

Resilience in Transportation

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Florida Department of Transportation, District 4

Broward County Climate Change Task Force

February 27, 2020



Overview

- ▶ What FDOT and partners have been doing to increase transportation system resiliency
- ▶ What is known about vulnerability of transportation infrastructure in Southeast Florida
- ▶ How data, tools, and approaches relating to resilience are evolving
- ▶ How resilience is being incorporated into long range planning for transportation system
- ▶ What is happening with SR-A1A (Hollywood) Tidal Flooding Study

What FDOT and partners have been doing to increase transportation system resiliency

Planning for Transportation System and Transportation Project Development Phases



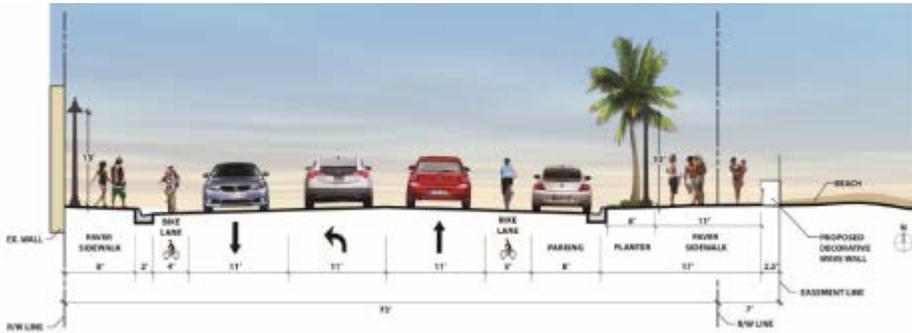
- ▶ *Have found increasing transportation system resiliency is not linear process always starting with long range planning and always ending with operations and maintenance. Instead, FDOT and partners are figuring out how best to increase resiliency on multiple fronts at same time.*

Storms and Sea Level Rise



Hurricane Sandy - SR A1A in Fort Lauderdale

Storms and Sea Level Rise

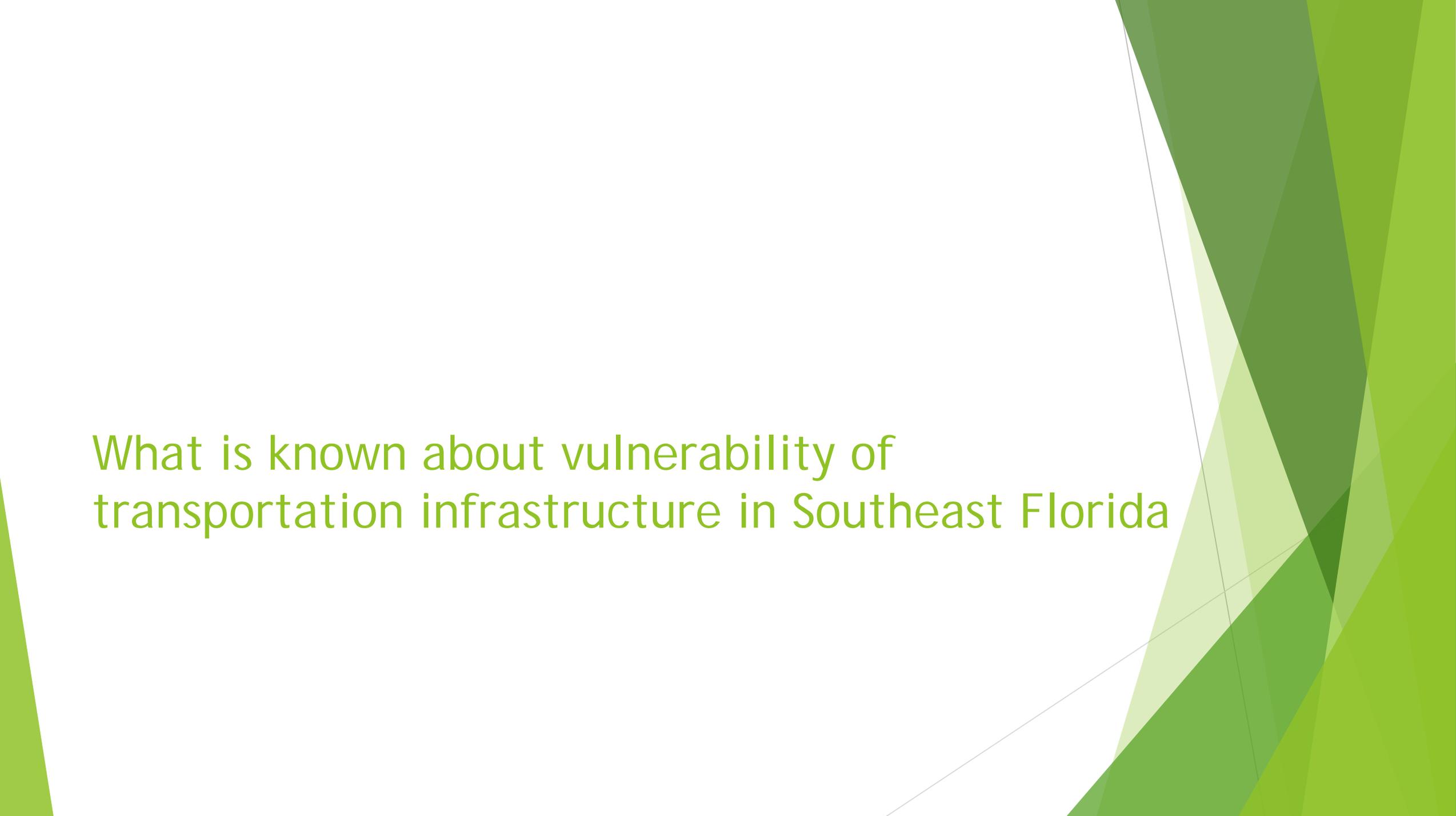


Permanent Project Reflecting Resiliency and Community Goals for SR A1A in Fort Lauderdale

Sea Level Rise and Flooding



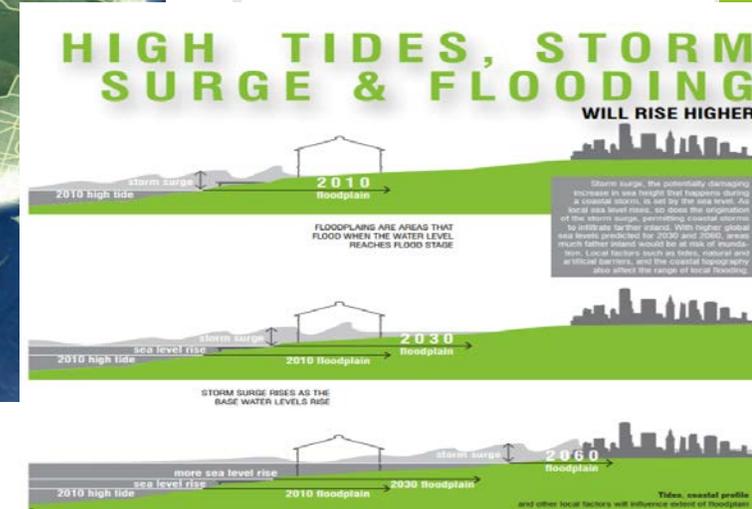
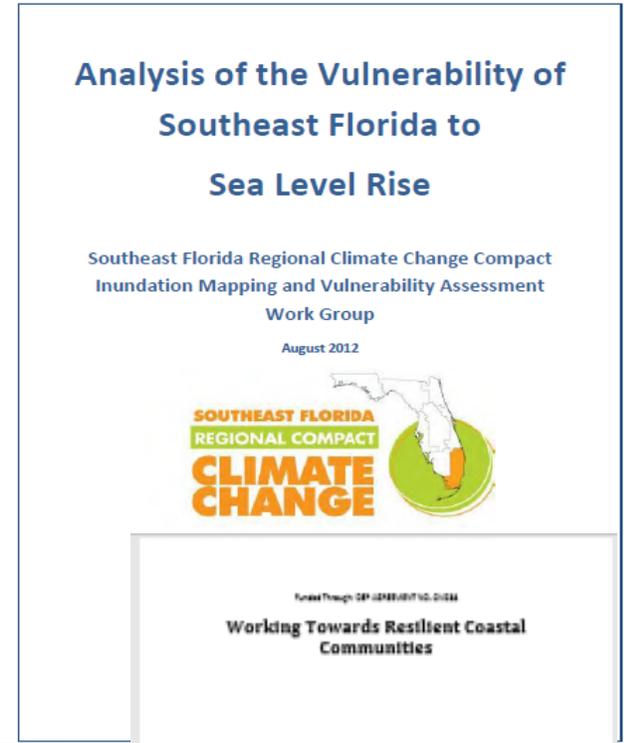
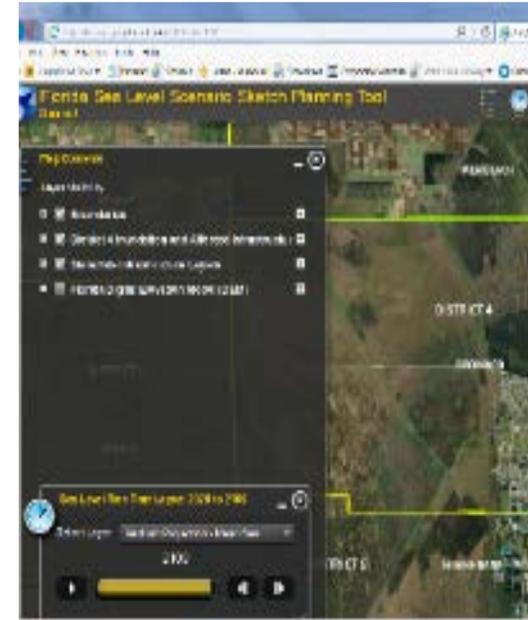
Installation of Tidal Backflow Preventers:
Aluminum Flap Gate Example

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What is known about vulnerability of
transportation infrastructure in Southeast Florida

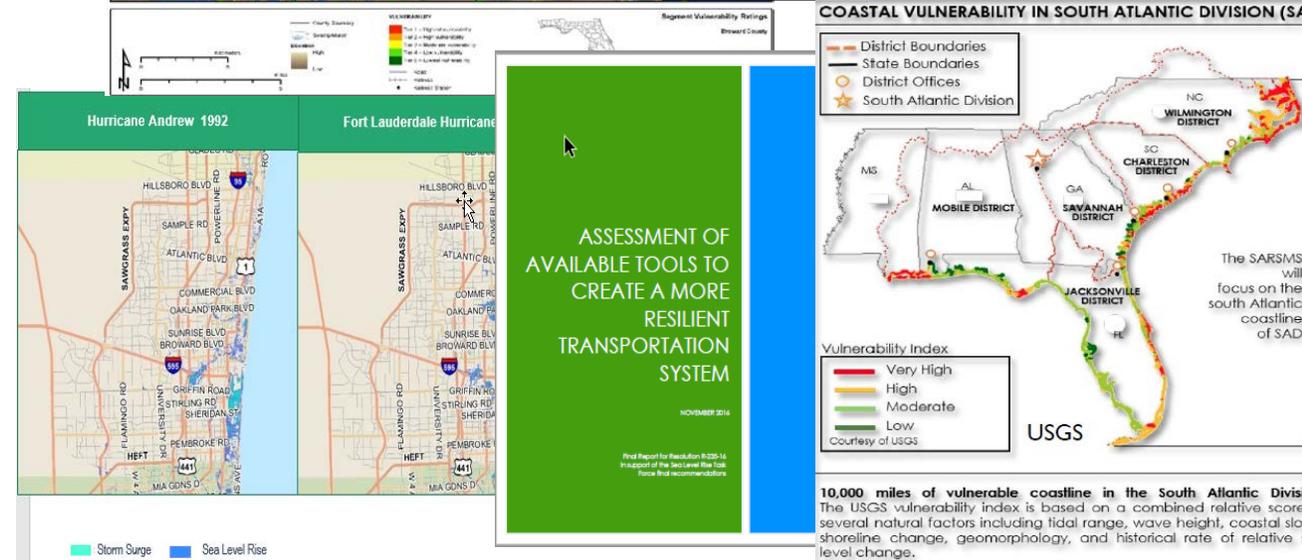
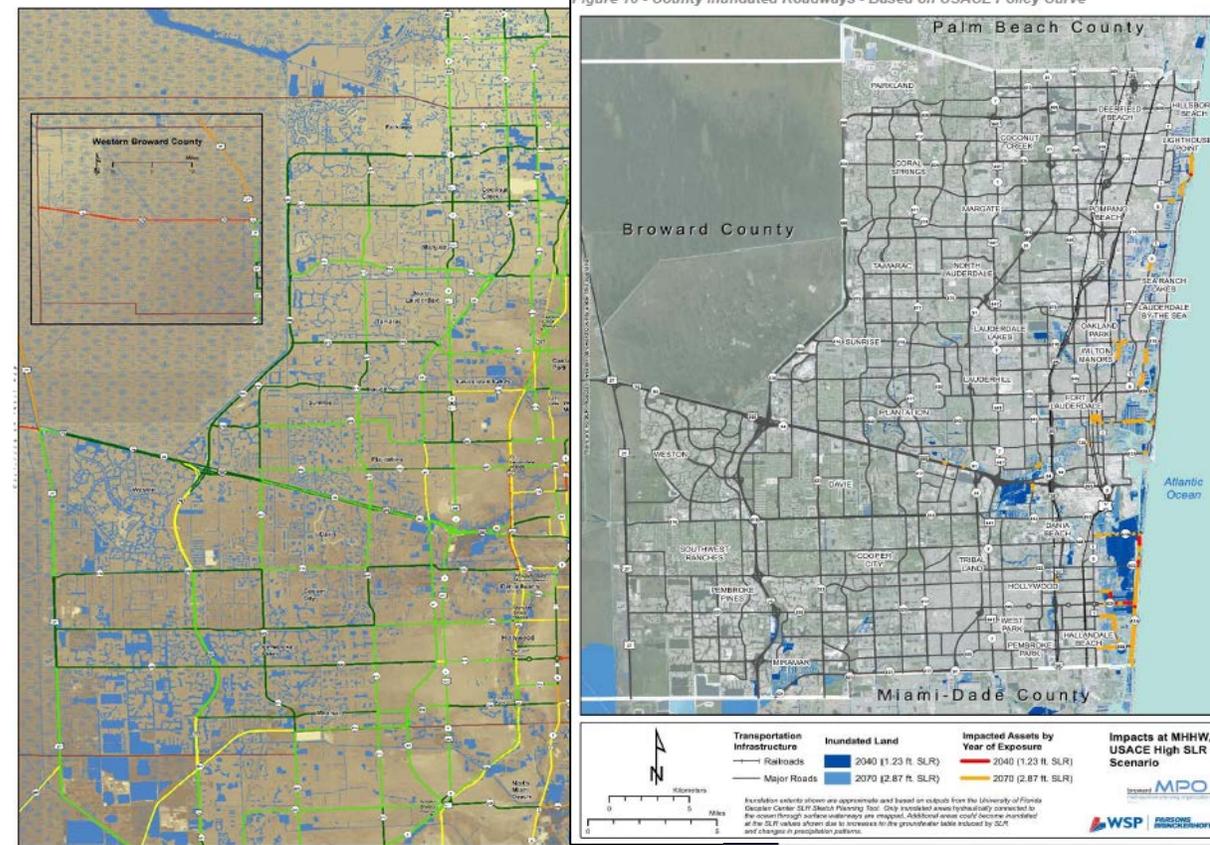
Identification of Vulnerable Transportation Infrastructure

- ▶ FDOT/UF GeoPlan Center Sea Level Scenario Sketch Planning Tool
- ▶ Analysis of the Vulnerability of Southeast Florida to Sea Level Rise (2012, Southeast Florida Regional Climate Change Compact)
- ▶ Municipal Vulnerability to Sea Level Rise Assessments (Broward County)
- ▶ *Climate Compact Seven County Inundation Assessment* - done through Seven50 regional visioning initiative (2014, SFRPC/TCRPC)



Identification of Vulnerable Transportation Infrastructure

- ▶ 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)
- ▶ Miami-Dade County Assessment of Available Tools to Create a More Resilient Transportation System (2016)
- ▶ South Atlantic Coastal Study (USACOE, underway)

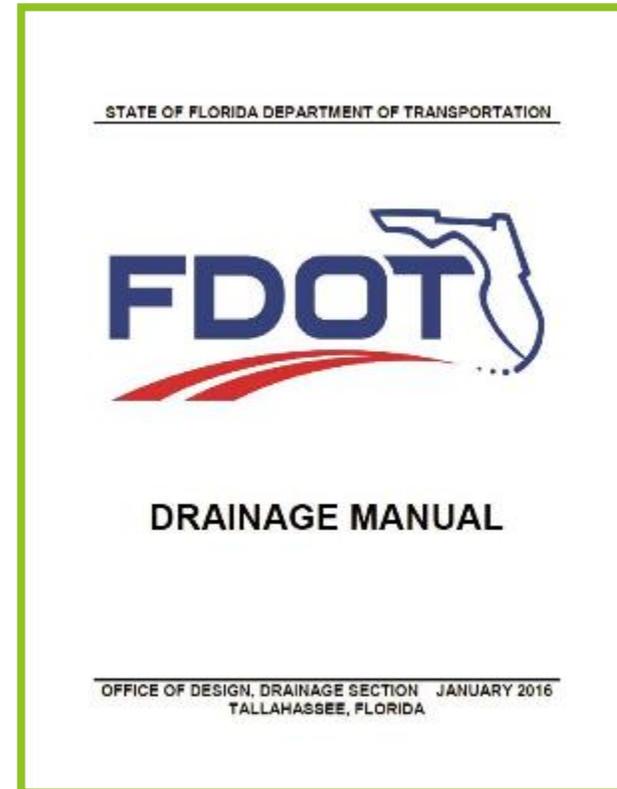


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How data, tools, and approaches relating to
resilience are evolving

Evolving Data, Tools, and Approaches

- ▶ Changes in 2016 to FDOT Drainage Manual
- ▶ Consider Sea Level Rise (SLR)
 - ▶ 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
- ▶ Monitoring federal guidance, SLR projection activities, etc.



Evolving Data, Tools, and Approaches

- ▶ FDOT:
 - ▶ Actively monitors in sea level rise along Florida's coastline
 - ▶ Maintains District 4 Drainage Inquiry Database of King Tide impacts and other flooding on state roads
 - ▶ Periodically updates design tools with rainfall, sea level, and other data
 - ▶ Consults with local governments on evolving erosion, drainage, and other such issues



Evolving Data, Tools, and Approaches

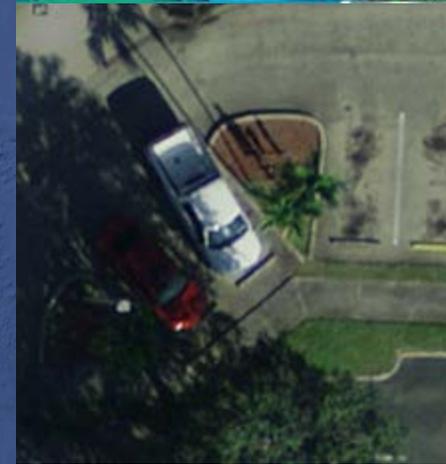
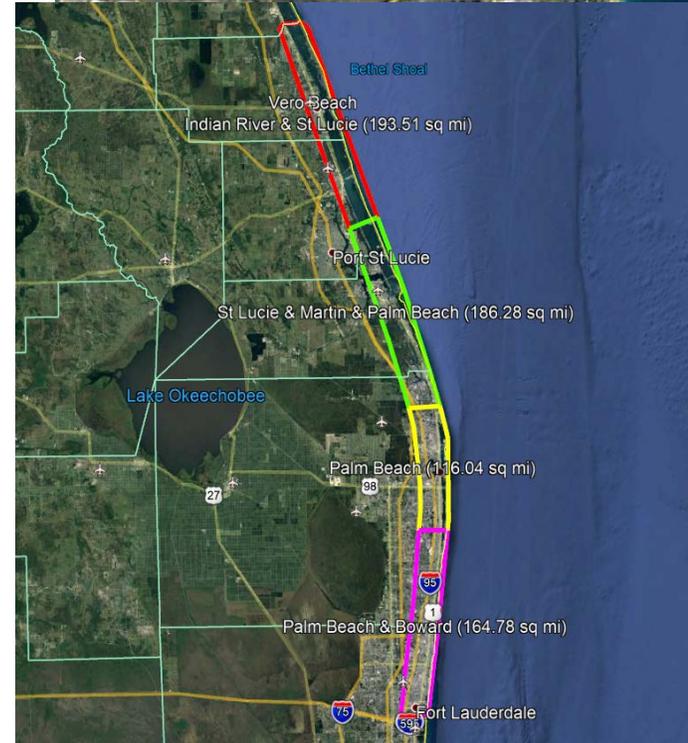
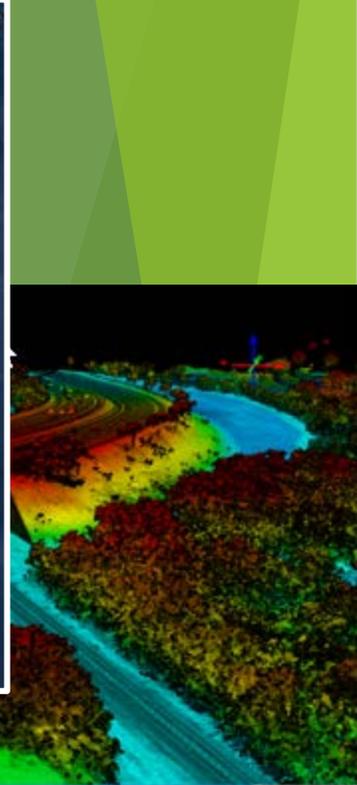
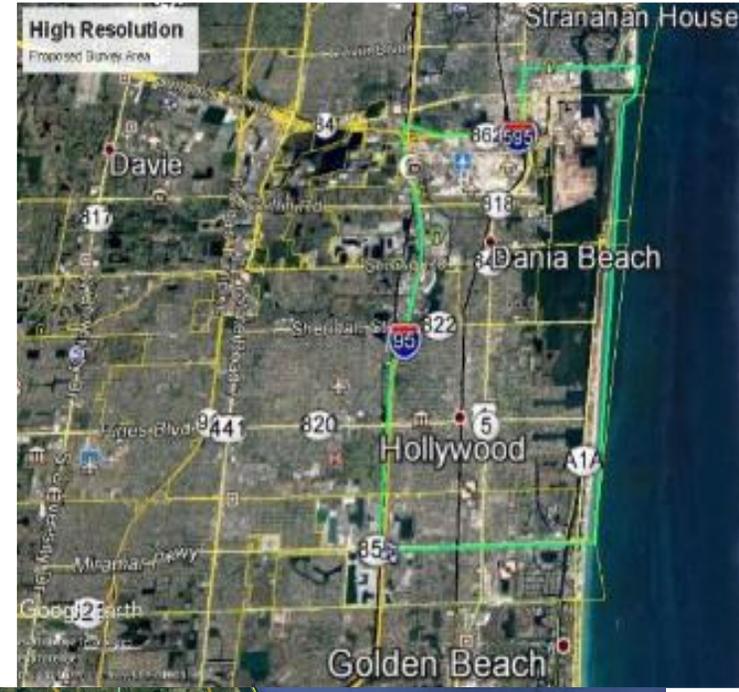
► High Resolution Elevation Data Project

► Pilot Study in Broward County

- Involved 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 useful for various purposes
- Covered 25-square mile area linked to USACE/ Broward County flood risk management study

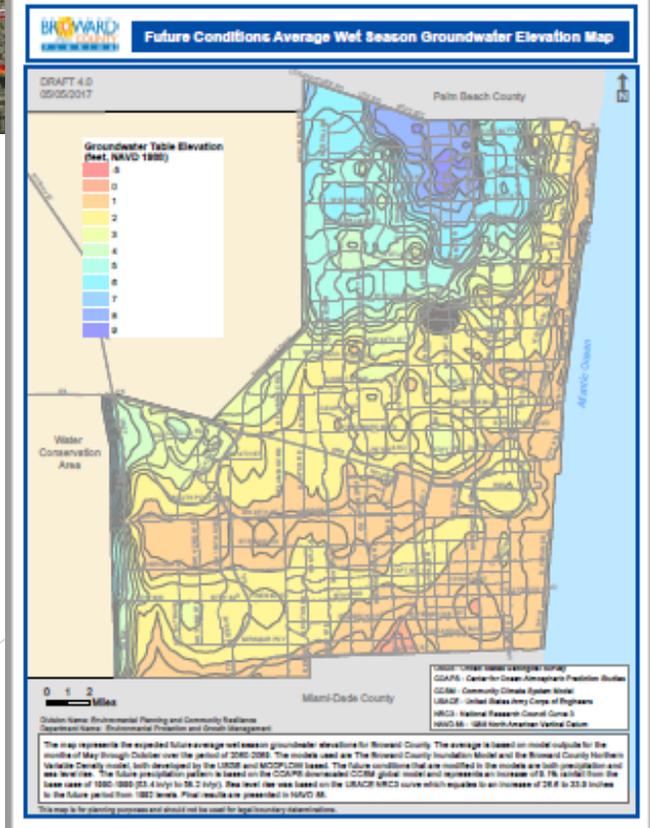
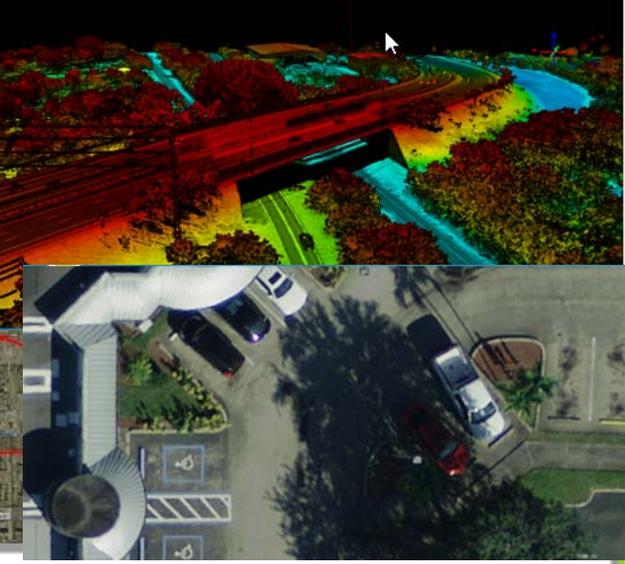
► East Coast Mapping Project in District 4

- Used lessons learned from pilot study
- Extends area covered along coast from Broward County to Indian River County
- Currently scheduled to conclude in fall 2020

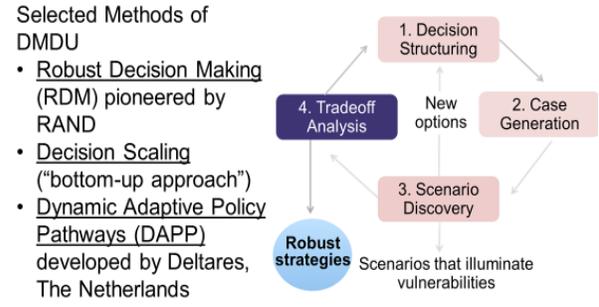


Evolving Data, Tools, and Approaches

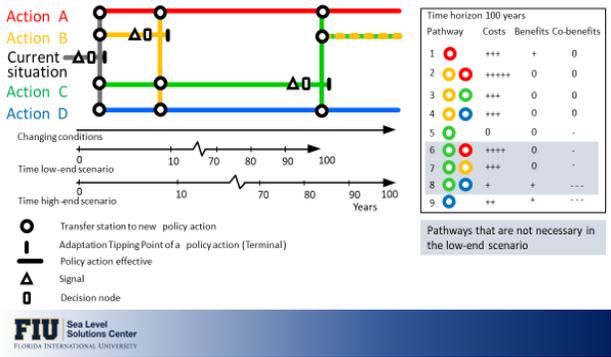
- ▶ Sharing Vulnerability Data: City of Sunrise
- ▶ Better Data and Tools:
 - ▶ High Resolution Elevation Data
 - ▶ Broward County Future Conditions Map Series
- ▶ New Approaches: Dynamic Adaptive Policy Pathways



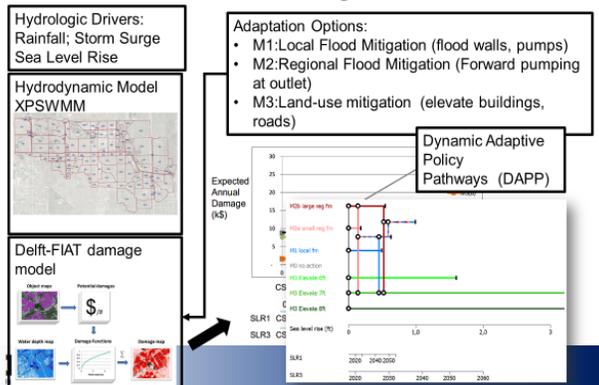
Decision Making Under Deep Uncertainty

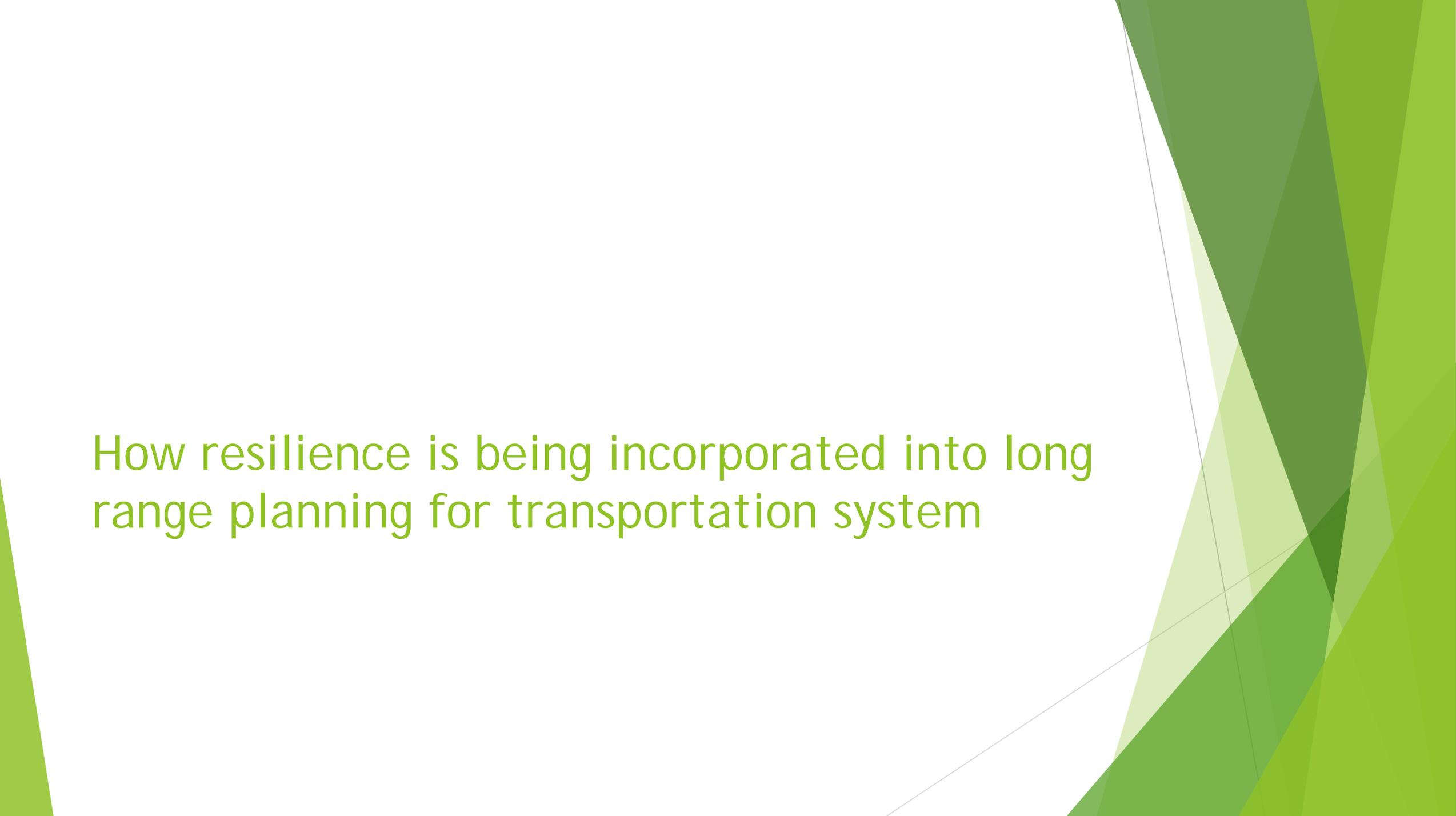


Dynamic Adaptive Policy Pathways (DAPP)



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



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How resilience is being incorporated into long range planning for transportation system

Planning for Transportation System and Transportation Project Development Phases

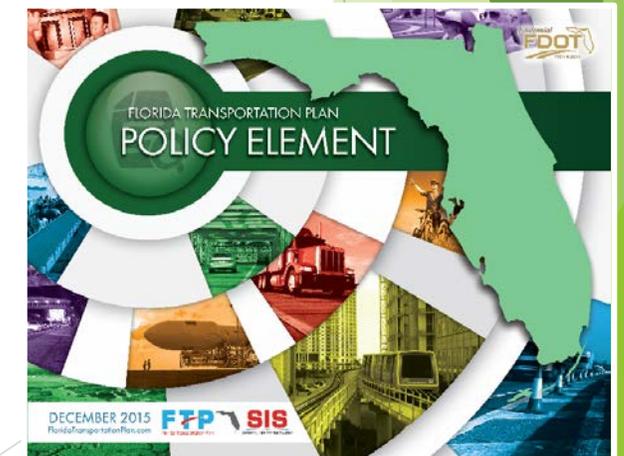
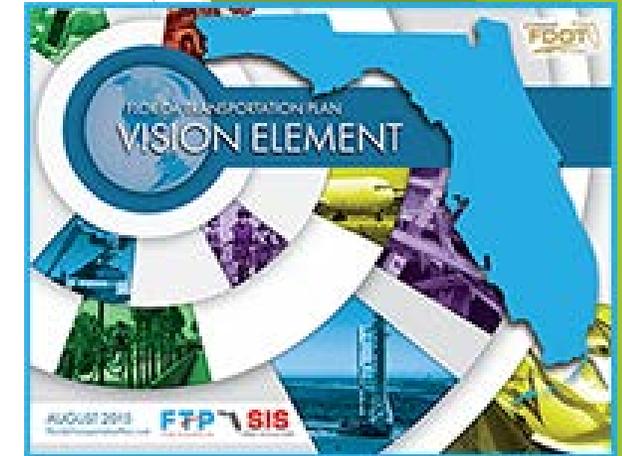


▶ *Long Range Planning for the Transportation System:*

- ▶ *Long Range Transportation Plan for State: Florida Transportation Plan*
- ▶ *Long Range Transportation Plans developed by metropolitan planning organizations, including Broward MPO and Southeast Florida Transportation Council (Miami-Dade TPO, Broward MPO, Palm Beach TPA)*

Transportation Policy

- ▶ Federal Fixing America's Surface Transportation (FAST) Act addresses planning for and expenditures on surface transportation system
 - ▶ *Added planning factor: Improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation*
- ▶ Florida Transportation Plan is statewide plan guiding Florida's transportation future
 - ▶ *Agile, Resilient, and Quality Infrastructure Goal*
- ▶ Florida Statutes - Long Range Transportation Plans
 - ▶ *Metropolitan planning organizations are encouraged to consider strategies that integrate transportation and land use planning to provide for sustainable development and reduce GHG emissions*

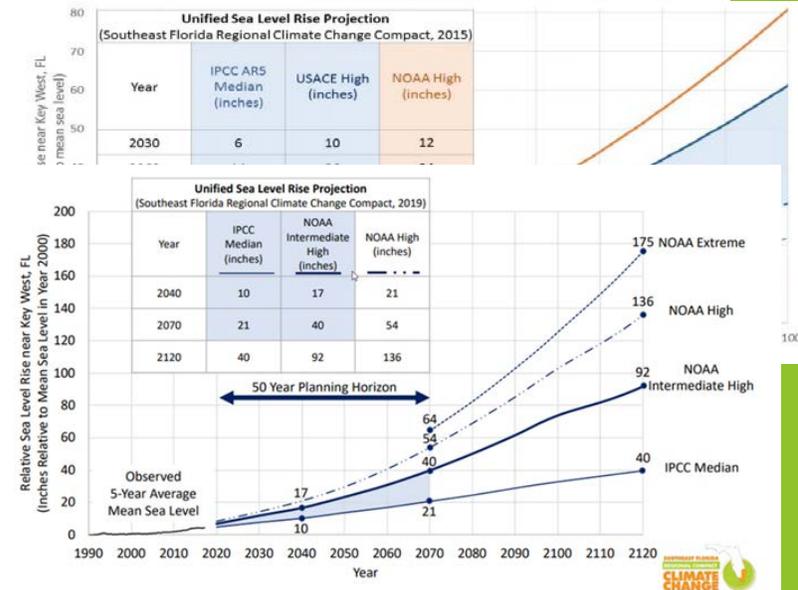


Climate Change Action Plans

- ▶ Mitigation and adaptation covered in transportation-related recommendations in Broward County Climate Action Plan and Regional Climate Action Plan 2.0
- ▶ Highlights from RCAP 2.0 -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*

**CLIMATE
ACTION
PLAN**

BROWARD COUNTY Local Strategy to Address Global Climate Change
FLORIDA



Florida Transportation Plan Update

- ▶ FTP update kicked off in May 2019, adoption in 2020
- ▶ Research for update:
 - ▶ Three state universities performed assessment of planning risks and alternative futures with five areas of inquiry: population, economics, environment, technology, and global issues
 - ▶ Identified four most common ways resilience is being addressed in long range transportation plans for other state DOTs:
 - ▶ Define goals & objectives
 - ▶ Identify asset vulnerabilities (defining needs)
 - ▶ Screen projects to avoid or modify investments in vulnerable areas (developing strategies)
 - ▶ Include resilience criteria for evaluating projects (evaluating alternatives, selecting investments)



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FLORIDA TRANSPORTATION PLAN

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Florida Transportation Plan Update

- Focusing update on four cross-cutting topics including resilience

Technology	Resilience	State/Interregional	Regional/Local
<ul style="list-style-type: none"> • Automated, connected, electric, and shared vehicles • Transportation system management and operations • Big data • New materials and processes 	<ul style="list-style-type: none"> • Extreme weather • Emergency evacuation and response • Sea level rise • Flooding • Economic and societal changes 	<ul style="list-style-type: none"> • SIS, including modal facilities • Trade & logistics • Multi-use/multi-modal facilities • Global, statewide, and interregional connectivity • Florida's economic drivers and industries 	<ul style="list-style-type: none"> • Urbanized, non-urbanized, and rural • Congestion relief • Land use and community planning • Regional visions • Environment • Economic development
			

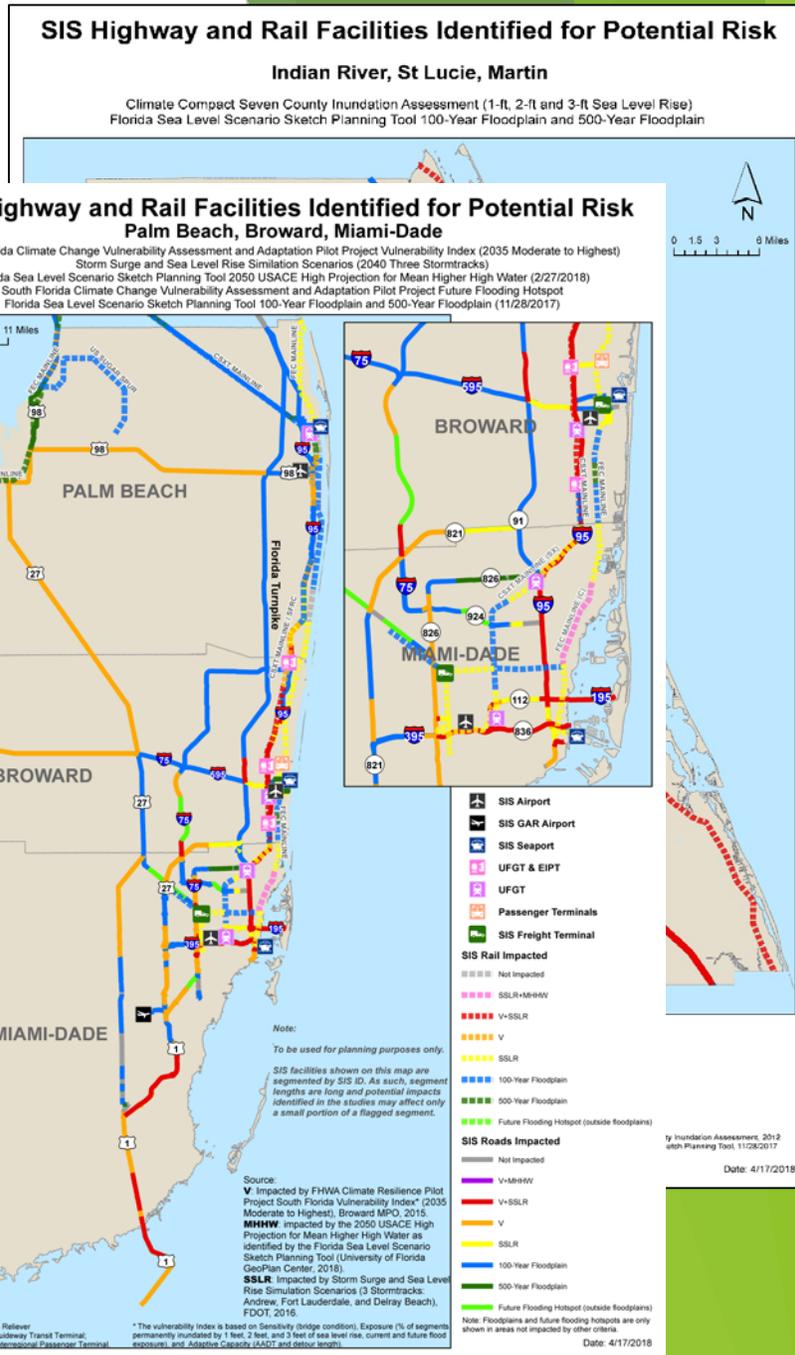
- Steering Committee for update supported by Resilience Subcommittee, including 'friends' from Southeast Florida



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2045 Long Range 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



Vulnerability Assessment of SIS Facilities

- ▶ Phase 1 - Completed
 - ▶ Identify and assess potential risk and vulnerability to SIS highway corridors and military access facilities from:
 - ▶ Storm Surge, Flooding (100-year), Sea Level Rise
 - ▶ Assess impacts to SIS highway corridors from evacuating and return traffic impacts from Hurricane Irma
- ▶ Phase 2 - Underway
 - ▶ Expand facilities assessed to include rail, SIS hubs, and SIS highway connectors
 - ▶ Expand risks and vulnerabilities considered, such as wildfire, extreme heat, and sinkholes
 - ▶ Expand assessment of hurricane impact case study
 - ▶ Develop Resiliency Action Plan



2045 Long Range 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 TPO 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 Long Range 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

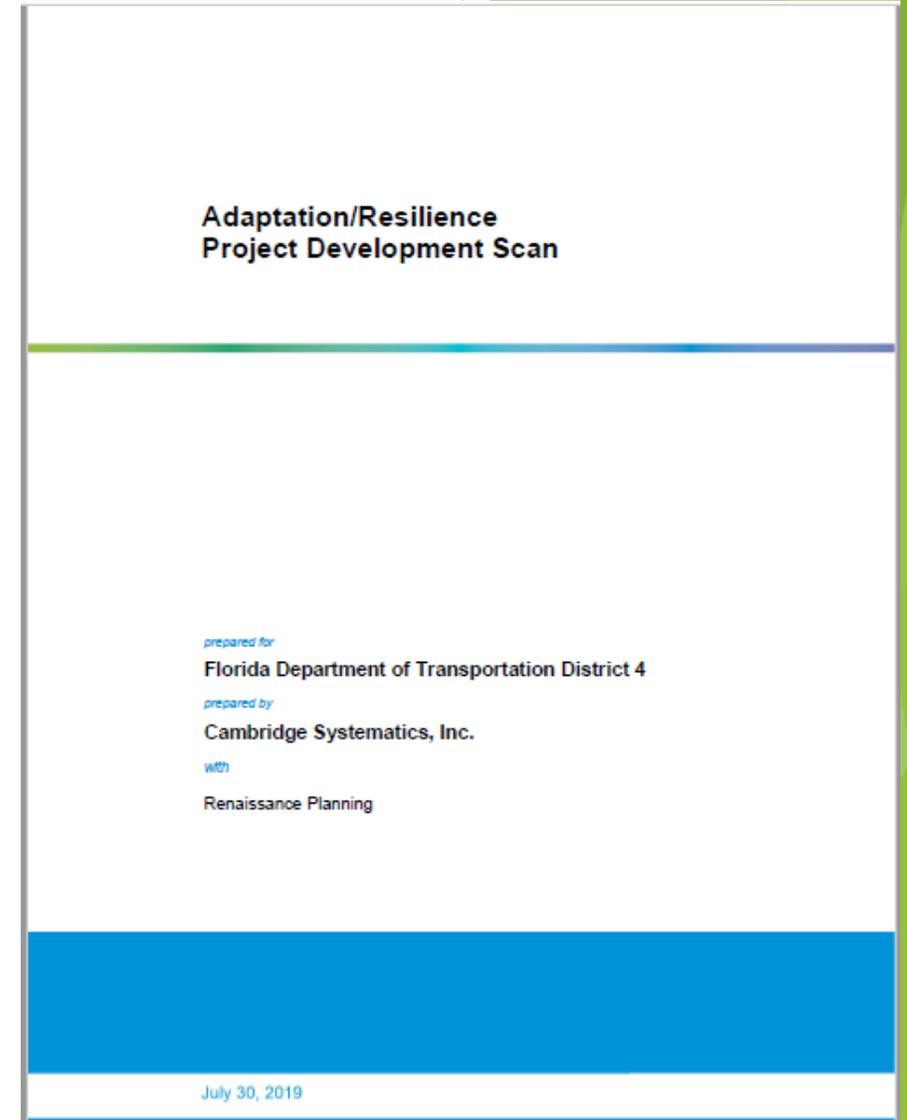
► Palm Beach TPA 2045 Long Range Transportation Plan

- 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%

D4 Adaptation/Resilience Project Development Project Scan

- ▶ Completed in response to question from Broward MPO on cost of studies to address resilience/adaptation for projects involving known or potentially vulnerable transportation infrastructure
- ▶ No single established process or methodology for navigating from conducting vulnerability assessments to identifying and integrating strategies into transportation project delivery process
- ▶ Broward MPO's 2045 Metropolitan Transportation Plan includes eight studies to determine resiliency improvements

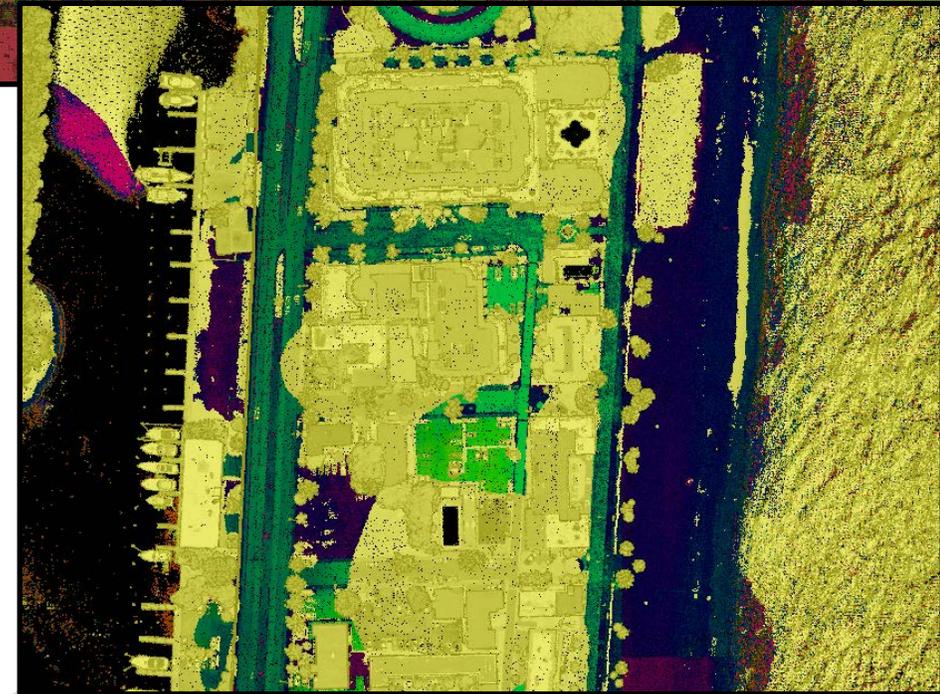
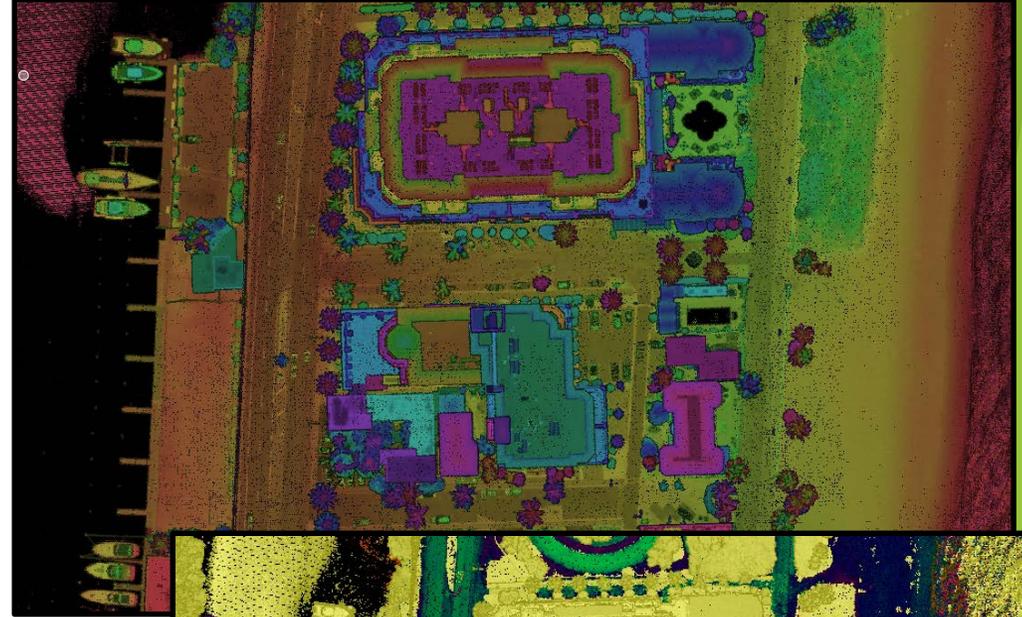




What is happening with SR-A1A (Hollywood) Tidal Flooding Study

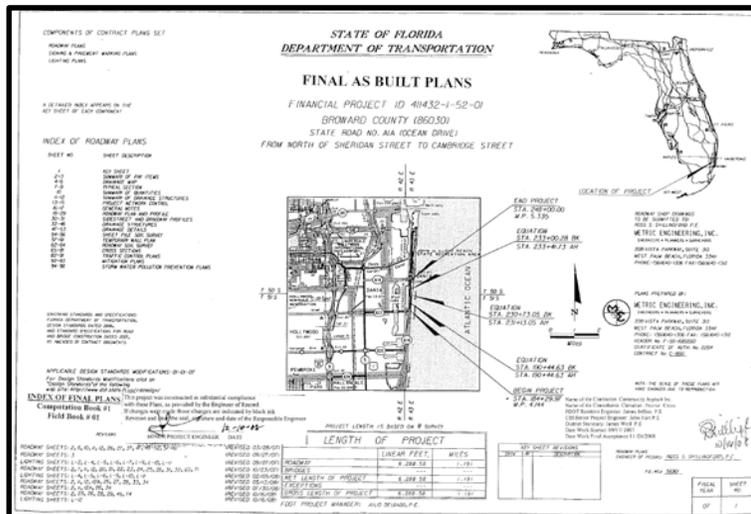
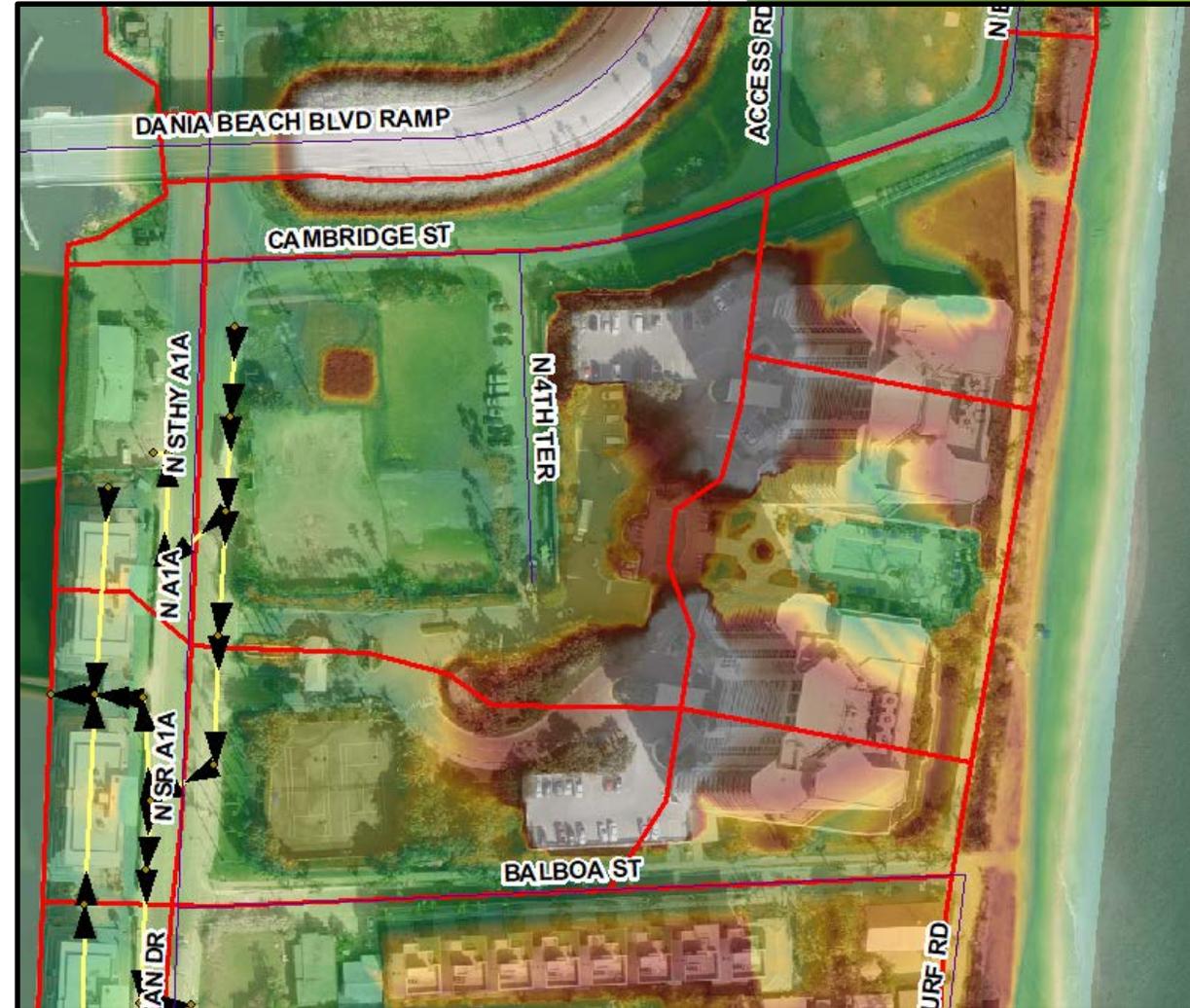
SR-A1A (Hollywood) Tidal Flooding Study

- ▶ Study area extends from ramp tie down just south of Hallandale Beach Boulevard to south end of A1A bridge just north of Dania Beach Boulevard
- ▶ Teaming Partners: FDOT District 4, Broward MPO, Broward County, City of Hollywood CRA, and City of Hollywood
- ▶ Study Status:
 - ▶ Received High Resolution LiDAR data from FDOT



SR-A1A (Hollywood) Tidal Flooding Study

- ▶ Received as-built data and CADD files from ongoing FDOT projects along corridor
 - ▶ Supports input of pipe and invert data, designation of pipe types and pipes that have been lined and identified pipes with back flow prevention installed
- ▶ Digital Elevation Model and CADD data are inputs to GIS for data manipulation and ICPR4 model development



SR-A1A (Hollywood) Tidal Flooding Study

NEXT STEPS:

- ▶ Field reviews to ground truth existing data and to obtain data not provided such as pipe sizes, inverts, types, and connections of existing systems
 - ▶ CADD data provided covers areas between Hollywood Boulevard and Sheridan Street, so pipes, inverts, and connections have been read into GIS.
 - ▶ Study team will obtain field data for areas between Hallandale Beach Boulevard and Hollywood Boulevard and between Sheridan Street and Dania Beach Boulevard.
 - ▶ Existing seawalls will be reviewed for consistency, gaps, elevation variations; also will look for indicators of upwelling or other seawall breach to high tide.

SR-A1A (Hollywood) Tidal Flooding Study

NEXT STEPS:

- ▶ Incorporate field data into GIS.
- ▶ Develop ICPR 4 model and start calibration runs to debug and verify model.
- ▶ Apply King Tides to model to determine flooding areas of vulnerability and to determine areas where potential solutions can reduce flooding.
- ▶ Apply current and revised rainfall with low and high tides to determine flooding potential based on rainfall.

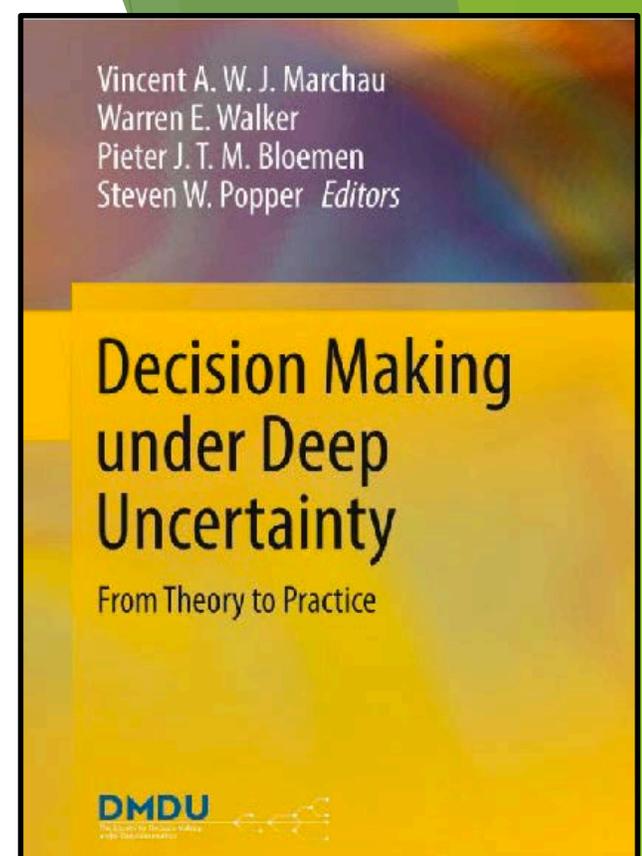
SR-A1A (Hollywood) Tidal Flooding Study

► Phase 1 Study Objectives

- Identify flooding associated with rainfall events.
- Identify flooding associated with King Tides.
- Establish existing conditions as a base line.

► Phase 2 Study Objectives

- Evaluate potential solutions to rainfall and King Tide events based on current data.
- Analyze potential solutions with sea level rise (SLR) projection from SE Florida Compact to determine effectiveness and to develop potential additional solutions for SLR.
- Apply Sea Level Scenario Sketch Planning Tool using Dynamic Adaptive Policy Pathway (DAPP) approach to determine which solutions should be implemented and when.
- Develop cost estimates for possible solutions



SR-A1A (Hollywood) Tidal Flooding Study

▶ Timelines:

▶ Phase 1

- ▶ Data Collection - Ongoing to end of February
- ▶ Model Development - Ongoing to end of March
- ▶ Existing Conditions reporting and summarization - April to June
 - ▶ Anticipate Existing Conditions Report June 19th

▶ Phase 2

- ▶ Evaluation of Alternatives- Mid April to end of May
- ▶ Alternatives reporting and summarization - Most of June
 - ▶ Anticipate Alternatives Report July 24th



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