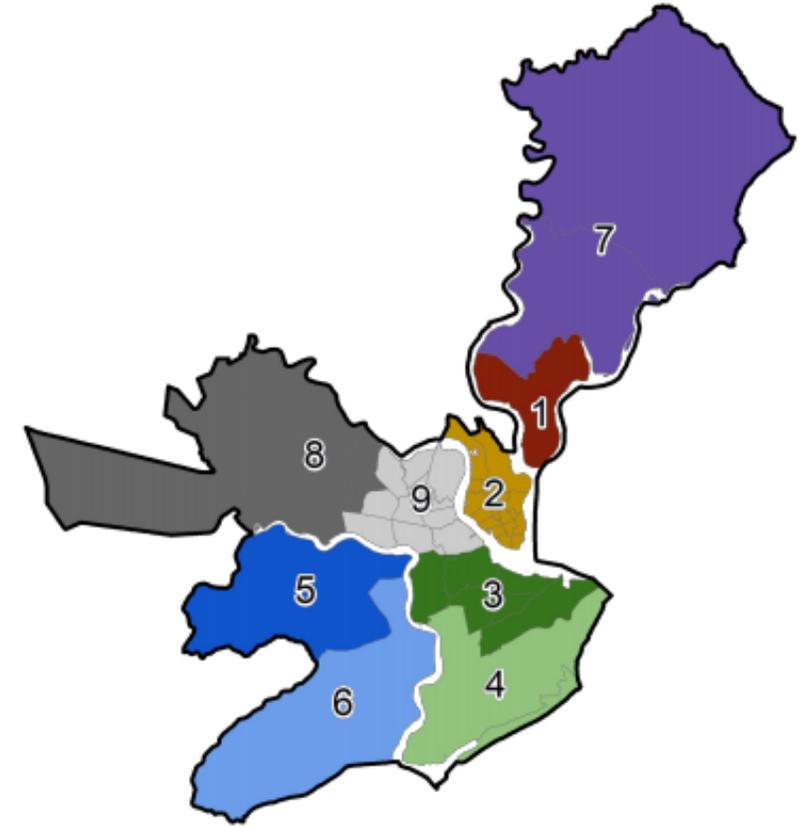
Can be assessed spatially where data is available

# West Palm Beach



# Charleston

## All Hazards Vulnerability and Risk Assessment



FLOODING



SEA LEVEL RISE



EARTHQUAKES



EXTREME HEAT



WATER SHORTAGE



HAZMAT

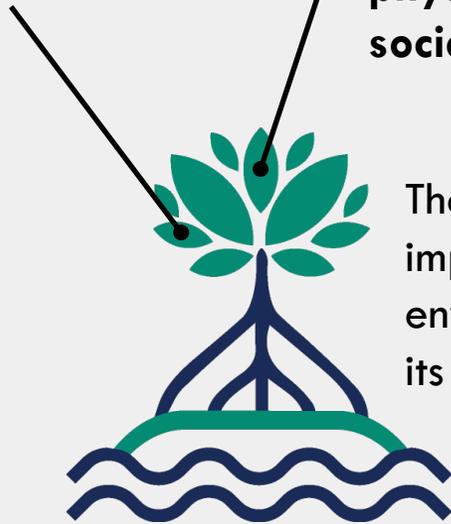
# COASTAL RESILIENCE PARTNERSHIP SOUTHEASTERN PALM BEACH COUNTY

The **eight** smaller leaves represent the local governments in the Coastal Resilience Partnership.

The three bigger leaves represent the regions similar **physical, geographic, and social** characteristics.

The mangrove is a nod to the importance of nature and the environment to the region and its economy.

Water is a tremendous asset to our region but is also a threat. Sea level rise is the most obvious sign of climate change in the region.



Unincorporated Palm Beach County

Lake Worth Beach

Lantana

Ocean Ridge

Boynton Beach

Delray Beach

Highland Beach

Boca Raton



# STUDY PROCESS

**1. Explore Climate Threats**



**2. Assemble Data**



**3. Assess Vulnerabilities and Risks**



**4. Investigate Potential Adaptation Strategies**



**5. Report and Tool Deployment**



# TOP DOZEN THREATS



High Winds



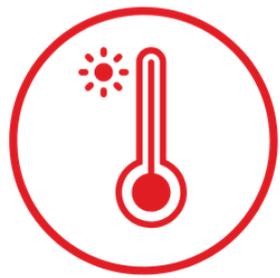
Rainfall-Induced Flooding



Harmful Algal Blooms



Pest & Disease Outbreaks



Extreme Heat



Drought



Wildfire



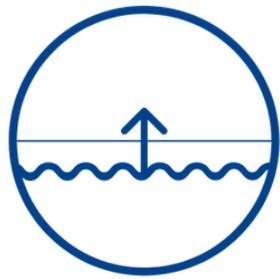
Shoreline Recession



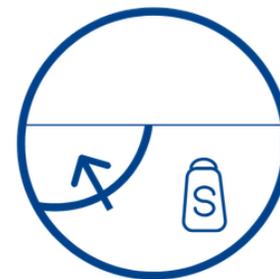
Tidal Flooding



Storm Surge



Groundwater Inundation



Saltwater Intrusion

# PUBLIC OUTREACH OVERVIEW

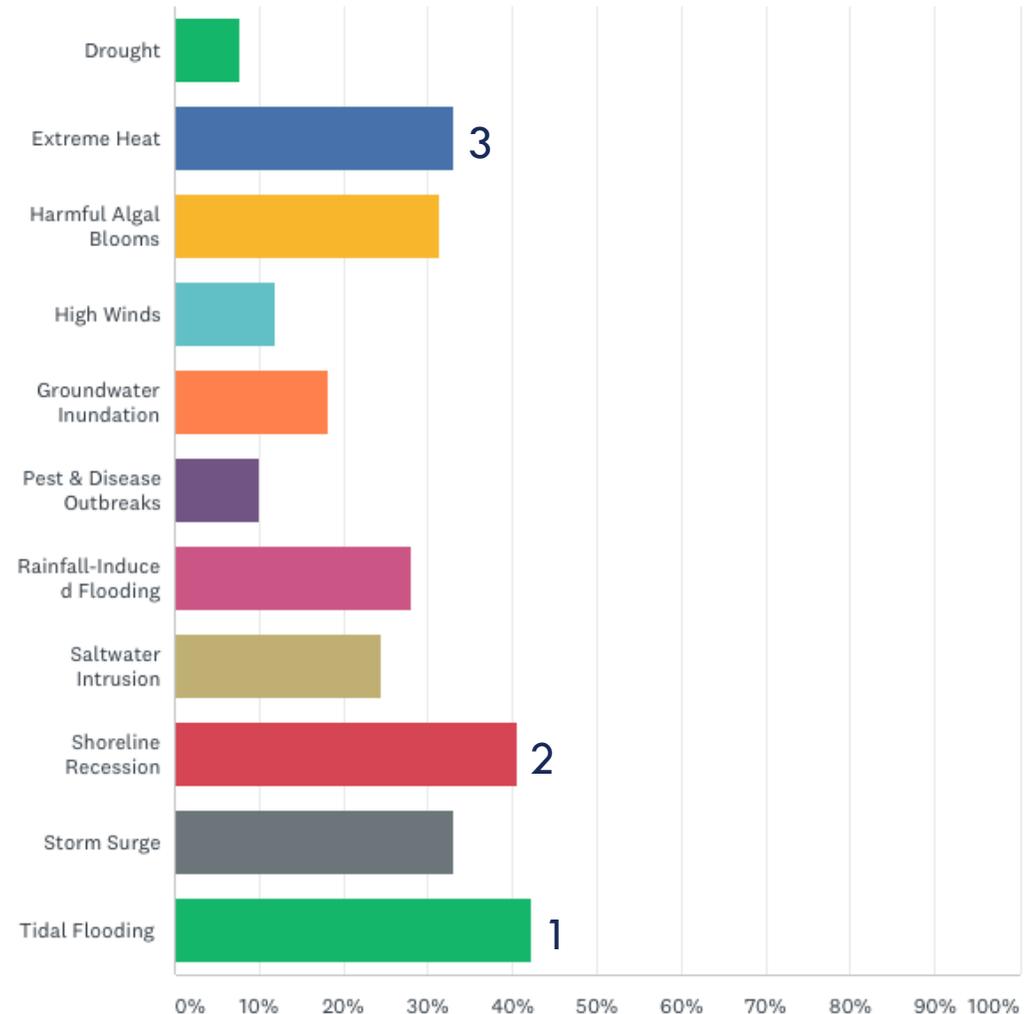
Public Engagement was an important part of this project and an essential part of the work of the Coastal Resilience Partnership.

**Two public workshops** were held as part of this study, and a third will be held to release the results. **Six staff workshops** were held as part of this study.

A **microregional survey** was done to help inform adaptation strategies.

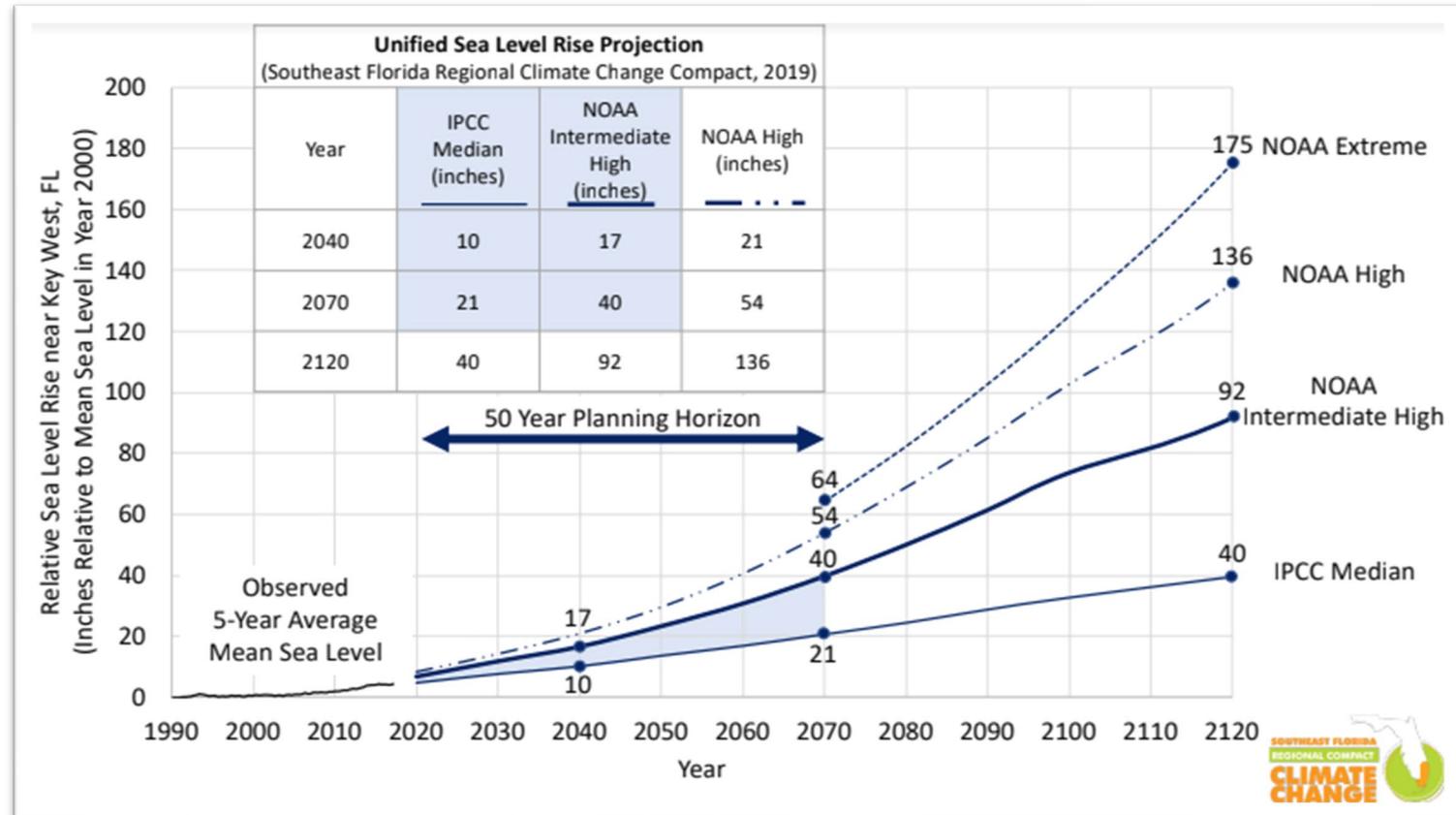
The CRP is looking at how 12 climate threats may affect our local area. In your opinion, which of these climate threats will have the biggest negative impact in Southeast Palm Beach County? (Check up to 3)

Answered: 558 Skipped: 87



# Sea level rise is a primary stressor to multiple threats

- Storm Surge: SLR is a component that increases risk
- Tidal Flooding: SLR will increase frequency and severity until a threshold of persistent inundation could be reached
- Groundwater/Saltwater Intrusion: SLR is the primary cause of these threats
- Rainfall-Induced Flooding: SLR interacts as a compounding event in coastal areas
- Shoreline Recession: SLR accelerates the movement of shoreline





# SEA LEVEL RISE PROJECTIONS

**NOAA High**  
Recommended for Sensitive and Critical Infrastructure

**NOAA Intermediate High**  
Recommended for Assets with Adaptive Capacity

**IPCC Median**  
Recommended for Assets with Short Life Cycle

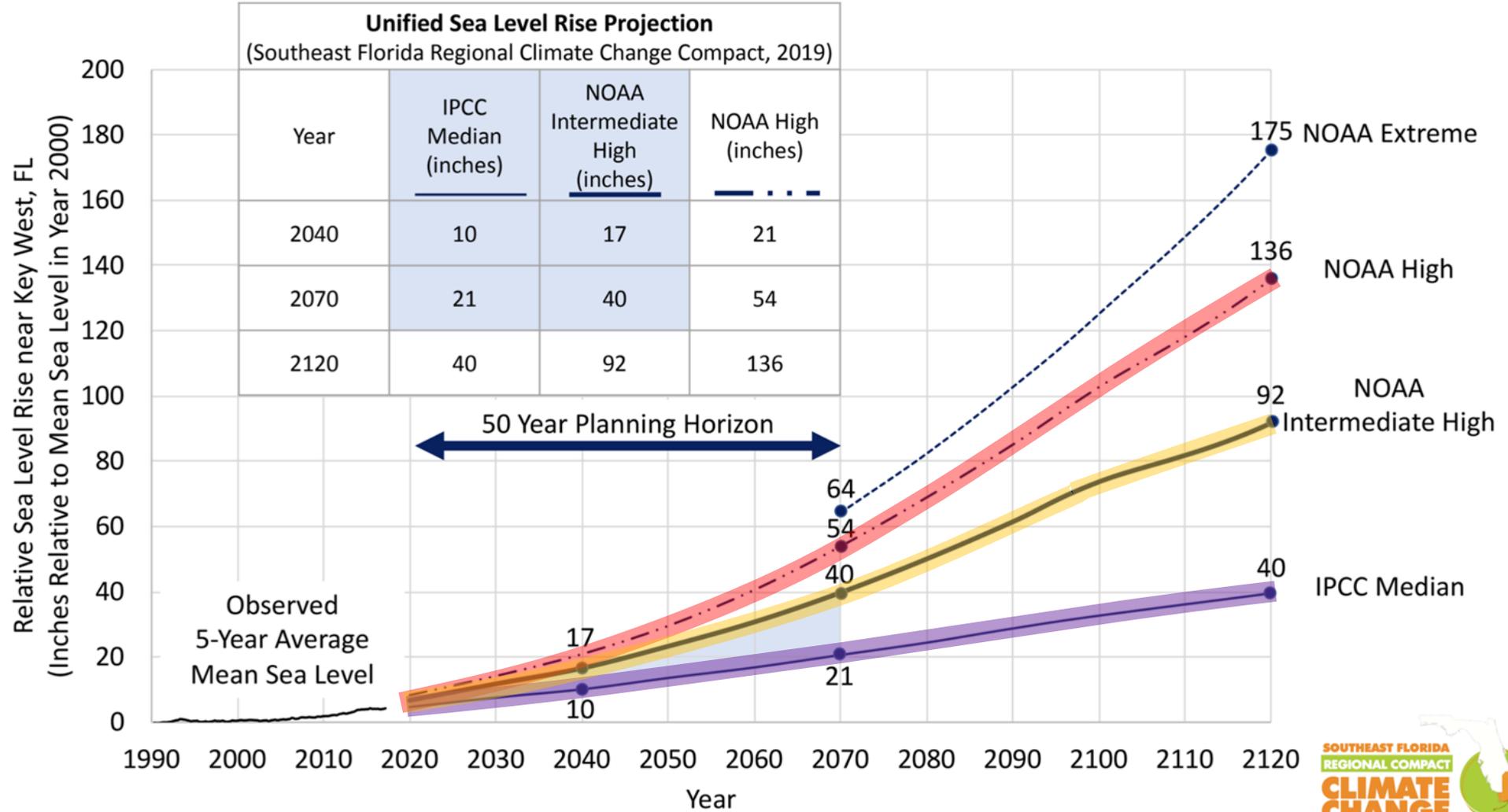


FIGURE 1: Unified Sea Level Rise Projection



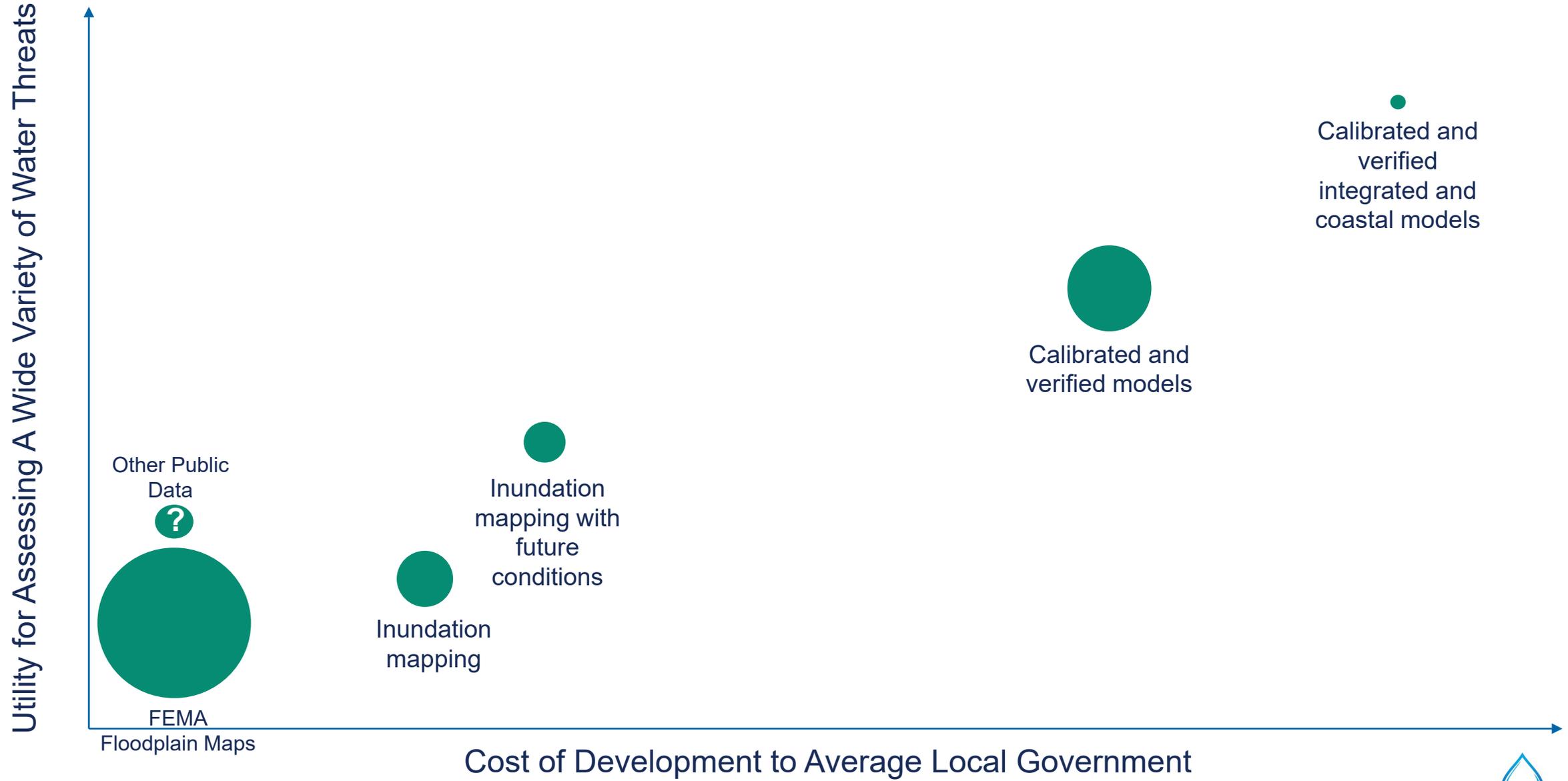
# CRP FLOOD SCENARIOS

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- The four selected thresholds are:
  - Current sea level (2020)
    - Rainfall-induced flooding analyzed the 25-, 100-, and 500-year/24-hour storm events)
  - 5 inches above current sea level (IPCC Median 2040)
  - 13 inches above current sea level (NOAA High 2040, serves as low-end of 2070 projection)
  - 33 inches above current sea level (NOAA Intermediate High 2070)

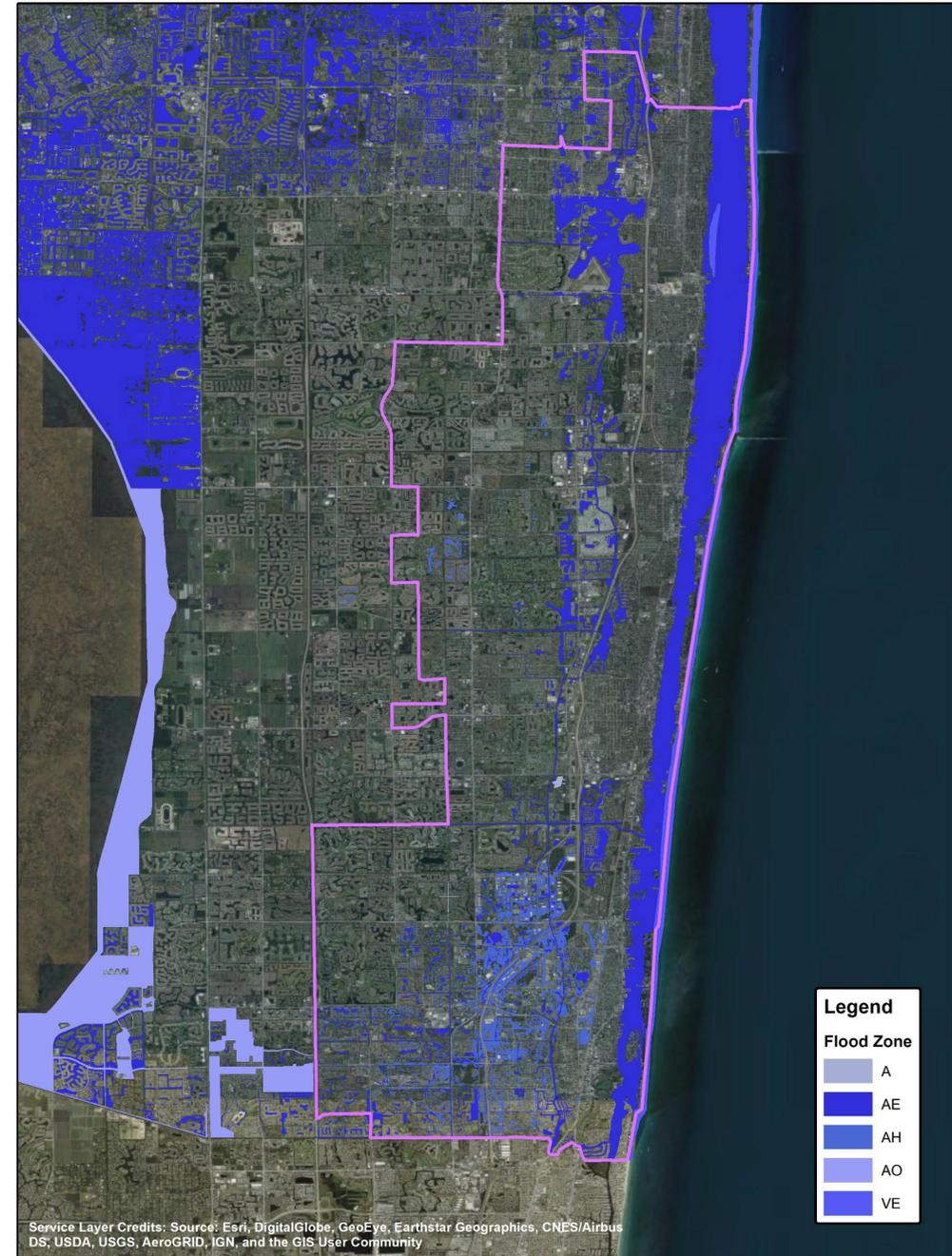


# FLOOD DATA USED IN “ALL THREAT” VULNERABILITY ASSESSMENTS

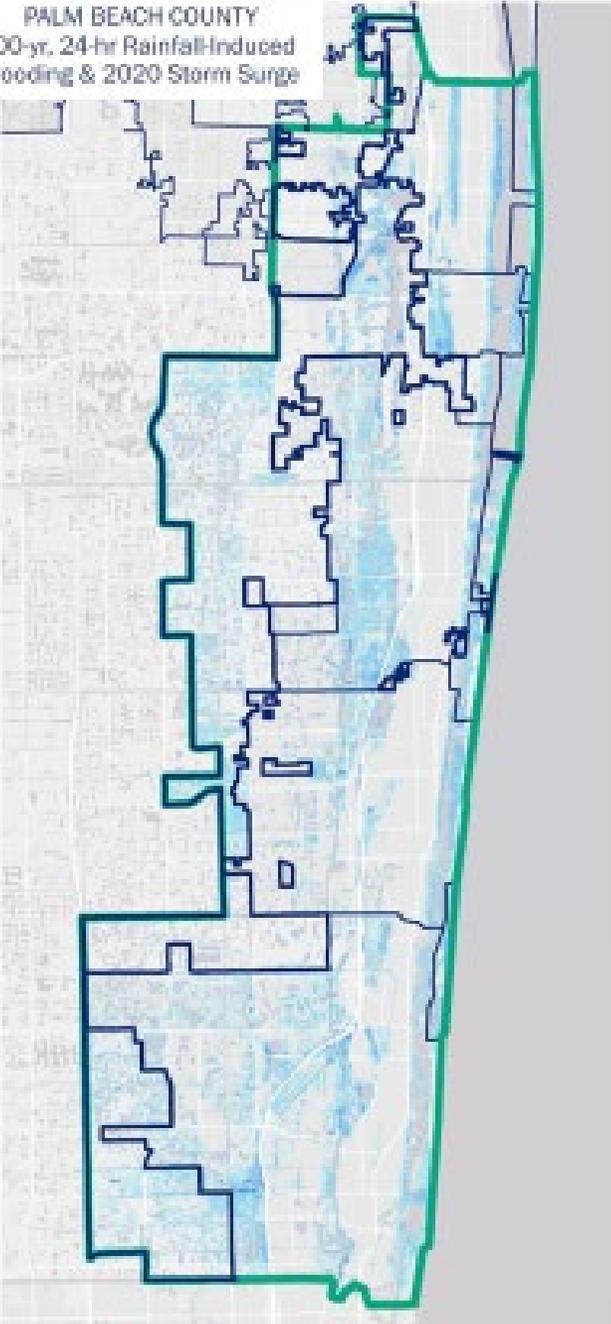


● = size of the dot indicates subjective number of VAs using this approach

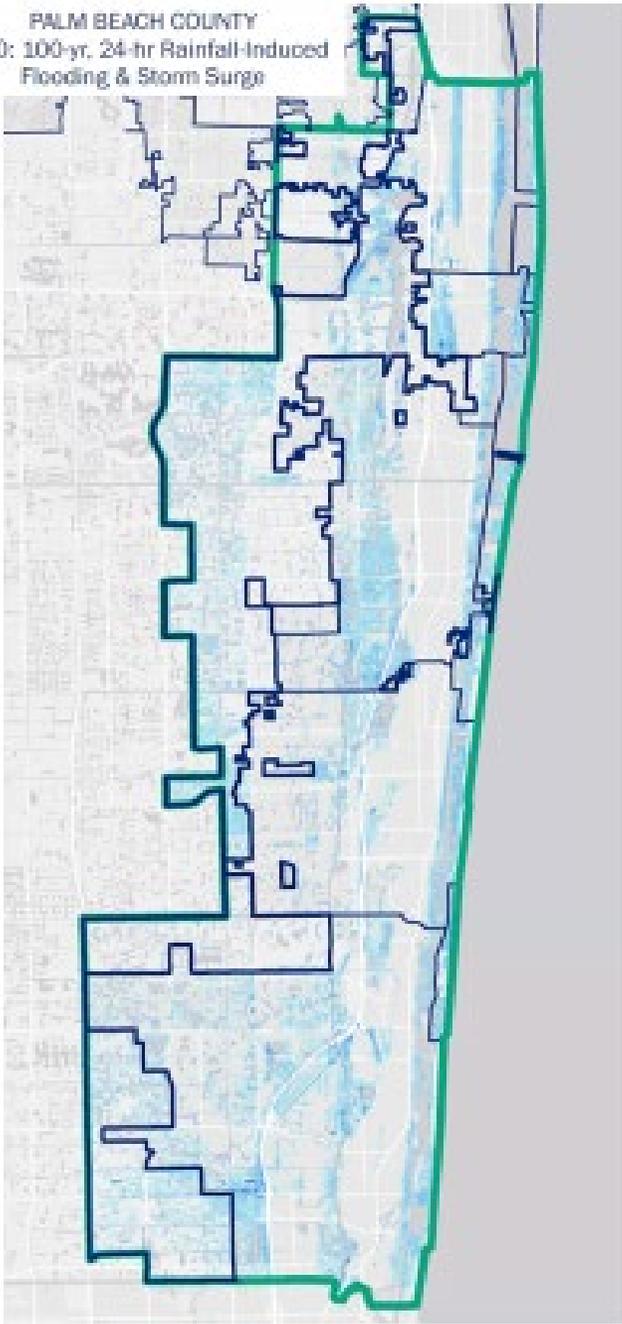
# FEMA HIGH RISK FLOOD ZONE COVERAGE FOR CCVA STUDY AREA



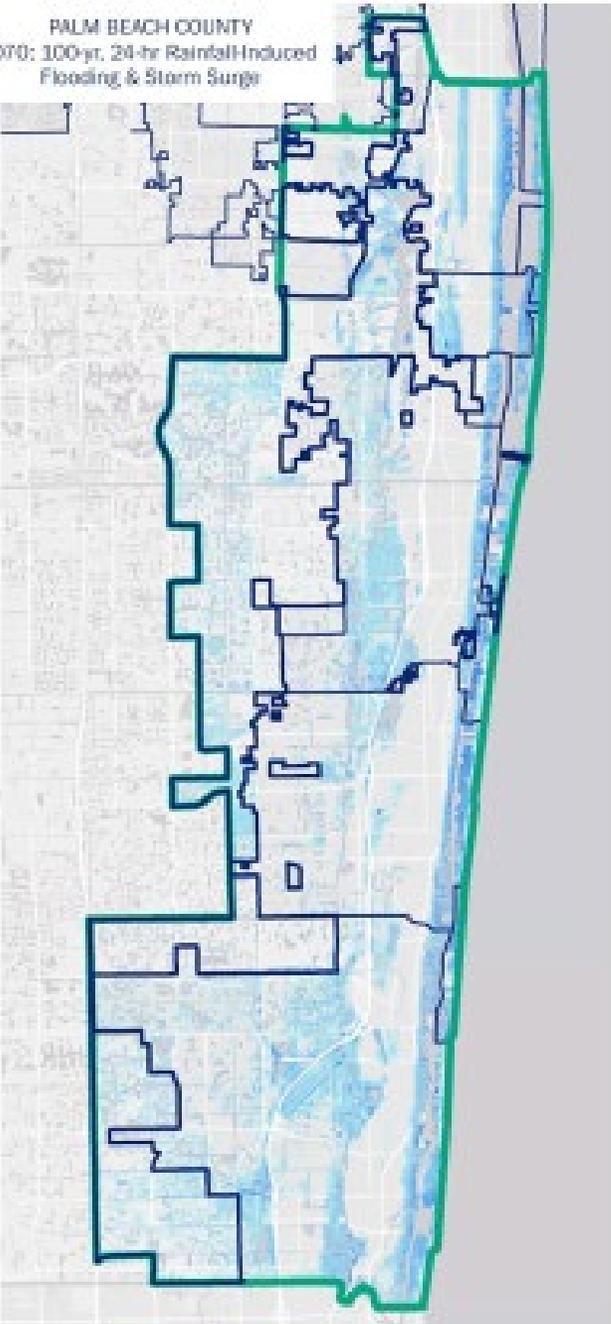
PALM BEACH COUNTY  
100-yr, 24-hr Rainfall-Induced  
Flooding & 2020 Storm Surge



PALM BEACH COUNTY  
2040: 100-yr, 24-hr Rainfall-Induced  
Flooding & Storm Surge



PALM BEACH COUNTY  
2070: 100-yr, 24-hr Rainfall-Induced  
Flooding & Storm Surge

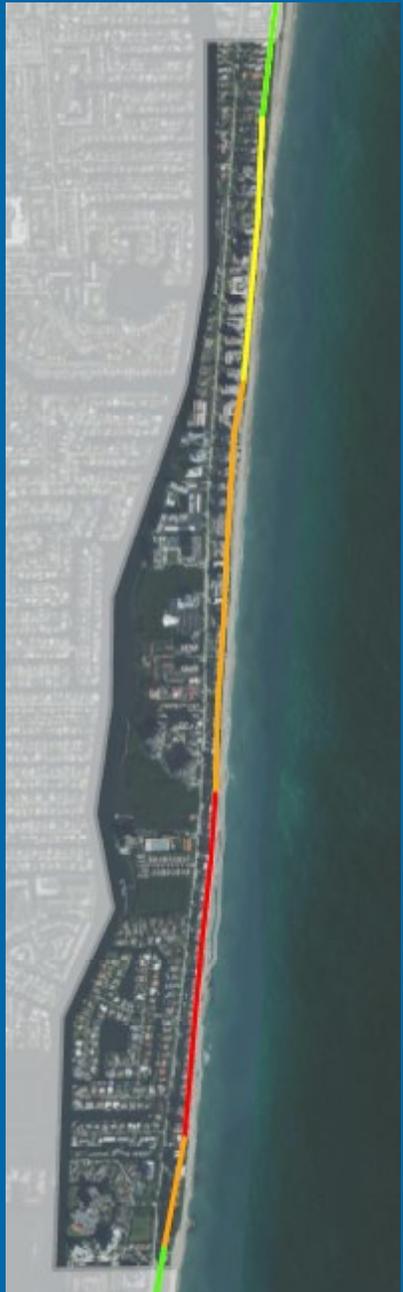




## PROJECT INNOVATIONS FOR WATER THREATS

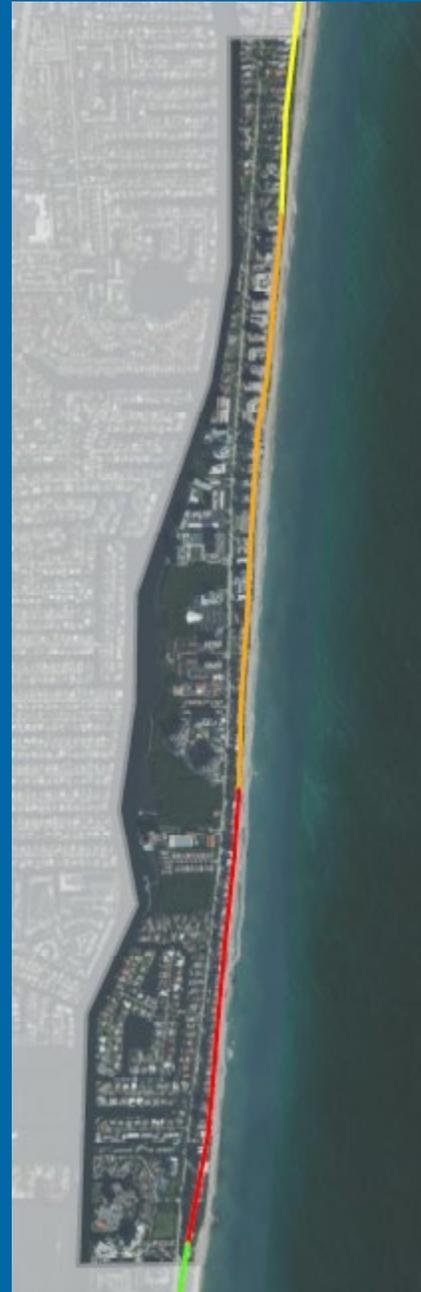
- **Use of depth grids for evaluating water threats (Collective and ATM)**
- **Development of a Shoreline Recession Index (Melany Larenas, ATM)**
- **Water Threats included HABs, Drought, Groundwater Inundation, Tidal Flooding, Rainfall-Induced Flooding, Storm Surge, and Saltwater Intrusion, and Pest & Disease**





**Legend**

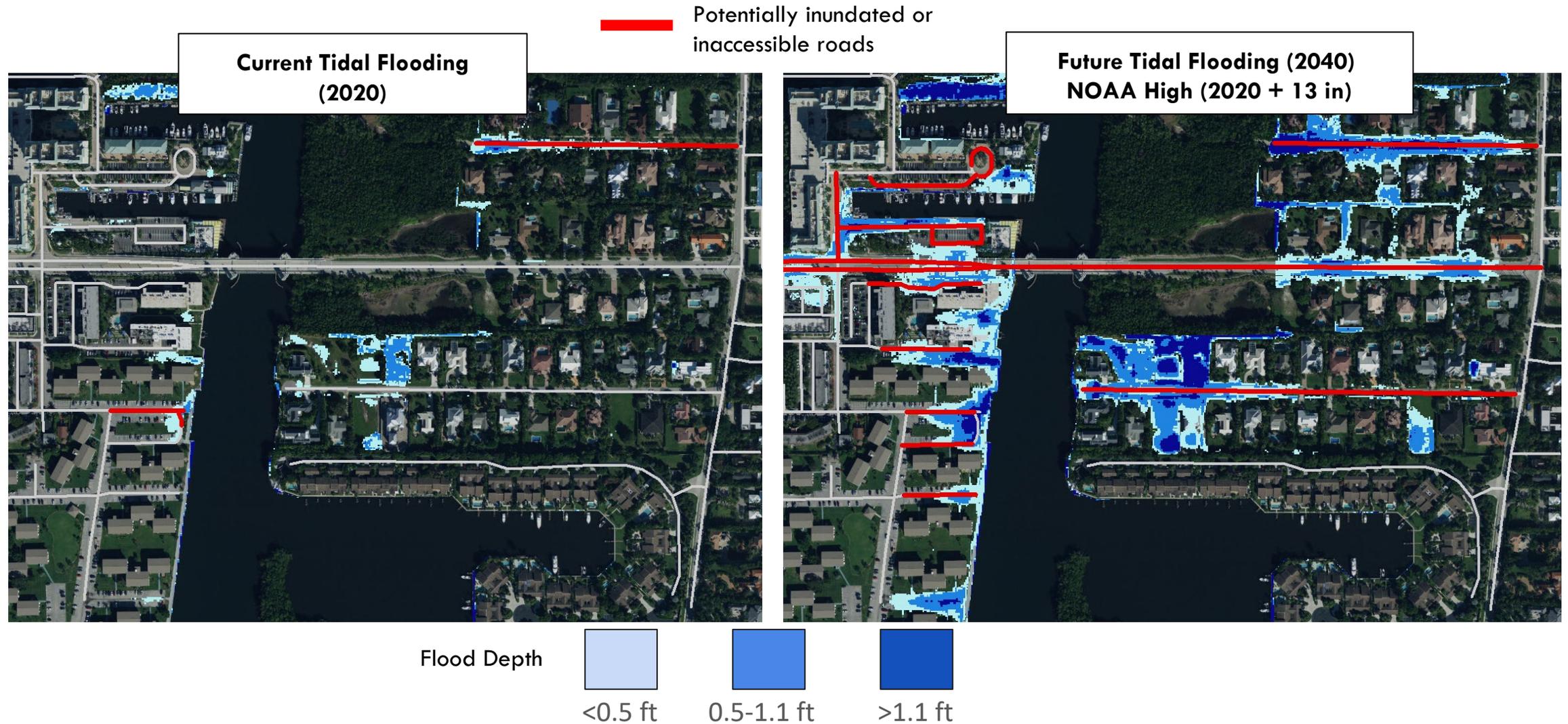
- Recession Index 2040  
5" SLR
- |  |   |
|--|---|
|  1 - Severe |  4 - Good      |
|  2 - Poor   |  5 - Excellent |
|  3 - Fair   |   |



**Legend**

- Recession Index 2070  
33" SLR
- |  |   |
|--|---|
|  1 - Severe |  4 - Good      |
|  2 - Poor   |  5 - Excellent |
|  3 - Fair   |   |

# Roadway Example: Future Change and Adaptation Based on Vulnerability Assessment Output

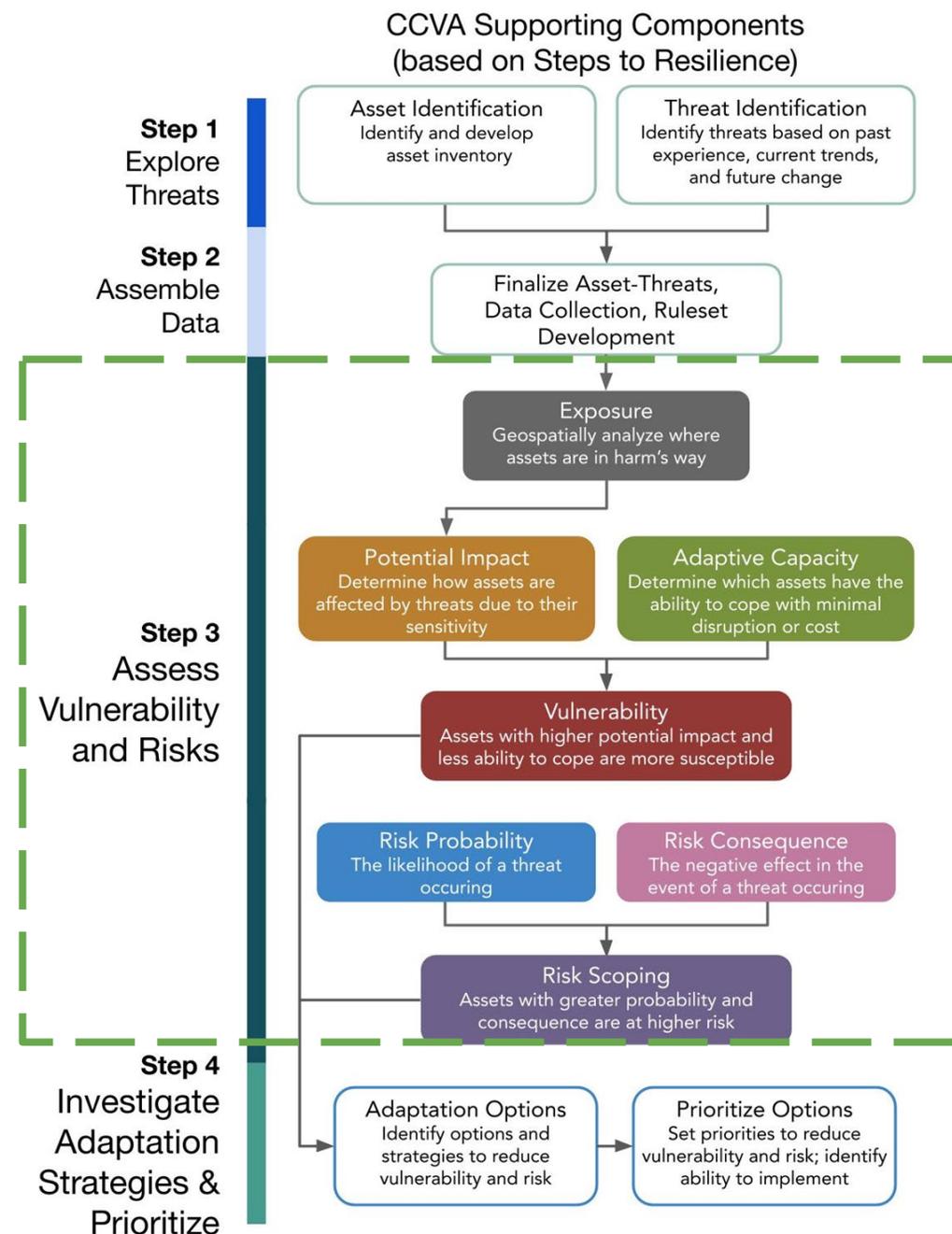


# Assessment Framework

Data-driven approach that focuses on aspects of:

**Vulnerability:** Susceptibility based on sensitivity/potential impact and adaptive capacity

**Risk Scoping:** The probability and negative consequence of threats.



# Asset Themes and Categories

The assessment considers assets and the services they provide

## Critical Facilities

- Energy & Communications
- Food Infrastructure
- Health & Medical
- Public Safety, Gov & Schools
- Transportation Facilities
- Water Infrastructure

## Property

- Commercial & Industrial
- Residential
- Parks & Cultural

## Natural Areas

### Roads & Mobility

- Major Roads
- Minor Roads
- Critical Access

### Economic Factors

- Assessed Property Value
- Sales Volume
- Jobs

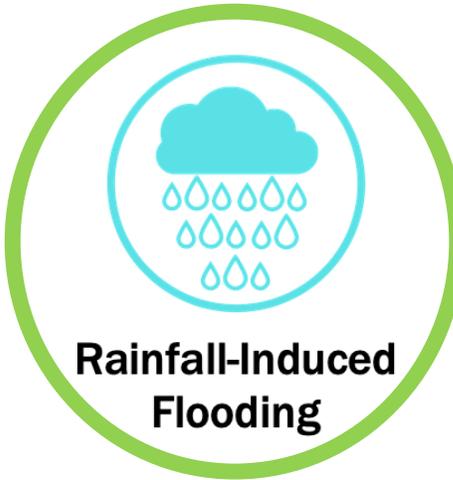
### People and Sensitive Populations



# Top Dozen Threats



High Winds



Rainfall-Induced Flooding



Harmful Algal Blooms



Pest & Disease Outbreaks



Extreme Heat



Drought



Wildfire



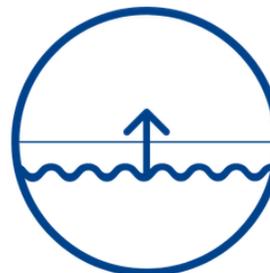
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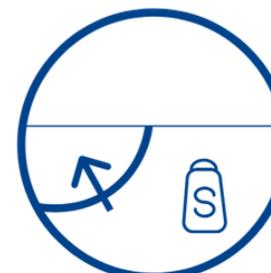
Tidal Flooding



Storm Surge



Groundwater Inundation



Saltwater Intrusion



# Same Exposure, Different Vulnerability



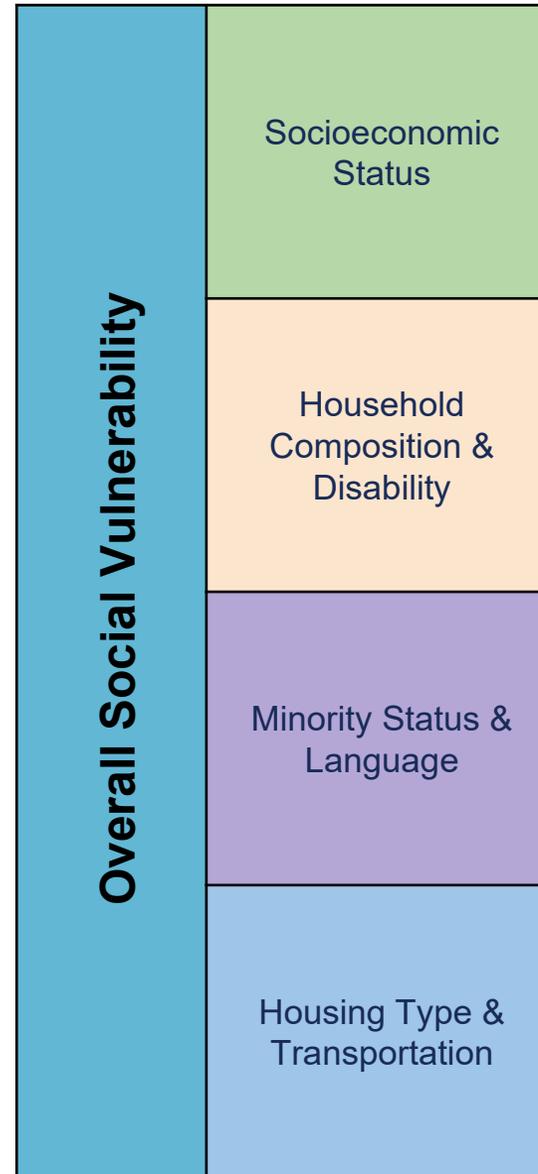
## Asset-scale Assessment Factors

- ✓ Criticality of buildings in floodplain
- ✓ BFE requirements
- ✓ Likelihood of flooding (e.g., 25-, 100-, 500-year flood risk)
- ✓ Potential flood depth

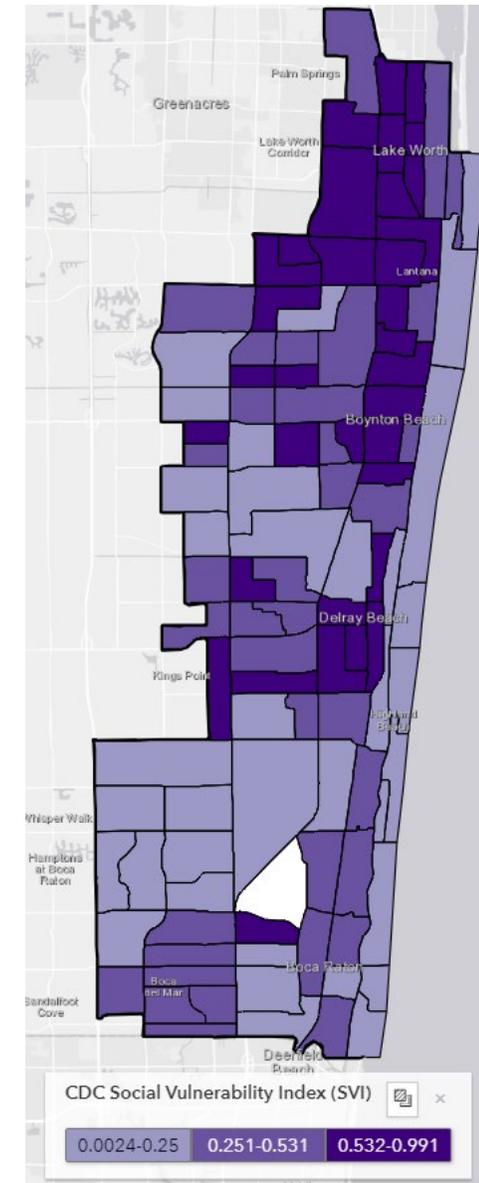
# Social Vulnerability

## Three types of considerations

1. Co-occurrence with physical vulnerability
2. Disruption or loss of critical community resource or services
3. Community stressors exacerbated by climate events



CDC's SVI Themes



# 2020 Conditions

Vulnerability and Risk for a few selected asset categories:

	<b>Total Assets</b>	<b>Rainfall Induced Flooding (2020, 100-yr)</b>	<b>Storm Surge (2020, 100-yr)</b>	<b>Tidal Flooding (2020)</b>
<b>Food Infrastructure</b>	219	42 (19%)	7 (3%)	1 (0.46%)
<b>Health &amp; Medical</b>	207	34 (16%)	5 (2%)	0
<b>Public Safety, Gov &amp; Schools</b>	1,466	146 (10%)	115 (8%)	3 (0.2%)
<b>Commercial &amp; Industrial</b>	3,792	616 (16%)	176 (5%)	13 (0.34%)
<b>Residential</b>	113,571	20,207 (18%)	8,458 (7%)	341 (0.3%)

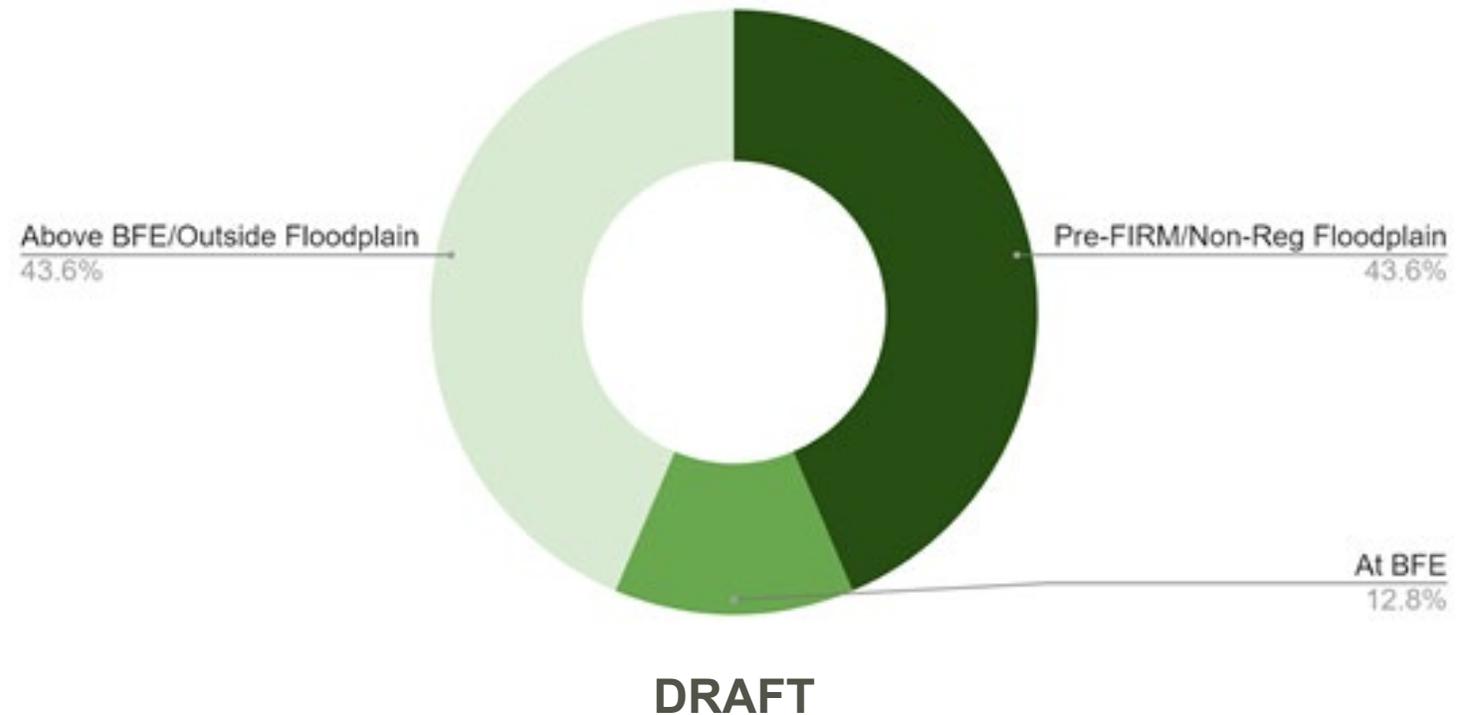


# Adaptive capacity is a driver of vulnerability to flooding

## Example: Residential properties and Rainfall Induced Flooding

Properties with low adaptive capacity (dark green) are those constructed before the first floodplain development ordinances or are outside the 100-yr regulatory floodplain extent

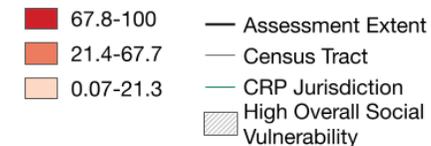
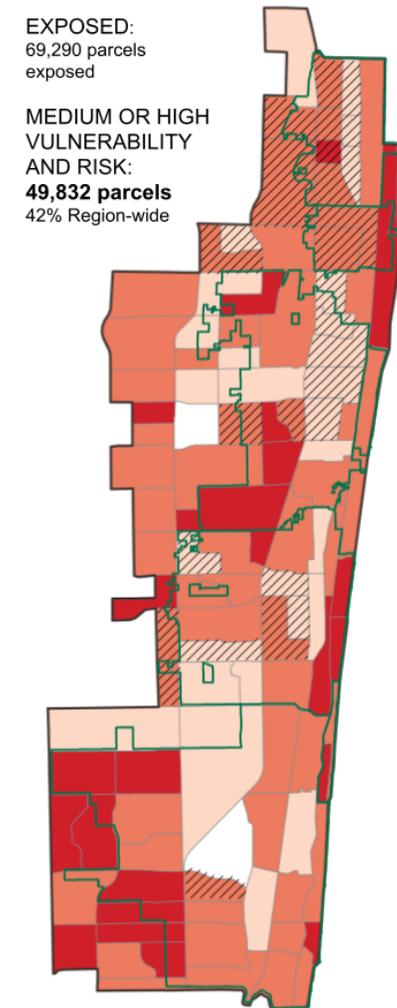
### Levels of Adaptive Capacity for Residential Properties Exposed to Rainfall Induced Flooding



# Example: Residential Property and Rainfall Induced Flooding

Census tract-level summary maps help to identify areas with highest levels of vulnerability and risk

- Residential has the highest level of vulnerability and risk (42% overall, 18% 100-yr only)
- High levels of vulnerability and risk associated with 16 of the most socially vulnerable census tracts
- 18 of the 69 (26%) assisted/public housing vulnerable and at risk

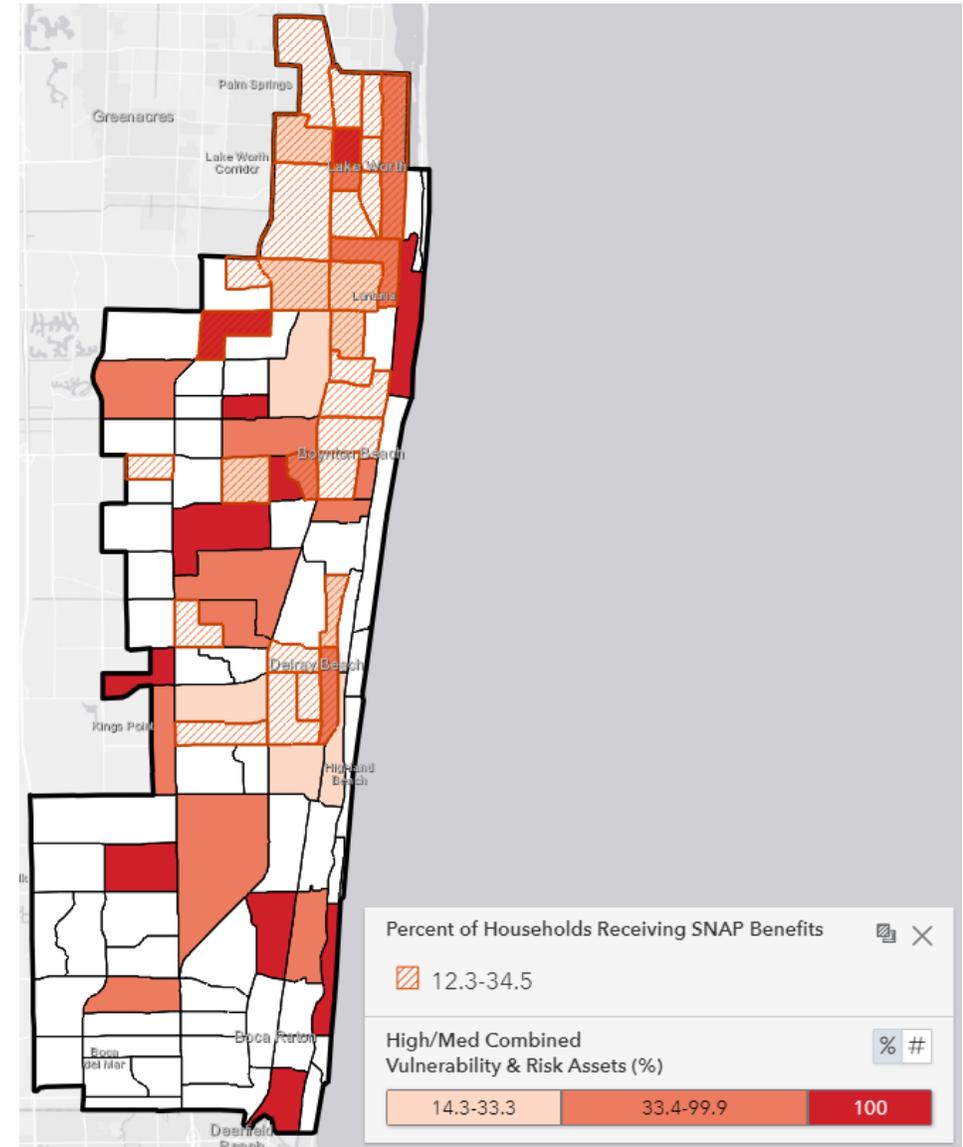


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# Example: Food Infrastructure and Rainfall Induced Flooding

More than a third of all food retailers/pantries are vulnerable across the region (including in about half of the highest SNAP participation areas)

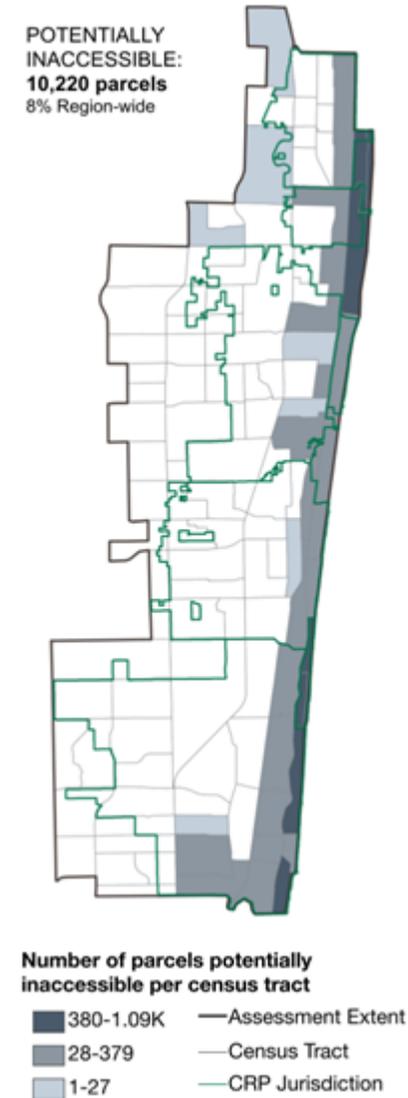


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## Example: Road Access and Storm Surge

- About 8% of major and 9% of minor roads with potential inaccessibility
- Over 10,000 (8%) of properties are also vulnerable to potentially inaccessibility
- Access determined from any fire station location and at least 0.5 ft of depth
- Social and Transportation vulnerability should be a key consideration for hazard mitigation, preparedness and evacuation/ response

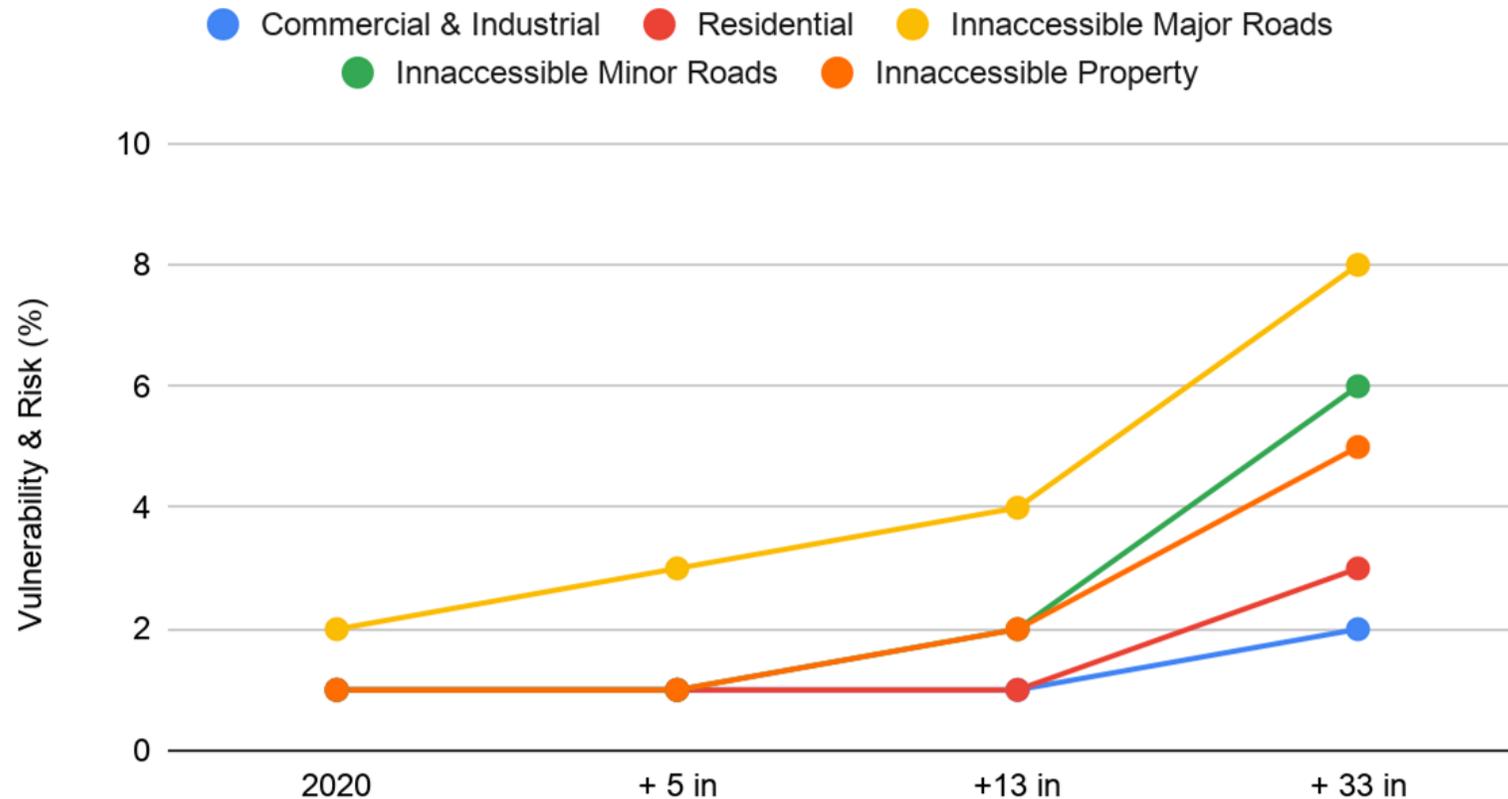


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# Future Change Example: Tidal Flooding

Assessment shows potential for increasing vulnerability and risk over time. Road connectivity related vulnerabilities are the most widespread and have the highest percentages vulnerable

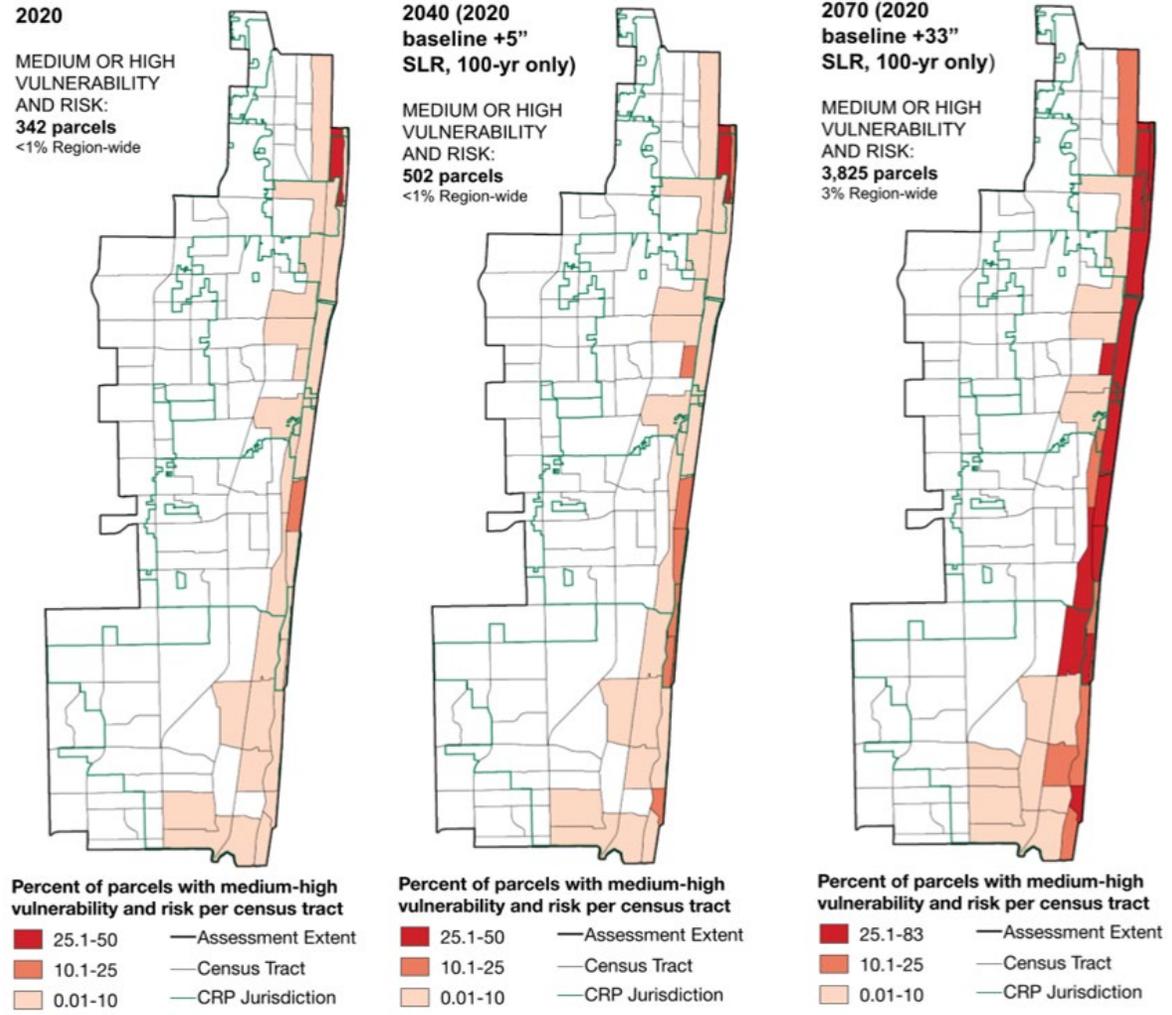


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# Future Change Example: Tidal Flooding

Vulnerability and risk to residential properties increases more than ten times between 2020 and 2070 (2020 baseline + 33" SLR)



**DRAFT**





# OVERVIEW OF ADAPTATION STRATEGIES

 <b>Infrastructure</b>	Physical Infrastructure
	Green Infrastructure
 <b>Land Use, Zoning, Building Codes and Standards</b>	Land Use - Practice
	Land Use - Planning
	Land Use - Policy
	Building Codes/Standards
 <b>Planning, Policy and Management (non- land use)</b>	Planning
	Policy
	Operations and Practice

 <b>Capacity Building</b>	External Partnerships
	Analysis and Research
	Monitoring and Technology
	Community Resources
 <b>Public Outreach</b>	Public Communication
	Community Engagement
 <b>Funding &amp; Financing</b>	Local Funding
	External Funding
	Financing

# Lessons Learned – Vulnerability Assessment Flood Mapping and Water Threats

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- Schedule time for post processing
- Analysis needs to fit the personality, schedule, and expectations of the community
- Florida needs to start developing more information on future hydrologic conditions and collaborating more with our Water Management Districts
- Depth grids are informative but time consuming to use
- Learning more about the data you lack is part of your VA process
- Consider packaging your final threat data in different ways
- This is a journey – get started early

# THANKS TO THE VILLAGE!

## Coastal Resilience Partnership

Boca Raton

Boynton Beach

Delray Beach

Lantana

Ocean Ridge

Highland Beach

Lake Worth Beach

Palm Beach County

City of West Palm Beach

City of Charleston

Lake Worth Drainage District

SFWMD

Broward County

Brizaga

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Erin Deady, PA

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Jones Edmunds: Justin Gregory

# Q&A

