Welcome

FTP/SIS Resilience Subcommittee

Welcome and Introductions

James Cromar, Broward County MPO

Florida Transportation Plan Overview

Jennifer Carver, AICP, FDOT Policy Planning

FLORIDA TRANSPORTATION PLAN (FTP)

- Florida's long range transportation plan
- A plan for all of Florida
- Provides policy guidance for all transportation partners
- Establishes a policy framework for expenditure of state and federal transportation funds

FLORIDA TRANSPORTATION PLAN (FTP)

- Vision Element
- Policy Element
- Implementation Element

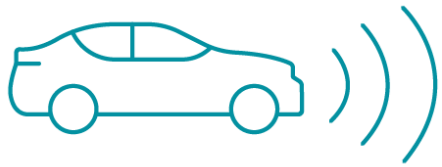
FTP UPDATE SCHEDULE OVERVIEW

- FTP Kickoff in May 2019
- 33 Member Steering Committee
  - Technology (ACES) Subcommittee
  - Resilience Subcommittee
  - Safety Advisory Group
- Public Engagement
  - Districts
  - MPOs
  - Webinars
  - Regional Workshops in Summer 2020
- Vision Element completed by December 2019
- Policy Element completed by December 2020

FTP CROSS CUTTING TOPICS

TECHNOLOGY

Will technology change how and when we travel?

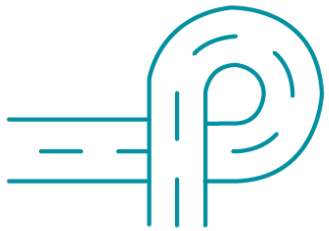


RESILIENCE

How do we prepare our transportation system for, and recover from, weather, environmental, economic, and operational disruptions?

STATE/ INTERREGIONAL

How do we improve the state's most strategic transportation systems?



REGIONAL/ LOCAL

What regional or local needs should we consider?

FTP Goals

SAFETY and **SECURITY**
for residents, visitors, and businesses

AGILE, RESILIENT, and **QUALITY**
Transportation **INFRASTRUCTURE**

CONNECTED, EFFICIENT, and
RELIABLE MOBILITY for people and freight

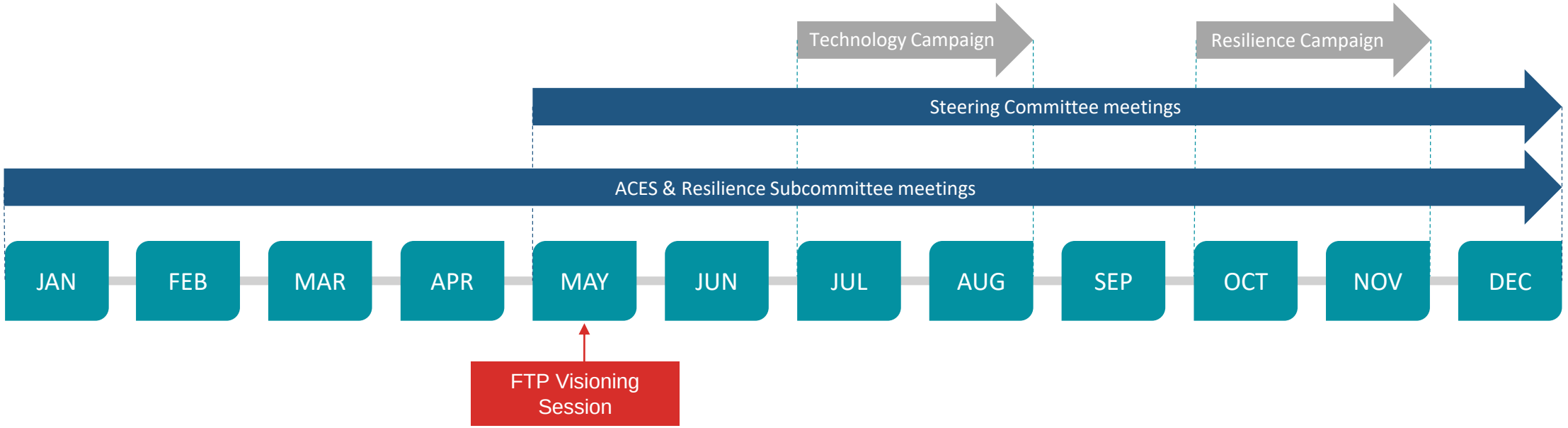
TRANSPORTATION CHOICES
that improve accessibility and equity

Transportation solutions that
ENHANCE FLORIDA'S ENVIRONMENT

Transportation systems that
ENHANCE FLORIDA'S COMMUNITIES

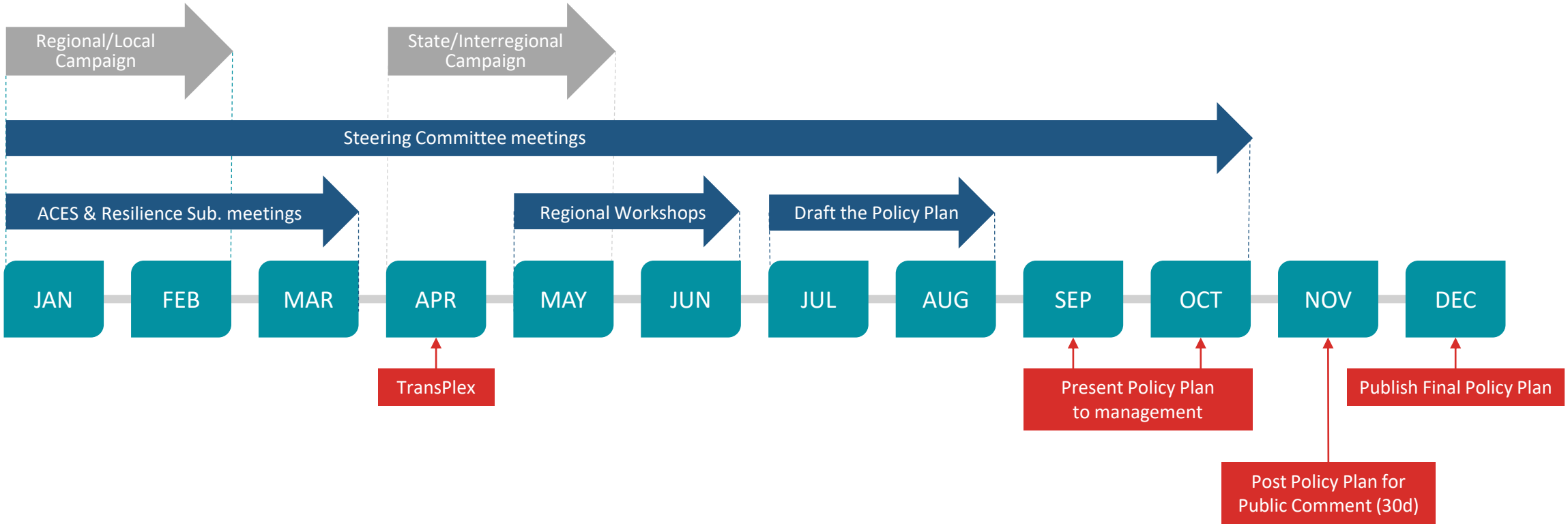
Transportation solutions that
STRENGTHEN FLORIDA'S ECONOMY

FTP EVENTS, MEETINGS, AND CAMPAIGNS



2019

FTP EVENTS, MEETINGS, AND CAMPAIGNS



2020

Resilience Subcommittee Overview

RESILIENCE SUBCOMMITTEE CHARGE

- Discuss themes, trends, and planning implications of transportation system resilience in Florida
- Identify policy-level objectives or strategies to address and/or maximize resilience to support the FTP goals and the SIS objectives
- Review and provide input, as requested, on related plans and processes, including those from FDOT and other partners
- Serve as transportation system resilience subject matter experts for the FTP-SIS Steering Committee and provide updates to the committee as needed

RESILIENCE SUBCOMMITTEE WORK PLAN

JULY 2019
- Resilience Subcommittee Kick-off Meeting

SEPTEMBER 2019
- Resilience Subcommittee Meeting (Web Conference)
  - Discuss long-range trends, challenges, and opportunities

OCTOBER 2019
- **Resilience Subcommittee Meeting (In Person)**
  - **Discuss opportunities to incorporate resilience into the FTP**

JANUARY 2020
- Resilience Subcommittee Meeting (Web Conference)
  - Discuss potential objectives and strategies to address resilience in the FTP

APRIL 2020
- Resilience Subcommittee Meeting (Web Conference)
  - Finalize recommendations for update of FTP Policy Element
  - Discuss how to implement strategies and identify innovative ways to make strategies actionable

Agenda Review and Overview of Activities

MEETING OBJECTIVES

- Partner presentations
- Review additional background information as needed
- Discuss opportunities to incorporate resilience into the FTP

AGENDA

Day 1

TIME	TOPIC
1:00 pm	Welcome, Introductions, and Subcommittee Charge
1:15 pm	Agenda Review and Overview of Activities
1:25 pm	Resilience in Transportation
1:55 pm	Activity 1: Priority Pyramid
2:10 pm	Freight Movement and Resilience Panel
3:05 pm	Break
3:20pm	Data to Support Decision Making
3:40 pm	Facilitated Discussion and Transition to Activity
4:00 pm	Activity 2: Identify Resilience Strategies
4:45 pm	Wrap-Up
5:00 pm	Adjourn Day 1

Day 2

TIME	TOPIC
8:30 am	Welcome and Introductions
8:45 am	Local and Regional Resilience Initiatives in Southeast Florida
9:45 am	Activity 3: Prioritize Resilience Strategies
10:45 am	Break
11:00 am	Decision Making Under Deep Uncertainty
11:20 am	Summary of Strategy Ranking Results
11:50 am	Wrap Up
12:00 pm	Adjourn Day 2

OVERVIEW OF ACTIVITIES

ACTIVITY 1: PRIORITY PYRAMID

- Purpose: Identify the priorities of the Resilience Subcommittee
- Outcomes: Top 6 Resilience Priorities that will be used to help evaluate strategies after this meeting

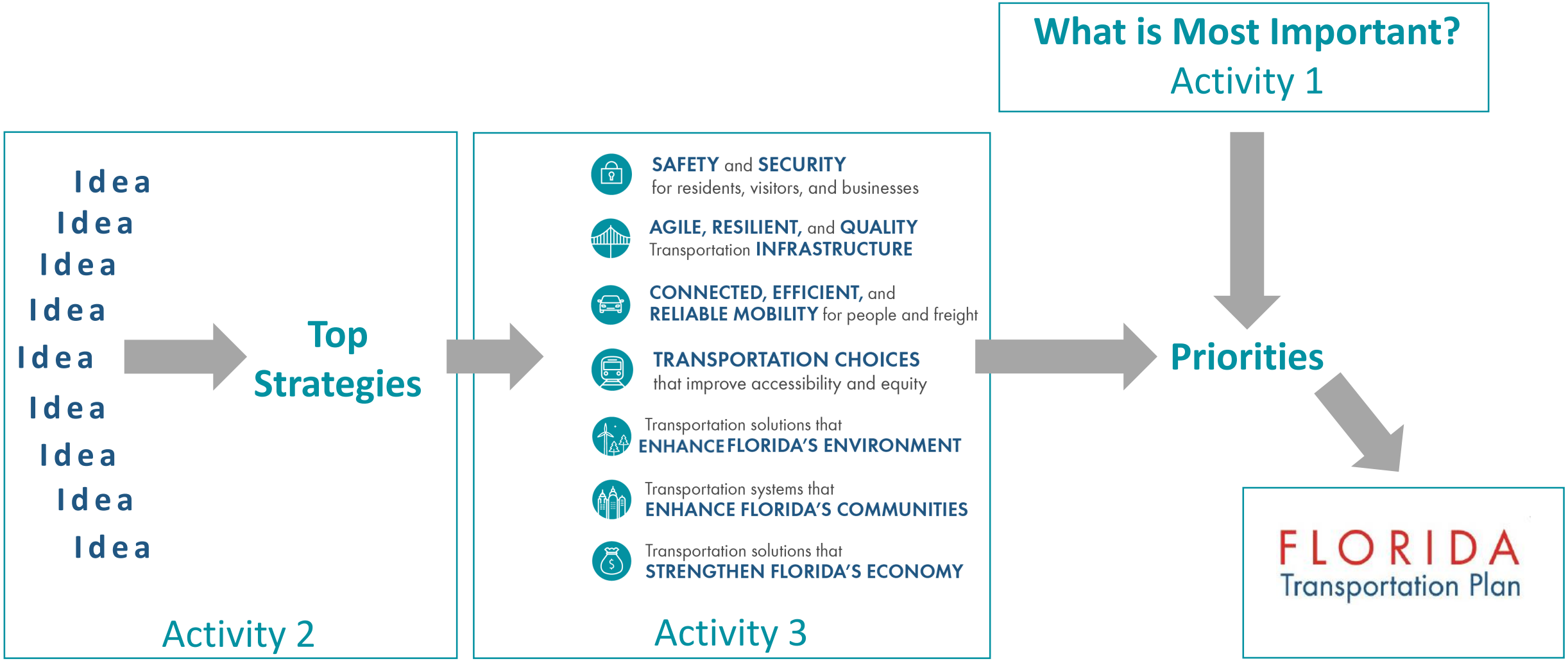
ACTIVITY 2: IDENTIFY RESILIENCE STRATEGIES

- Purpose: Identify a list of potential resilience strategies
- Outcomes: Suggested strategies for evaluation and prioritization in Activity 3

ACTIVITY 3: PRIORITIZE RESILIENCE STRATEGIES

- Purpose: Evaluate and prioritize potential resilience strategies
- Outcomes: Prioritized resilience strategies with identified geography, timeframe, and key partners

OVERVIEW OF ACTIVITIES



Resilience in Transportation

Resilience in Transportation

Lois Bush, James Poole, Craig James,
Andrew Jungman, Shereen Yee Fong
FDOT Districts 4 and 6

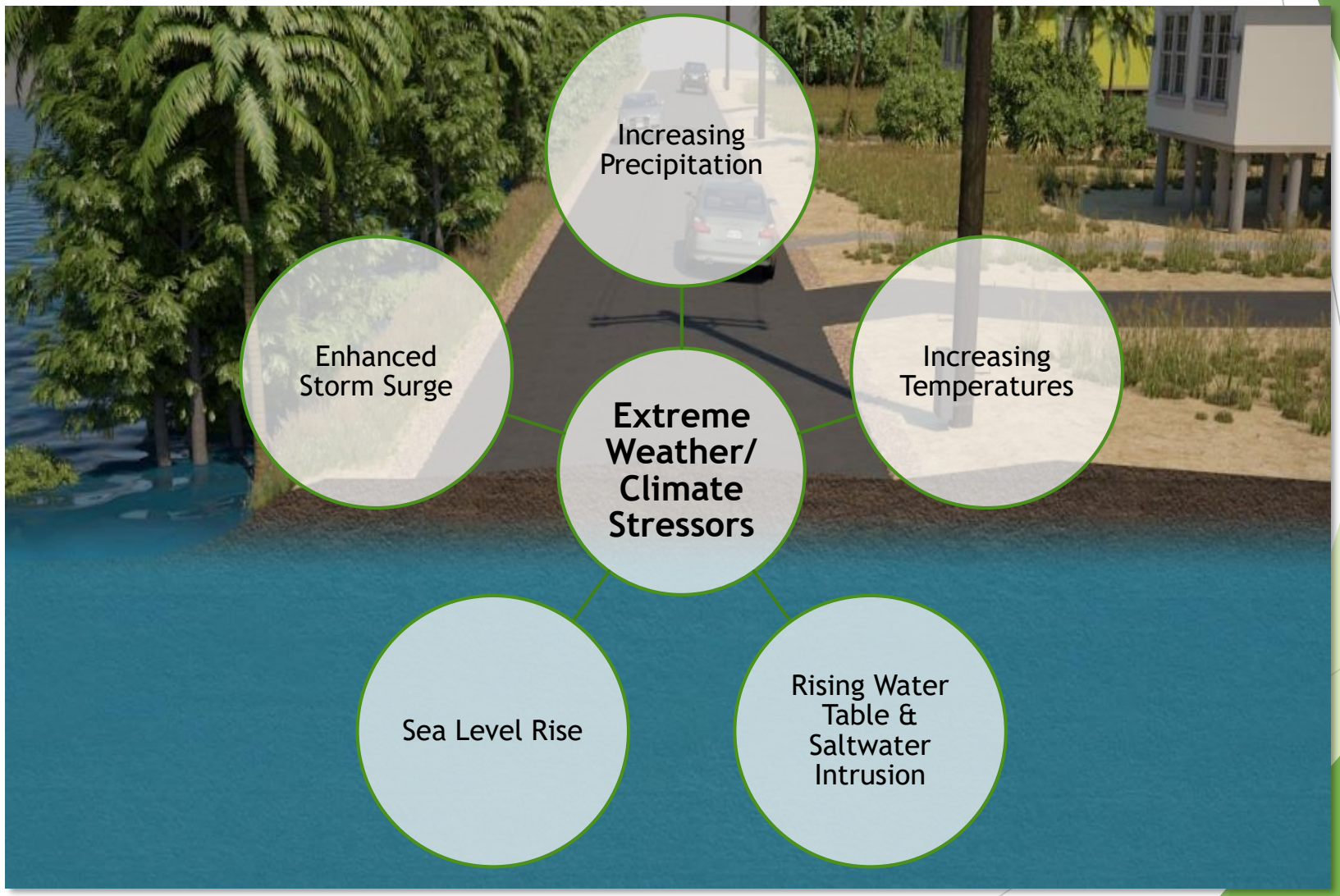
FTP-SIS Resilience Subcommittee

October 29, 2019

Overview

- Extreme weather and climate stressors
- Approaches to increasing transportation system resiliency
- Examples of FDOT activities
- Planning for future of transportation system

Extreme Weather/Climate Stressors for Transportation System - Southeast Florida



Source: Broward MPO

Extreme Weather/Climate Stressors for Transportation System - Southeast Florida

Sea Level Rise

- **Permanent inundation**: 900 miles of roadway, six ports, and 28 airports are at risk of permanent inundation to three feet of sea level rise (mid-range estimate for 2100) in Monroe, Miami-Dade, Broward, and Palm Beach counties
- **Sub-base saturation**: maintenance challenges
- **Land use changes**: alteration of long term travel patterns & overall functionality

Source: FDOT

Rising Water Table and Saltwater Intrusion

- Reduced drainage capacity
- Increased maintenance needed due to erosion of pavement subgrades during tidal events
- Increased bridge scour & bridge girder corrosion from salt water

Extreme Weather/Climate Stressors for Transportation System – Southeast Florida

Storm Surge

- Pavement washouts & loss of tunnel service
- Inundation of sensitive electrical system & loss of power required to operate pump systems
- Reduced service life for some structures
- Inundation of assets designed without the consideration of storm surge
- Bridges embankment erosion, deck damage, undermining of foundations from increases in flow and velocity, increased scour potential, & approach washout and damage

Source: FDOT

Extreme Weather/Climate Stressors for Transportation System - Southeast Florida

Increasing Precipitation

- Exacerbation of existing issues:
  - Frequent localized flooding issues during precipitation events
  - Limited capacity to absorb groundwater due to a high groundwater table
- Increased travel impacts from localized flooding during regular rainfall events

Increasing Temperatures

- Heat kinks & rail buckling
- Overheating of electrical equipment (e.g., power controls, signal rooms), & blackouts
- Material expansion and contraction
- Derailments, delays, connection loss, disruption of operations, and increased maintenance needs

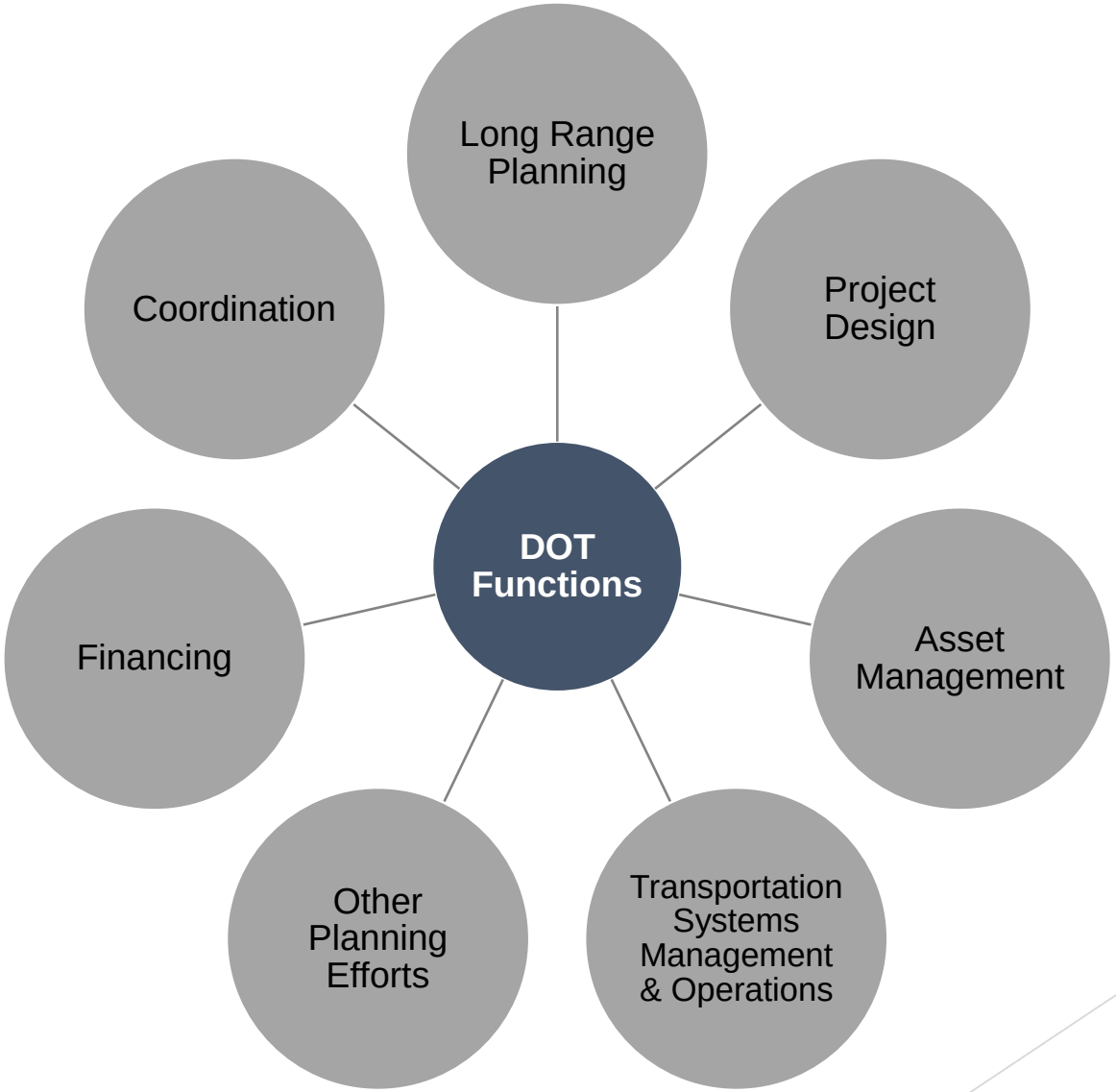
Approaches to Increasing Transportation System Resiliency

Planning for Transportation System and Transportation Project Development Phases

- *Have found increasing transportation system resiliency is not linear process always starting with long range planning and always ending with operations and maintenance. Instead, FDOT and partners are figuring out how best to increase resiliency on multiple fronts at same time.*

Adaptation Objectives

- Reduce risks to infrastructure & operations
- Promote investments that reduce future overall system risk
- Ensure investments meet expected useful life & performance measures
- Ensure investments & decisions do not create new risk
- Ensure fiscal responsibility by promoting investments that minimize overall costs



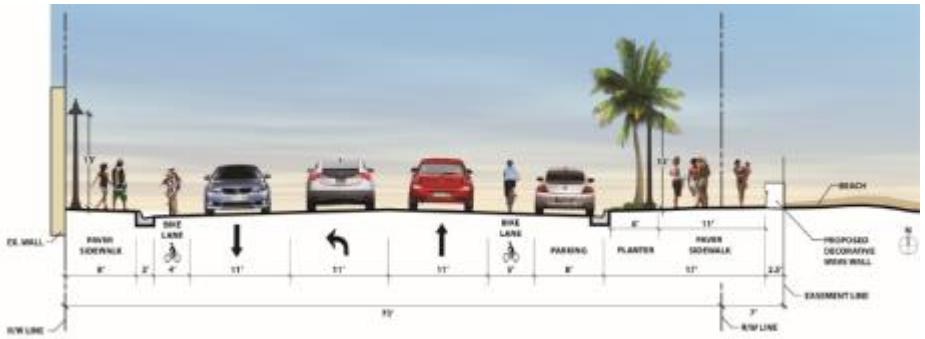
Examples of FDOT Activities

Involving Collaboration

Storms and Sea Level Rise

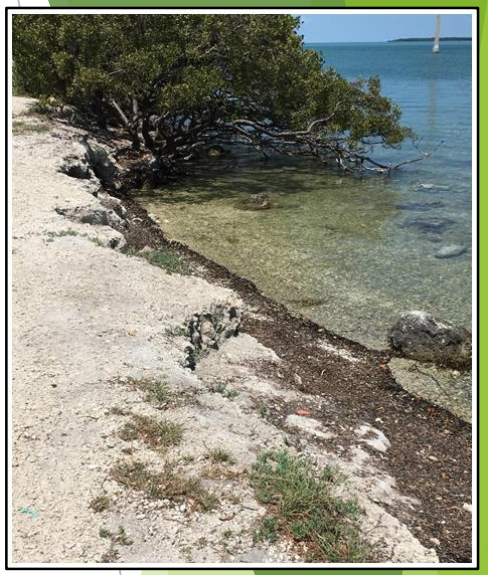
Hurricane Sandy - SR A1A in Fort Lauderdale

Storms and Sea Level Rise



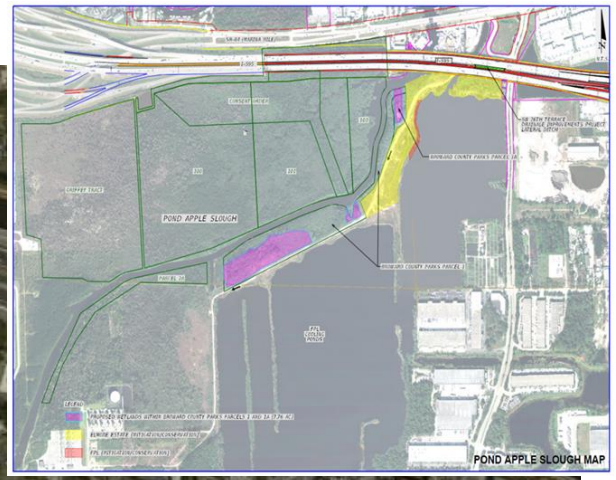
Permanent Project Reflecting Resiliency and Community Goals for SR A1A in Fort Lauderdale

Sea Oats Beach and The Fills



US-1/Overseas Highway Shoreline Protection and Road Raising Projects

Community and Agency Partnerships



Community and Agency Partnerships

- USACE Florida Keys Coastal Storm Risk Management (CSRM) Feasibility Study
  - FDOT is Cooperating Agency
- USACE Miami-Dade Back Bay CSRM Feasibility Study
  - FDOT is Participating Agency
- Tamiami Trail Modification: Next Steps Project
  - NPS is lead federal agency and in partnership with FDOT
- Resilient305 Strategy
  - FDOT is a key collaborator with Miami-Dade County and local municipalities

US Army Corps of Engineers®

NATIONAL PARK SERVICE

MONROE COUNTY 18 23 SOUTHERNMOST COUNTY IN THE UNITED STATES

305 RESILIENT

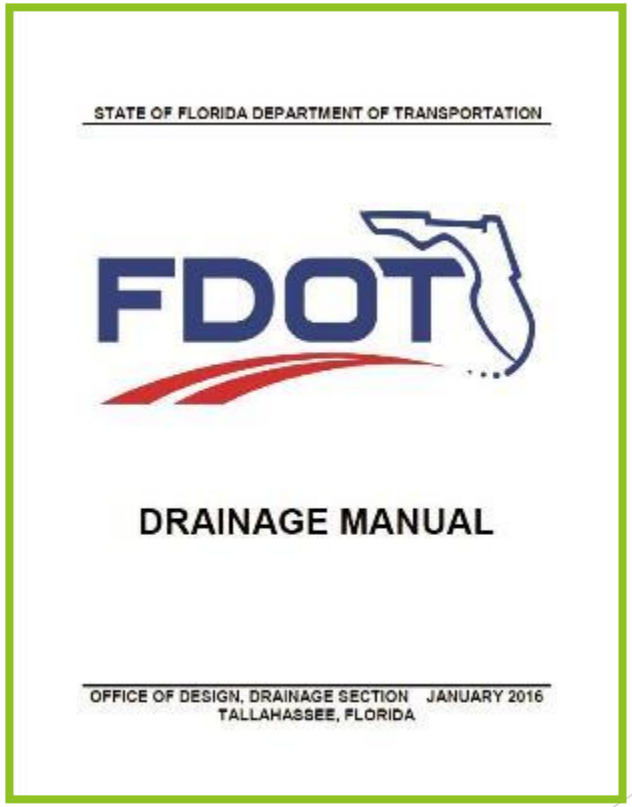
MIAMI-DADE COUNTY

Examples of FDOT Activities

Increasing Resiliency Through Design and Retrofits

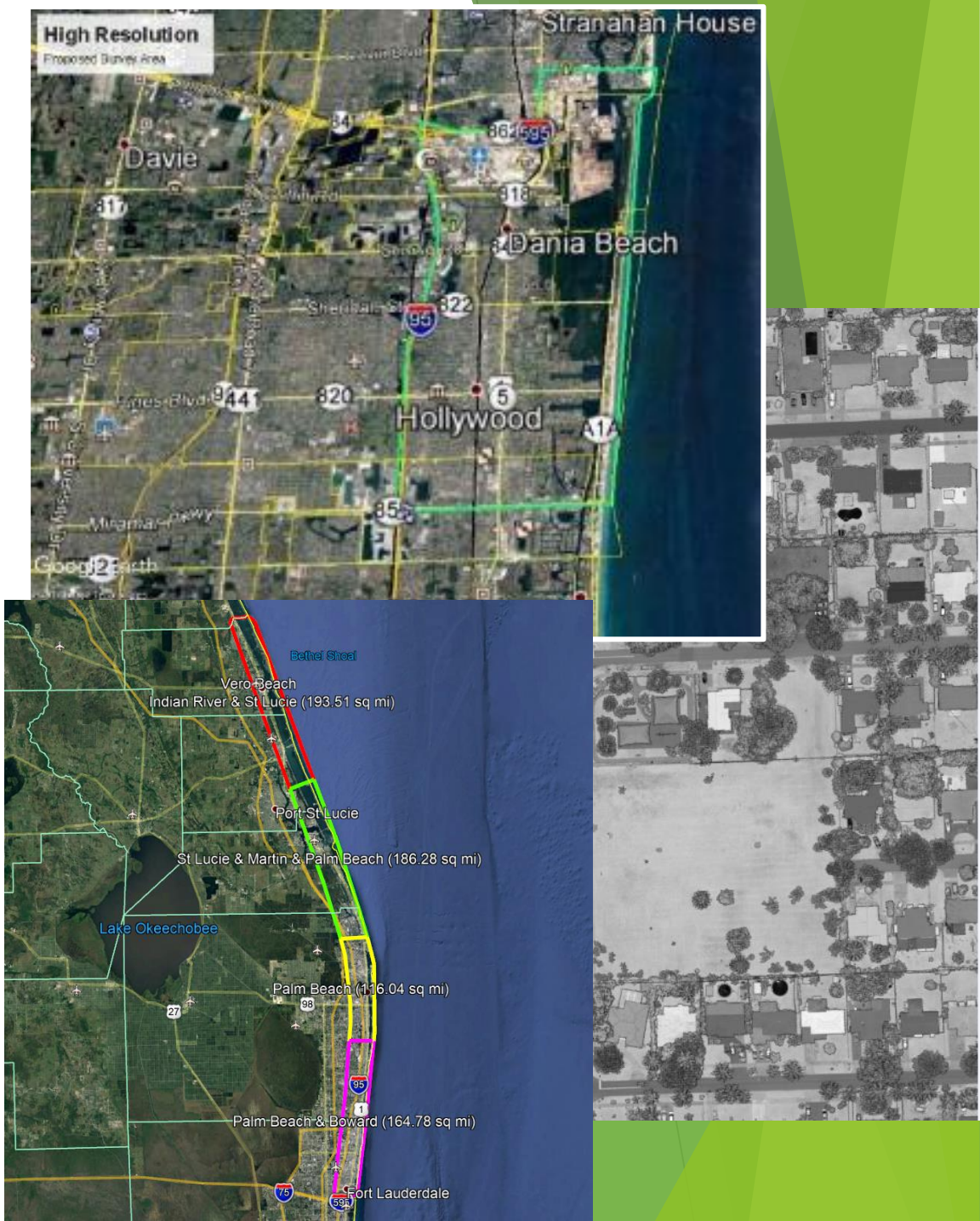
Sea Level Rise and Project Drainage Design

- Changes in 2016 to FDOT Drainage Manual
- Consider Sea Level Rise
  - Currently based on historical tide gauge records extrapolated for project design life
- Required for coastal projects including new construction, reconstruction, and projects rebuilding drainage systems



Enhanced Data and Tools

- High Resolution Elevation Data Project
  - Pilot Study in Broward County
    - Coordinated effort involving FDOT Central Office Surveying and Mapping Office, FDOT District 4, and Broward County
    - Combined two techniques to achieve highly accurate elevation data over large areas that can be used for designing transportation projects and other purposes
    - Covered 25-square mile area drawn with intent to help support USACE/Broward County flood risk management study
  - East Coast Mapping Project in District 4
    - Used lessons learned from pilot study
    - Extends area covered along coast from Broward County to Indian River County
    - Being completed in phases and currently scheduled to conclude in June 2020



Ongoing Monitoring

- Actively monitor trends in sea level rise along Florida's coastline
- Maintain District 4 Drainage Inquiry Database of King Tide impacts and other flooding on state roads
- Periodically update design tools with rainfall, sea level, and other data
- Consult with local governments on evolving erosion, drainage, and other such issues

Sea Level Rise and Flooding

Installation of Tidal Backflow Preventers:

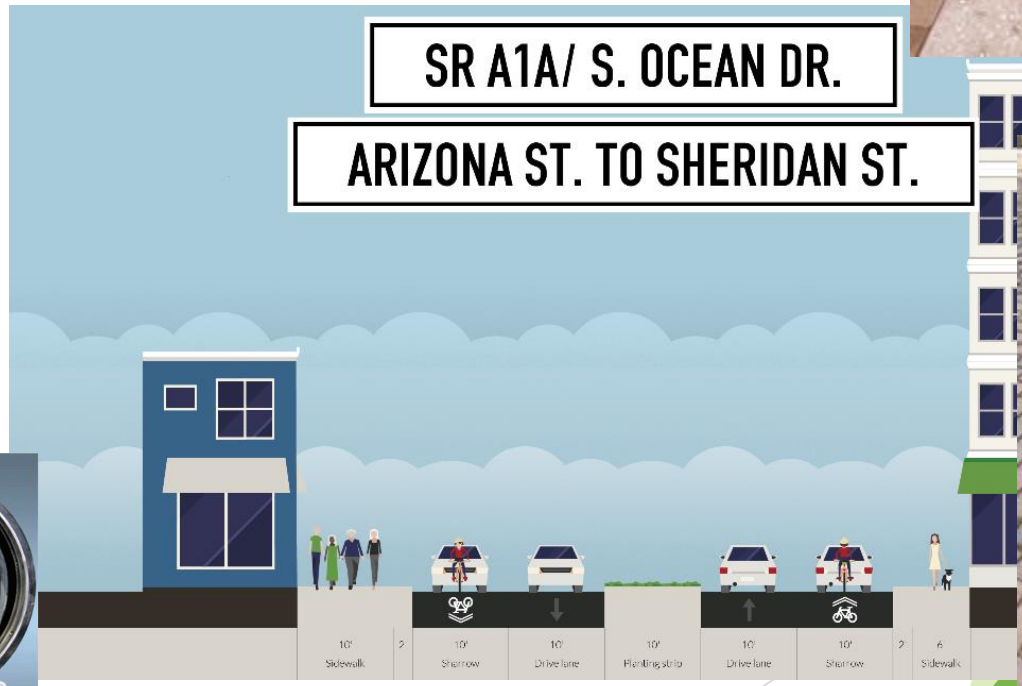
Aluminum Flap Gate Example

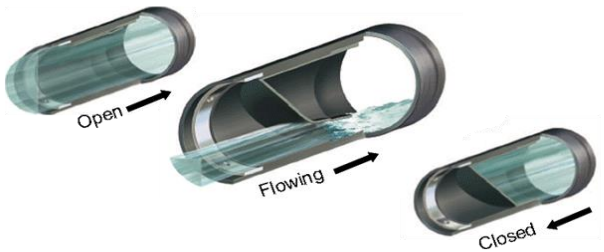
Integrating Water with Transportation - Miami Beach

- Addressing flooding to improve level of service for roadways – Indian Creek Drive/SR A1A Emergency Evacuation Route
- Pump stations – emergency by-passes
- Outfalls with backflow preventers

SR-A1A in Hollywood

- Resurfacing project from Monroe Street to Sheridan Street that includes:
  - Multimodal improvements
  - Retrofit components to increase resilience including installation of backflow preventers, lining of drainage pipes, and other features
- Local funding contribution

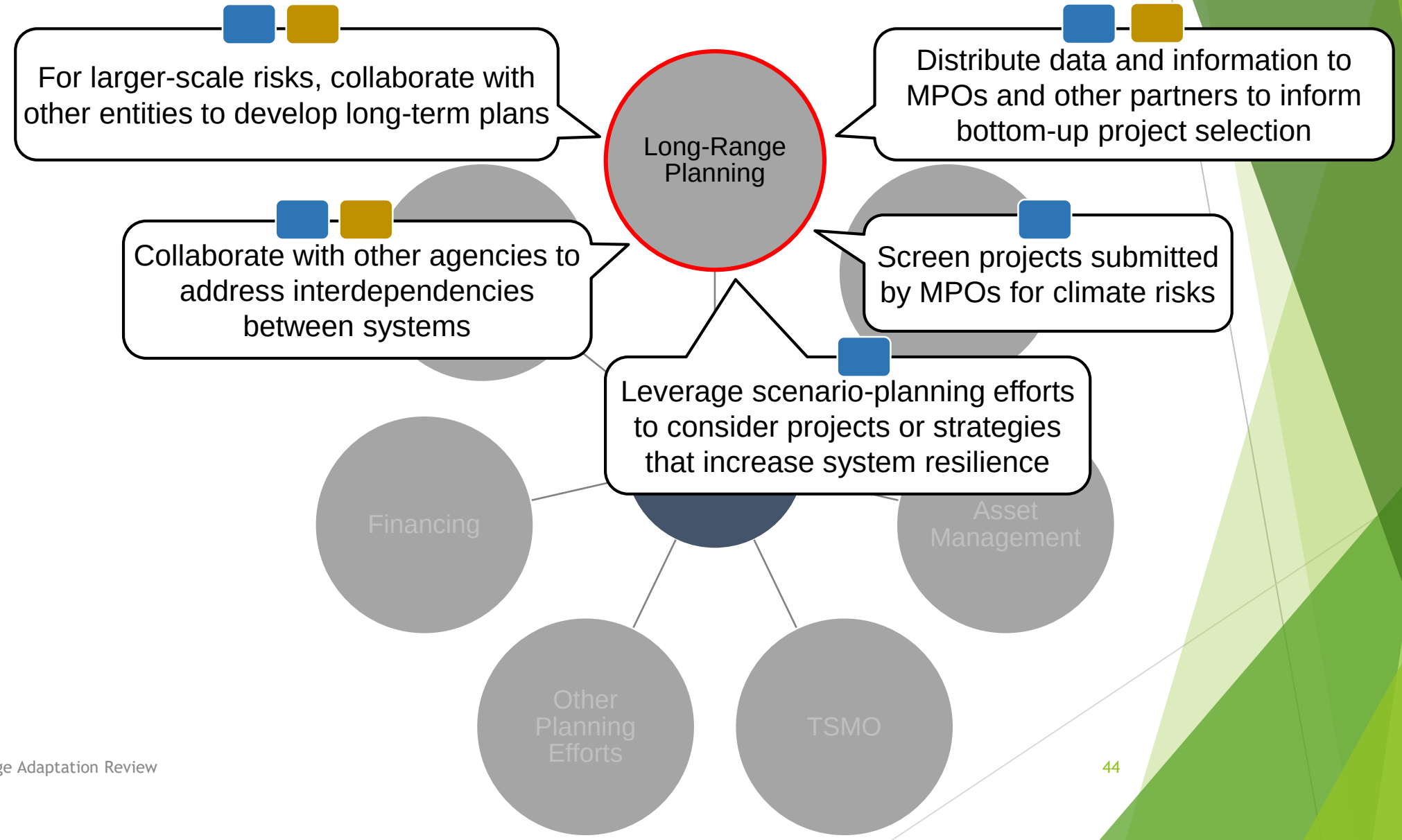




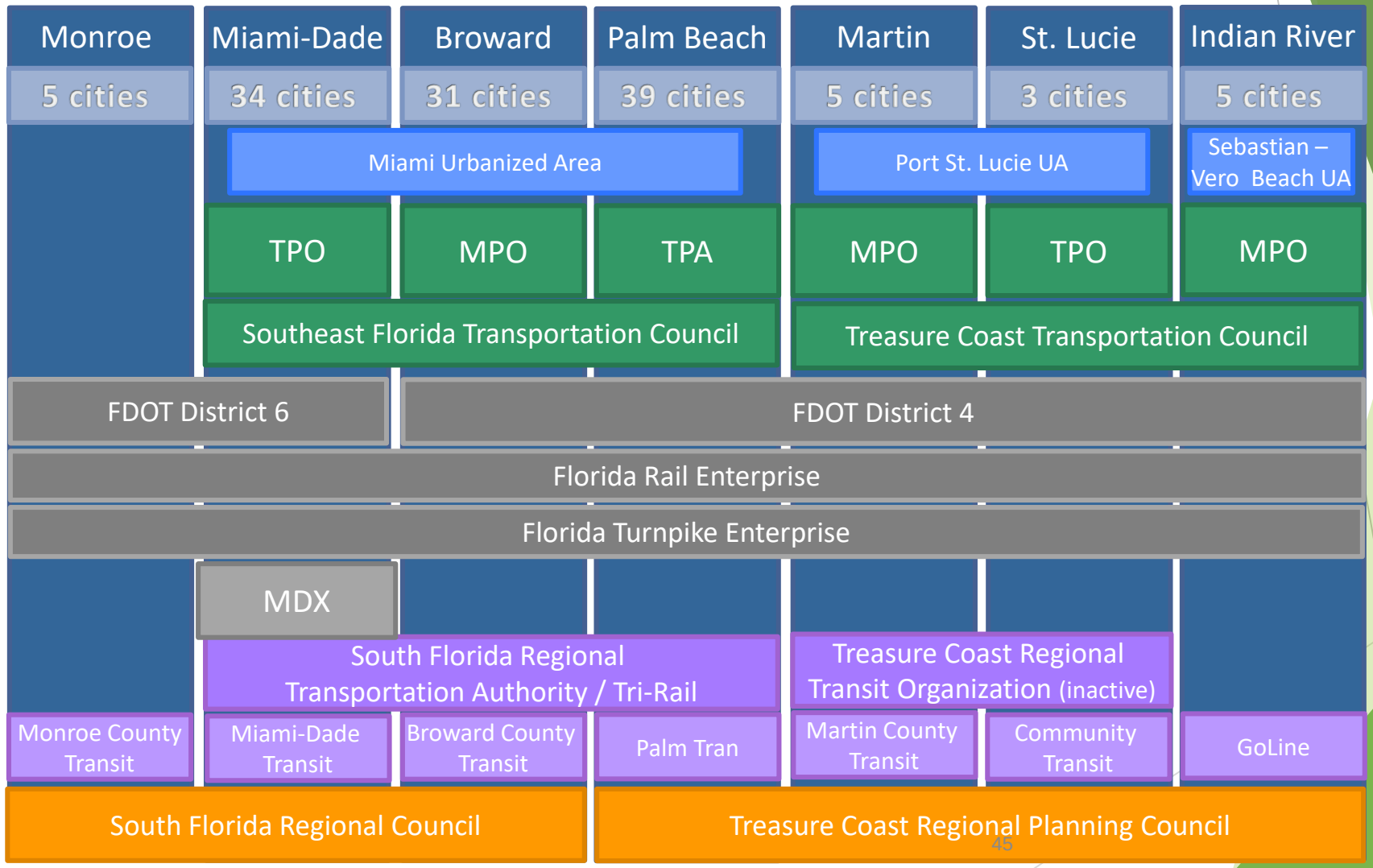
Planning for Future of Transportation System

As a group of partners – FDOT, MPOs, transit agencies, local governments, and others

Long-Range Planning Best Practices



Transportation Governance in Southeast Florida - Many Partners with Multiple Plans



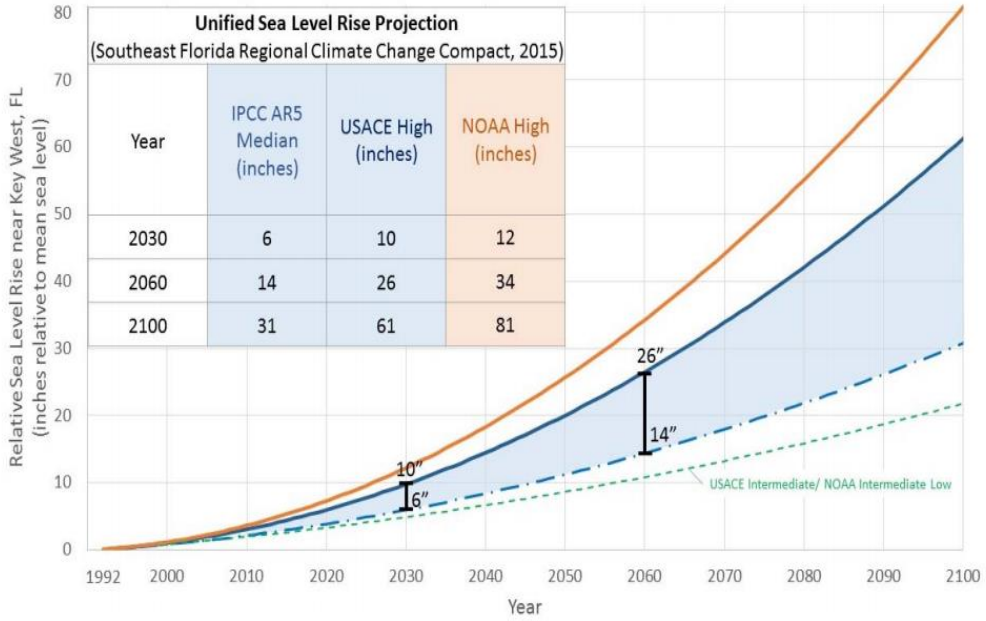
Southeast Florida Regional Climate Change Compact: Monroe, Miami-Dade, Broward, Palm Beach Counties

Regional Climate Action Plan 2.0 – Sample of Recommendations in Sustainable Communities and Transportation Focus Area

- ***ST-1: Incorporation of unified sea level rise projections into plans***
- ***ST-3: Identification of priorities for resilience investments using vulnerability and risk assessment analyses and tools***
- ST-10 & ST-11: Promotion of transit oriented and compact development
- ST-12: Recognition of transportation system's most vulnerable users and incorporation of sustainable elements (complete streets)
- ST-15: Urban tree canopy to protect pedestrians and bicyclists from heat and pollution exposure
- ***ST-17: Transportation investments that reduce GHG emissions and increase resilience of transportation system – coordinated planning, performance metrics, project prioritization, funding***
- ST-18: Increased use of transit for movement of people
- ST-19: Complete networks of bicycle and pedestrian facilities, including for transit access
- ST-20 & ST22: Expanded use of TDM and implementation of TSM&O strategies
- ST-21: Resilience, efficiency, and use of low-carbon modes for movement of freight
- ***ST-23: Evidence-based planning and decision-making***

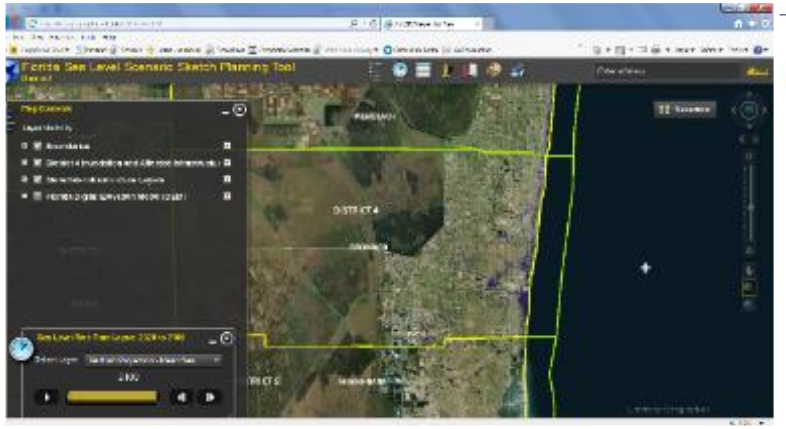
Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

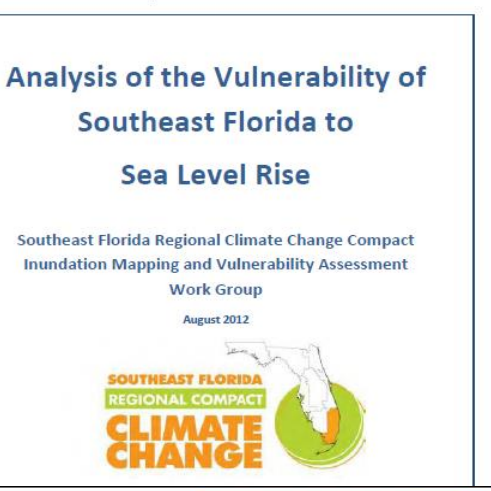
Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81

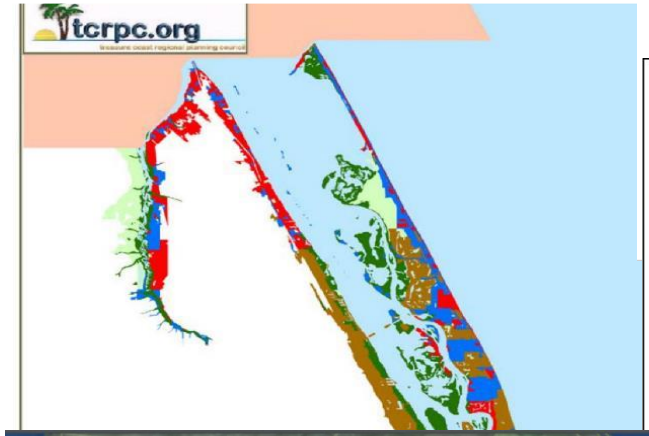


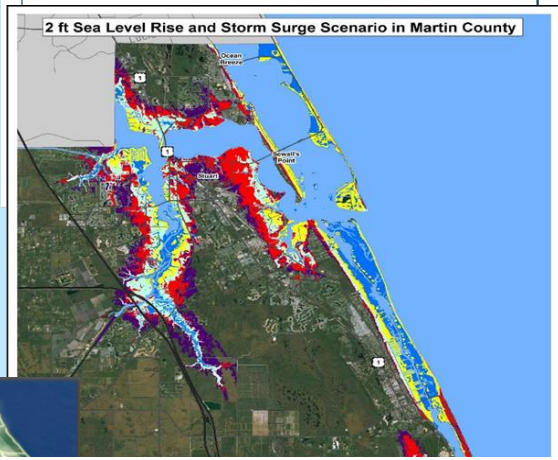
Planning for the Future – Supporting Tools and Data

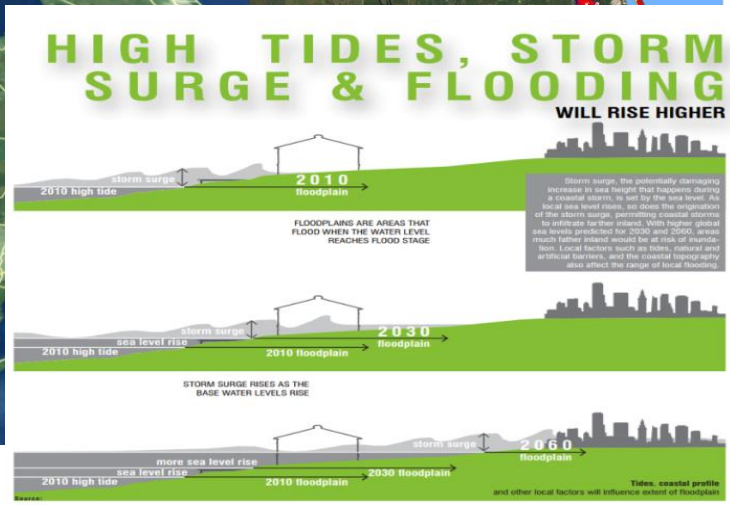
- FDOT/UF GeoPlan Center Sea Level Scenario Sketch Planning Tool
- Sea Level Rise in the Treasure Coast Region (2005,TCRPC)
- Analysis of the Vulnerability of Southeast Florida to Sea Level Rise (2012, Southeast Florida Regional Climate Change Compact)
- Treasure Coast Vulnerability Analysis for Post-Disaster Redevelopment (2012,TCRPC)
- *Climate Compact Seven County Inundation Assessment* – done through Seven50 regional visioning initiative (2014, SFRPC/TCRPC)





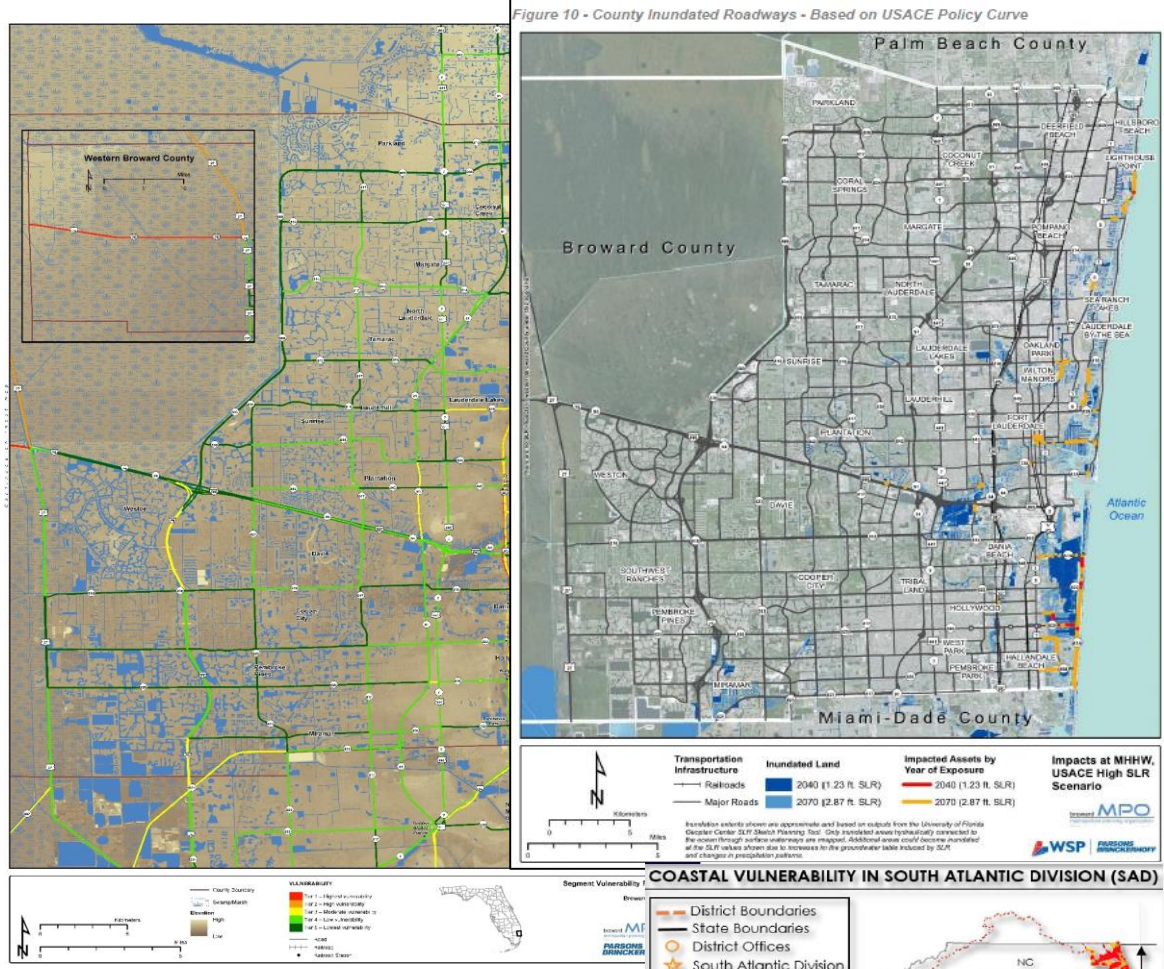


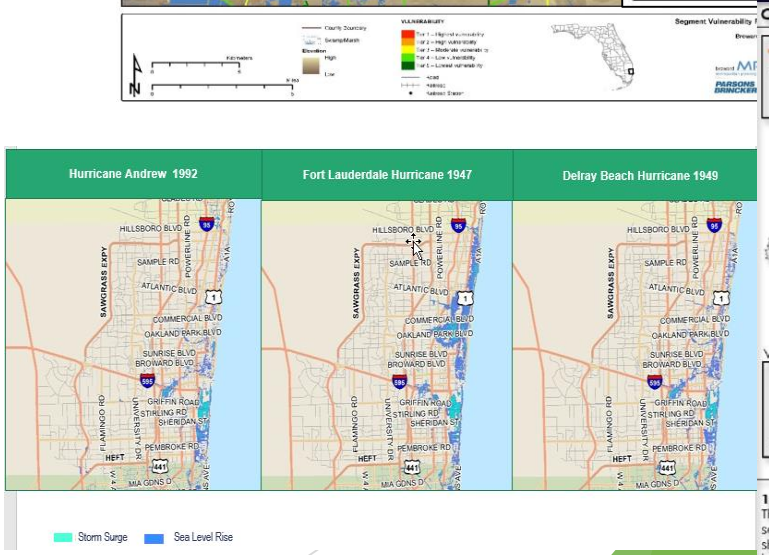


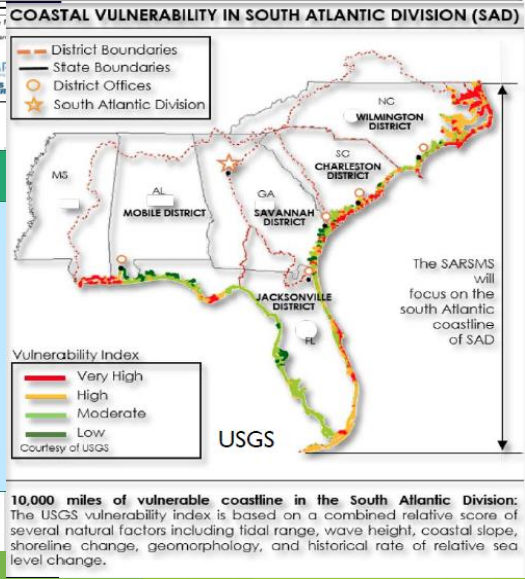


Planning for the Future – Supporting Tools and Data

- South Florida Climate Change Vulnerability Assessment and Adaptation Pilot Project for four Compact counties (2015, Broward MPO lead)
  - Supplementary Storm Surge, Sea Level Rise, and Transportation Network Disruption Project (2016, FDOT District 4)
  - Follow up study that determined vulnerability for additional transportation facilities in Broward County and identified set of potential projects to improve long-term resiliency of transportation system (2016, Broward MPO)
- Evaluation of impacts of increasing Design High Water elevation due to sea level rise on roadway base clearance (2018, FDOT District 6)
- South Atlantic Coastal Study (USACOE, underway)

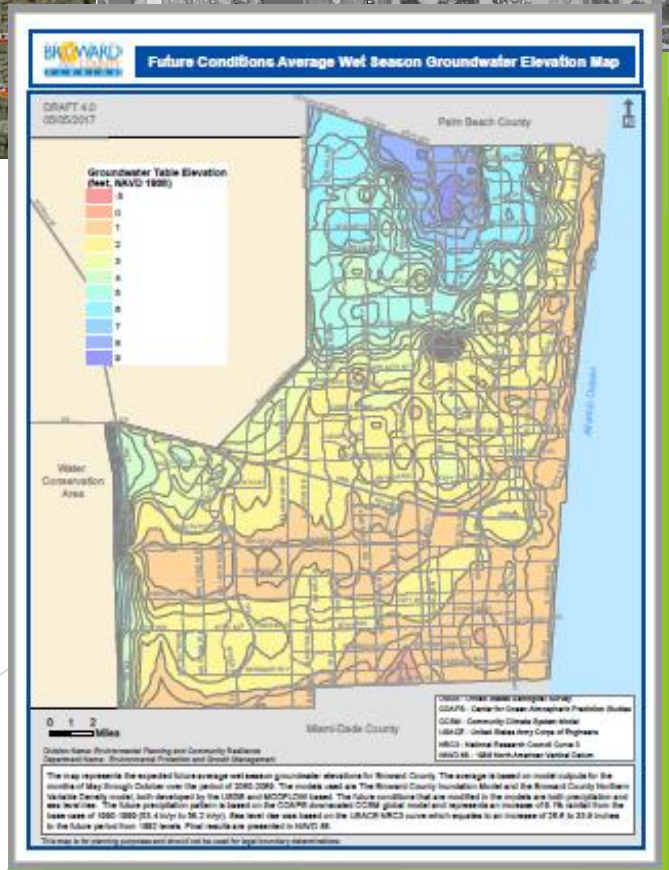


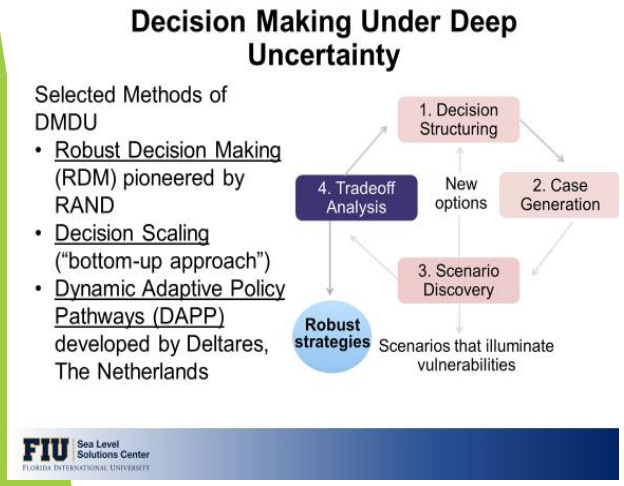


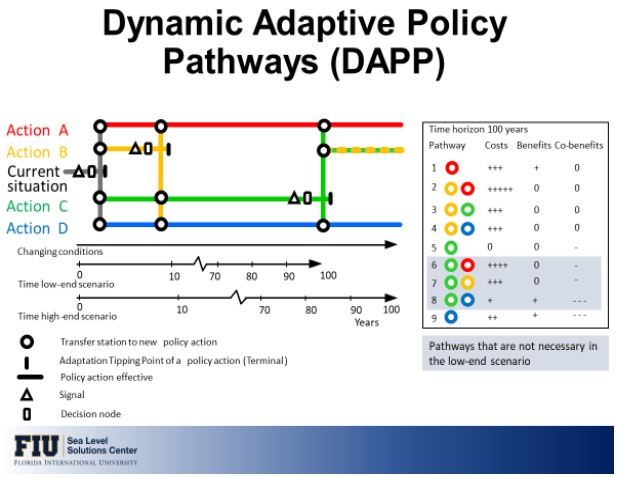


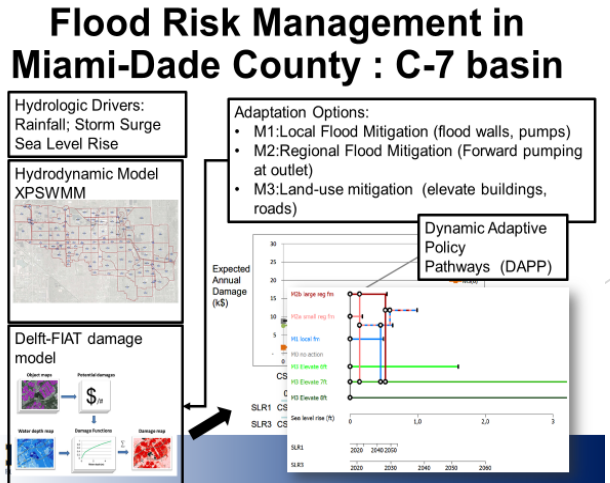
Evolving Data/Tools/Approaches - Examples

- Sharing Vulnerability Data: City of Sunrise
- Better Data: High Resolution Elevation Data
- New Tools
  - Broward County Future Conditions Map Series
- New Approaches: Dynamic Adaptive Policy Pathways



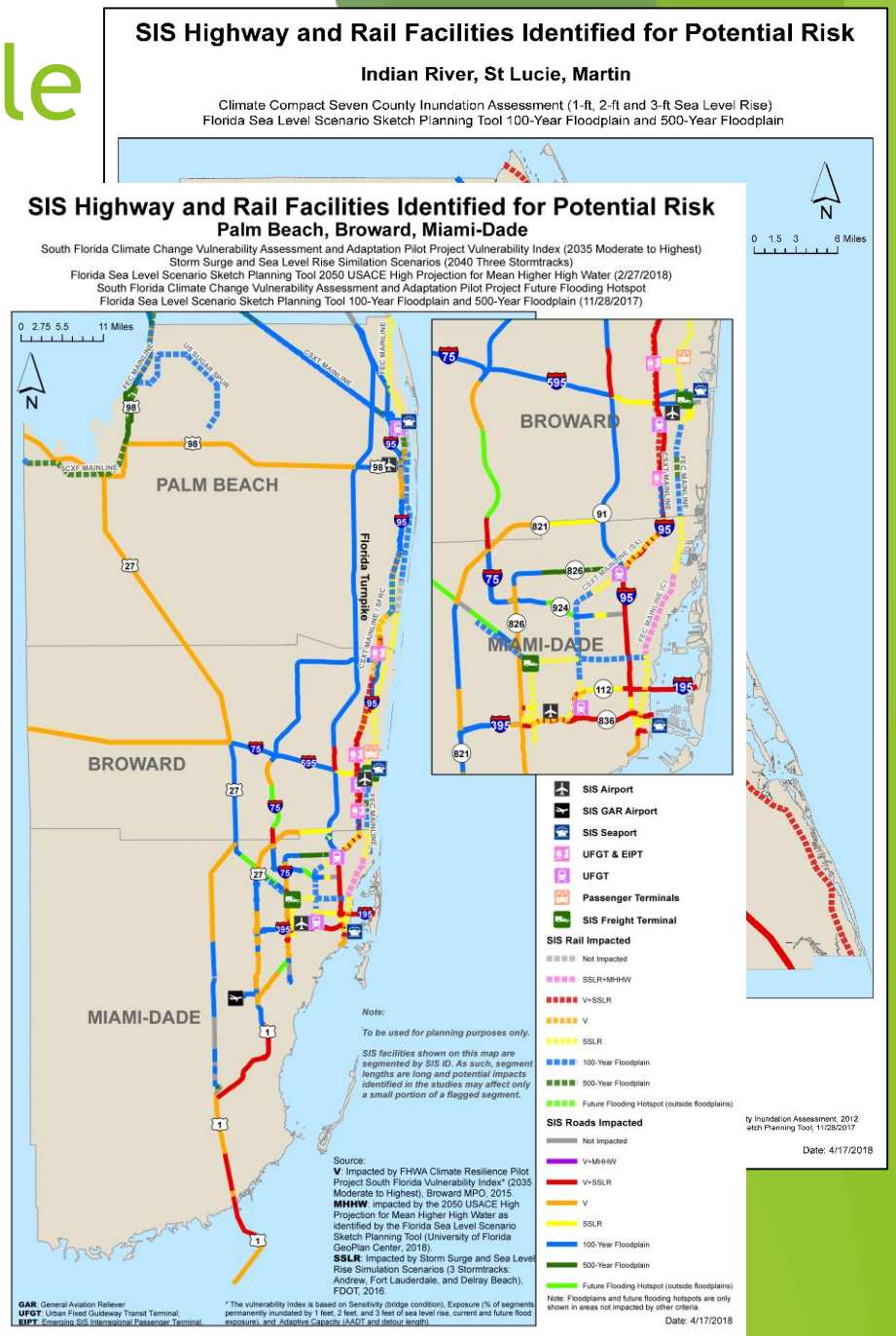






2045 Transportation Planning Cycle

- FDOT District 4 – Resilience considered in development of Strategic Intermodal System 2045 Multimodal Unfunded Needs Plan and SIS Cost 2045 Feasible Plan
  - Improvements identified for SIS 2045 MMUNP on vulnerable SIS facilities ‘tagged’ so known or potential vulnerabilities will be considered if/as they move from needs plan into SIS funding plans
  - Resilience considered in prioritization of and cost estimates for highway projects in SIS 2045 CFP
  - GIS data layers collected or created for these efforts available to MPOs and other partners



2045 Transportation Planning Cycle

- Southeast Florida MPOs have made additional strides on resilience in 2045 transportation planning cycle
- Southeast Florida Transportation Council (Miami-Dade, Broward, Palm Beach) 2045 Regional Transportation Plan
  - Objectives
    - Support the efforts of Southeast Florida Regional Climate Change Compact by coordinating among regional partners for transportation system resiliency and adaptability.
    - Promote both adaptation and growth management strategies to address and increase resilience to coastal flooding.
- Miami-Dade TP0 2045 Long Range Transportation Plan
  - Sustainability Chapter including vulnerability assessment and other components (e.g., Resilient305 Strategy, GreenPrint)
  - Objectives on reducing vulnerability and increasing resilience of transportation system under Improve and Preserve the Existing Transportation System goal

2045 Transportation Planning Cycle

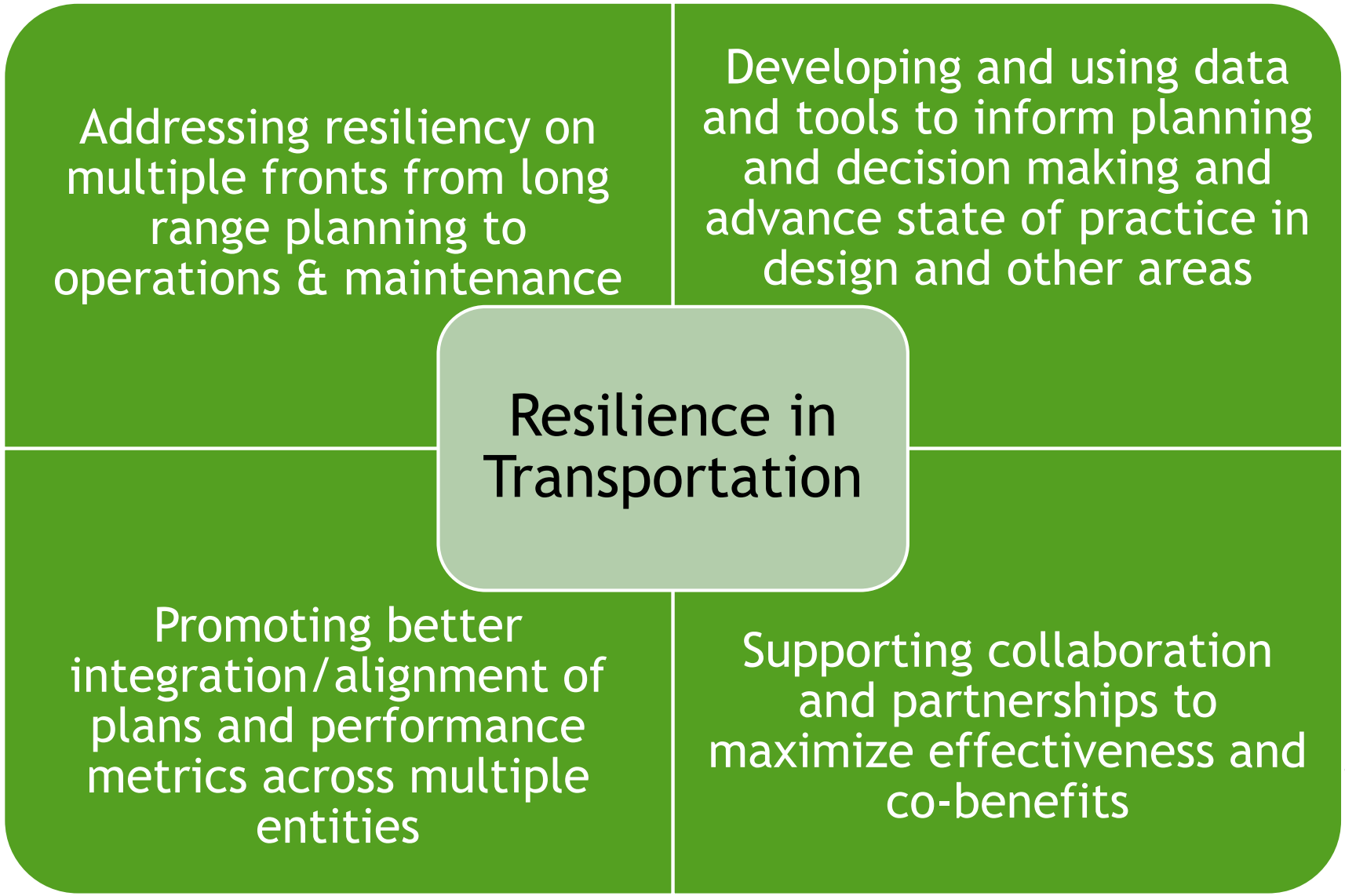
- Broward MPO 2045 Metropolitan Transportation Plan
  - Resiliency objective and performance measures with targets under Strengthen Communities goal
  - Sea level rise mitigation and extreme weather resiliency among evaluation criteria used to prioritize projects

Sea Level Rise Mitigation/Extreme Weather Resiliency	+2	Project located within sea level rise vulnerability area (Tier 1-3) and will mitigate infrastructure in this area.
	+1	Project will result in infrastructure that is more resilient to extreme weather events.
	0	Project not located within sea level rise inundation area.

  - Cost feasible plan component identifies eight roadway segments for further study to identify resiliency improvements
  - Resiliency scenario looked at network impacts if certain roadways are inundated by sea level rise based on current 2045 projections
- Palm Beach TPA 2045 Long Range Transportation Plan
  - Targets for performance measures under Resiliency goal

Item	Actual Values					Proposed Targets	
	2014	2015	2016	2017	2018	10-Year	25-Year
% of mileage susceptible to 1.2-ft sea level rise & historic storm surge levels	n/a	n/a	n/a	n/a	3.9%	3%	2%
Mileage susceptible to a 1% chance of annual flooding	n/a	n/a	n/a	n/a	26.7%	25%	20%

Recap – Key Themes



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Activity 1: Priority Pyramid

Activity 1

- Resilience – The ability for the transportation system to absorb the consequences of disruptions, to reduce the impacts of disruptions and maintain mobility

Florida Transportation Plan, Policy Element, 2015

Freight Movement and Resilience Panel

FTP-SIS Resilience Subcommittee Meeting

Freight Movement and Resilience Update

October 29, 2019

FDOT

FMO
FREIGHT & MULTIMODAL OPERATIONS

Freight Mobility & Trade Plan (FMTP)

Purpose

- Identify freight mobility issues and needs
- Develop policies, programs and projects
- Support economic development and commercial trade
- Fulfill federal regulations

Characteristics

- Multimodal – all freight modes
- Intermodal connectivity
- Understandable & pragmatic
- Implementable plan
- Supports on-going planning
- Prioritization: Highest needs matched with project selection

Cohesion

- Supports LRTP
- Aligns with modal plans: Rail, Highway, Maritime, Space and Air
- Supports federal freight goals
- Provides support & guidance for local freight planning/District plans

Freight Scenario Planning

Each scenario is focused on impacts to the movement of freight:

1) Technology
2) Resiliency
3) Economy

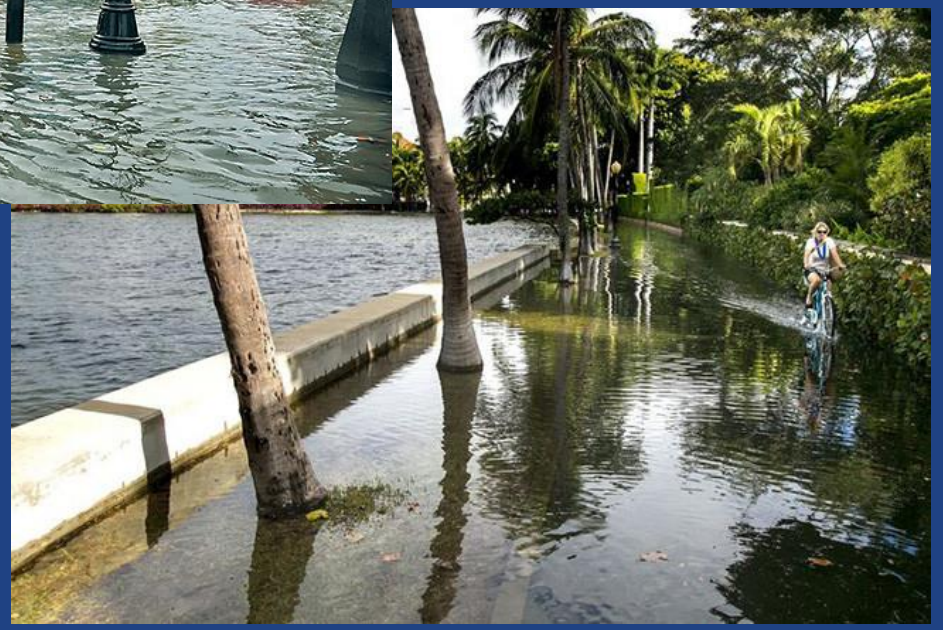
Identify infrastructure, operational, policy, and programming strategies

Scenario 2: Resiliency

2045 Scenario Defined:

- +4º (F)
- +12” along coasts
- +Frequency/ strength
- +Extreme events

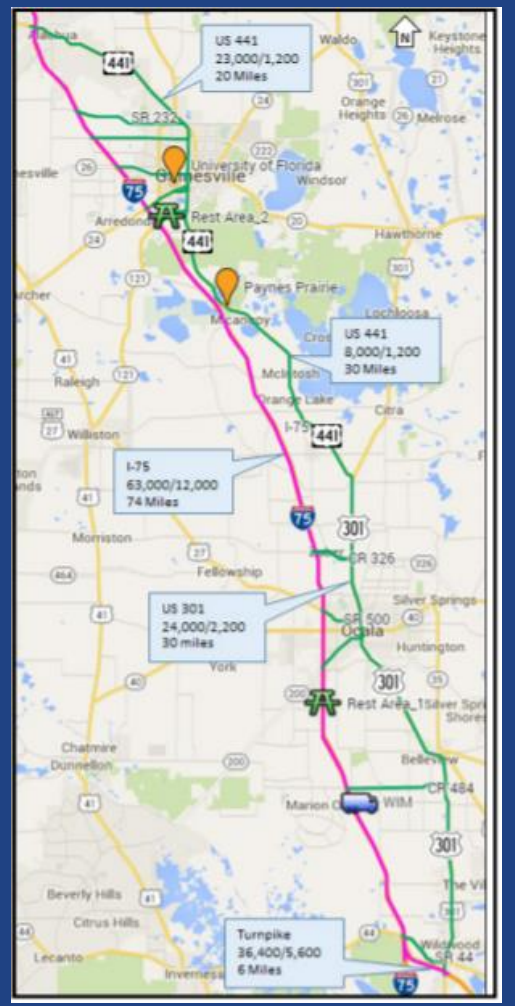
Image Source: Florida Trend



Scenario 2: Resiliency

Implications for Freight

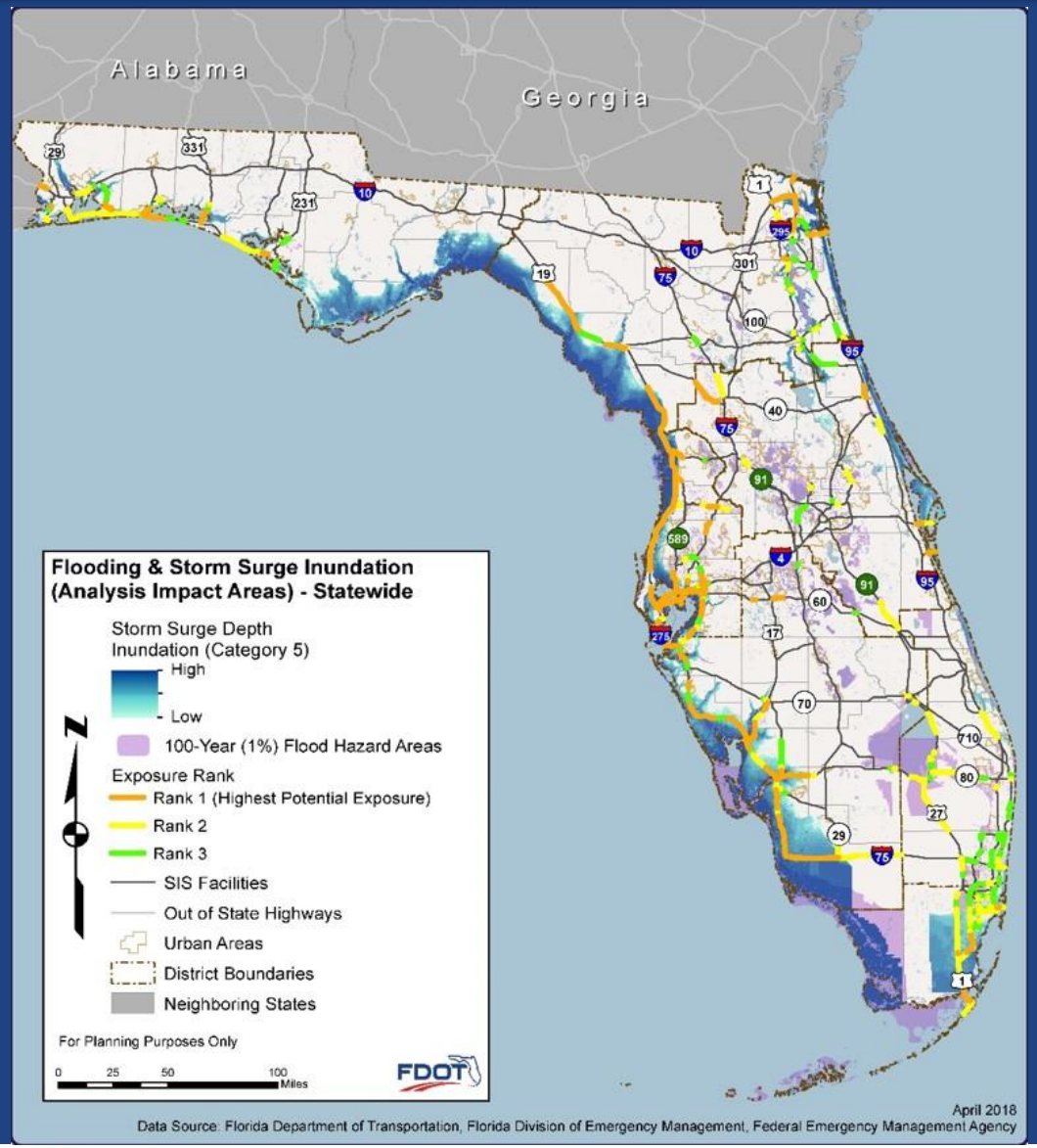
1) Increased use of parallel corridors
2) Supply chain resiliency
3) Emergency management preparedness & response
   a) Bulk reserves of commodities
4) Seaport (and airport) strategies to mitigate rising water table (from SLR)

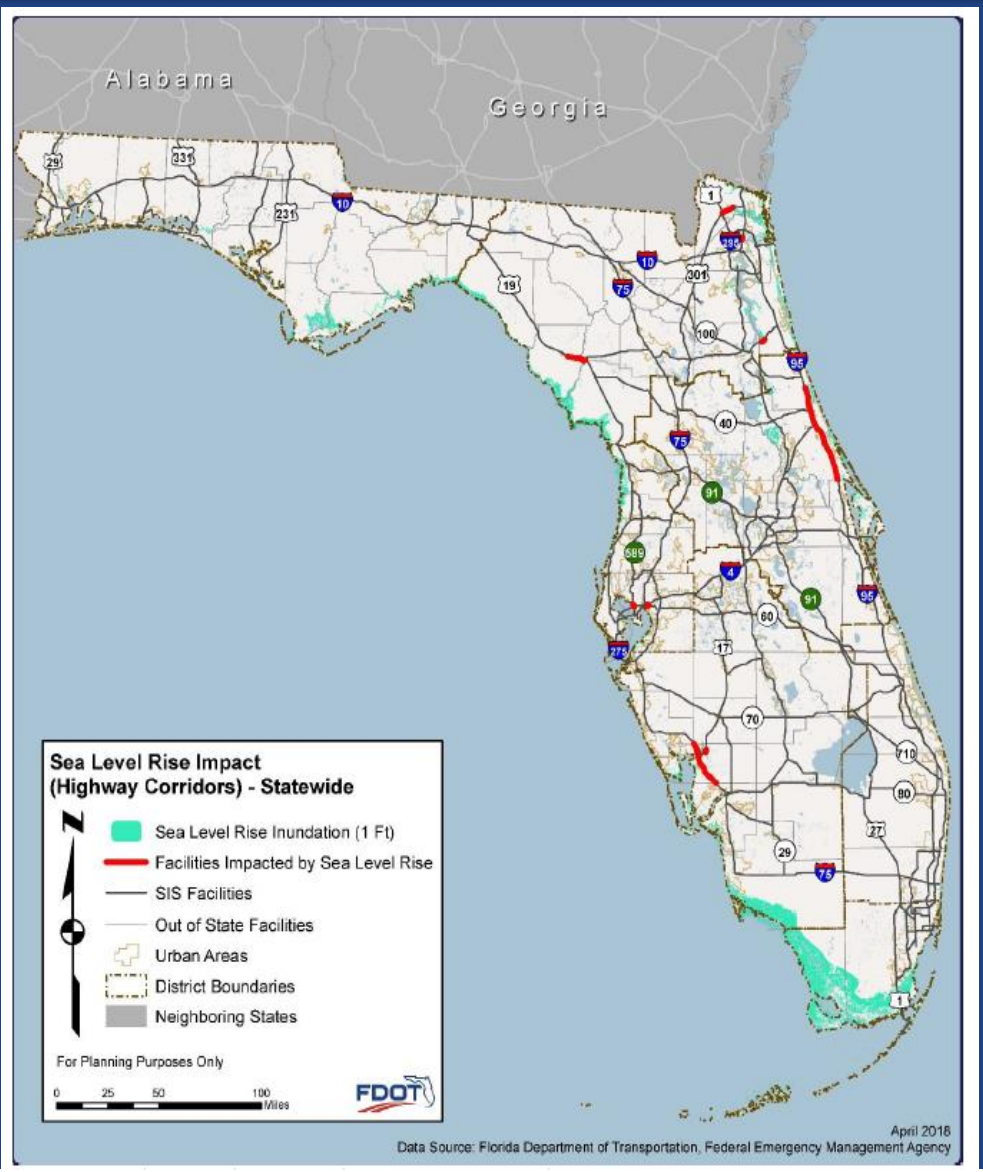


Scenario 2: Resiliency

Florida Freight Advisory Committee feedback:

Scenario 2: Resiliency





FDOT FMO FREIGHT & MULTIMODAL OPERATIONS

Holly Cohen

Freight and Rail Planning Administrator,
Florida Department of Transportation

605 Suwannee Street, MS 25
Tallahassee, FL 32399
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holly.cohen@dot.state.fl.us

FDOT

FMO
FREIGHT & MULTIMODAL OPERATIONS

Florida's Seaports: Critical Components in Freight Movement and Resilience

FLORIDA PORTS COUNCIL

@floridaports

www.flaports.org

Find us on Facebook

Florida Seaports

#flaports

Florida Seaports are Economic Drivers

$87.3 B

VALUE OF WATERBORNE TRADE MOVED THROUGH FLORIDA SEAPORTS

900,000

JOBS SUPPORTED BY FLORIDA SEAPORTS

$117.6 B

ECONOMIC VALUE GENERATED BY FLORIDA SEAPORTS

#flaports

Florida Seaports Coordination Efforts

PREPAREDNESS

actions taken before a storm event to avoid or limit a disruptive impact

RESPONSE

actions to address immediate impacts of the storm event

RECOVERY

actions taken to get the port to pre-storm event operating levels

Critical Elements of Seaport Response & Recovery

CHANNEL SURVEYING & REOPENING

RESTORING ELECTRICAL POWER

RESUMING FUELING TERMINAL OPERATIONS

FLORIDA PORTS COUNCIL

www.flaports.org

Find us on Facebook and Twitter!

Break

Data to Support Decision Making

Data to Support Decision Making

Crystal Goodison, Associate Director + Associate Scholar,
University of Florida GeoPlan Center

UF | GEOPLAN CENTER

UF | UNIVERSITY of FLORIDA

We support land use, transportation & environmental planning in Florida by providing geospatial and planning expertise, data, and training to stakeholders in the planning process.

FGDL
FLORIDA GEOGRAPHIC DATA LIBRARY

etdm
Efficient Transportation Decision Making

What we do:

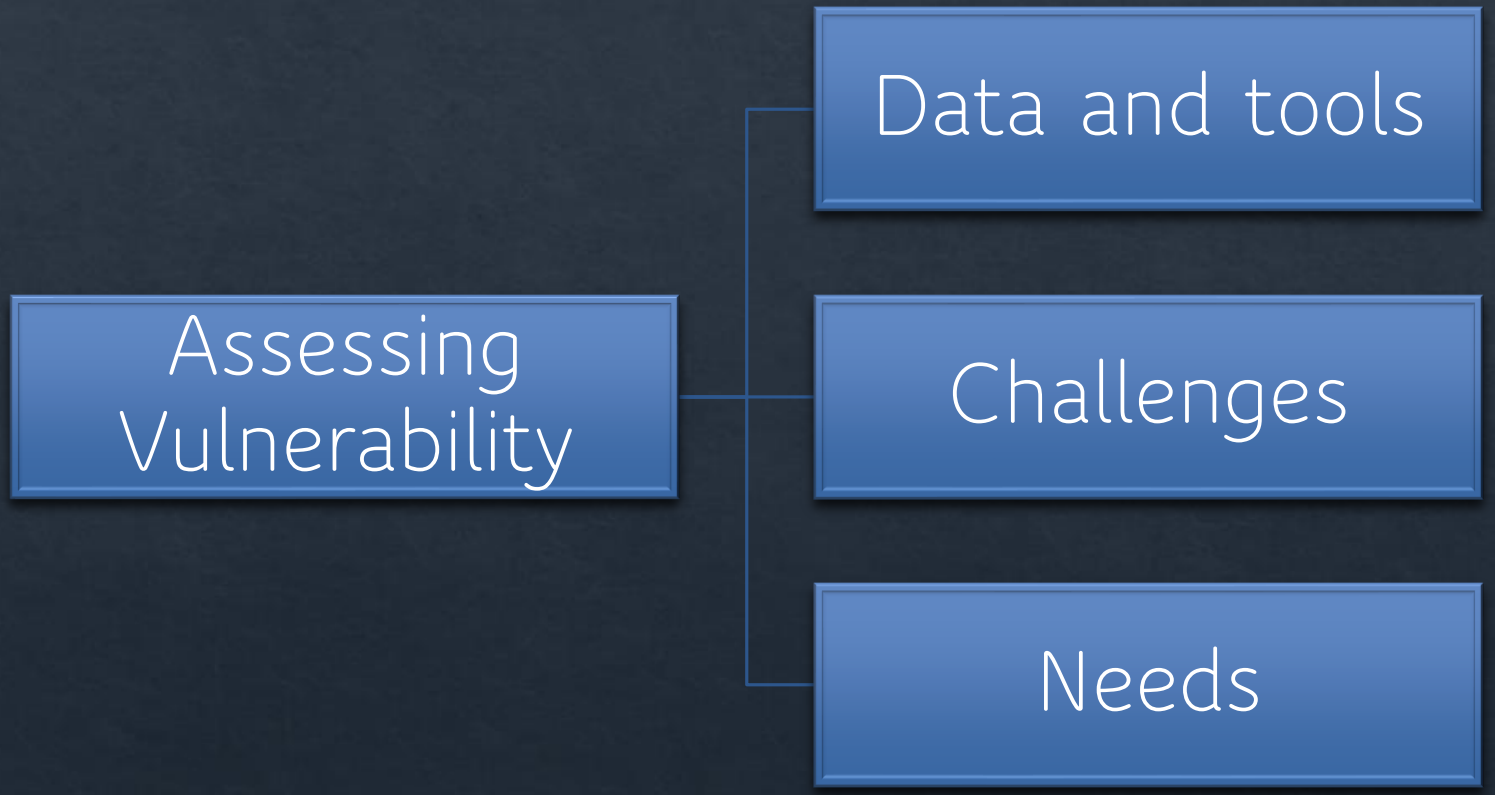
- Create, standardize & distribute geospatial data
- Data integration and database creation
- Design and operate enterprise systems for analysis, visualization, and decision making
- Turn data into information

FLORIDA 2070

SEA LEVEL SCENARIO
SKETCH PLANNING TOOL

SIGNAL FOUR ANALYTICS

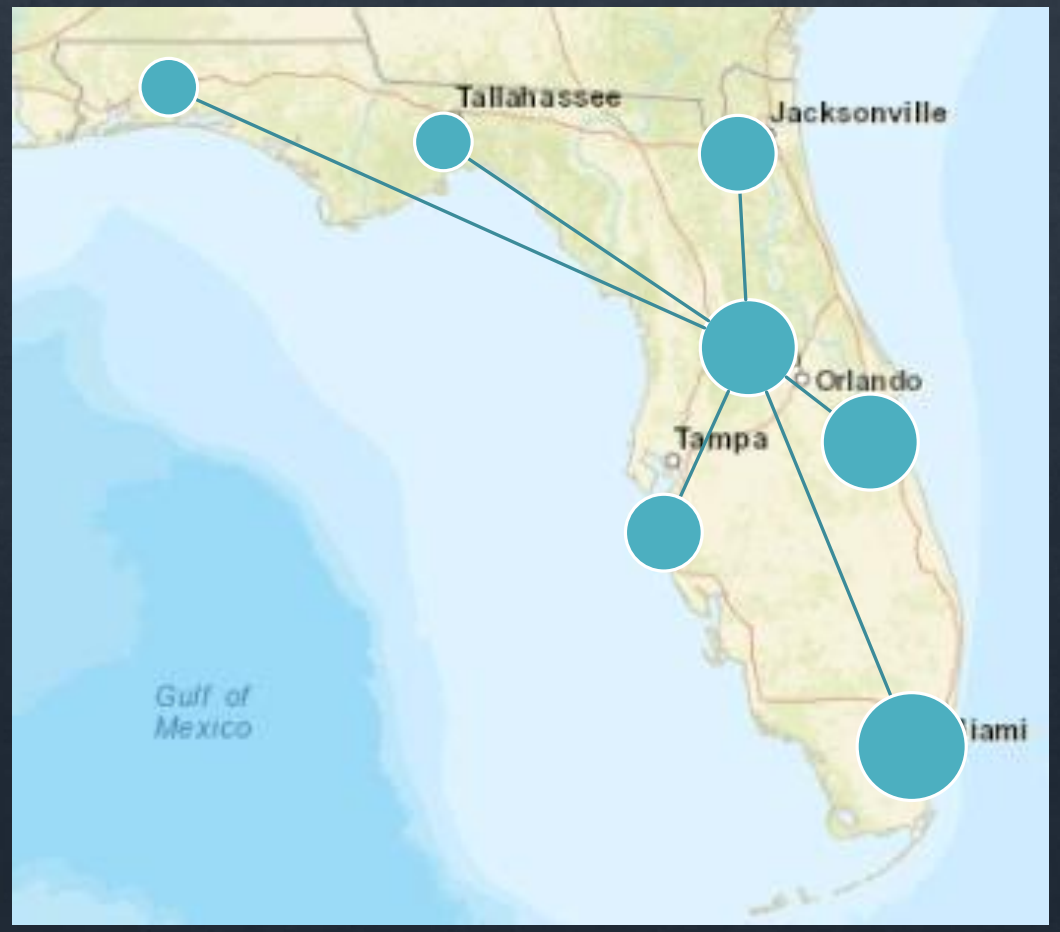
Outline



How do we prepare our transportation system for, and recover from, weather, environmental, economic, and operational disruptions?

I don't know but…

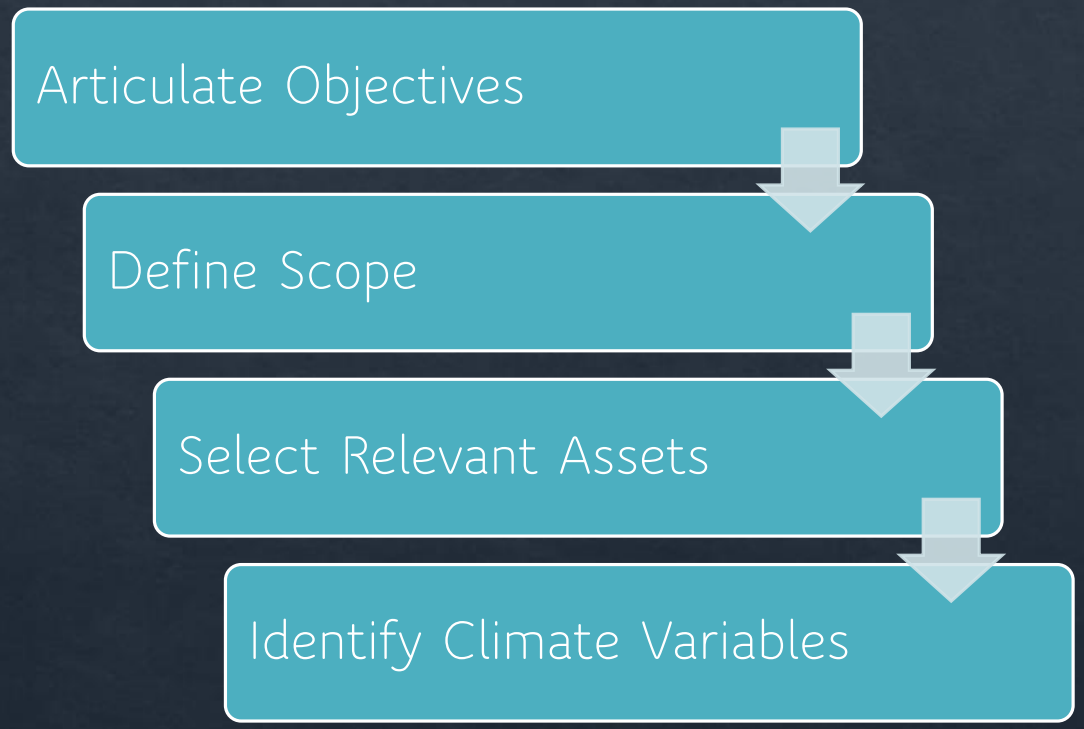
- Prepare transportation system for short-term, mid-term, and long-term disruptions
- **Understand our vulnerabilities** at various spatiotemporal scales
- **Increase adaptive capacity** of system at all level. **Support regional and local transportation partners** with data, tools, guidance, and training
- Acknowledge **what we don't know**



Know Your Vulnerabilities

FHWA Extreme Weather & Climate Vulnerability Assessment Framework

Define Objectives and Scope

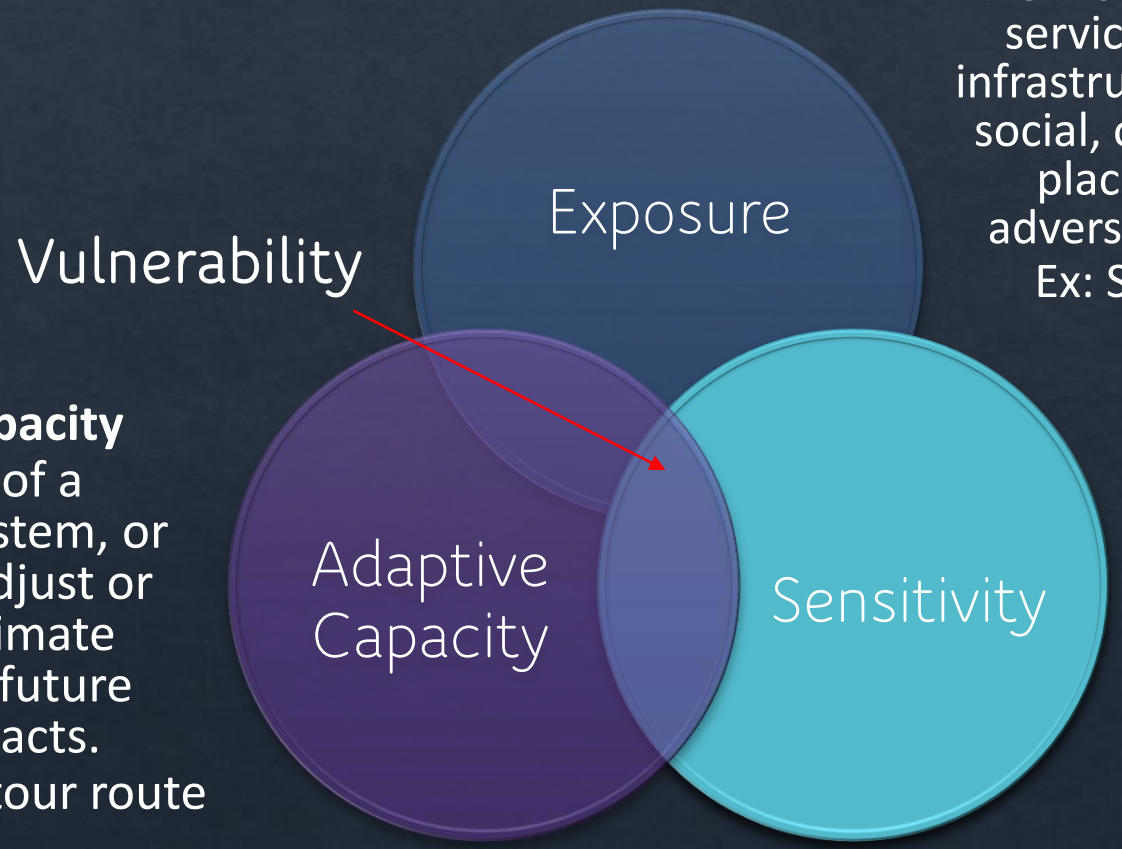


- **Vulnerability of what to what?**
- Scope: geographic area, level of detail, time frame
- Assets of interest
- Climate stressors and indicators

These steps determine types and scales of data needed. Defining these early (before starting) will save time and expectations.

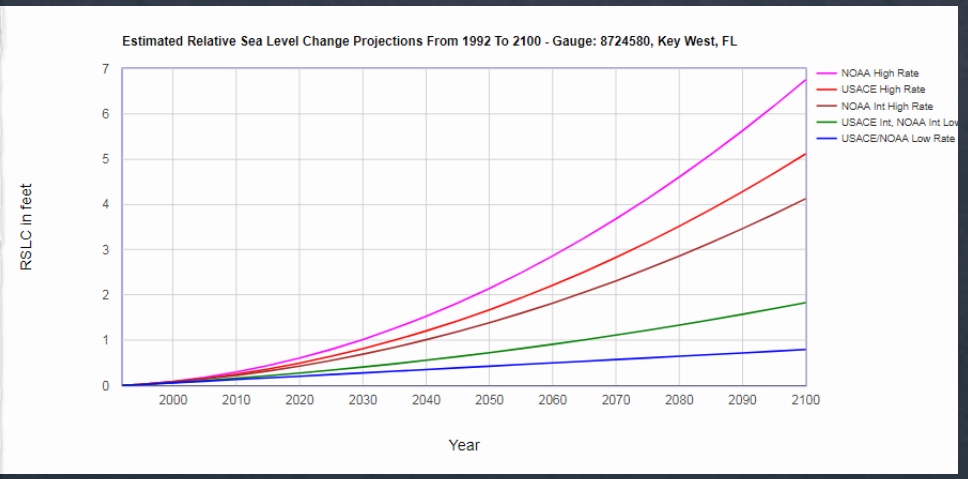
measuring vulnerability

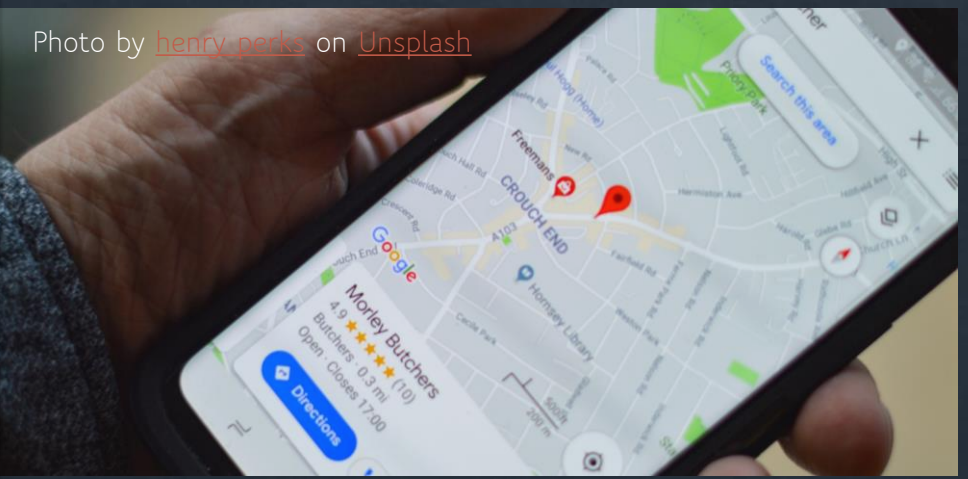
Exposure
The presence of people, livelihoods, environmental services and resources, infrastructure; or economic, social, or cultural assets in places that could be adversely affected (IPCC)
Ex: Storm surge, SLR



Adaptive Capacity
The ability of a community, system, or structure to adjust or cope with climate variability or future climate impacts.
Ex: Length of detour route

Sensitivity
The degree to which a community, systems or structure are affected by climatic stressor.
Ex: Condition of asset



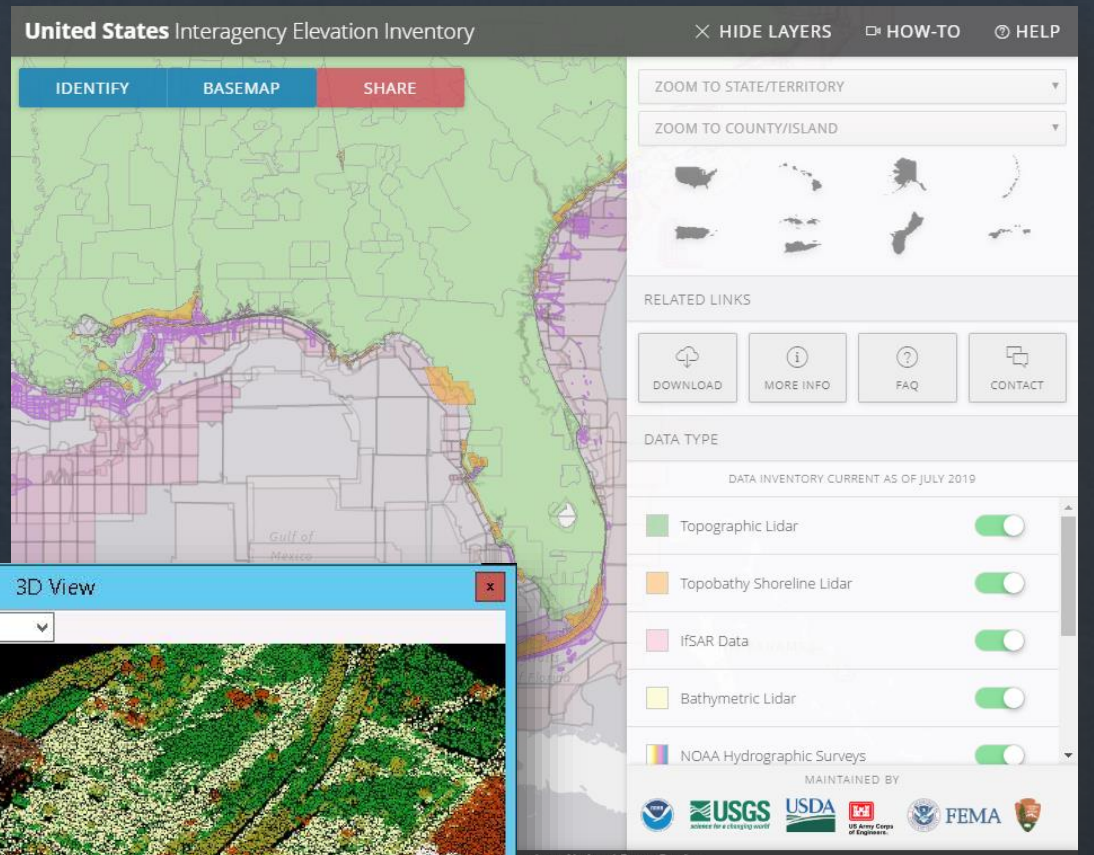


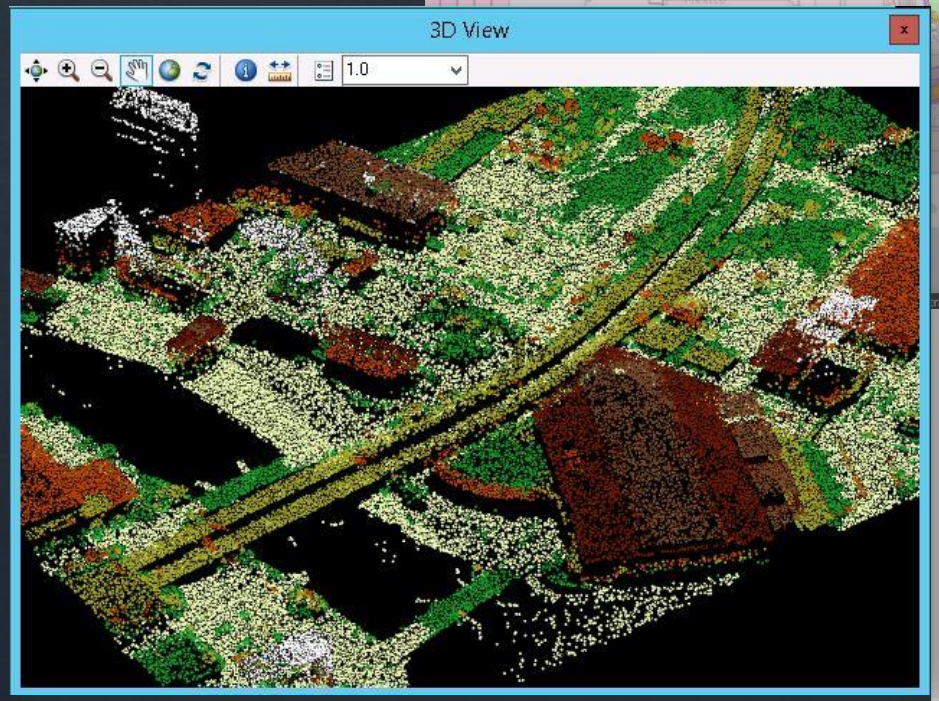
Critical Data for Vulnerability Assessments

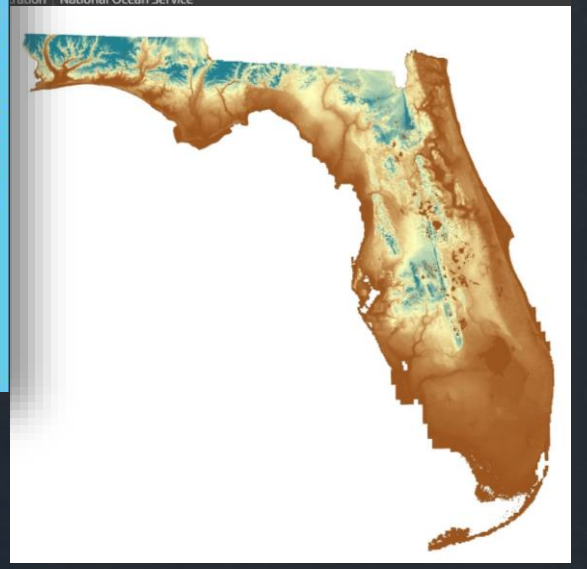
- **Elevation Data**
- **Climate Stressors** (SLR, Storm Surge, Precipitation, Temperature, etc). Where, how much, when?
- **Detailed location data on resources** of interest (people, transportation asset information, critical facilities, etc)

High resolution elevation data

- United States Interagency Elevation Inventory (USIEI).
- Florida Division of Emergency Management – Updated lidar collection in progress
- FDEM expects final deliverables (1m DEMs & classified LAS) will be available for download on USGS National Map around December 2020.







Data on Climate Stressors

- Sea Level Rise
- Storm Surge
- Nuisance/ high tide flooding
- Precipitation
- Floodplains
- Temperature

We need more than data

DATA

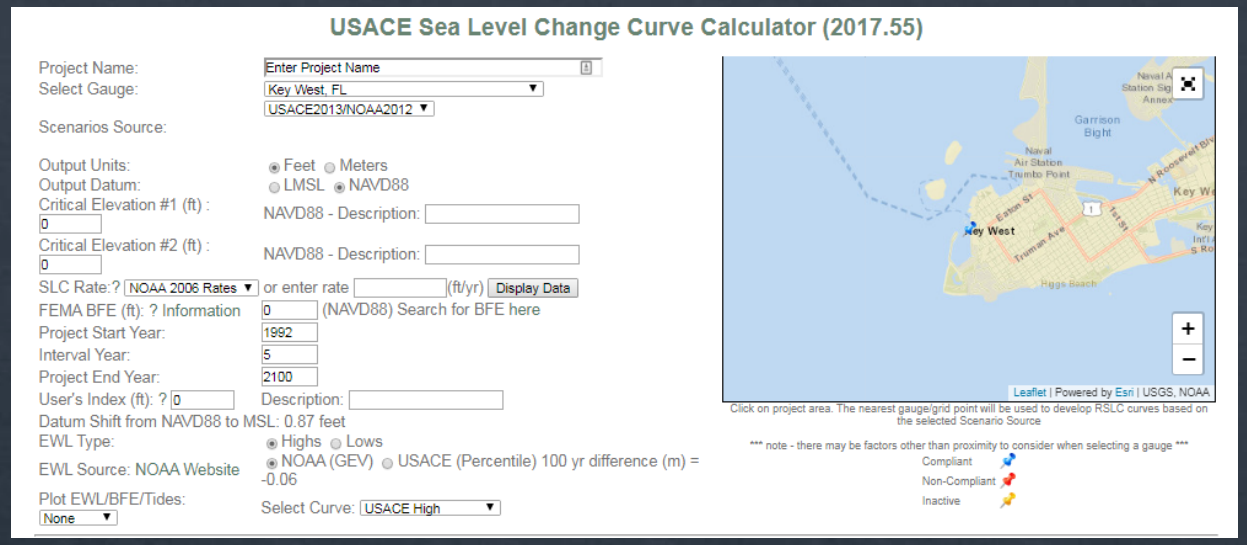
METHODS & GUIDES

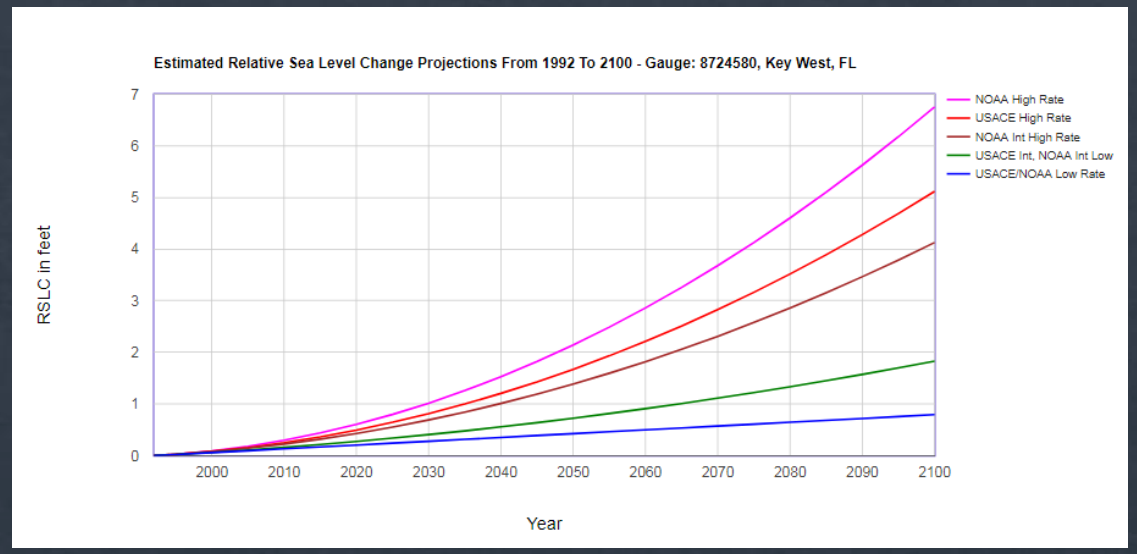
ANALYSES

TOOLS

TRAINING

Helpful tools, data, and guidance: Sea level rise & flood exposure





Sea level rise: About how much and when?

U.S. Army Corps of Engineers

Sea-Level Change Curve Calculator

Guidance for Choosing & Using Scenarios

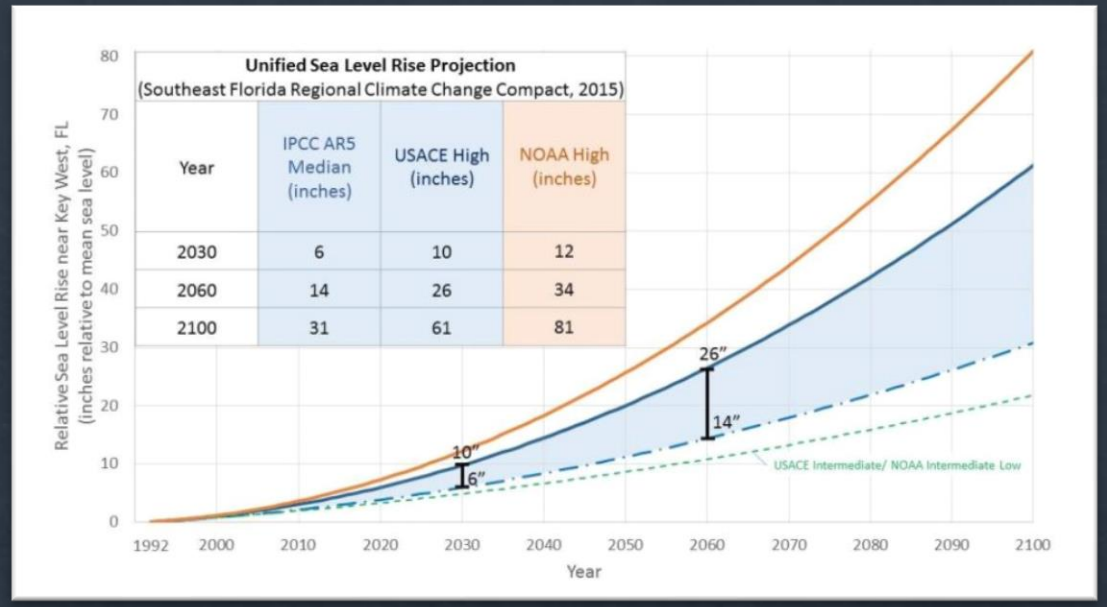
The Compact - Unified SLR Projections & Integration into Local Policy

TBRPC - Recommended Projections of SLR in the Tampa Bay Region

Localized projections for consistent application across region

USACE Sea Level Tracker

- Actual MSL vs projected SLR for selected tide gauges



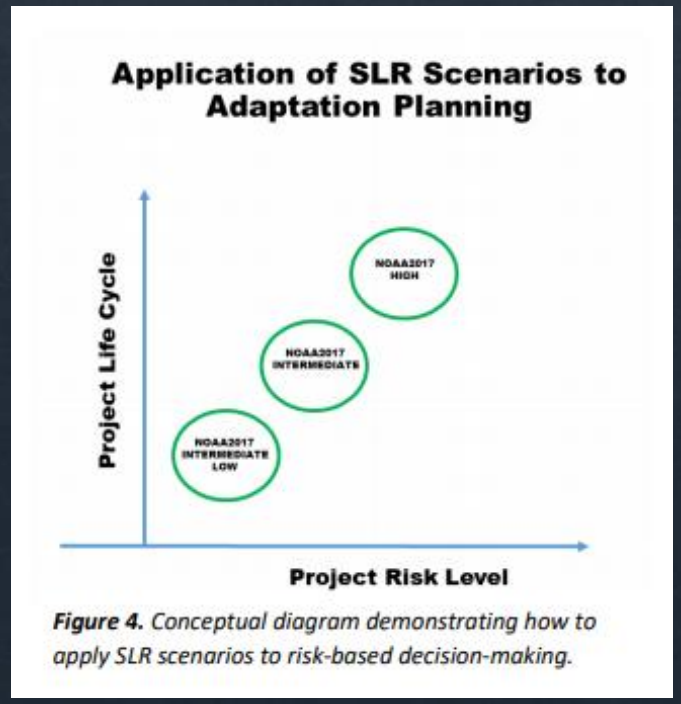
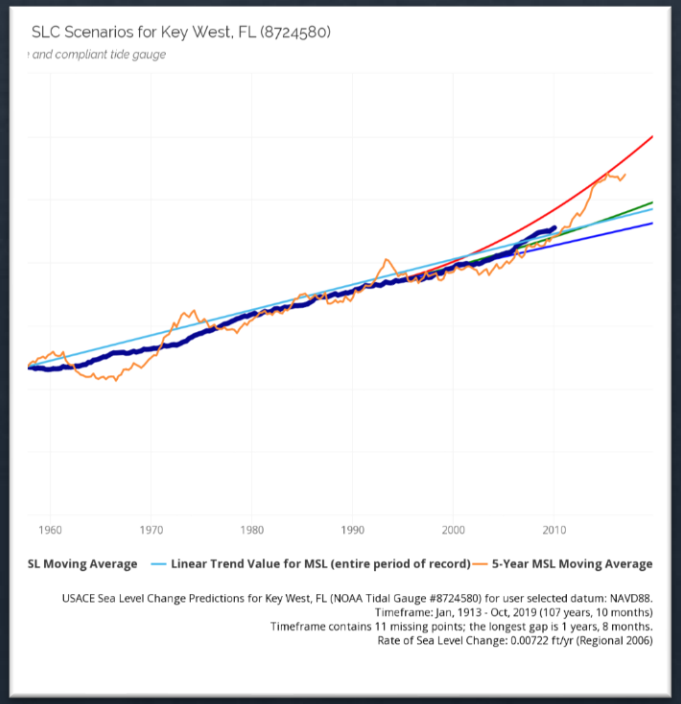
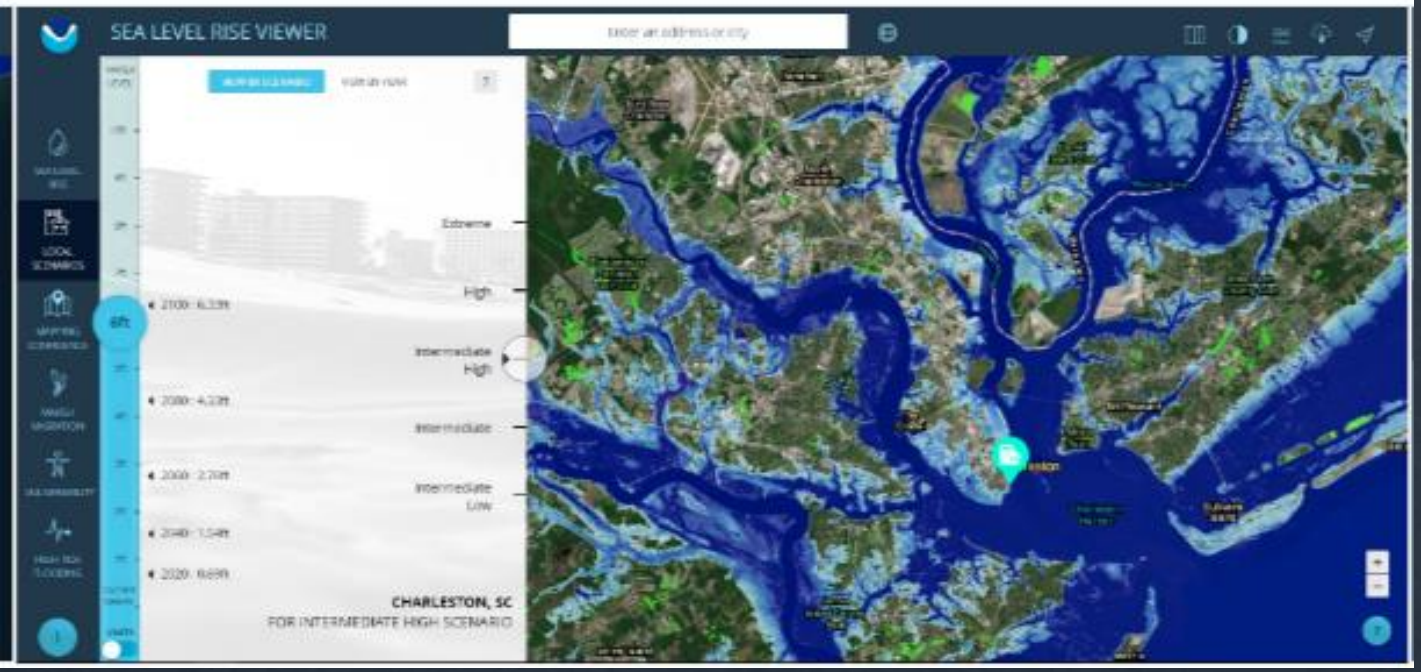
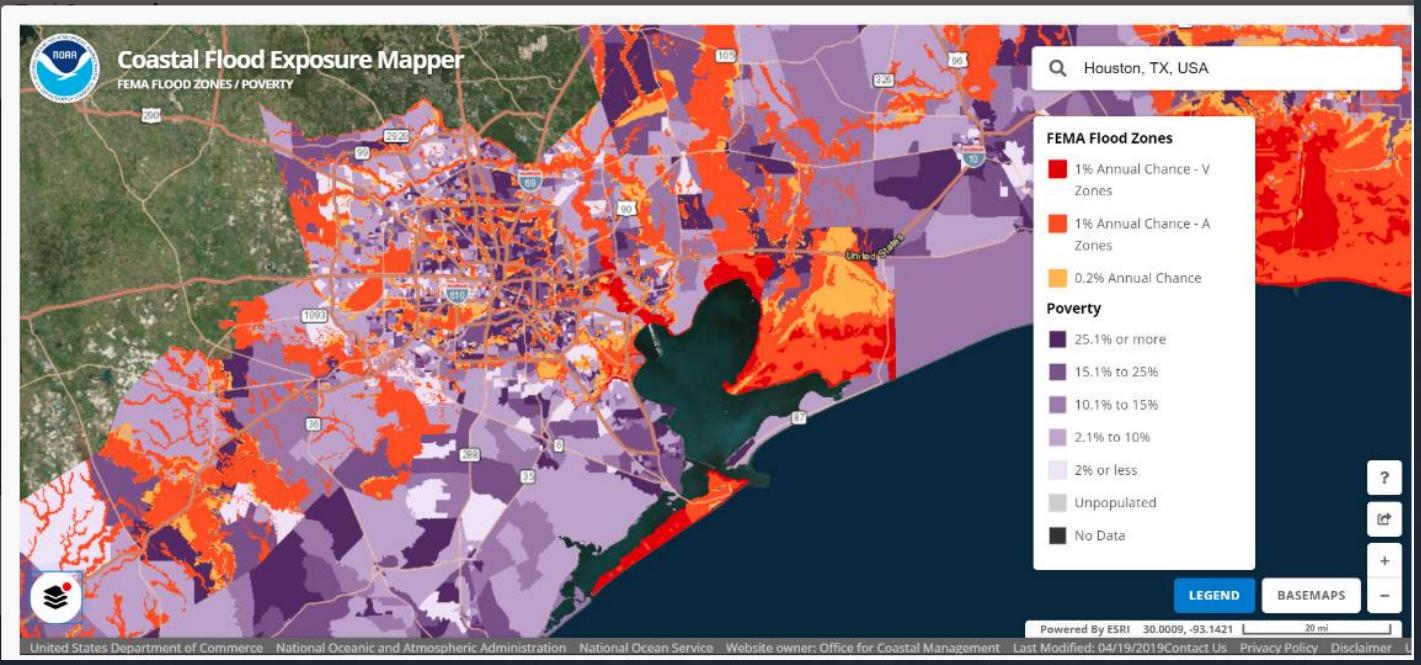


Figure 4. *Conceptual diagram demonstrating how to apply SLR scenarios to risk-based decision-making.*







NOAA Digital Coast

Sea Level Rise Viewer

- **Local SLR projections (in foot increments)**

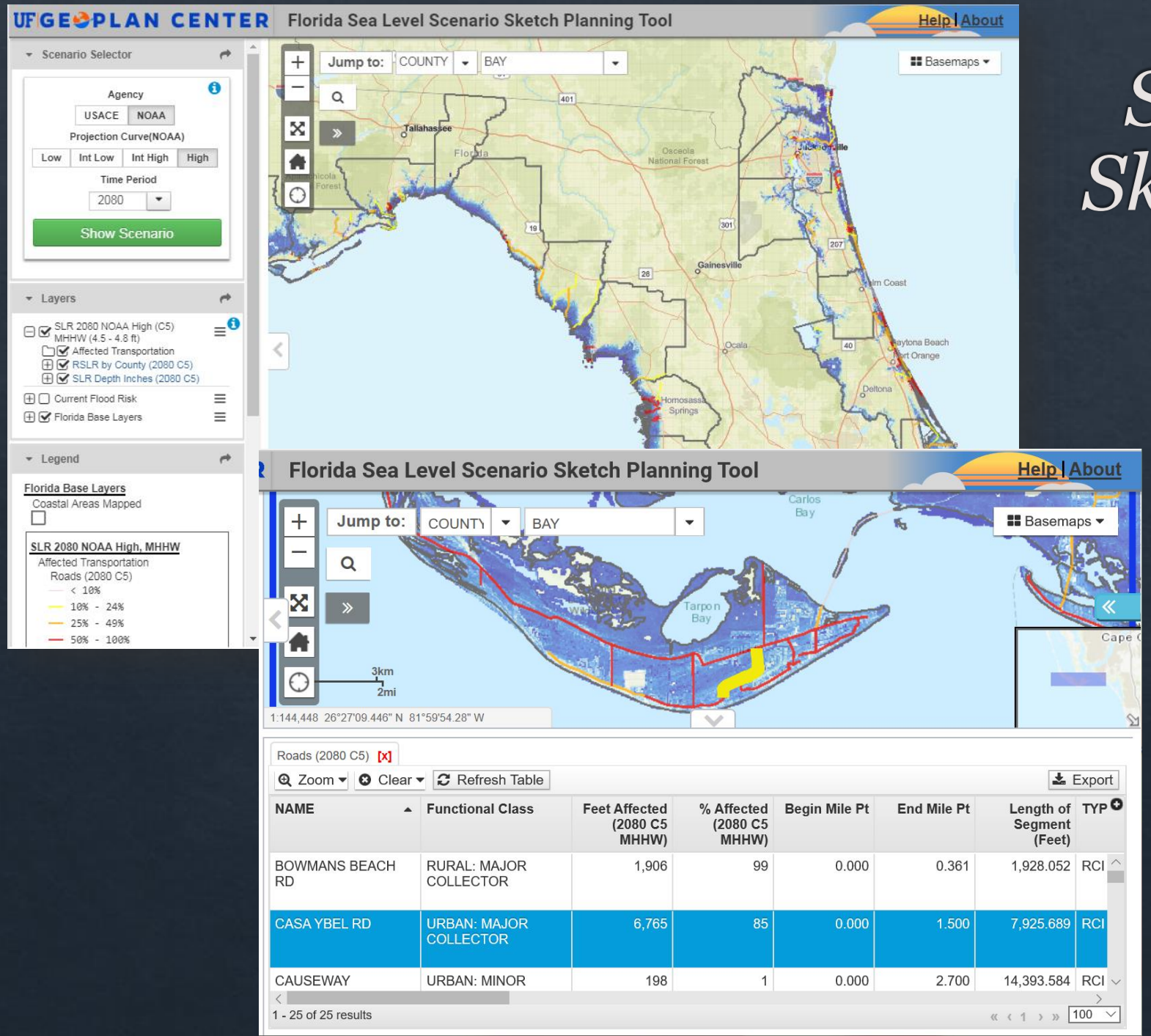
Coastal Flood Exposure Mapper

- **Current & future flood risk**

Data Downloads:

- **SLR Extent & depth by foot for U.S.**
- **DEM**
- **Tidal Surfaces for SLR Mapping**

Training, Tools, and Methods



Sea Level Scenario Sketch Planning Tool

Planning level tool for screening and comparing SLR scenarios & potential transportation impacts

- **Local SLR projections** mapped for 36 counties, MHHW
- **SLR Projections (5):** NOAA, 2012, USACE, 2013
- **Decades:** 2040 - 2100
- Analyses of state and county roads exposed to SLR and current flood risk

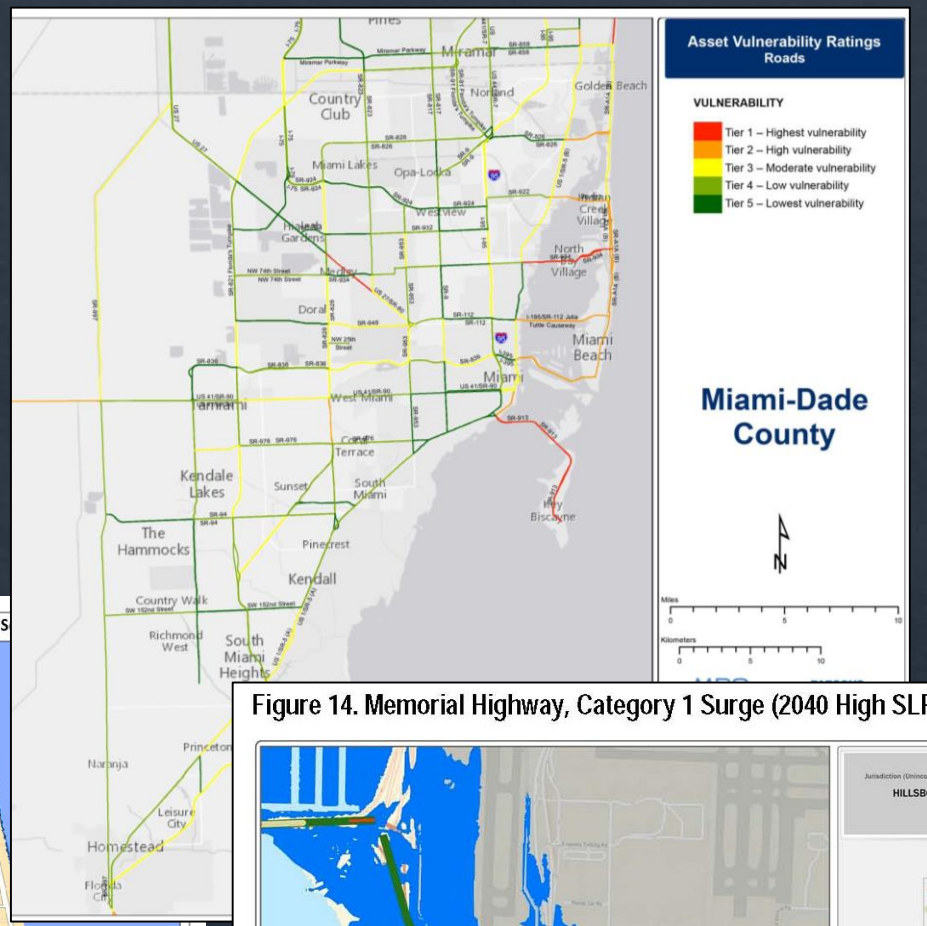
Pilot Projects

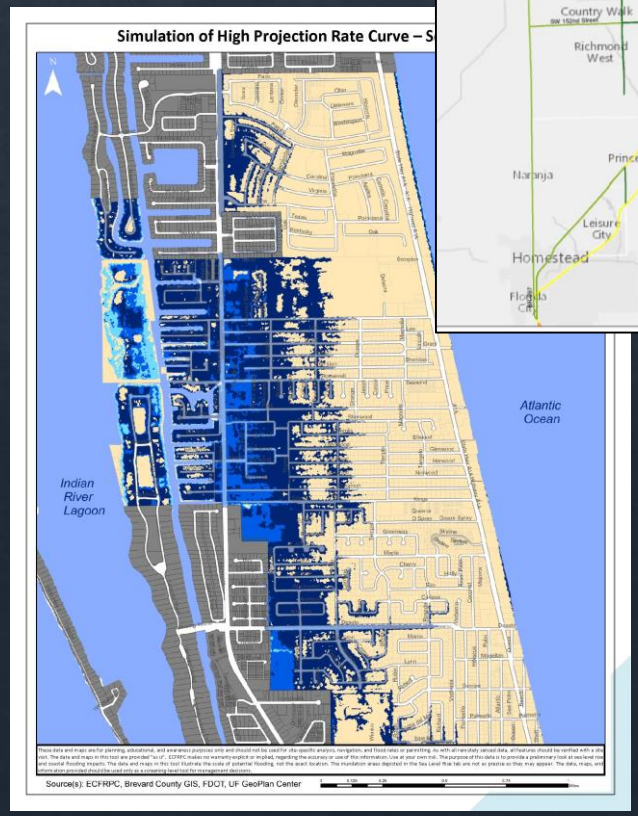
Testing data and tools and understanding full scope of data needs. Feedback!

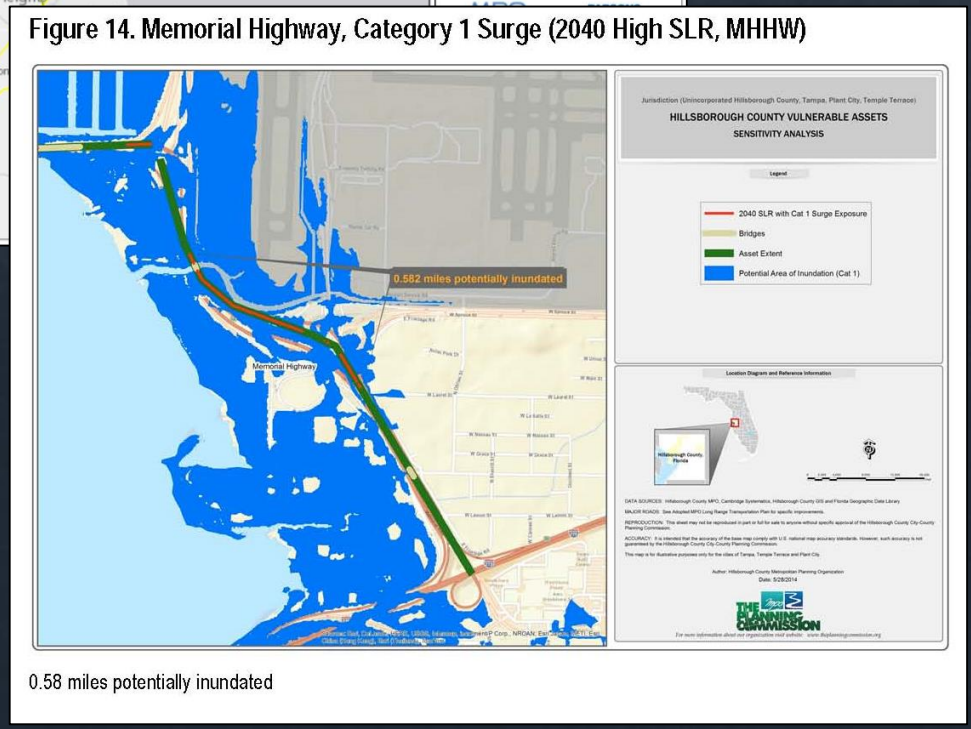
South Florida Climate Change Vulnerability Assessment and Adaptation Pilot Project

Hillsborough MPO Pilot Project

City of Satellite Beach, ECFRPC







Sketch Planning Tool
What's coming in Spring 2020

NOAA 2017 PROJECTIONS

UPDATED DATA

LOCAL ROADWAYS

TRAINING WORKSHOPS

FEEDBACK

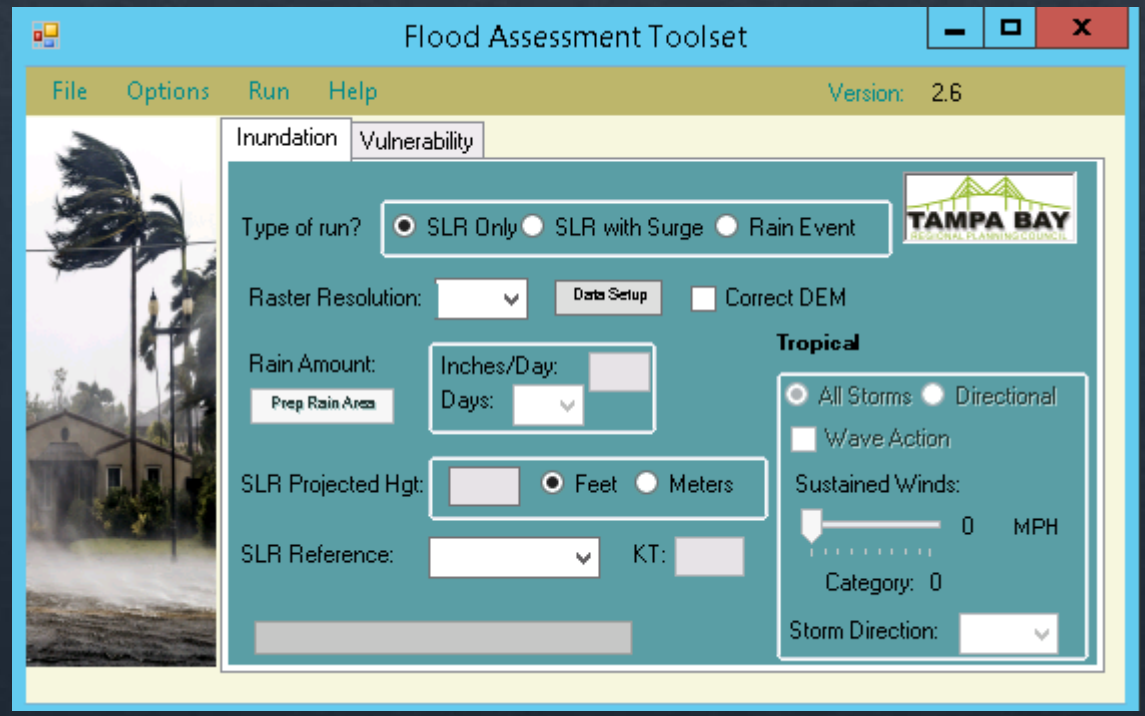
Flood Assessment Tool: Storm Surge, SLR & Precipitation

Tampa Bay Regional Planning Council

- Originally created to standardize methods for regional hurricane evacuation studies
- Now includes SLR, Surge + SLR, rain event

Working with Hillsborough MPO on 2nd FHWA Climate Resilience Pilot

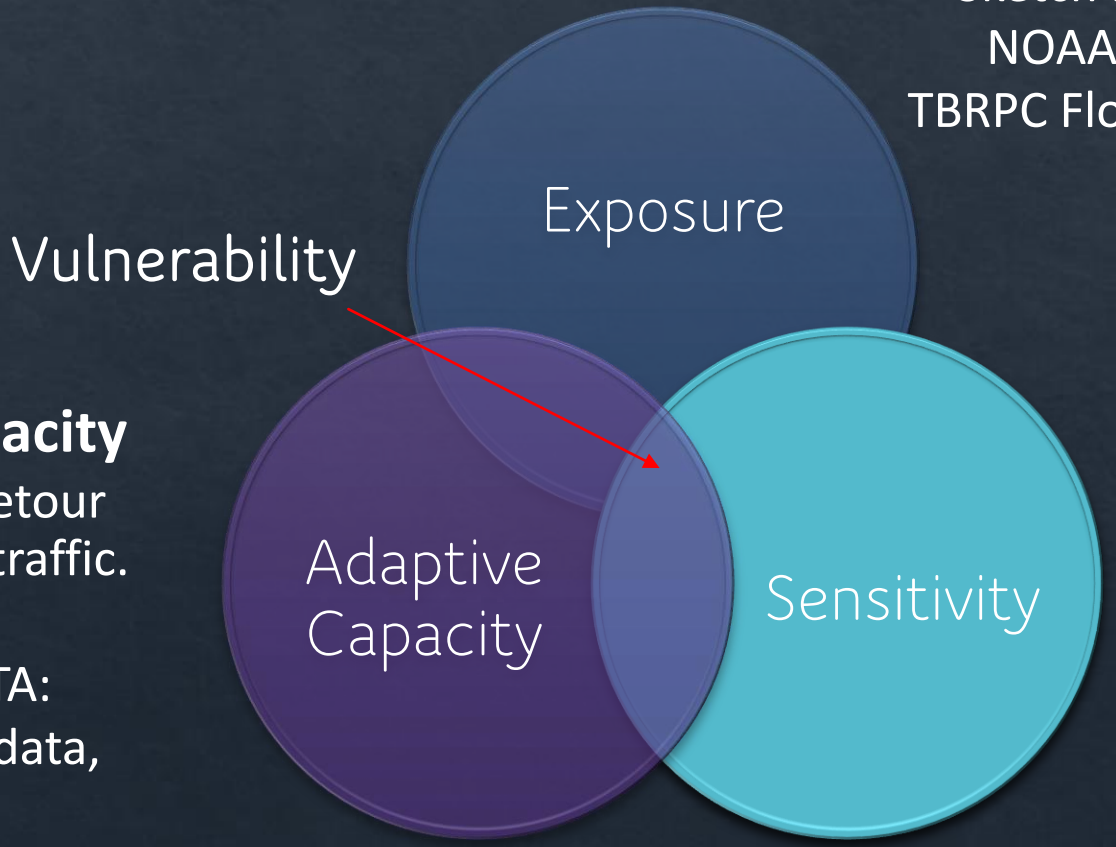
- Regional level vulnerability assessment of transportation to flooding in Tampa Bay region. Collab w/ Pinellas and Pasco County MPOs.
- Coordinate w/ FDOT and local hazard mitigation planners to integrate results into regional and county LRTPs, and county & statewide HMPs



Measuring vulnerability

Exposure
Ex: Storm surge, SLR

LOTS OF TOOLS & DATA:
Sketch Planning Tool
NOAA SLR Viewer
TBRPC Flood Assessment Tool



Adaptive Capacity
Ex: Length of detour route, avg daily traffic.

TOOLS & DATA:
Detailed asset data, indicators

Sensitivity
Ex: Asset-level information: asset conditions, bridge scour rating, substructure

TOOLS & DATA:
FHWA Sensitivity Matrix
Asset level data, Indicators

Challenges and Lessons Learned

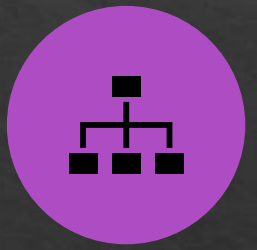
- Lots of good data and tools out there, but learning how to use is time consuming
- Standardized frameworks, methods, and tools allow for consistent vulnerability assessments to be replicated over time and geographic space
- Invest time upfront to define objectives and data needs
- Integrating different data formats, scales, and purposes is challenging
- Things change and so should assessments

Needs & Looking Ahead

Information hubs for sharing FL specific data, analyses, tools, best practices

More training and technical assistance (climate extension model and regional collaboratives)

More data and tools for addressing sensitivity and adaptive capacity

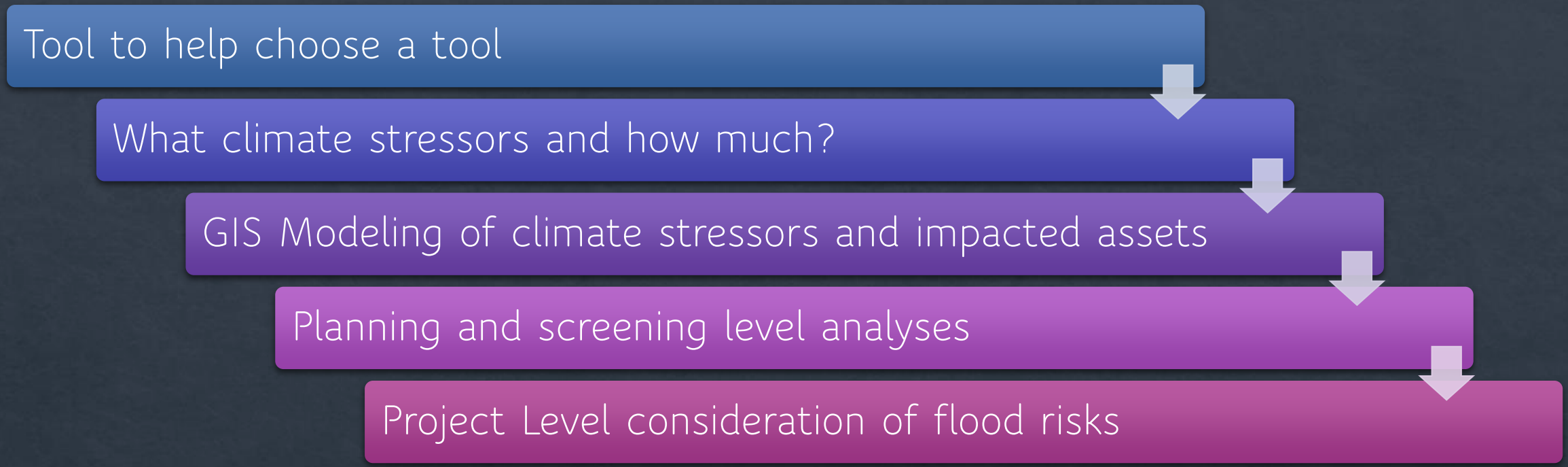


Modeling frameworks that are iterative

Scenario modeling to account complexity, interactions, behavior, and surprise

And thank you!

Crystal Goodison
goody@geoplan.ufl.edu



Different Tools for Different Scales and Phases of Assessment Process

Data & Tools on Other Climate Stressors

Nuisance or High Tide Flooding

- NOAA - https://coast.noaa.gov/slrdata/
- Critical for understanding short and mid-term flood impacts.

Temperature & Precipitation

- **CMIP Climate Data Processing Tool (USDOT)** calculates detailed temperature and precipitation variables from raw climate model data. Designed for transportation practitioners.

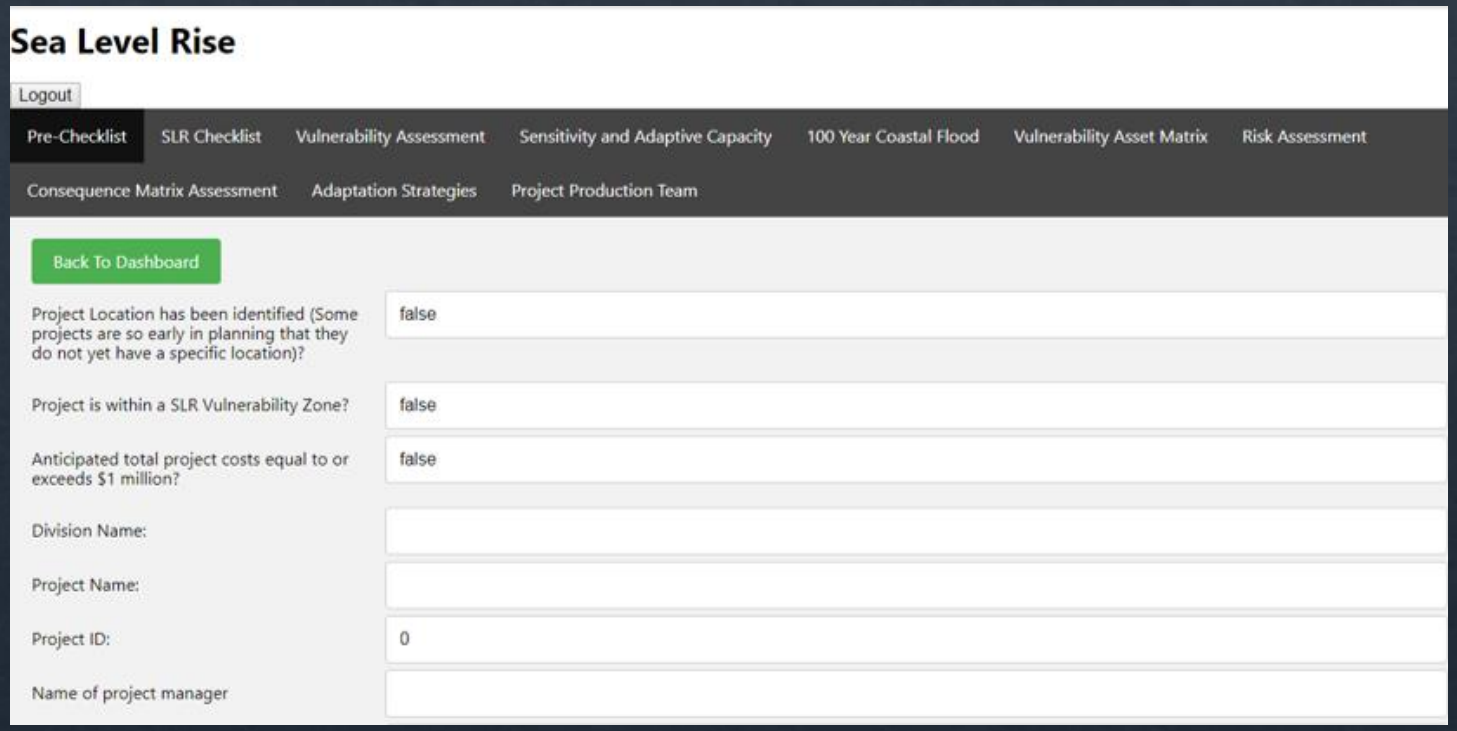
Resource & Asset Data

Type of Data	Source
Transportation Assets and Attributes	FDOT, County, FGDL
Population: densities, socially and economically vulnerable	Census, FGDL
Parcels and property values, building footprints	FL Dept of Revenue, County Property Appraisers, FGDL
Critical Facilities	FL Division of Emergency Management, County, FGDL
Environmental Resources	FDEP, FWC, USFWS, FGDL
Cultural & historic resources	FL Bureau of Arch Resources, FGDL

Project Level Tools

For integrating flood exposure on project by project basis

- Pinellas County –SLR Capital Planning Tool- Online tool
- Northeast Regional Council Infrastructure Resilience Planning Checklist PDF



Facilitated Discussion

Resilience Priorities Initial Takeaways

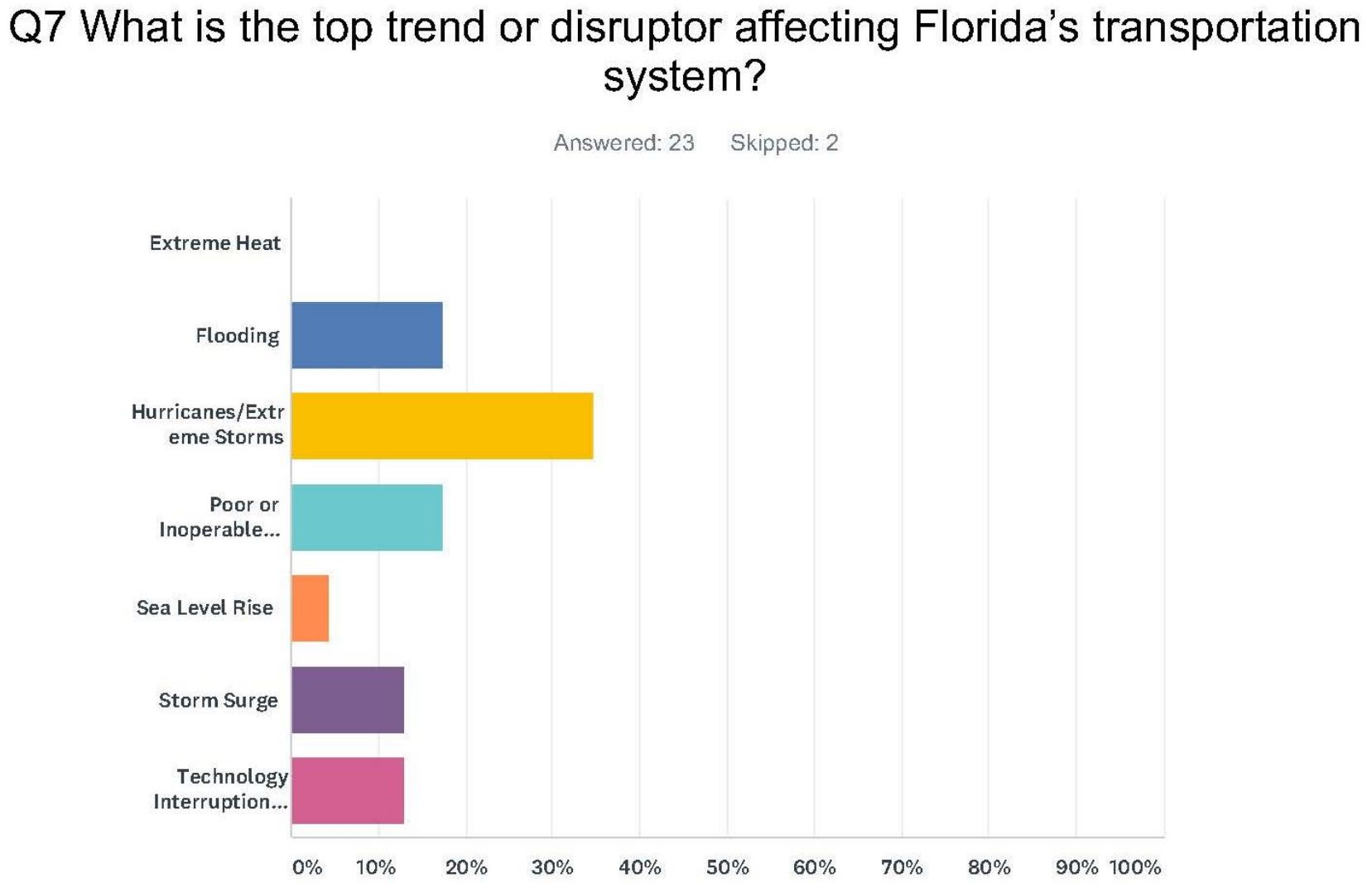
- Develop **consistent statewide transportation planning** practices that incorporate resilience
- Establish a **statewide framework** for collaboration to achieve transportation resilience
- Minimize the impact to **mobility** before, during, and after a disaster
- Develop and implement **policies, tools, guidance, and design standards** that reduce risk
- Integrate resilience **data** into transportation planning and design

Discussion Questions

- What do you see as the biggest VULNERABILITIES in Florida transportation?
- What RESOURCES do we need to improve the resilience of our local, regional and state transportation systems?
- In what ways do you think TECHNOLOGY will improve the resilience of our transportation network?

Activity 2: Identify Resilience Strategies

Activity 2


Q7 What is the top trend or disruptor affecting Florida's transportation system?
Answered: 23 Skipped: 2
Extreme Heat
Flooding
Hurricanes/Extreme Storms
Poor or Inoperable...
Sea Level Rise
Storm Surge
Technology Interruption...
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Day 1 Wrap Up

WRAP UP DAY 1

- Questions and comments
- See you tomorrow at 8:30 am

Resilience Subcommittee Meeting – Day 2

Welcome and Introductions

Local and Regional Initiatives in Southeast Florida

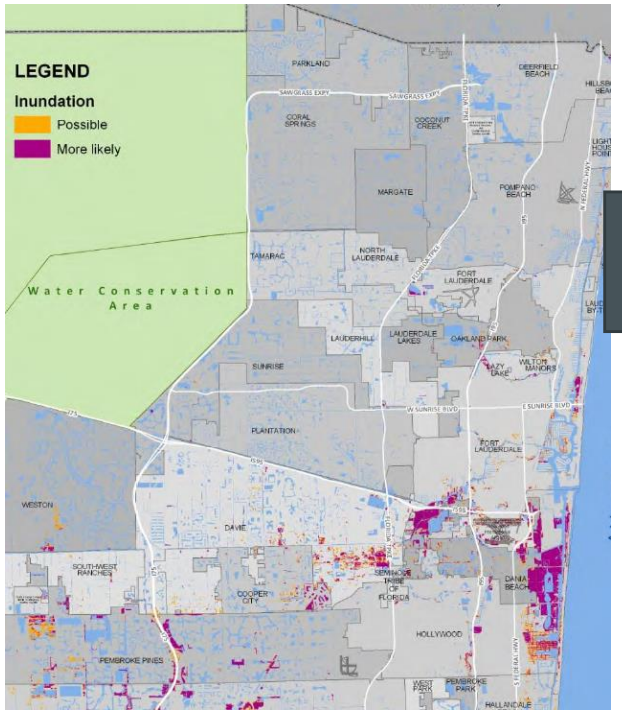
Broward Resilience

Dr. Jennifer Jurado

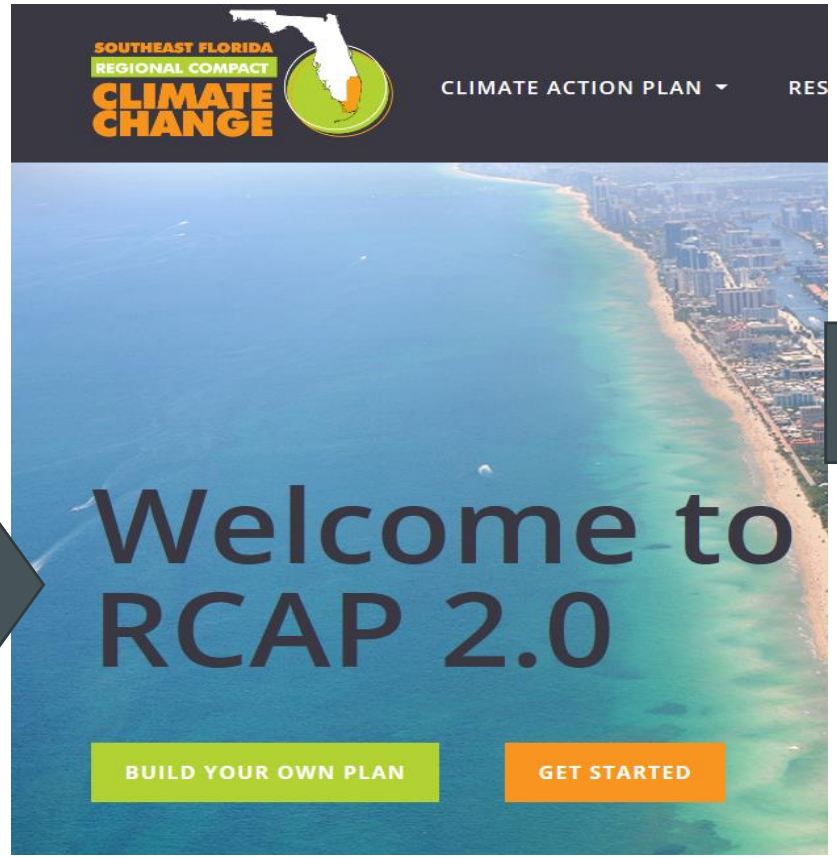
Broward County Environmental Planning and Resilience Division

SOUTHEAST FLORIDA REGIONAL COMPACT CLIMATE CHANGE

Sea Level Rise Vulnerability Assessment (2012)



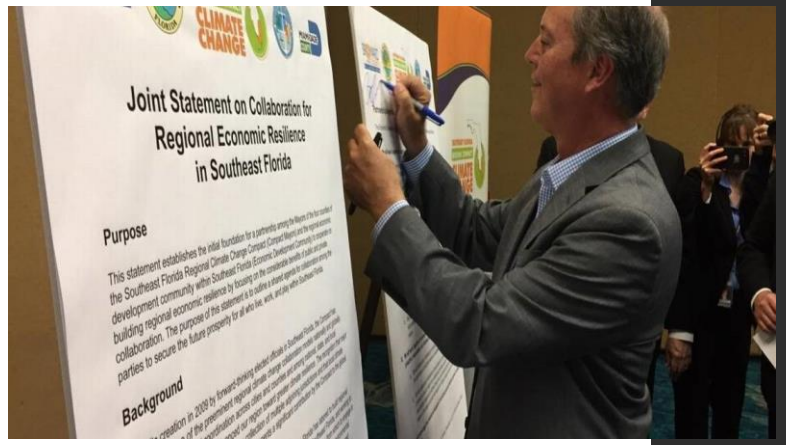
Vulnerable City Roads and Infrastructure (2014)



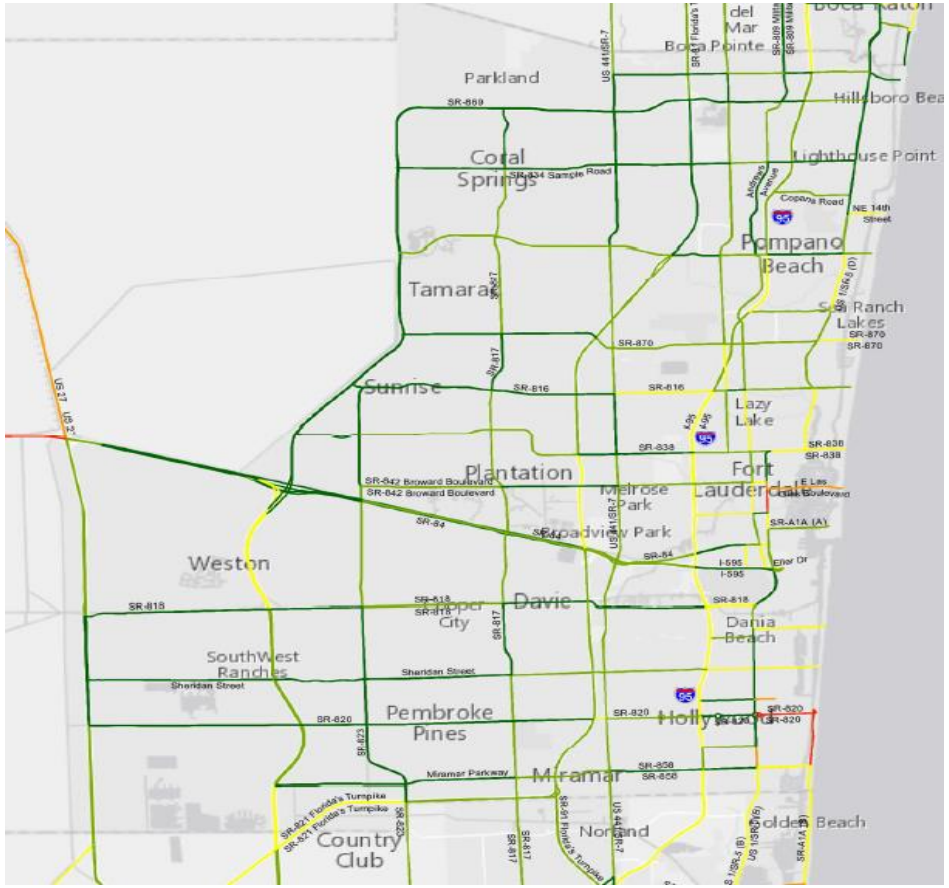
Sustainable Communities and Transportation (23 actions)

Energy and Fuel (12 actions)

Regional Economic Resilience



Risks to Transportation Network

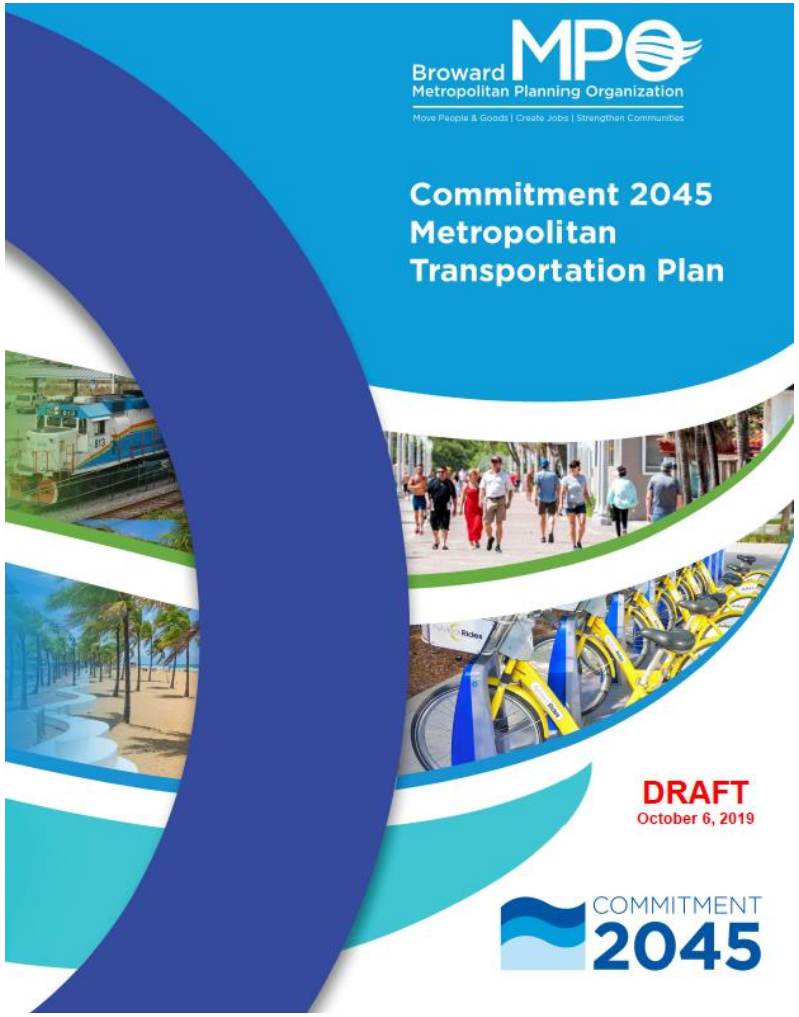


Broward MPO

VULNERABILITY

- Tier 1 – Highest vulnerability
- Tier 2 – High vulnerability
- Tier 3 – Moderate vulnerability
- Tier 4 – Low vulnerability
- Tier 5 – Lowest vulnerability

- 2015 Climate Vulnerability Assessment
  - Surge, sea level rise, 100 yr rainfall
  - HAZUS-US (SLOSH)
- 2045 Long Range Transportation Plan
  - Resiliency Scenario: ***prohibit*** future investment in vulnerable roads
  - ***Prioritize*** projects that improve resilience regardless of vulnerability

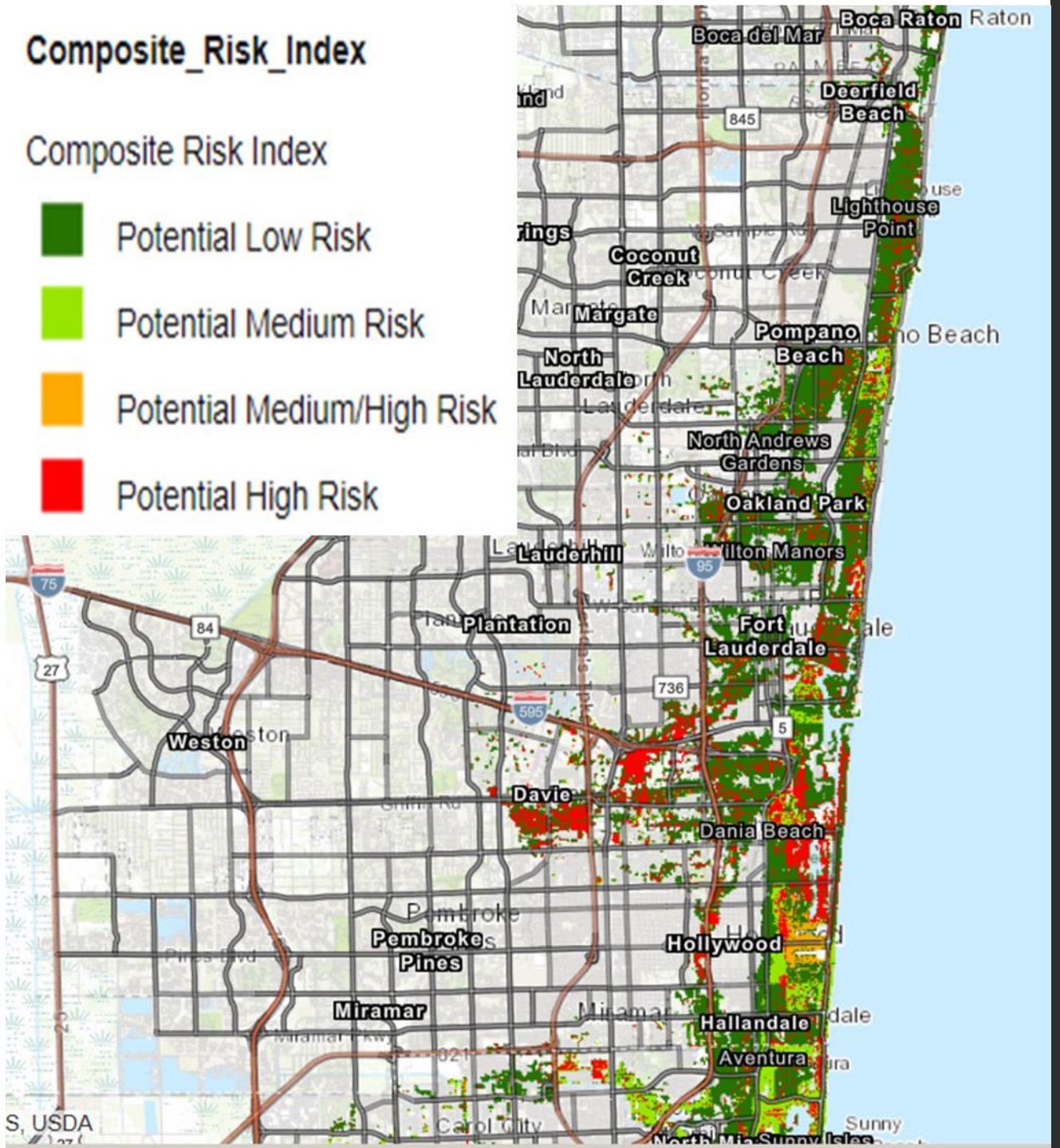


Broward MPO

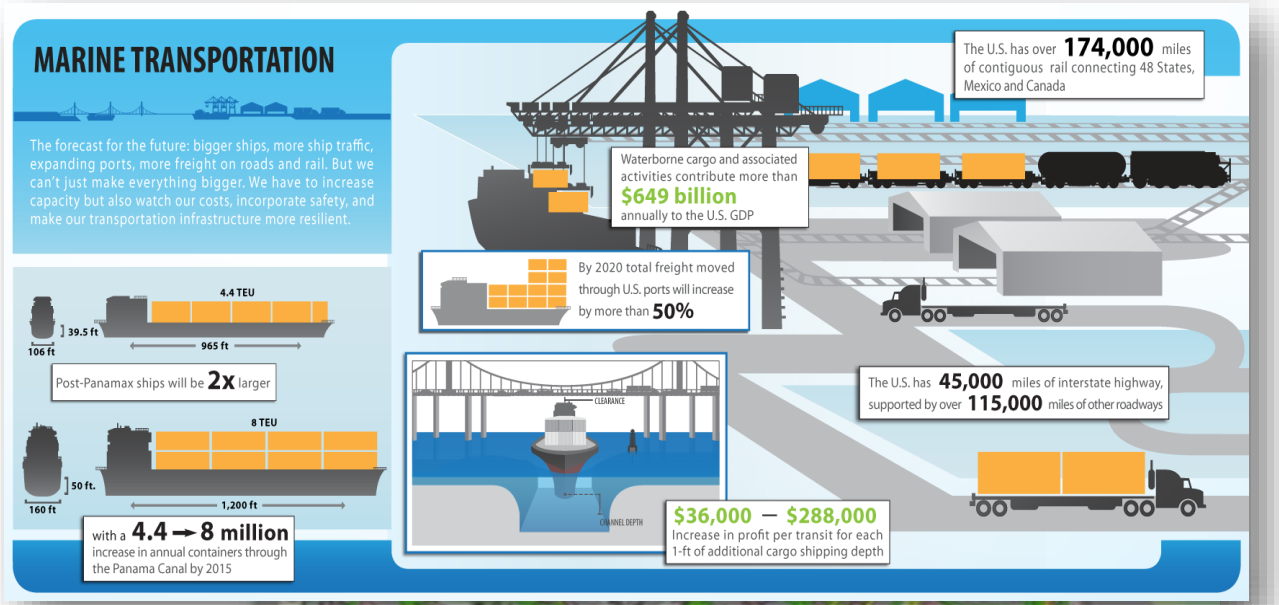
- **2045 Long Range Transportation Plan**
  - Resiliency Scenario: ***prohibit*** future investment in vulnerable roads
  - ***Prioritize*** projects that improve resilience regardless of vulnerability
- **2045 Roadway Plan** (Resilience Studies, 2026-2030, **$11M Total**)
  - #20 SRA1A, Arizona St to Hallandale Blvd, $1.5M
  - #21 Hollywood Blvd, US-1 to SRA1A, $1.5M
  - #22 US-1/SR-5, Las Olas Blvd to Davie Blvd, $1.5M
  - #23 Las Olas, $1.5M
  - #24-25 US-1, $1.75M
  - #26 Hallandale Beach Blvd, $1.5M
  - #28 Johnson St, $750k (non state)

USACE South Atlantic Coastal Study

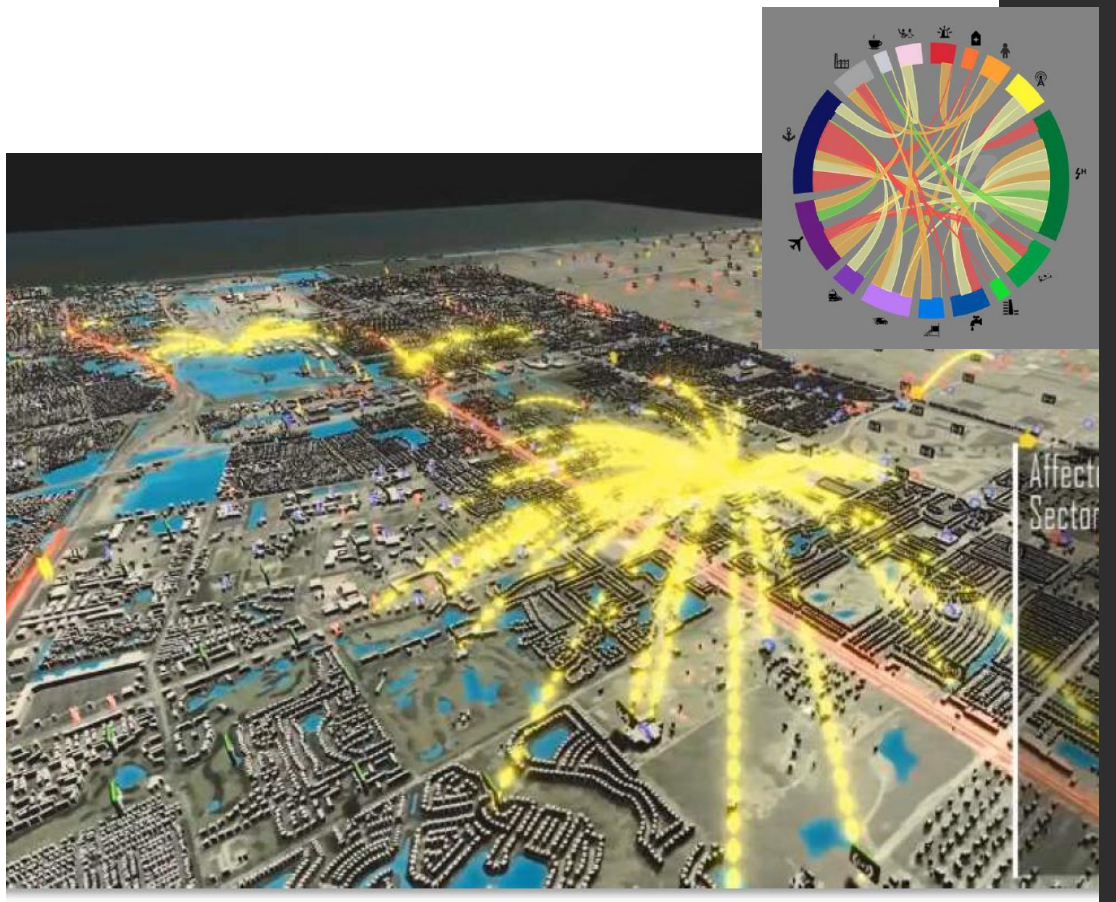
- Exposure Index based on Population and Infrastructure (60%), Environment (30%), Social (10%)
- Pending request for Southeast Florida to be Focus Area
- Opportunity to submit mitigation measures for future studies/ appropriations
- Mitigation includes elevation, drainage improvements, levees, surge barriers, living shorelines



Cascading Impacts



Surge impacts to Port transportation network (NOAA grant, FAU-Seatech)



Impacts from future rainfall on interdependent sectors (Deltares)

Regional Tidal Flood Monitoring

- 2017 Hurricane Irma: 3.9’ NAVD
- 2005 Hurricane Wilma: 2.8’ NAVD
- **2019 Hurricane Dorian: 2.5’ NAVD**
- 2019 King Tide: 1.9’ NAVD*
- 2018 King Tide: 1.8’ NAVD*
- 2017 King Tide: 2.2’ NAVD
- 2016 King Tide: 1.8’ NAVD
- 2015 King Tide: 1.8’ NAVD

*Data from South Port Everglades NOAA gauge; Others from Virginia Key, Miami


2018

2018


2017

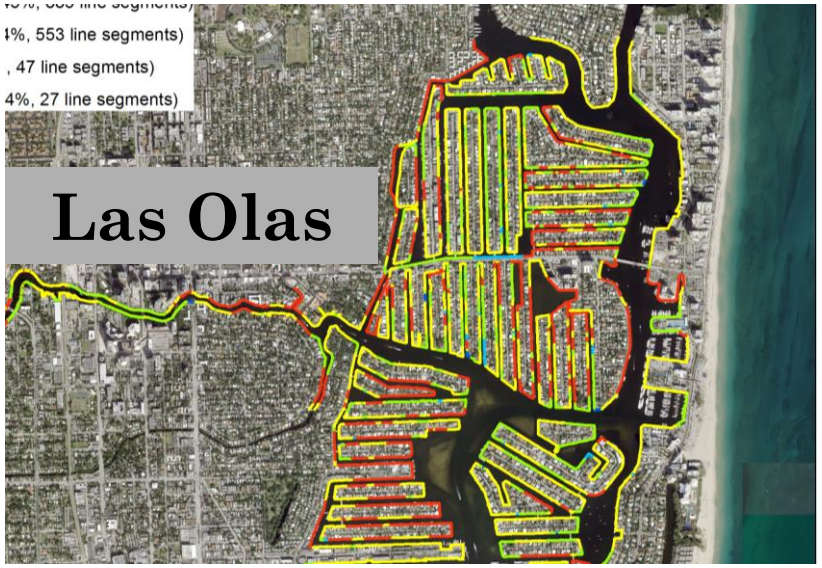
SRA1A, Hollywood

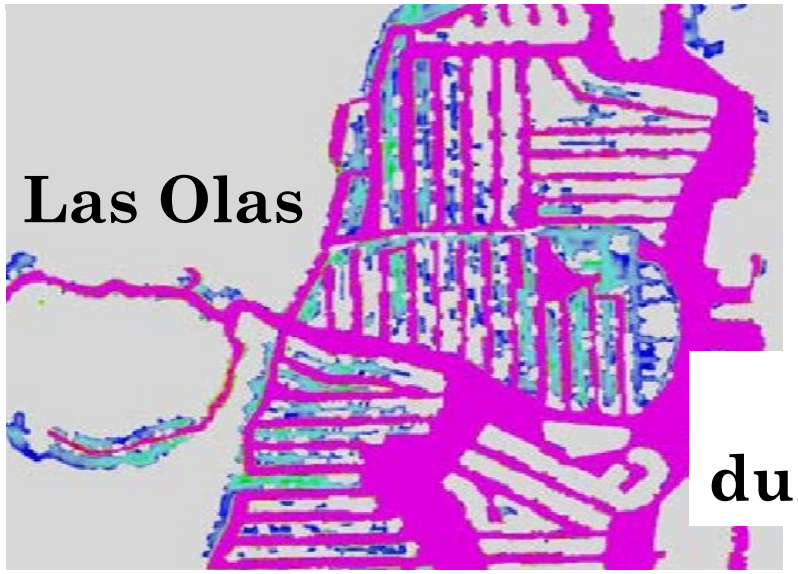
Backflow- Seepage-
Overtopping- Structure Failure

USACE Future Flood Risk Assessment

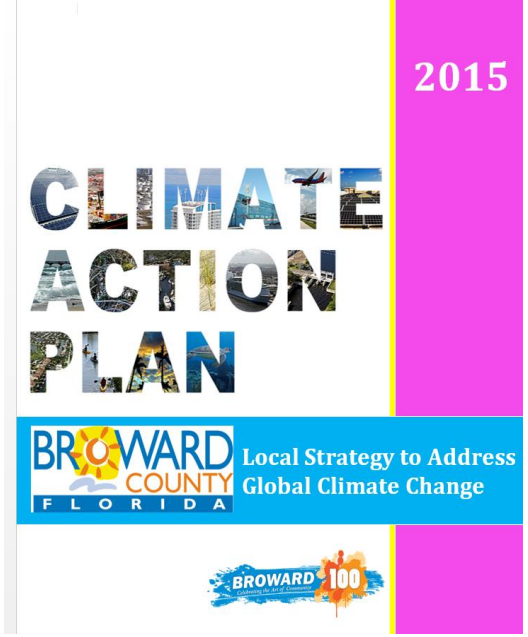
- Identified vulnerable shorelines
- Hydrodynamic modeling of king tides and surge today and in 2070
- Fort Lauderdale and Hollywood
- Testing of adaptation strategies

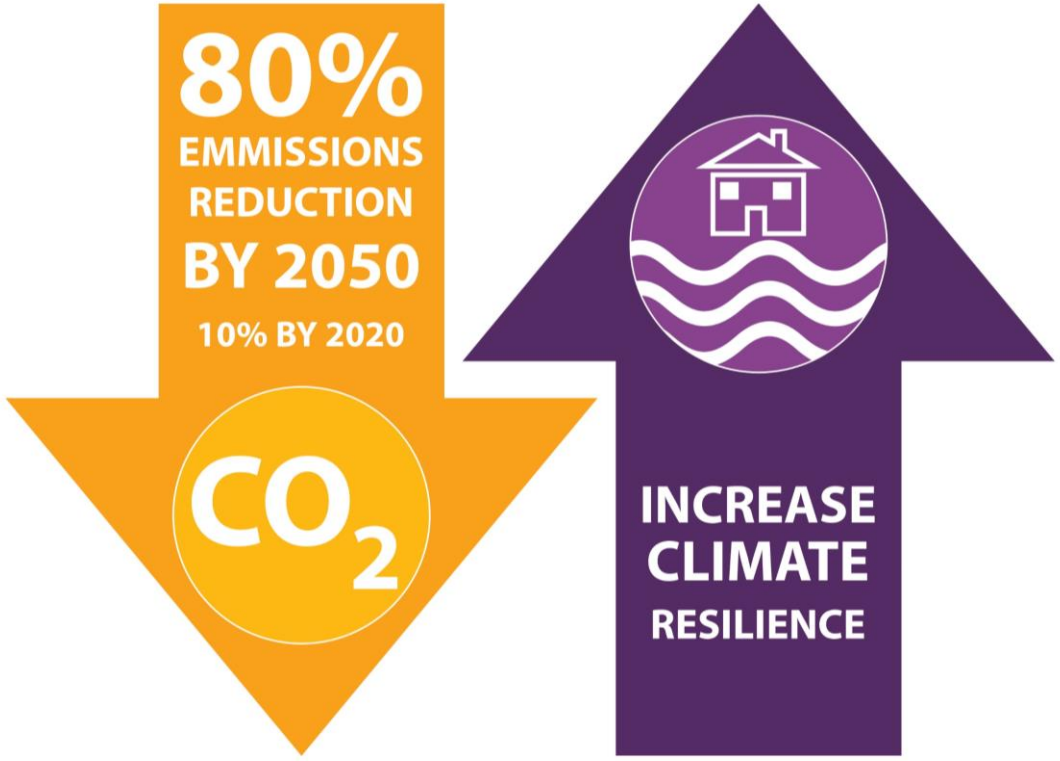
Vulnerable Shorelines





Overtopping during King Tide 2060





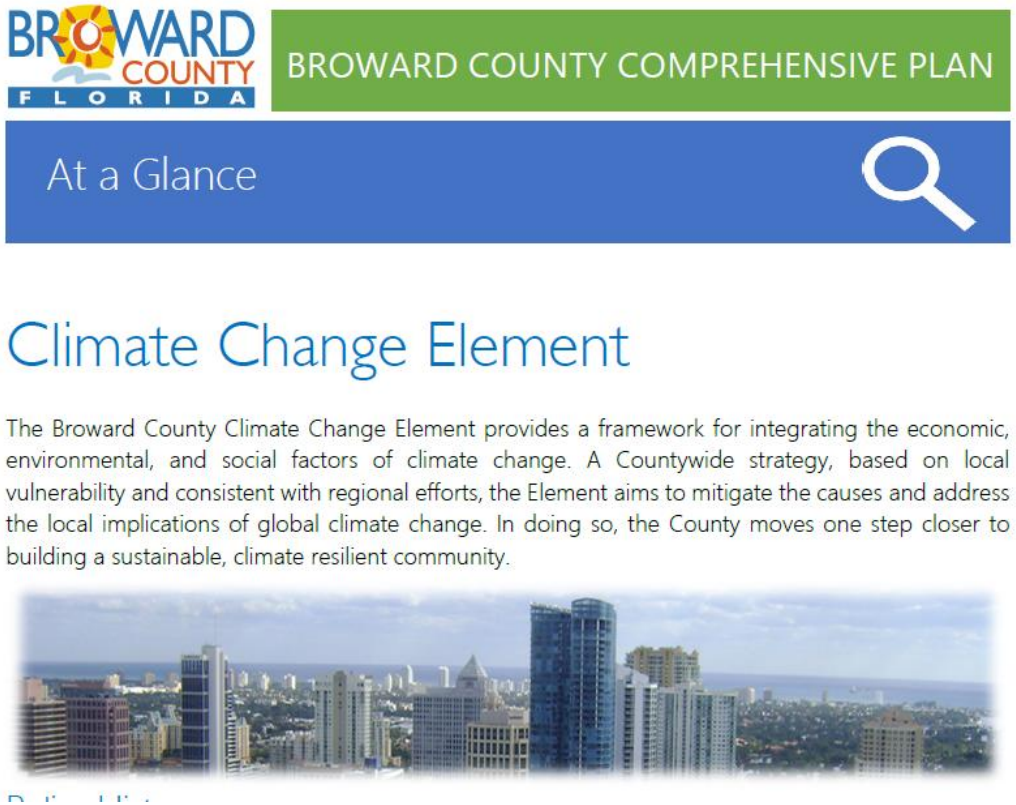
Broward Climate Action Plan

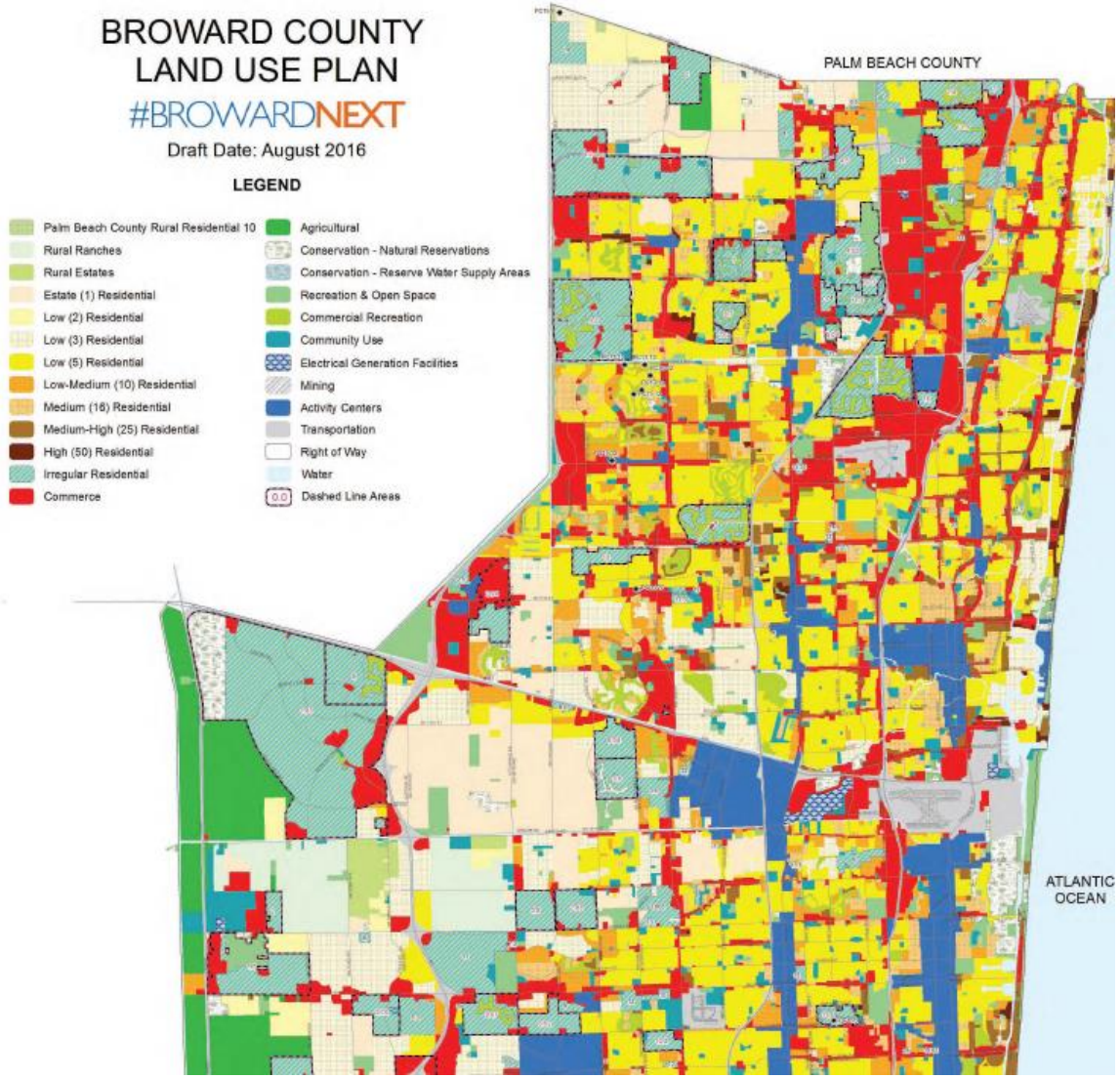
- Action #2 Contribute to climate planning efforts for transportation
- 96 actions total, 52 relevant to transportation

Resilient Planning

Comprehensive Plan

- Partner to ensure adaptation is incorporated into planning, siting, construction, replacement and maintenance
- Assess infrastructure vulnerability
- Address resilience and survivability of infrastructure to sea level rise and storms
- Advance transportation choices that reduce GHGs





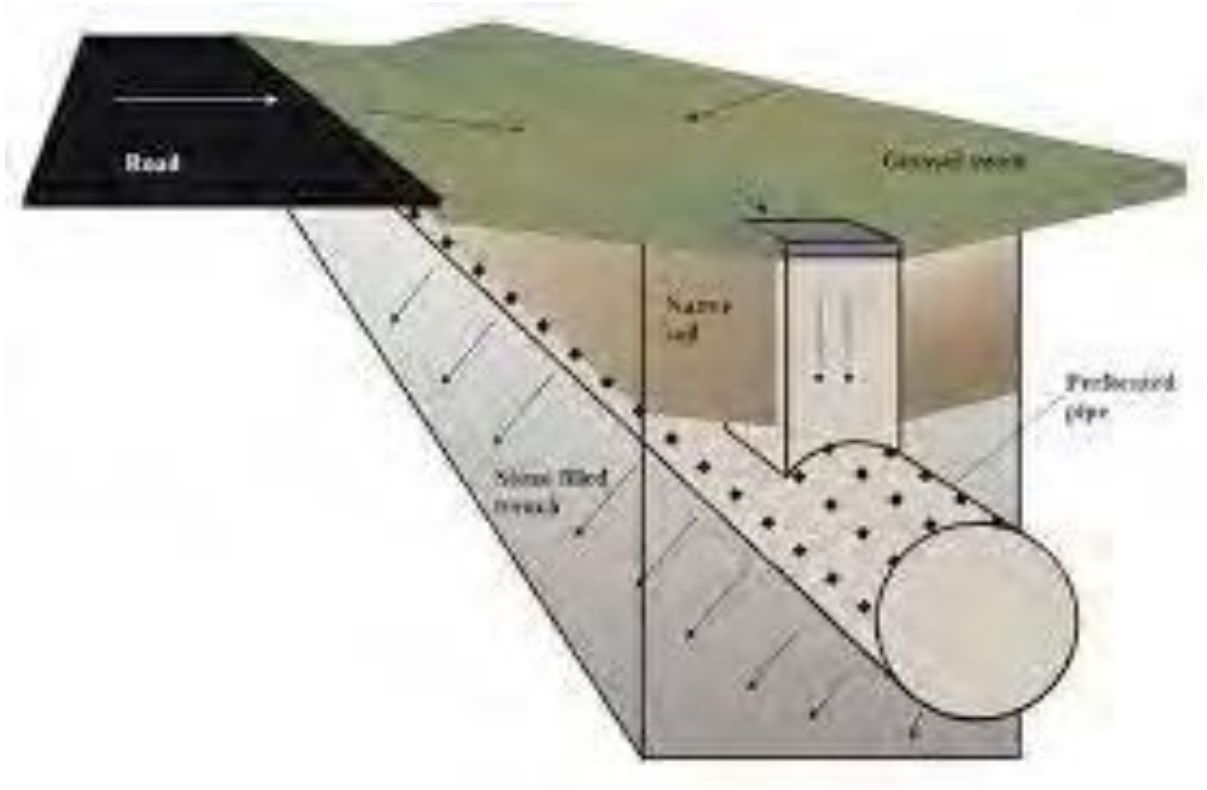
Resilient Redevelopment

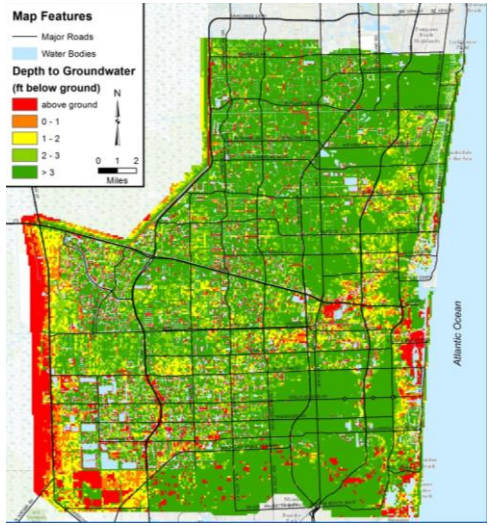
Land Use Plan

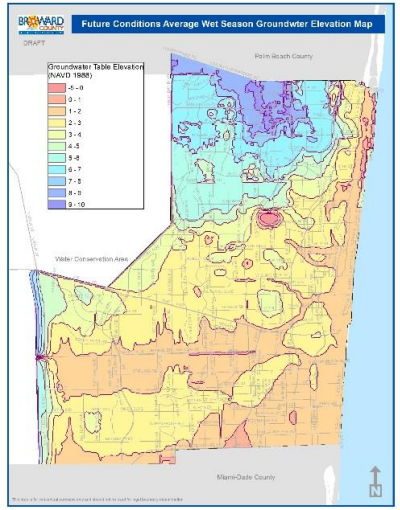
- Priority Planning Areas Map
  - Trigger for additional resiliency criteria, 2 feet of sea level rise
- Adaptation Action Area Designation
  - Prioritize for funding and adaptation
- Resilience Criteria for Land Use Densification Application
  - Consider flood risk, life of infrastructure and projections
  - Require city commitment of maintaining access and functionality
  - Resilience of issued permits
- Tidal Flood Barrier Resilience Standard
  - Minimum elevation of 5 feet NAVD by 2050
  - 71-87% of seawalls will need to be raised more than 2 feet.

Future Conditions Ordinance

- Requires use of future groundwater table elevations map for surface water drainage systems when major redevelopment occurs
- Best practice to apply to state road drainage projects**

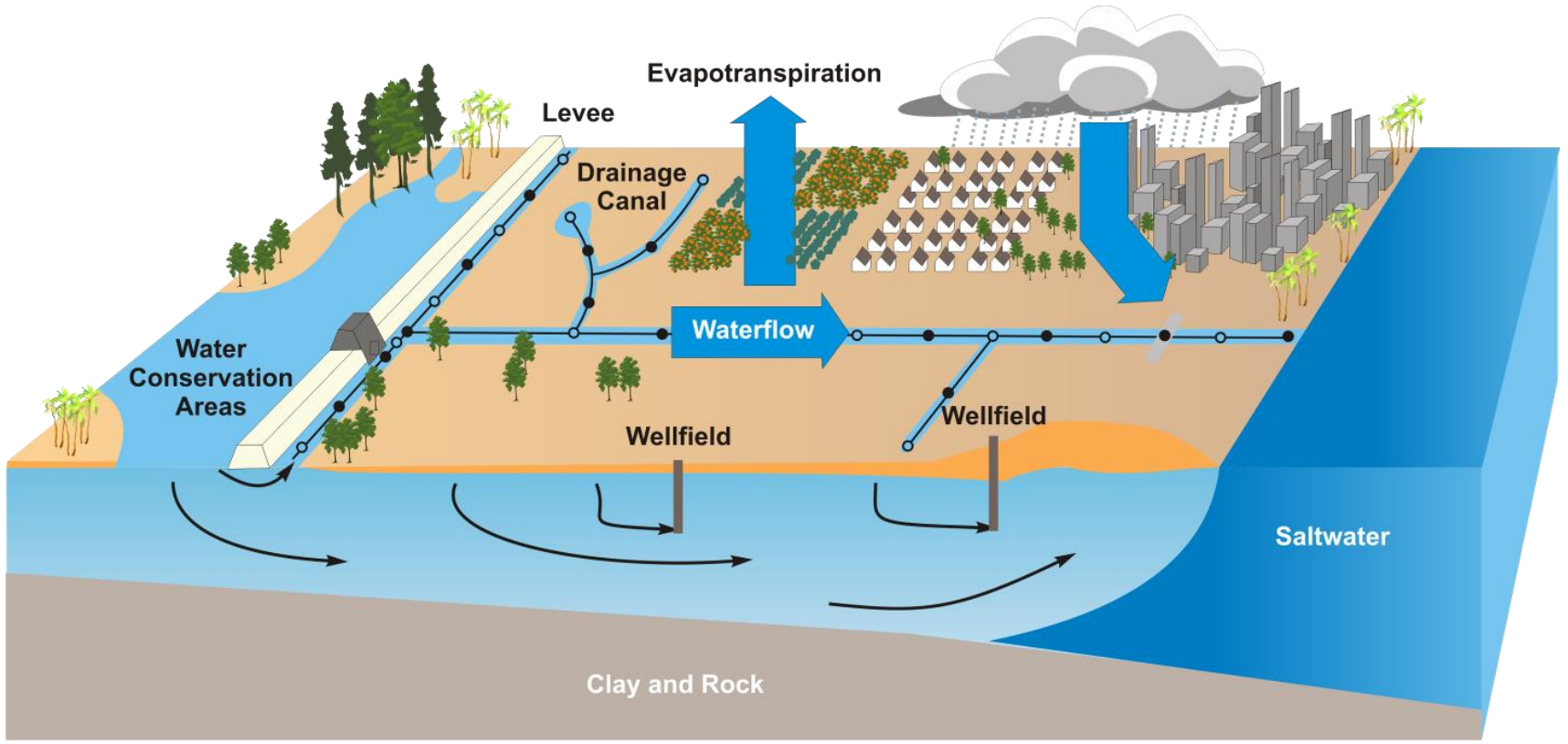






100 Year Community Flood Map

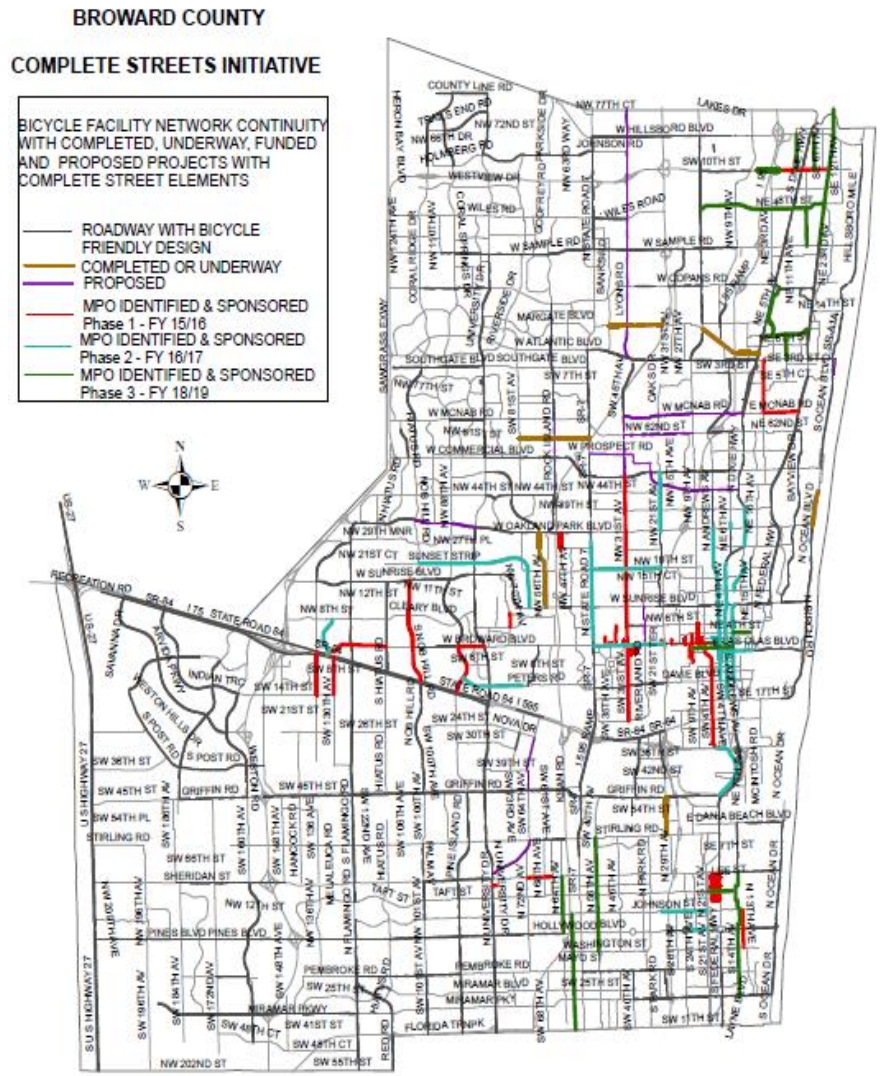
- Future IDF Rainfall Curves
- 100 Year Flood Modeling for Future Conditions
- Sets finished floor elevation if higher than FEMA FIRM
- Projects future development elevations for consideration in top of road evaluations**



Must Upgrade Flood Control System

Complete Streets Program

- Interagency staff team reviewing projects for optimized multimodal use, safety and potential for improvements to drainage, landscaping, lighting and asset quality
- Useful model for organizational coordination between FDOT, MPO, County and Cities
- Reviews and comments on project plan and priorities



uroe: Broward County Highway Construction and Engineering
OWARD MPO 8/13/13

Emissions reduction strategy

- County committed to Under2MOU to reduce emissions by 80% by 2050
  - Zero Emissions Vehicle Challenge
    - Electrify fleet by 2030
    - Charger installations at County facilities
    - Electric buses and on site battery storage
  - Community EV Strategy
    - Projected need assessment across County
    - Rebates for Commercial/ Multifamily Charger Installations
    - Workplace Charging
    - EV Rentals at Airport

Points of Interest

- Recognize SRA1A, Hollywood as an urgent need in Broward
- Comprehensively review schedule and project list prioritization of vulnerable corridor replacement
- Define requirements for maintaining level of service
- Apply County resilience criteria in design and planning
- Continue support for tools like Sea Level Rise Sketch Planning Tool
- Include processing of LIDAR in scope to increase accessibility/ use
- Evaluate and upgrade existing pump infrastructure
- Advance mechanism for collaboration on adaptation of intersecting infrastructure
- Identify opportunities to collaborate on living shoreline demonstration projects (Hillsboro Mile, Old Griffin Road)

A1A, Hollywood Corridor

October 2017 King Tide Flooding with Wind

SOUTHEAST FLORIDA REGIONAL COMPACT CLIMATE CHANGE

BROWARD COUNTY FLORIDA

MIAMI-DADE COUNTY

PALM BEACH COUNTY FLORIDA

SoutheastFloridaClimateCompact.org

Implementation support to the Compact is provided by:

INSTITUTE FOR Sustainable Communities

With funding support from:

THE KRESGE FOUNDATION

THANK YOU

Dr. Jennifer Jurado

jjurado@Broward.org

954.519.1464

Meeting of Florida Transportation Plan Strategic Intermodal System Policy Plan Resilience Subcommittee

Fort Lauderdale October 30, 2019

Jim Murley, Chief Resilience Officer
Miami-Dade County
Office of Resilience

GEOGRAPHIC AREA*

2,431 square miles

2/3 protected land, local/national parks, waterways, urban development boundary

*United States Census

7.7 Million people ride Public buses + Metrorail **every month**

POPULATION*

2.7 million people

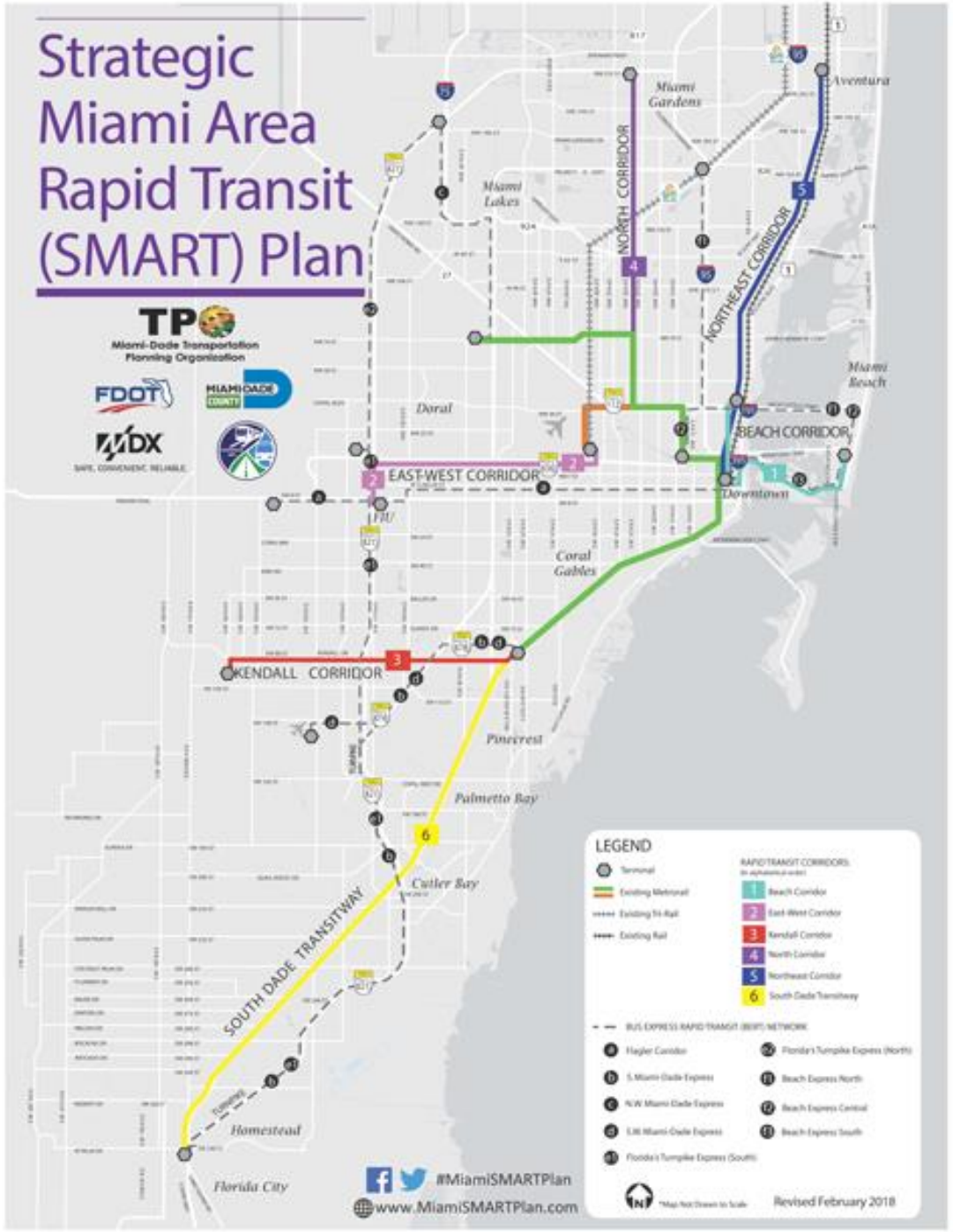
6th M-DC is the 6th most congested county in the Nation

33 minute average commute time

30 mins quicker than by car

62% of transit riders use buses


MIAMI-DADE
TRANSPORTATION PLANNING ORGANIZATION
2045
LONG
RANGE
TRANSPORTATION
PLAN



WHY IS THE SMART PLAN SO CRITICAL?

The SMART Plan includes rapid transit corridors and express bus routes to increase connectivity for approximately

77% of Miami-Dade County residents that travel outside their residential district for employment to other areas of the County.

SMART PLAN FACTS

1.7 MILLION RESIDENTS

More than half of the County's population live within 2-miles of SMART Plan Corridors.

855,000 JOBS

Are located within a 2-mile radius of SMART Plan Corridors.

Miami-Dade County SMART Plan South Corridor

The Goals of the 2045 LRTP Are:

1. Maximize Mobility Choices Systemwide

2. Increase the Safety of the Transportation System for All User

3. Increase the Security of the Transportation System for All Users

4. Support Economic Vitality

5. Protect and Preserve the Environment and Quality of Life and Promote Energy Conservation

6. Enhance the Integration & Connectivity of the System Across & Between Modes, For People and Freight

7. Optimize Sound Investment Strategies for System Improvement and Management/Operations

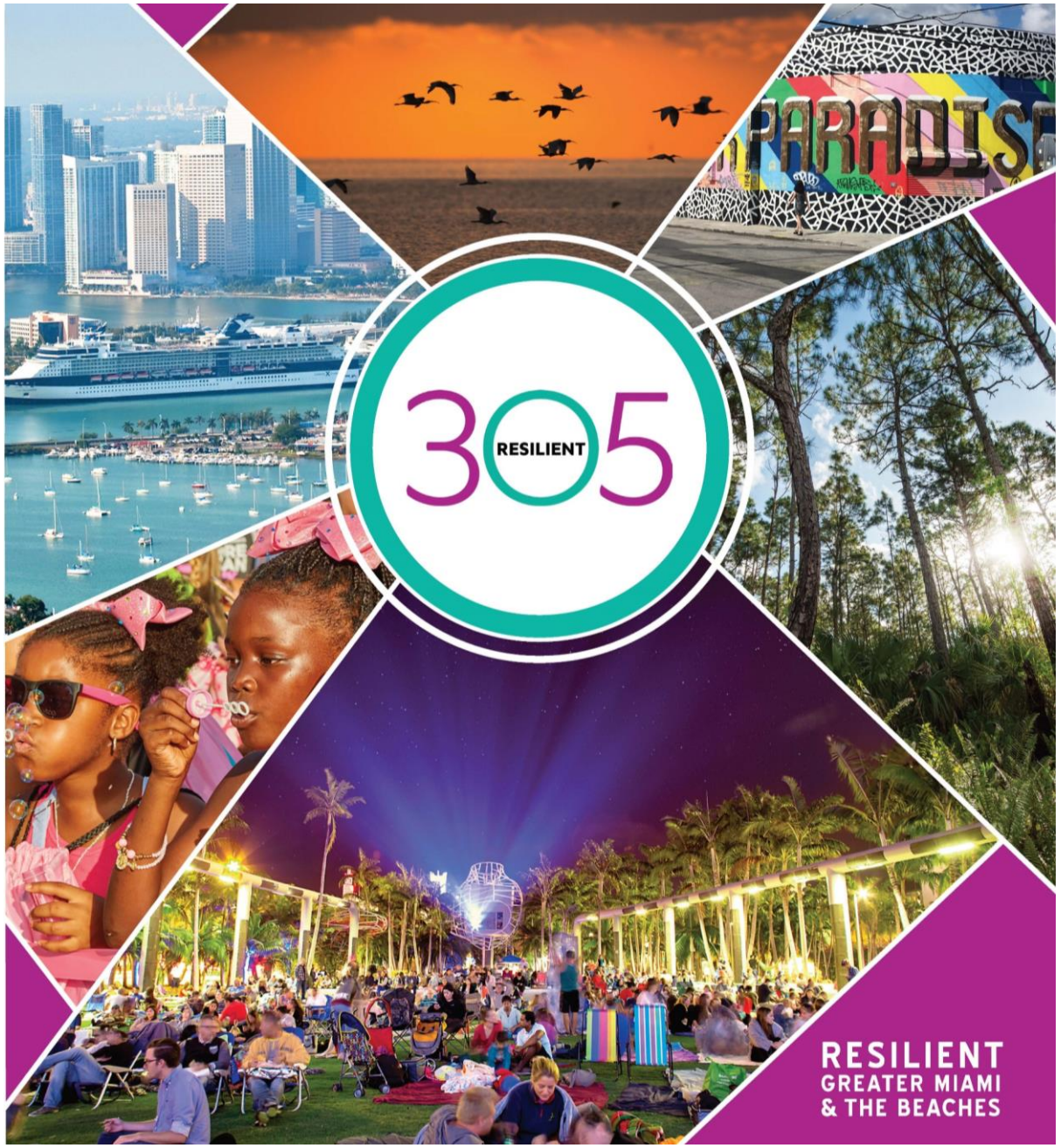
8. Improve and Preserve the Existing Transportation System

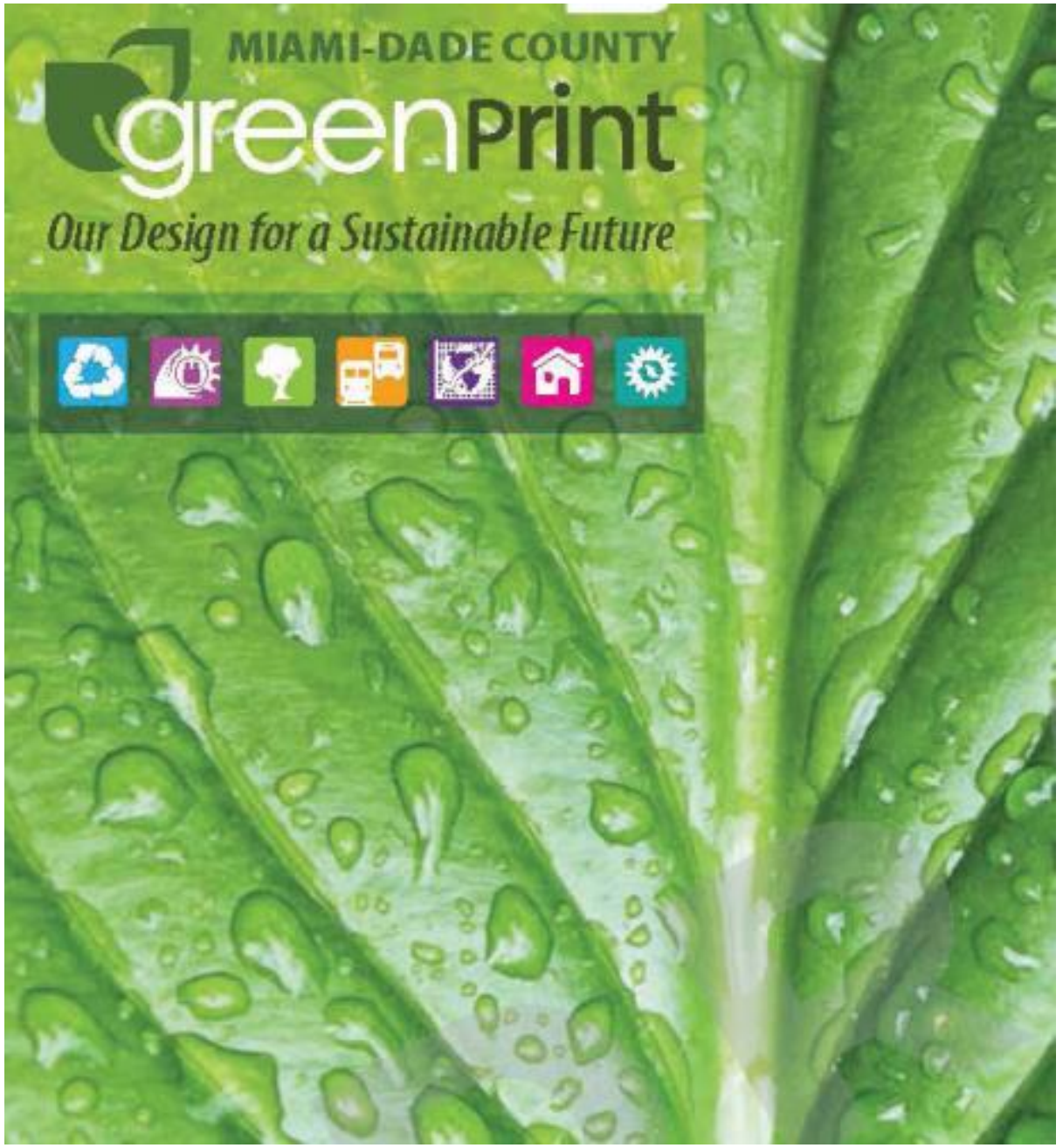
LAND USE SCENARIO & VISIONING PLANNING

Supports the implementation of the SMART Plan through:

1. Identification of land use policies for future transit-oriented development (TOD)

2. Understanding the interrelationship between transit alternatives and land use scenarios


305
RESILIENT
RESILIENT
GREATER MIAMI
& THE BEACHES


MIAMI-DADE COUNTY
greenPrint
Our Design for a Sustainable Future

SMART Plan Trails Program

THE UNDERLINE PHASE 1:
THE BRICKELL BACKYARD

MIAMI BEACH ATLANTIC GREENWAY
TRAIL BEACHWALK SECTION

KROME TRAIL INAUGURAL RIDE

Miami’s Underline – a 10 mile green space under the metro rail

SOUTH FLORIDA

CLIMATE CHANGE VULNERABILITY ASSESSMENT

Identify Assets of Interest

Regional Road Network

Tri-Rail Network

Calculate the Vulnerability Scores for Each Asset

Sensitivity

- Bridge condition index
  - Scour ratings (roads)
  - Substructure conditions rating (roads)

Exposure

- % of segment permanently inundated by SLR (1,2, & 3 ft.)
- Current flood exposure index (stormsurge and precipitation)
- Future potential flood exposure index (storm surge and precipitation)

Adaptive Capacity

- Average annual daily traffic (roads)
- Tri-Rail ridership on segment (rail)
- Detour length (roads)

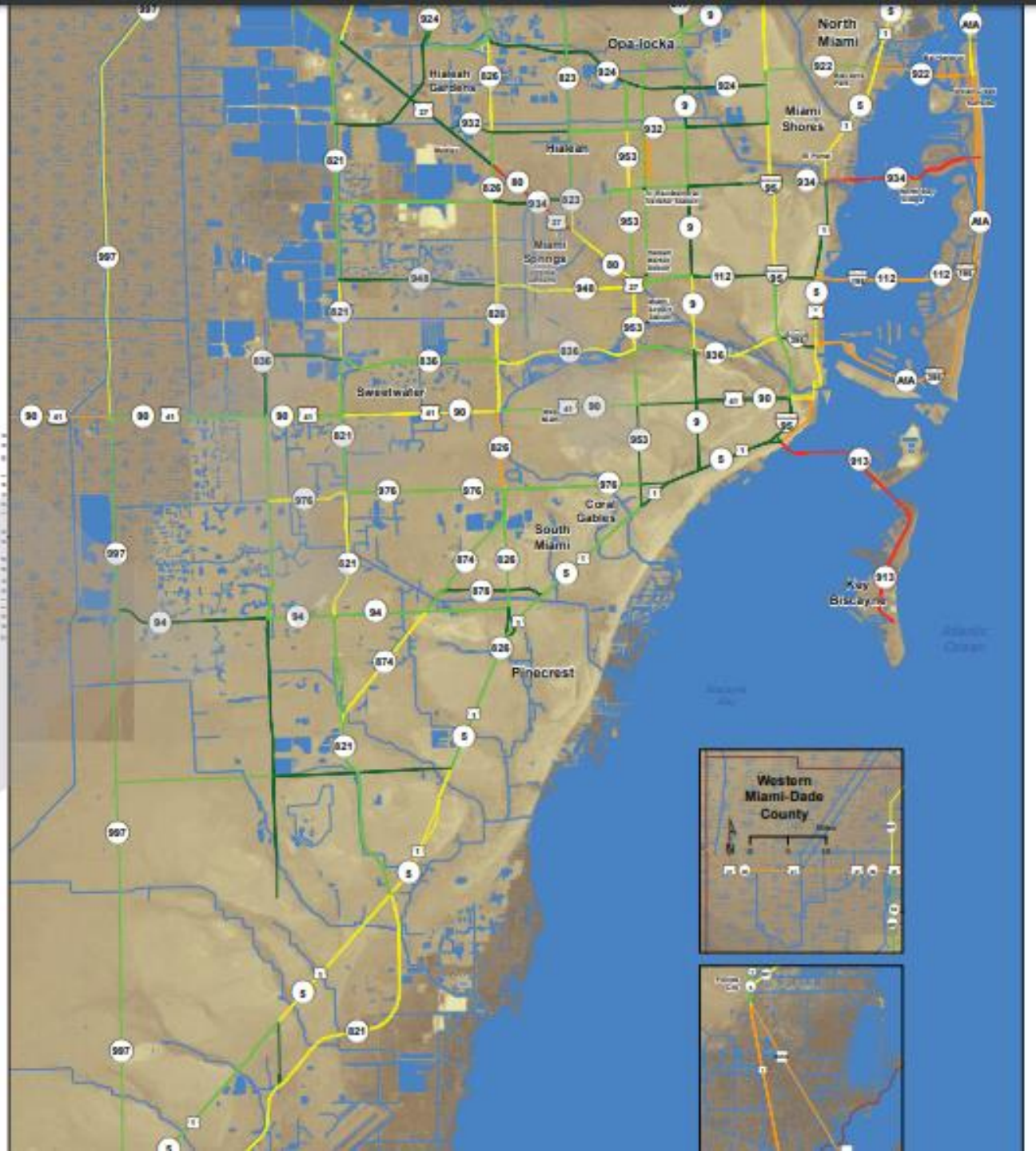
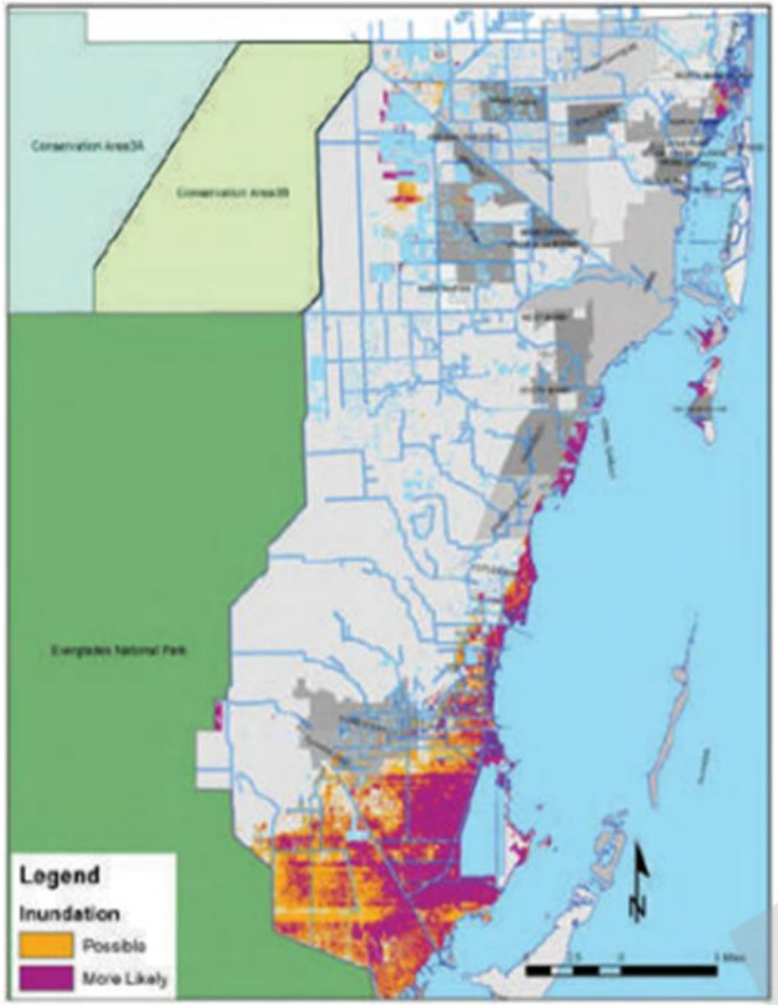
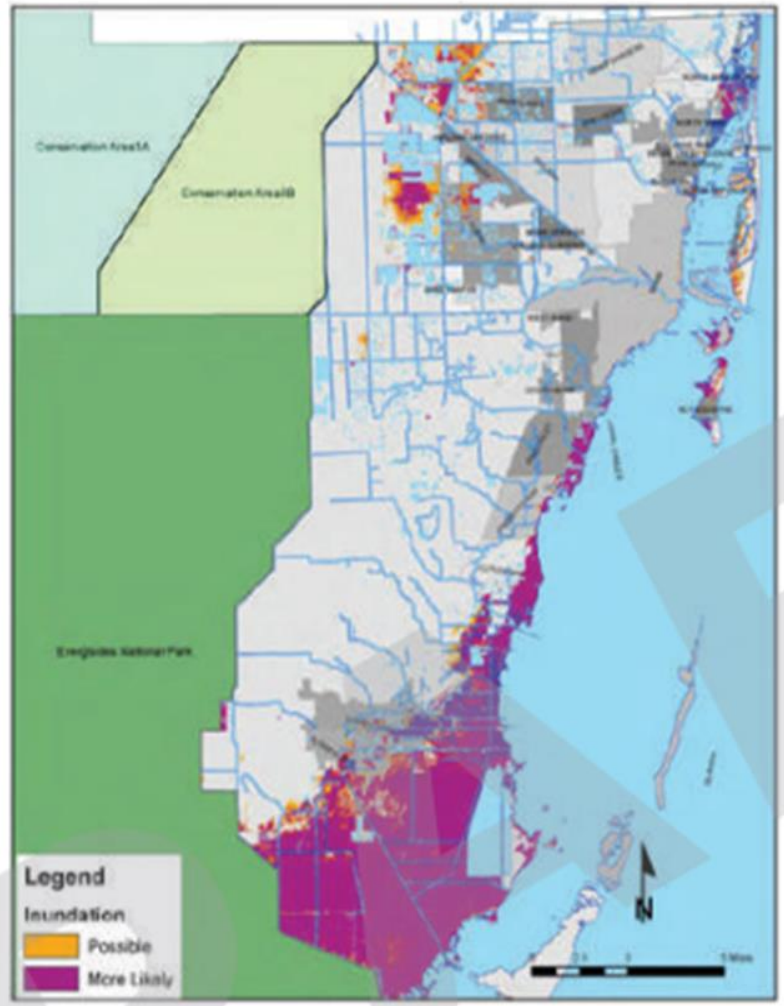


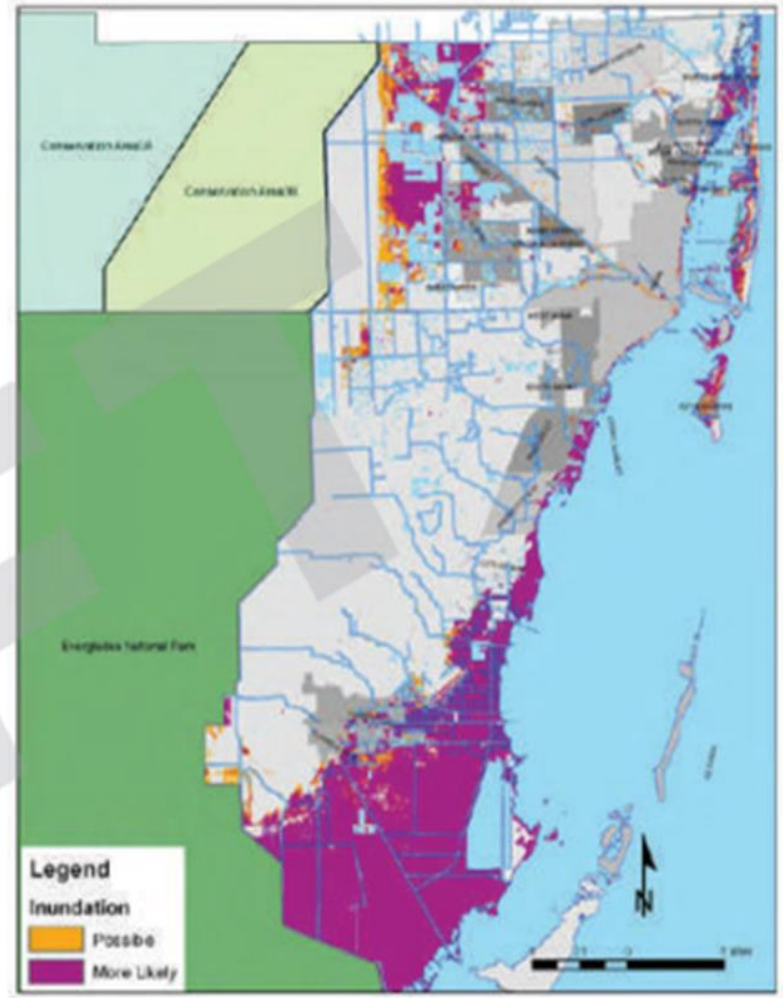
FIGURE 8-2: AREAS VULNERABLE TO SEA LEVEL RISE



1-foot Sea Level Rise in Miami-Dade



2-foot Sea Level Rise in Miami-Dade

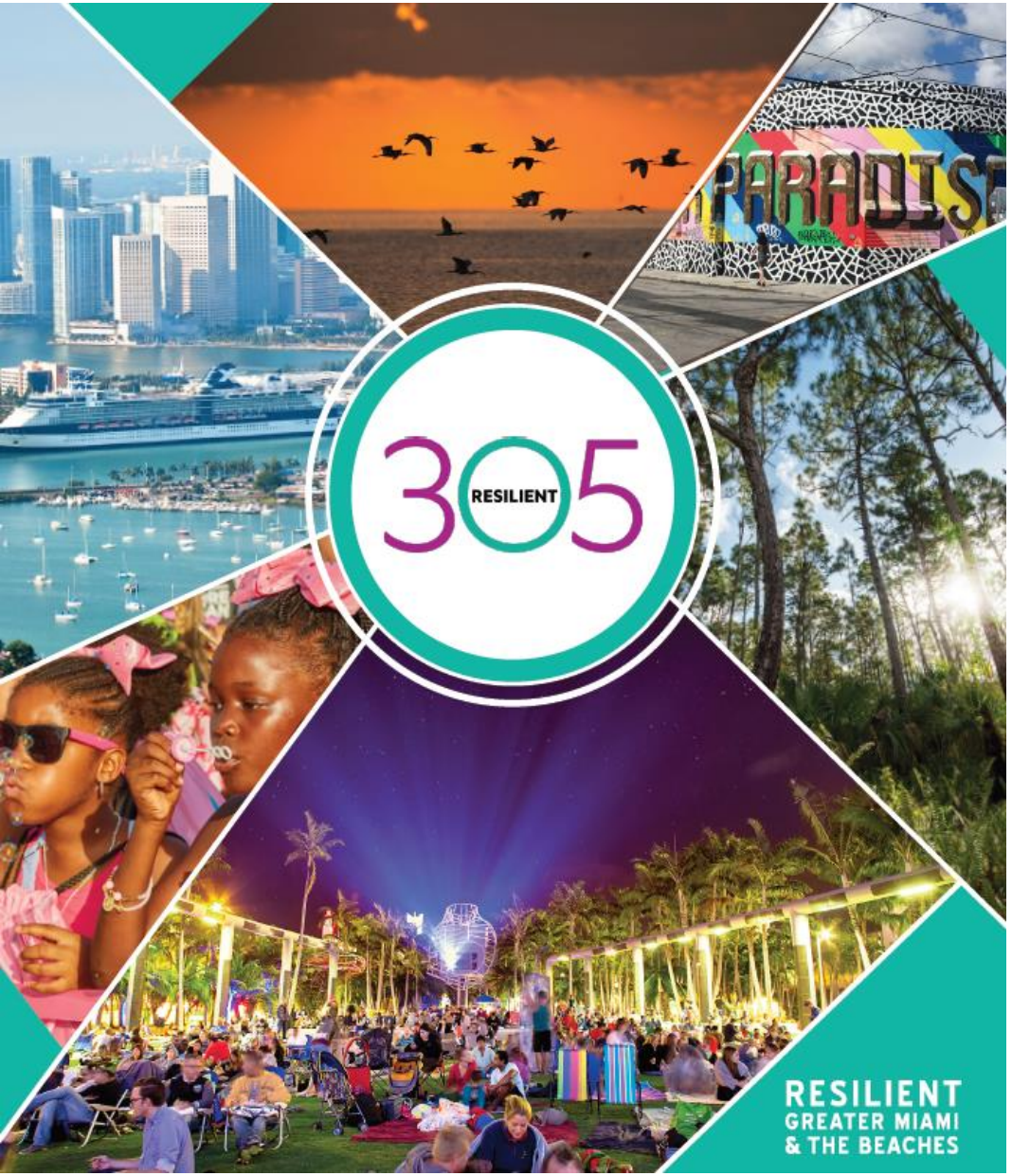


3-foot Sea Level Rise in Miami-Dade

HURRICANE PREPAREDNESS

The DTPW Hurricane Manual outlines how Miami-Dade DTPW works together to prepare for and recover from hurricanes and other natural disasters. The Manual addresses all roads in Miami-Dade County, including: county, state, turnpike, and MDX roads.

GREATER MIAMI & THE BEACHES 100 RESILIENT CITIES PROGRAM



PLACES

OBJECTIVES

- Enhance Natural Systems
- Safeguard Urban Systems
- Create Mobility Options
- Increase Energy Efficiencies
- Enhance Housing Options

19 actions | **5** spotlights

11 case studies

PEOPLE

OBJECTIVES

- Cultivate Financial Stability
- Advance Public Health Priorities
- Strengthen Community Response
- Communicate the Concept of Resilience

22 actions | **13** spotlights

8 case studies

PATHWAYS

OBJECTIVES

- Pre-plan for Post Recovery
- Cultivate Resilience Expertise
- Leverage our Experience
- Develop Shared Resources
- Leverage our Dollars

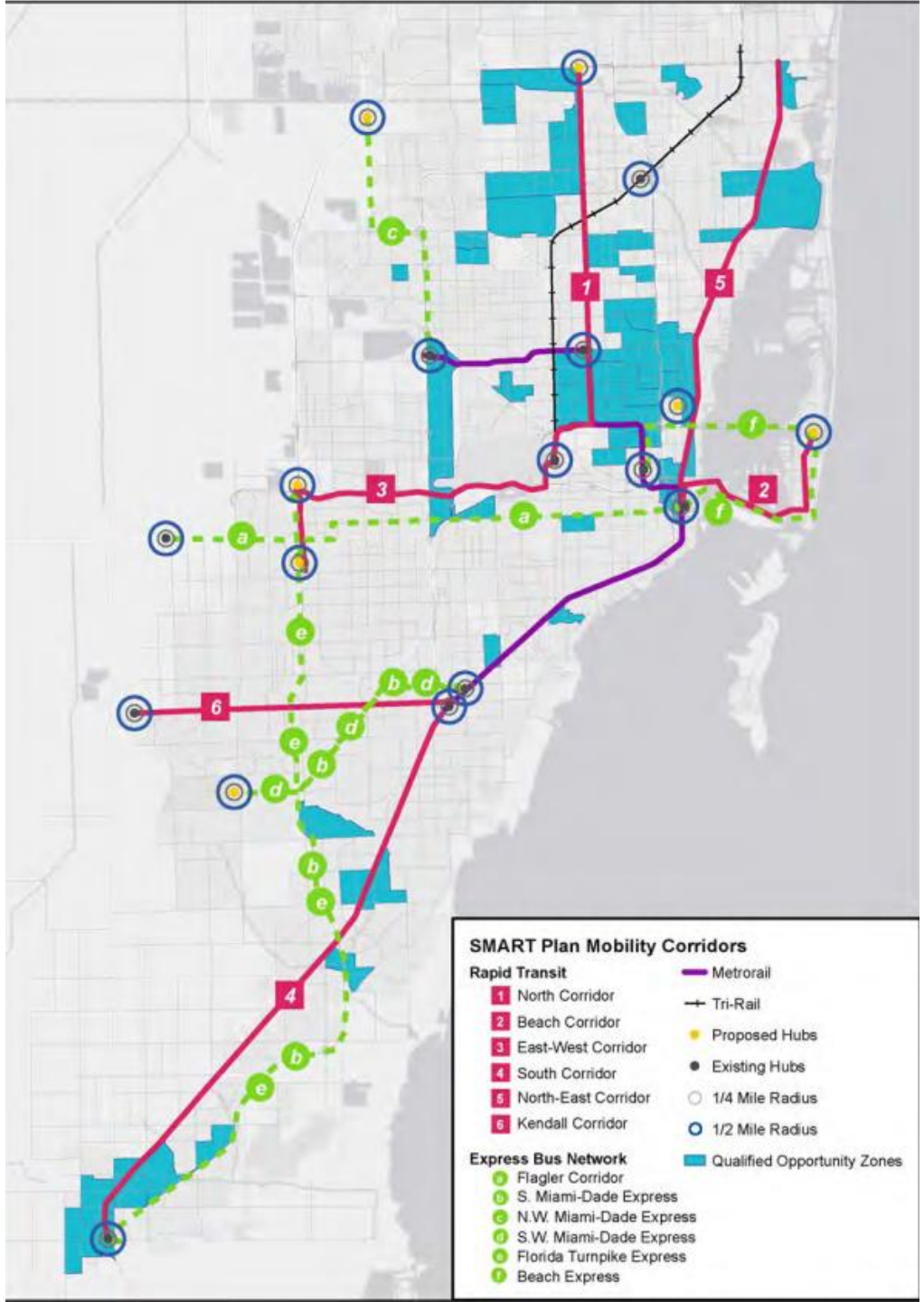
18 actions | **6** spotlights

9 case studies

ACTION 11:
MAXIMIZE OPPORTUNITY ZONES

City of Miami Mayor Francis Suarez and Dr. Benjamin (Ben) Carson, Sr. U.S. Housing and Urban Development Secretary talked to the press during the Opportunity Zone Summit hosted by Mayor Suarez, taking place September 27, 28, at the James L.Knight Center in Miami, on Friday, September 27, 2019. PEDRO PORTAL

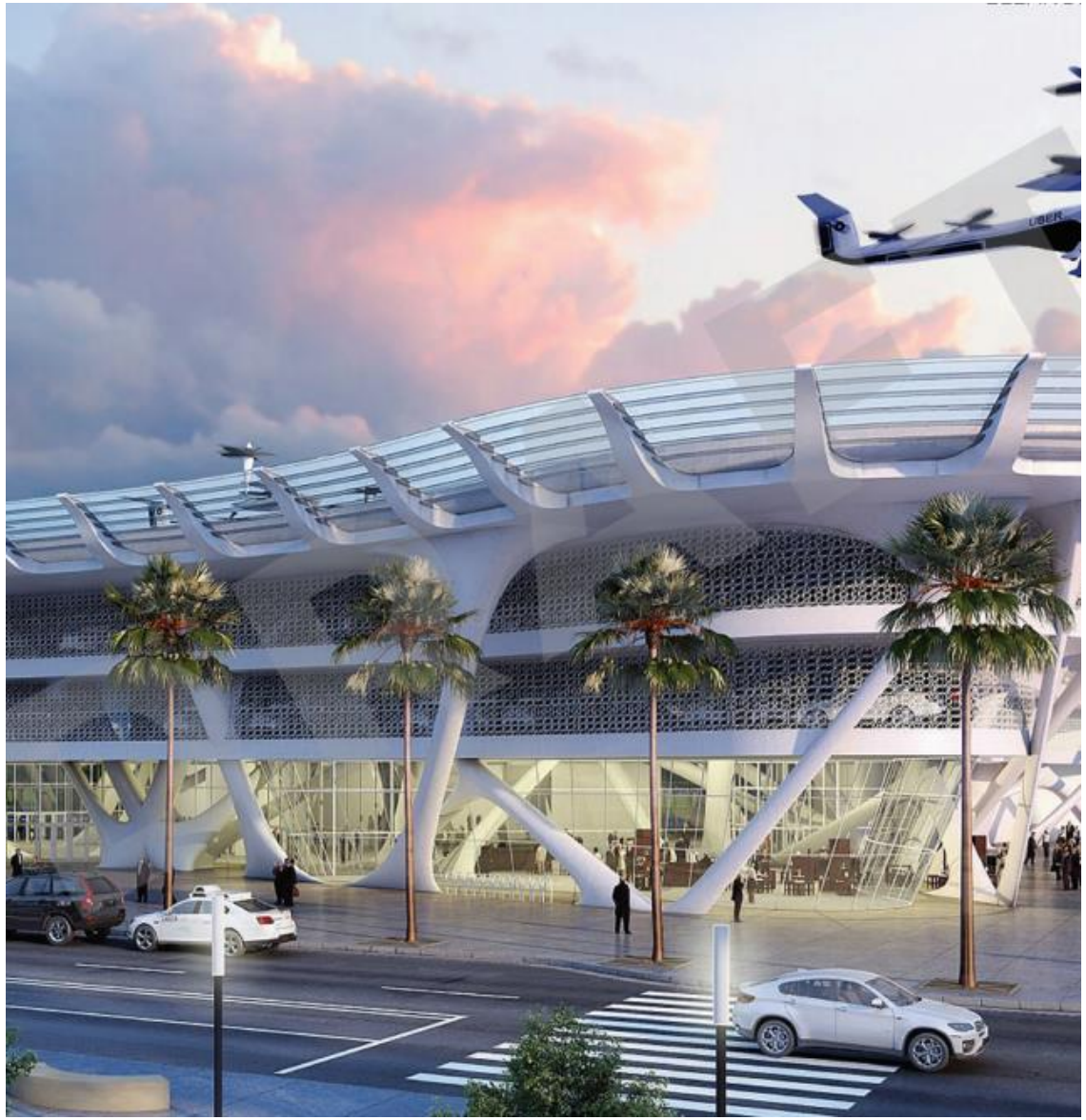
PPORTAL@MIAMIHERALD.COM



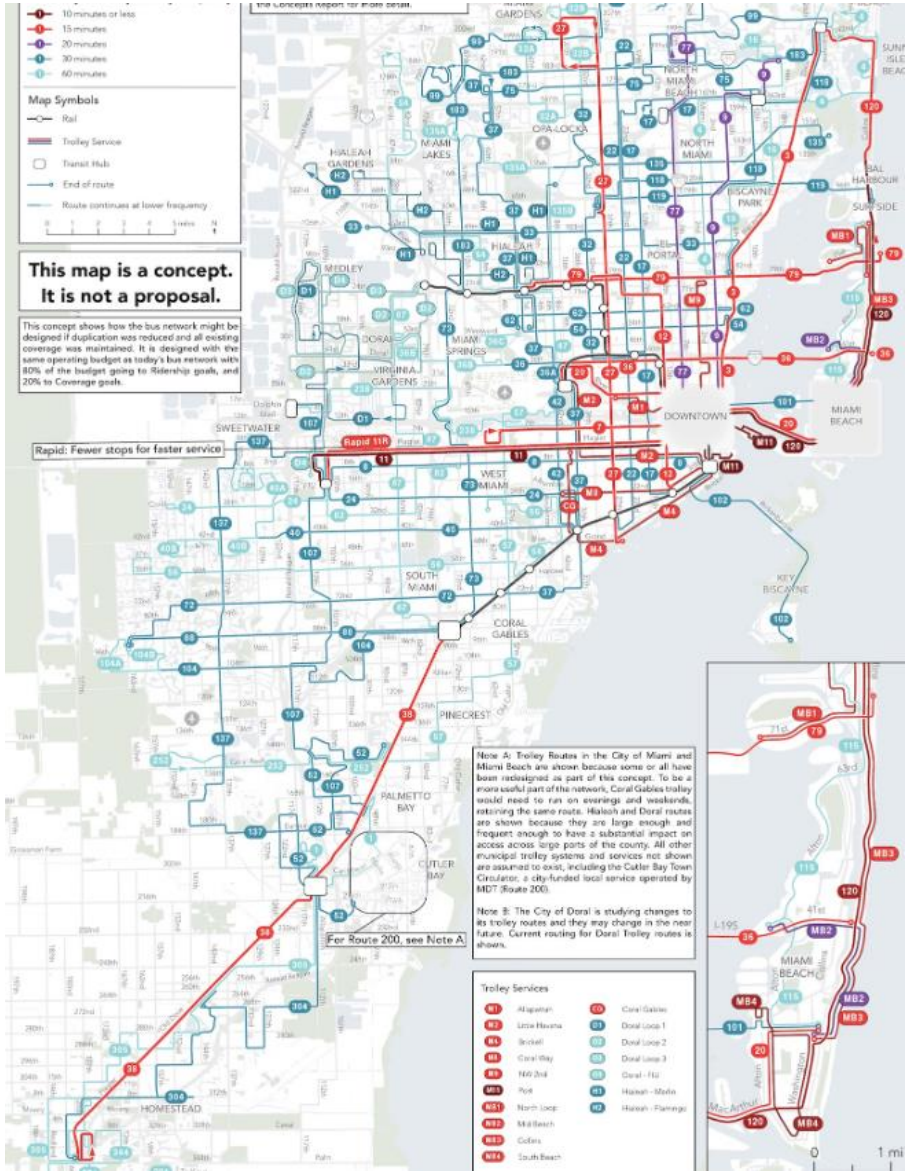
ACTION 7:
IMPLEMENT SEA LEVEL RISE STRATEGY

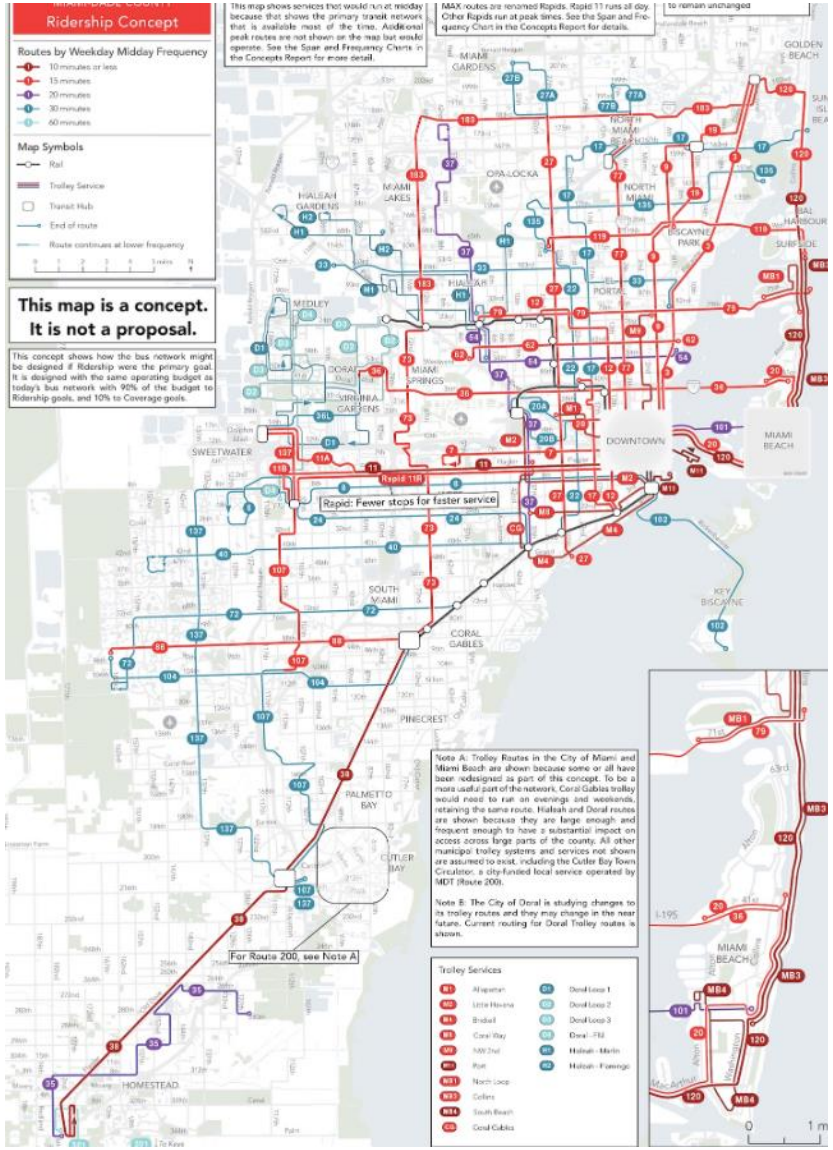
Build on high ground around transit

ACTION 12:
DEVELOP MOBILITY HUBS IN THE 305



ACTION 13:
DESIGN A BETTER BUS NETWORK





Coverage vs Ridership Concepts

Option A covers more area of the County with less frequent routes.

Option B covers less area of the County with a higher concentration of ridership around the urban core and densely populated areas.

ACTION 14:
DRIVE INTO THE FUTURE

ACTION 15:
IT'S ELECTRIC

ACTION 16:
EXPAND RENEWABLE ENERGY

Miami-Dade County
Office of Resilience

MITIGATION

reducing climate pollution

ADAPTATION

preparing for climate change

COMMUNICATION

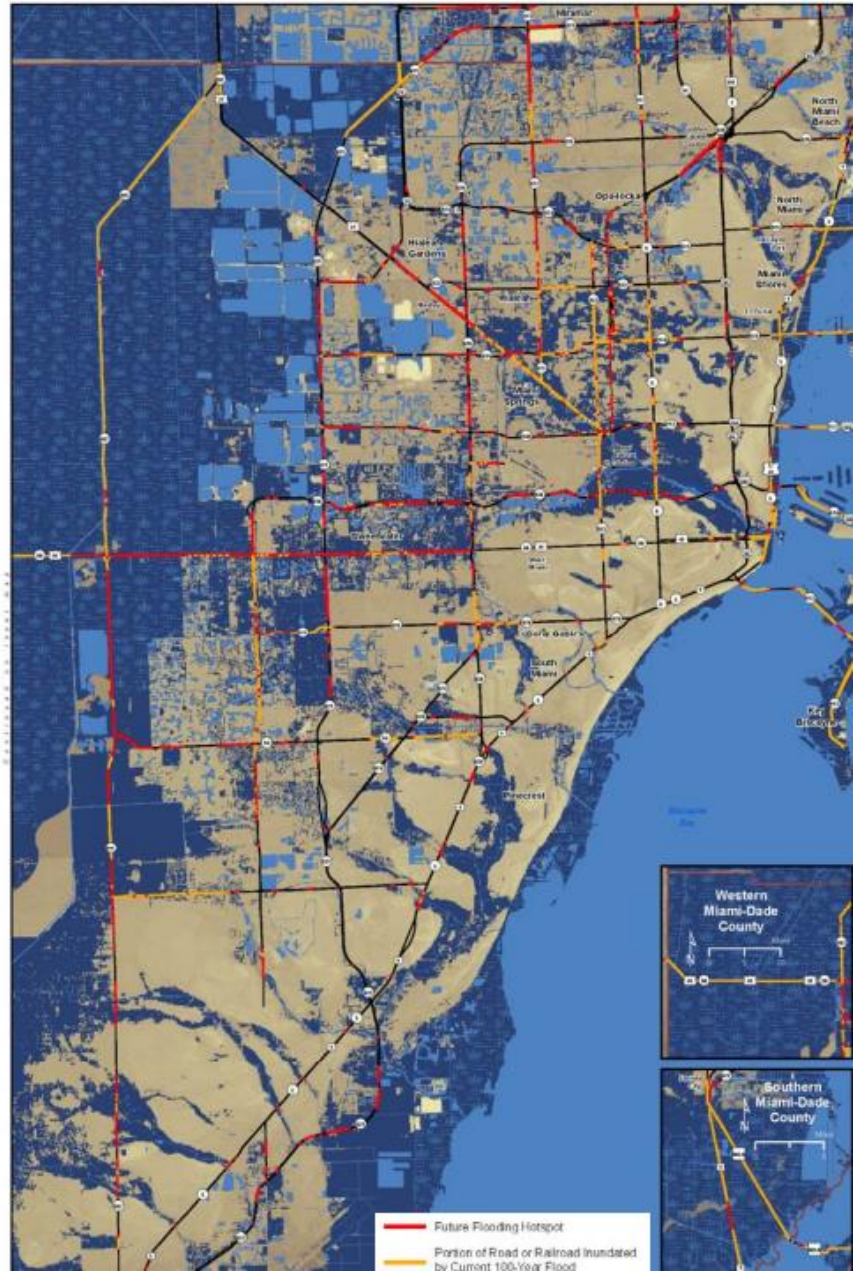
Connecting and engaging

ASSESSMENT OF AVAILABLE TOOLS TO CREATE A MORE RESILIENT TRANSPORTATION SYSTEM

NOVEMBER 2016

Final Report for Resolution R-235-16
in support of the Sea Level Rise Task
Force final recommendations

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



The Rapid action plan considered properties and projects countywide

Properties:

1090 total County properties

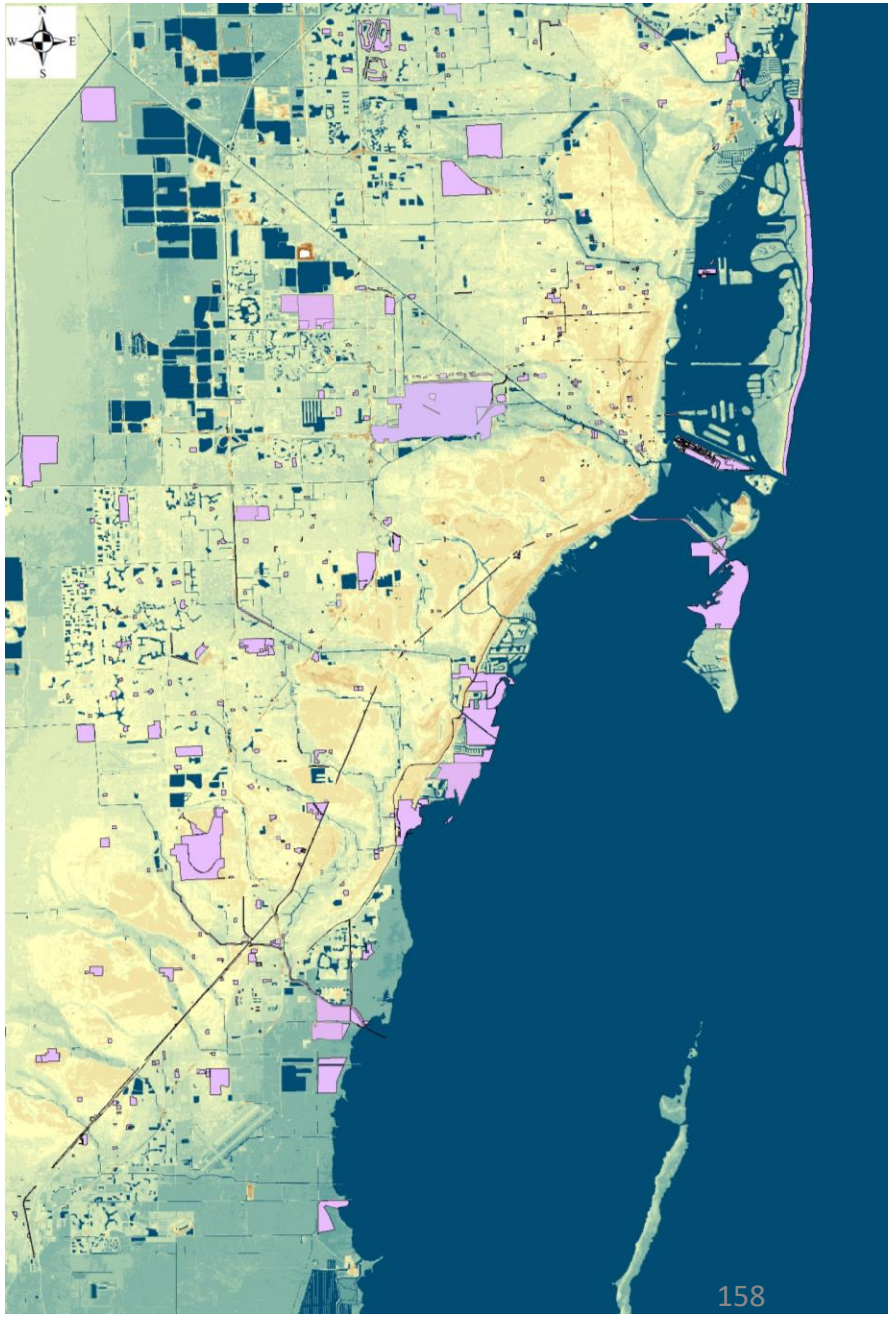
Projects:

CIP
Capital Improvement Plan

348 projects

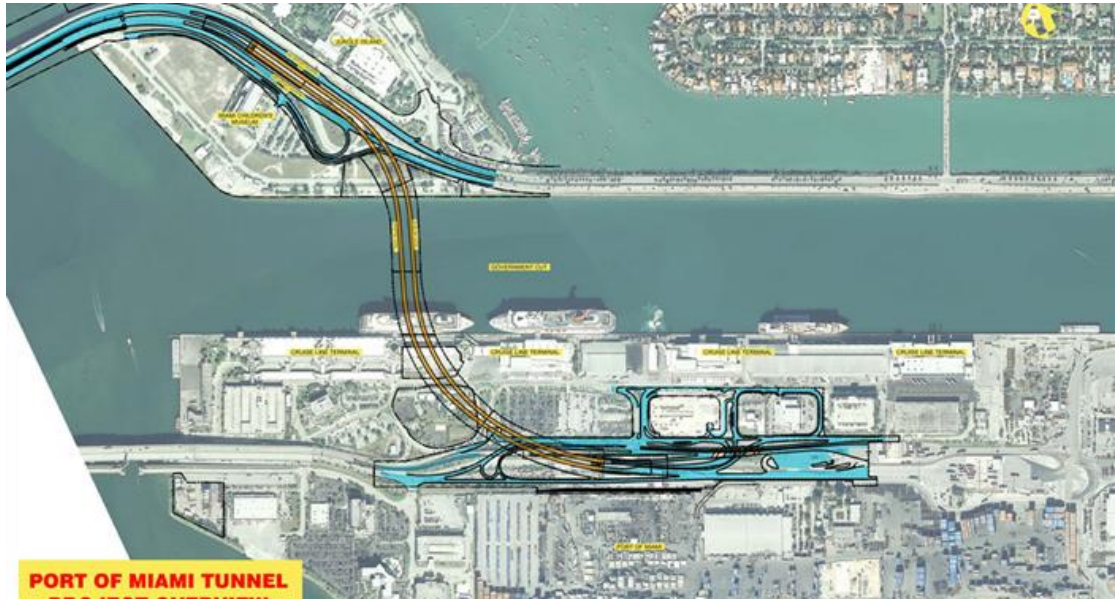
LMS
Local Mitigation Strategies

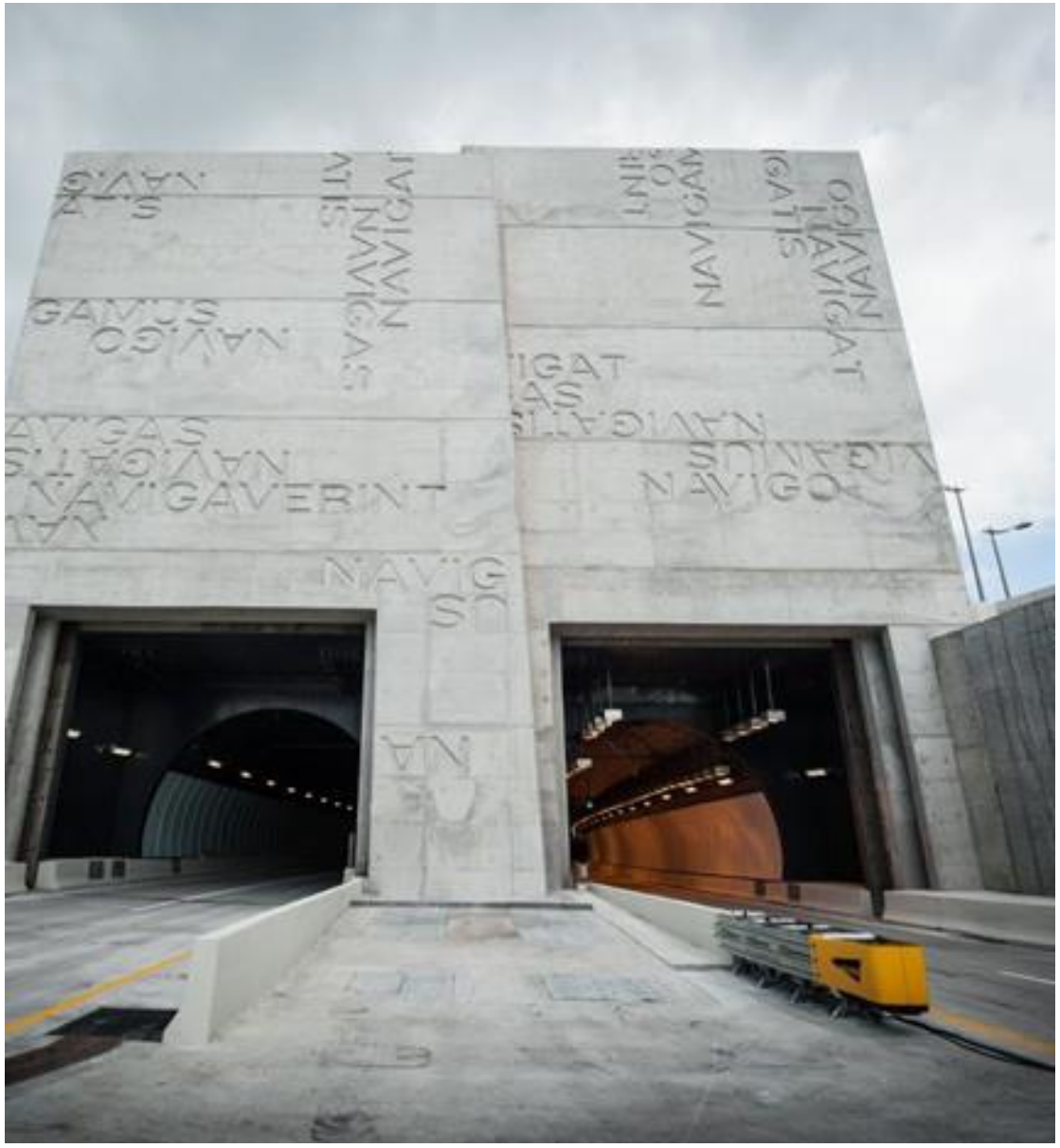
1,163 projects



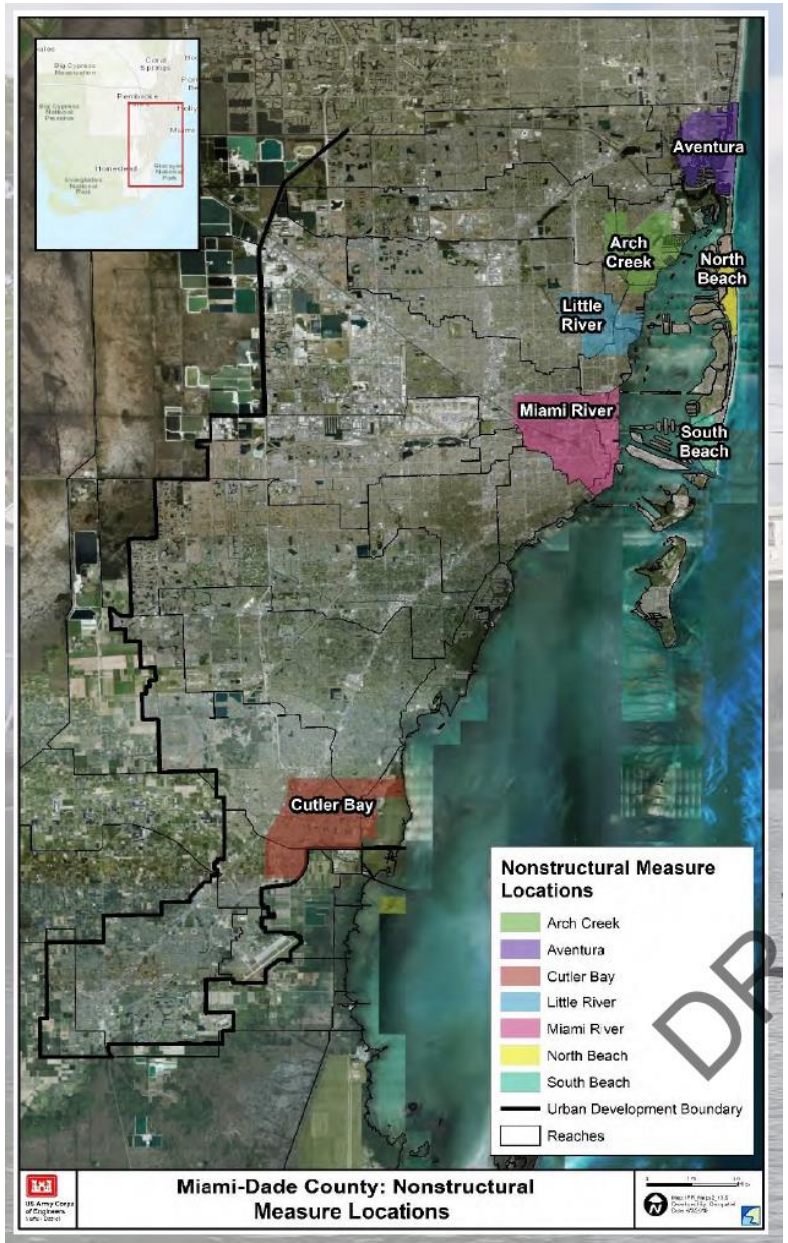
Risks to Transportation Infrastructure

PortMiami Tunnel – Resilient Infrastructure





U.S. Army Corp Back Bay Coastal Storm Risk Management Feasibility Study



Potential measures being considered :

- Structural alternatives (such as tidal gates and backflow preventers)
- Non-structural alternatives (such as flood proofing, relocation, and elevation of structures)
- Natural and nature-based features (such as mangrove plantings, reefs, and wetland plantings).

ELECTRIC VEHICLES

Miami-Dade Ordinance Seeks to Increase EV Charging Stations

Transit Oriented Development

The Underline

Link at Douglas

Motion at Dadeland

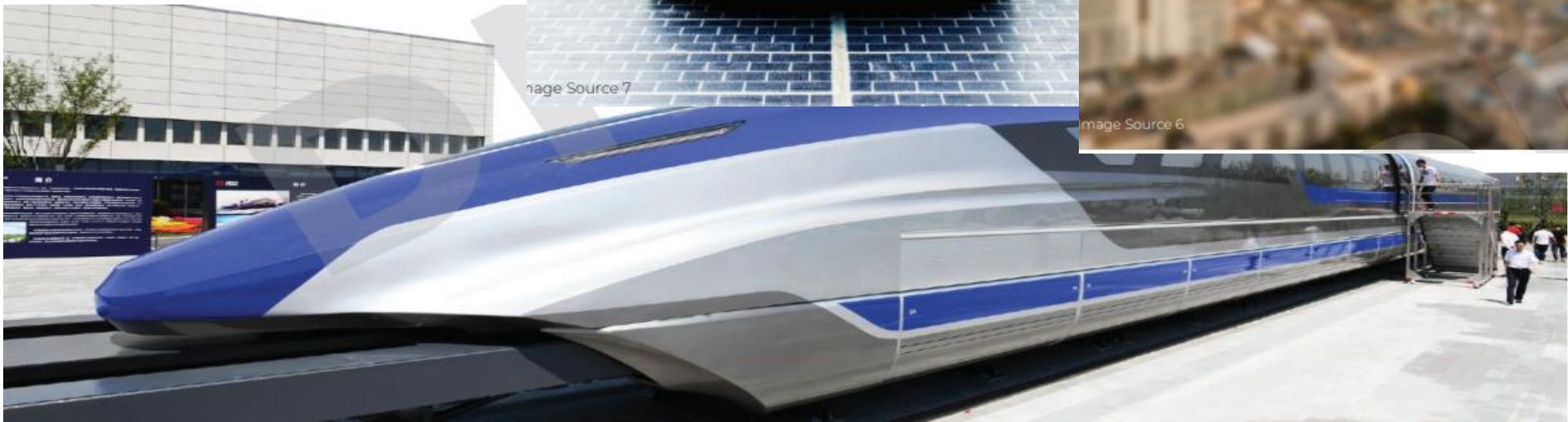
Grove Central

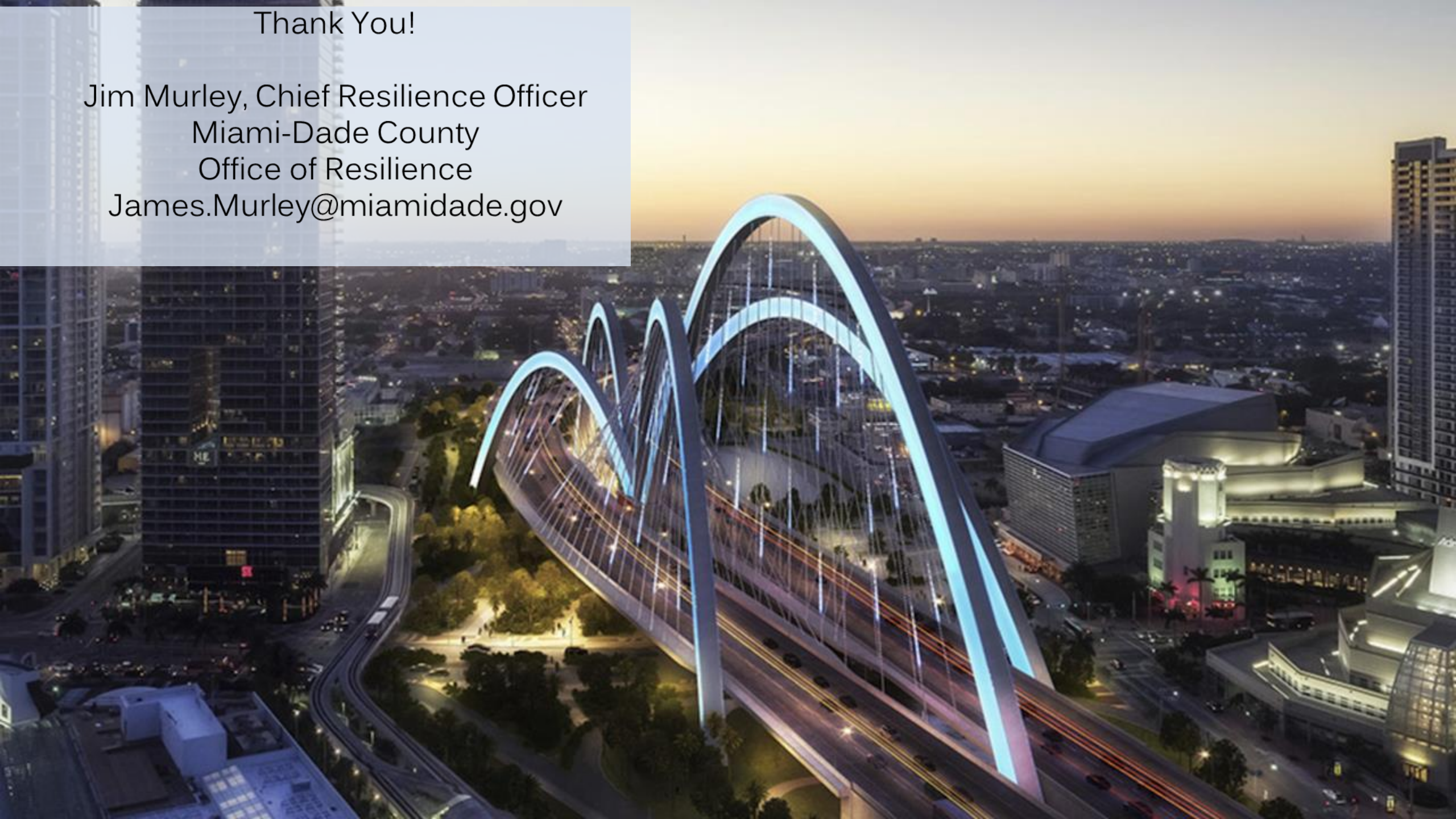
Virgin Rail Multimodal Transportation Station

- Smart Grid
- Solar Roadways
- Electric Cars

nage Source 7

mage Source 6



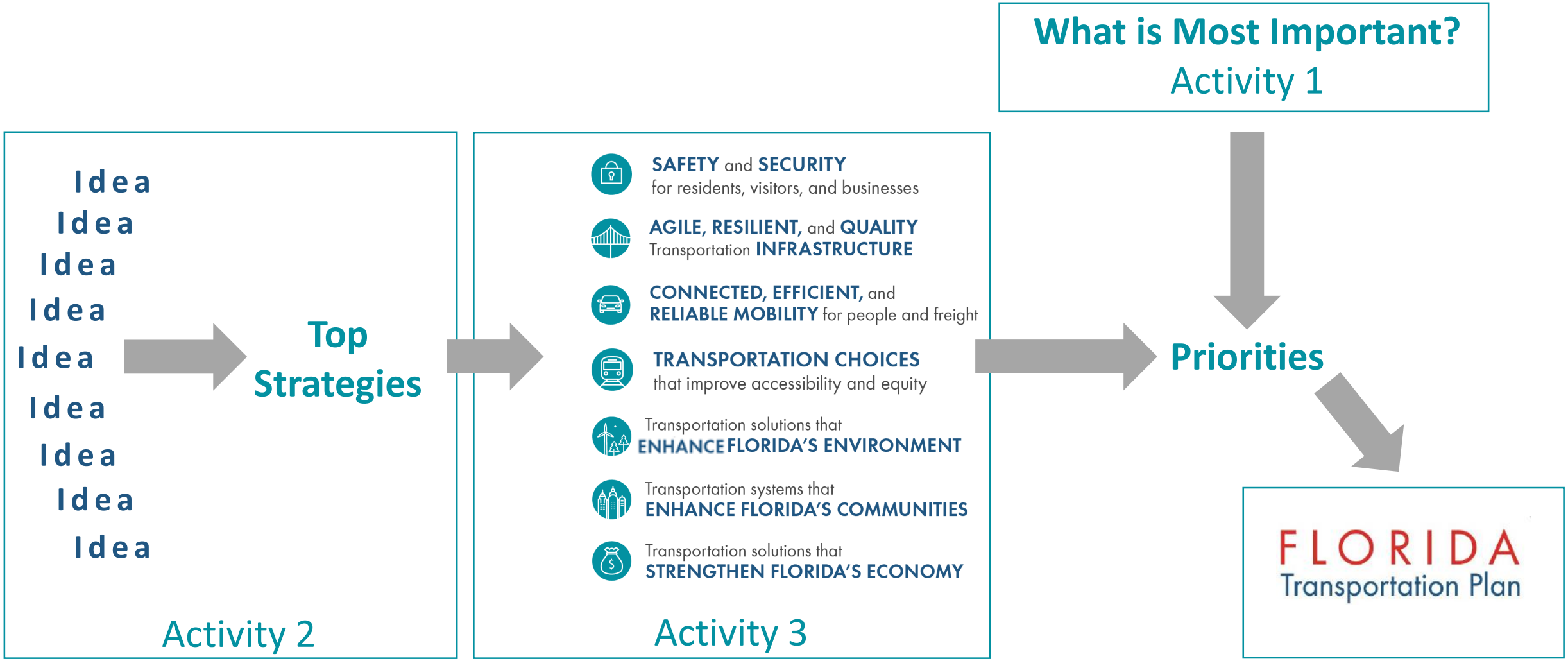


Thank You!

Jim Murley, Chief Resilience Officer
Miami-Dade County
Office of Resilience
James.Murley@miamidade.gov

Activity 3: Prioritize Resilience Strategies

OVERVIEW OF ACTIVITIES



Activity 1 Resilience Priorities Takeaways

- Develop **consistent statewide transportation planning** practices that incorporate resilience
- Establish a **statewide framework** for collaboration to achieve transportation resilience
- Minimize the impact to **mobility** before, during, and after a disaster
- Develop and implement **policies, tools, guidance, and design standards** that reduce risk
- Integrate resilience **data** into transportation planning and design

Activity 2 Top Strategies

- Integrate land use in transportation planning for stronger growth management
- Sustainable funding to support resilience responses (dedicated)
- Improve collaboration and coordination across entities including regional, statewide, county, and community organizations
- Modify transportation facility design to improve infrastructure resiliency
- FDOT assume leadership role
- Incorporate resilience into FDOT design standards (for new construction and rehabilitation)
- Define resiliency and develop standards across goals and objectives
- Better coordination in operating and maintaining facilities (eliminate jurisdictional facilities)
- Reduce dependence on one overwhelmingly dominant mode (cars/road)
- An accepted process and content to conduct vulnerability analysis studies
- Develop standards for statewide stormwater management for public and private, including natural infrastructure
- Improve coordination across jurisdictions and plans to more fully establish resilience efforts and achieve co-benefits
- Stable funding source (reduce dependence on gas tax/find an alternative)
- Better coordination of local land use plans and transportation
- Use natural infrastructure
- Study infrastructure concerns / failures that were identified elsewhere. Consider adapting strategies to Florida. (LA, USACE, Netherlands)
- Use transportation projects to leverage replacement of vulnerable/aging utility infrastructure
- Monitor and incorporate impacts of emerging technology in resilience plans
- Require resilience in infrastructure planning and design
- Identify incentives to relocate land uses dependent on vulnerable infrastructure
- Development of more inland ports to less vulnerable areas and design coastal ports to transfer more needed and vulnerable products to these areas when threatened

Activity 3

SAFETY and **SECURITY**
for residents, visitors, and businesses

AGILE, RESILIENT, and **QUALITY**
Transportation **INFRASTRUCTURE**

CONNECTED, EFFICIENT, and
RELIABLE MOBILITY for people and freight

TRANSPORTATION CHOICES
that improve accessibility and equity

Transportation solutions that
ENHANCE FLORIDA'S ENVIRONMENT

Transportation systems that
ENHANCE FLORIDA'S COMMUNITIES

Transportation solutions that
STRENGTHEN FLORIDA'S ECONOMY

Decision Making Under Deep Uncertainty

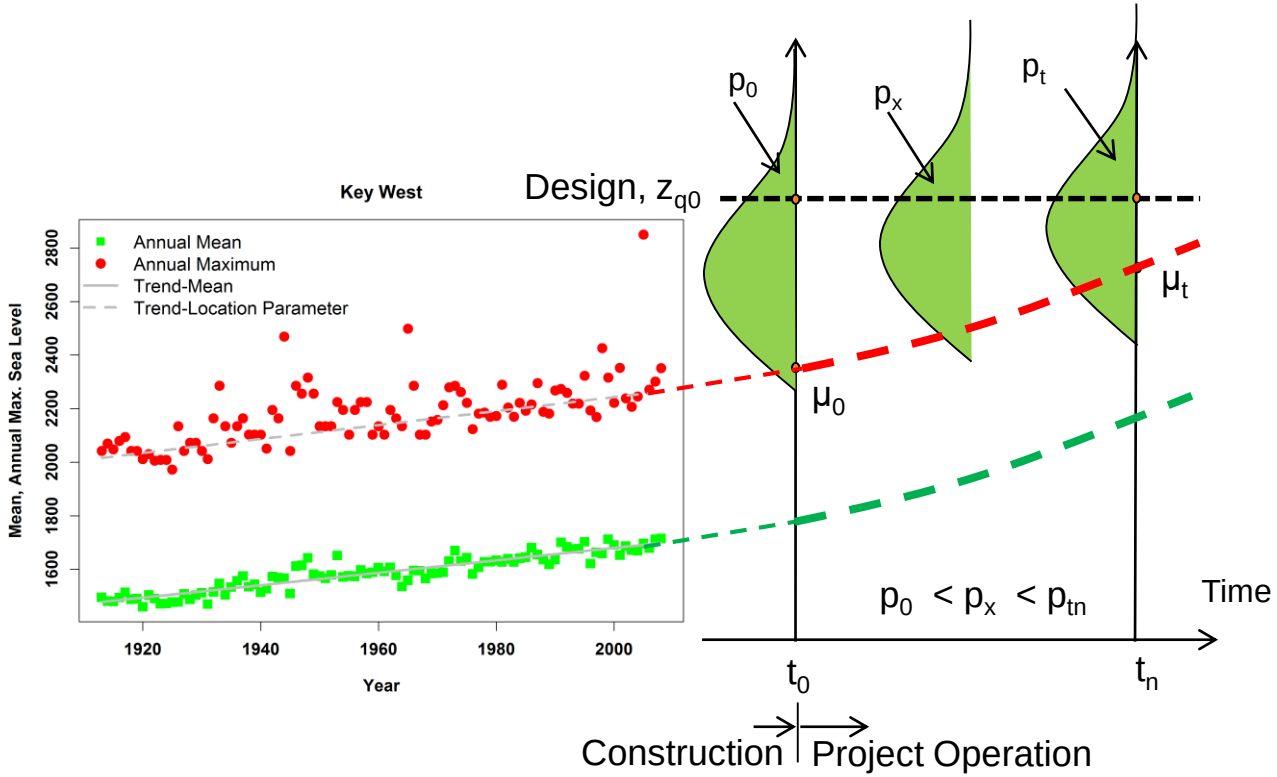
FDOT District 4
October 30, 2019

Deep Uncertainty

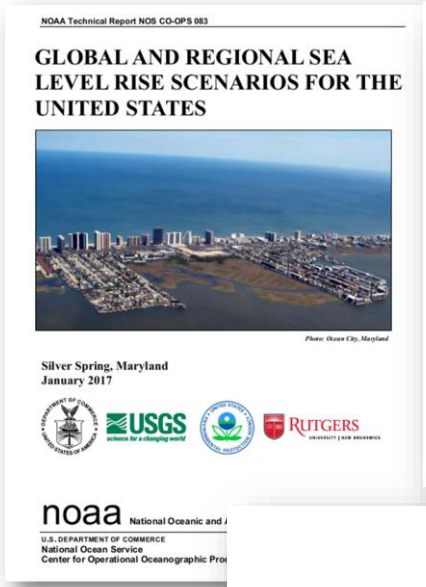
- ***Deep uncertainty*** *is a situation in which analysts do not know or cannot agree on (1) models that relate key forces that shape the future, (2) probability distributions of key variables and parameters in these models, and/or (3) the value of alternative outcomes.*

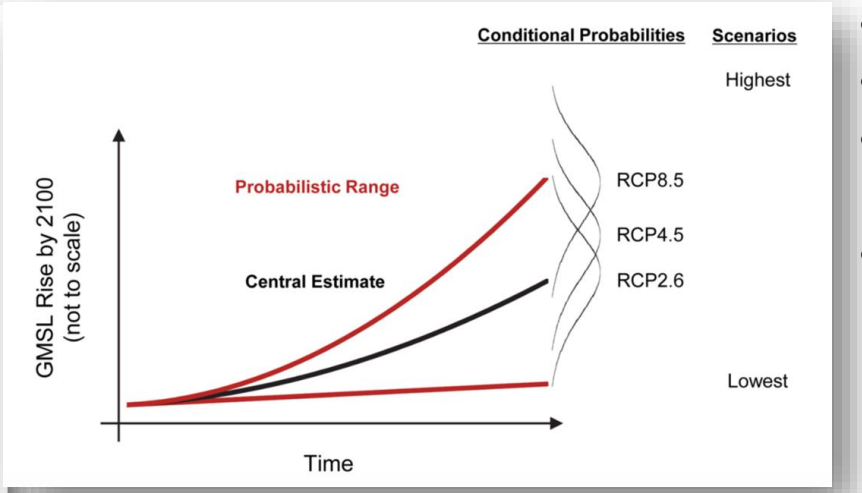
Hallegate et al. (2012)

Designing for Sea Level Rise: Case of Nonstationarity

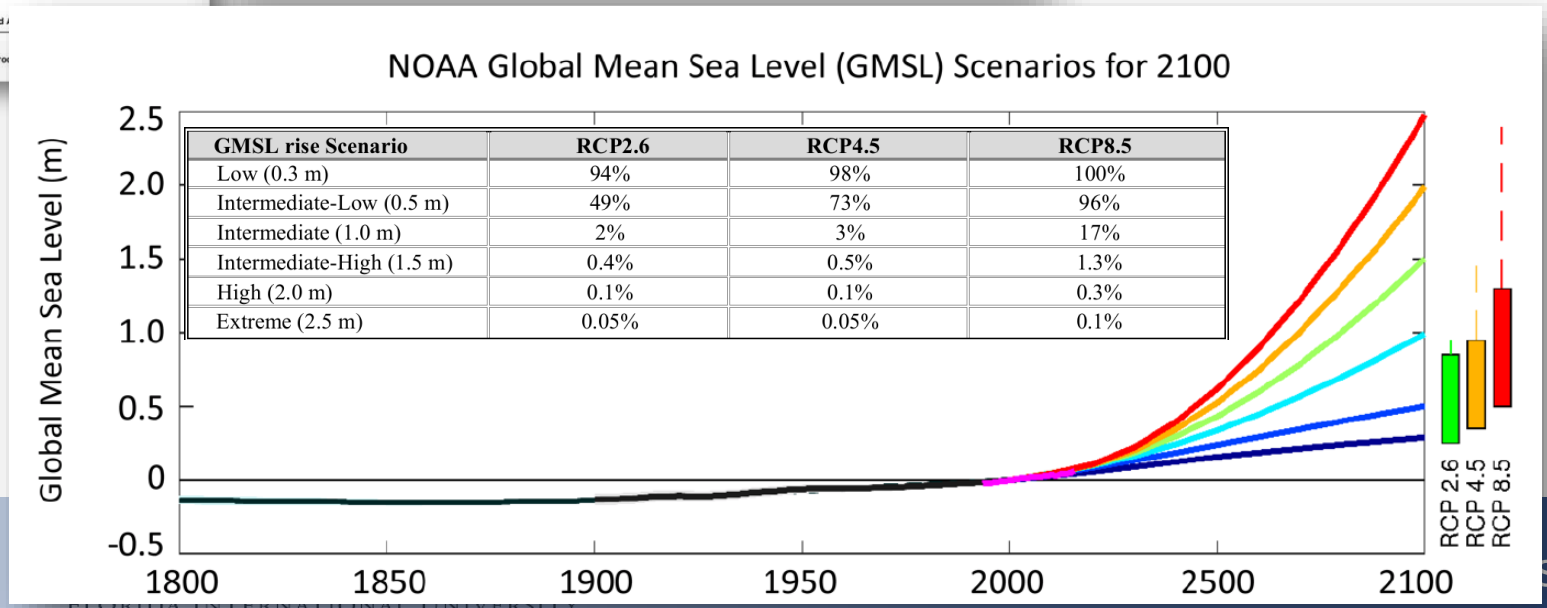


NOAA (Sweet et al. 2017) for 4th National Climate Assessment





- Kopp et al. (2014)
- Bayesian Probabilities
- Expert elicitation to get the tails
- **DeConto & Pollard (2016):** Antarctica can contribute more, hence 2.5 m scenario

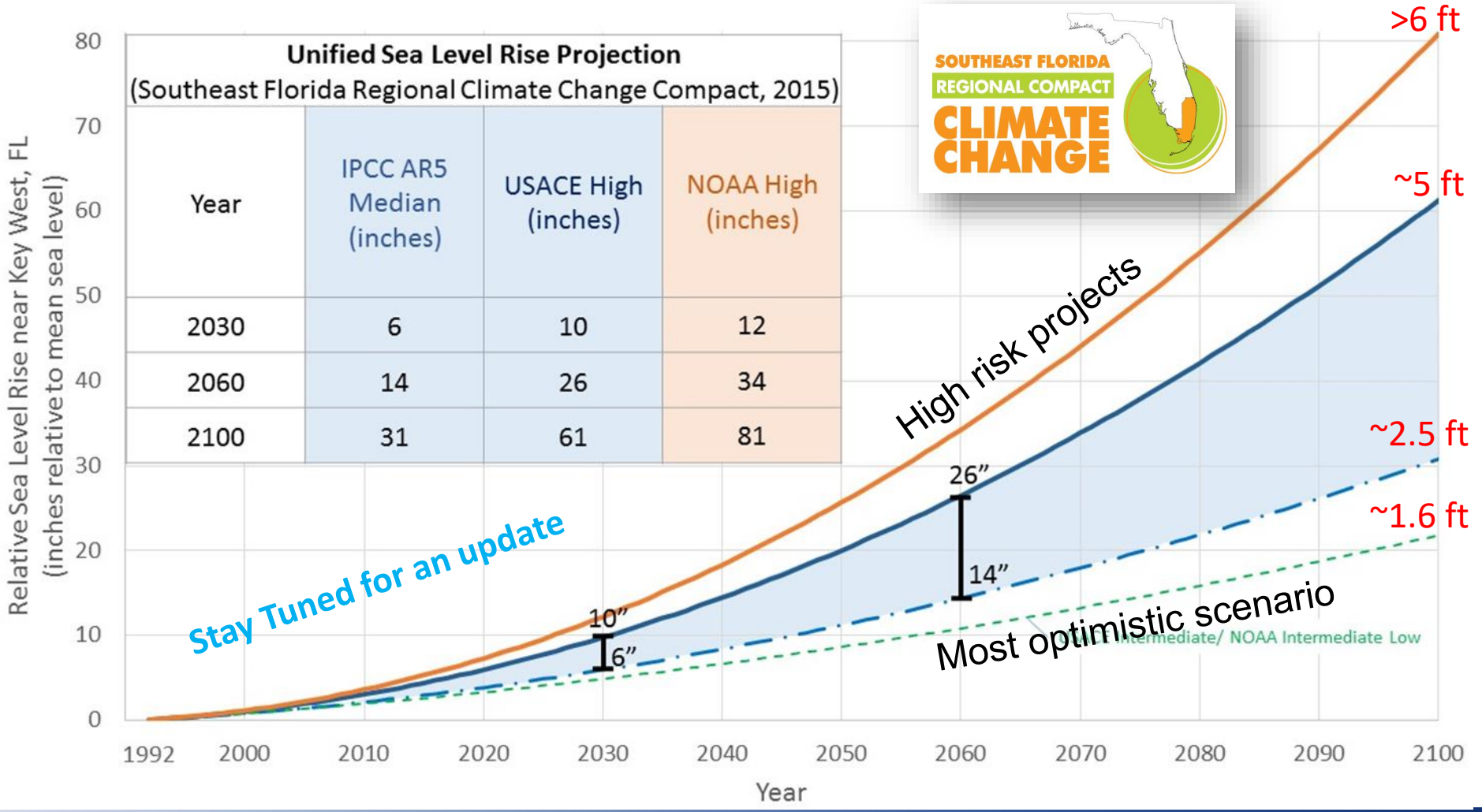


GMSL rise Scenario	RCP2.6	RCP4.5	RCP8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

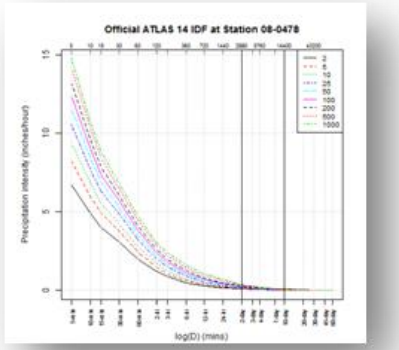
Regional Sea Level Projections

Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

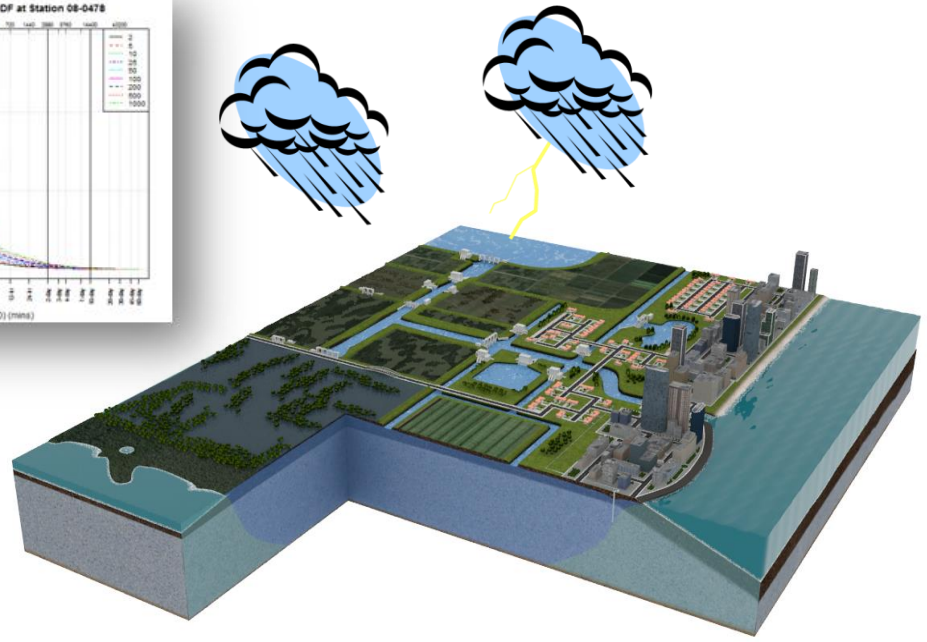
Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81

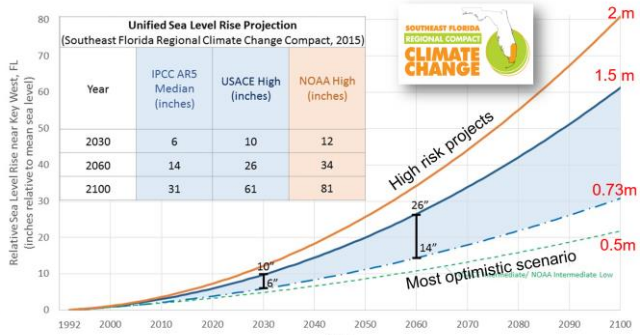


Uncertainties in the Nonstationary Environment



Rainfall Extremes: IDF Curves





SLR: Which Scenario?

Future Storminess?

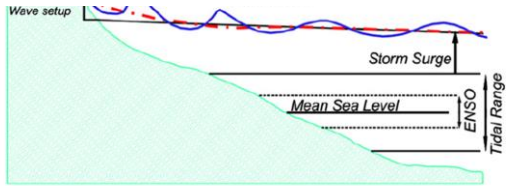


Fig. 2. Diagram illustrating the contributions to sea level due to tides, storm surge and wind-generated waves.

Gulf Stream Episodic?

Application of DMDU Concepts

Society for Decision Making under Deep Uncertainty (DMDU), Annual Meeting, November 13-15, 2017, Oxford, England

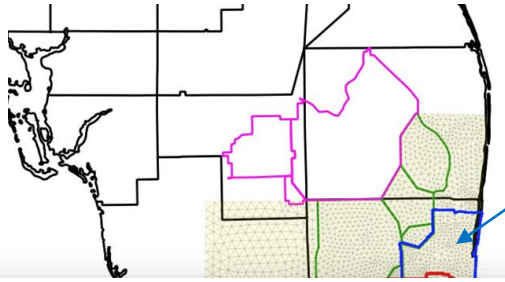
Oxford, England

Selected Methods of DMDU

- Robust Decision Making (RBM) pioneered by RAND
- Decision Scaling ("bottom-up approach")
- Dynamic Adaptive Policy Pathways (DAPP) developed by Deltares, The Netherlands

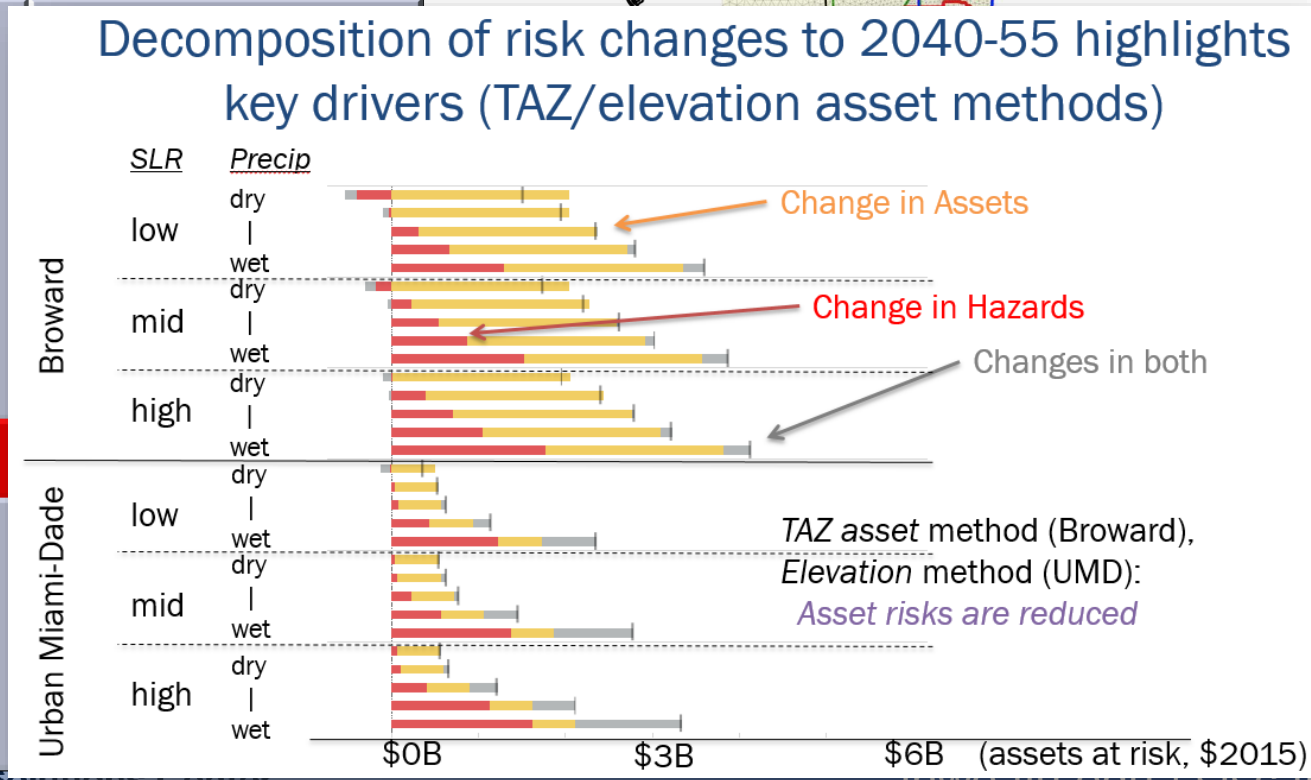
Water Management and Adaptation Planning in South Florida (RAND Corp.)*

- Vulnerability of Miami-Dade (2.7M) and Broward Counties (1.9M) to groundwater inundation



Broward SEAWAT Model

Uncertainties (X)	Levers (L)
• Sea Level Rise (low, med, high) • Rainfall (119 scenarios->5) • Population (Random, Elevation, Traffic Analysis Zone)	
Relationships	
Groundwater models Economic model	



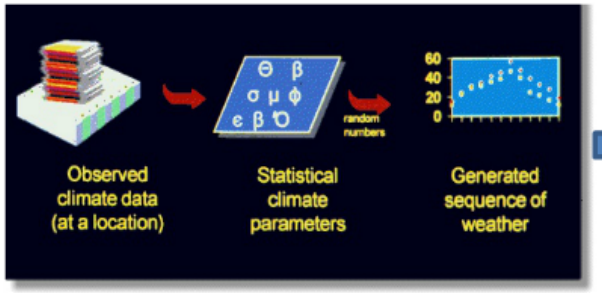
*Supported by MacArthur Foundation

"Stress Test"

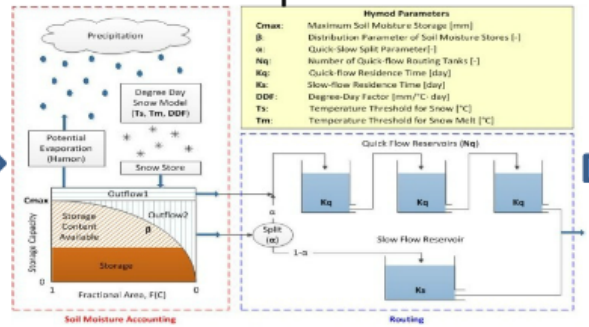
Decision Scaling

NonClimate Uncertainties

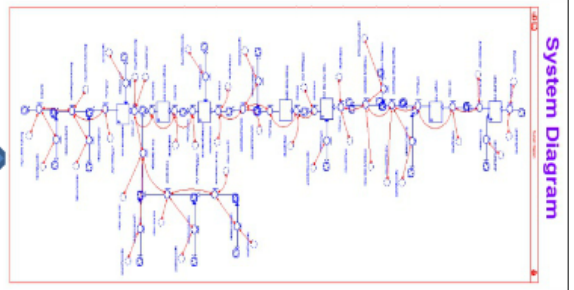
Climate/Weather Generator



Climate Response Model

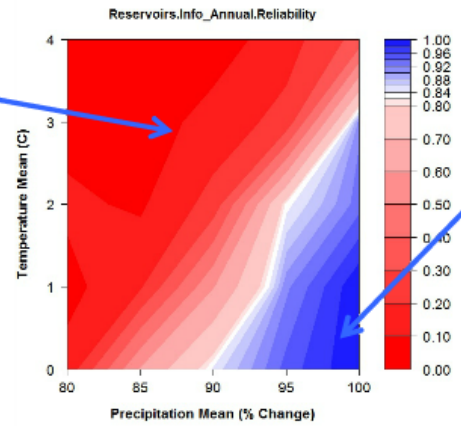


System Model



Vulnerability

Robust



Dynamic Adaptive Policy Pathways (DAPP)

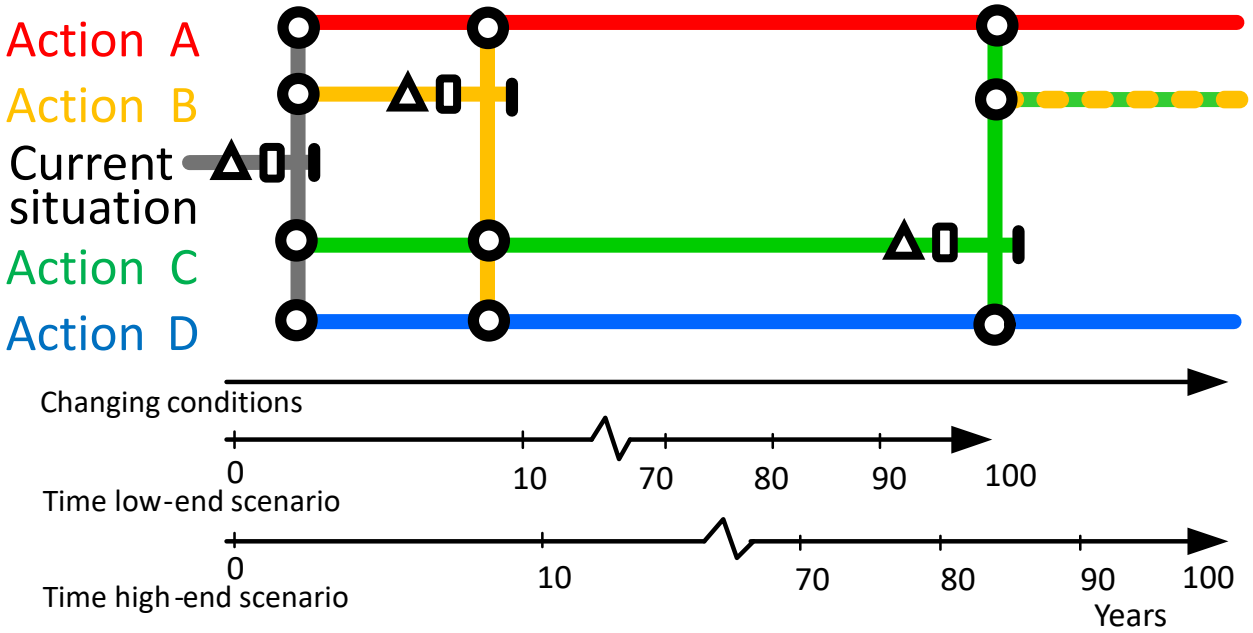
Decisions are made over time in dynamic interaction with the system and cannot be considered independently.

- 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)



Transfer station to new policy action

Adaptation Tipping Point of a policy action (Terminal)

Policy action effective

Signal

Decision node

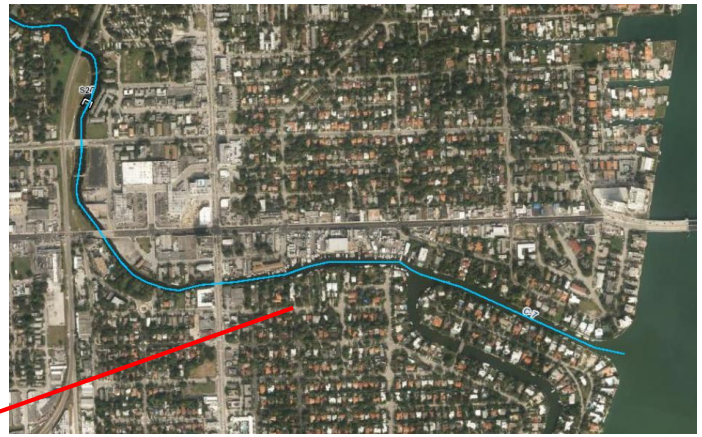
Time horizon 100 years

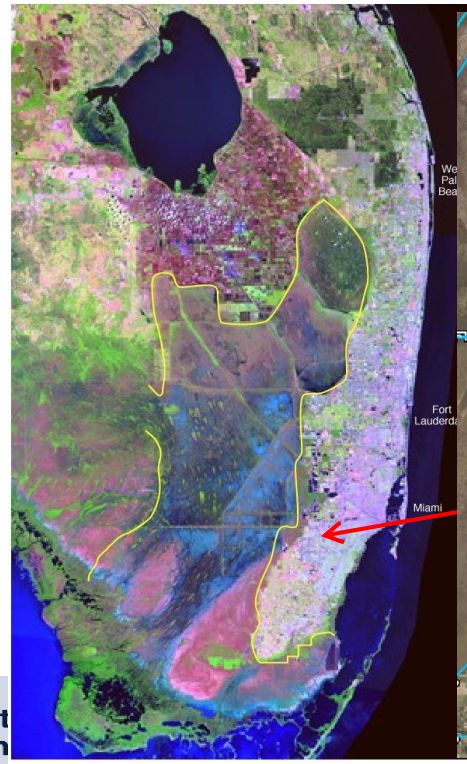
Pathway	Costs	Benefits	Co-benefits
1	+++	+	0
2	+++++	0	0
3	+++	0	0
4	+++	0	0
5	0	0	-
6	++++	0	-
7	+++	0	-
8	+	+	- - -
9	++	+	- - -

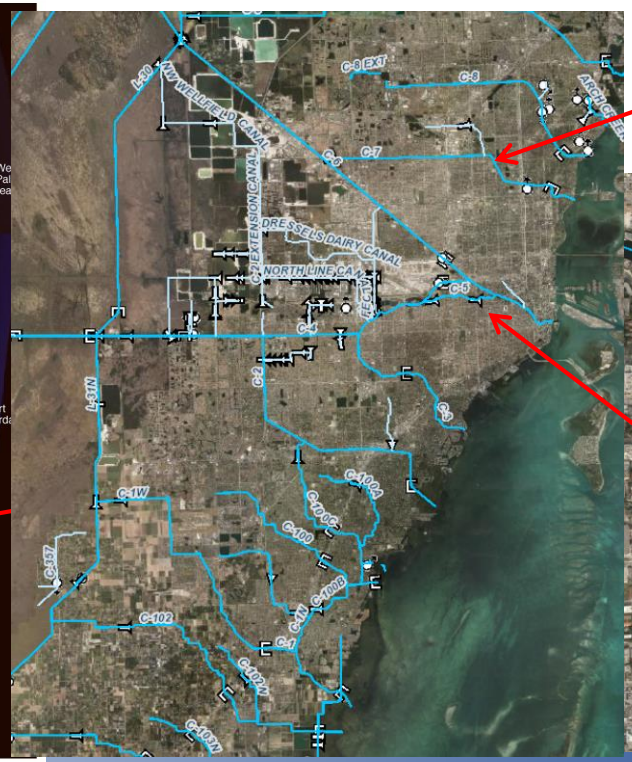
Pathways that are not necessary in the low-end scenario

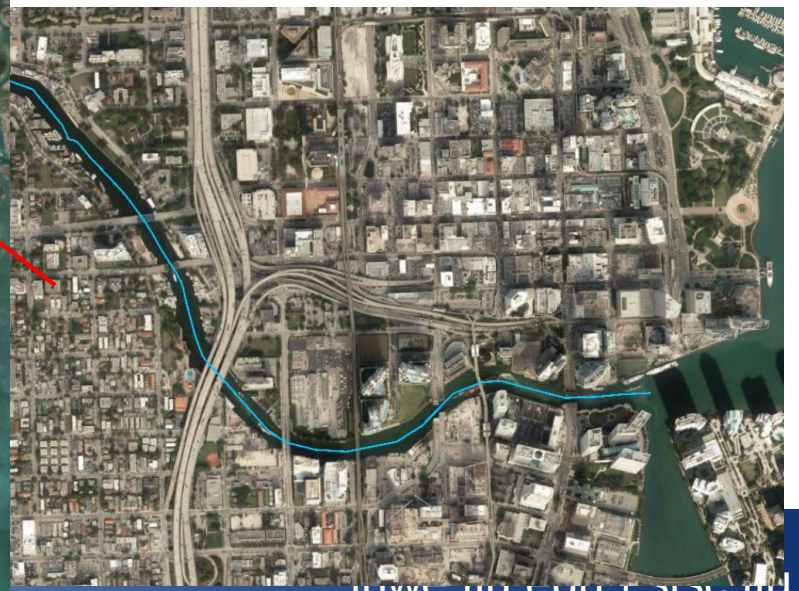
Project Setting

S. Florida: Low topography, High groundwater table, sandy soils and porous limestones, complex water management systems.



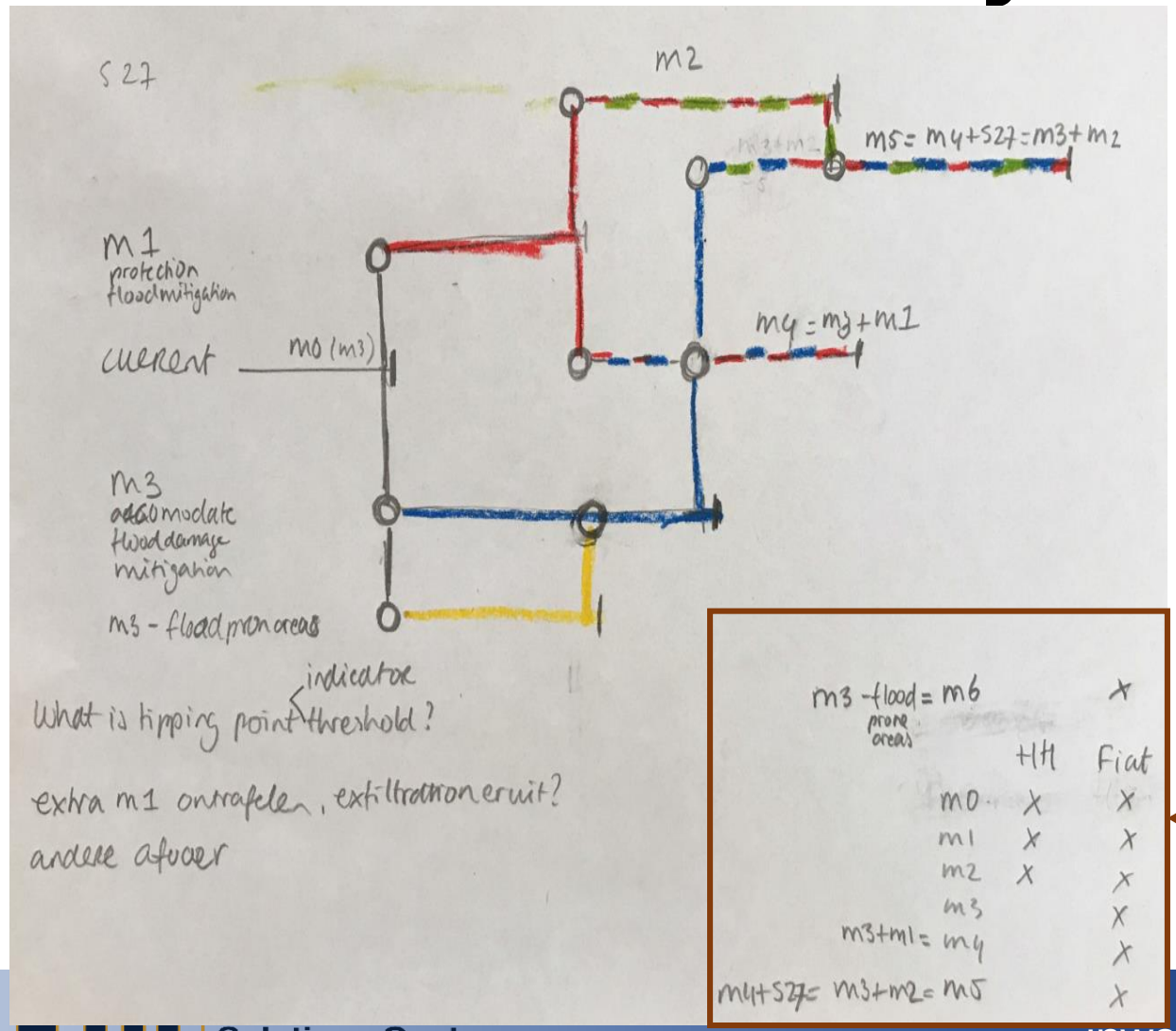






Level I: Initial analysis

Level I: Initial analysis



To be modeled

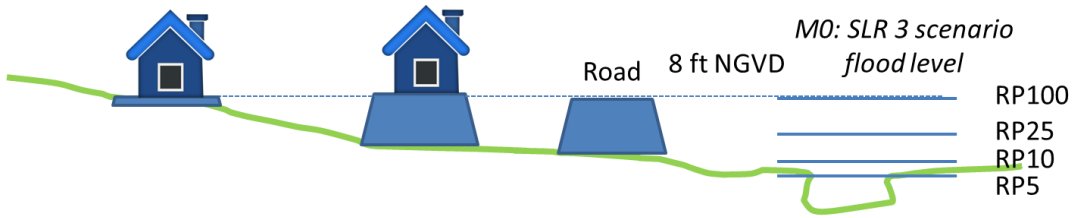
Measures

Options assessed:

M1 – Local flood mitigation: flood walls, exfiltration trenches, flap gates, and local pumps

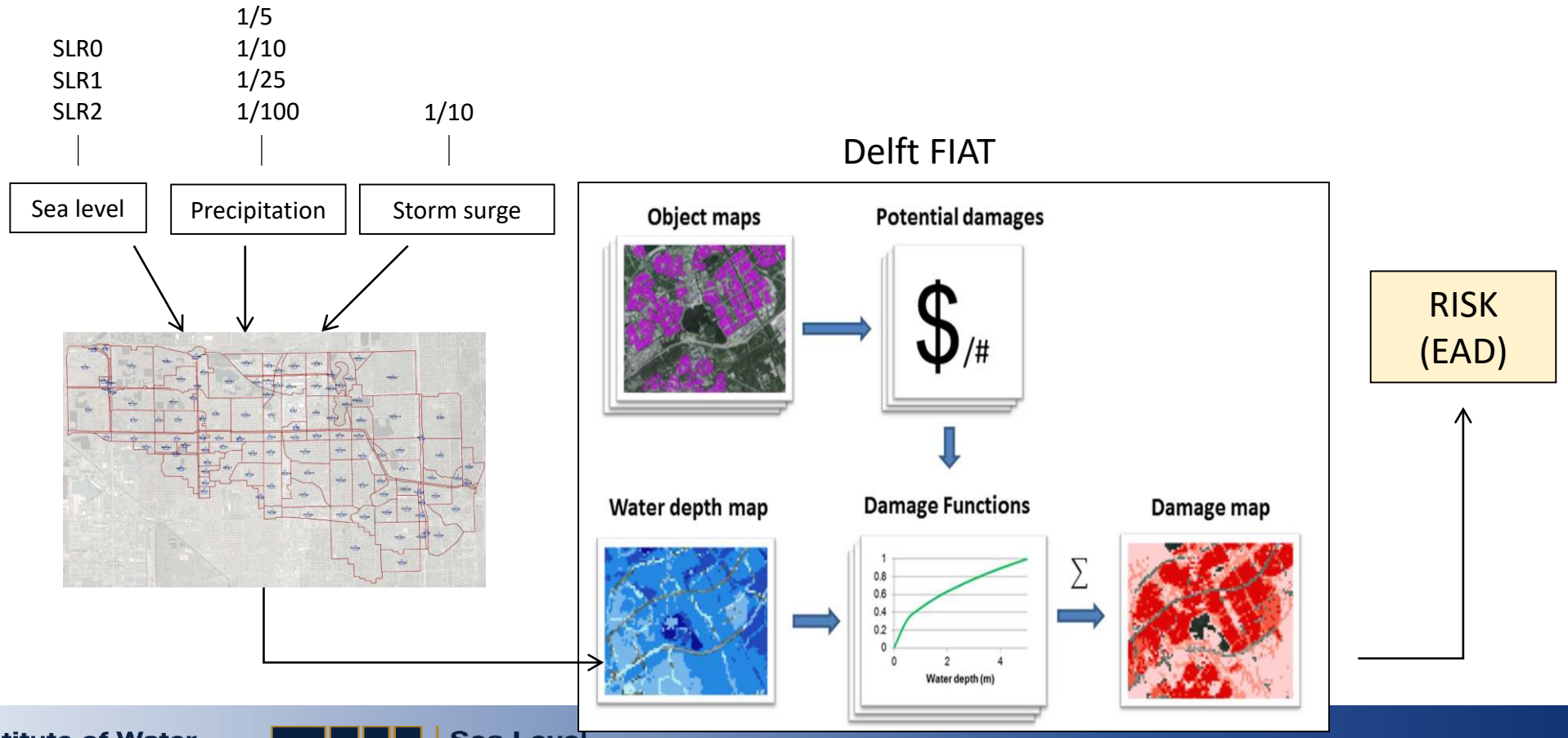
M2 – Regional flood mitigation: forward pumps at S-27 coastal structure (small & large pumps)

M3 - Land-use mitigation: raise roads and buildings to 6, 7 or 8 feet elevation

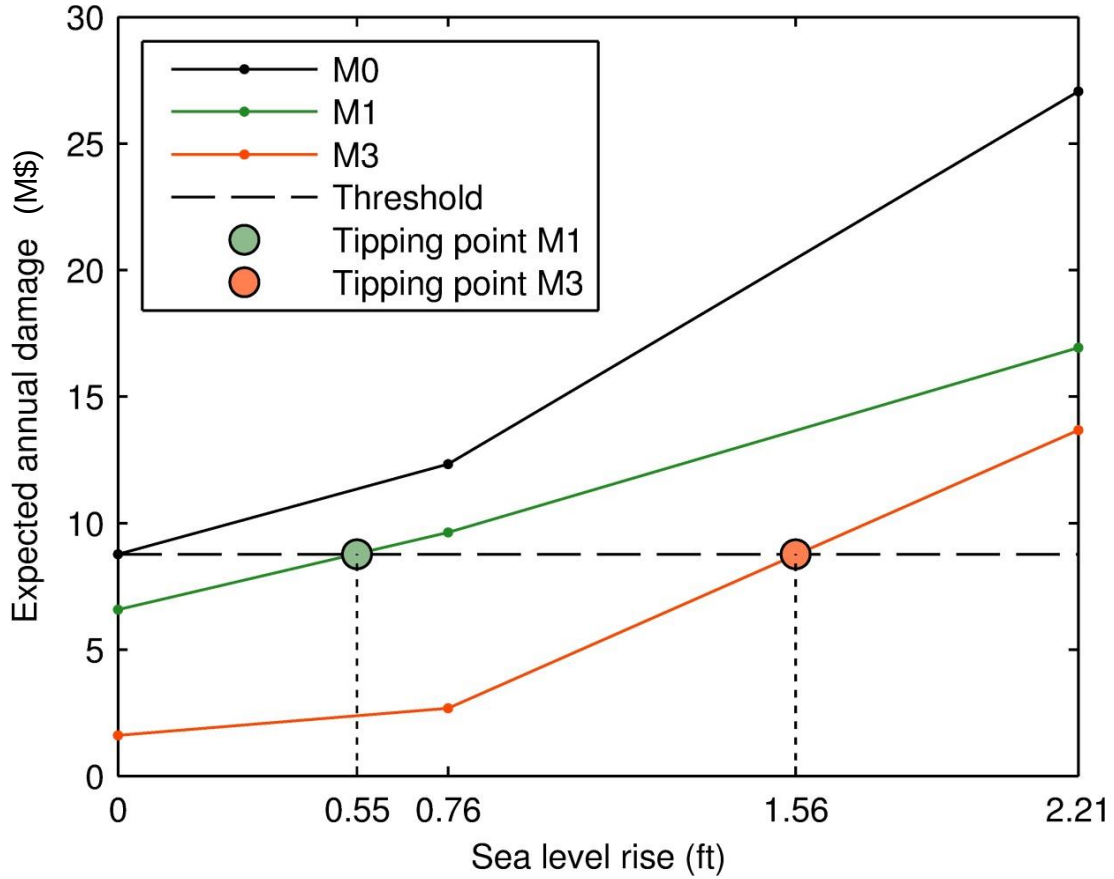


Level II: Vulnerability/risk assessment

Hydrologic modeling + Delft FIAT (flood impact assessment tool)



Adaptation tipping points



if SLR1 then in 2045
if SLR3 then in 2025

if SLR1 then > 2065
if SLR3 then in 2050

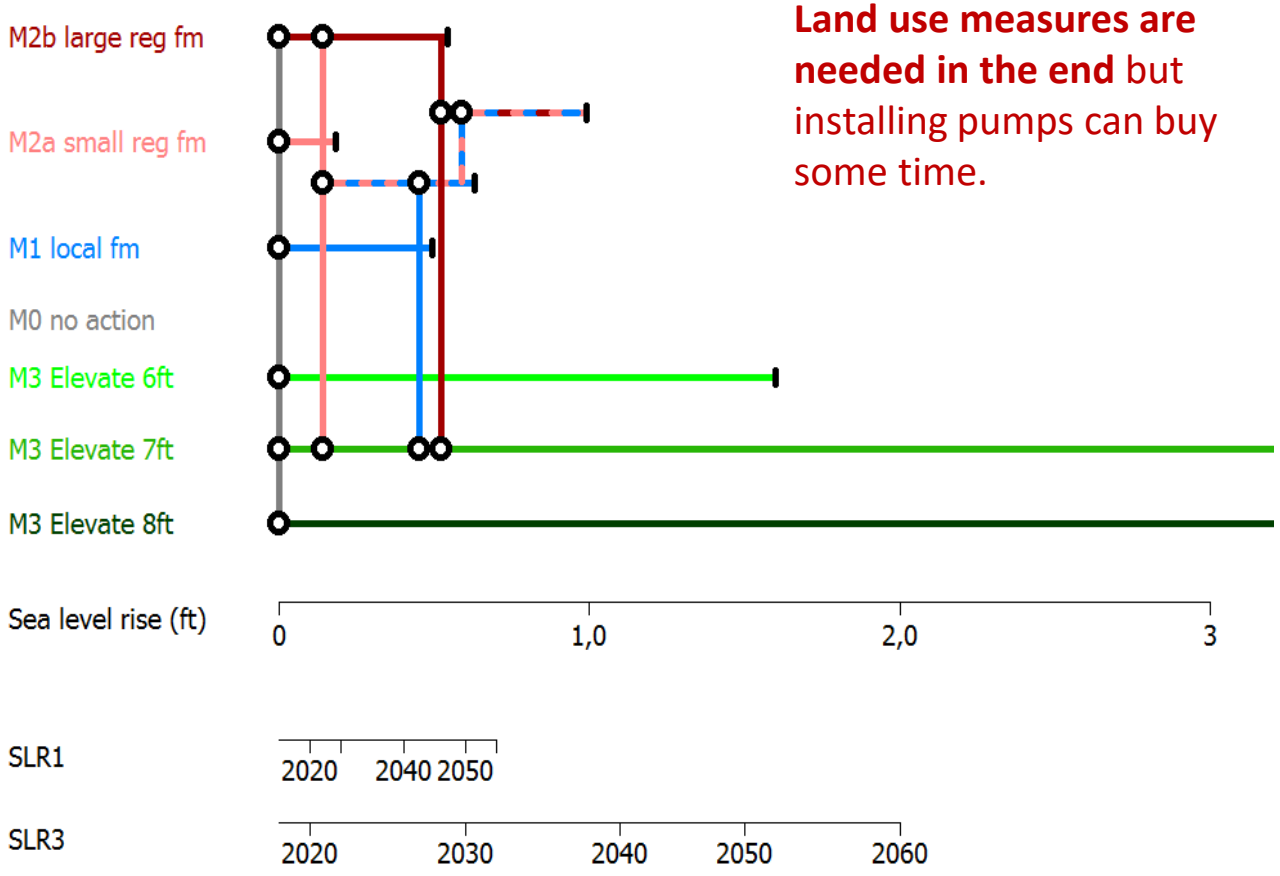
SLR1 2065 (0.76 ft)

SLR3 2065 (2.21 ft)

Pathways

Adaptation Pathways Map:

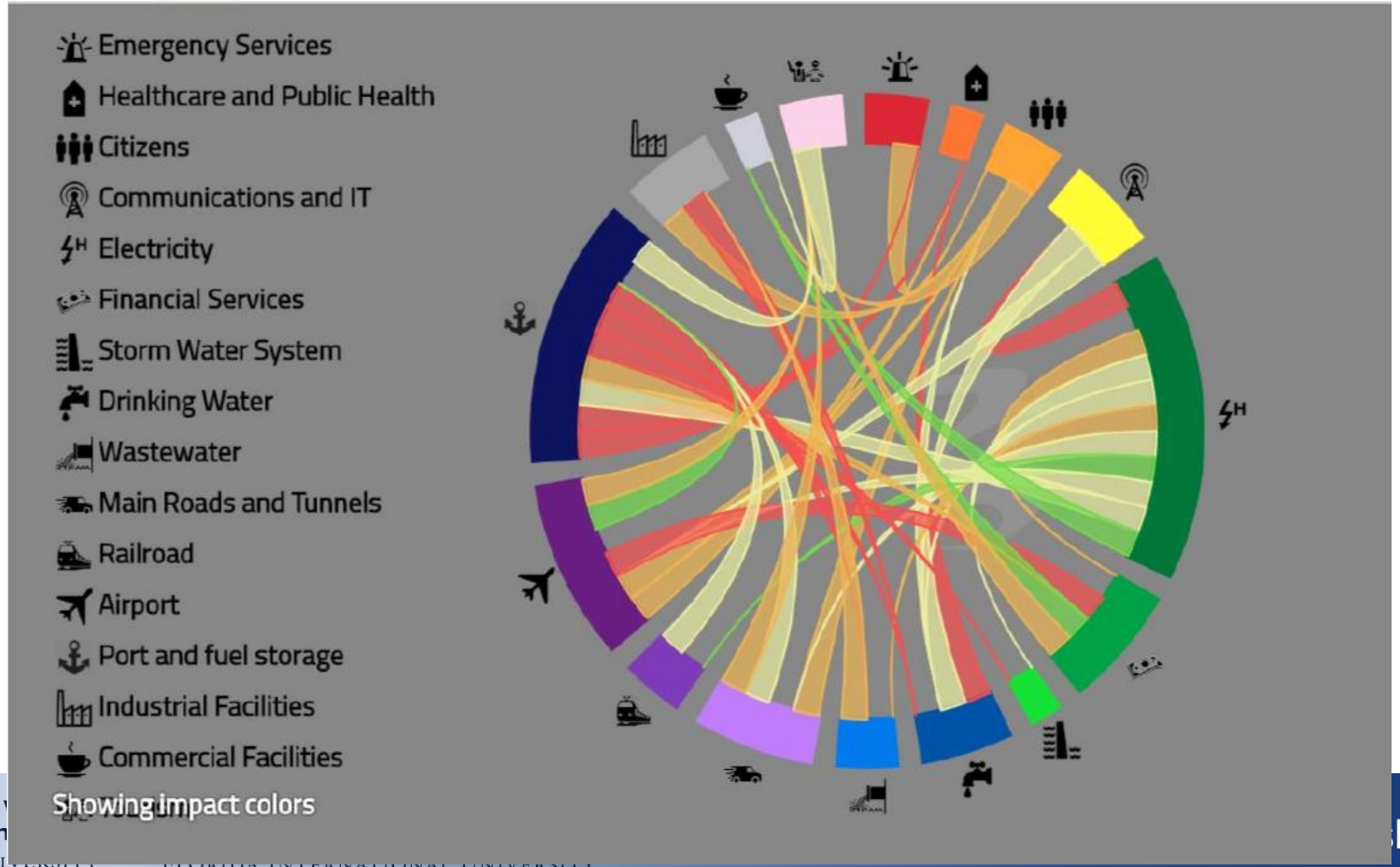
- From M1 and/or M2 to M3
- Hydraulic measures combined with M3(6ft) gets you to 1.5ft SLR
- Pathways between M3 measures are not logical
- Estimated effect M1+M2



Land use measures are needed in the end but installing pumps can buy some time.

Map generated with Pathways Generator, ©2015, Deltares, Carthago Consultancy

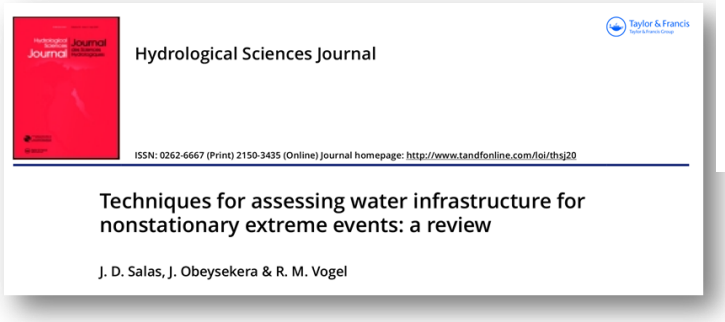
Circle Project (Broward County, Deltares- Netherlands, SFWMD

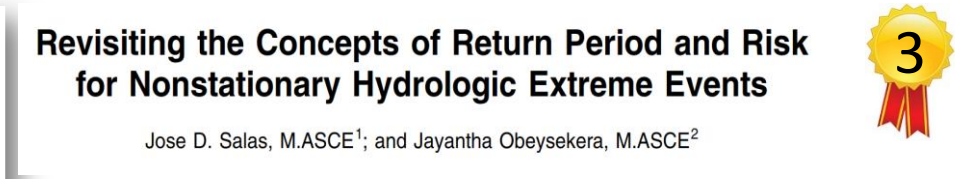


Questions?

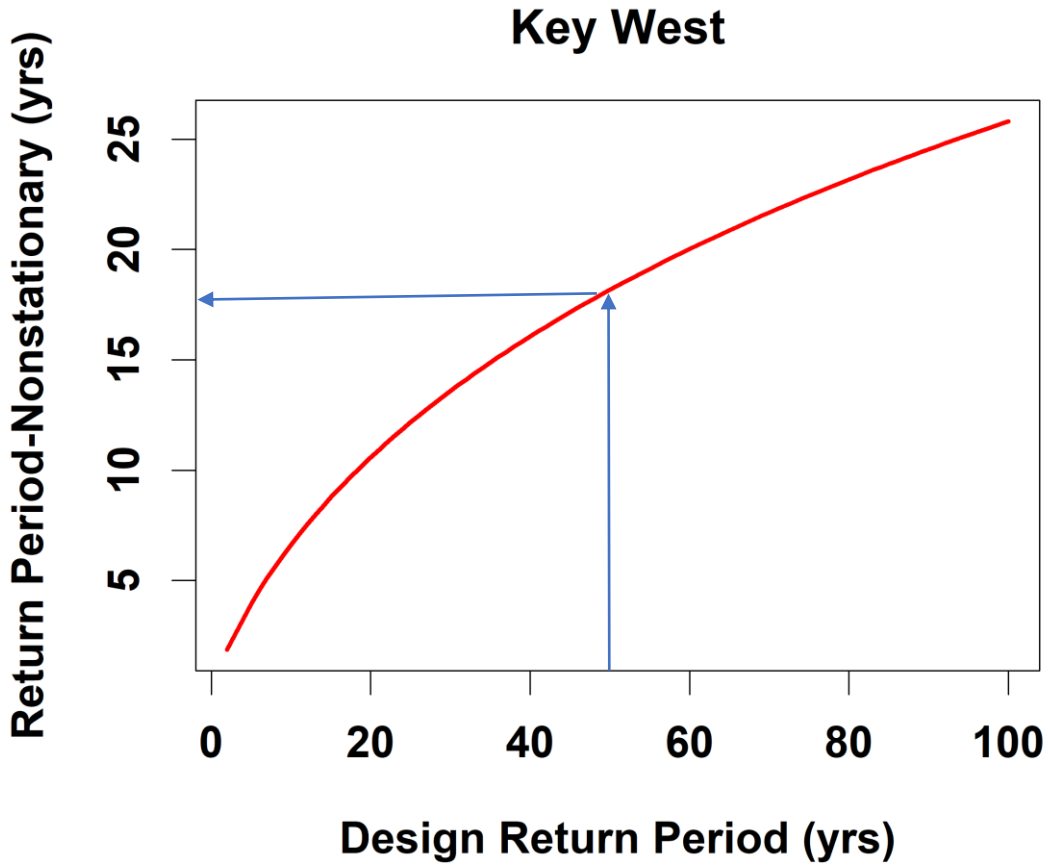
Design Criteria

- ❑Expected Waiting Time – Return Period (EWT)
- ❑Expected Number of Events (ENE)
- ❑Design Life Level (DLL) – Risk Based





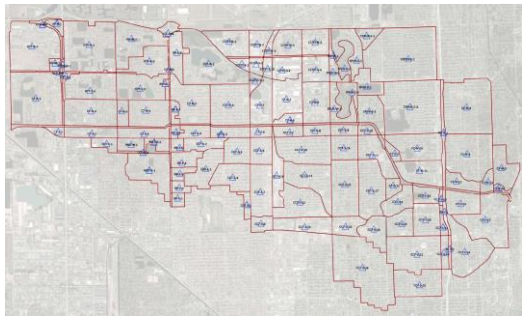
Return Period (EWT) Curve for Key West



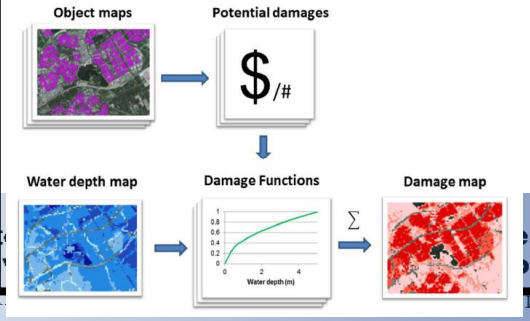
Flood Risk Management in Miami-Dade County (with Deltares) : C-7 basin

Hydrologic Drivers:
Rainfall; Storm Surge
Sea Level Rise

Hydrodynamic Model
XPSWMM



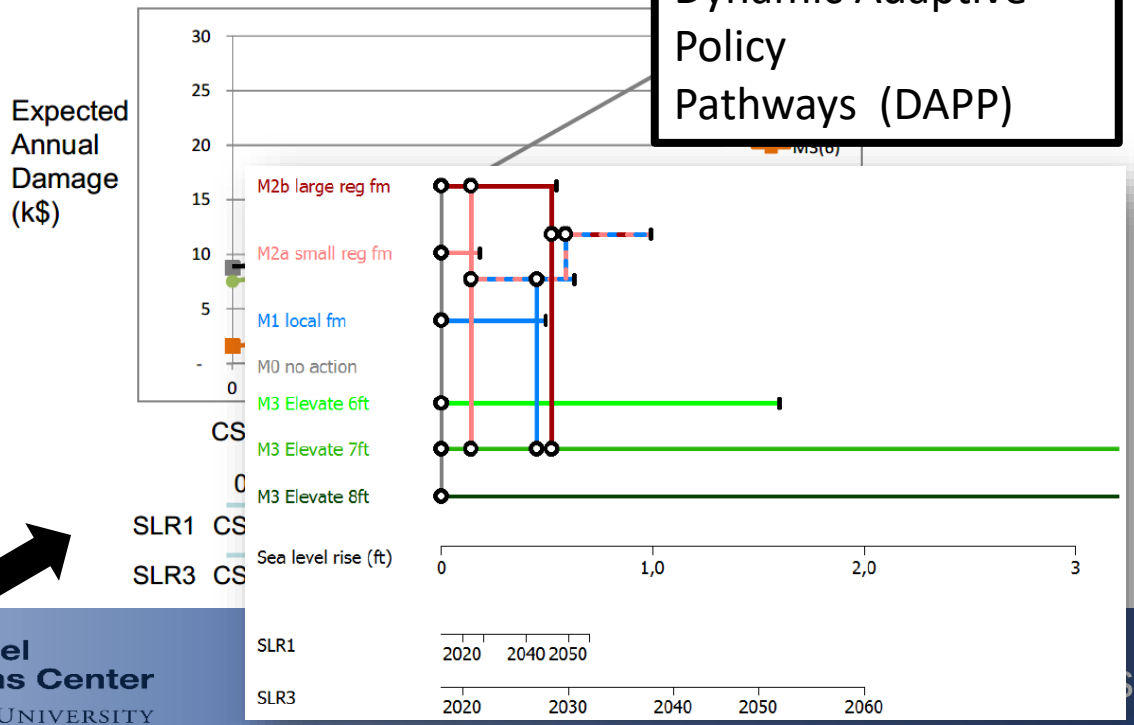
Delft-FIAT damage model



Adaptation Options:

- M1:Local Flood Mitigation (flood walls, pumps)
- M2:Regional Flood Mitigation (Forward pumping at outlet)
- M3:Land-use mitigation (elevate buildings, roads)

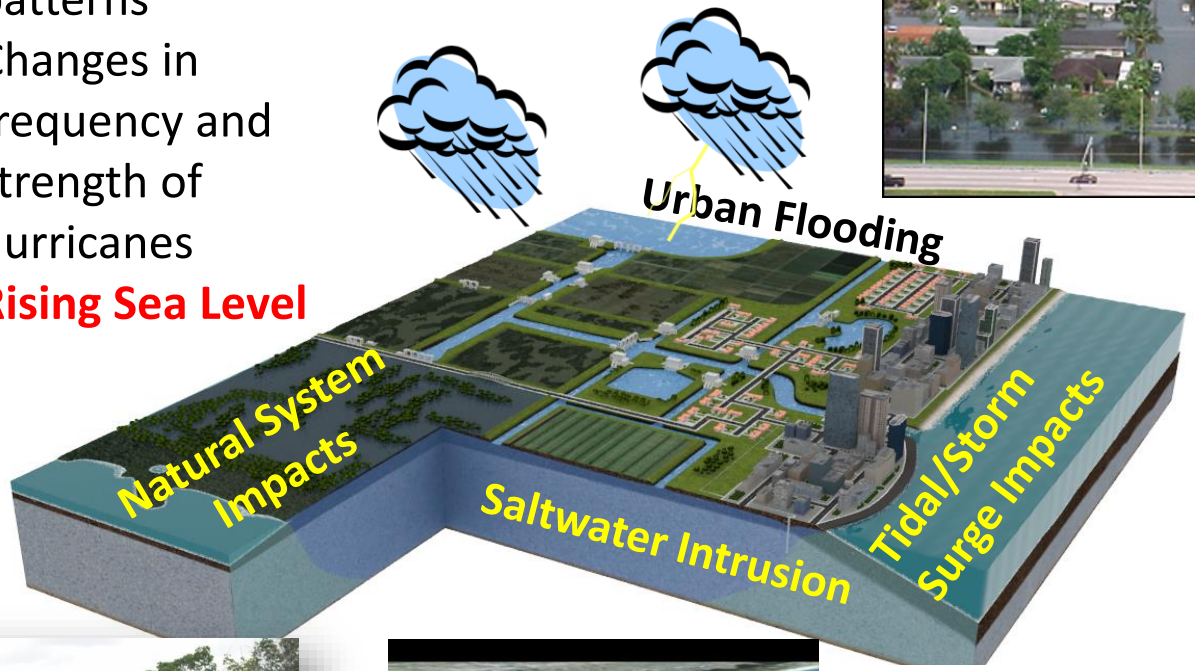
Dynamic Adaptive Policy Pathways (DAPP)

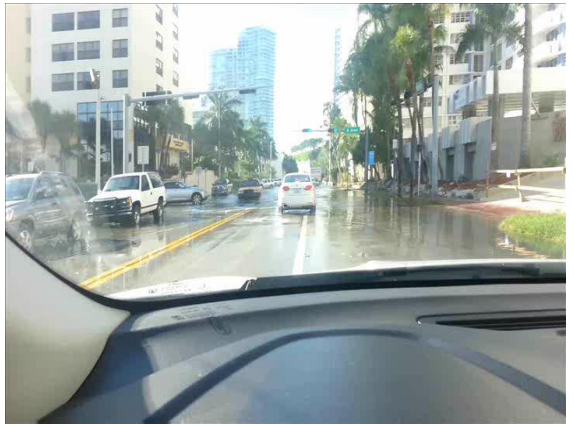


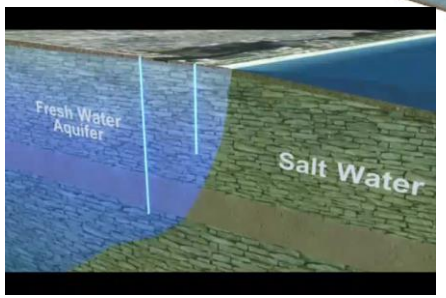
Impacts of Changing Climate and Rising Sea Levels

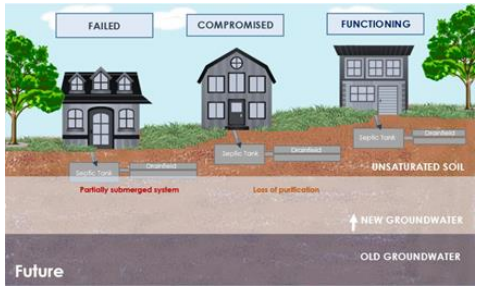
Drivers/Stressors:

- Increasing Temperature
- Change in rainfall patterns
- Changes in frequency and strength of hurricanes
- **Rising Sea Level**



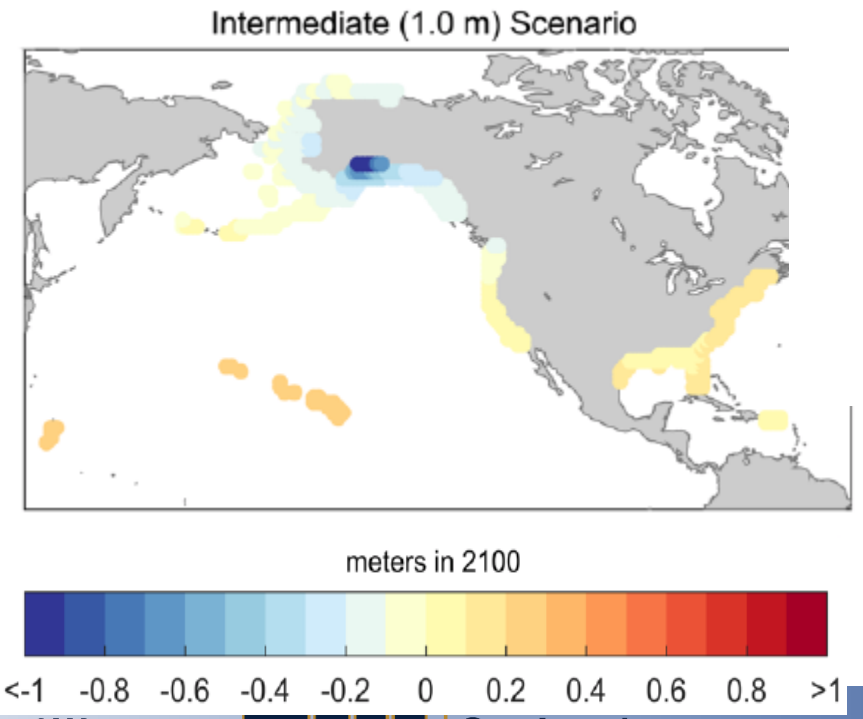






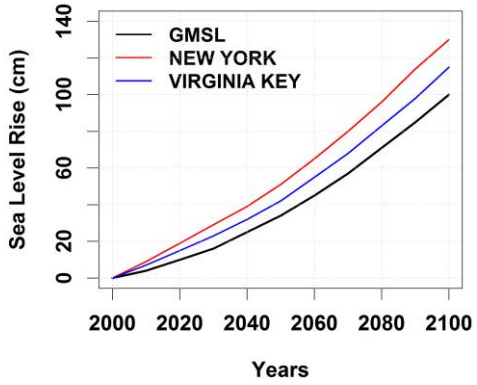
Regional Sea Level Projections

- Both Hall et al. (DoD 2016) and Sweet et al. (NOAA 2017) accounted for all components



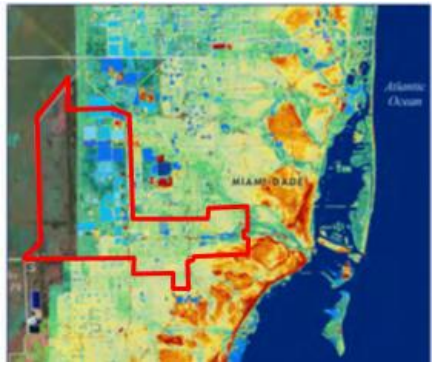
Florida

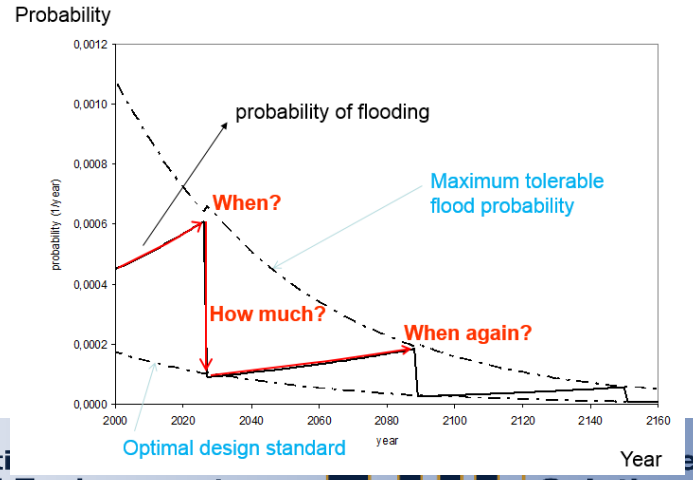
Regional Sea Level Curves



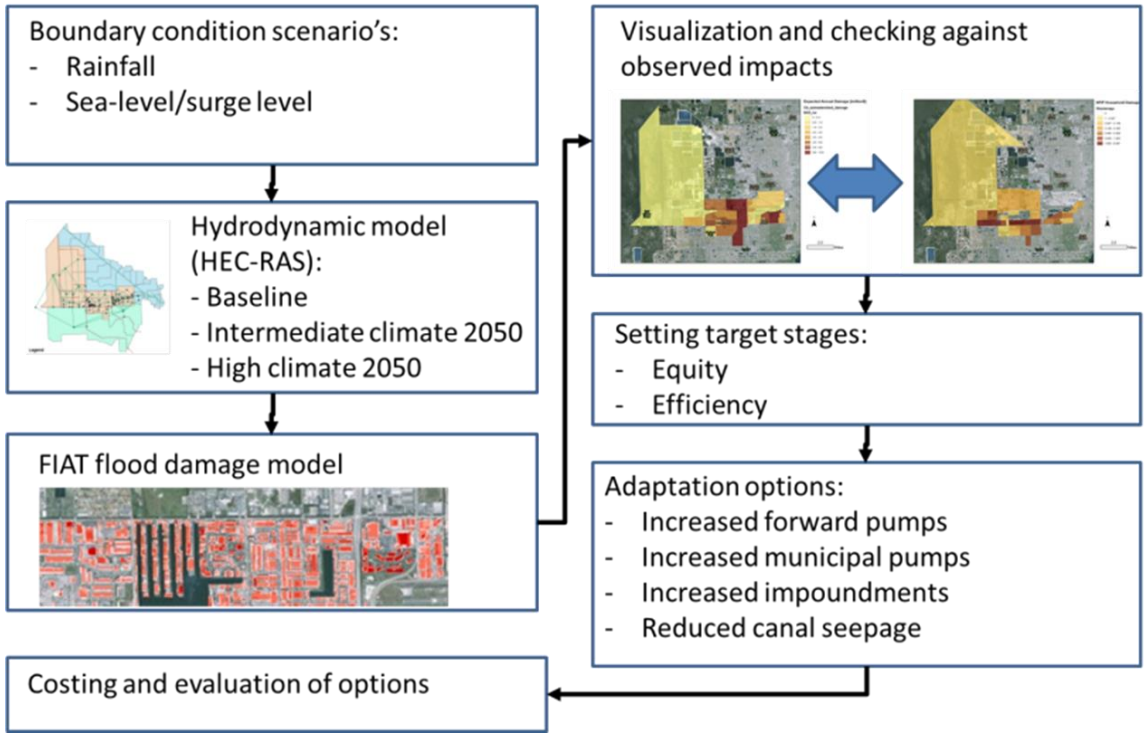
Flood Risk Management in Miami-Dade County (with Deltares)

- Determine optimal investment in flood risk reduction in the C-4 basin



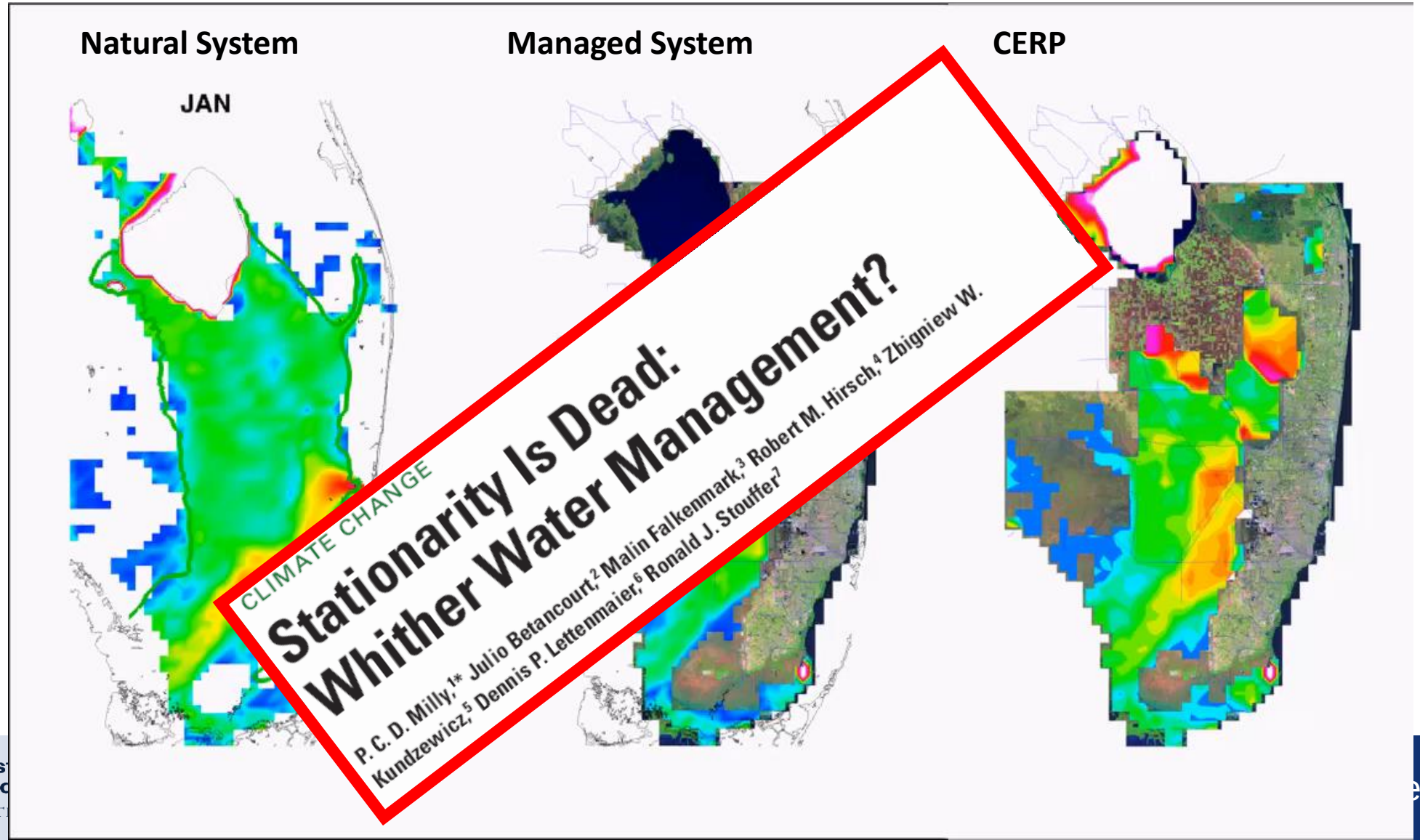


Workflow:



Lessons: (a) Hydraulic model + FIAT is useful for economic analysis of flood damages
(b) Optimization model could not be pursued
(c) Equity and Efficiency are useful concepts

Climate Change: Do we need a new paradigm?



Day 2 Wrap Up

WRAP UP AND NEXT STEPS

- Summarize meeting outcomes
- November 2019
  - Steering Committee Meeting
- January 2020
  - Resilience Subcommittee Web Conference
- April 2020
  - Resilience Subcommittee Web Conference