FDOT TRANSPORTATION SYMPOSIUM

2020 Webinar Series

Toward a Resilient Transportation System

Jennifer Carver, Crystal Goodison, Jayantha Obeysekera

August 25, 2020

FDOT TRANSPORTATION SYMPOSIUM

2020 Webinar Series

Toward a Resilient Transportation System

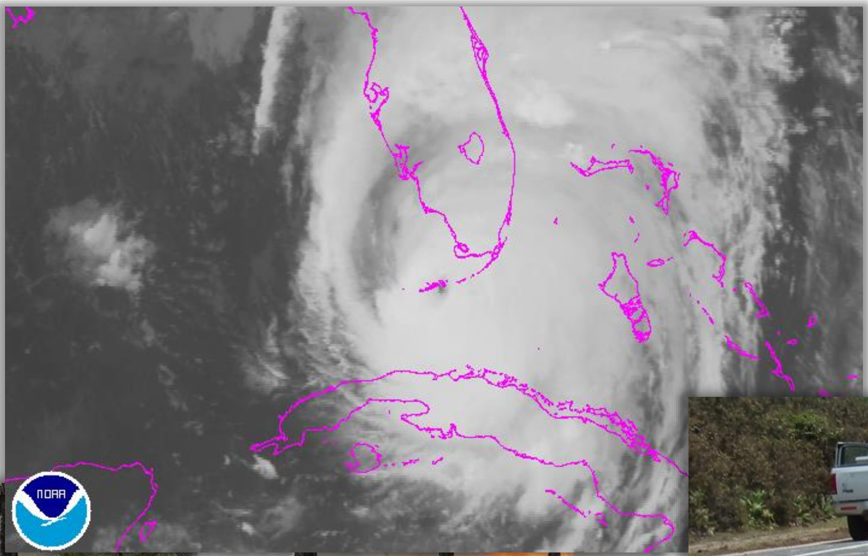
Jennifer Z. Carver, AICP

August 25, 2020

Natural Hazards Impacting Florida

- **Hurricane Storm Events**
- **Precipitation Events**
- **Sea Level Rise**
- **Wildfires**
- **Drought**
- **Sinkholes**

Irma making landfall in the Florida Keys
Credit: NOAA



A law enforcement vehicle patrols a flooded street in Everglades City, Florida, U.S., September 11, 2017. REUTERS/Bryan Woolston

US 98 in Franklin County. FDOT

Credit: Florida Forest Service

FDOT TRANSPORTATION SYMPOSIUM

Presenters

Jennifer Z. Carver, AICP
Florida Department of Transportation

Crystal Goodison
GeoPlan Center
University of Florida

Jayantha Obeysekera, Ph.D., P.E.
Sea Level Solutions Center
Institute of Environment
Florida International University

FDOT TRANSPORTATION SYMPOSIUM

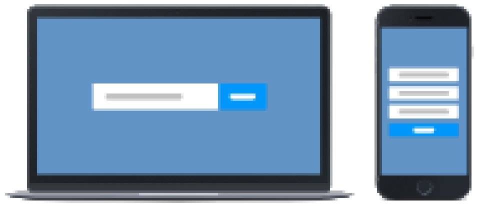
Sharing Our Ideas

Poll Everywhere – multiple ways to access the polls:

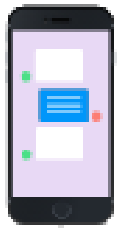
- Visit www.PollEv.com/fdotplanning from your phone, tablet, or laptop to access the polling questions

- Text “FDOTplanning” to 22333 to join the poll and respond to the polls via text message

Web

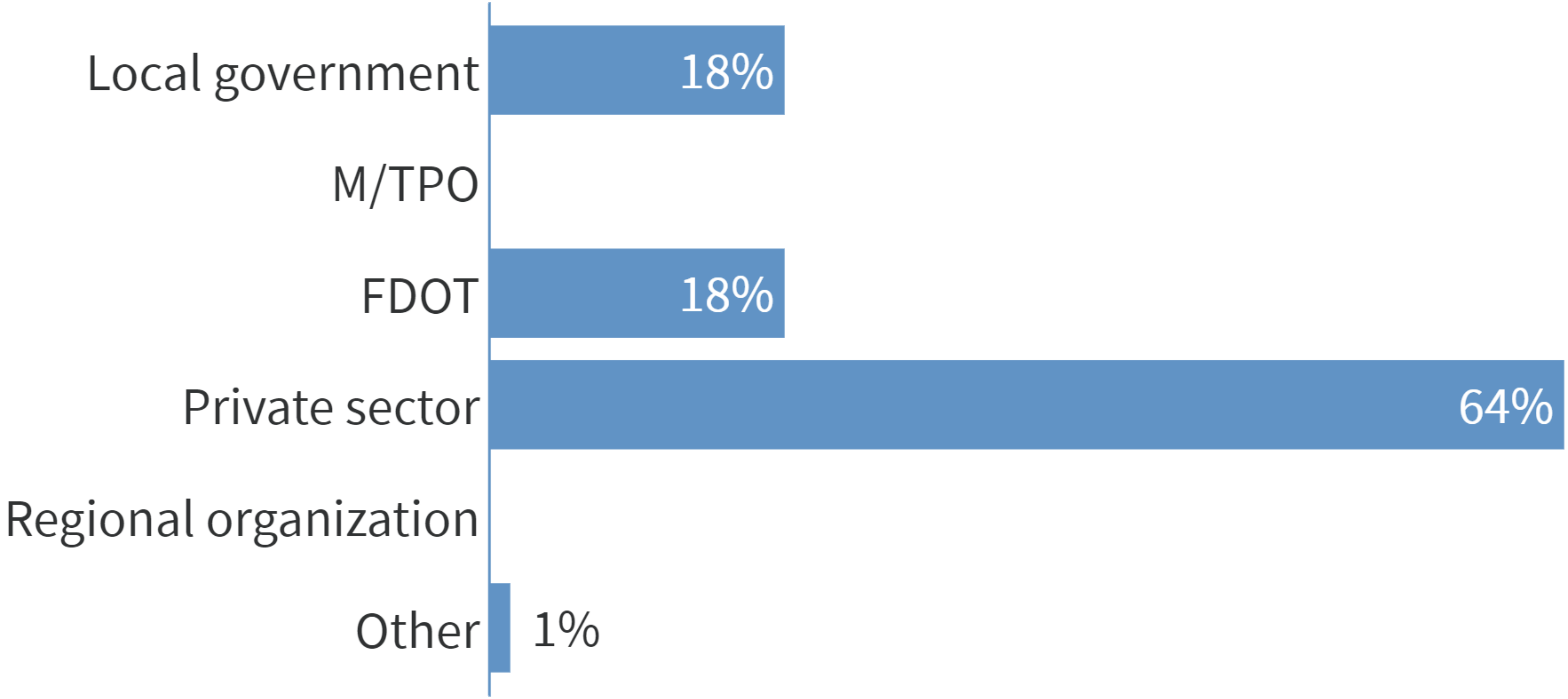


Text



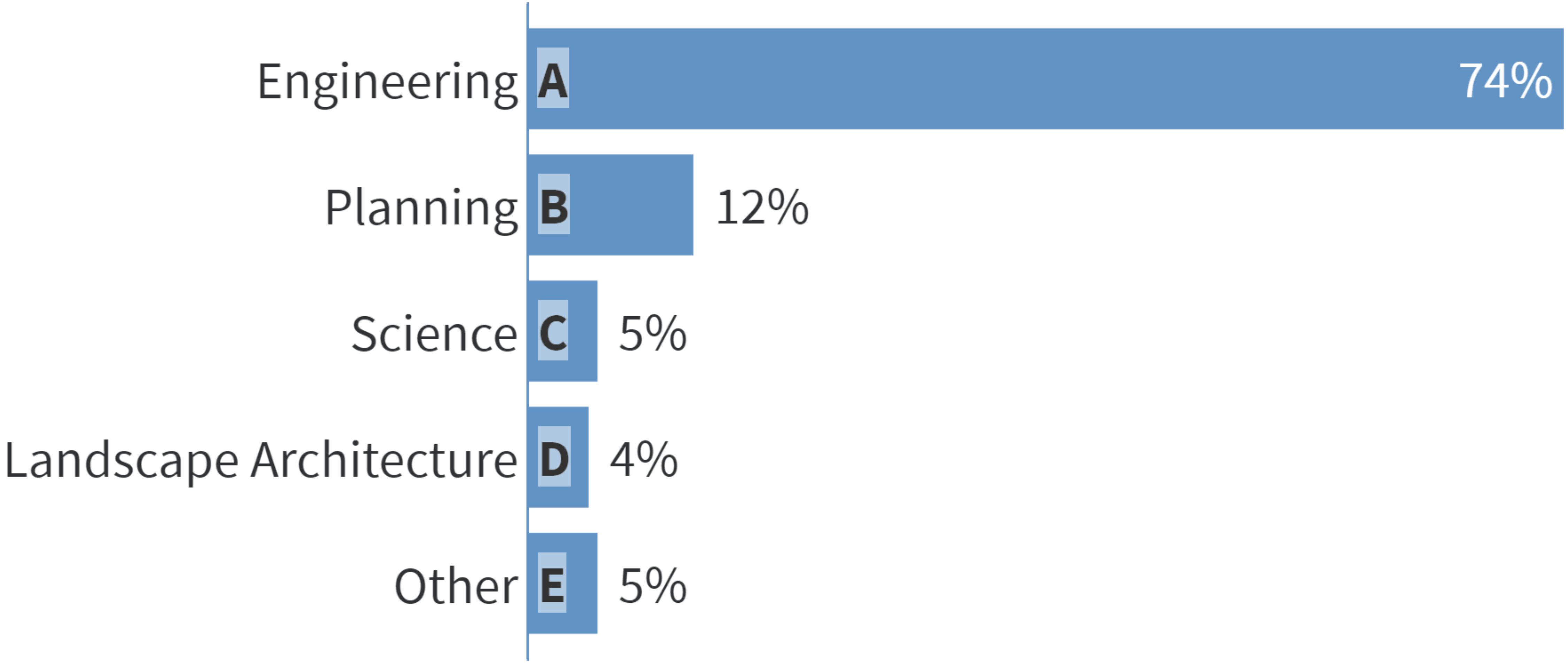
Important note: A record of the poll responses will be kept for statutory records retention requirements

What type of organization do you represent?



FDOT TRANSPORTATION SYMPOSIUM

What is your professional area of expertise?



Why Resiliency?

Resiliency -- The ability of the transportation system to adapt to changing conditions and prepare for, withstand, and recover from disruptions.

Why? Mitigate risk, make wiser investment decisions, and provide more reliable transportation.

Fixing America's Surface Transportation (FAST) Act

- Resiliency/reliability; reduce stormwater impacts; reduce vulnerability

FDOT 23 Code of Federal Regulations (CFR) Part 667

- Evaluate options for facilities that have been repaired/reconstructed 2+ times due to emergency events

FDOT Resiliency Initiatives

Statewide Planning
- Florida Transportation Plan
- Transportation Asset Management Plan (TAMP)

FDOT Resiliency Policy

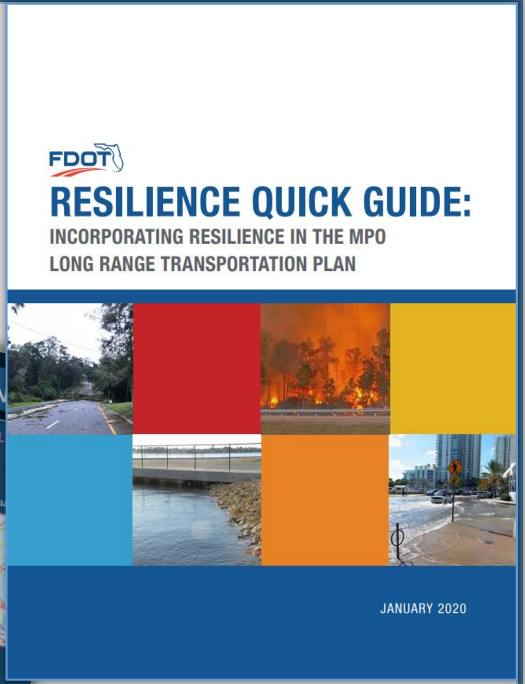
SIS Vulnerability Assessment

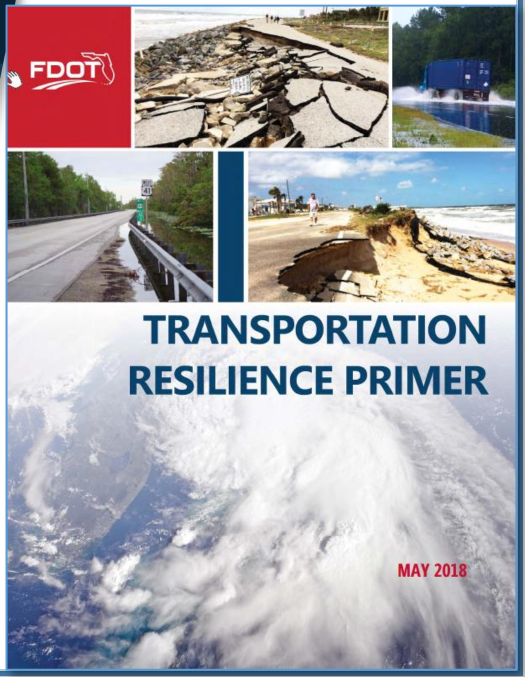
Tools, Guidance, Standards
- Guidance for MPOs
- Sea Level Scenario Sketch Planning Tool
- Case Studies/Adaptation Planning

Research

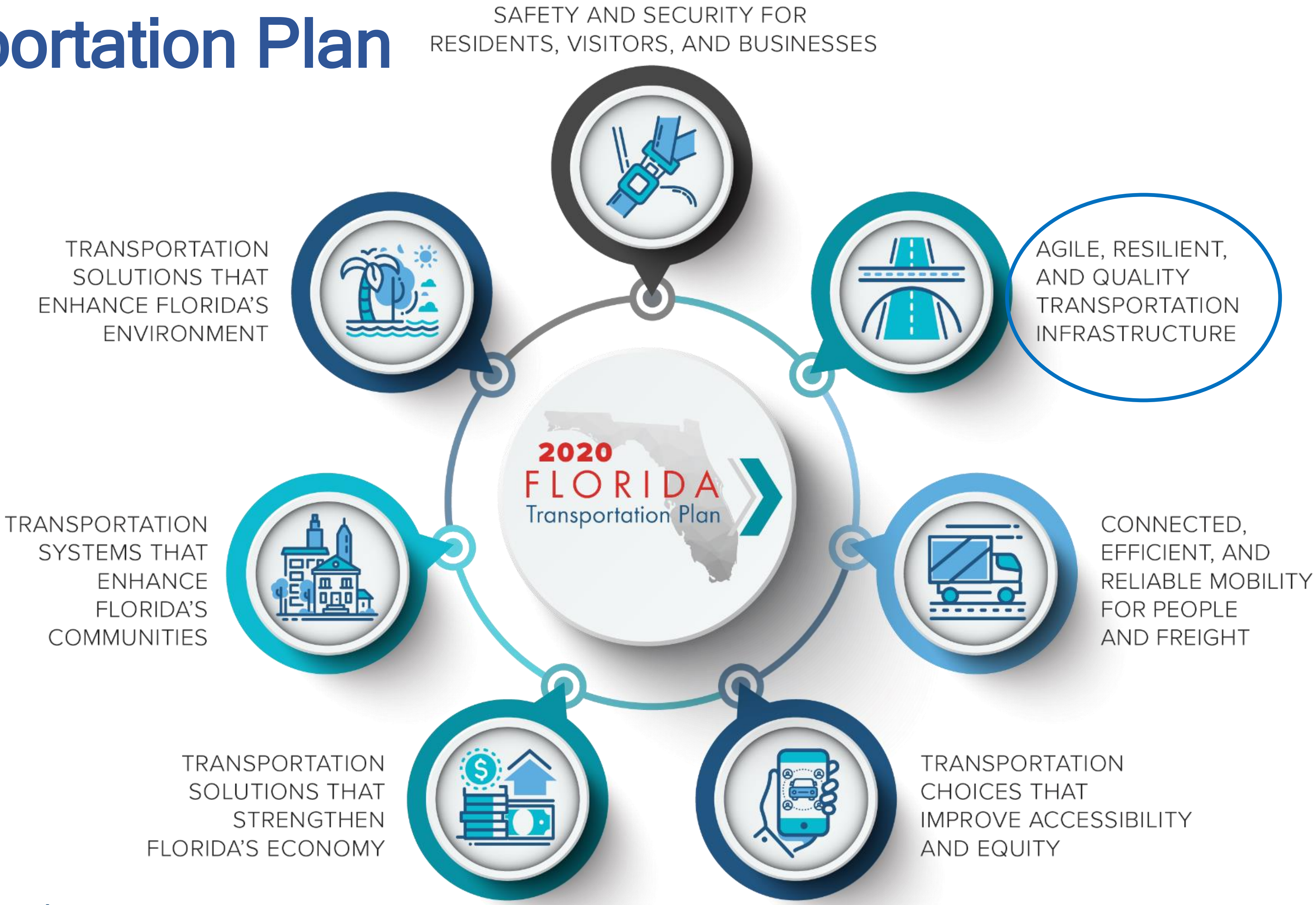
Interagency Coordination/Collaboration

Projects





Florida Transportation Plan



www.floridatransportationplan.com

Strategic Intermodal System (SIS) Vulnerability Assessment

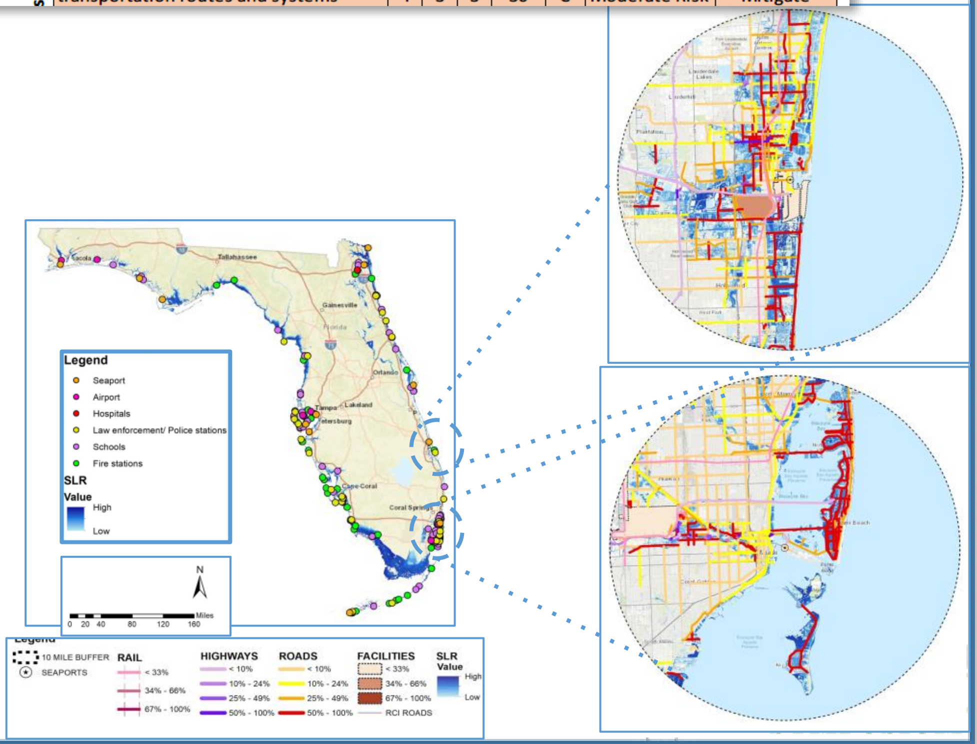
Research

FDOT – Completed/Ongoing

- Development of a Methodology for the Assessment of Sea Level Rise Impacts on Florida's Transportation Modes and Infrastructure
- Development of GIS-Based Tool for Assessment of SLR Impacts
- Risk in Transportation Planning & Implications for Planning and Project Implementation
- Transportation Resilience and Vulnerable Populations
- Resilience Index for Transportation System

NCHRP Projects

	Risk Event	Likelihood	Consequence	Vulnerability	Overall Risk	Timeframe	Risk Level	Consequence Management
	Threats							
security for residents, visitors, and businesses	Hacking and cybersecurity threats to public and private transportation	4	4	5	80	E	Extreme Risk	Avoid
	New technology causes investment to be prematurely obsolete	4	4	5	80	E	Extreme Risk	Avoid
	Intensification of development in high hazard areas	5	4	4	80	C	Extreme Risk	Avoid
	Aging population causes surge in demand for safe mobility options	5	4	3	60	E	High Risk	Coordinate
	Wildfires disrupt major transportation routes and reduce visibility	4	3	4	48	U	Moderate Risk	Mitigate
	New technology systems perform unsafely or increase liability	3	5	3	45	U	Moderate Risk	Avoid
	Failure to evacuate vulnerable populations due to evacuation routes in high hazard areas	2	5	4	40	U	Moderate Risk	Coordinate
	Arterial flooding disrupts major transportation routes and systems	4	3	3	36	C	Moderate Risk	Mitigate



Upcoming FDOT Projects

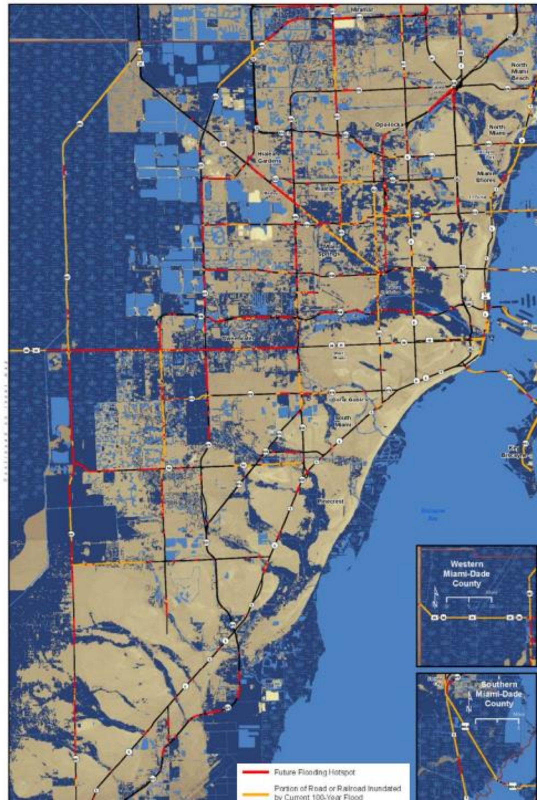
Research

- Incorporation of Climatic and Hydrologic Nonstationarity into FDOT Planning and Design Guidelines & Processes
- Florida Sea Level Scenario Sketch Tool Updates & Enhancement

Study

- Integrating Resiliency in the Transportation Planning Process: A Baseline Assessment of Florida's MPOs

Figure 7: Future flooding "hot spots" in Miami-Dade County.



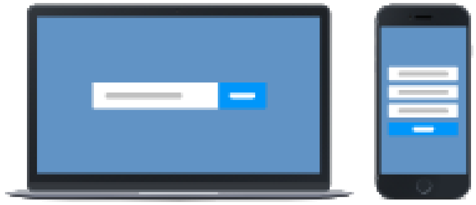
Sharing Our Ideas

Poll Everywhere – multiple ways to access the polls:

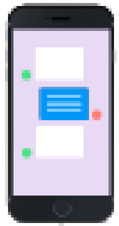
- Visit www.PollEv.com/fdotplanning from your phone, tablet, or laptop to access the polling questions

- Text "FDOTplanning" to 22333 to join the poll and respond to the polls via text message

Web

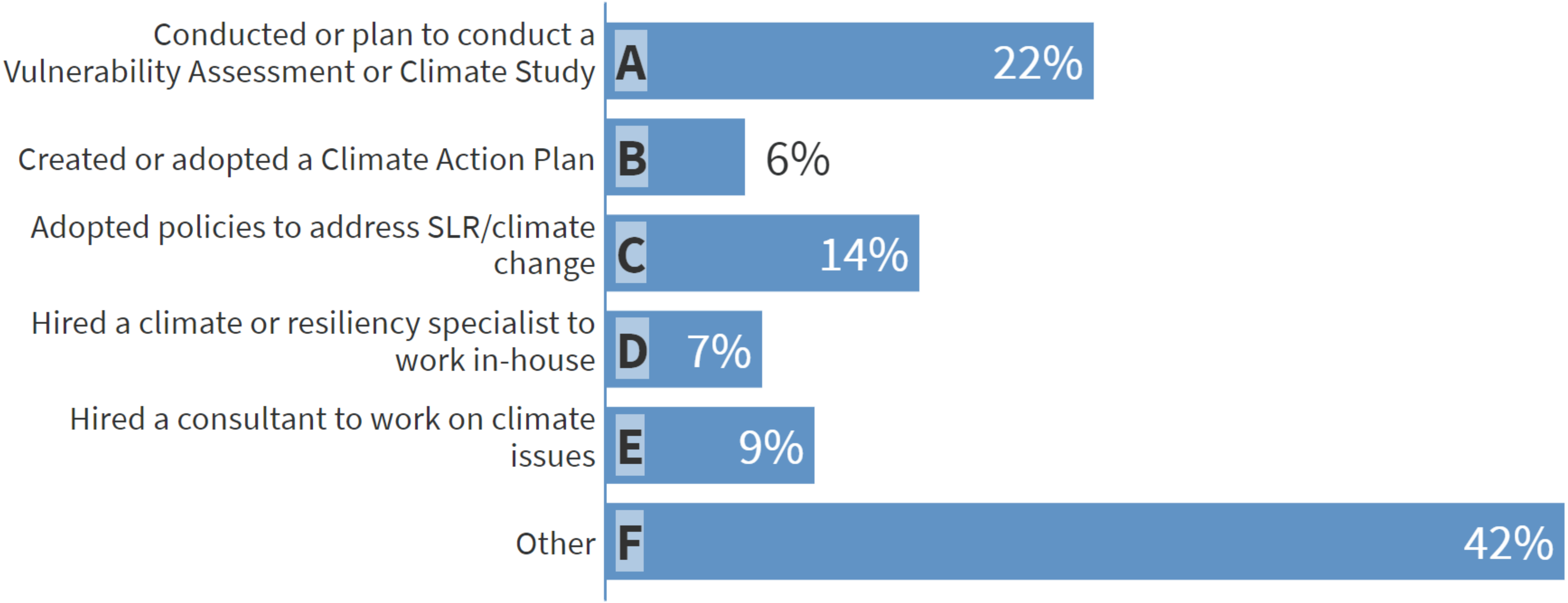


Text



Important note: A record of the poll responses will be kept for statutory records retention requirements

What methods does your organization use to address climate change including sea level rise?



FDOT TRANSPORTATION SYMPOSIUM

TOWARD A RESILIENT TRANSPORTATION SYSTEM

Crystal Goodison,
Associate Director + Associate Scholar, UF GeoPlan Center

UNIVERSITY OF FLORIDA GEOPLAN CENTER

The GeoPlan Center is a geospatial research and teaching facility, in the UF School of Landscape Architecture & Planning.

We support land use, transportation, and environmental planning in the State through the following activities:

- Standardize, enhance, and distribute geospatial data
- Design and maintain enterprise mapping systems and tools for visualization, analysis, and decision support
- Turn data into information
- Training and education

UF | GEOPLAN CENTER

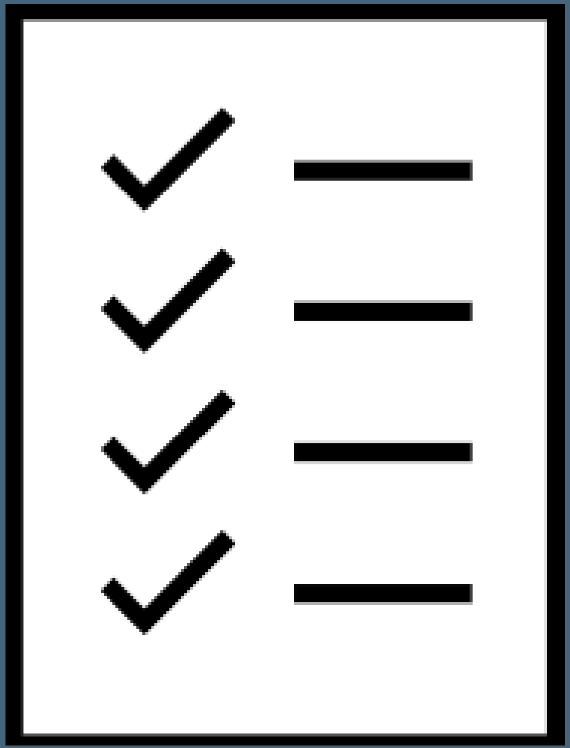
FGDL
FLORIDA GEOGRAPHIC DATA LIBRARY

etdm
Efficient Transportation Decision Making

FLORIDA 2070

SIGNAL FOUR ANALYTICS

OUTLINE OF PRESENTATION



History of UF GeoPlan resiliency work with FDOT

Sea Level Scenario Sketch Planning Tool

- Current Features
- Updates coming

Upcoming Work:

- Assessing MPO Data Needs for Transportation Resiliency
- Research Project – Framework for Project Level Analysis

WHERE WE'VE BEEN

- **2011-13:** Initial Sketch Tool Build. USACE 2013 Projections
- **2013-15:** FHWA Pilots, Data scale, Feedback
- **2016-17:** NOAA 2012 projections, new map viewer
- **2017:** Training workshops around State
- **2019-20:** NOAA 2017 projections, data update, training

SEA LEVEL SCENARIO SKETCH PLANNING TOOL

- Geospatial tools and data to assess potential impacts of current and future flooding on the transportation system
- Planning-level analyses shows where and when sea level rise is projected to occur in Florida under various SLR scenarios
- Data available statewide, but use local SLR projections
- Publicly accessible tool & data: sls.geoplan.ufl.edu

Map Viewer: Visualize areas of inundation and affected infrastructure

GIS Data Layers: SLR Inundation Surfaces & Affected Infrastructure layers

SLR Calculator: Create custom inundation layers

DATA AVAILABLE IN THE MAP VIEWER

Data Available

- 35 coastal counties mapped
- 5 Sea Level Rise Projections
- Four time periods: 2040, 2060, 2080, 2100

Transportation Analyses

Segment-level analysis of current & future flood risk:

- Future flood risk: from 20 SLR scenarios
- Current flood risk: 100-year & 500-year floodplains, storm surge zones

Base transportation data used:

- Focus on State owned facilities (RCI on and off system)

SLR PROJECTIONS MAPPED

Current SLR projections in Sketch Tool:

USACE 2013

- Upper curve ~ 5ft (1.5m) by 2100

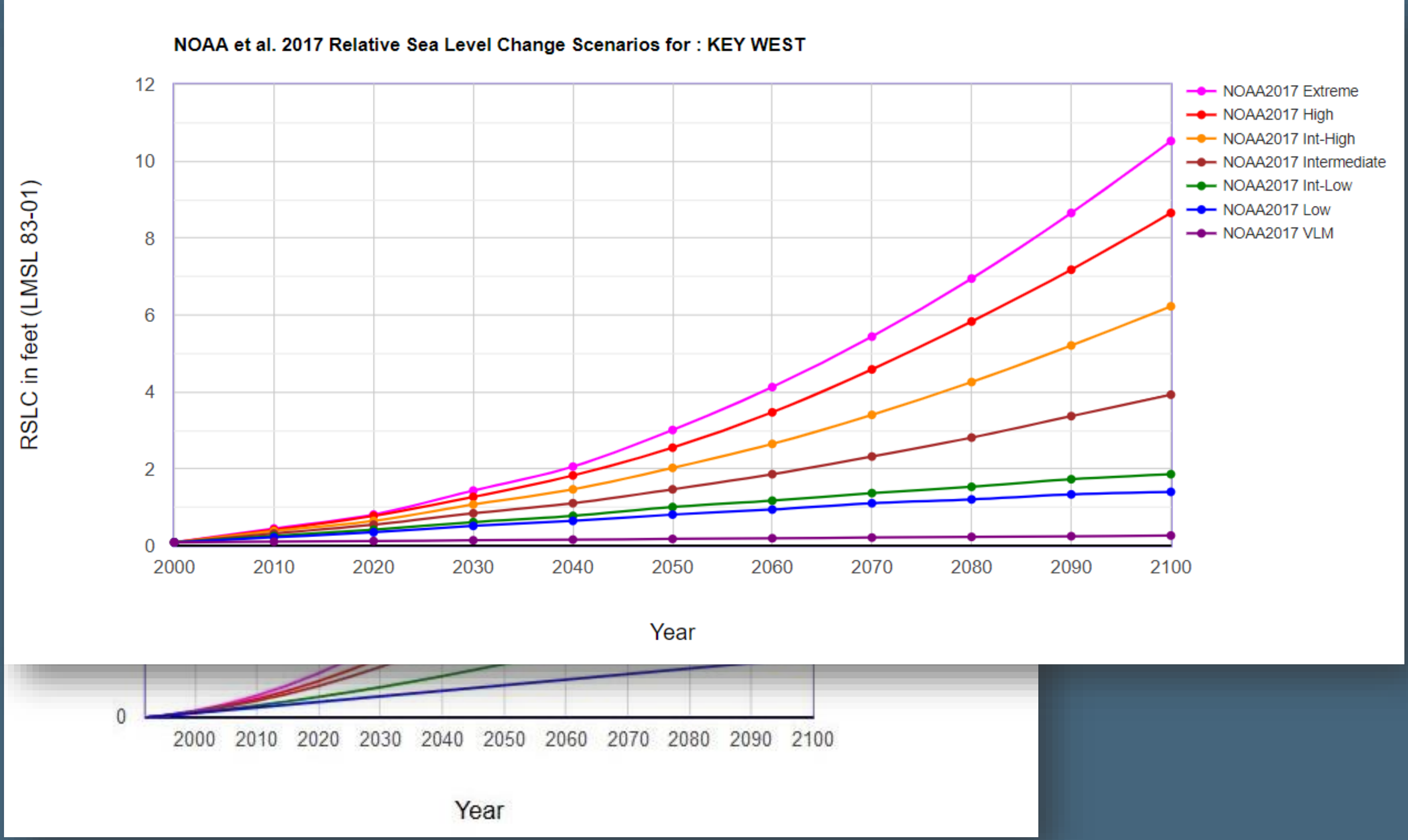
NOAA 2012:

- Upper curve ~ 6ft (2m) by 2100

Coming:

NOAA 2017:

- Upper curve ~ 10ft (3m) by 2100



MAPPING INPUTS

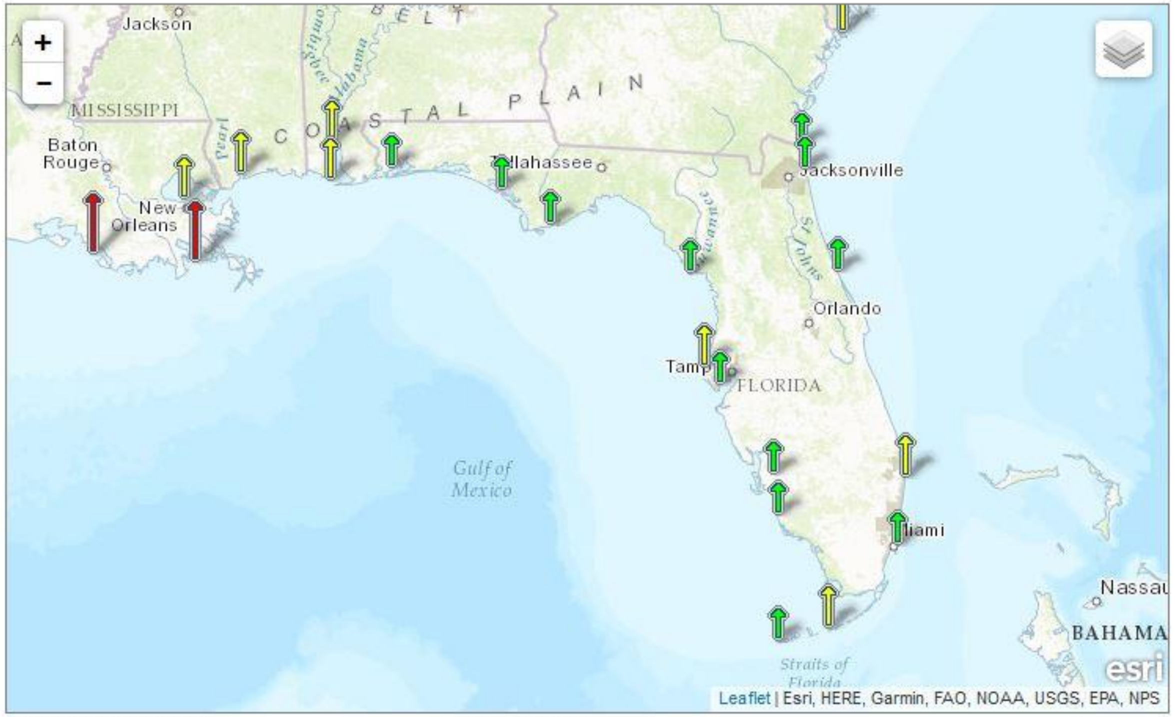
1. USACE Sea Level Change Calculator (calculates USACE & NOAA SLR Projections) http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html
2. NOAA Sea Level Trends
3. NOAA Tidal Grids (regional MHHW conditions)
4. High resolution elevation data

Consider regional Unified SLR Projections when choosing inputs

Sea Level Trends

East Coast | West Coast | Gulf Coast | Alaska | Hawaii | Global

View in Google Earth



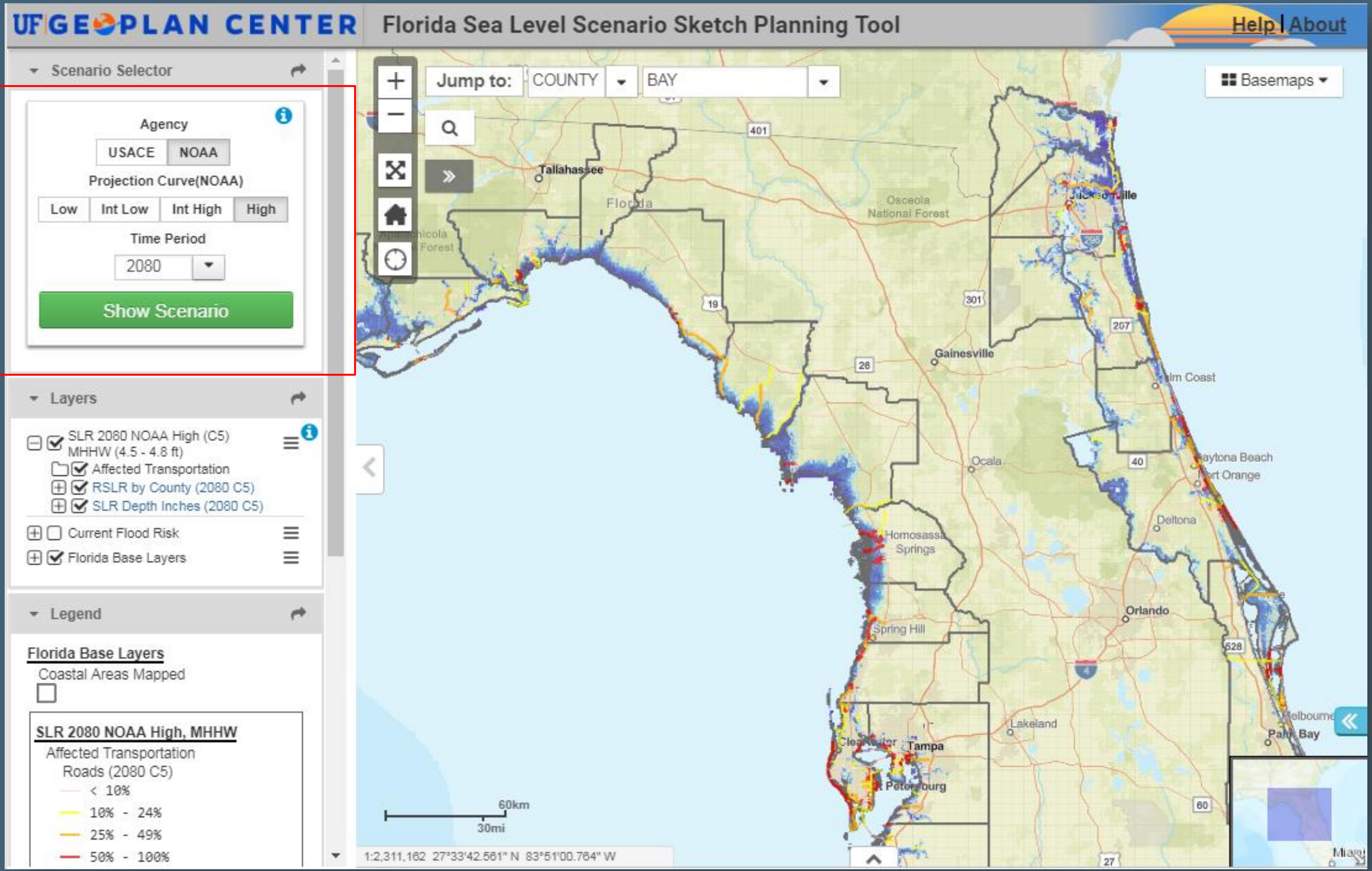
The map above illustrates regional trends in sea level, with arrows representing the direction and magnitude of change. Click on an arrow to access additional information about that station.

Sea Level Trends
mm/yr (feet/century)

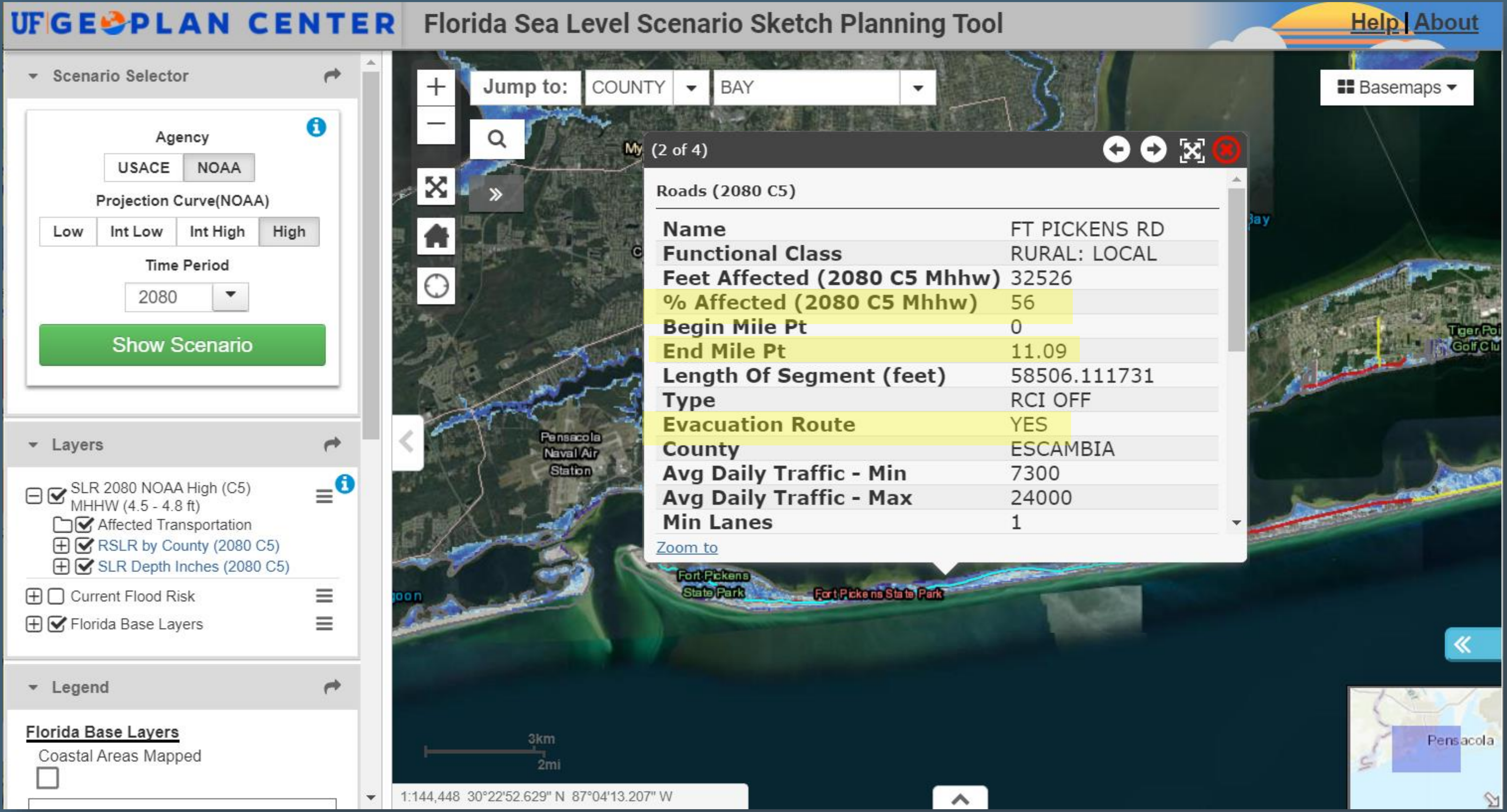
15 to 21 (5 to 7)	6 to 9 (2 to 3)	-3 to 0 (-1 to 0)	-12 to -9 (-4 to -3)
12 to 15 (4 to 5)	3 to 6 (1 to 2)	-6 to -3 (-2 to -1)	-15 to -12 (-5 to -4)
9 to 12 (3 to 4)	0 to 3 (0 to 1)	-9 to -6 (-3 to -2)	-18 to -15 (-6 to -5)

MAP VIEWER FEATURES

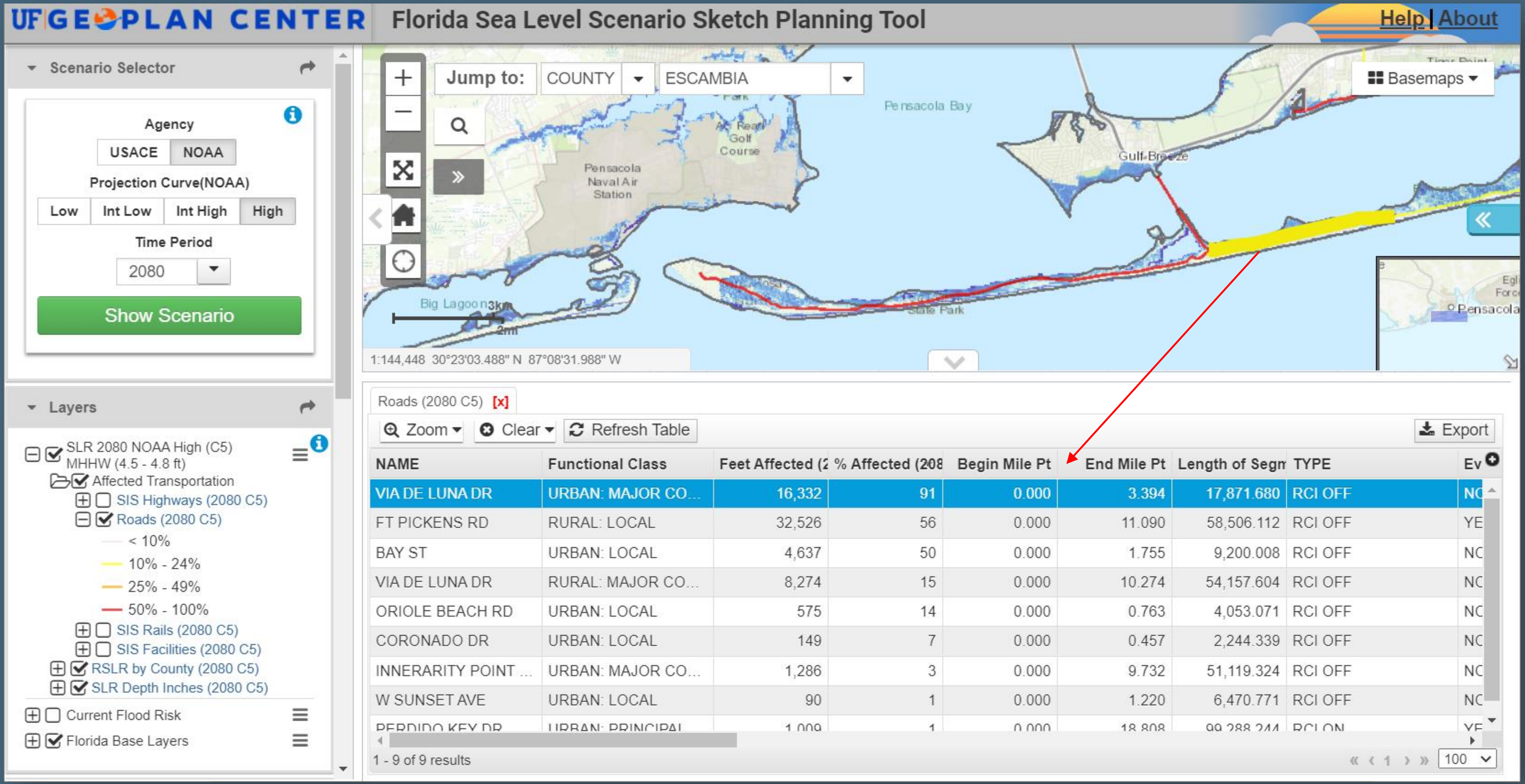
Select a scenario



EXPLORE THE DATA

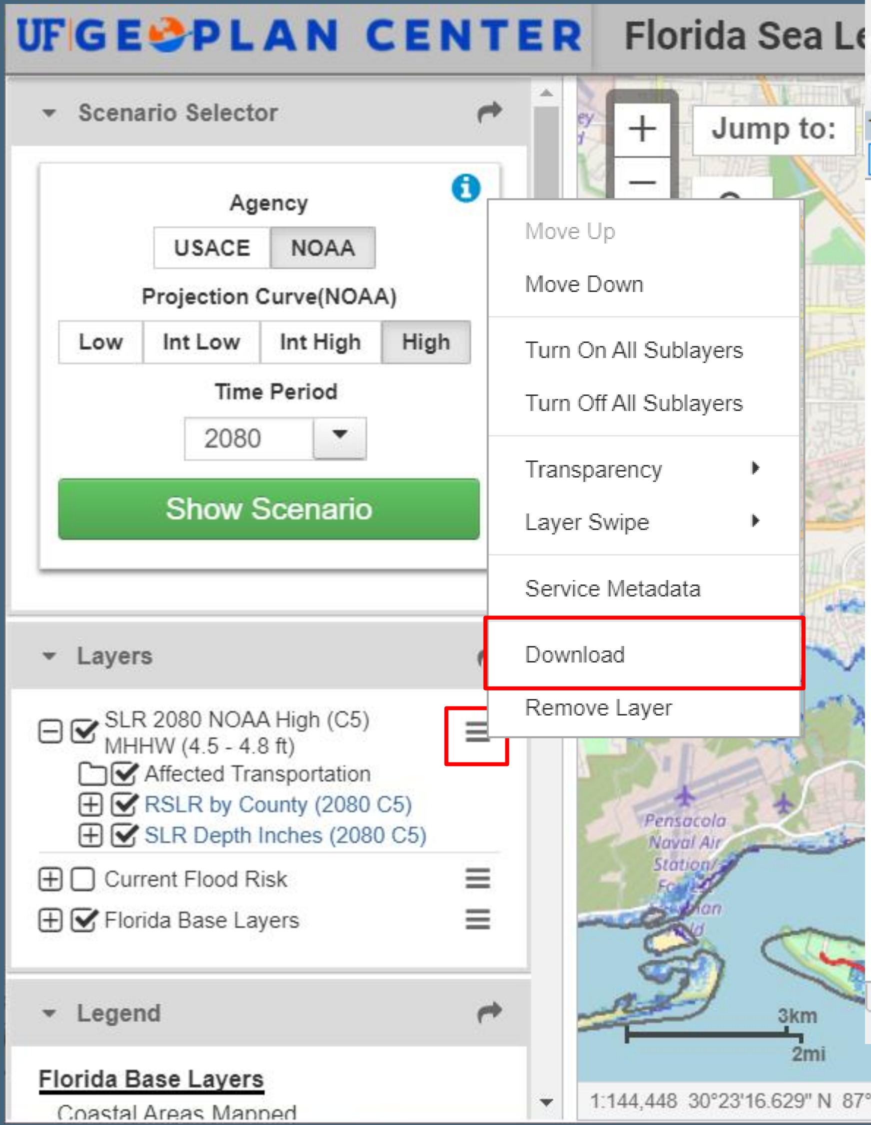


EXPLORE & EXPORT ATTRIBUTE TABLE

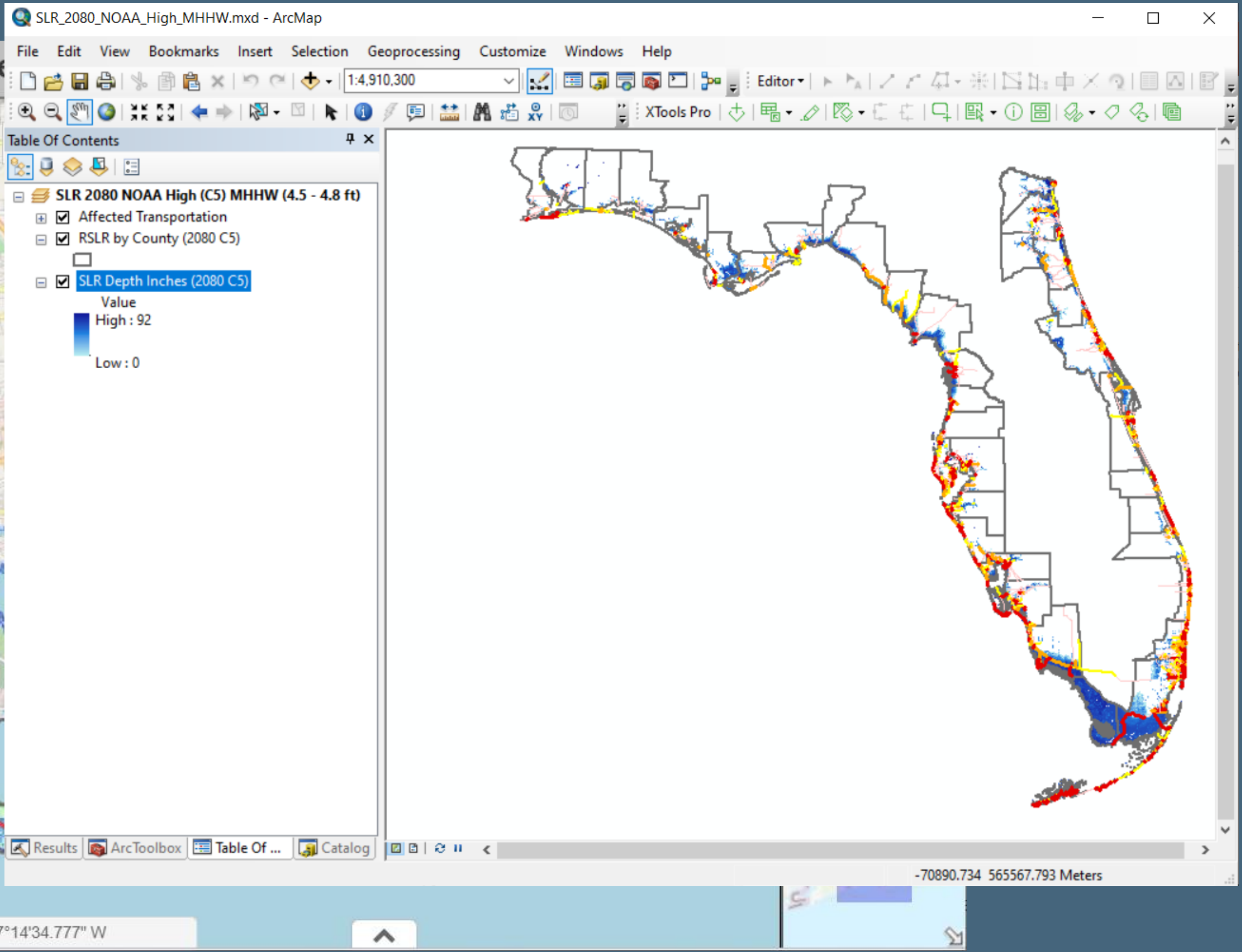


COMPARE SCENARIOS WITH SWIPE TOOL

GET THE DATA…



UF GEOPLAN CENTER
Florida Sea Le
Scenario Selector
Agency
USACE
NOAA
Projection Curve(NOAA)
Low
Int Low
Int High
High
Time Period
2080
Show Scenario
Layers
SLR 2080 NOAA High (C5) MHHW (4.5 - 4.8 ft)
Affected Transportation
RSLR by County (2080 C5)
SLR Depth Inches (2080 C5)
Current Flood Risk
Florida Base Layers
Legend
Florida Base Layers
Coastal Areas Mapped
Jump to:
Move Up
Move Down
Turn On All Sublayers
Turn Off All Sublayers
Transparency
Layer Swipe
Service Metadata
Download
Remove Layer
Pensacola Naval Air Station
3km
2mi
1:144,448 30°23'16.629" N 87°14'34.777" W



SLR_2080_NOAA_High_MHHW.mxd - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:4,910,300
Editor
XTools Pro
Table Of Contents
SLR 2080 NOAA High (C5) MHHW (4.5 - 4.8 ft)
Affected Transportation
RSLR by County (2080 C5)
SLR Depth Inches (2080 C5)
Value
High : 92
Low : 0
Results
ArcToolbox
Table Of ...
Catalog
-70890.734 565567.793 Meters

WHAT'S COMING: THIS FALL

NOAA 2017

UPDATED BASE DATA

LOCAL ROADWAYS

TRAINING WEBINAR

Our website:
sls.geoplan.ufl.edu

Crystal Goodison,
cgoody@ufl.edu

WHERE WE'RE GOING

- **2011-13:** Initial Sketch Tool Build. USACE 2013 Projections
- **2013-15:** FHWA Pilots, Data scale, Feedback
- **2016-17:** NOAA 2012 projections, new map viewer
- **2017:** Training workshops around State
- **2019-20:** NOAA 2017 projections, more training
- **2020-21:** Survey of MPO Resiliency Activities and Data Needs
- **2021 - 22:** Framework for project level analyses

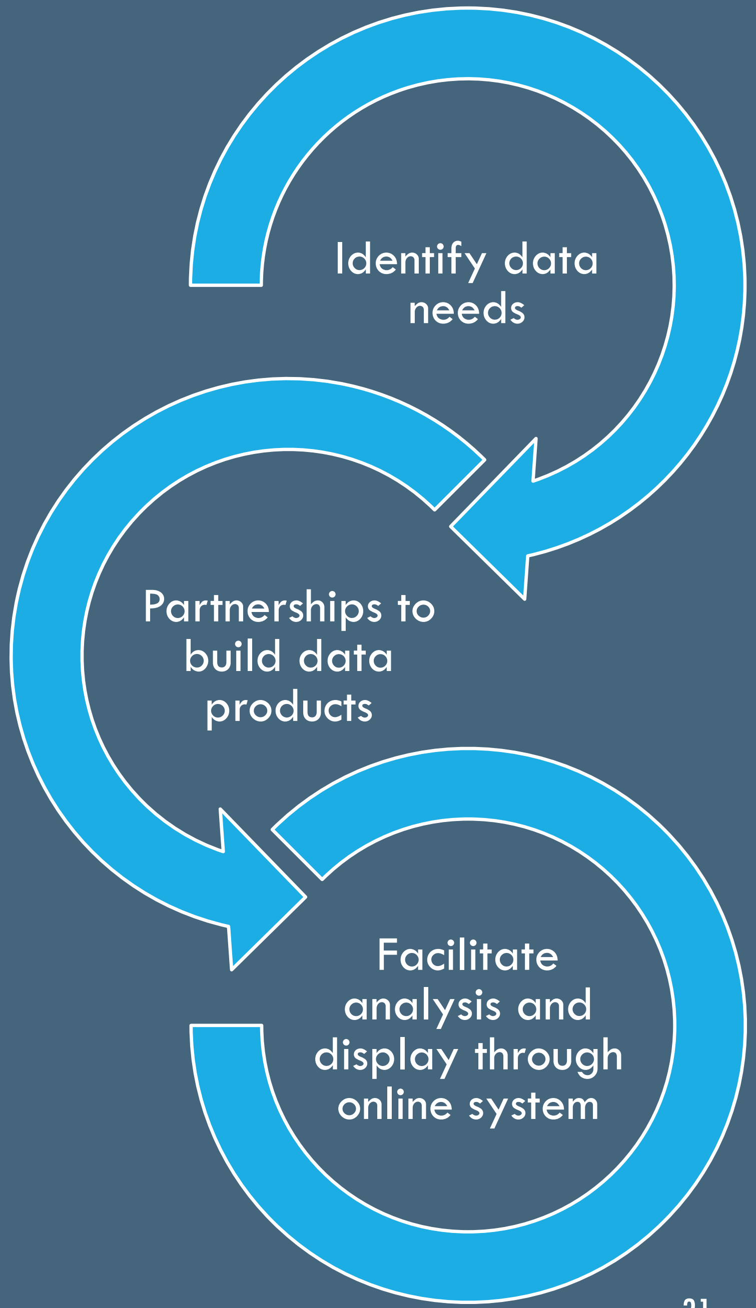
UPCOMING RESEARCH (2020 - 22)

2020-21: State of the Practice & Data Needs for MPO Resiliency

- Deep dive into resiliency activities in FL, obstacles, and data needs for implementing resiliency into the planning process

2021 -22: Building Geospatial Framework to Move from Planning to Project Scale

- Expanding beyond SLR to incorporate other data sources/climate. For ex: precipitation, inland flooding, etc.
- Looking for partners to help us develop data and determine interoperability
- Building online tool and geoprocessing framework to facilitate on-demand analysis of specific transportation projects and more comprehensive consideration of future conditions




QUESTIONS
?

What are the challenges in applying resiliency principles in project designs?

"Awareness" "Funding" "lack of a consistent method in applying risk mitigation costs" "Unknowns" "Paying now for later" "Project scope requirements & funding limitations" "Identifying countermeasures" "Budget"

"questionable data" "Existing policies, current government approach is not set up to accommodate" "$$$" "funding" "Money" "Politics" "Cost" "how to design for the UNKNOWN" "Money." "Value added"

"Cost and resistance" "Changing Directions" "Infrastructure planning is not set up to look at long-term; too focused on near-term, especially infrastructure in coastal areas" "Funding" "Money budget" "policy" "Collaboration"

"POLITICS AFFECTING GUIDANCE" "we can do it, but others may not, so what is the point" "Funding and politics" "Funding" "cost-effective solutions" "being able to predict the future" "Insurance" "Politics and money"

"low buildings" "Balancing cost vs. benefit" "Concurrence" "Cost" "Uncertainty" "Reality" "Money" "Funding - Cost" "Lack of standards" "Ever changing conditions" "PD&E studies used old information"

"Money" "There aren't really design standards related to resiliency." "Agreement on SLR Scenarios by Government Agency Stakeholders" "Elevating roadways and treatment facilities along side existing development/topography due to increased tailwater."

"designing for unknown" "Budget" "Getting agency direction on how to address." "The design time frame longer than 20/30 years may not be realistic. Advances in technology and real time conditions may change the scenario." "Buy in" "future"

"forecasting parameters may change drastically" "Unclear targets" "Funding" "Politics." "Funding" "Uncertainty" "Understanding of priority" "money" "Justifying the Cost" "Funding & politics"

"Funding, sufficient data to make decisions on a project level. There is no universal definition of resiliency." "Subsurface infrastructure maintenance" "Policy" "roadway specs" "Budgeting these requirements" "Funding" "Money"

"technology changes in future" "No standards for design" "Point of diminishing returns" "Accepting change by public" "Funding!!!! These are expensive projects." "D" "feasible design criteria" "Drainage challenges"

"Politics" "Funding" "Public perception" "FDOTPLANNING" "Geometric constraints" "guidance and cost." "Politics" "Funding" "Cost. lack of Consistency or Policy" "Politics" "Funding"

"Amount of existing R/W or the need to pay for additional R/W to allow for a resilient TF." "modeling inaccuracies" "knowledge" "Public perception" "funding" "Data" "Budget constraints" "Unknowns"

"Lack of projects demonstrating success" "Impacts to adjacent land uses" "Money"

"Green infrastructure designs that are seen as more resilient are more maintenance intensive. There is a lack of long-term maintenance data." "Current land use." "New poll" "Scope" "Money" "being flexible, learning to address uncertainty"

"justification for return on investment, making a case." "Funding" "funding"

Towards a Resilient Transportation System in a Changing Environment of Climate Change: Paradigm Change

Jayantha Obeysekera ('Obey'), Ph.D.,P.E.
Director and Research Professsor
Sea Level Solutions Center
Institute of Environment

FDOT Transportation Symposium

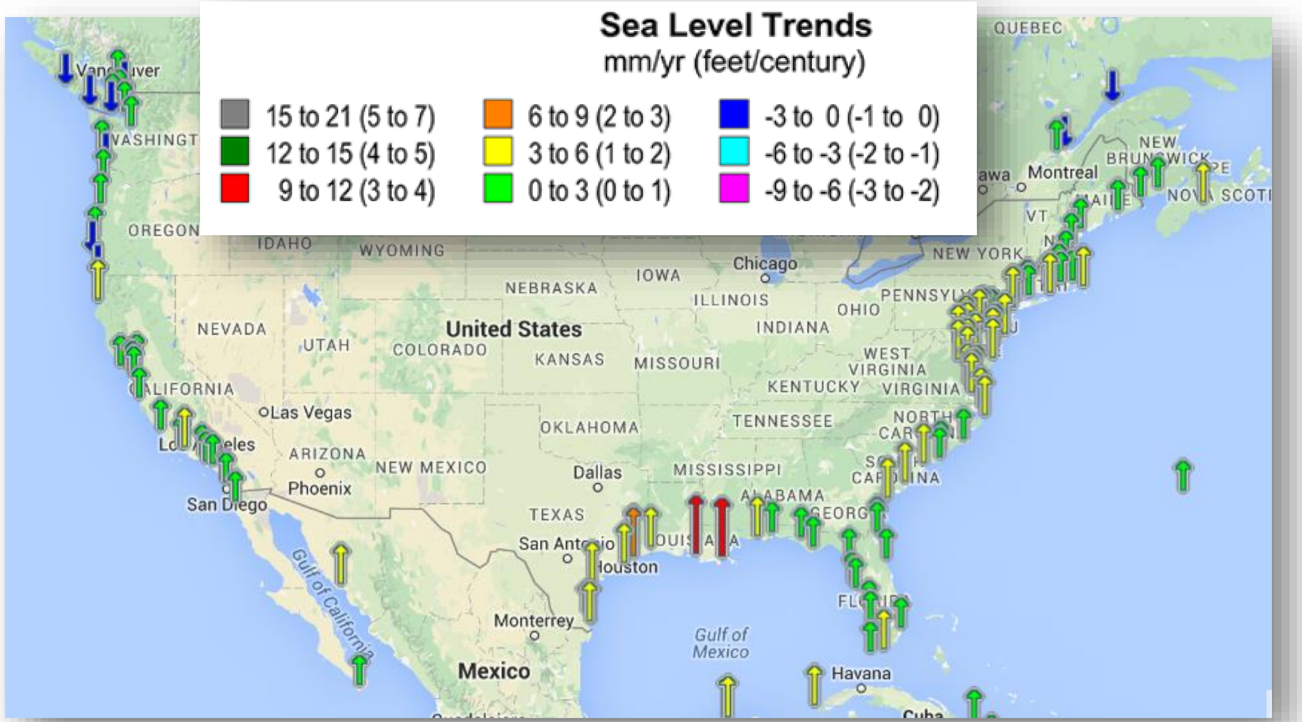
Web: https://environment.fiu.edu | http://slsc.fiu.edu **Facebook**: @FIUWater | **Twitter**: @FIUWater

Outline

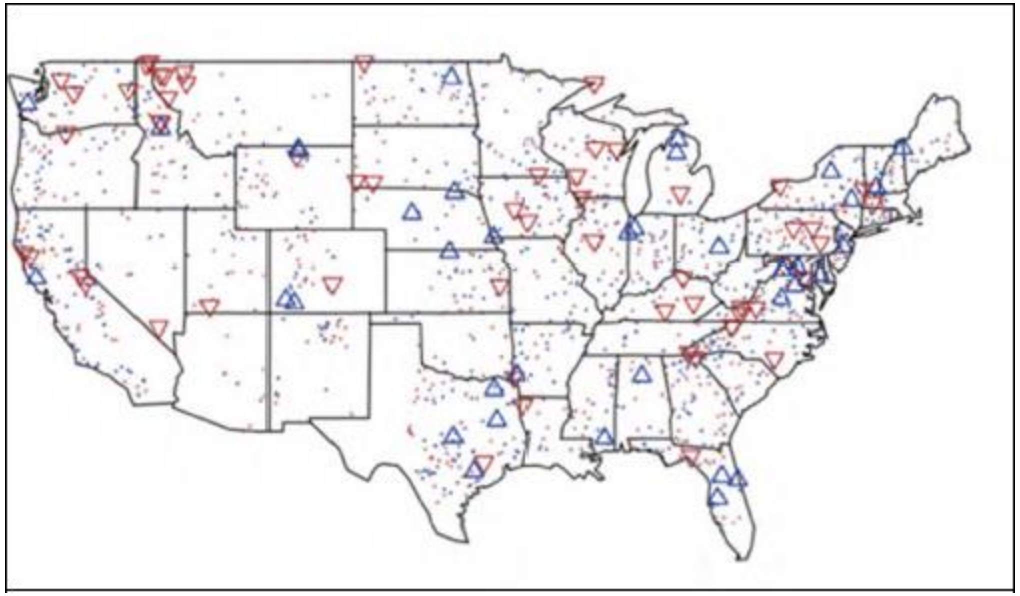
- Changing environment: Need a new paradigm for infrastructure design (coastal and interior regions)
- Rising Sea Levels
- Changing Rainfall Extremes
- Dealing with Uncertainty: Dynamic Adaptive Pathways in Project Implementation

Drivers of Change: Sea Level Rise and increases in Riverine Flooding

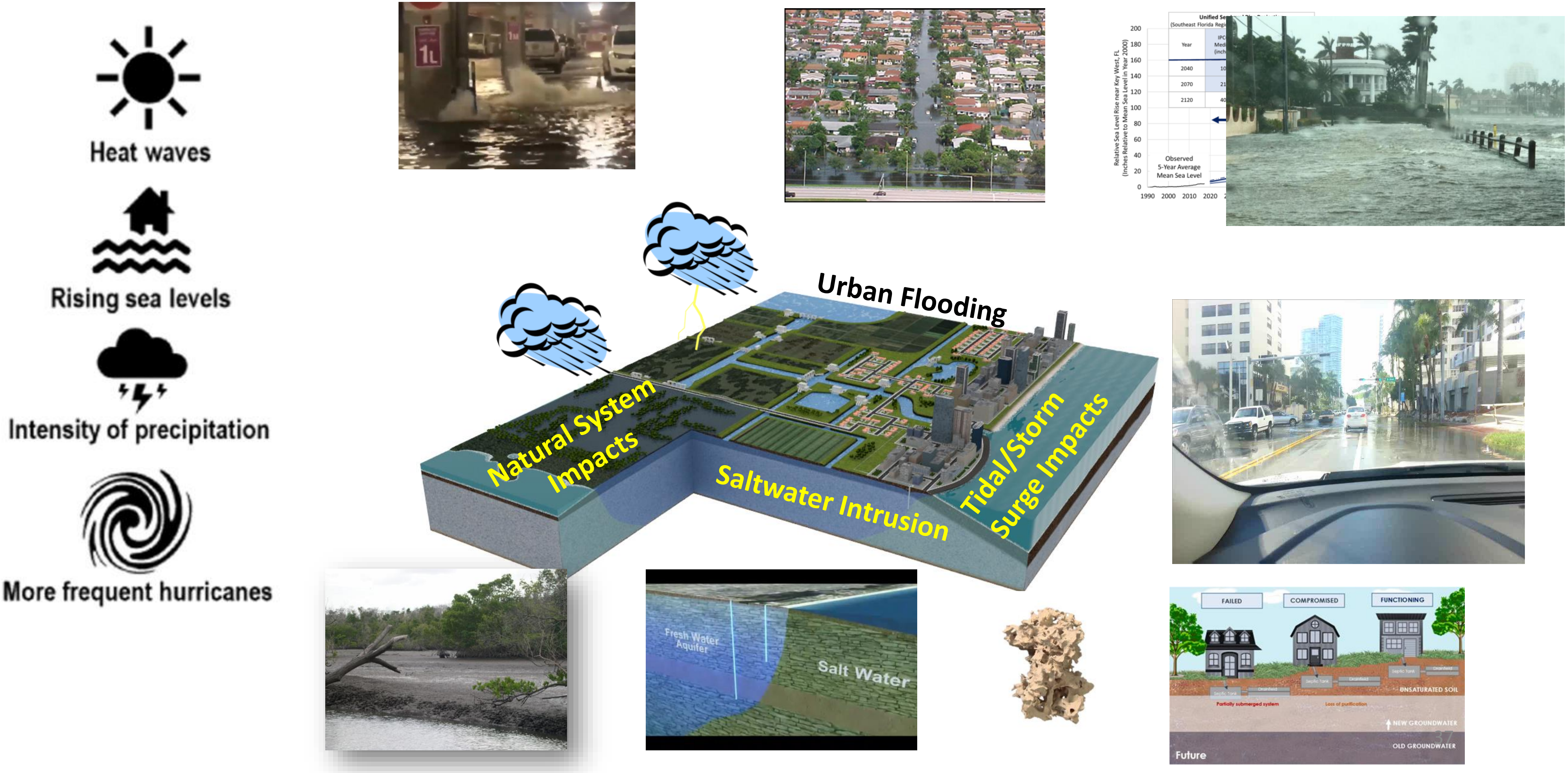
Sea Level Rise Trends



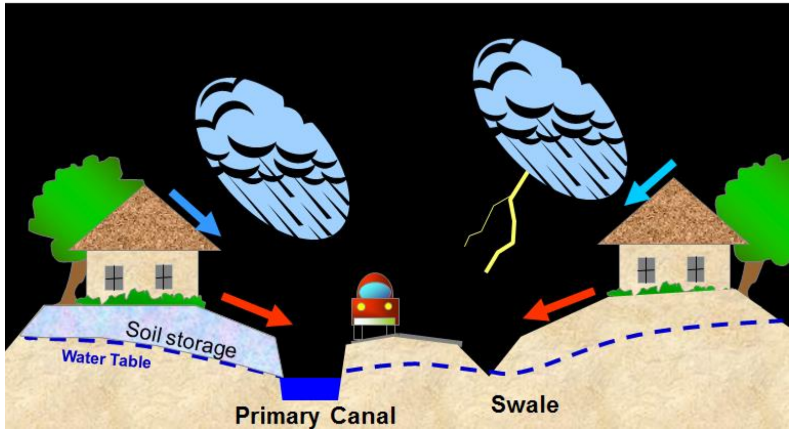
Peak Flow Trends

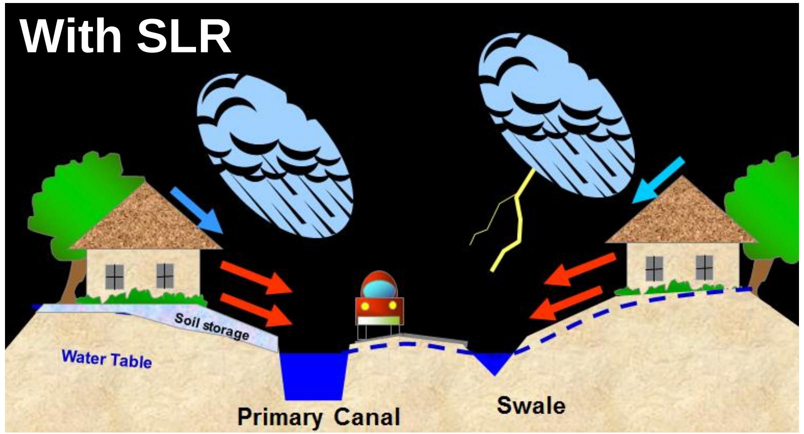


Impacts of Changing Climate and Rising Sea Levels

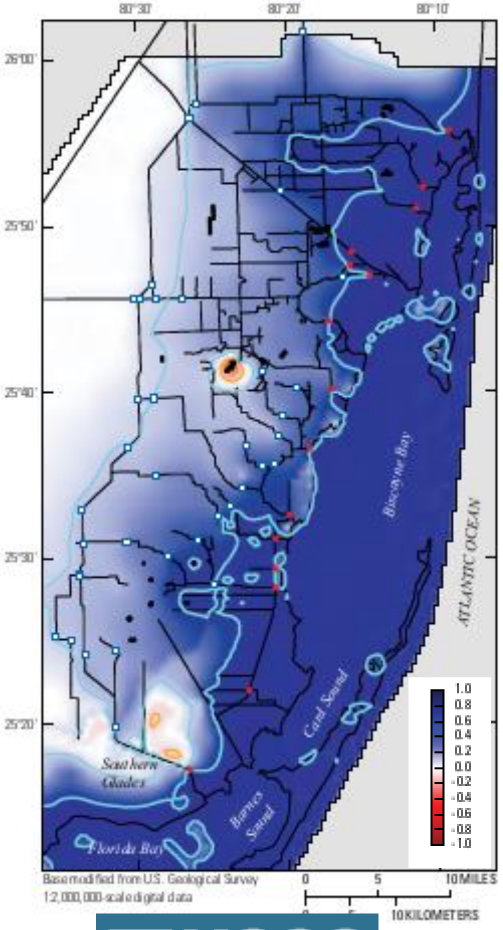


Non-uniform water table increase: modeling results (Miami Dade)

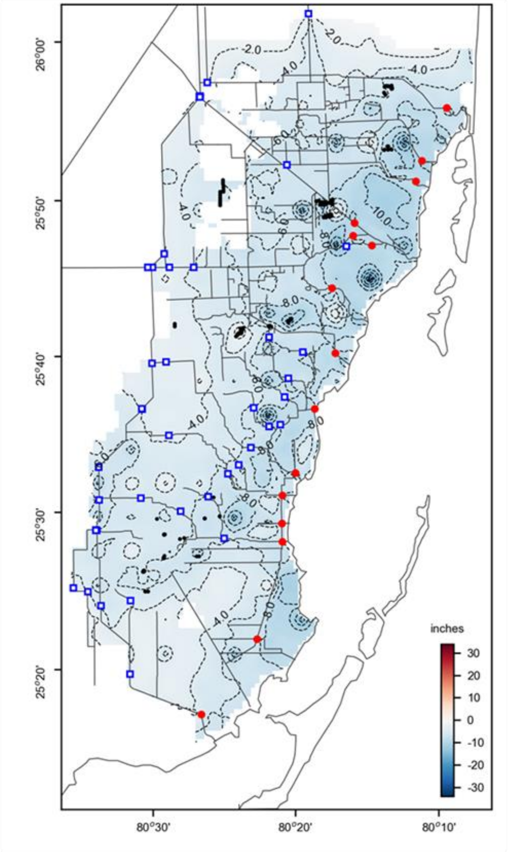




Higher water table
& more runoff

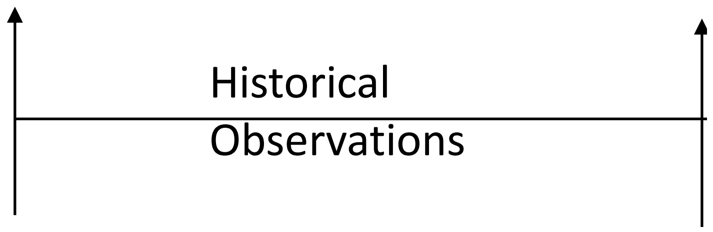


Difference in wet season soil storage
HIGH SLR – CALIBRATION (inches)



Loss of Soil Storage

Hydrologic Design: Moving from Stationarity to Nonstationarity



TYPE STORM DRAIN	FREQUENCY
General design	3-year
• General design work that involves replacement of a roadside ditch with a pipe system by extending side drain pipes • General design on work to Interstate Facilities	10-year
• Outfalls	25-year
• Interstate Facilities for which roadway runoff would have no outlet other than a storm drain system, such as in a sag inlet or cut section • Outlets of systems requiring pumping stations	50-year

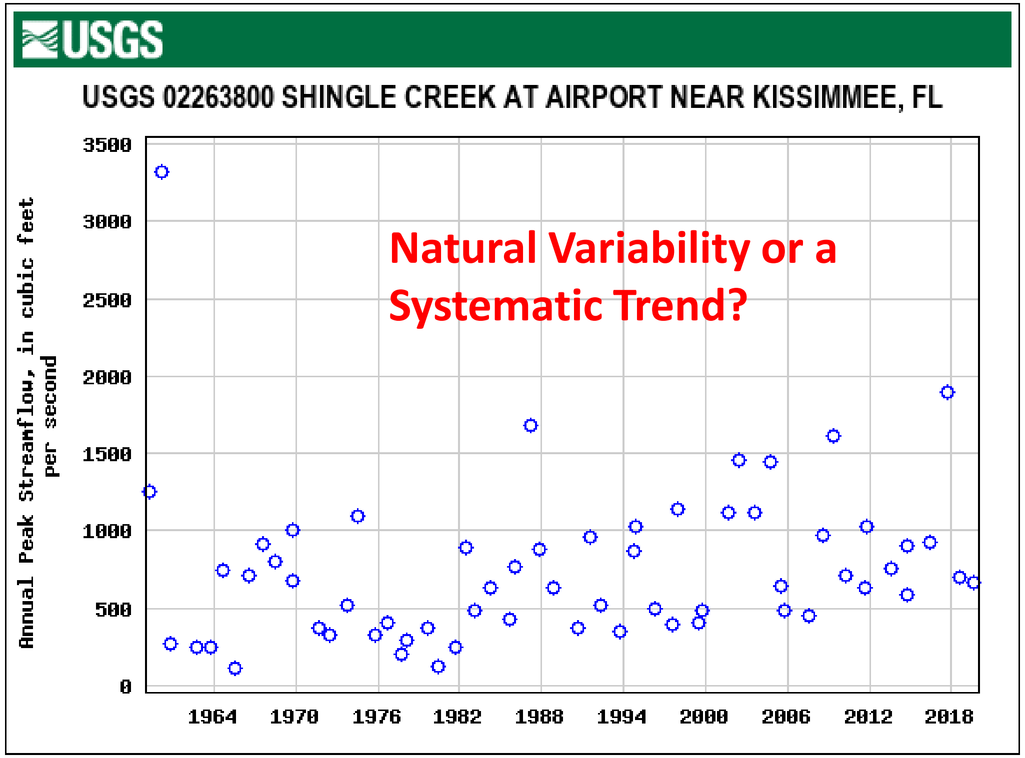
Relevant FDOT Literature

- FDOT Drainage Manual dated January 2020
- **FDOT Drainage Design Guide dated January 2020**
- Regional guidance documents developed by regional district, if applicable
- **FHWA Hydraulic Engineering Circular No. 17, 2nd Edition**
- **FHWA Hydraulic Engineering Circular No. 25, Second Edition or any updates**
- Design Storm Surge Hydrographs For the Florida Coast (September 2003)
- **NOAA ATLAS 14 Point Precipitation Frequency Estimates**
- NOAA Sea Level Trends at Tide Gages around Florida
- **NOAA Regional Sea Level Projections**
- Regional Sea Level Projections published by various organizations such as the SE Florida Climate Compact in Florida and the Tampa Bay region.

"..sea level rise coupled with storm surges can ***inundate coastal roads that would not have inundated in the past****, necessitate more* ***emergency evacuations****, and require costly, and sometimes* ***recurring, repairs to damaged infrastructure.*** *Inland flooding from unusually* ***heavy downpours*** *can disrupt traffic, damage culverts, and reduce service life.* ***High heat can degrade materials, resulting in shorter replacement cycles and higher maintenance costs****." (HEC-17)*

Causes & Detection of Nonstationarity

Natural Factors	Atmospheric and oceanic (climate) variability Wildfires and forest fires Volcanic eruptions and earthquakes Land subsidence Landslides
Anthropogenic (Human-Induced) Factors	Land use changes Climate Change Development of water resources projects



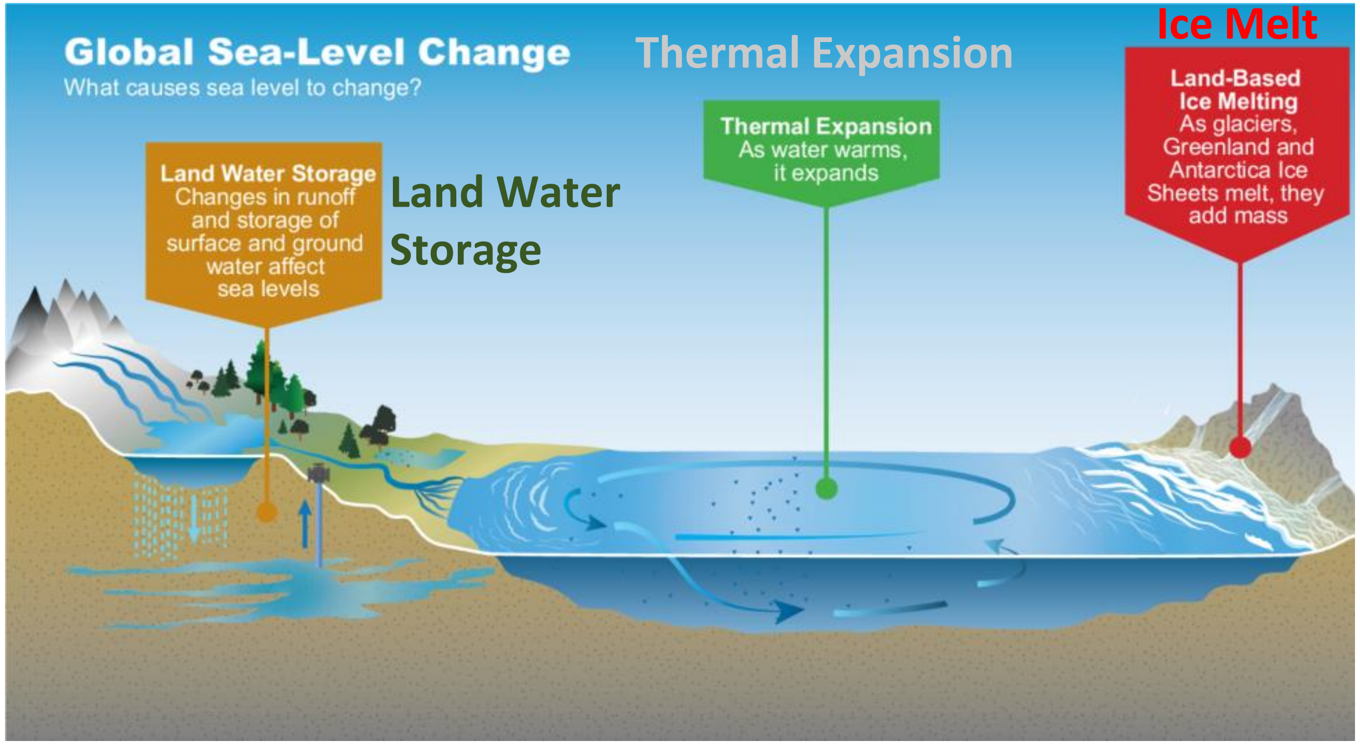
Statistical Methods: **Parametric & Nonparametric**

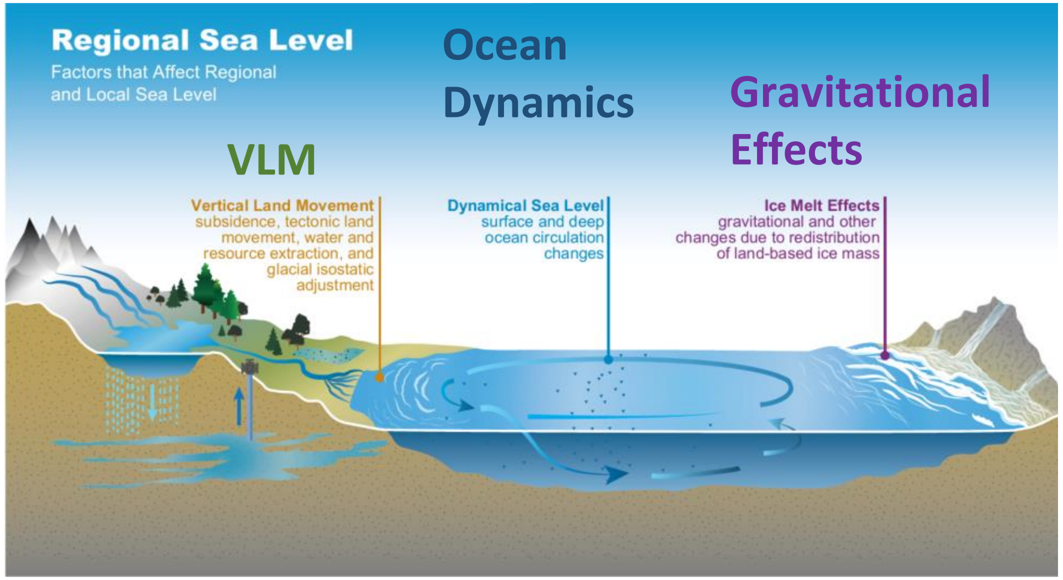
US Army Corps of Engineers:

Nonstationarity Detection Tool (NSD) – PROD

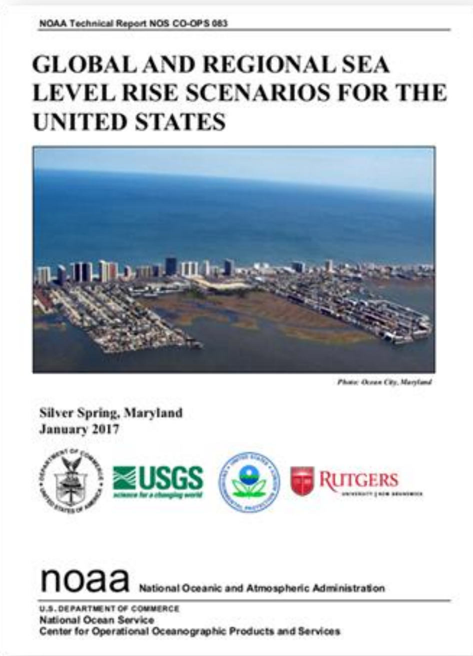
http://corpsmapu.usace.army.mil/cm_apex/f?p=257:1:0

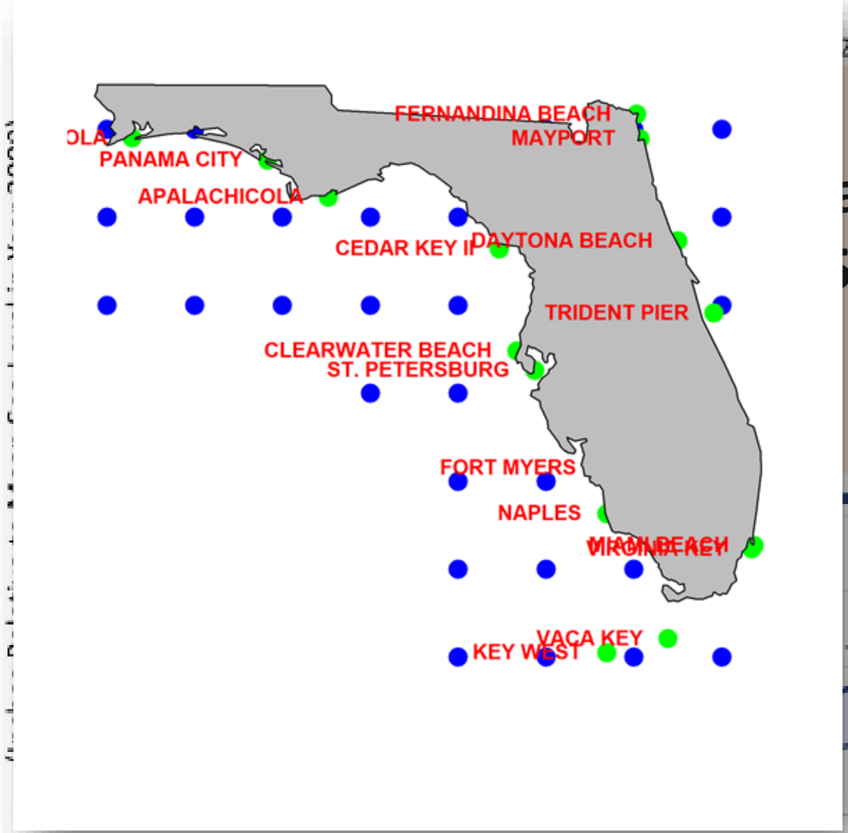
Sources of Global and Regional Sea Level Change





Planning for Sea Level Rise





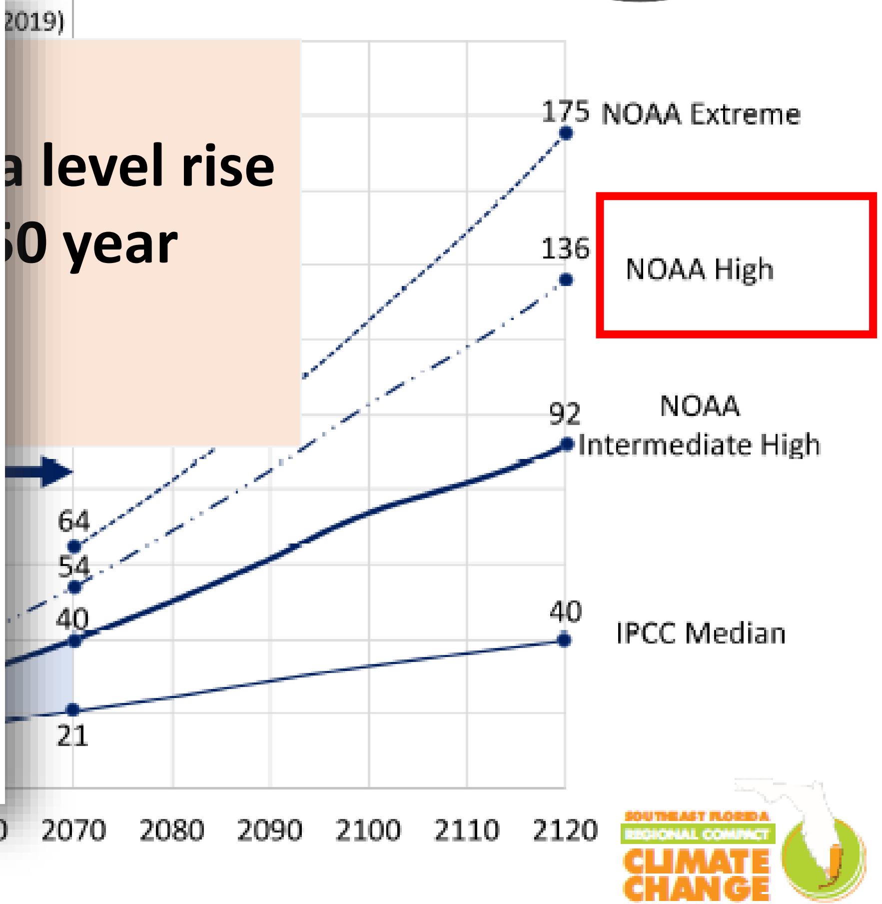
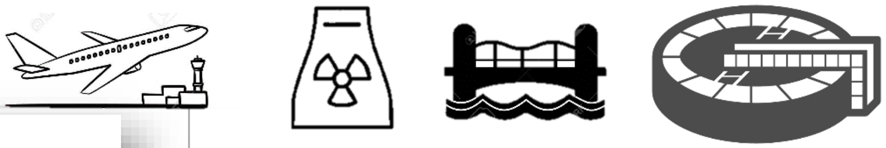
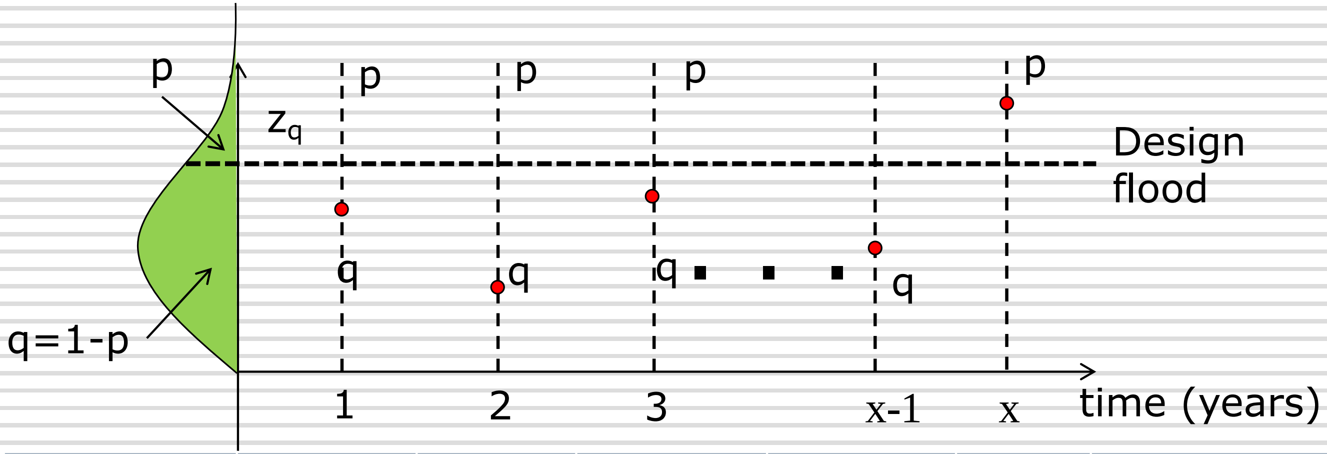


FIGURE 1: Unified Sea Level Rise Projection



Return Period under Stationarity

No-Flood/Flood occurrence



Event	NF	NF	NF	...	F	
Probability	1-p	1-p	1-p	. . .	p	

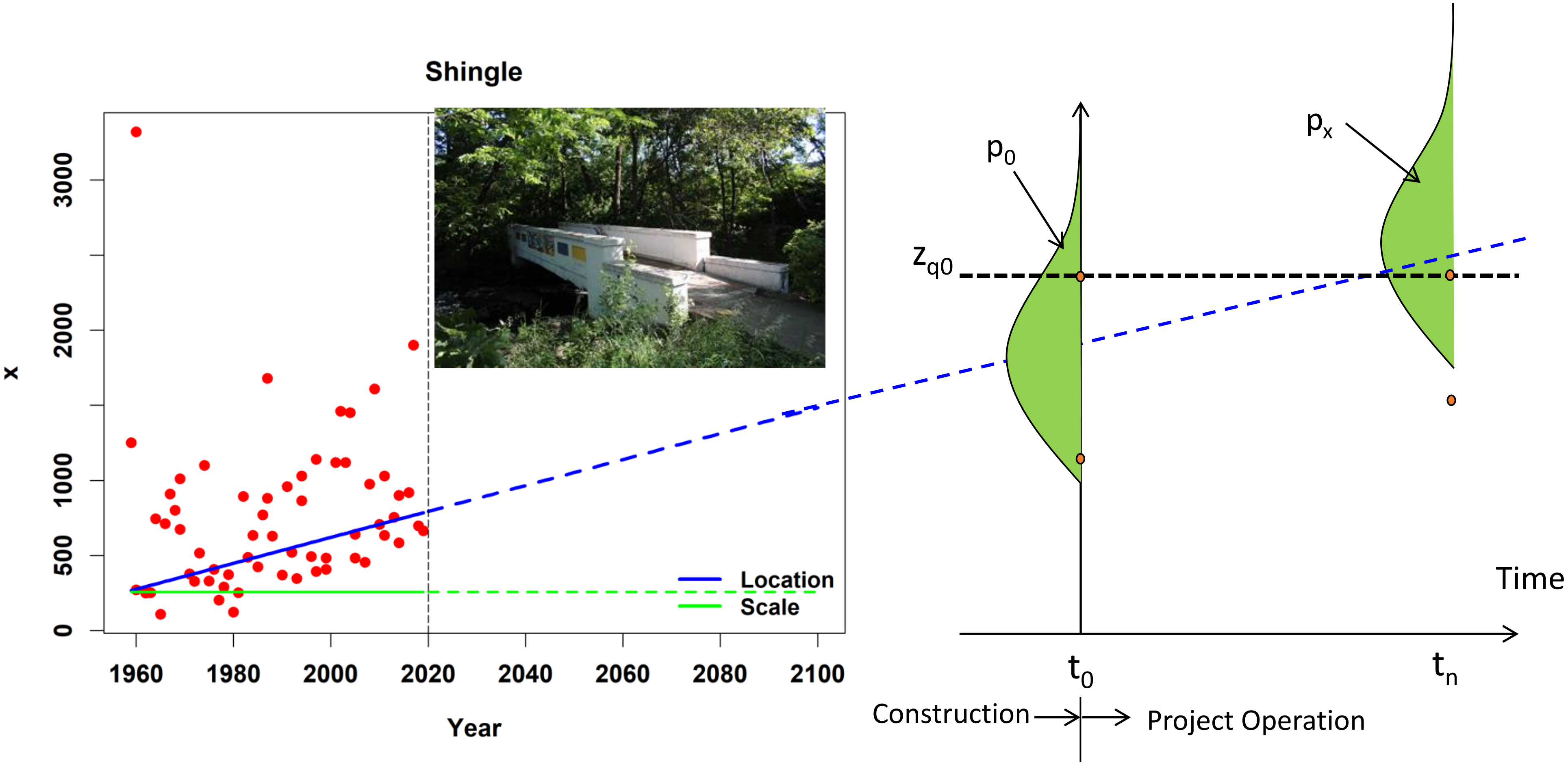
NF = No flood event exceeding z_q F = Flood event exceeding z_q

Geometric Distribution:

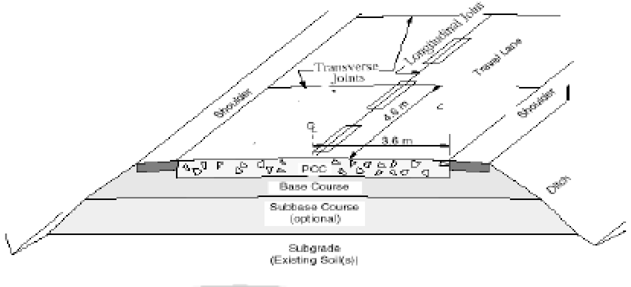
Return Period:
T = 1/p

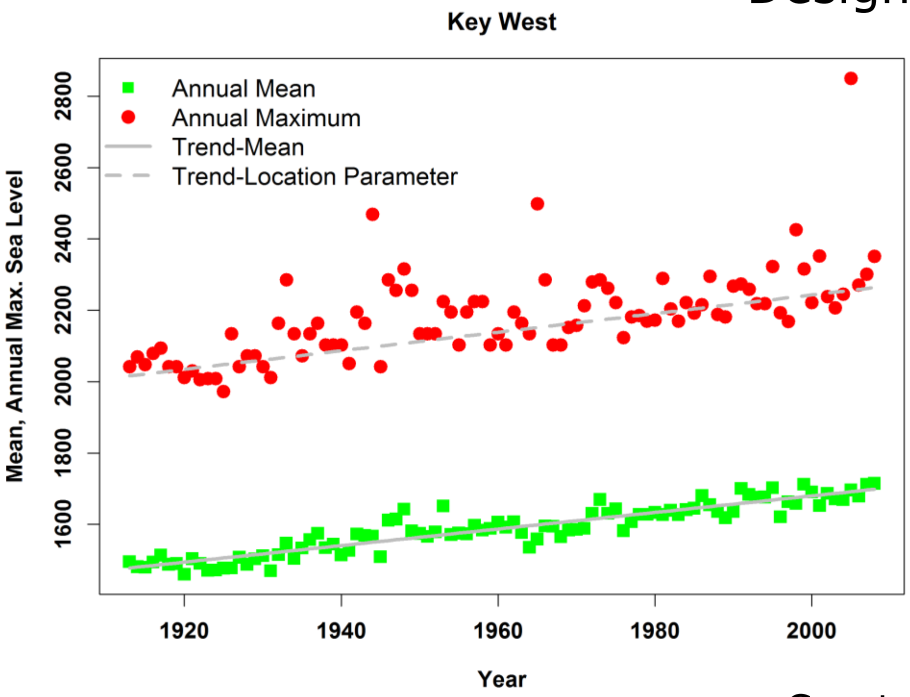
If T=100 yr then event has 1/% chance of exceedance

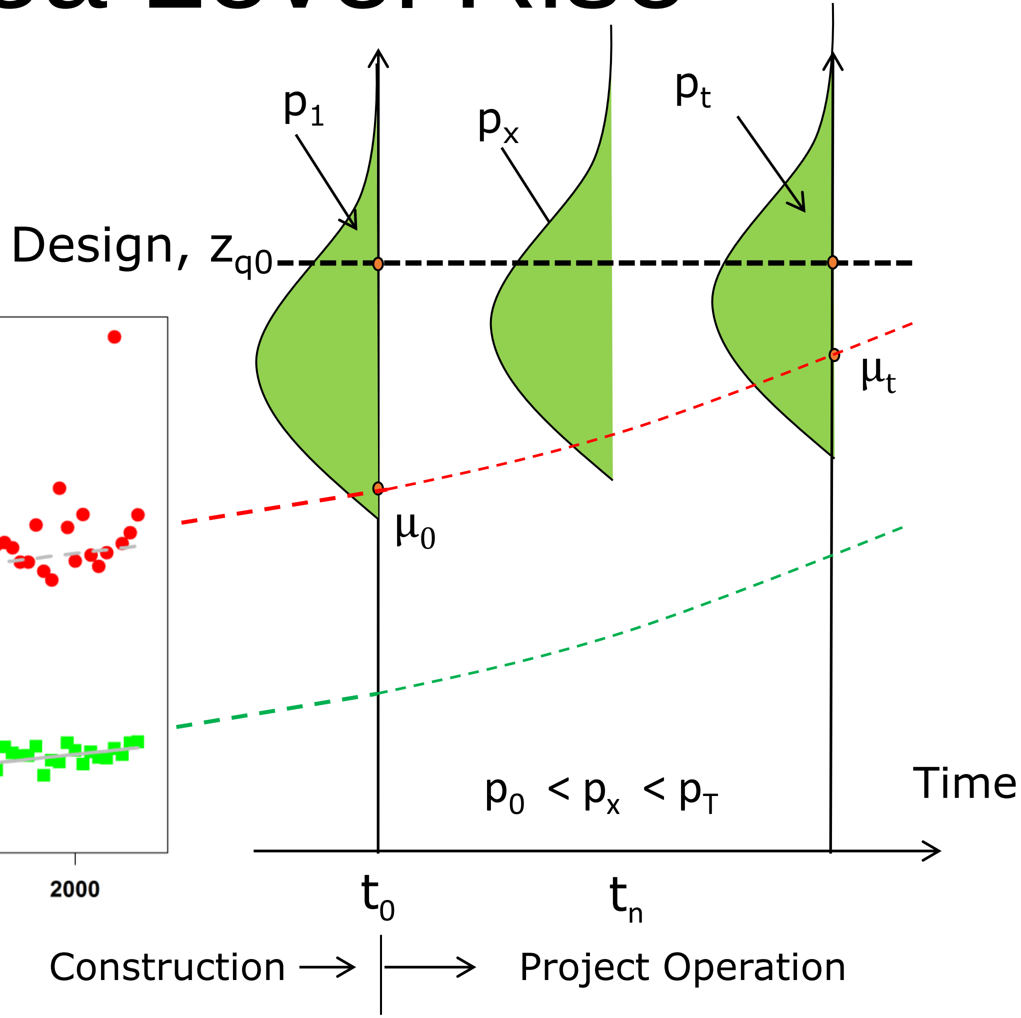
Nonstationarity: Extreme Floods



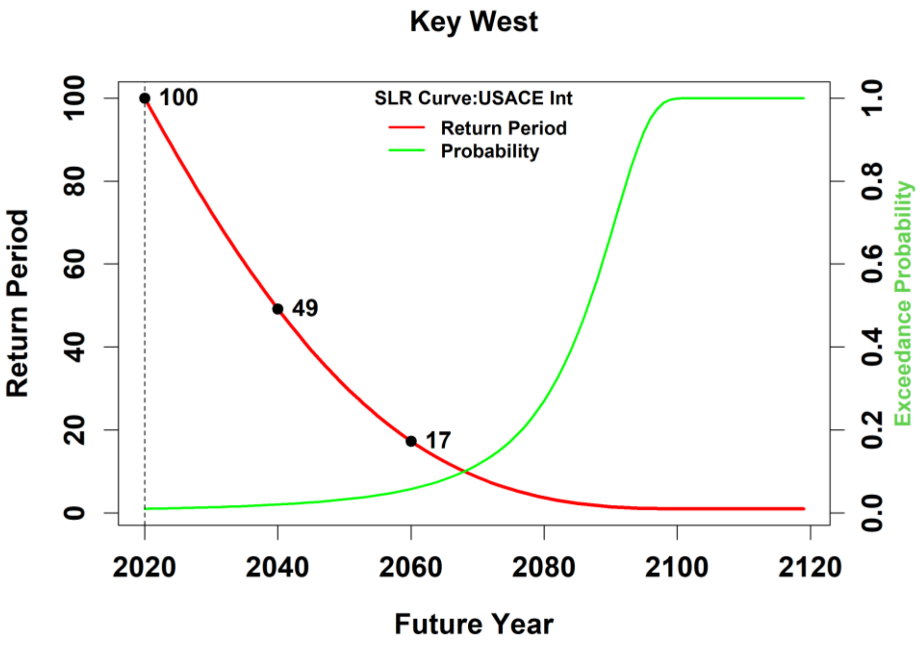
Nonstationarity: Sea Level Rise

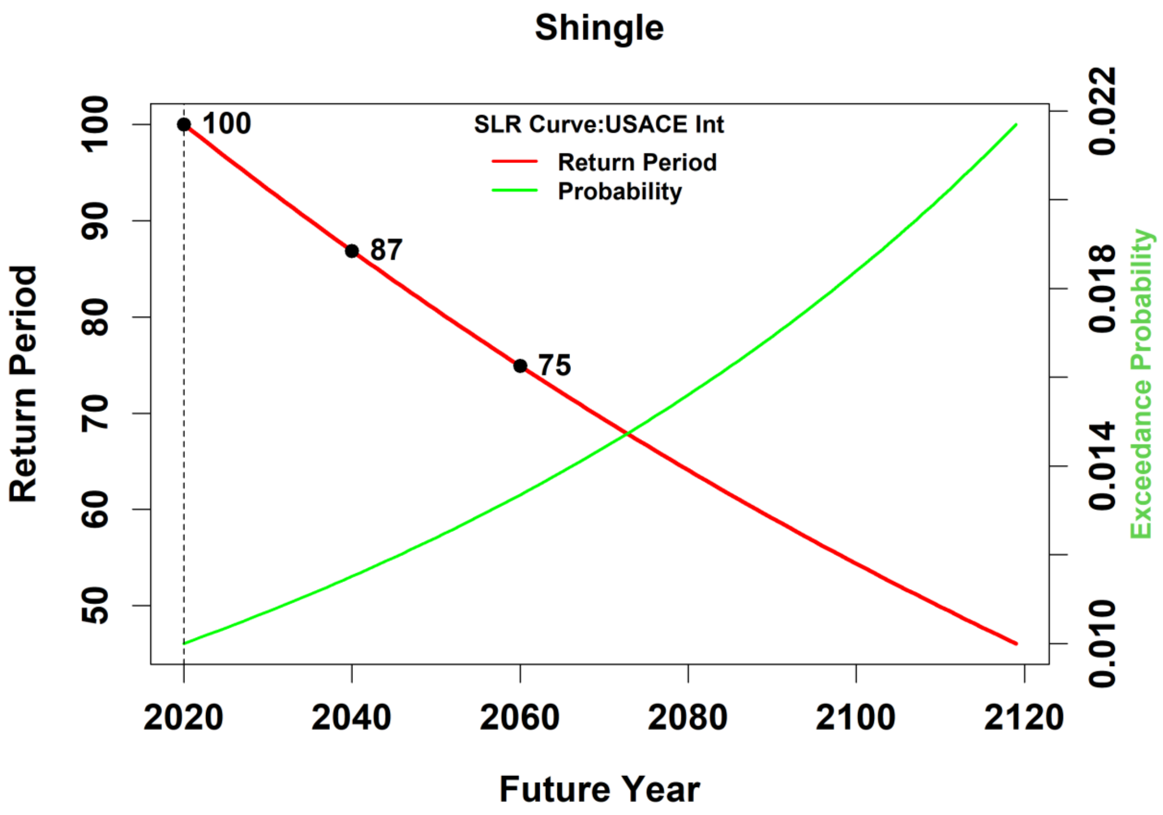






Why Designs under Stationary assumption may fail?





New Paradigm: Return Period and Risk under Nonstationarity

- Return Period is defined as the "expected time for the first exceedance" (expected waiting time)

$$\boldsymbol{T = E[X] = 1 + \sum_{x=1}^{\infty} \prod_{t=1}^{x} (1 - p_t)}$$

- Risk

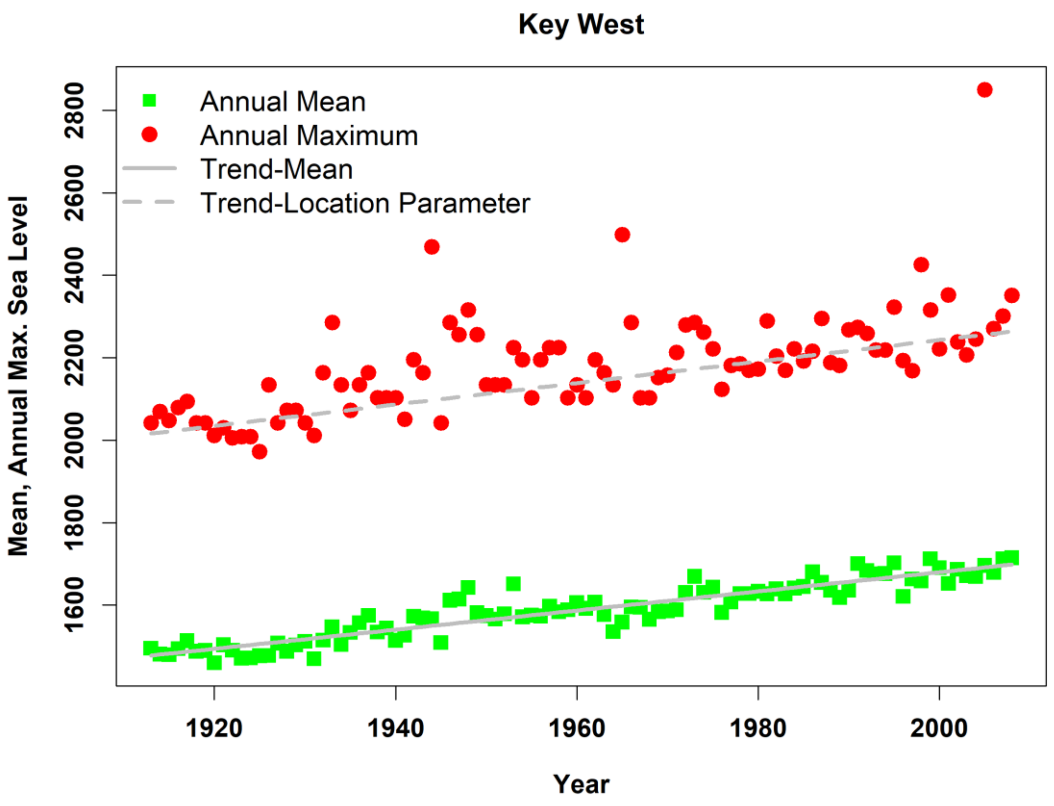
$$R = 1 - \prod_{i=1}^{n} (1 - p_i)$$

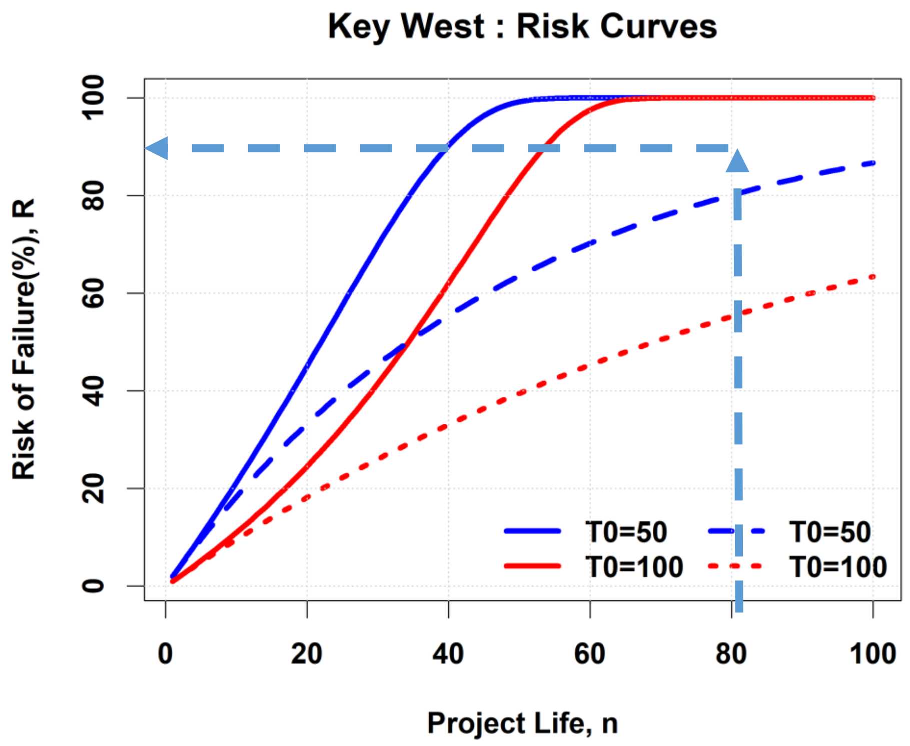
Methods under stationarity

$$T = 1/p$$

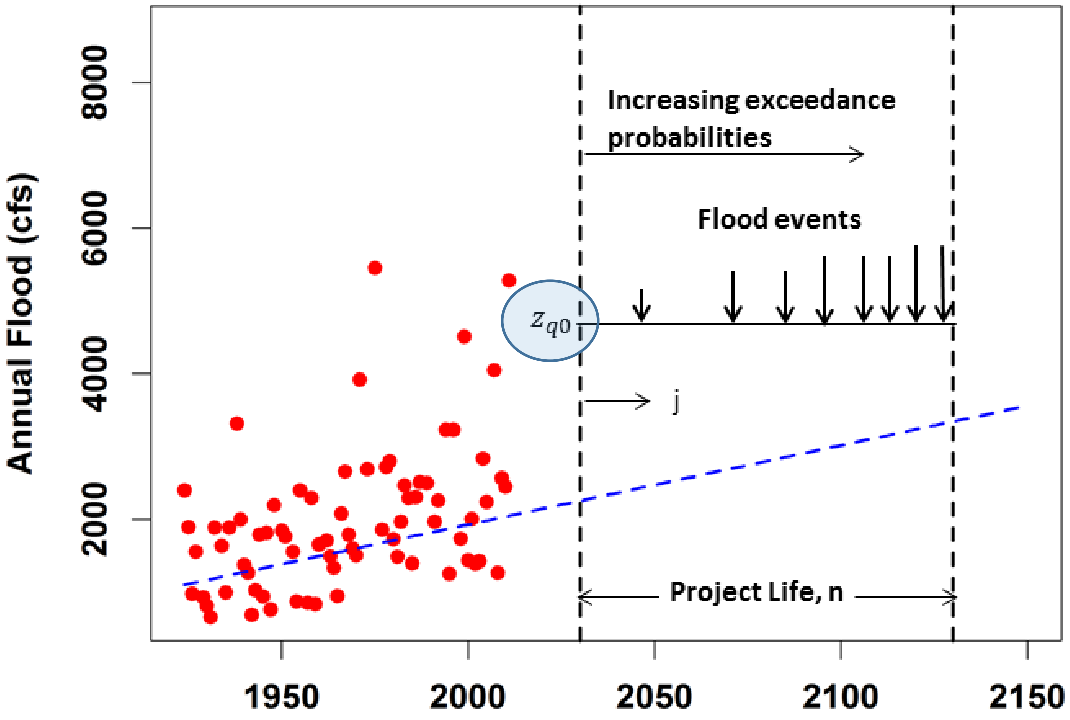
$$R = 1 - \ 1 - p)^n$$

Example: Key West

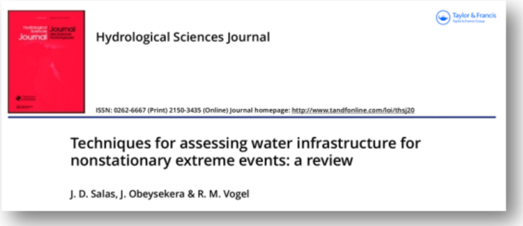




Hydrologic Design considering Nonstationarity



- ❑Expected Waiting Time – Return Period (**EWT**)
  - ✓Waiting time for the first execeedance
- ❑Expected Number of Events (**ENE**)
  - ✓Tolerance for frequency of flooding
- ❑Design Life Level (**DLL**)
  - ✓Design for a specified risk (say, 5%)


Hydrological Sciences Journal

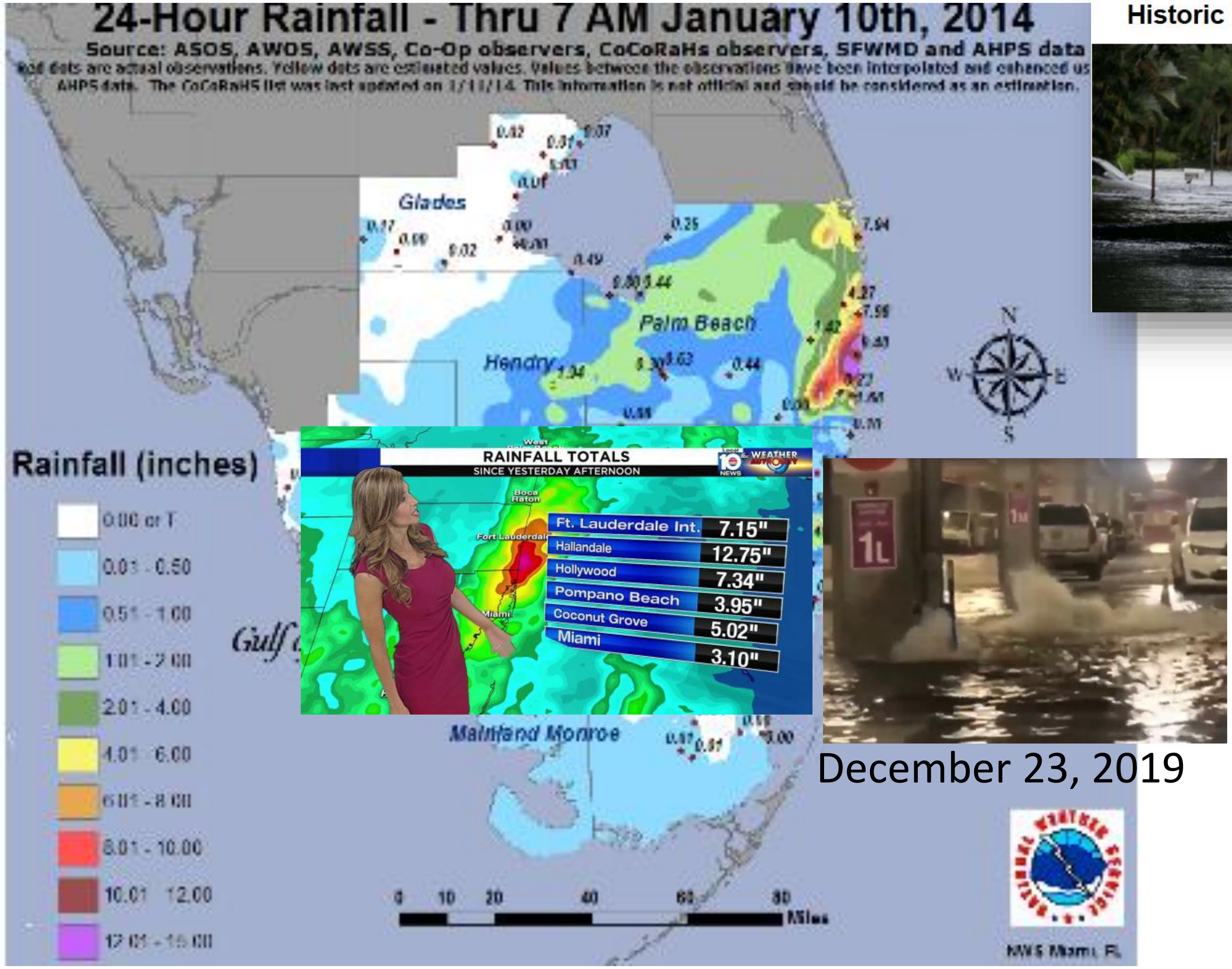
Techniques for assessing water infrastructure for nonstationary extreme events: a review

J. D. Salas, J. Obeysekera & R. M. Vogel

Revisiting the Concepts of Return Period and Risk for Nonstationary Hydrologic Extreme Events

Jose D. Salas, M.ASCE[1]; and Jayantha Obeysekera, M.ASCE[2]

Rainfall Flooding and Heat Stress



December 23, 2019

Heat index above	Historical	By midcentury	By late century	By late century, *if we limit warming to 2°C*
90°F	150 days per year	183 days per year	198 days per year	179 days per year
100°F	34 days per year	126 days per year	160 days per year	108 days per year
105°F	5 days per year	79 days per year	131 days per year	51 days per year

Climate Projection Uncertainties

Natural Variability

General Circulation Model

GCM (IPCC, 2007)

- BCM2
- CGHR
- CGMR
- CNC[illegible]
- [illegible]
- [illegible]HOG
- FGOALS
- GFCM20
- GFCM21
- GIAOM
- INCM3
- IPCM4
- MIHR
- MIMR
- MPEH5
- NCCCSM
- NCPCM

Model Uncertainty and Spread

Downscaling

Statistical

- Constructed Analogues (CA)
- Bias Correction and Spatial Downscaling (BCSD)
- Weather Generators

Dynamical

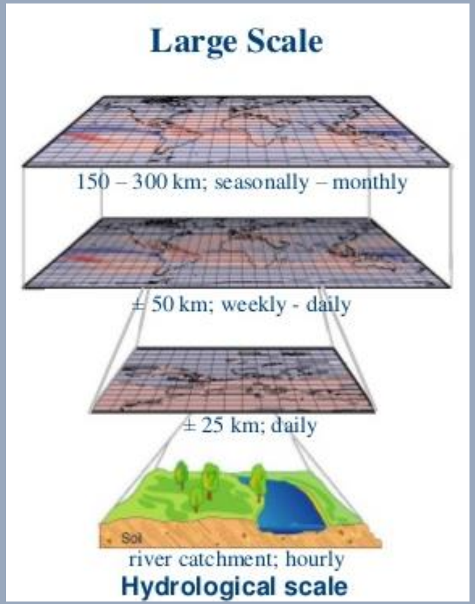
- Regional Climate Models (RCMs)

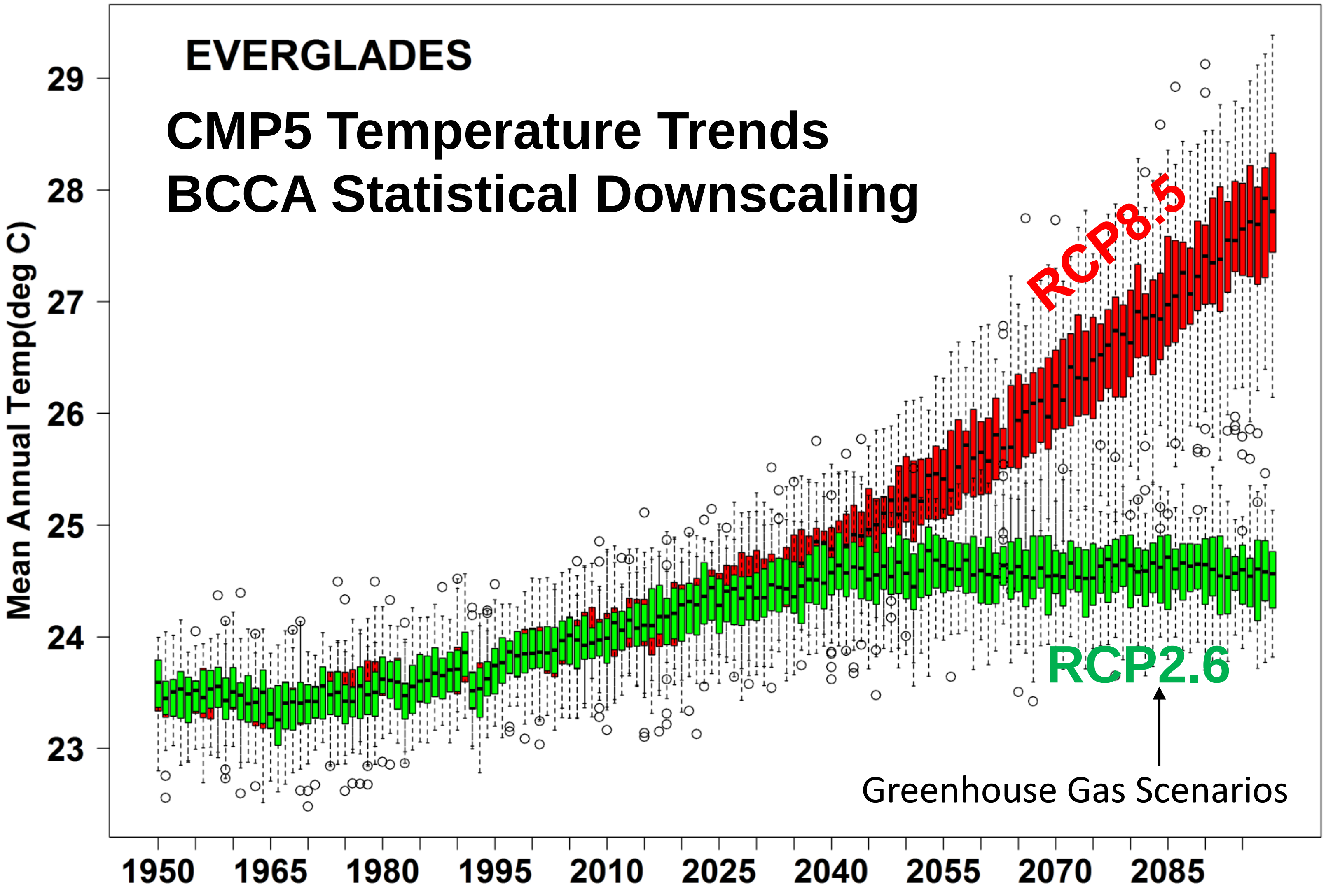
Ice Sheet Dynamics

Scenarios (2081-2100)

RCP2.6	RCP4.5	RCP6.0	RCP8.5
0.3-1.7 (°C)	1.1-2.6 (°C)	[illegible] (°C)	2.6-4.8(°C)
0.26-0.55 (m)	[illegible] (m)	0.33-0.63 (m)	0.45-0.82 (m)

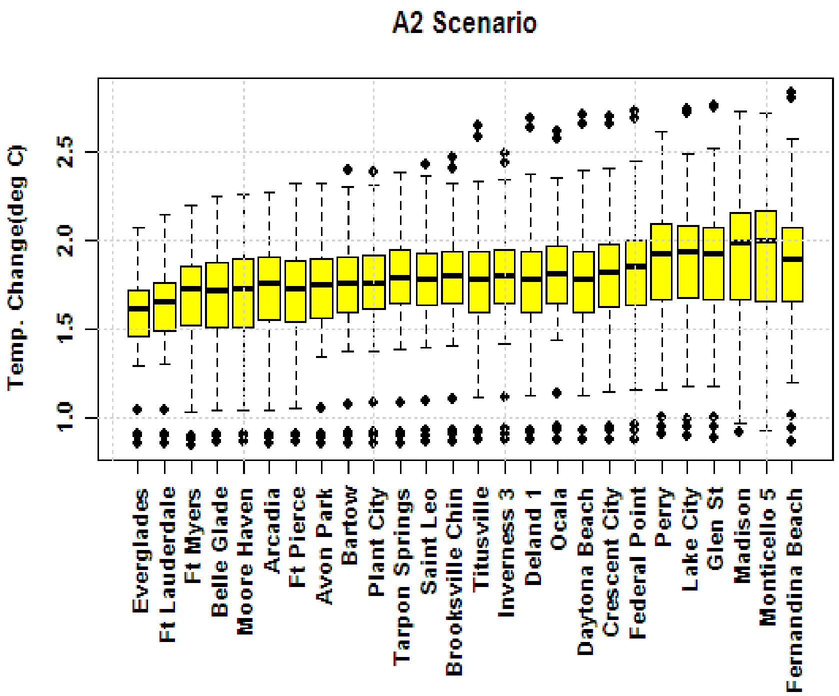
Scenario Uncertainty



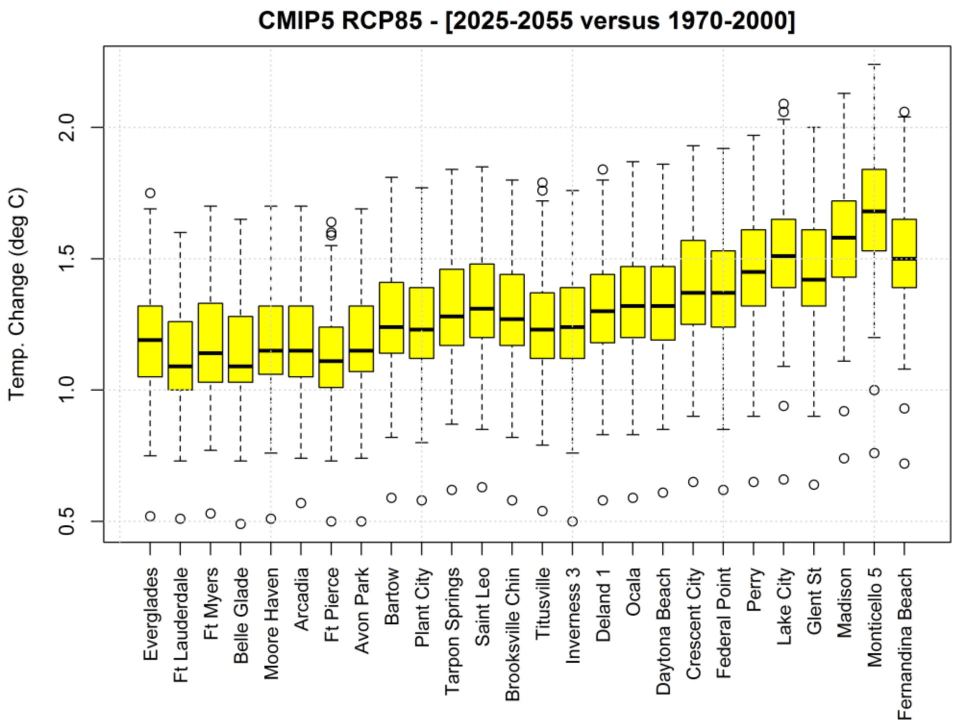


FIU | Sea Level Solutions Center
FLORIDA INTERNATIONAL UNIVERSITY

Spatial Trends in Florida (Temperature)

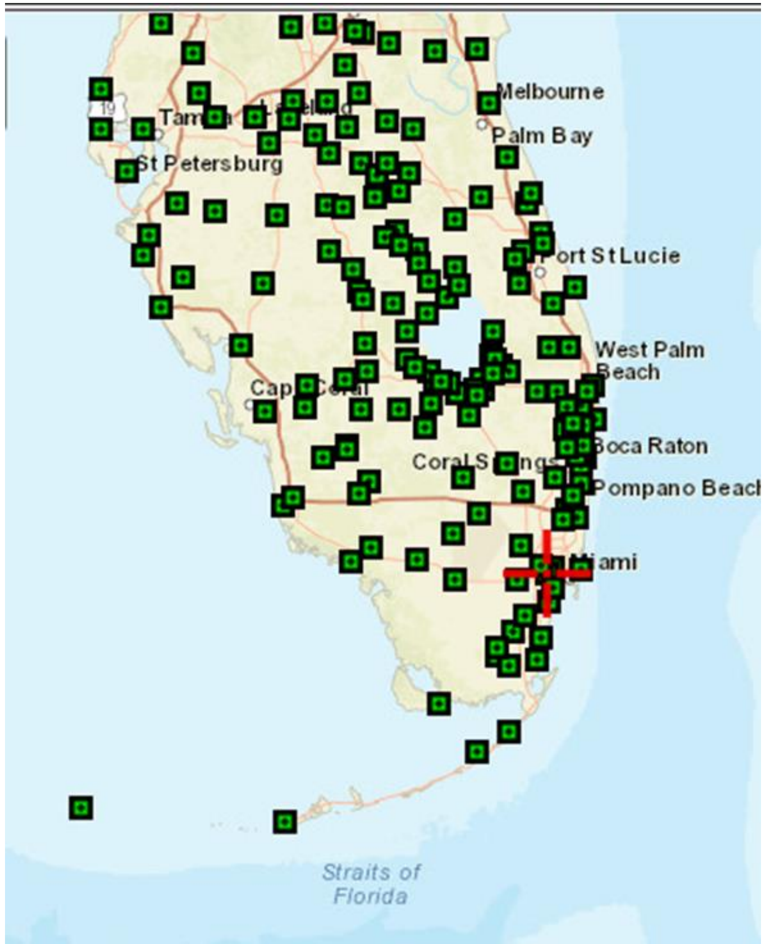


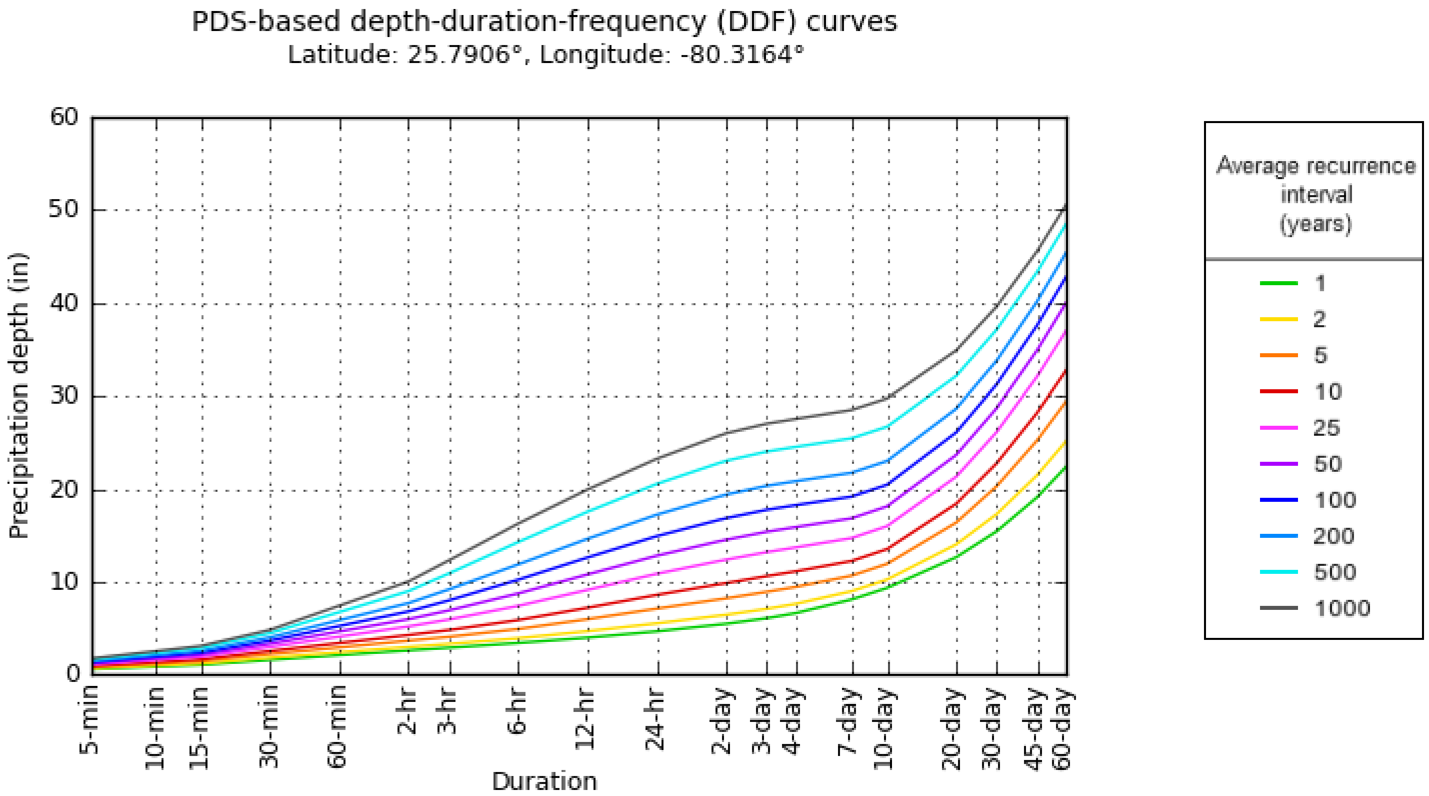
CMIP3



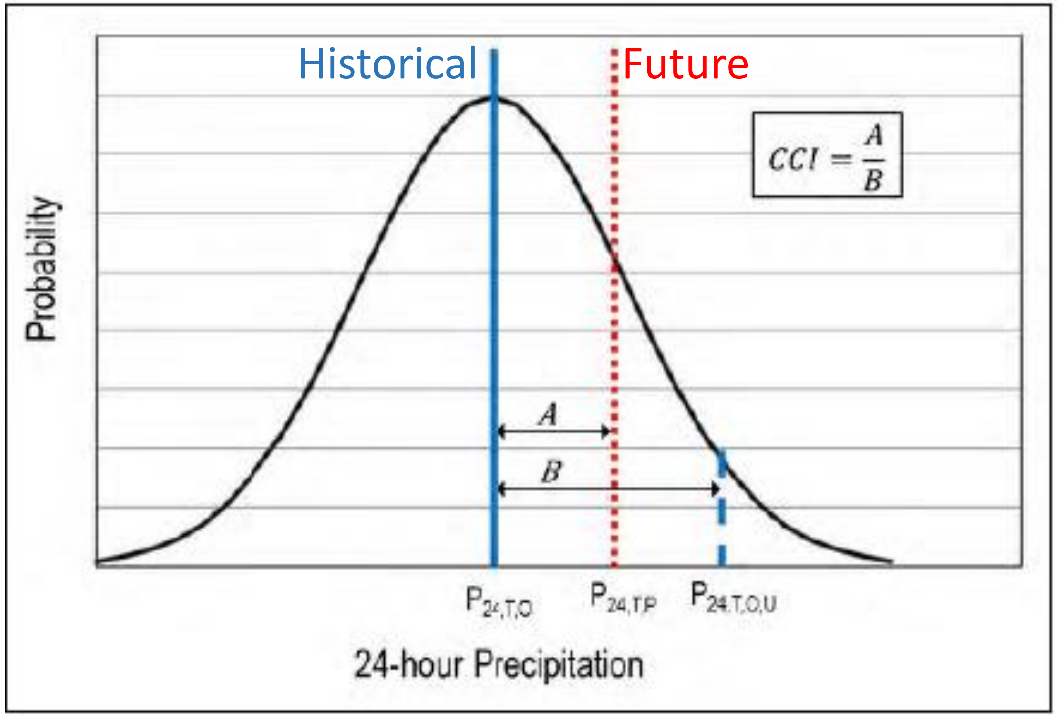
CMIP5

NOAA Atlas 14 Volume 9





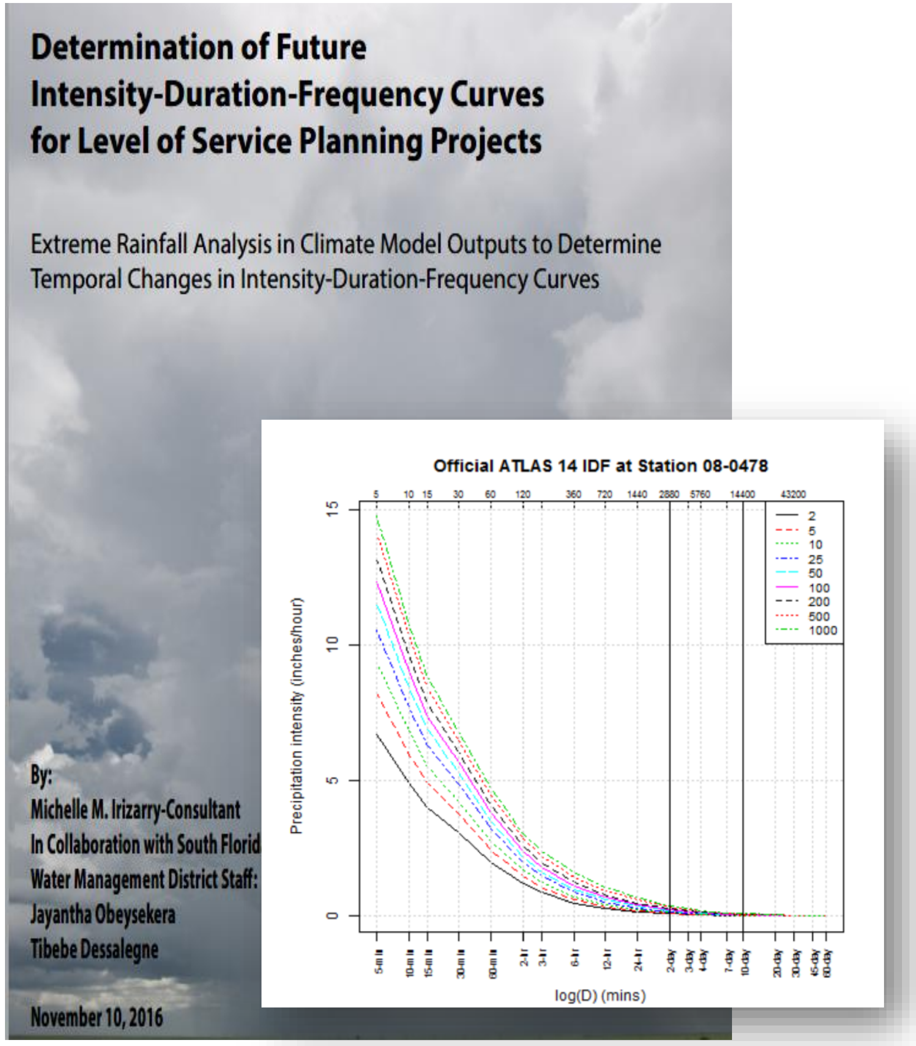
HEC-17 Approach: **Climate Change Indicator**



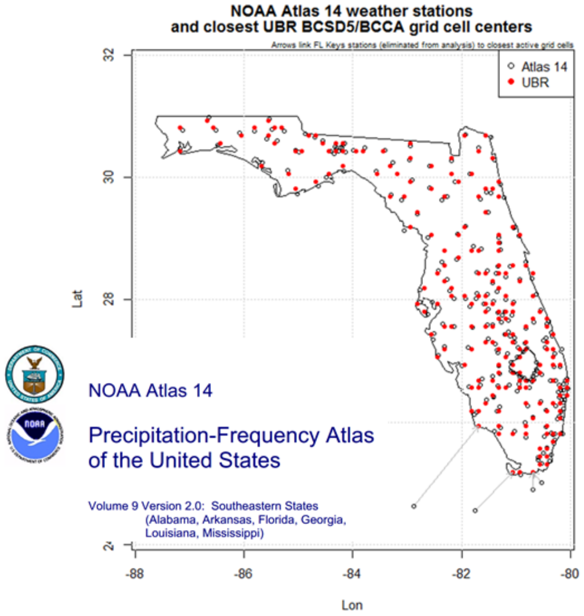
If CCI < 0.4, historical data likely sufficient

If CCI > 0.8 further analysis of projected conditions may be warranted.

Extreme rainfall: Is there any skill?

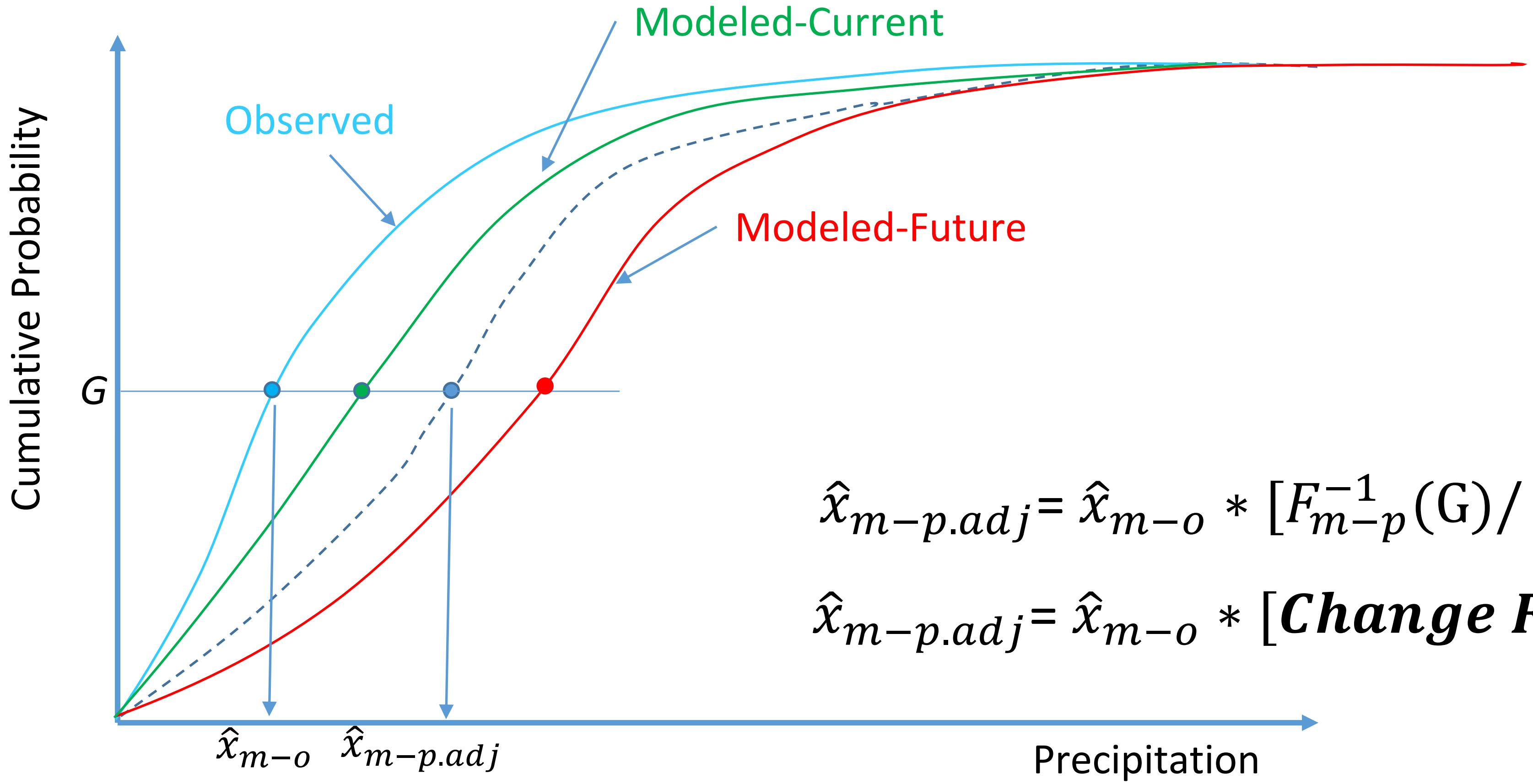


- **BCCA bias corrected downscaling method used by US Bureau of Reclamation: mute out the extremes**
- **Much lower and less variable extremes in the downscaled models compared to the observational dataset**
- **Bias is larger than delta**



Perc	24-hr_2-year	24-hr_5-year	24-hr_10-year	24-hr_25-year	24-hr_50-year	24-hr_100-year
5%	-2.35 (-57.4%)	-3.28 (-59.6%)	-3.99 (-60.8%)	-5 (-62.3%)	-5.86 (-63.3%)	-6.82 (-64.2%)
10%	-2.33 (-57%)	-3.25 (-59%)	-3.96 (-60.4%)	-4.94 (-61.4%)	-5.76 (-62.1%)	-6.71 (-62.9%)
50%	-2.25 (-54.9%)	-3.1 (-56.3%)	-3.76 (-57.3%)	-4.67 (-58.1%)	-5.45 (-58.7%)	-6.34 (-59.2%)
90%	-2.19 (-53.5%)	-3.05 (-55.3%)	-3.66 (-55.9%)	-4.53 (-56.3%)	-5.24 (-56.3%)	-6.01 (-55.8%)
95%	-2.16 (-52.9%)	-3.03 (-54.7%)	-3.64 (-55.3%)	-4.43 (-54.7%)	-5.11 (-54.5%)	-5.84 (-54.1%)

Multiplicative Quantile Delta Mapping (probably a better method)



$$\hat{x}_{m-p.adj} = \hat{x}_{m-o} * [F^{-1}_{m-p}(G) / F^{-1}_{o-c}(G)]$$

$$\hat{x}_{m-p.adj} = \hat{x}_{m-o} * [\boldsymbol{Change\ Factor, CF}]$$

Dynamic Adaptive Policy Pathways (DAPP)

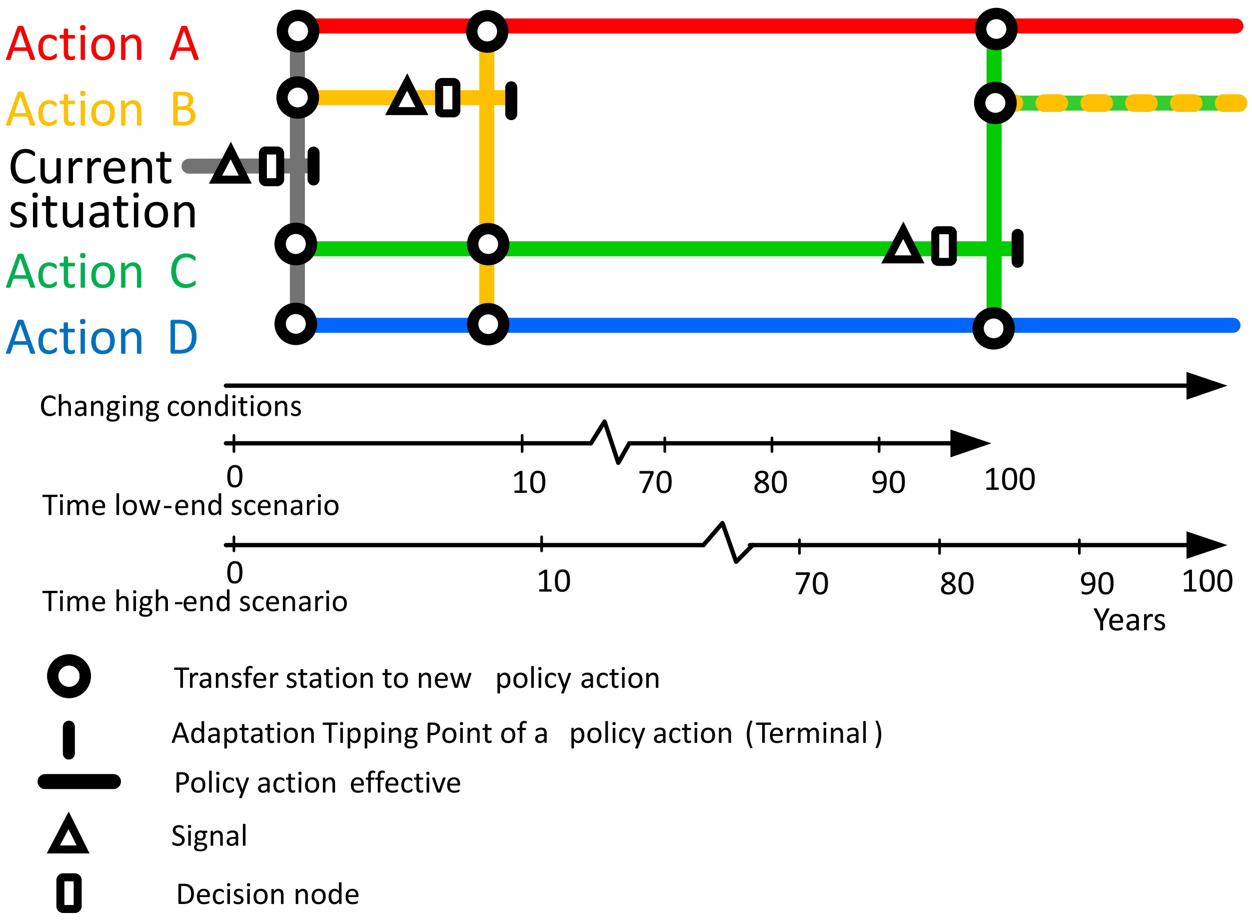
Decisions are made over time in dynamic interaction with the system and cannot be considered independently.

- An approach that explicitly includes decision making over time and sequences of decisions (pathways) under uncertainty.
- Supports planners to design a dynamic adaptive plans: short-term actions, long-term options, adaptation signals.

“Different roads leading to Rome”

Haasnoot et al. (2013) Glob. Env. Change. 10.1016/j.gloenvcha.2012.12.006

Dynamic Adaptive Policy Pathways (DAPP)



Time horizon 100 years

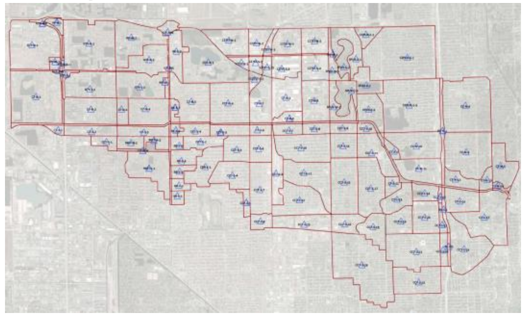
Pathway	Costs	Benefits	Co-benefits
1	+++	+	0
2	+++++	0	0
3	+++	0	0
4	+++	0	0
5	0	0	-
6	++++	0	-
7	+++	0	-
8	+	+	- - -
9	++	+	- - -

Pathways that are not necessary in the low-end scenario

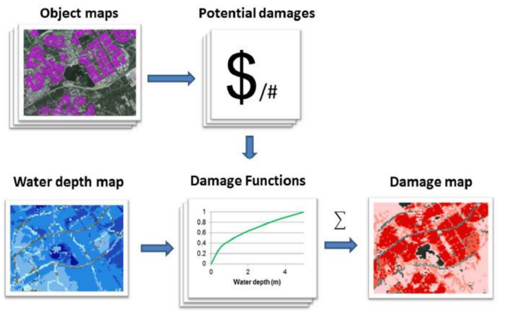
Flood Risk Management in Miami-Dade County : C-7 basin

Hydrologic Drivers:
Rainfall; Storm Surge
Sea Level Rise

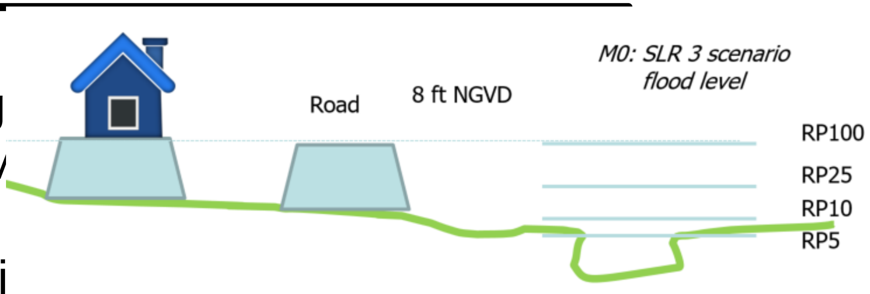
Hydrodynamic Model
XPSWMM



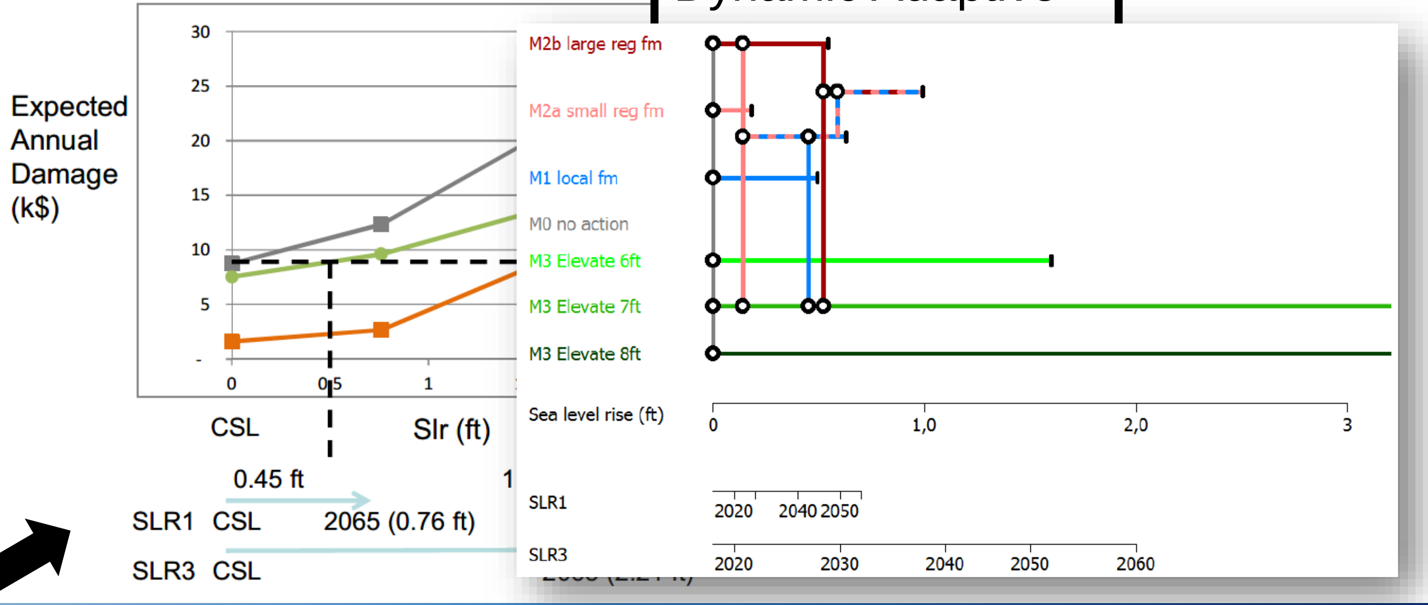
Delft-FIAT damage model



Adaptation Options:
- M1:Local Flood Mitig
- M2:Regional Flood M at outlet)
- M3:Land-use mitigati roads)



Dynamic Adaptive



Summary: Five Resilience Principles

- ➢Adopt a system's approach;
- ➢Look at beyond-design events;
- ➢Build and prepare infrastructure according to 'remain functioning'
- ➢Increase recovery capacity by looking at social and financial capital; and
- ➢Remain resilient into the future

Resilience in practice: Five principles to enable societies to cope with extreme weather events

Karin de Bruijn[a,*], Joost Buurman[b], Marjolein Mens[a], Ruben Dahm[a], Frans Klijn[a,c]

Questions?

FDOT
TRANSPORTATION
SYMPOSIUM
2020 Webinar Series

Contact Information

Jennifer Z. Carver, AICP
Statewide Community Planning Coordinator
Florida Department of Transportation
Office of Policy Planning
850.414.4820
Jennifer.carver@dot.state.fl.us

Crystal Goodison
Associate Director + Associate Scholar, GeoPlan Center
University of Florida
352.392.2351
goody@geoplan.ufl.edu

Jayantha Obeysekera, Ph.D., P.E.
Director, Sea Level Solutions Center
Research Professor, Institute of Environment
Florida International University
305.919.4119
jobeysek@fiu.edu

FDOT TRANSPORTATION SYMPOSIUM
2020 Webinar Series