

# IMPROVED PLANNING PROCESSES TO PROTECT INFRASTRUCTURE FROM COASTAL FLOOD HAZARDS

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SOUTH FLORIDA REGIONAL COUNCIL





**What's the need? Data driven decision-making - CPOK**

**What is being done? Overview of initiatives**

**The Infrastructure Protection Resources Project**

**Trainers and Tools: Coastal Flood Hazard Resiliency**

**Next Steps Moving Forward**



# NEED TO ADDRESS CURRENT & FUTURE IMPACTS

- Tidal Flooding
- Saltwater Intrusion
- Failing Drainage
- Malfunctioning Canals
- Beach Erosion
- Habitat loss
- Reduced Groundwater Storage

#### GLOBAL MEAN SEA LEVEL

↑ 3.4  $\pm 0.4$   
mm/yr

#### OCEAN MASS

↑ 1.8  $\pm 0.4$   
mm/yr

#### STERIC HEIGHT

↑ 0.8  $\pm 0.2$   
mm/yr

#### GREENLAND ICE MASS CHANGE

↓ 287  $\pm 29$   
Gt/yr

#### ANTARCTICA MASS VARIATION

↓ 134  $\pm 79$   
Gt/yr

## Understanding Sea Level

NASA keeps track of sea level change and its causes from space. Find out more about how NASA satellite observations help our understanding of this complex topic.

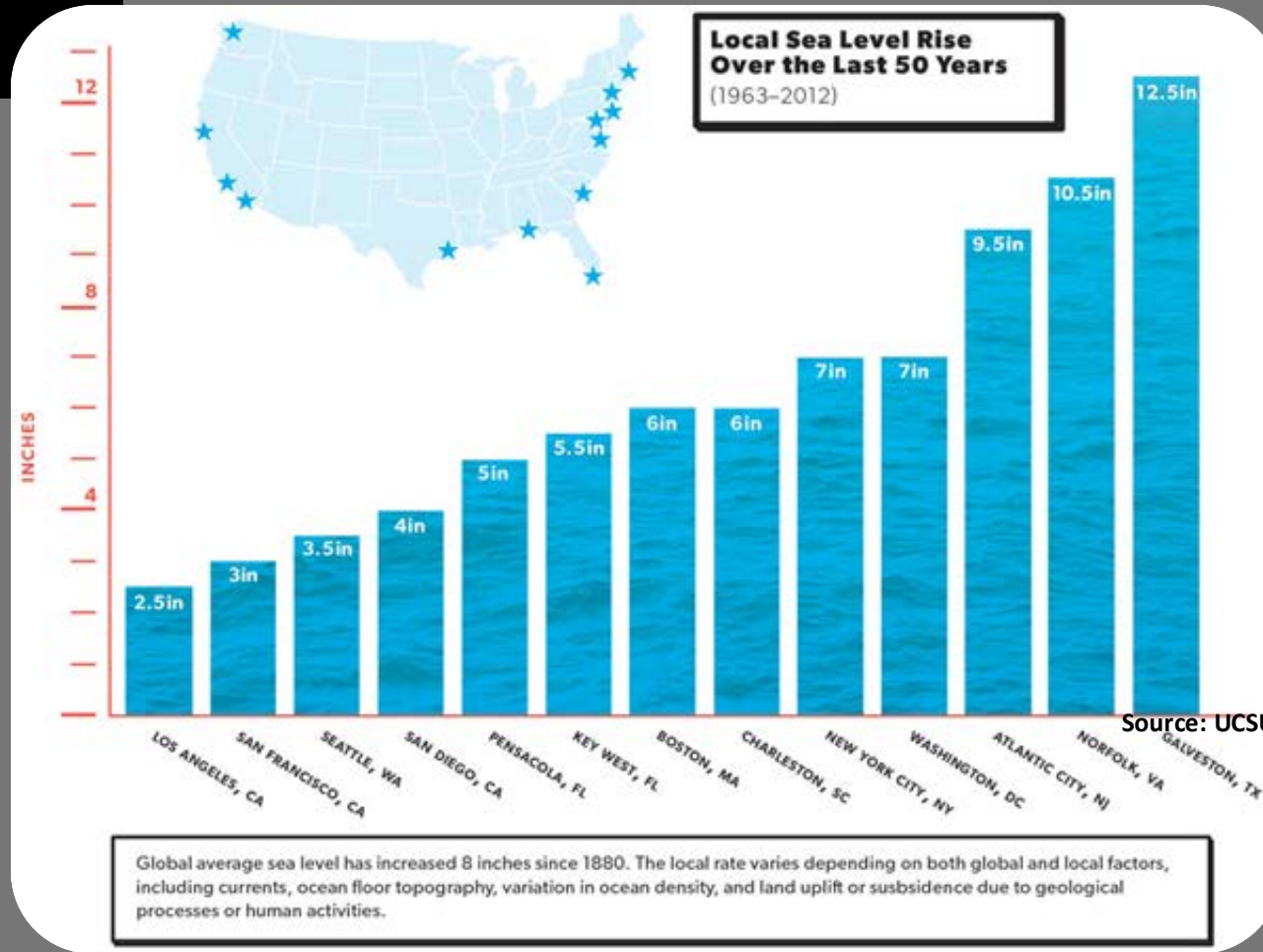
Causes

Observations

Projections

Adaptation

# WHAT CAUSES CHANGES IN SEA LEVEL?



- LOCAL Sea level rise
- GLOBAL Sea level rise
  - Land ice accounted for about 65% of the total SLR budget from 1993 to 2008.

(Church et al., 2011)

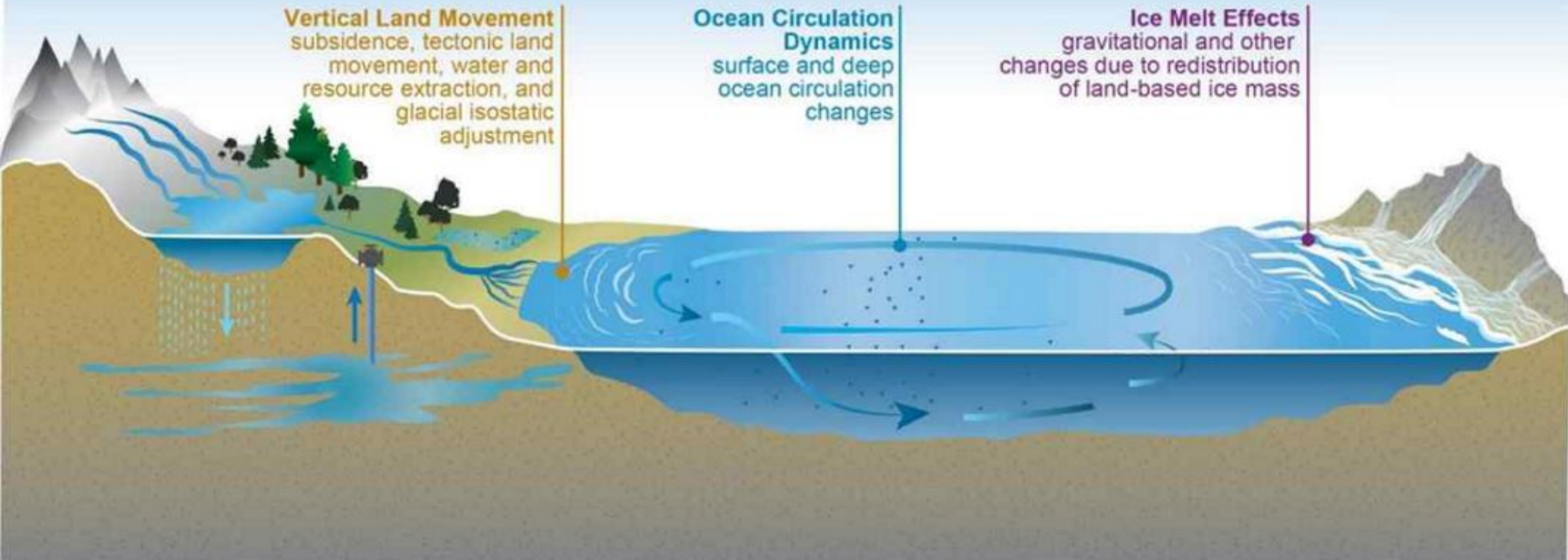
# Regional Sea-Level Rise

Factors that Affect Regional  
and Local Sea Level

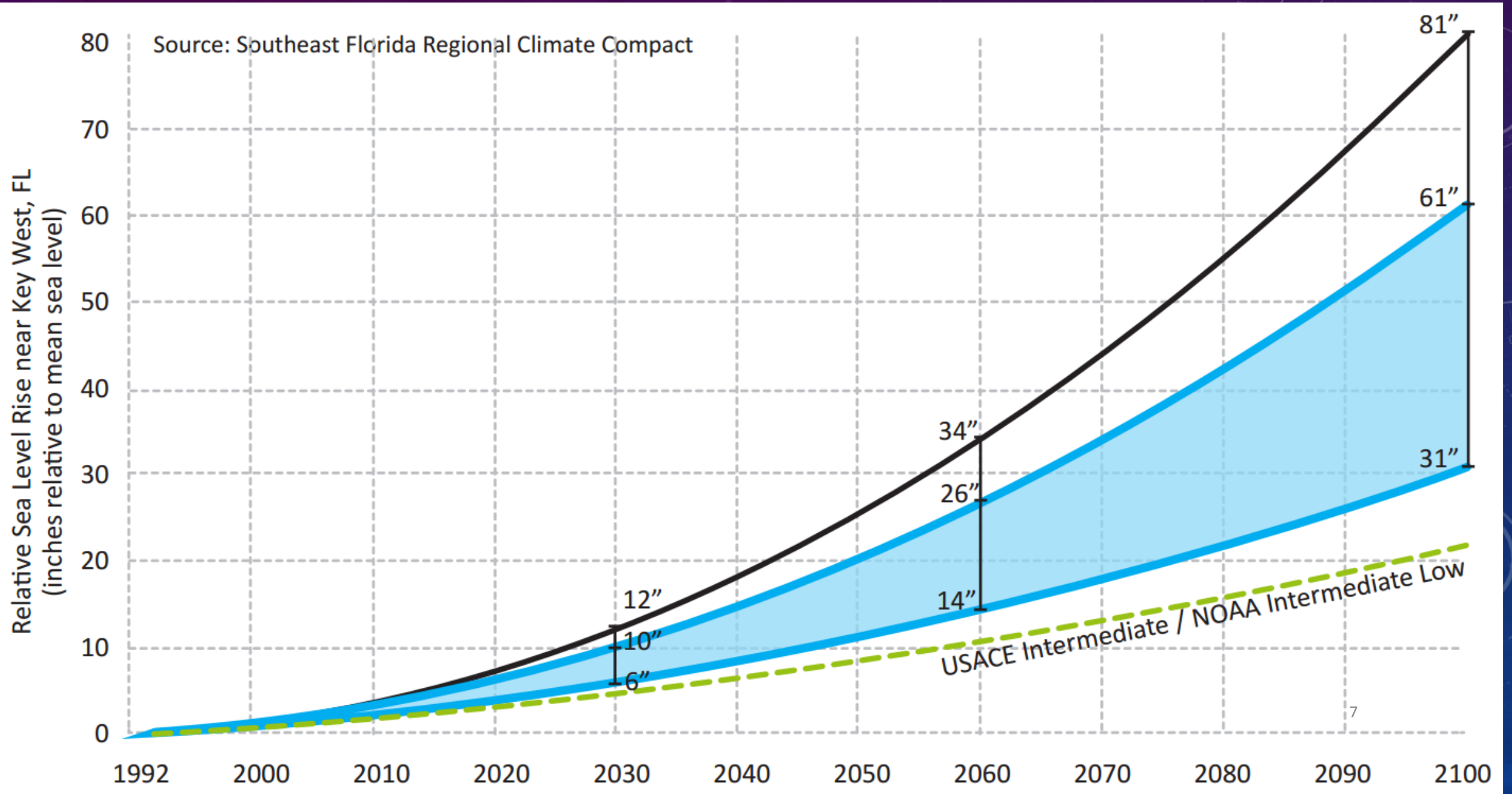
**Vertical Land Movement**  
subsidence, tectonic land  
movement, water and  
resource extraction, and  
glacial isostatic  
adjustment

**Ocean Circulation  
Dynamics**  
surface and deep  
ocean circulation  
changes

**Ice Melt Effects**  
gravitational and other  
changes due to redistribution  
of land-based ice mass



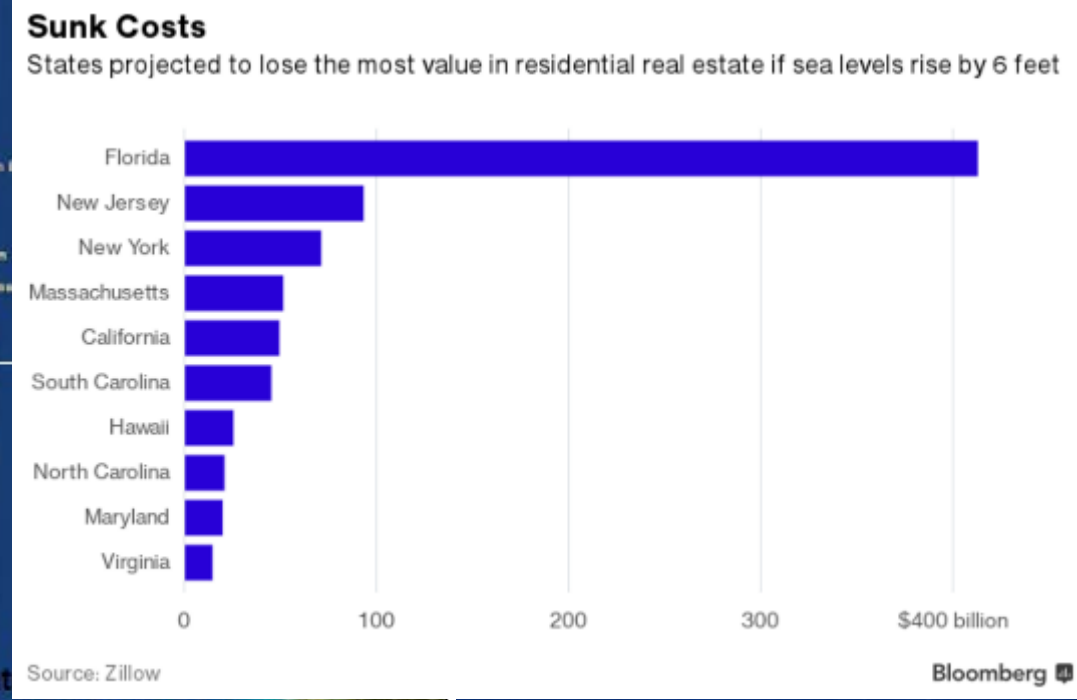
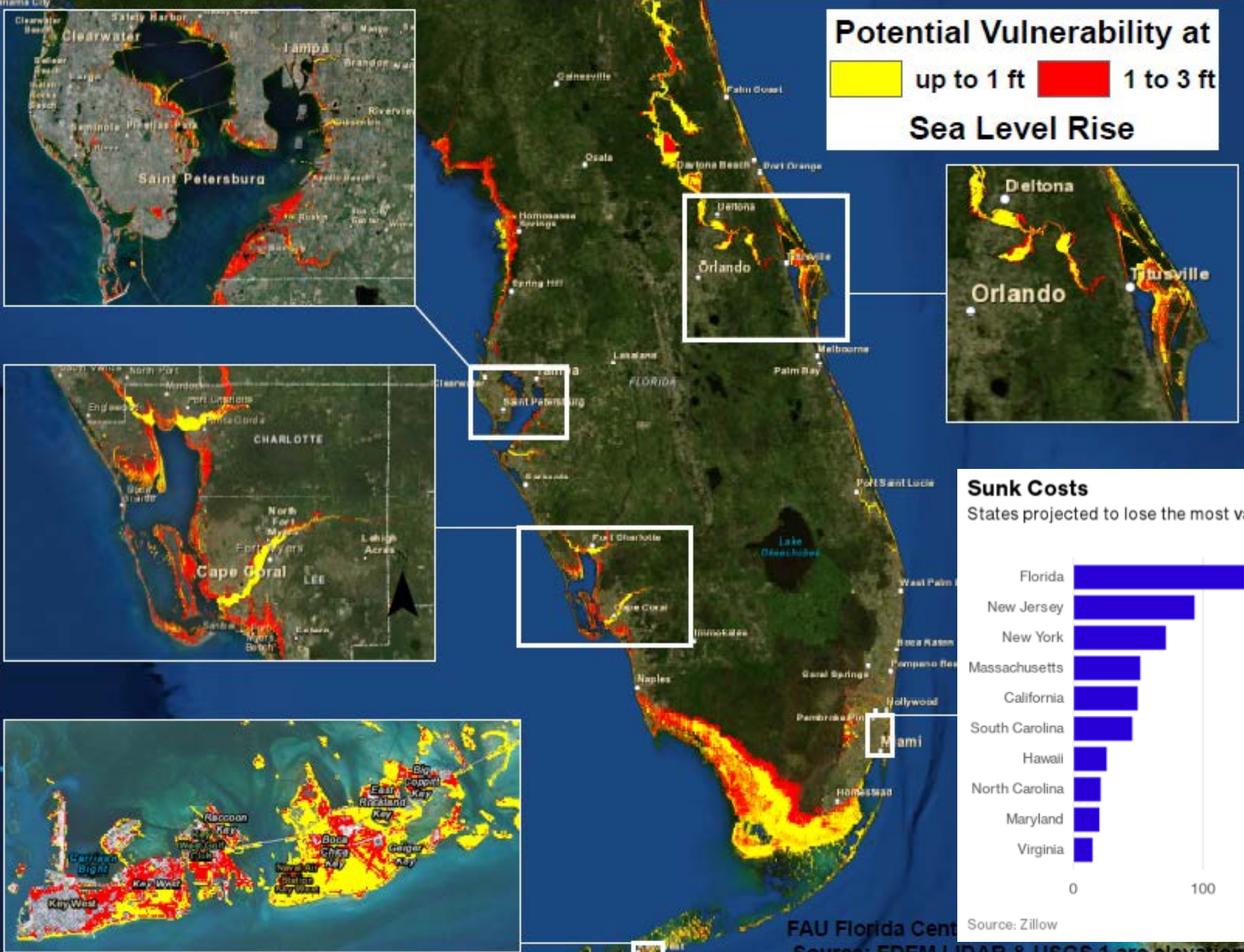
# FUTURE PROJECTIONS



# Florida's Risk: New Zillow Report

**Potential Vulnerability at Sea Level Rise**

up to 1 ft
  1 to 3 ft





# COASTAL RESILIENCY PROJECTS

- PARTNERSHIPS!
  - Compact Initiatives
  - County/municipal Work
  - Community organizations
  - Academic
- SFRC Work
  - Adaptation Action Areas
  - Train the Trainers
  - Impacts of SLR on Public Health
  - DEO TA for Infrastructure Resilience

# RESILIENT REDESIGN WORKSHOPS

## Invited Experts

Kingdom of Netherlands  
Florida Climate Institute

3-day design workshops

Transferable models of resilience for  
South Florida



# COUNTY/MUNICIPAL WORK

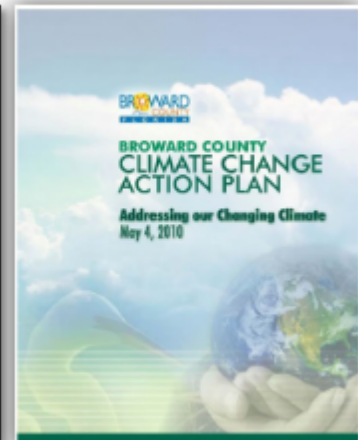
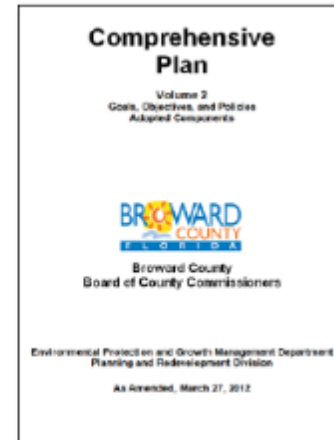


MIAMI BEACH

OFFICE OF THE MAYOR AND COMMISSION



- Comprehensive Plan
- Climate Change Action Plan



# COMMUNITY ORGANIZATIONS

**CATALYST**  
M I A M I

WE CULTIVATE  
LEADERS *to*  
STRENGTHEN  
FAMILIES *and*  
COMMUNITIES.



**DELRAY BEACH  
RISING WATERS  
TASK FORCE**



**HIGHWATERLINE  
HIGHWATERLINE**



FIU SLR SOLUTION CENTER  
FAU CES  
[CLIMATE.MIAMI.EDU/](http://CLIMATE.MIAMI.EDU/)



Florida  
Climate Institute

## Member Universities



FAU  
FLORIDA ATLANTIC  
UNIVERSITY



FIU  
FLORIDA  
INTERNATIONAL  
UNIVERSITY



University of  
Central  
Florida

UF  
UNIVERSITY of  
FLORIDA

UNIVERSITY  
OF MIAMI  
U

USF  
UNIVERSITY OF  
SOUTH FLORIDA

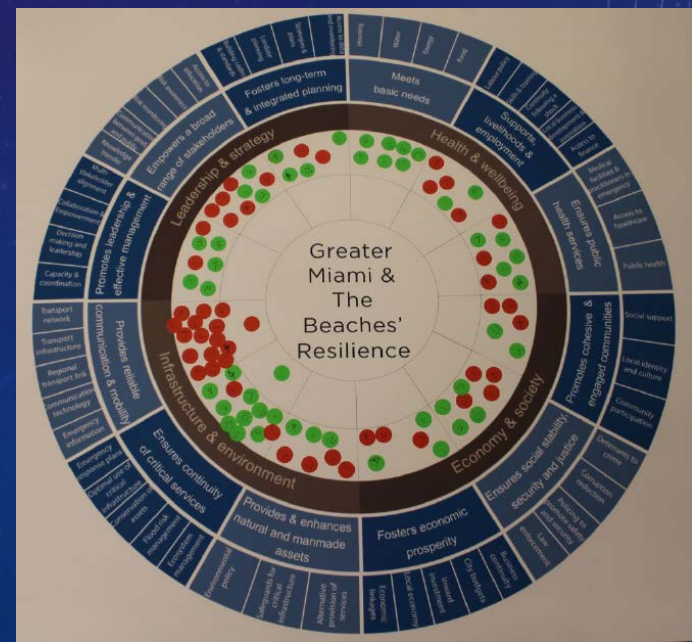
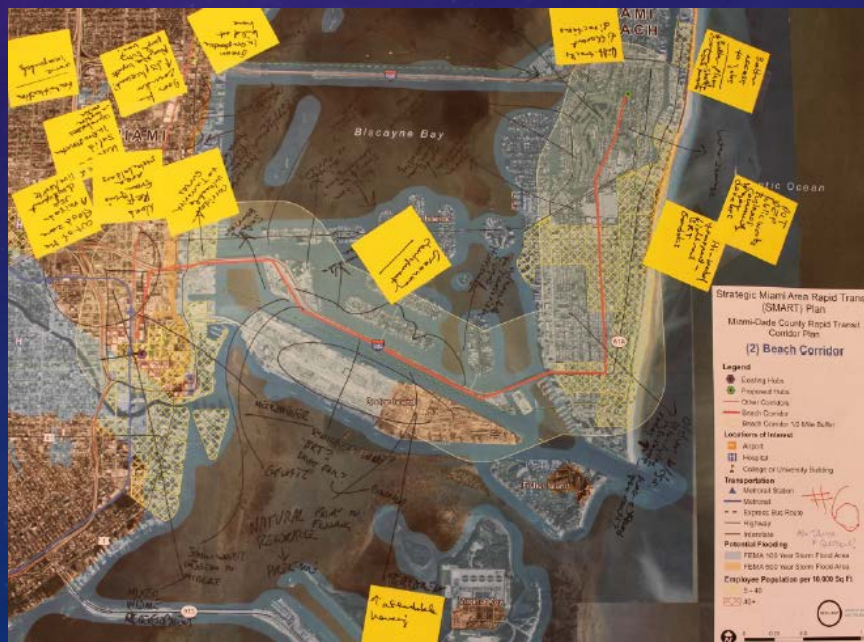
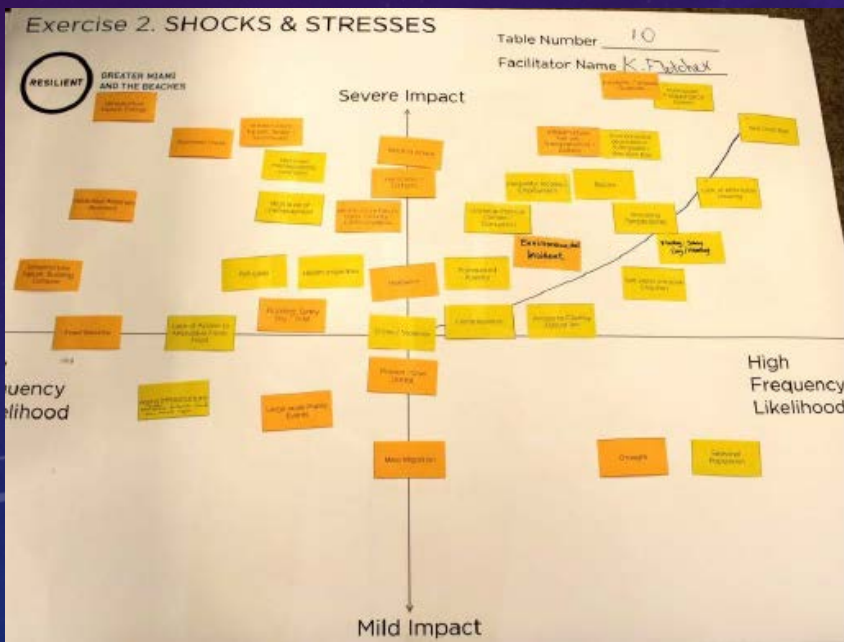
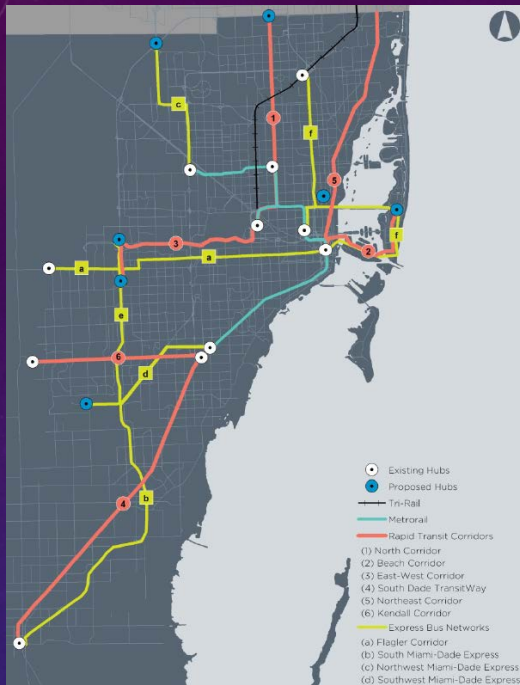


GREATER MIAMI  
& THE BEACHES



WHO IS GREATER  
MIAMI AND THE  
BEACHES?

GREATER MIAMI AND THE BEACHES  
RESILIENCE STRATEGY



# PRIORITIZED SHOCKS AND STRESSES

## Shocks

Hurricanes/Tornado (22%)

Economic Crash (11%)

Infrastructure Failure - Cyber Security/ Communications (9%)

Infrastructure Failure - Transport/ Access (9%)

## Stresses

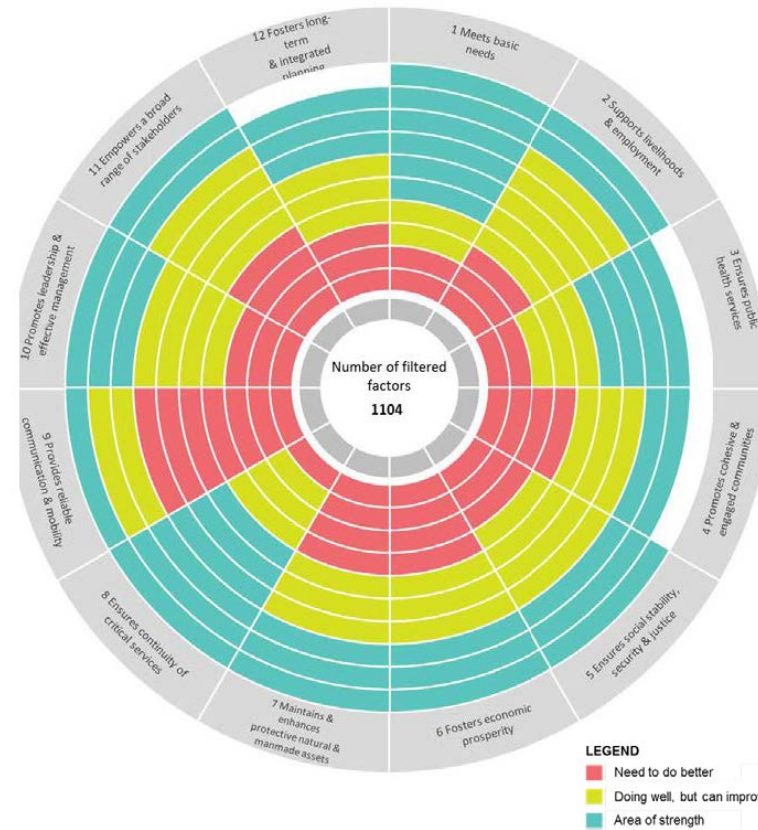
Inadequate Transportation System (15.5%)

Sea Level Rise (15.5%)

Aging Infrastructure (15.5%)

Lack of Affordable Housing (14%)

Access to Quality Education (7%)



## RESILIENCE PRIORITIES

GM&B was selected as a member of 100 Resilient Cities in part based on priorities noted in their application:

### Shocks

- Hurricane + Typhoon + Cyclone
- Infrastructure Failure
- Coastal Flooding
- Rainfall Flooding

### Stresses

- Rising Sea Level + Coastal Erosion
- Overtaxed + Unreliable Transportation System
- Pronounced Poverty
- Lack of Affordable Housing

# STRENGTHS AND WEAKNESSES

## Strengths

Ensures continuity of critical services (21%)

Meets basic needs (14.5%)

Fosters long-term and integrated planning (10%)

## Weaknesses

Provides reliable communications and mobility (31%)

Empowers a broad range of stakeholders (12.5%)

Supports livelihoods and employment (8%)

Ensures social stability, security and justice (8%)

Provides and enhances natural and manmade assets (8%)

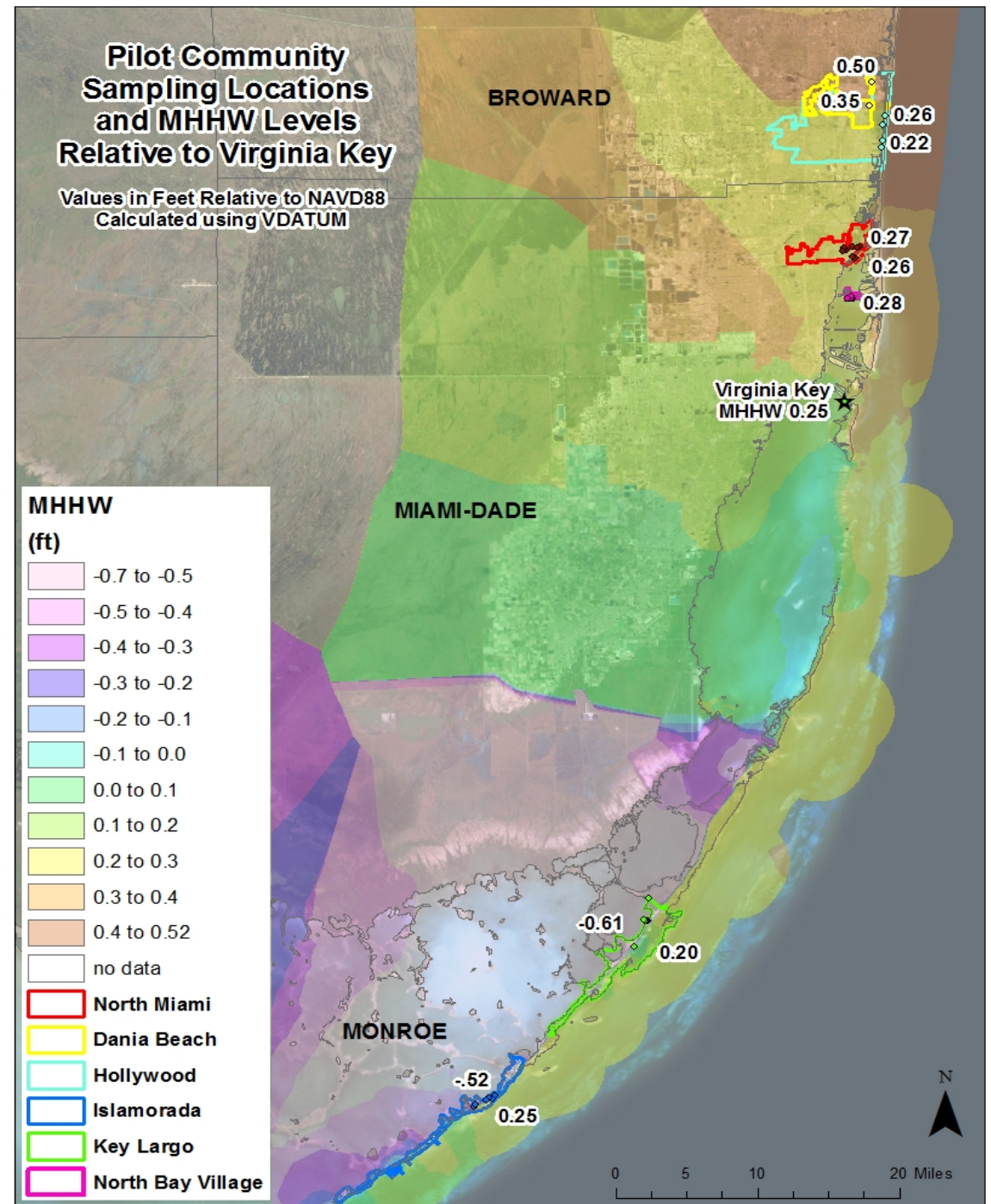


# IMPROVING THE PLANNING PROCESS TO PROTECT INFRASTRUCTURE EMERGING FROM COASTAL FLOOD HAZARDS

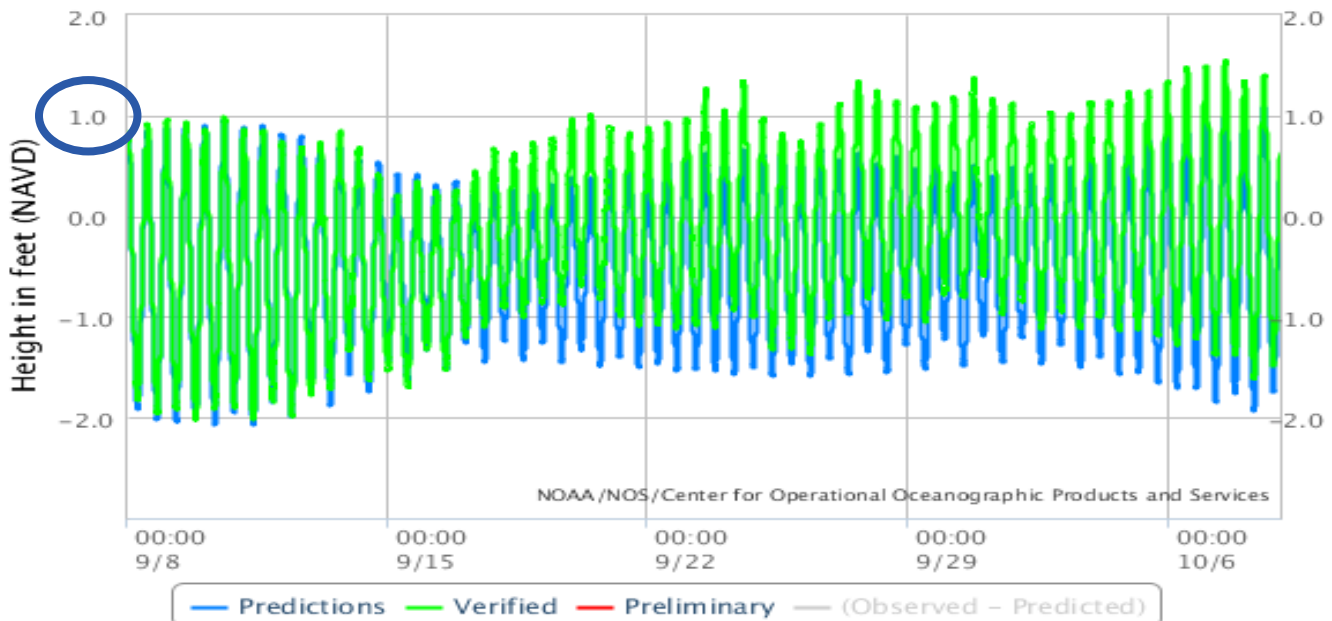


# WHAT DON'T THE MODELS TELL US?

Identifying and Ground-Truthing Tidal Flooding Hotspots in 6 Pilot Communities

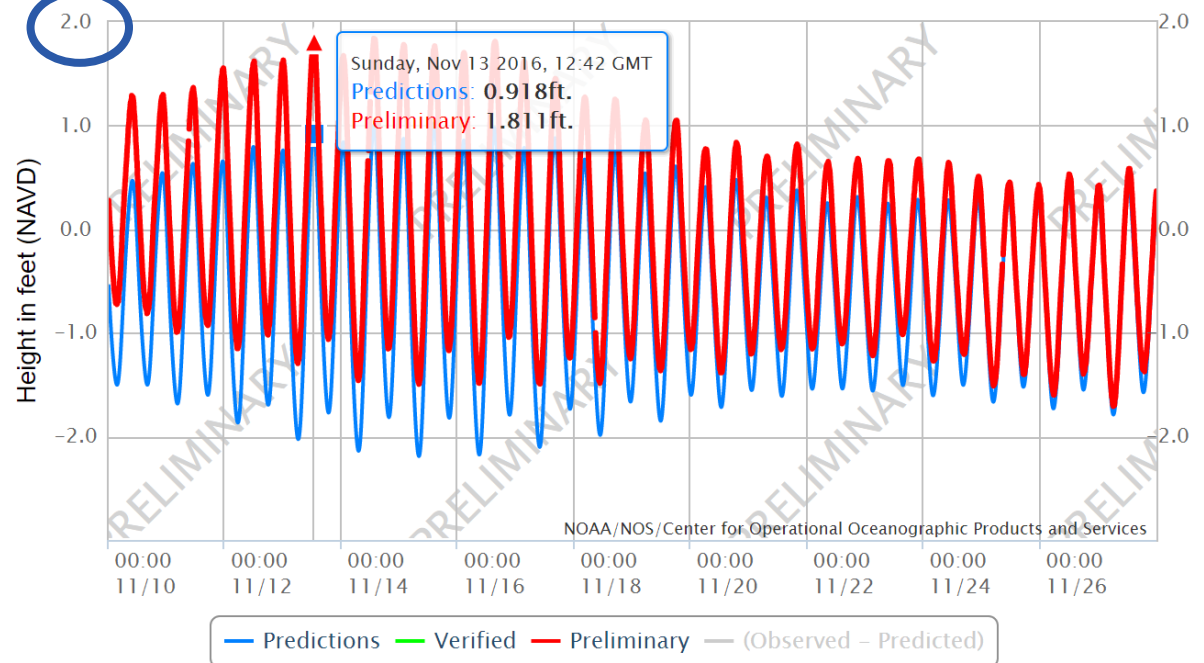
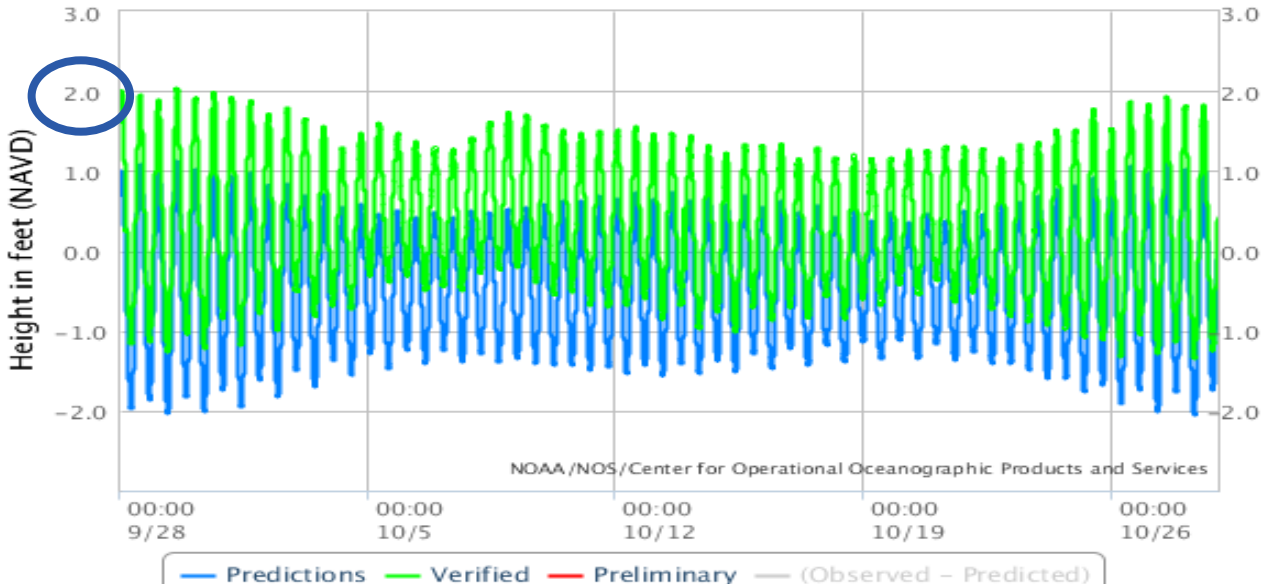


NOAA/NOS/CO-OPS  
 Observed Water Levels at 8723214, Virginia Key FL  
 From 2014/09/08 00:00 GMT to 2014/10/08 23:59 GMT



# King Tide 2016 Sep - Nov

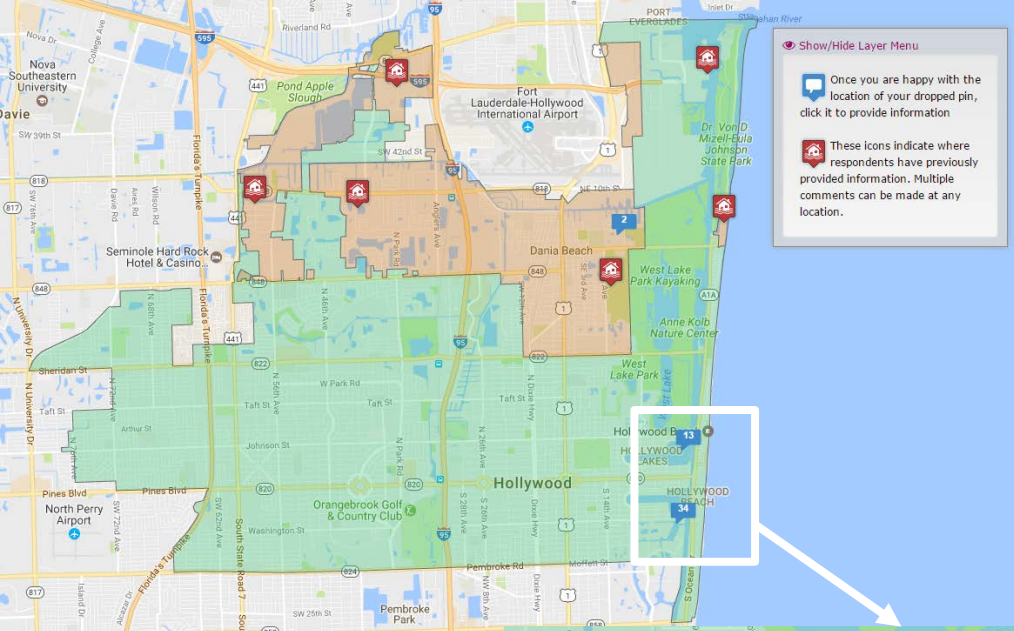
NOAA/NOS/CO-OPS  
 Observed Water Levels at 8723214, Virginia Key FL  
 From 2015/09/28 00:00 GMT to 2015/10/28 23:59 GMT



# Hollywood King Tide 2016 September vs October







Show/Hide Layer Menu

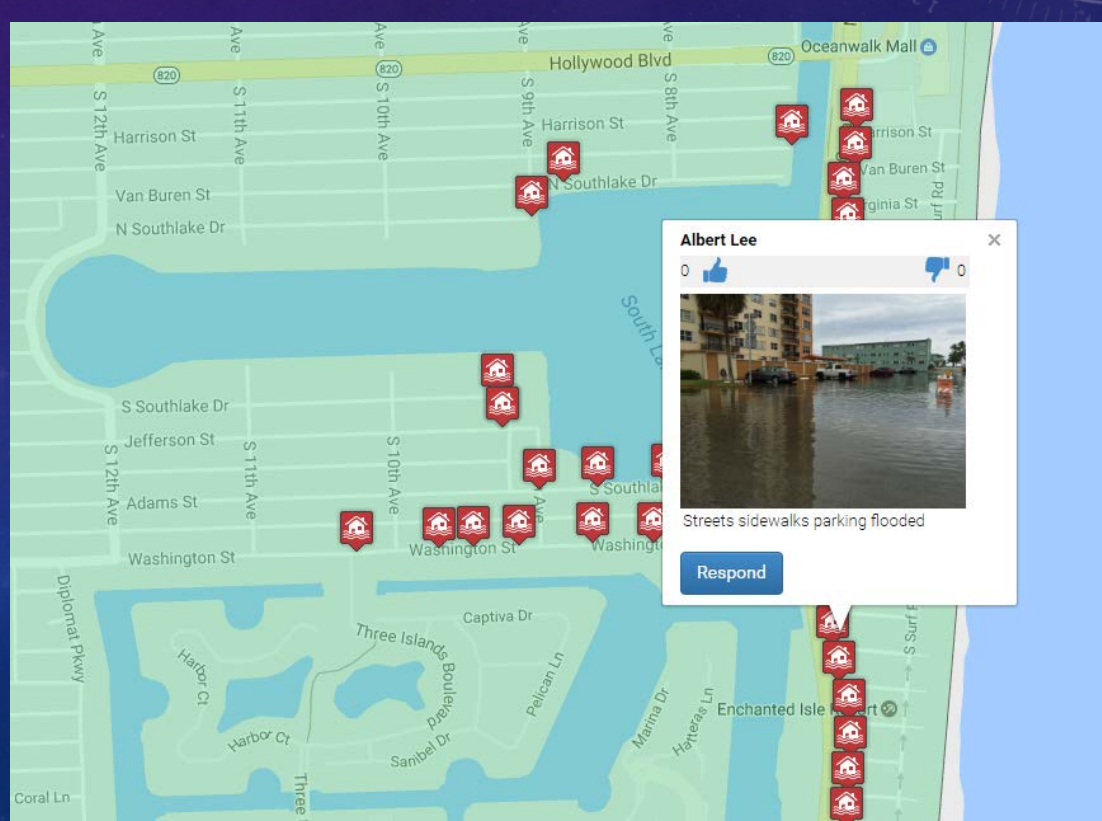
Once you are happy with the location of your dropped pin, click it to provide information

These icons indicate where respondents have previously provided information. Multiple comments can be made at any location.

# Infrastructure Resilience Survey


Investigators: Keren Bolter, PhD, Christina Miskis, and Vince Edwards. Thank you for your interest in taking this brief survey. It may take about 5-10 minutes. Your participation in this survey is completely voluntary and your responses will remain confidential. We appreciate your input!

The purpose of the survey is to measure infrastructure resilience in communities within South Florida. Please help us identify the extent of existing and emerging tidal flooding conditions and any planned mitigation in your community. A potential benefit that you may receive from participation is knowing that you made a personal contribution to a regional scorecard which supports infrastructure resilience. The results will give local governments insight on innovative



**Albert Lee**

0 0

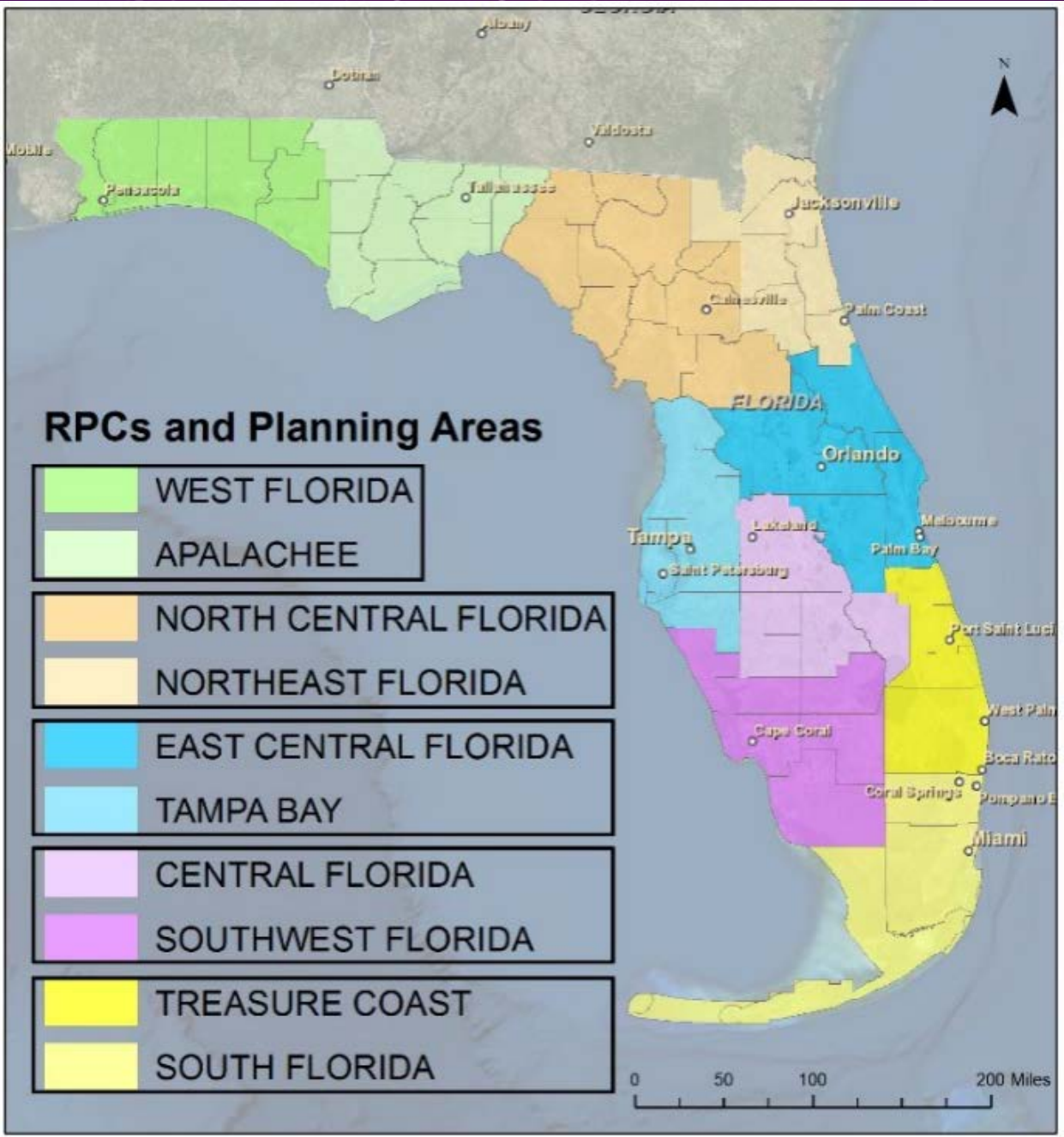


Streets sidewalks parking flooded

[Respond](#)

# PROJECT BACKGROUND

**TRAINERS AND TOOLS:  
BUILDING COASTAL FLOOD HAZARD  
RESILIENCY IN FLORIDA'S REGIONAL  
PLANNING COUNCIL COMMUNITIES**





# COASTAL RESILIENCY TOOLS BUFFET







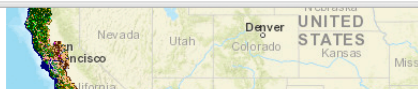
**PUNTA GORDA TRAINING 11/17**



# DigitalCoast

OFFICE FOR COASTAL MANAGEMENT

/digitalcoast/tools/



### C-CAP Land Cover Atlas

View and explore coastal land cover and change data

#### Contributing Partners

NOAA OCM

🔗 Reporting, Visualization



### CMECS Crosswalk Tool

Translates existing benthic habitat data sets to the Coastal and Marine Ecological Classification Standard (CMECS)

#### Contributing Partners

NOAA OCM

🔗 Analysis



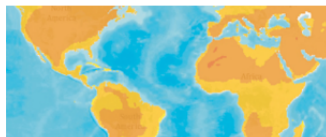
### CanVis

Visualize future scenarios using your photographs and this tool's object icons

#### Contributing Partners

NOAA OCM, USDA National Agroforestry Center

🔗 Visualization



### Climate Wizard

Use state-of-the-art climate models and statistical analysis to view, generate, and download climate change maps and tables

#### Contributing Partners

The Nature Conservancy

🔗 Analysis, Reporting, Visualization



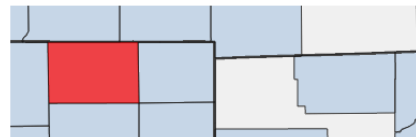
### Coastal Change Hazards Portal

Create a map of potential ecological, social, and economic impacts from rising seas and changing climate

#### Contributing Partners

USGS

🔗 Analysis, Reporting, Visualization



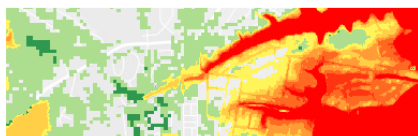
### Coastal County Snapshots

Turn complex data into easy-to-understand stories, complete with charts and graphs

#### Contributing Partners

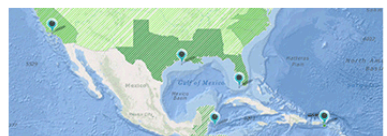
NOAA OCM

🔗 Reporting



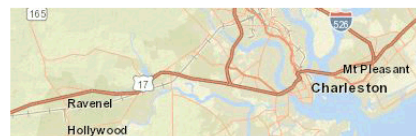
### Coastal Flood Exposure Mapper

Maps people, places, and natural resources that are potentially exposed to coastal flooding



### Coastal Resilience Mapping Portal

Create a map of potential ecological, social, and economic impacts from rising seas and changing climate






### Data Access Viewer

Find and download data hosted on the NOAA Office for Coastal Management website

<https://coast.noaa.gov/digitalcoast/tools/>

# 58 Tools

# HAZARD ASSESSMENT TOOLS

<p><b>CANVIS</b> NOAA</p> 	<p><b>SEA LEVEL RISE (SLR) VIEWER</b> NOAA</p> 	<p><b>COASTAL FLOOD EXPOSURE MAPPER</b> NOAA</p> 	<p><b>UF</b> UNIVERSITY of FLORIDA <b>SKETCH PLANNING TOOL</b> UF GEOPLAN CENTER</p>
<p>Intended to elicit higher levels of stakeholder engagement, CanVis utilizes no data and modifies imagery to show potential inundation scenarios.</p>	<p>Can facilitate stakeholder engagement, scoping and inventory, and assessment and analysis, SLR Viewer offers an online interactive platform in map format to display a variety of sea level rise scenarios.</p>	<p>Helps start community discussions about hazard impacts with maps of your area that show people, places, and natural resources exposed to coastal flooding.</p>	<p>Offers a variety of sea-level rise analyses related to transportation ;intended to promote stakeholder engagement, scoping/inventory, assessment/analysis, and planning.</p>

Before

After



Before

After



# CANVIS

Developed by NOAA Office for Coastal Management

[coast.noaa.gov/digital-coast/tools/canvis](https://coast.noaa.gov/digital-coast/tools/canvis)



Before

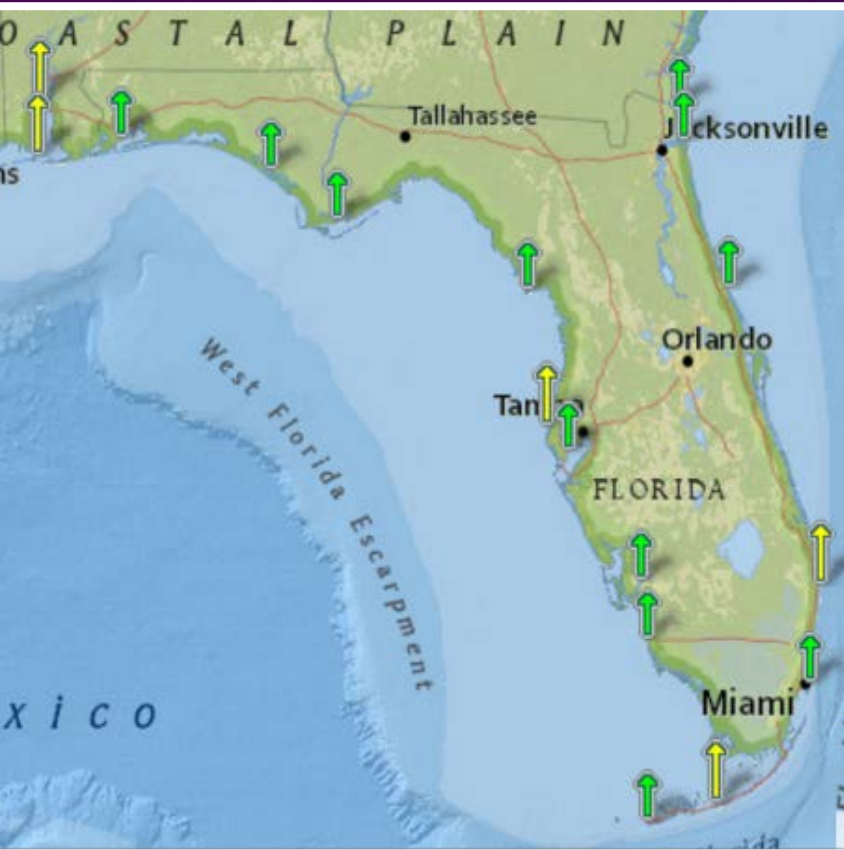
After



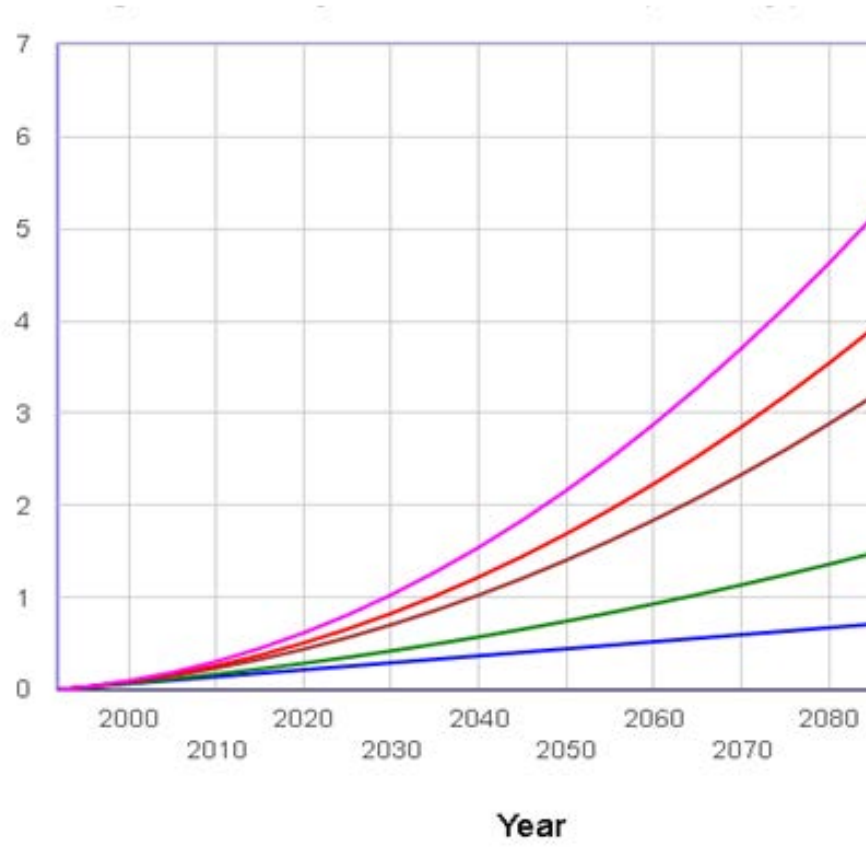
Before

After

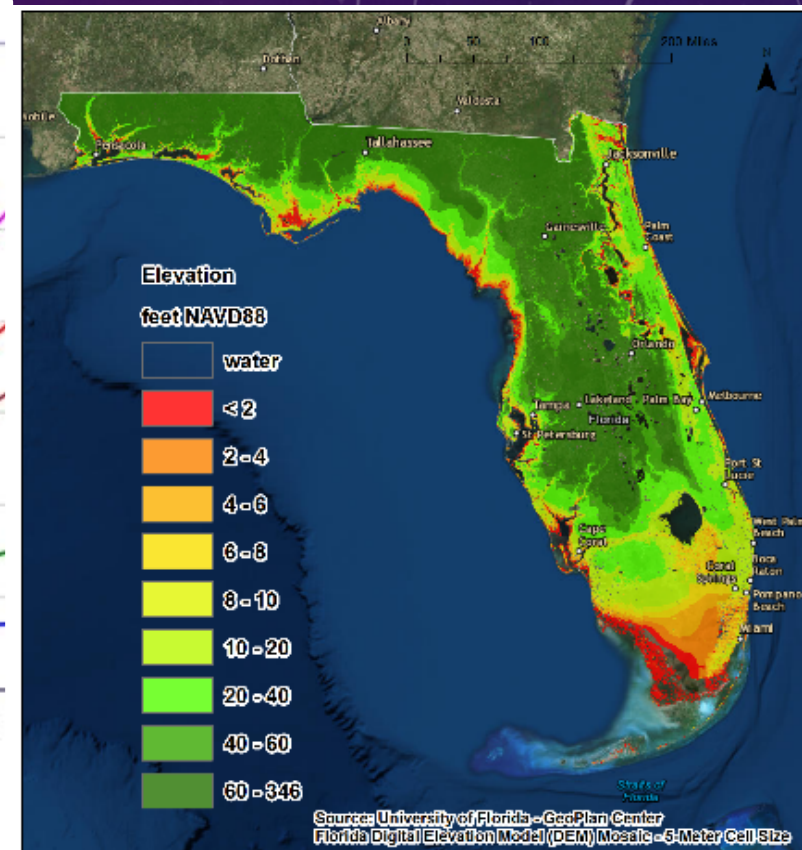
# MAPPING SLR: DATA INPUTS & METHODS



Local trend  
data and  
water levels



Future scenarios of SLR.  
How fast will SLR and when?  
Use local data for  
projections

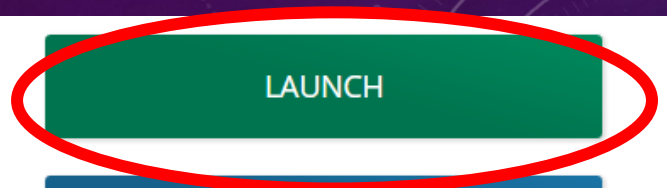
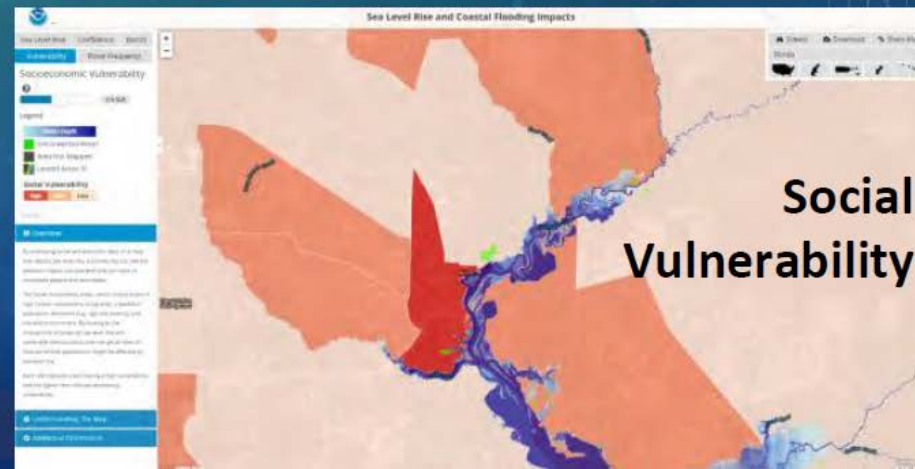
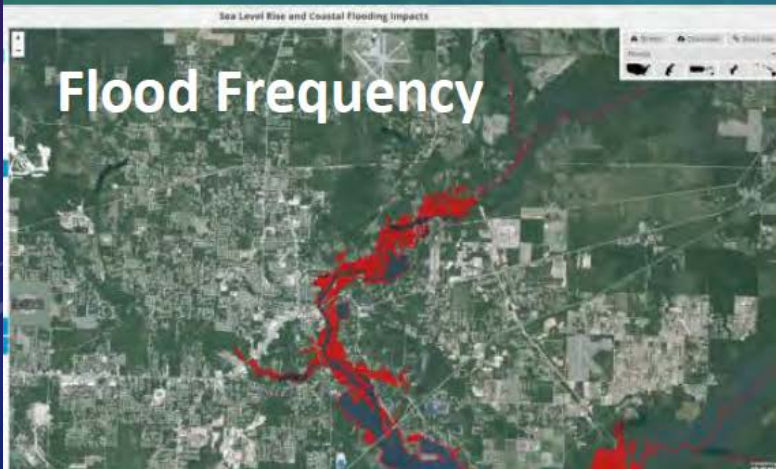
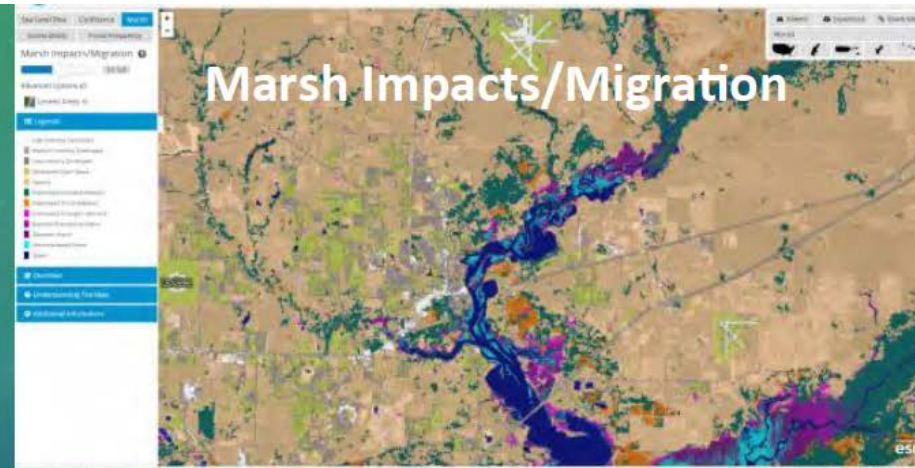


High resolution digital  
elevation model from  
LIDAR

# Sea Level Rise Viewer

NOAA Office for Coastal Management

## Overview



## Related Resources

Stories	25
Data	7
Publications	5
Tools	4
Videos and Webinars	3
Self-Guided Resources	2
Classroom, Instructor-Led	2
Contributing Partners	1

- National Oceanic and Atmospheric Administration Office for Coastal Management





# Sea Level Rise and Coastal Flooding Impacts

Sea Level Rise Confidence Marsh

Vulnerability Flood Frequency

## Sea Level Rise ?



### Legend

- Water Depth**
- Low-lying Areas
- Area Not Mapped
- Visualization Location
- Leveed Areas ?

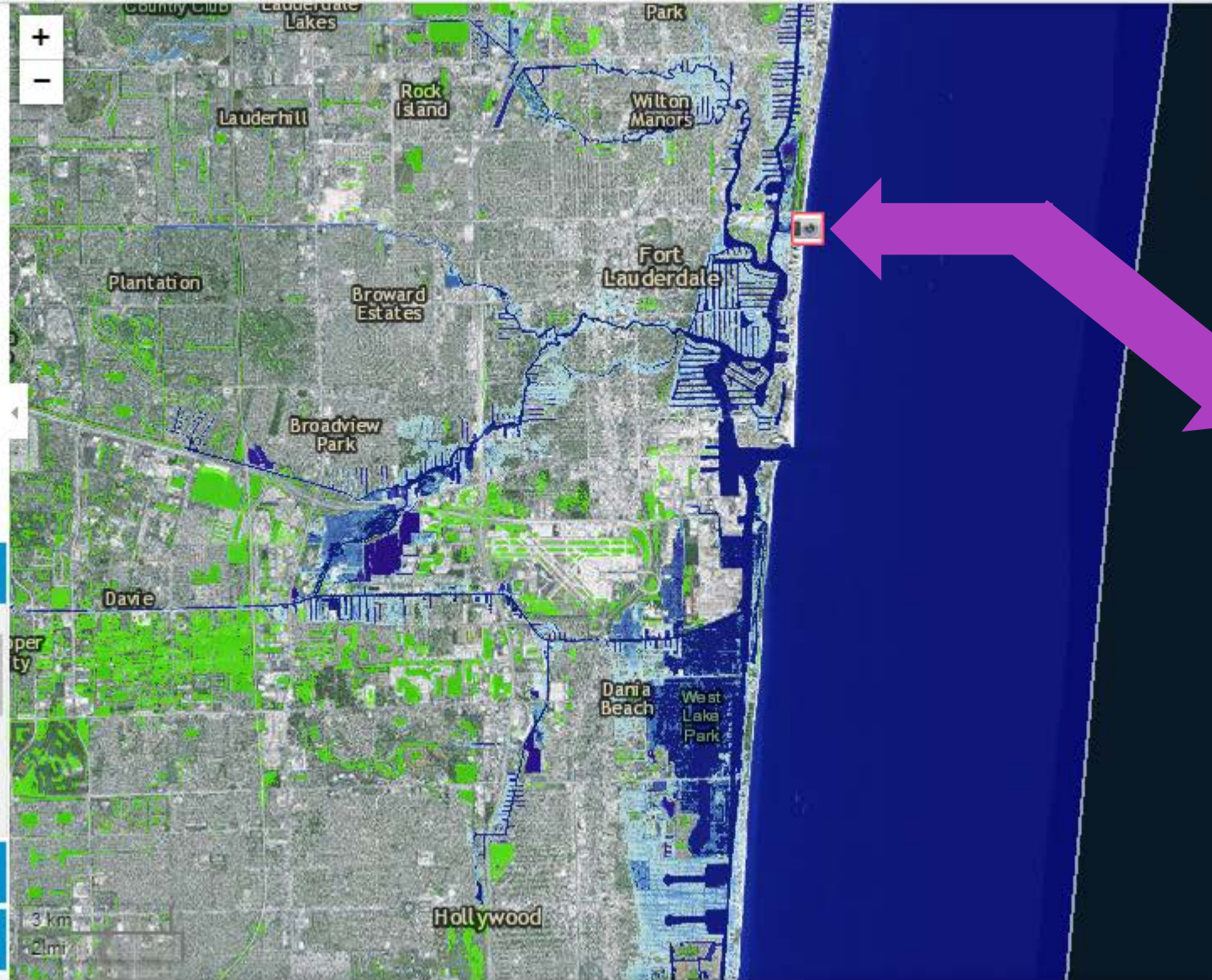
### Overview

Use the slider bar above to see how various levels of sea level rise will impact this area.

Levels represent inundation at high tide. Areas that are hydrologically connected are shown in shades of blue (darker blue = greater depth).

### Understanding The Map

### Additional Information



Streets Download

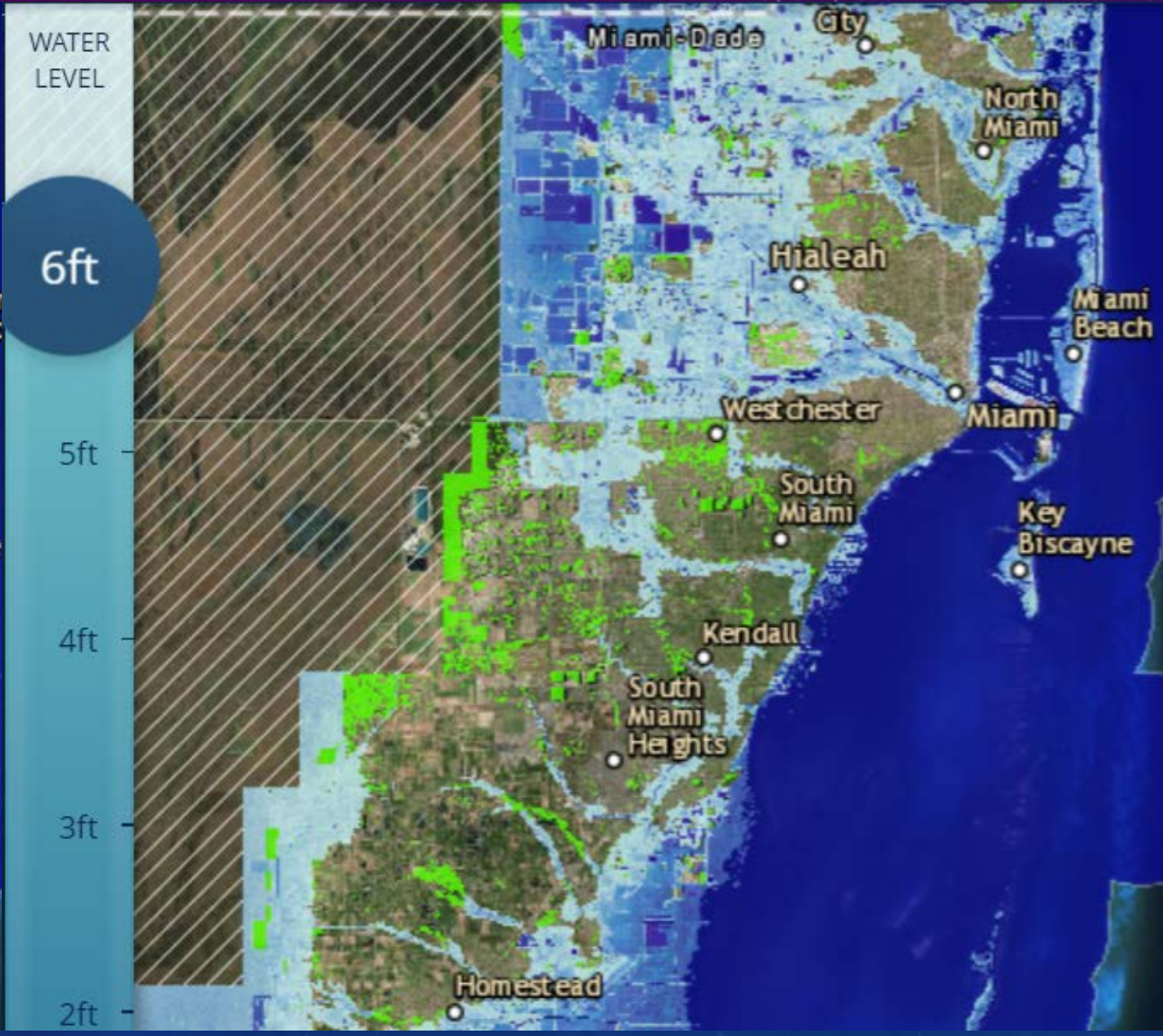
Zoom to: State or Territory



## Hugh Taylor Birch State Park



Use the slider to view a simulation of sea level rise at this location.







# COASTAL FLOOD EXPOSURE MAPPER

Developed by NOAA  
Office for Coastal  
Management

The information in this product is  
based on the Roadmap for  
Adapting to Coastal Risk



[www.coast.noaa.gov/digitalcoast/tools/flood-exposure](http://www.coast.noaa.gov/digitalcoast/tools/flood-exposure)

## Select the Flood Hazards Map or One of the Community Exposure Maps

Select a section below to view maps showing flood hazards or different aspects of community exposure to those flood hazards.

First-time user? Starting with Flood Hazards is a good idea.



### Flood Hazards

Flooding events are among the more frequent, costly, and deadly hazards that can impact coastal communities. There are two types:

- Short-term (episodic) – Temporary flooding caused by extreme conditions, including storm surge, tsunamis, inland flooding, and shallow coastal flooding.
- Long-term (chronic) – Flooding caused by a rise in relative sea level or some other change in conditions.

### Flood Hazard Layers

- Coastal Flood Hazard Composite
- Shallow Coastal Flooding
- FEMA Flood Zones
- Storm Surge Scenarios
- Sea Level Rise Scenarios

### Societal Exposure Maps

- Population Density
- Percent in Poverty
- Percent Elderly (>65)
- Employees
- Projected Population Growth

### Infrastructure Exposure

- Development
- Critical Facilities
- Development Patterns

### Ecosystem Exposure

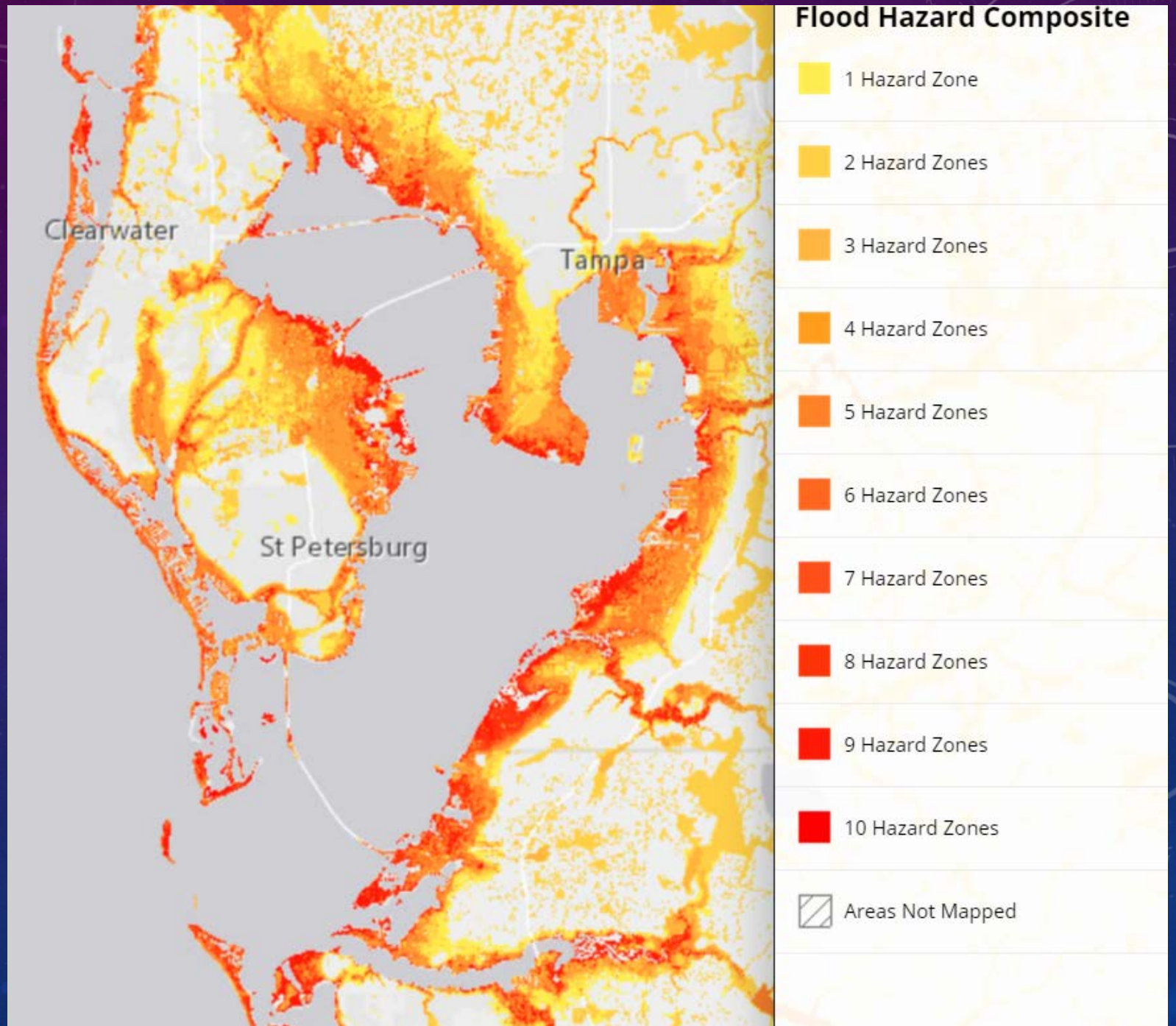
- Natural Areas and Open Space
- Potential Pollution Sources
- Natural Protection

# NOAA COASTAL FLOOD EXPOSURE MAPPER\_

## Hazard Zones:

- FEMA Zones (% annual chance):  
A zone (1%) & 0.2%
- Shallow Coastal Flooding (NWS  
flood thresholds)
- Sea Level Rise (Above MHHW): 1  
ft & 2 ft & 3 ft
- Storm Surge (by Hurricane  
Category): 1 & 2 & 3

**Number of Hazards: 9**



# SKETCH PLANNING TOOL

Developed by the University of Florida GeoPlan Center

[sls.geoplan.ufl.edu](https://sls.geoplan.ufl.edu)



## SEA LEVEL SCENARIO SKETCH PLANNING TOOL

A planning tool for preliminary assessment of vulnerable transportation infrastructure due to sea level change

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# SKETCH PLANNING TOOL

## INTERACTIVE MAPS

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## VIEW MAPS

Use the map to the right or click on one of the links below to view interactive maps of Sea Level Scenarios.

The maps show potential inundation and affected transportation infrastructure due to sea level change. Inundation maps were developed using sea level change projections from the U.S. Army Corp of Engineers and tide gauge and sea level trend data from NOAA (see [About Page](#) for more information on methods).

[User Guide for Map Viewer \(PDF\)](#)

### FDOT DISTRICT 1 MAP VIEWER

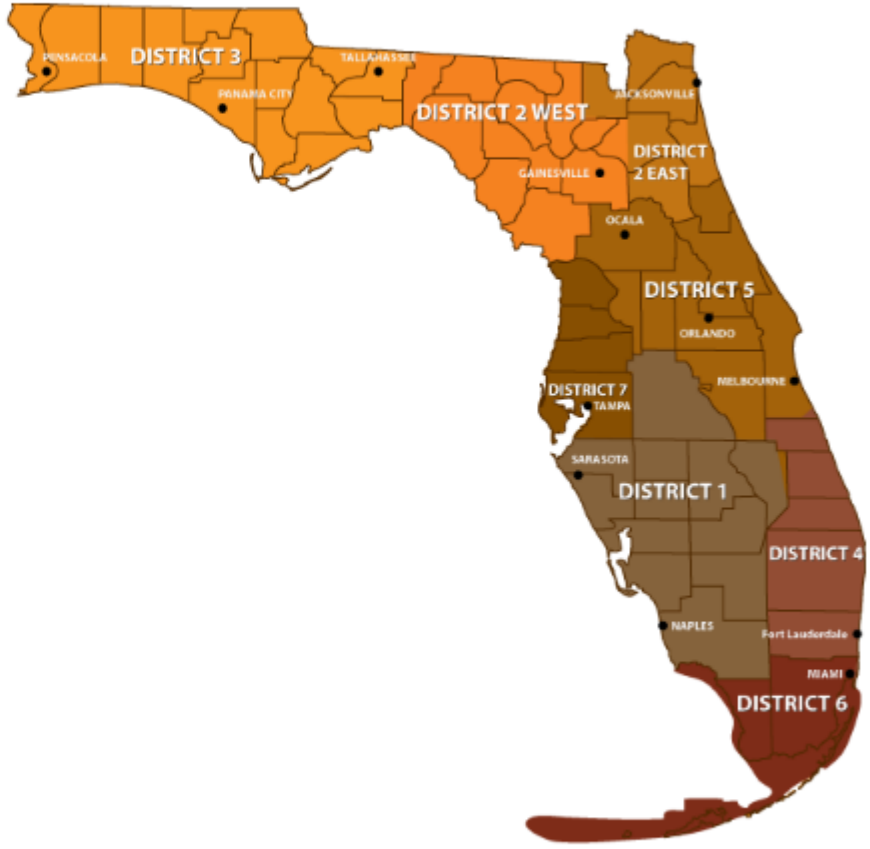
Major cities: Bradenton, Fort Myers, Lakeland, Naples, Sarasota  
Counties: Charlotte, Collier, De Soto, Glades, Hardee, Hendry, Highlands, Lee, Manatee, Okeechobee, Polk, and Sarasota

### FDOT DISTRICT 2 EAST MAP VIEWER

Major cities: Jacksonville, Palatka, St. Augustine  
Counties: Baker, Clay, Duval, Nassau, Putnam, St. Johns

### FDOT DISTRICT 2 WEST MAP VIEWER

Major cities: Gainesville and Lake City  
West Counties: Alachua, Bradford, Columbia, Dixie, Gilchrist, Hamilton, Lafayette, Levy, Madison, Suwannee, Taylor, Union

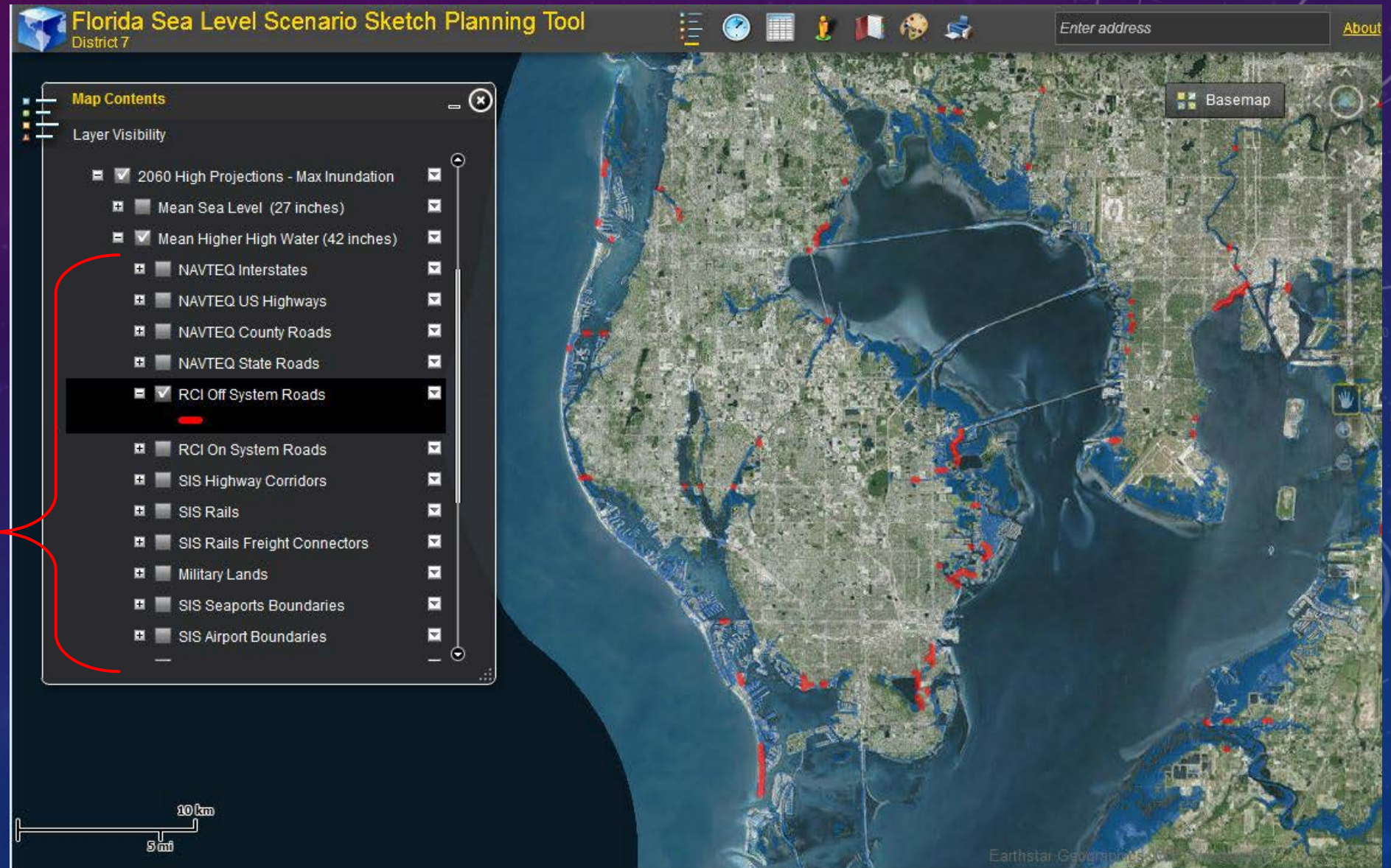


# VIEW AFFECTED TRANSPORTATION FACILITIES

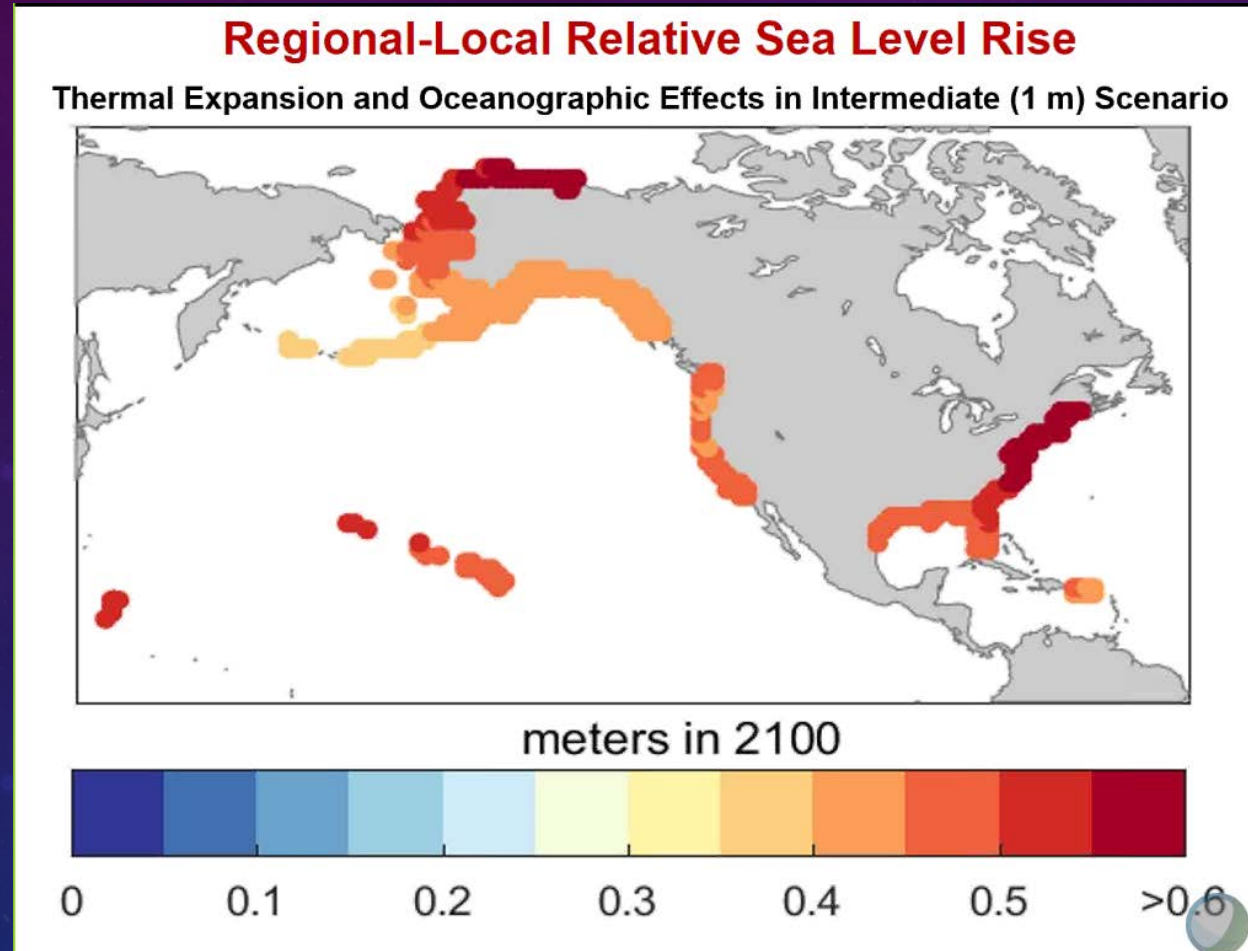
Tampa Bay, 2080,  
High Projection

View transportation  
facilities potentially  
exposed to  
inundation various  
SLR scenarios.

Available  
transportation  
layers by  
scenario



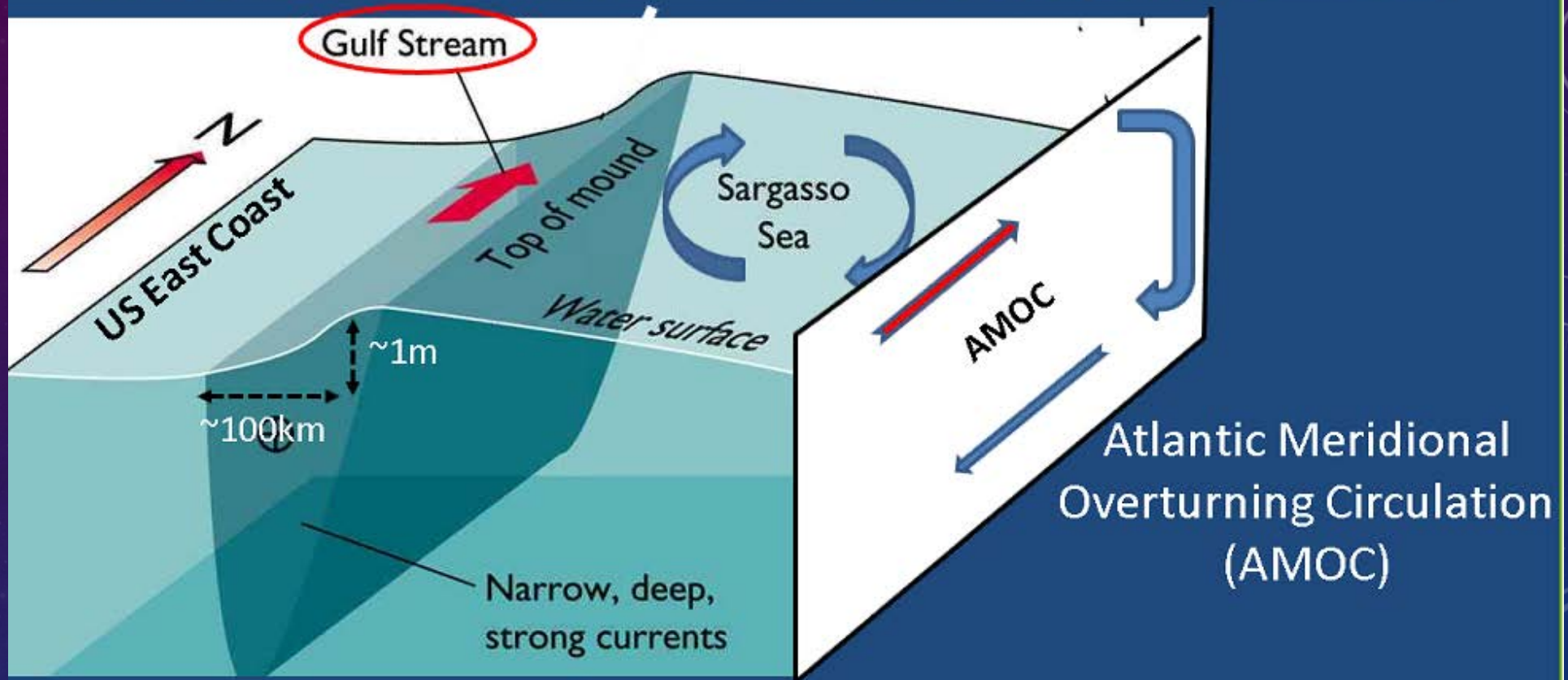
# GULF STREAM BABY





# How can ocean dynamics affect coastal sea level?

Sea level is not level: ocean currents → sea level slope (Geostrophic balance)



Slide Credit

Tal Ezer

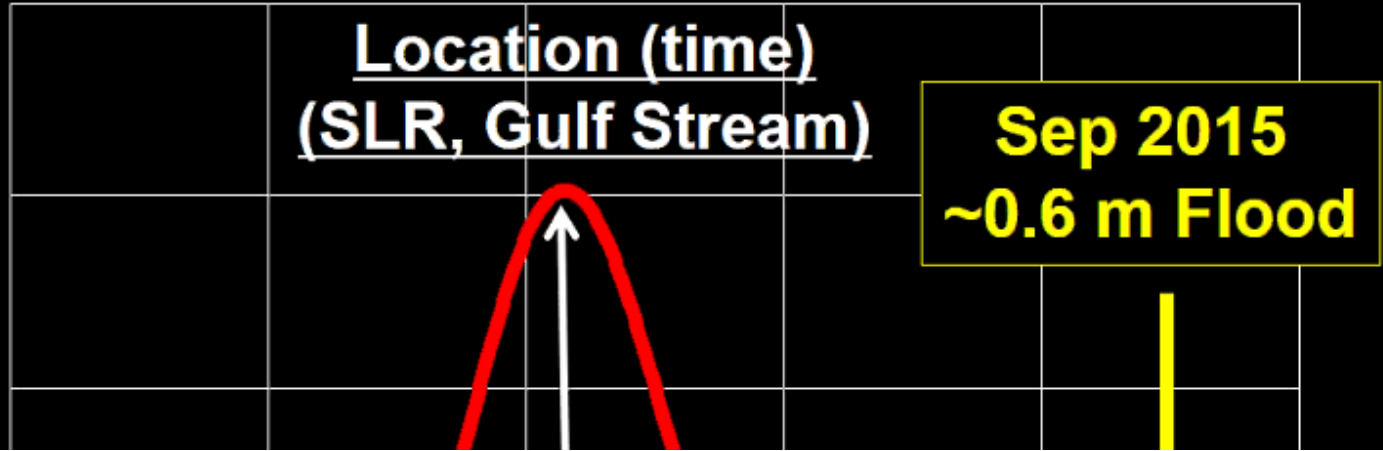
Old Dominion U

- The Gulf Stream keeps sea level on the US East Coast ~1-1.5 m (3-5 feet) lower than water offshore → variations in GS strength or position will affect SL.

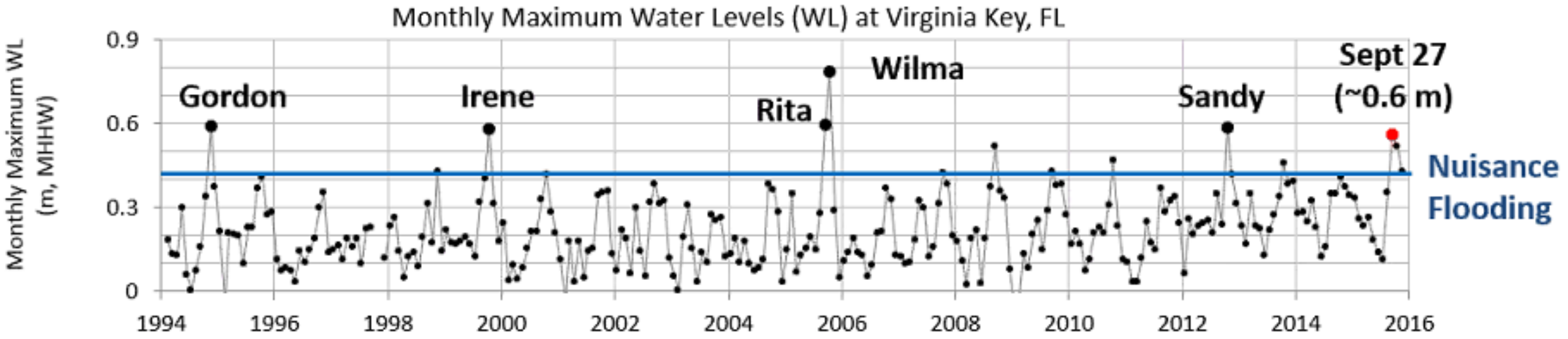
- In warmer climate the Atlantic Ocean circulation is expected to weaken  
If the Gulf Stream slows down → sea level on the US coast could rise!!!

# South Florida Tidal Flood Probabilities

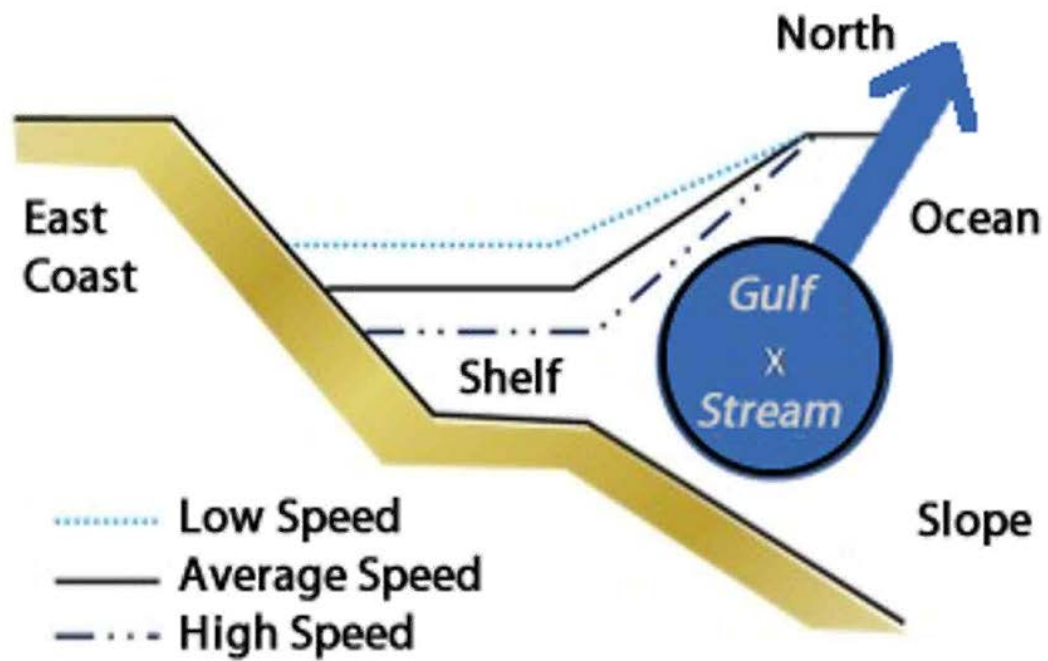
Occurrence  
of tide in a year



Slide Credit  
Billy Sweet  
NOAA



## Gulf Stream (measured by AOML Undersea Cable) Induced Changes in Sea Level



Adapted from Sweet et al. (2009)



# COMMUNICATING ABOUT SEA LEVEL RISE

- Health Impacts
- Financial Impacts
- Habitat Loss
- Environmental Justice
- Sustainability for future generations
- Catastrophic/  
creeping



NATIONAL  
GEOGRAPHIC

Years of Living  
Dangerously



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# Thank you!

## Additional Resources:

<https://coast.noaa.gov>

[Sfrpc.org](https://sfrpc.org)

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