



Integrating Resiliency into the Transportation Planning Process

Current State of the Practice for Florida MPOs

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1 Executive Summary

To better prepare for and adapt to worsening extreme weather events and climate stressors, transportation planning and infrastructure design must account for changing conditions caused by climate change. To address these concerns, the Fixing America's Surface Transportation (FAST) Act in 2015 brought requirements for transportation agencies to consider resiliency in their planning processes. Because resiliency is still an emerging topic for many agencies, peer learning and sharing of experiences is an important part of increasing the resiliency of Florida's transportation system.

This report reviews the current state of practice for how Florida MPOs are integrating resiliency in their long range planning processes to highlight the needs and opportunities for advancing transportation resiliency in the State. This report includes (1) a summary of how and why resiliency is integrated in the 2045 Long Range Transportation Plans (LRTPs), (2) notable MPO resiliency practices, (3) major challenges in addressing resiliency, and (4) opportunities for advancing resiliency planning in Florida. This report is intended to assist transportation planners by documenting notable practices, sharing information, and identifying priority needs.

The Research Team ("the Team") reviewed the 2045 LRTPs of Florida's 27 MPOs to categorize how resiliency was integrated in the Goals and Objectives, Performance Measures and Evaluation Criteria, and Resiliency Strategies. The Team also reviewed vulnerability assessments and related studies to highlight specific data and tools used and needed for understanding local and regional impacts. Stakeholder interviews with 19 MPOs were conducted to understand each organization's history of resiliency activities, motivations, and challenges. As MPOs begin the 2050 LRTP cycle, this report and the categorization provided here allows for MPOs to quickly find examples of how other MPOs are addressing resiliency in these plan components. Below are some of the highlights from this project.

Review of Long Range Transportation Plans and Vulnerability Assessments

From the review of the 2045 LRTPs, the Team found that all MPOs addressed resiliency in their goals and objectives. Some MPOs aligned resiliency with existing goals, while others developed resiliency-specific goals or objectives. About 40% of Florida's MPOs adopted resiliency-related evaluation criteria in their project screening or prioritization. About one-third of MPOs incorporated resiliency into their performance measures or targets.

Over half of Florida's MPOs have conducted or plan to conduct a vulnerability assessment. Only coastal MPOs, which face flooding threats from rising sea levels, storm surge, and nuisance flooding, have completed vulnerability assessments. Future inland flooding impacts and demographics shifts (inland migration) are emerging areas of climate resiliency that are in need of addressing. Conducting an independent climate change vulnerability assessment may not be

feasible for all MPOs due to the limited agency resources, but some can leverage the results of existing local studies and utilize online tools for assessing impacts. The passage of the Bipartisan Infrastructure Law (BIL) in 2021 provides funding opportunities and incentives for MPOs to conduct vulnerability assessments and resiliency planning efforts.

Notable Practices

The Team found that MPOs were resourceful in pursuing resiliency issues, resulting in successes towards advancing transportation resiliency. Notable practices by Florida MPOs include:

- **Participation with local resiliency steering committees and regional climate collaboratives** to coordinate on climate and hazard mitigation issues and learn about strategies for adaptation and mitigation to inform long range planning efforts.
- **Utilizing resources and outputs from local studies and vulnerability assessments** to inform the long range planning process.
- **Engaging stakeholders.** One MPO convened a Transportation Resilience Advisory Group to give input on resiliency projects and issues. Another MPO developed a Resilience Guidance Paper to inform staff and engage committee members on resiliency.
- **Leveraging grant funding** to support local and regional vulnerability assessments, and training workshops, and capacity building.
- **Developing resiliency funding strategies.** A few MPOs are planning to or have developed resiliency-specific funds to address resiliency needs.
- **Focus on maintenance and prevention.** While not always called resiliency strategies, drainage improvements and stormwater maintenance contribute towards flood risk reduction and increase transportation systems resiliency.
- **Highlighting equity concerns in resiliency.** Some MPOs are addressing and highlighting social equity concerns within long range plans and resiliency planning.
- **Developing long-term planning frameworks.** A few MPOs are developing planning frameworks and master plans to guide adaptation planning and implementation. These plans offer a roadmap for identifying and implementing adaptation and mitigation strategies, defining interagency coordination and roles, and institutionalizing resiliency through the planning process.

Challenges

MPOs cited a number of challenges in their resiliency planning efforts, including:

- **Funding challenges,** including a lack of funding to support studies, mismatch between resiliency needs and eligible funding sources, and competing funding priorities.

- **Institutional challenges**, such as lack of staff capacity, limited implementation roles, and coordination of resiliency strategies throughout project development.
- **Lack of a centralized repository for resiliency data** and the **need for decision support tools** to help with cost-benefit analyses and project-level screening of impacts.
- **Lack of public support and leadership** for engaging in climate change planning and tension between existing and future needs.
- **Lack of guidance** to address uncertainty and long-time horizons, choose climate scenarios, and select appropriate adaptation and mitigation strategies.

Opportunities

Many opportunities exist to advance transportation resiliency planning in Florida. Below are actionable opportunities that can be pursued by MPOs, the Florida Department of Transportation (FDOT), and partnering organizations.

- **Leverage PROTECT Program funding** for resiliency planning (developing resilience plans, vulnerability assessments, data, tools), constructing resilience improvements, improving evacuation routes, and protecting at-risk coastal infrastructure.
- **Continue to build capacity and share information.** Offer additional peer exchanges, cultivate resiliency champions, and develop a resiliency contact list of MPO staff.
- **Increase access and centralization of resiliency data** using FDOT’s Environmental Screening Tool and development of other curated portals.
- **Support public engagement on climate change.** Show local impacts, examples, and trends when discussing climate change to build a longer memory of local events.
- **Develop guidance to support resiliency planning needs**, such as choosing appropriate climate scenarios, dealing with uncertainty, and selecting adaptation and mitigation strategies to address specific types of vulnerabilities.

2 Introduction

Florida’s transportation system faces threats from current and future climate stressors, such as heavy precipitation events, increasing extreme heat, wildfires, worsening droughts, and coastal flooding (Jacobs, et al., 2018). To better prepare for and adapt to these climate stressors, transportation planning and infrastructure design must account for changing conditions caused by climate change. Using a resiliency-based approach is becoming a common way to plan, prepare, and adapt to such changes. The Federal Highway Administration (FHWA) defines

resilience as “the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions” (FHWA, 2014).

The passage of “The Fixing America’s Surface Transportation (FAST) Act” in December 2015 brought requirements for transportation agencies to consider transportation resiliency in their transportation planning processes. Requirements for MPOs include: consideration of a new planning factor (to improve the resiliency and reliability of the transportation system); coordination with agencies and officials responsible for natural risk reduction and consideration of strategies to reduce the vulnerability of existing transportation infrastructure to natural disasters (FHWA, 2017). While the FAST Act requires resiliency to be considered in transportation plans, it does not provide guidance on how to integrate resiliency into the planning process (Weilant, Strong & Miller, 2019). The impacts of climate change vary by geography and there is no one-size-fits-all approach for designing and implementing adaptation and mitigation strategies.

Some state DOTs and MPOs in the U.S. have begun integrating resiliency into the transportation planning process. A study of all state DOTs and 101 MPOs nationally found that about half of the agencies studied had incorporated resiliency into their transportation plans (Dix, Zgoda, Vargo, Heitsch, & Gestwick, 2018). Of those agencies addressing resiliency, most were still in the early phases of the planning process and had not widely integrated resiliency into practice or project selection (Dix et al., 2018, National Academies, 2018). Obstacles to planning and implementation include the lack of understanding or information about climate impacts, vulnerability assessments, and models to assess impacts (Dix et al., 2018), as well as the need for resiliency champions and leadership (National Infrastructure Advisory Council, 2015). Regional transportation agencies have varying human, technical, and financial resources, resulting in uneven abilities to study and address climate impacts and solutions. Finally, public attitudes about climate change may necessitate that agencies take different approaches to communicating and defining the needs for adaptation and mitigation measures.

The passage of the Bipartisan Infrastructure Law (BIL) in 2021 brings opportunities for MPOs to address resiliency planning and implementation. The new Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) Program provides \$7.3 B in formula funding to state DOTs and \$1.4B in discretionary competitive funding. A variety of activities and projects are eligible for competitive funding, including planning grants, resilience improvements, community resilience and evacuation routes, and at-risk coastal infrastructure. Planning grants are available to develop resilience improvement plans (RIP), conduct resiliency planning, develop data and tools for vulnerability assessments, and capacity building. For agencies with a RIP, BIL offers an opportunity for a reduced federal match for projects funded under PROTECT.

The purpose of this report is to review the current state of practice for how Florida MPOs are integrating resiliency into their long range planning processes to highlight the needs and opportunities for advancing transportation resiliency in the State. The next section describes the methods for developing this report. Following that, this report includes four major sections:

- How and why resiliency is addressed in the 2045 Long Range Transportation Plans (LRTPs) and a review of vulnerability assessments
- Notable MPO resiliency practices
- Challenges in integrating resiliency into the transportation planning process
- Opportunities for advancing resiliency planning in Florida

This report is intended to assist transportation planners by documenting notable practices, sharing information, and identifying priority needs.

3 Methods

To review the current state of practice for how MPOs are integrating resiliency into their long range planning processes, the Team conducted (1) an extensive document review and (2) stakeholder interviews.

3.1 Document Review

This project used a modified framework developed by Dix et al. (2018) to categorize MPOs' resiliency efforts throughout the transportation planning process. The modified framework is described in Table 1, showing the five major categories used for the project, along with the associated topics assessed and assessment methods. The five categories included (1) LRTP Goals and Objectives, (2) Vulnerability Assessments and Tools, (3) Collaborations and Partnerships, (4) Performance Measures and Evaluation Criteria, and (5) Resiliency Strategies.

For this project, the Team reviewed a variety of materials (primarily documents) to categorize resiliency planning efforts. These included:

- 2045 adopted long range transportation plans, metropolitan transportation plans, and associated documents (appendices, technical memos, supporting documents/studies)
- Vulnerability assessments and related studies (where applicable)
- MPO websites
- FHWA Florida MPO Resilience Peer Exchange Materials (August 2020)
- Information gathered by FDOT Office of Policy Planning
- Stakeholder Interviews

For each MPO, a team member compiled information from the sources above to assess the questions in the "Questions and Topics Assessed" column in Table 1. Then another team

member cross-referenced the information and any follow-up questions were highlighted for inclusion in the stakeholder interviews. The data was then synthesized in this report to assess common practices and approaches for addressing resiliency.

Table 1. Categorization of Resiliency Activities by MPO

Category	Questions and Topics Assessed	Assessment Method
LRTP Goals and Objectives	How is resiliency defined? How is resiliency framed? (e.g. safety and security, livability, sustainability) How is resiliency addressed in the LRTP goals and objectives?	LRTP Review, Documents
Vulnerability Assessments and Tools	How are transportation vulnerabilities to climate change identified? Has a vulnerability assessment been conducted? What climate stressors are addressed for this region? Where are MPOs getting climate information and data? What tools & data are used to assess vulnerability? What additional information is needed?	LRTP Review, Documents, Vulnerability Assessments, Interviews
Collaborations and Partnerships	Are MPOs partnering and collaborating with other institutions for understanding vulnerability?	LRTP Review, Interviews
Performance Measures and Evaluation Criteria	Are performance measures used to track and evaluate resiliency goals? Are resiliency criteria being used in project prioritization? Are vulnerability assessments used for project prioritization?	LRTP Review, Documents, Interviews
Resiliency Strategies	What kinds of strategies, policies, or projects are MPOs using to address resiliency? (e.g., regulatory standards, adopting standardized climate projections, resiliency funding, drainage/ stormwater management)	LRTP Review, Documents, Interviews

3.1.1 MPOs Included in this Study

Florida has 27 MPOs, with varying populations and municipalities served, and differing geographies and organizational structures (see Figure 1 for the Map of FL MPOs). In this project, the Team reviewed the 2045 LRTPs for all 27 MPOs in Florida (see References section for list of MPOs and links to 2045 LRTPs).

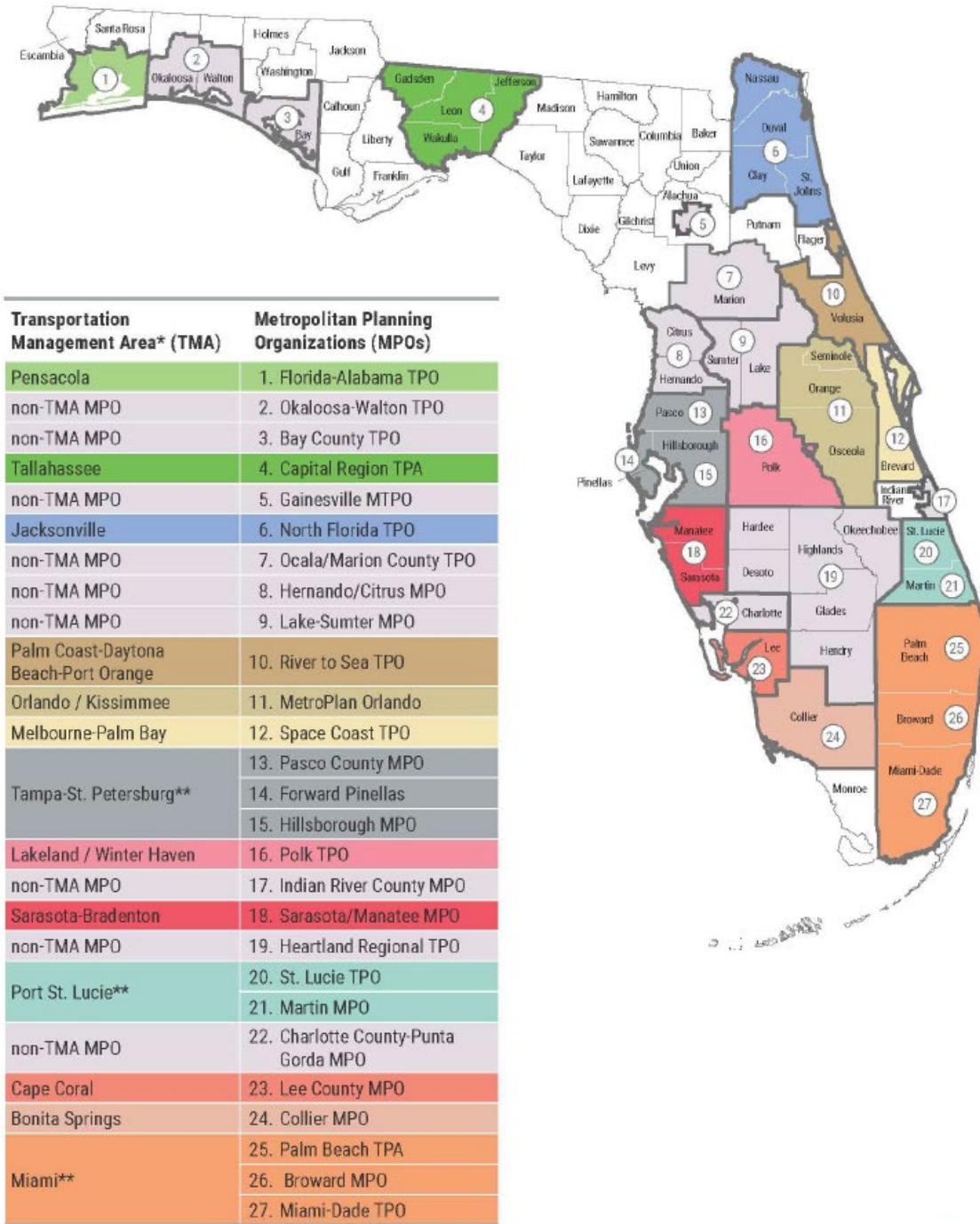


Figure 1. Florida MPO/TMA Areas (source FDOT, 2021)

3.2 Stakeholder Feedback

The interviews were conducted in tandem with the document review and provided clarification and further insight into the context of resiliency activities. MPOs in Florida vary in size, structure, and resources, reflecting the various ways in which they are approaching and integrating resiliency into their planning processes. Hearing the first-hand experiences of staff was critical to understanding the broader context of the organizations' goals, challenges, and opportunities. Conversations with practitioners shed light on factors that may not be fully articulated in the LRTP documents, such as an organization's history of resiliency activities, working with other stakeholders, and circumstances that motivated resiliency planning efforts. In addition, the interviews were helpful to illuminate the network of regional actors and institutions that influence resiliency planning efforts for the MPOs. Overall, the interviews refined and reinforced information learned from the document review, while adding to the comprehensiveness of this report.

To gather stakeholder feedback, the Team conducted semi-structured interviews with MPO staff. The interview objectives were to (1) clarify and supplement the information gathered in the document review; (2) understand the motivations, challenges, and regional context for resiliency planning; and (3) determine the data, tools, and guidance needed to integrate climate information into the transportation planning and project development processes. A set of interview topics and questions was developed to guide the interview process based on these objectives.

For each MPO, the 2045 LRTP and supporting documents were reviewed prior to the stakeholder interview. While the questions were used to guide the interview process, not all questions were asked in all interviews. The interviews were semi-structured so that questions could be tailored to our existing knowledge of the agency's efforts. This allowed for efficiency in the interview process and use of MPO staff time, where questions were targeted towards knowledge gaps.

A total of 29 people representing 19 MPOs participated in the interviews. Due to time and funding constraints, interviews were not intended to be conducted for all 27 MPOs. MPOs were purposively selected based on our knowledge of agency's past or present resiliency activities (e.g., known from prior work with the MPO, from FDOT project manager and others sharing information, and from activities catalogued in the document review). The majority of the MPOs interviewed (17 of 19) are coastal. This is because a majority of Florida's MPOs are coastal (21 of 27) and much of the resiliency efforts in Florida have been focused on coastal flooding and sea level rise (SLR).

The interviews were conducted between July 8, 2021, and February 3, 2022, and primarily via Zoom. Institutional Review Board (IRB) approval was obtained from the University of Florida

(IRB Project #: 202001486), per research requirements. Interview notes (from the PI and Co-PI) and audio transcripts were used to distill common themes and takeaways and highlight novel activities undertaken by the MPOs in their resiliency planning efforts. The transcriptions and recordings are not available outside the UF project team, in accordance with IRB protocols.

The Team is incredibly grateful to the staff who generously shared their time and unique perspectives with us. This process shed light on various factors affecting why, how, and when MPOs engage in resiliency efforts.

4 How Resiliency is Integrated in Long Range Plans

The purpose of this section is to review and categorize how and why resiliency is defined and addressed in the 2045 LRTPs of Florida's MPOs. In the state, many MPOs have been integrating resiliency into the planning process and this report offers a review of their activities to date. As MPOs look forward to the 2050 LRTP cycle, the categorization provided here allows for quick access to examples of how other MPOs are addressing resiliency in these plan components.

4.1 Motivations for Resiliency Planning

MPOs have various motivations for integrating resiliency in their planning efforts. During the stakeholder interviews, a few themes emerged regarding motivations for resiliency planning, including compliance with federal regulations, experience with extreme weather events, training and learning opportunities, local and regional resiliency efforts, staff interest, and leadership. These motivations are not mutually exclusive; MPOs often noted multiple motivations.

Compliance with FAST Act. Compliance with the 2015 FAST Act and corresponding federal planning factor for resiliency and reliability was a top motivation. But it is important to note that some MPOs began their resiliency efforts before these requirements and others have additional reasons for integrating resiliency into planning.

Experience with Extreme Weather Events. Past extreme weather events, which impacted the local transportation system, was a common motivator for addressing resiliency in planning. For example, previous hurricanes and tropical storm events (such as Sandy [2012], Irma [2017], Michael [2018], and Invest 92L [2017]) brought flooding and damage to local and regional transportation networks. Recovery and response efforts to these events have highlighted the need for mitigation and adaptation strategies to better prepare for future extreme weather events.

Training and Learning Opportunities. Technical training for vulnerability assessment tools and educational workshops about climate change and SLR impacts were often cited as a motivator

for resiliency planning. For example, participants mentioned attending training workshops for the UF GeoPlan Center’s Sea Level Scenario Sketch Planning Tool, where having access to information and an increased awareness of future flood hazards spurred organizations to pursue vulnerability assessments or develop other resiliency planning activities. Additional training and learning opportunities were offered through city, county, and regional resiliency efforts.

Local and Regional Resiliency Efforts. Transportation resiliency planning does not occur in a vacuum. MPO resiliency efforts often happen in tandem and coordination with local and regional resiliency efforts. Some MPO staff indicated their participation on local or regional steering committees, attending stakeholder meetings or workshops, and/or utilizing the resources created as outputs from the assessments to inform the long range planning process. For some MPOs, participation with local and regional resiliency efforts added to their motivation to integrate resiliency into transportation planning.

Similarly, a few MPOs were motivated by neighboring MPOs. In some cases, smaller organizations looked to follow on the lead of larger MPOs that took initial steps due to greater staff capacity, access to resources, and/or a more favorable political environment. In other cases, MPOs experienced positive “peer pressure” from neighboring MPOs that were engaging in activities (such as a vulnerability assessment or resiliency plan) and felt the need to “keep up.”

Staff Interest. Another common motivator was agency staff with a particular interest in flood hazards, climate change, and/or environmental issues. A personal passion for these considerations often galvanized activities in their professional practice, and the led to action at the agency. For example, one participant commented:

“Well, right now you're talking to the person who has a little bit of a passion for it. That's me... I don't consider myself an environmentalist, but I did come into this world from actual sort of architecture and urban design, and I just love the whole notion of people having healthy, safety, beautiful places to live, and that doesn't mean you're under water.”

Another participant summed up a common sentiment that, while we face many challenges addressing flood risks and SLR, these are “*exciting times to be working on resiliency issues.*”

Leadership. Several MPOs cited leadership as a primary motivator in their resiliency planning efforts. Participants cited support of local elected officials, MPO directors, or agency administrators in pursuing or engaging in resiliency efforts. Some MPOs cited grassroots leadership, where advisory committee members brought forward resiliency issues for further study. Another participant cited a change in agency leadership, which brought a stronger focus

on resiliency and collaboration. While MPOs described political will and agency leadership as important to their efforts, they also stressed how individual champions can be quite impactful, where *“one person can go a long way.”*

4.2 Goals & Objectives

This section discusses how MPOs are addressing climate resiliency in their LRTP goals and objectives and how resiliency is defined and/or approached. The goals and objectives set forth the intentions of the regional transportation system and drive the planning process. Resiliency definitions and LRTP goals are closely linked, as the definition typically drives the approach to addressing or achieving resiliency within the transportation system. First, definitions of resiliency will be reviewed, followed by discussion and examples of LRTP goals and objectives.

4.2.1 How do MPOs Define Resiliency?

Within the LRTP and MPO documentation (websites, reports, etc.), the terms “resilience” or “resiliency” are often not defined or vary in their definitions. About one-third of Florida MPOs explicitly define “resilience”, “resiliency” or a “resilient transportation system” in their LRTPs or on their websites. This is common across many types of organizations (not only MPOs) – as the concept of resiliency has been widely applied across numerous disciplines, resulting in no clear or consistent definition (Transportation Research Board [TRB], 2017). In the transportation context, there is a need to better define resiliency so that transportation professionals can align their understanding of what resilient transportation systems are and how to measure resiliency (TRB, 2018).

FHWA defines resiliency as “the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions” (FHWA, 2014). FDOT defines resiliency as “the ability of the transportation system to adapt to changing conditions and prepare for, withstand, and recover from disruption” (FDOT, 2020). Some Florida MPOs have adopted these definitions, while others have modified or expanded upon this definition to include the types of disruption their regional transportation system is likely to experience (such as weather events, hurricanes, flooding, traffic incidents). Other MPOs have adopted alternative definitions of resiliency or resilient transportation systems. At least two MPOs (Collier County and North Florida) have included social equity as a component of a resilient transportation system. Table 2 includes resiliency definitions collected by the Team.

Table 2. Resiliency Definitions

Resiliency Definition	Organization
Resiliency includes the ability of the transportation system to adapt to changing conditions and prepare for, withstand, and recover from disruption.	FDOT Policy No. 000-525-053 , 2020
Resilience or resiliency is the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.	FHWA Order 5520 , 2014
Resilience is the ability to adapt to changing conditions, as well as being able to prepare for, withstand, and recover from disruption.	Bay County TPO (2045 LRTP, p. 23)
A resilient transportation system is one that supports mobility, system preservation, and evacuation needs, and addresses social equity.	Collier County MPO (2045 LRTP, p. 3-10)
Resilience is about being better prepared for an increasing occurrence of shocks, such as hurricanes, and infrastructure failures, as well as better mitigating stresses, such as sea level rise and sunny day flooding, crippling traffic, and severe economic inequities.	Miami-Dade TPO (2045 LRTP, p. 08-02)
The ability to adapt to changing conditions and recover from disruptions, such as major weather events.	Ocala Marion MPO https://ocalamariontpo.org/tpo-projects/
A reliable and resilient multimodal transportation infrastructure provides accessible and diverse transportation options that ensure mobility, system preservation, supports evacuation needs, and addresses social equity.	North Florida TPO (2045 LRTP, p. 43)
Resiliency reflects our ability to mitigate, prepare for, respond to, and recover rapidly after disruptive events such as flooding, hurricane impacts, wildfires, or major traffic incidents. It is important for our transportation system to be resilient to maximize its reliability to move people and goods.	River to Sea TPO (2045 LRTP, p. 1-7)
Resiliency is an established emphasis area of the SCTPO Governing Board that meets the need to respond to community needs and long-term visions. The process will consider some of the most critical shocks and stressors experienced by the area, such as flooding, storm surge, sea level rise, increased development, and funding.	Space Coast TPO (2045 LRTP, p. 5-12)

4.2.2 Resiliency Goals and Objectives

All Florida MPOs address the federal resiliency and reliability planning factor to some degree in their LRTP goals and objectives, though some do not explicitly use the term “resiliency” or “resilience”. Many MPOs address resiliency with a specific, stand-alone goal and/or objectives (see Table 3), while others align aspects of resiliency within multiple goals and objectives. The Team found that about half of MPOs developed specific resiliency goals and objectives, while the other half uses an integrated approach to align resiliency with existing goals and objectives. The approach depends on how resiliency is defined and interpreted locally. Different aspects of resiliency and how to achieve resiliency are highlighted based on how organizations and individuals frame, or interpret, the issue.

Among all approaches to resiliency goals and objectives, the team determined that the most common framings of transportation resiliency were as follows:

- **System Preservation:** Extreme weather events damage and threaten transportation infrastructure, creating a need to increase system resiliency through the maintenance and retrofitting of existing infrastructure as needed.
- **System Efficiency & Reliability:** Resiliency focusing on bouncing back after disruptions, minimizing disruption times from natural hazards.
- **Safety & Security:** Focus on emergency response times, ensuring safe evacuation routes, and safe asset conditions.
- **Hazard Mitigation/Disaster Risk Reduction:** Resiliency as an extension of hazard mitigation and disaster risk reduction, focus on avoiding or minimizing damage and/or disruption to transportation system from natural hazards.
- **Sustainability & Livability:** Resiliency as an extension of sustainability, environmental protection, quality of life, and social equity.

There is no recommended or “correct” way to address resiliency nor a one-size-fits-all method. Resiliency is interpreted and grounded within the existing context of locally important issues and approaches. Table 3 below provides examples of resiliency-specific goals and objectives.

Table 3. Resiliency Goals and Objectives Examples

MPO	Goal	Objective(s)
Broward MPO (Commitment 2045 MTP, p. 1-3)	Strengthen Communities	Promote Resiliency in Response to Climate Change and Weather-Related Events
Capital Region TPA (Connections 2045 LRTP p. 1-4)	Security: Promote and implement transportation improvements for all modes ensuring resilience and security of the transportation system.	N/A
Collier MPO (2045 LRTP, p. 3-10)	Consider Climate Change Vulnerability & Risk in Transportation Decision Making	<p>Identify key climate impacts (rising sea levels, hurricanes, etc.)</p> <p>Identify sensitive assets and thresholds for impacts</p> <p>Identify, evaluate, and adopt strategies to address identified vulnerabilities</p> <p>Screen projects during planning to avoid making investments in particularly vulnerable areas</p>
Indian River County MPO (2045 LRTP, p. 2-5)	Protecting the Natural and Social Environment	Increase resiliency of infrastructure for extreme weather and climate trends
Martin MPO (2045 LRTP, p. 12)	Innovation: A transportation system with an ability to harness changes in the future.	Prioritize projects that improve extreme weather resiliency and/or harden infrastructure against SLR

MPO	Goal	Objective(s)
<p>Miami-Dade TPO (2045 LRTP, p. 02-21)</p>	<p>Preserve the Existing Transportation System</p>	<p>Improve the resiliency/reliability of the transportation system</p> <p>Reduce the vulnerability and increase the resilience of critical infrastructure to the impacts of climate and events. Preserve infrastructure (sustainability and resilience)</p> <p>Site and design new transportation infrastructure to minimize exposure to SLR within the infrastructure life span, based on the Southeast Florida Regional Climate Change Compact’s 2015 Unified SLR Projection</p>
<p>North Florida TPO (2045 LRTP, p. 43)</p>	<p>Create Reliable and Resilient Multimodal Infrastructure</p>	<p>Incorporate climate risk in project planning, system preservation, maintenance, and determine appropriate measures to mitigate risk or repurpose threatened facilities</p> <p>Address social equity in adaptation/resilience strategy implementation</p>
<p>Ocala Marion MPO (2045 LRTP, p. 15)</p>	<p>Protect Natural Resources and Create Quality Places</p>	<p>Improve the resilience of the transportation system through mitigation and adaptation strategies to deal with catastrophic events</p>
<p>Pasco MPO (2045 LRTP, p. 5-6)</p>	<p>Create Quality Places</p>	<p>Plan for issues related to sea level rise, energy conservation, air quality, and environmental mitigation and impacts</p>
<p>Sarasota/Manatee MPO (2045 LRTP, p. 3-1)</p>	<p>Infrastructure Resiliency</p>	<p>Identify and mitigate the effect of extreme weather events on the system</p>
<p>Space Coast TPO (2045 LRTP, p. 2-3)</p>	<p>Preserve and Provide a Resilient Transportation System through Balancing Social and Environmental Resources</p>	<p>Improve the resiliency of the transportation system through mitigation and adaptation strategies to address sea level rise and other shocks and stressors</p>

4.2.3 Vision and Mission Statements

A few MPOs have developed vision or mission statements which integrate resiliency. Examples include:

- **Martin MPO** *“To create and maintain a safe, efficient and resilient multimodal transportation network to meet mobility and accessibility needs of Martin County’s residents and visitors, while preserving the environment, supporting economic growth and enhancing the quality of life.”* (Martin 2045 LRTP, p. 11).
- **Okaloosa-Walton TPO** *“2045 Mission: To preserve and enhance reliable transportation systems that are safe, efficient, resilient, socially and environmentally responsible, technologically advanced, financially constrained, coordinated with land use patterns, and allow for modal choice.”* (Okaloosa-Walton TPO 2045 LRTP Goals & Objectives, p. 3).

4.3 Vulnerability Assessments and Tools

Conducting a vulnerability assessment is one common method for understanding transportation system vulnerabilities to climate change and future conditions. This section describes the vulnerability assessments conducted by Florida MPOs, highlighting the climate stressors addressed in each region and the tools and data sources used to assess climate impacts and vulnerabilities.

Over half of Florida’s 27 MPOs have completed or plan to complete a vulnerability assessment to evaluate their regional transportation system vulnerabilities to climate change and future conditions (see Figure 2 and Appendix A). For this project, the Team looked for assessments that include consideration of how future conditions due to climate change would impact transportation facilities. A wide range of assessments were reviewed. Some assessments were in-depth studies that developed datasets, conducted customized modeling, and assessed multiple climate stressors. Other assessments used online screening tools to determine potential impacts. All such assessments are useful to informing the long range planning process and each reflect different scales of analyses and need.

All MPOs who had completed or planned to complete a vulnerability assessment were coastal agencies. Hence, many of the assessments were focused on coastal flooding issues due to sea level rise and storm surge. This is also likely due to the high availability of tools to screen and assess for coastal flood hazards, and the lack of tools and data to address future inland flooding. For the few coastal MPOs who had not completed a climate change vulnerability assessment, other studies focusing on coastal flood hazard, namely storm surge, were used to address evacuation, safety, and hazard mitigation needs.

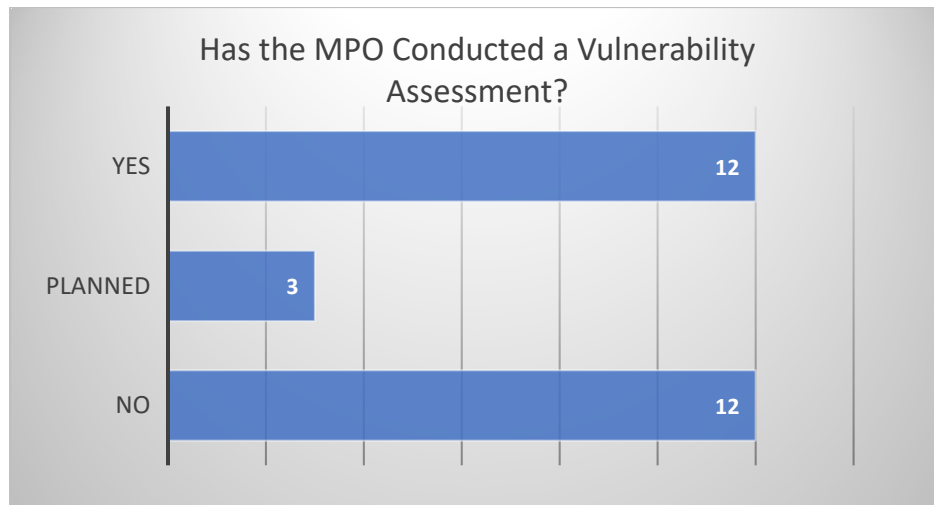


Figure 2. Summary of MPO Vulnerability Assessments

Conducting an independent climate change vulnerability assessment may not be feasible for all MPOs. The complexity of such assessments and limited agency resources (money, time, personnel) can restrict or prevent agencies from conducting these assessments. However, MPOs can apply for new PROTECT funding to complete such assessments. MPOs who develop resilience improvement plans, which must include a risk-based vulnerability assessment and a prioritized investment plan with funding sources, may be eligible for reduced federal match requirements for projects funded under PROTECT. Additionally, some MPOs can leverage the results of existing studies conducted by other local agencies (where available) to inform their assessments. In all cases, a first step in understanding local vulnerability to climate change is to review any local or regional studies to gain context and potential resources.

Some MPOs have received grant funding to conduct vulnerability assessments, while others used internal resources. Figure 3 below shows the percentage of funding sources by assessment, with over half of the assessments being funded internally. All but one MPO (St. Lucie TPO) hired consultants to conduct the assessments. The FHWA Resilience Pilot Program has been an important source of resources to support vulnerability assessments in Florida. About half of the MPOs that had completed assessments were funded under this program. Hillsborough TPO has participated in two rounds of the FHWA Resilience Pilot Program: first in 2013-14 for a solo assessment, then again in 2019 in partnership with Forward Pinellas and Pasco County MPO for a regional assessment. FHWA funded another regional assessment in 2015, covering Southeast Florida with three MPOs participating (Broward, Miami-Dade, and Palm Beach) alongside Monroe County. In 2016, Broward MPO leveraged the regional assessment and conducted a follow-up assessment to focus on County facilities not included in the previous assessment. For these six MPOs that participated in the FHWA Resilience Pilot Program, the population of these areas represents nearly 40% of the State’s population.

A few MPOs have conducted multiple vulnerability assessments, refining their assessments with updated data and analyses to inform their LRTP and planning efforts. Broward and Hillsborough TPOs were already mentioned above. In addition, St. Lucie TPO conducted multiple assessments. The first assessment, completed in 2019, was done internally, leveraging two online tools: the Sea Level Scenario Sketch Planning Tool (<https://sls.geoplan.ufl.edu/view-maps/>) and the Coastal Flood Exposure Mapper (<https://coast.noaa.gov/floodexposure/>). Later in 2021, St. Lucie TPO utilized the results of a county vulnerability assessment to review and update their transportation vulnerabilities to a newer set of SLR projections released in 2017 by the National Oceanic and Atmospheric Administration (NOAA). Updating assessments is important to reflect the most current climate scenarios and to integrate newer data and models.

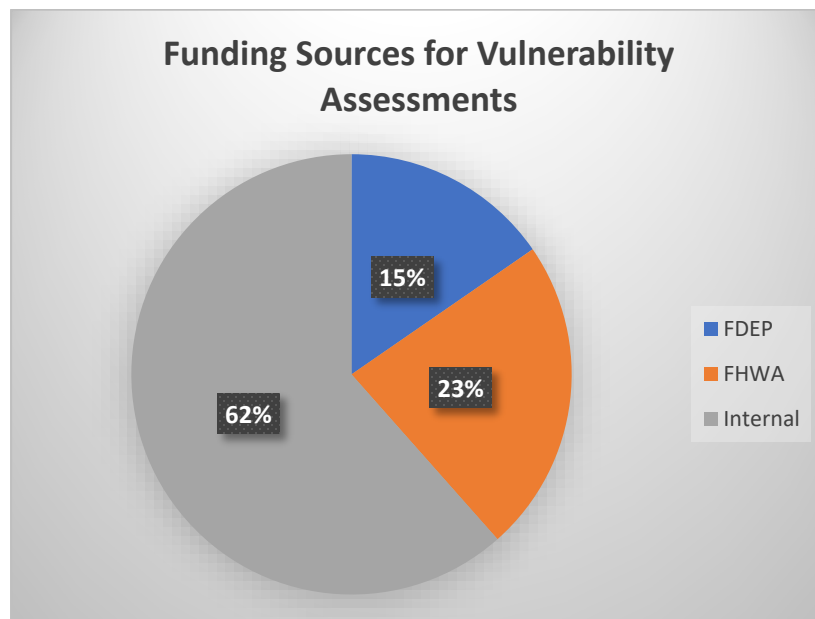


Figure 3. Funding Sources for Vulnerability Assessments (by Assessment)

In-Progress and Planned Assessments

In addition to the projects listed in Appendix A, a few MPOs have planned assessments. Hernando-Citrus MPO's Unified Planning Work Program (UPWP) FY21/22 includes a resiliency study for the region to be completed by June 2022. In FY22, Martin MPO began a transportation network resiliency study to assist with future planning and decision-making, as specified in their UPWP FY20/21 – FY21/22. Phase 1 of the study will be finalized in FY23, as specified in the UPWP FY22/23 – FY23/24. In late 2021, Sarasota/Manatee MPO began work on

a Resiliency/Vulnerability Assessment, which aims to develop methods and tools to integrate resiliency corridor planning with transportation planning and decision making to better evaluate and mitigate risks impacting the region’s transportation system. The vulnerability assessment methodology will be modeled after the Resilient Tampa Bay Transportation project supported by the FHWA Resilience Pilot Program. Additional key outcomes include development of a method to identify and prioritize mitigation strategies (by costs, resource needs, permitting requirements, and more), development of an online resiliency tool (interactive map), and technical training. The study and related resiliency efforts will be overseen by the recently developed Transportation Resilience Advisory Group.

4.3.1 Climate Stressors and Projections Used

Vulnerability assessments reviewed in this research primarily addressed coastal flooding issues of SLR and storm surge. A few assessments included analysis of inland flood hazards. See Appendix A for climate stressors addressed in the assessments. While spatial data of future projected inundation from SLR are highly available, future projections of storm surge and inland flood hazard areas are less available. These less available data may be developed in accordance with updated state requirements for vulnerability assessments funded under FDEP’s Resilient Florida Grant Program as well as requirements for FDOT to develop a resilience action plan that considers the transportation impacts from various flood risks such as tidal, rainfall, and storm surge (HB7053, Statewide Flooding and Sea Level Rise Resilience, 2022).

Current coastal flood hazard areas are mostly derived using SLOSH Storm Surge models and FEMA 100-year (1%) and 500-year (0.2%) floodplain areas. Future storm surge is estimated in various ways in the reviewed assessments. For a few assessments, a SLR amount is added to the National Hurricane Center’s SLOSH model Maximum of Maximums (MOM) output (Hillsborough TPO, Resilient Tampa Bay Transportation). FEMA’s HAZUS-MH model was also used to estimate future coastal storm surge with the addition of SLR (Resilient Volusia and Resilient Flagler, River to Sea TPO). Broward MPO’s 2016 vulnerability assessment used probabilistic models of future storm surge developed by researchers at the University of Florida (Broward MPO, 2016, p. 21).

Current inland flood hazard areas were commonly assessed with FEMA 100-year (1%) and 500-year (0.2%) floodplain areas. Only a few assessments included future inland flooding areas. The regional South Florida Vulnerability Assessment (2015) developed a future flooding hotspot index, based on elevation and proximity to the existing 100-year flood hazard zones (Broward MPO, 2015, p.

Common Climate Stressors and Data Sources
<ul style="list-style-type: none">• SLR Inundation (NOAA, UF, GIS modeling)• Storm Surge (SLOSH model, HAZUS-MH)• FEMA 1% and 0.2% Floodplains – for coastal and inland flood hazard areas

22). The Resilient Tampa Bay Transportation (RTBT) project, supported by the FHWA Resilience Pilot Program, included precipitation modeling, with two scenarios for inland flooding events. One scenario was a representative rain event for road surface infrastructure and the other scenario was a more substantial event (RTBT, 2020, p. 2-9).

4.3.1.1 Sea Level Rise Projections

There are numerous SLR scenarios and projection curves that estimate when and how much SLR will occur. MPOs use a range of different SLR projections and planning horizons in the vulnerability assessments reviewed for this research (see Appendix A, column “Climate Stressors and Scenarios” for specific list of SLR scenarios and horizons). Additionally, Table 4 lists the most commonly used SLR scenarios and projections used by Florida MPOs. In regard to planning horizons, some assessments aligned with the LRTP horizon (2045 or using 2040 and 2050 to approximate). Others included multiple horizons to capture short-, mid-, and long-term potential impacts (such as 2040, 2070, and 2100).

Table 4. SLR Scenarios Used by MPOs

Acronym	Source	Projections
USACE (2013)	U.S. Army Corps of Engineers (2013). Incorporating Sea Level Change into Civil Works Programs. ER 1100-2-8162 .	Includes three projections: Low, Intermediate, and High Curve, respectively representing a global SLR of 0.2m, 0.5m, and 1.5m by 2100.
NOAA (2012)	National Oceanic and Atmospheric Administration (2012). Global Sea Level Rise Scenarios for the United States National Climate Assessment. NOAA Technical Report OAR CPO-1	Includes four projections: Low, Intermediate Low, Intermediate High, and High, respectively representing a global SLR of 0.2m, 0.5m, 1.2m, and 2m by 2100.
NOAA (2017)	National Oceanic and Atmospheric Administration (2017). Global and Regional Sea Level Rise Scenarios for the United States. NOAA Technical Report NOS CO-OPS 083	Includes six projections: Low, Intermediate-Low, Intermediate, Intermediate-High, High, Extreme, representing a global SLR between 0.3m and 2.5m. <i>NOAA 2017 is an update of NOAA 2012 scenarios. NOAA 2022 was released in Feb 2022.</i>

There was some consistency amongst MPOs located in areas with regional climate collaboratives, such as the Southeast Florida Regional Climate Change Compact, the Tampa Bay Regional Resiliency Coalition, and the East Central Florida Regional Climate Collaborative. In

these areas, regional recommended projections were selected with scientific expertise, community and stakeholder input, and considerations of unique local conditions. MPOs can leverage these recommended SLR projections for each respective region. This not only provides for a common target for analysis and planning but also removes the need to determine which scenarios to use, which can be a complex and lengthy process. It should be noted that these recommended projections are typically revisited and updated as updated climate science and global projections are released. Depending on when the vulnerability assessment is conducted, the SLR projections used for the assessment may not align with the most current projections adopted. When resources are available, assessments should be re-evaluated and updated with the most current SLR projections. For example, the updated NOAA SLR Scenarios were released in February 2022 and MPOs may want to consult these updated scenarios when developing their 2050 LRTPs.

Regional vulnerability assessments (that cover multiple, contiguous MPO areas), such as those completed under FHWA Resilience Pilot Program (<https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/>), also used consistent climate scenarios and SLR projections over the geographic region. These assessments sometimes go beyond SLR – for example in Tampa Bay, where they modeled 11 scenarios of SLR, inland flooding, and storm surge. This regional approach to conducting a vulnerability assessment provides a robust and interconnected view of the potential climate impacts in the region, allows for more stakeholders to leverage the expertise of the team, and aligns analyses in such a way to avoid additional impacts from conflicting scenarios and data used across jurisdictional lines.

4.3.2 Data & Tools

There are numerous online mapping tools that can be used to produce high-level assessments of potentially vulnerable areas due to SLR and coastal flooding. Such tools have facilitated the development of coastal vulnerability assessments by municipalities, MPOs, and other agencies seeking to understand their current and future flood risks. For the vulnerability assessments reviewed, the most commonly tools used were the University of Florida (UF) GeoPlan Center’s Sea Level Scenario Sketch Planning Tool, NOAA’s Digital Coast Tools (Sea Level Rise Viewer and Coastal Flood Exposure Mapper), and Federal Emergency Management Agency’s (FEMA) Multi-Hazard Loss Estimation Methodology (HAZUS-MH) (see Figure 4 and Table 5). Some assessments utilized multiple tools.

The majority of MPOs that used the Sketch Planning Tool were participants or local hosts of the 2017 training workshops that the UF GeoPlan Center conducted. Additionally, the UF GeoPlan Center worked with two FHWA Resilience Pilots in 2014-15 (Hillsborough TPO and Broward

MPO), testing data and gaining feedback on the tool. Technical training and pilot projects are important for increasing utilization of tools and data within the planning process.

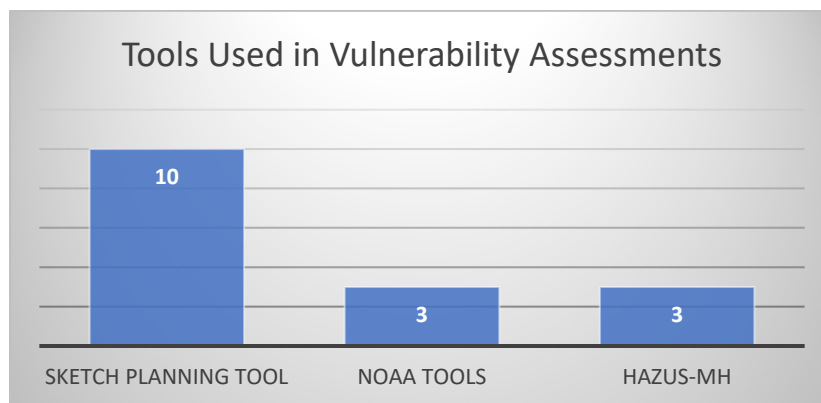


Figure 4. Tools Used in Vulnerability Assessments

Table 5. Sources of Vulnerability Assessment Tools

Tool Name	Source	URL
Coastal Flood Exposure Mapper	NOAA	https://coast.noaa.gov/floodexposure/
Multi-Hazard Loss Estimation Methodology (HAZUS-MH)	FEMA	https://www.fema.gov/flood-maps/products-tools/hazus
Sea Level Rise Viewer	NOAA	https://coast.noaa.gov/slr/
Sea Level Scenario Sketch Planning Tool	UF GeoPlan Center	https://sls.geoplan.ufl.edu/viewer/

4.3.3 Scenario Planning

Scenario planning is commonly used by regional planning councils and MPOs to envision, analyze, and prepare for future challenges, opportunities, and uncertainty. Scenarios represent future conditions that could occur in response to external forces (such as new technology adoption or environmental conditions) or deliberate policy choices (such as land use/development patterns) (FHWA, 2016). A few MPOs have incorporated resiliency into their scenario planning process.

The **Broward MPO** MTP, Commitment 2045, utilizes five scenarios: Trend, Compact Development, Technology, Resiliency, and Community Vision. Each scenario explored different approaches to the transportation network and was evaluated through six factors: accessibility, mobility, safety, equity, economic vitality, and environmental stewardship. The Resiliency Scenario was a modified variation of the Trend Scenario, removing funding constraints and excluding projects located in areas vulnerable to SLR. As identified in the 2016 Extreme

Weather and Climate Change Risk study, roads impacted by 2-ft SLR were removed from the network to test the impact on the transportation system.

The **River to Sea TPO** 2045 LRTP utilizes scenario planning across three scenarios: Technology, Resiliency, and Funding. The Resiliency Scenario utilized SLR scenarios adopted through the Regional Resiliency Action Plan (for Brevard and Volusia Counties) to evaluate areas and facilities vulnerable to SLR for the 2040 planning horizon. The lower bound for evaluation used the USACE 2013 High SLR scenario for 2040 (about 1.1 ft. above baseline year of 2000) and the upper bound used NOAA 2017 High SLR scenario (about 1.77 ft. above baseline year of 2000). Inundation areas from these SLR scenarios were evaluated against the projects identified in the Connect 2045 Needs Assessment, resulting in a set of potentially vulnerable projects.

The **MetroPlan Orlando** 2045 MTP uses six key drivers (population, economy, visitation, technology, land use and development, climate) across four scenarios: Traditional Trends, Disruptive Dilemmas, Tech Transformations, and Climate Consequences. SLR impacts and temperature increases were included in all four scenarios, with one scenario featuring much higher SLR impacts. The Climate Consequences scenario focuses on a rapid increase in population due to migration from coastal counties and emphasizes the need to increase resiliency of critical infrastructure to cope with increased extreme weather events and flooding.

In the **Sarasota/Manatee MPO** 2045 LRTP, the scenario planning process used four scenarios: Trend, Environmental Health, Economic Diversity, and Vibrant Places. As part of the modeling process, lands projected to be inundated by a 4-foot SLR by 2070 were considered along with other protected lands (conservation and wetlands) as not suitable for future development. Additionally, a coastal development context, along with other environmental and land use development contexts, was used to allocate population and growth. The scenario planning process, with input from stakeholders, resulted in three visions for the regional transportation system: promote economic opportunities, preserve environmental health and sustainability, and provide place-type and travel choices. The vision “Preserve environmental health and sustainability” focuses on sustainability and resiliency from storms and flooding.

4.4 Collaborations and Partnerships

MPO resiliency efforts often happen in tandem and coordination with local and regional resiliency efforts, such as vulnerability assessments, local resiliency committees, and regional climate collaboratives. Additionally, climate change is a complex and technical field, with continuously improving and emerging science, data, and tools. No one municipality, community, or agency can “go it alone”. MPOs recognize the need to work with partner agencies and local communities to understand vulnerabilities, engage stakeholders in resiliency discussions, and identify strategies to increase resiliency of the transportation system.

MPOs already coordinate with their local emergency management departments on local mitigation strategy plans, emergency preparedness, and disaster risk reduction, which are increasingly addressing climate change. Some MPOs participate with local or regional climate initiatives, which allows for learning about local climate impacts. Some of these initiatives produce climate vulnerability assessments or other hazard related studies, which can be leveraged by MPOs to inform their planning efforts. These studies provide context for local conditions, can offer preliminary screening of vulnerable areas, and allows MPOs to focus scarce resources. Regional climate collaboratives have also been an important resource for MPOs that provide learning, partnerships, technical training, and access to resources.

Highlighted below are some local and regional collaborations and partnerships and how these are aiding MPO resiliency planning efforts.

4.4.1 Local Collaborations and Partnerships

Lee County MPO has leveraged local studies on hazard mitigation and flood reduction to inform their understanding of resiliency and vulnerabilities in their region. Back-to-back flooding events in the summer of 2017 motivated two local flood mitigation and drainage studies. The Lee County Flood Mitigation Plan (2020) recommends concept projects to mitigate future flooding due to significant storm events and includes regional models to evaluate future (2040) scenarios of development, associated changes in impervious surface, and SLR. While transportation was not the focus of this plan, it identifies opportunities for coordination with transportation and road projects, as well as with land acquisition for conservation and water quality projects. The Mullock Creek Drainage Basin study aims to speed up the timeline for drainage improvements using a \$7.1 million award from the Florida Department of Economic Opportunity's Rebuild Florida Infrastructure Repair Program.

Martin MPO is coordinating with the Martin County Board of County Commission's Resiliency Planning Working Group on local resiliency planning initiatives. The Working Group includes members from Martin County Coastal Engineering, Ecosystem Restoration and Management, Office of Community Development, Surveying, Growth Management Department, and Martin MPO. The Working Group works closely with the Martin County Coastal Division, which is leading a Resilient Coastlines Program grant to develop a vulnerability assessment and resiliency plan. Results of the grant project and input from the Working Group will inform the MPO's transportation network resiliency study and overall resiliency efforts.

Miami-Dade TPO maintains a close working relationship with the County and the County's Office of Resilience. Rather than replicate resiliency efforts, the TPO participates in larger County-led initiatives (i.e. Resilient 305) and leverages those efforts to inform their long range plans. The dedicated staffing and attention provided by the Office of Resilience has become a

value-added component to their transportation planning processes. Additionally, the Resilient 305 initiative helps align the TPO and other stakeholders in the region to get on the same footing.

St. Lucie TPO is working closely with St. Lucie County and other local agencies to improve climate resiliency in the region. As a key participant with the County Resilience Planning Steering Committee, the TPO is able to coordinate on local climate and hazard mitigation issues. In 2020, the County received a \$75k FDEP Community Resilience Planning Grant to perform a SLR vulnerability assessment, which evaluated impacts to water resources, transportation and critical facilities, historic resources, and vulnerable populations. St. Lucie TPO was able to leverage the assessment, which was completed in 2021, for their Transportation Asset/Service Vulnerability Assessment Update (also in 2021). In 2021, St. Lucie County was awarded a \$600k CDBG Mitigation Grant (through the Rebuild Florida General Planning Support Program), which will build on the prior assessment. The TPO will continue their involvement in this 3-year long project, which will develop a resiliency plan and a unified hazard mitigation effort.

4.4.2 Regional Collaboration and Partnerships

4.4.2.1 Tampa Bay Region

Sarasota/Manatee MPO. In 2018, Sarasota/Manatee MPO was one of six regions in the nation awarded a Federal Transit Administration grant to receive training on developing an emergency recovery plan. The All Hazards Recovery Plan Workshop was a two-day training course that focused on developing such a plan and brought together regional stakeholders from Sarasota, Manatee, and Hillsborough Counties and their municipalities, including representatives from the MPOs, RPCs, emergency management, public transit, school board, academia and private consultants. The MPO is currently working on a Resiliency/Vulnerability Assessment, which was a resulting recommendation from the workshop.

The Tampa Bay TMA (Forward Pinellas, Pasco MPO, and Hillsborough TPO), partnered with FDOT District 7, and Tampa Bay Regional Planning Council (TBRPC) on the Resilient Tampa Bay Transportation Project, supported by the FHWA Resilience Pilot Program.

The **Tampa Bay Regional Resiliency Coalition (TBRRC)**, which is coordinated by the TBRPC, has been an important resource for MPOs in the Tampa Bay region. The Coalition currently includes 29 government agencies and 80 partners working together to assess and address regional climate impacts. These regional efforts are supported by the Tampa Bay Climate Science Advisory Panel (CSAP), which is an ad hoc network of scientists and resource managers working to develop science-based recommendations for the region. The TBRRC has developed technical resources and guidance documents, attracted and secured funding, and convened

stakeholders. Numerous MPOs in the Tampa Bay region (including Hernando/ Citrus, Hillsborough, Sarasota/Manatee, Pasco, and Pinellas) have leveraged resources from TBRRC and/or cited the group for continued coordination on resiliency issues:

- **Forward Pinellas** is a partner of the TBRRC and participates in the One Bay Resilient Communities Working Group, which includes the Tampa Bay Regional Transportation Authority Land Use Working Group, the One Bay Technical Team, and the TBRPC Regional Planning Advisory Committee. The group meets multiple times a year to develop resiliency solutions for the Tampa Bay area.
- **Hernando/Citrus MPO** recognizes the TBRRC’s efforts to develop strategic regional responses for reducing the impacts of climate change. The MPO cites that they will work with the TBRRC and other partners such as FDOT, local public works departments, and emergency planning agencies to help strengthen the transportation system’s resiliency to man-made and natural hazards (Hernando/Citrus 2045 LRTP, p. 4-68).
- **Sarasota/Manatee MPO** cites the TBRRC for coordination of climate adaptation and mitigation activities across county lines. The 2045 LRTP states that the “LRTP should take care to consult the RRC in developing project priorities and policies to address climate risks and to improve transportation system resiliency” (Sarasota/Manatee 2045 LRTP, p. 7-5).

4.4.2.2 East Central Florida Region

The **River to Sea TPO** and **Space Coast TPO** were early members of the **East Central Florida Regional Resiliency Collaborative (ECFR2C)**, which is coordinated by the East Central Florida Regional Planning Council (ECFRPC). Prior to the formalization of the ECFR2C, the ECFRPC had assisted both TPOs with transportation vulnerability assessments. Additionally, both TPOs participated in developing a Regional Resiliency Action Plan (RRAP) for Volusia and Brevard Counties. Currently, staff members from both TPOs serve on the ECFR2C steering committee and as co-chairs of the ECFR2C’s Infrastructure Technical Advisory Committee. Participation with the ECFR2C allows for learning opportunities, collaboration, and leveraging of ECFR2C resources and studies.

River to Sea TPO formally adopted a Sea Level Rise Planning Policy Statement and Sea Level Rise Projection through River to Sea TPO Resolution 2020-07. The scenarios are consistent with those developed for the RRAP for Volusia and Brevard Counties, which the TPO helped to develop. For SLR planning, the resolution established 2040 as the planning horizon, USACE 2013 High as the lower bound, and NOAA 2017 High as the upper bound.

Space Coast TPO. The TPO’s 2045 LRTP calls attention to agency coordination for risk reduction and for building community and transportation resiliency against natural hazards. Key partners

in these efforts include Brevard County Emergency Management (BCEM), Space Coast Area Transit, and ECFR2C. The BCEM serves on the TPO's Technical Advisory Committee and is provided direct access to real-time traffic monitoring and management during evacuations and post-storm recovery. Additionally, the BCEM participated in the TPO's 2018 Vulnerability Assessment and hosted a technical training for the Sea Level Scenario Sketch Planning Tool in 2017. Space Coast Area Transit coordinates evacuations for residents that are transportation disadvantaged, playing a key role in risk reduction.

4.4.2.3 Southeast Florida Region

The **Southeast Florida Regional Climate Change Compact** (The Compact) is an agreement between the counties of Broward, Miami-Dade, Monroe, and Palm Beach to coordinate on climate change projects, policies, and strategies across jurisdictional boundaries. The Compact's Regional Climate Action Plan (RCAP) is the guiding document for coordinating climate adaptation and mitigation and provides recommendations, implementation guidance, and shared best practices for municipalities. The Compact has long provided technical resources, training opportunities, and support for understanding climate change in the region and implementing strategies. **Broward MPO, Miami-Dade TPO, and Palm Beach TPA** all cite participation with and use of The Compact's resources.

In 2015, **Broward MPO, Miami-Dade TPO, Palm Beach TPA**, and Monroe County participated in a regional vulnerability assessment entitled "South Florida Climate Change Vulnerability and Adaptation Pilot Project", as part of the FHWA Resilience Pilot Program. In 2016, Broward MPO leveraged the regional assessment and conducted a follow-up assessment to focus on County facilities not included in the previous assessment.

4.4.2.4 Heartland Region

The **Heartland TPO** participated in *Heartland 2060: Building a Resilient Region*, a regional visioning collaboration for their six-county region (Polk, Hardee, Highlands, Okeechobee, Desoto, Glades and Hendry). The visioning effort explored three economic futures for the region: the current economy, the tourism and ecotourism economy, and the trade and logistics economy. The population, economic, and employment data gathered for the visioning effort were used in the TPO's LRTP. Heartland 2060 defines resiliency as "the ability to respond to unexpected events" and identifies the need for planning for climate stressors like drought and extreme weather (Heartland 2060, p 3). The TPO plans to maintain consistency with the Heartland 2060 plan.

4.5 Performance Measures and Evaluation Criteria

This section describes how Florida MPOs are incorporating resiliency into their performance measures and/or evaluation criteria for project prioritization or selection. Included here are

performance measures or evaluation criteria that the MPOs identified as meeting resiliency objectives. Most of these highlighted in the sections below include consideration of flooding due to future conditions (namely SLR) and current conditions (storm surge, inland flooding/floodplains).

4.5.1 Prioritization and Evaluation Criteria

About 40% of Florida MPOs are using resiliency-related evaluation criteria to screen or prioritize projects. The criteria are a mixture of qualitative and quantitative approaches to screen and assess projects. Table 7 lists examples of specific resiliency evaluation criteria developed and used by Florida MPOs in their LRTPs. These criteria commonly address whether the project is located in a flood prone area (due to sea level rise, hurricane storm surge, and/or 100-year floodplain). Lee County MPO included criteria that considers whether the project has been impacted by past weather events. North Florida TPO used the results of their Resiliency and Vulnerability Assessment (2019) to rank major roads in the region for the 2020 TIP. Other criteria award extra points to projects if they include features that will address flooding or stormwater issues.

Some MPOs incorporate resiliency in their annual call for projects. **River to Sea TPO** has incorporated resiliency criteria in their project prioritization for Traffic Operations & Safety and Bicycle & Pedestrian projects. Projects that address the resiliency of the transportation system in their proposals get extra points. **Forward Pinellas** added a set of resiliency criteria to their multimodal project prioritization, worth up to 10% of the total points. The criteria evaluate mobility on designated evacuation routes, consideration of SLR impacts, commitment to design to the 100-year flood, and applicant involvement with the Tampa Bay Resiliency Coalition.

Overall, prioritization criteria are largely used to weight projects in vulnerable areas and highlight the need for hardening or retrofitting to better withstand future conditions. As climate change issues continue to exacerbate extreme weather events, an inverse approach may be needed to identify areas to discontinue investment, based on the overall flood profile of the area. This is a sensitive issue best discussed with local communities, as they set their future growth and development priorities.

4.5.2 Performance Measures

Performance measures and targets are used to measure and track progress on established goals and objectives over time. In this review, the Team found approximately one-third of Florida's MPOs are using resiliency performance measures. Some MPOs align resiliency with performance measures relating to safety, security, or system preservation. For example, targets for pavement and bridge condition were associated with Hillsborough TPO's "State of Good Repair & Resiliency" and Sarasota/Manatee MPO "Infrastructure/ Resiliency". Pasco and

Broward MPO both utilize lane miles of evacuation routes per 100,000 people as one of their resiliency-related measures. Other MPOs have developed specific resiliency performance measures and targets, as shown in Table 7. Most of these specific resiliency measures concern flooding issues, such as SLR, storm surge, and high tides. One measure (St. Lucie TPO) includes the percentage of projects which incorporate adaptation or mitigation features, such as higher elevations, improved drainage, or resilient construction materials.

Table 6. Example Evaluation Criteria

MPO	Category	Evaluation Criteria
Broward MPO (2045 LRTP, p. 4-15)	Environmental Stewardship	Improvements Related to Sea-Level Rise Mitigation/ Extreme Weather Resilience
Capital Region TPA (2045 LRTP, Appendix D. Project Prioritization, p. D-3)	Resilience: Project contributes to the resiliency of the network	Project [is/ is-not] located in a 100-year floodplain or in an area susceptible to storm surge. <i>Points awarded if project is located in flood area</i>
Collier MPO (2045 LRTP, p. 3-10)	Promotes transportation infrastructure resiliency in the face of climate change and sea level rise	Within 0.25 miles of NOAA 1 foot-SLR flooding area = 5 Within 0.25 miles of NOAA 1-foot SLR low-lying area = 3 Not in high risk areas= 0 <i>Higher points awarded for projects in flood prone area</i>
Lee County MPO (2045 LRTP, Appendix D, p. D-1)	Transportation infrastructure resiliency	Has a weather related event impacted this project? <i>Scores given based on number of facility closures and/or evacuation zones.</i> <u>Score and description</u> 0 = Facility had no impacts or is in Hurricane Zone D or E 5 = Facility had 5 closures from weather events or is in Hurricane Zone B or C 7 = Facility had 5-10 closures from weather events or is in Hurricane Zone A 10 = Facility had greater than 10 closures from weather events

MPO	Category	Evaluation Criteria
Martin MPO (2045 LRTP, Appendix G, Highway/ Roadway Projects Prioritization, p. 15)	Extreme weather resiliency	Project gets a 1-point bump if located in vicinity of flood prone area (SLR, storm surge, king tides).
Ocala Marion TPO (2045 LRTP, p. 15)	Improve the resiliency of the transportation system through mitigation and adaptation strategies to deal with catastrophic events	100-year flood zone area applied to adjacent or intersecting facilities.
Sarasota/Manatee MPO (2045 LRTP, p. 3-1)	Infrastructure/ Resiliency	<p>Does the project:</p> <ul style="list-style-type: none"> • Address aging or deteriorating infrastructure on roads or bridges? • Address flooding or stormwater issues in flood hazard areas of storm surge zones?
Space Coast TPO (2045 LRTP, p. 2-3)	Improve the resiliency of the transportation system through mitigation and adaptation strategies to address sea level rise and other shocks and stressors	Points for including adaptation strategies concerning sea level rise, flooding, and extreme weather events and projects that improve treatment of storm water
St. Lucie TPO (2045 LRTP p. 3-13)	Improve transportation system's stability/ resiliency in event of climate change, emergencies, or disasters.	Is project a vulnerable roadway due to sea level rise? <i>If yes, assign score of 2 points</i>

Table 7. Examples of Resiliency Performance Measures

MPO	Goal or Objective	Performance Measures and/or Targets
<p>Broward MPO (Commitment 2045 MTP, p. 6-12)</p>	<p>Transportation System Vulnerability & Resiliency</p>	<p>Miles of Public Roads and Rail Forecasted to be Permanently Inundated by between 1 ft. and 2 ft. of Sea Level Rise.</p> <p><i>Target: Decrease by 2045</i></p>
<p>Hillsborough TPO (2045 LRTP, p. 32)</p>	<p>Good Repair & Resiliency</p>	<p>Protect 250 lane miles of highly vulnerable and critical roads from heavy rain and storm surge with shoreline protection, pavement hardening, and stormwater drainage improvements.</p>
<p>Indian River County MPO (Connecting IRC 2045 LRTP, p. 6-7)</p>	<p>Increase resiliency of infrastructure for extreme weather and climate trends</p>	<p>Percent of new projects incorporating enhanced features (such as higher elevations, increased drainage capacity, and more resilient construction materials as appropriate into new projects).</p> <p><i>Target: Improved by 2045</i></p>
<p>Martin MPO (2045 LRTP, p. 17)</p>	<p>Prioritize projects that improve extreme weather resiliency and/or harden infrastructure against sea level rise.</p>	<p>Transportation improvement projects located in areas prone to inundation due to storm surge, king tides and other extreme events including SLR. <i>(Higher is better).</i></p>
<p>North Florida TPO (2045 LRTP, p. 43)</p>	<p>Create Reliable and Resilient Multimodal Infrastructure</p>	<p>Consideration for vulnerable, at-risk facilities. <i>Benchmark: Evaluation of projects/scenarios.</i></p> <p>Number of projects on an evacuation route. <i>Benchmark: Evaluation of projects/scenarios.</i></p>

MPO	Goal or Objective	Performance Measures and/or Targets
Palm Beach TPA (2045 LRTP, p. 82)	Goal: Preserve Objective: Resiliency	Percentage of federal aid eligible mileage susceptible to: <ul style="list-style-type: none"> • Inundation by 1.2-foot SLR and historic storm surge. 2018 (Actual): 3.9%. <i>Targets:</i> Reduce to 3% by 2030 and 2% by 2050 • 1% chance annual flooding. 2018 (Actual): 26.7%. <i>Targets:</i> Reduce to 25% by 2030 and 20% by 2050
Pasco MPO (2045 LRTP, p. 5-13)	Provide a Reliable, Resilient, and Efficient Multimodal Transportation System	Lane miles of evacuation routes per 100,000 population Centerline miles of high resilience priority facilities (as defined in the Resilient Tampa Bay: Transportation Pilot Program Project)
St. Lucie TPO (2045 LRTP, p. 3-13)	"Improve transportation system's stability/resiliency in event of climate change, emergencies, or disasters	Percentage of roadway lane miles subject to climate change impacts.

4.6 Resiliency Strategies

This section highlights the strategies that MPOs have identified and adopted to address identified vulnerabilities and meet resiliency goals and objectives. These include a diverse range of activities such as setting aside funding for resiliency-focused projects, features, or studies; conducting stormwater mitigation and maintenance; building datasets to track flooding issues; and developing frameworks to guide future resiliency planning and implementation.

4.6.1 Resiliency Funding Strategies

A few MPOs are planning to or have developed resiliency-specific funds to address resiliency needs.

- **Sarasota/Manatee MPO** developed a \$75 million boxed fund “to protect high-risk, critical infrastructure, reduce roadway flooding, and protect against severe storms” (Sarasota/Manatee MPO 2045 LRTP, p. 12-7). This funding will be available for projects identified in their upcoming resiliency and vulnerability study.
- **North Florida TPO** put aside funding to address projects with resiliency components. The LRTP notes that the Cost Feasible Plan includes a mobility program that funds the

Resilience Program, which will continue to review projects and identify mitigation measures or design changes to improve transportation resiliency.

- **Hillsborough TPO** developed an investment program for vulnerability reduction (e.g. stormwater and drainage). Approximately \$1.5 billion was allocated towards Vulnerability Reduction for the period of 2026-2045 (Hillsborough TPO, 2019b). In the State of the System Report, the MPO notes that local jurisdictions have programmed significant funds to upgrading stormwater and resiliency projects in their current Capital Improvements Plans. Over the next five years, Hillsborough County is estimated to spend more than \$232 million, to be invested in canal dredging, upgrading and replacing culverts to mitigate roadway flooding, and a regional watershed study to address chronic flooding in South Tampa (Hillsborough TPO, 2019c).

4.6.2 Flooding-Related Strategies

Flooding, both coastal and inland, threatens the safety and reliability of the transportation system. Several MPOs are engaging in strategies to mitigate the impacts of current flooding, with a recognition that climate change will exacerbate flooding issues.

Gainesville MTPO 2045 LRTP lists tree-trimming and stormwater maintenance/mitigation as the two primary preventative measures for addressing resiliency. Tree trimming is used preventively to mitigate downed trees that commonly block roadways after hurricanes, tropical storms, and severe thunderstorms. Another preventative measure is stormwater maintenance along local roadways, which is conducted by Alachua County and the City of Gainesville. Finally, the MTPO area includes several major stormwater and flood mitigation projects implemented by FDOT to reduce historic flooding areas.

Lee County MPO is building a dataset of roadways impacted by flooding issues to better track and mitigate current flooding impacts. This dataset is used to identify areas of repetitive flooding and prioritize transportation projects to improve/ mitigate the flooding. The dataset is compiled from media and news stories, comments from users, and studies from local partners. The data identifies site characteristics, such as vegetation, debris, sediment, or damaged infrastructure, which contribute to the flooding issues and can be targeted for resolution.

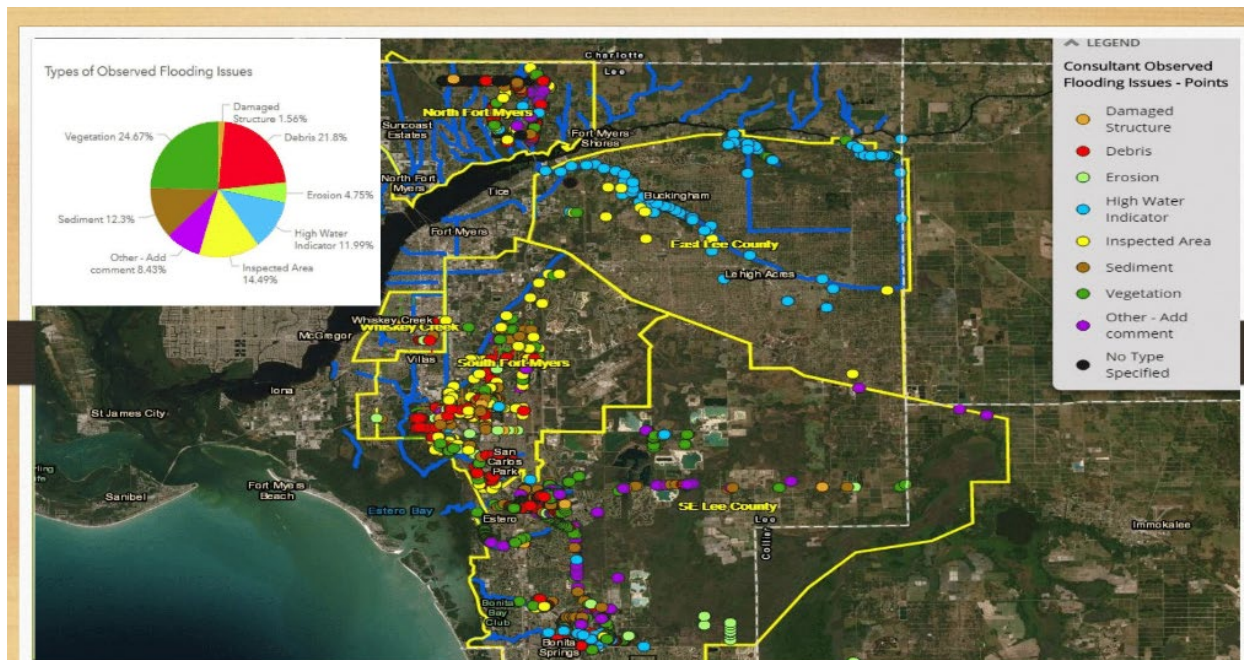


Figure 5. Lee County MPO Dataset of Flood Issue Locations

North Florida TPO: SR A1A/Naval Station Mayport Resiliency Assessment. North Florida TPO's UPWP FY 2020/21 – 2021/22 included a study to identify resiliency strategies for SR A1A, surrounding Mayport Naval Station. The roadway and area are particularly vulnerable to flooding. The project looked at three road segments around the station and three types of flooding, including: 100-year storm flood hazard areas; Storm Surge (Category 1, 2, & 3); and SLR USACE High Scenario for 2035, 2065, and 2100 (about 1, 2, and 4 feet of SLR respectively). The project identified several adaptation options for moderately to highly vulnerable roadways and categorized them as near term (0-5 years), mid-term (5-15 years), and long-term (15-20 years) solutions. Recommended strategies include raising the road and armoring, construction of living shorelines along adjacent areas, and addition of a barrier wall with riprap.

4.6.3 Resiliency Master Plans and Frameworks

Vulnerability assessments help identify where, when, and how climate change may impact transportation facilities, but often do not lay out strategies or solutions for addressing these vulnerabilities. Identifying and selecting appropriate strategies is complex, context-dependent, and often necessitates deeper study. Hence, some agencies choose to develop frameworks or master plans to guide their adaptation planning and implementation. These plans offer a roadmap for identifying adaptation and mitigation strategies, defining interagency coordination and roles, and institutionalizing resiliency through the planning process.

Space Coast TPO Resiliency Master Plan. As a follow up to the 2018 Vulnerability Assessment, SCTPO in 2020 began development of a Resiliency Master Plan (RMP), which will serve as a roadmap for addressing transportation resiliency in the region. The RMP will identify specific shocks and stressors impacting the transportation system and region, identify vulnerable corridors, and develop strategies to increase the resiliency of the system to cope with shocks and stressors. The TPO defines shocks as acute events that abruptly put pressure on the system and stressors as ongoing issues that impact a system over time, slowly reducing the resiliency of the system. The RMP will consider a broad set of shocks and stressors, such as sea level rise, storm surge & flooding, aging infrastructure, funding, cyber security of the system, wildfires, and heat & drought (*these have not yet been finalized*). Completion of the RMP is anticipated in 2022, after which its recommendations are expected to be incorporated into the 2050 LRTP.

Broward MPO Transportation Resiliency Framework Study/ Resiliency Corridor Studies. This study aims to develop a framework for incorporating climate change preparedness into project planning, design, and construction. Utilizing the MPO's prior vulnerability assessments, the Broward MPO's 2045 MTP identified eight highly vulnerable corridors for resiliency studies, which were included in the Cost Feasible Plan. These studies will examine the type and extent of flooding, impacts to the surrounding area, and identify appropriate strategies for mitigation. Resulting strategies and information will be used for determining the capital outlay needed to address the impacts. Further, these studies will develop a toolbox and typology of strategies that can be used for consistent evaluation of future projects and selection of appropriate mitigation measures. This 18-month study, which began in February 2021, aims to serve as a bridge between the MPO and future FDOT studies.

4.6.4 Other Strategies

Ocala Marion TPO. The TPO is in the process of developing a Resilience Guidance Paper to inform themselves and engage committee members on the broader topic of resiliency. The forthcoming paper will first include a broad definition of resiliency, with a discussion of the shocks and stressors affecting the area. The paper will also include a GIS analysis of federal aid roadways exposed to three current climate stressors: inland flooding, wildfires, and sinkholes. The draft paper found that approximately 60% of the TPO's federal aid roadways are exposed to flooding (as defined by FEMA 1% flood hazard areas). The TPO coordinated with Marion County on the data for these stressors, which were collected for the Local Mitigation Strategy Plan. The paper will also include a matrix of resiliency strategies and a summary of potential State and Federal funding opportunities for meeting resiliency requirements.

5 Notable Practices

While challenges certainly abound, it is important to recognize the many successes and progress made by dedicated staff across the state. Highlighted below are some of the notable practices by MPOs in their resiliency planning efforts. Table 8 also includes a brief summary of these notable practices. Across the board, MPOs highlighted the importance of building and leveraging relationships and partnerships to facilitate their resiliency planning efforts.

5.1 Local and Regional Partnerships

Many MPOs participate with **local climate or resiliency steering committees** to coordinate on local climate and hazard mitigation issues.

- **Martin MPO** is a member of the Martin County’s Resiliency Planning Working Group, which includes representatives from county departments of Coastal Engineering, Ecosystem Restoration and Management, Community Development, Surveying, and Growth Management Department. The group is involved with a Resilient Coastlines Program grant to develop a vulnerability assessment and resiliency plan, which will inform the MPO’s transportation network resiliency study and overall resiliency efforts.
- **St. Lucie TPO** is a member of the St. Lucie County Resilience Planning Steering Committee. The committee includes representatives from three city governments and county staff from Emergency Management, Community Health, Regional Planning, Transportation, Economic Development and School Board. The committee is currently giving input on a 3-year Community Development Block Grant (CDBG) grant to develop a county resiliency plan and a unified hazard mitigation effort.

Participation with regional climate collaboratives to learn about emerging science and strategies for adaptation and mitigation to inform long range planning efforts. Participation with these groups has built MPO capacity on climate issues, given transportation agencies a seat at the table, and brought together diverse stakeholders to work on resiliency initiatives. Over one-third of Florida’s MPOs are located in regions where these groups currently exist and additional regional climate collaboratives are becoming established in other regions.

- The Tampa Bay Regional Resiliency Coalition (TBRRC), an initiative of the Tampa Bay Regional Planning Council (TBRPC), has been an important resource for MPOs in the Tampa Bay region (**Hernando/Citrus, Hillsborough, Sarasota/Manatee, Pasco, and Pinellas**). These MPOs have leveraged technical resources and guidance documents, attended workshops and webinars, and cited the group for continued coordination on resiliency issues.

- **River to Sea TPO and Space Coast TPO** were early members of the East Central Florida Regional Resiliency Collaborative (ECFR2C), which is coordinated by the East Central Florida Regional Planning Council (ECFRPC). Staff members from both TPOs serve on the ECFR2C steering committee and as co-chairs of the ECFR2C's Infrastructure Technical Advisory Committee. River to Sea TPO adopted a policy for utilizing a set of regional SLR scenarios (collaboratively developed with the ECFRPC) for more consistent analysis and policy making across multiple counties.
- The Southeast Florida Regional Climate Change Compact (The Compact), has been an important resource for MPOs in the Southeast Florida region (**Broward MPO, Miami-Dade TPO, and Palm Beach TPA**). For over a decade, the Compact has provided technical resources, training opportunities, and support for understanding climate change in the region and implementing strategies.
- Emerging collaboratives in Southwest and Northeast Florida are convening local and regional stakeholders and becoming important resources of local climate knowledge and guidance.

5.2 Utilizing Existing Studies and Resources

Utilizing resources and outputs from local studies and vulnerability assessments to inform the long range planning process. In many regions, past and current climate and hazards studies are used to inform long range plans. Some MPOs may not need to conduct an independent vulnerability assessment, but can instead leverage the results of existing studies.

- In 2021, **St. Lucie TPO** utilized the results of a county vulnerability assessment to review and update their transportation vulnerabilities to a newer set of NOAA SLR projections.
- **Florida-Alabama TPO** used local plans and vulnerability assessments (from Escambia County and City of Pensacola Climate Action Task Force) to coordinate on local projects and inform their LRTP.
- **Lee County MPO** leveraged local and regional studies on flood mitigation, drainage, and regional resiliency to inform their understanding of vulnerabilities and project prioritization.
- **Collier MPO** has attended workshops and meetings for several local and regional resiliency studies. While data products from these studies were not ready in time for the 2045 LRTP, there may be opportunities for inclusion in the 2050 LRTP.

5.3 Stakeholder Engagement and Education

Engaging stakeholders through advisory groups and education.

- **Sarasota/Manatee MPO** developed a **Transportation Resilience Advisory Group** to give input on their Resiliency/ Vulnerability Assessment study and the Barrier Island Traffic Study.
- **Ocala-Marion TPO** is developing a **Resilience Guidance Paper** to inform themselves and engage committee members on the broader topic of resiliency. The paper will include a GIS analysis of local impacts (from inland flooding, wildfires, and sinkholes), a matrix of resiliency strategies, and a summary of State and Federal resiliency funding opportunities.

5.4 Leveraging Grant Funding

Leveraging grant funding to support local and regional vulnerability assessments and training workshops.

- **Hillsborough TPO** participated in two rounds of the FHWA Resilience Pilot Program: first in 2013-14 for a solo assessment, then again in 2019 in partnership with **Forward Pinellas and Pasco County MPO** for a regional assessment. A primary objective of the regional assessment was to inform the 2045 LRTPs. Regional assessments offer consistent analysis and consideration of interconnected impacts across jurisdictional boundaries.
- In Southeast Florida, **Broward MPO, Miami-Dade TPO, and Palm Beach TPA** participated alongside Monroe County in the FHWA Resilience Pilot Program. In 2016, Broward MPO conducted a follow-up assessment to focus on County facilities not included in the previous assessment.
- In 2018, **Sarasota/Manatee MPO** was awarded a Federal Transit Administration grant to host a two-day training workshop on developing an emergency recovery plan. The *All Hazards Recovery Plan Workshop* brought together regional stakeholders from Sarasota, Manatee, and Hillsborough Counties and their municipalities, including representatives from the MPOs, RPCs, emergency management, public transit, school board, academia and private consultants.

5.5 Developing Funding Strategies

A few MPOs are planning to or have developed resiliency-specific funds to address resiliency needs.

- **Sarasota/Manatee MPO** developed a \$75 million boxed fund to address flooding and protect critical infrastructure. The funding will be available for projects identified in their upcoming resiliency and vulnerability study.
- **North Florida TPO** put aside funding for a Resilience Program to identify mitigation measures or design changes to improve transportation resiliency.
- **Hillsborough TPO** developed an investment program for vulnerability reduction (e.g. stormwater and drainage). Approximately \$1.5 billion was allocated towards Vulnerability Reduction for the period of 2026-2045.

5.6 Focus on Maintenance and Prevention

Across Florida, proper drainage is critical for safety, mobility, system preservation, and more. While not always called resiliency strategies, drainage improvements and stormwater maintenance contribute towards flood risk reduction and increase transportation systems resiliency.

- **Gainesville MTPO** highlights stormwater maintenance along local roadways conducted by Alachua County and the City of Gainesville as important preventative measures for addressing resiliency.
- **Lee County MPO** is building a dataset of roadways impacted by flooding issues to better track areas of repetitive flooding and prioritize transportation projects to mitigate the flooding. The data identifies site characteristics, such as vegetation, debris, sediment, or damaged infrastructure, which contribute to the flooding issues and can be targeted for resolution.
- **Forward Pinellas** recognizes the importance of green infrastructure to mitigate stormwater impacts, improve water quality, and add visual appeal to projects.

5.7 Consideration of Inland Impacts and Migration

Scenario Planning for **MetroPlan Orlando's 2045 MTP considered inland impacts of SLR and temperature increases** in all four scenarios. The Climate Consequences scenario focused on a **rapid increase in population due to migration from coastal counties** in Florida and emphasized the need to increase resiliency of critical infrastructure to cope with increased extreme weather events and flooding.

5.8 Highlighting Equity Concerns within the Context of Resiliency

Collier MPO and **North Florida TPO** both address social equity within their definitions of a resilient transportation system (see Table 2 on p. 10 for definitions).

5.9 Developing Planning Frameworks

A few MPOs have started to develop planning frameworks and master plans, which guide their adaptation planning and project selection. These frameworks can offer a roadmap for identifying adaptation and mitigation strategies, defining interagency coordination roles, institutionalizing resiliency throughout the transportation process (planning, design, and construction).

- **Broward MPO Transportation Resiliency Framework Study** aims to develop a framework for incorporating climate change preparedness into project planning, design, and construction. Eight highly vulnerable corridors are being studied for flood impacts and development of a toolbox of strategies for evaluation of future projects and selection of appropriate mitigation strategies. Expected completion is late 2022 (For more details, see p. 33).
- **Space Coast TPO Resiliency Master Plan** will serve as a roadmap for addressing transportation resiliency in the region. The Plan will identify specific shocks and stressors impacting the transportation system, identify vulnerable corridors, and develop adaptation and mitigation strategies. Completion of the RMP is anticipated in 2022, and recommendations are expected to be incorporated in the 2050 LRTP (For more details, see p. 33).

Table 8. Summary of Notable Resiliency Practices

Notable Practice	Examples
Participation with local resiliency steering committees and groups	Martin MPO is a member of the Martin County’s Resiliency Planning Working Group. St. Lucie TPO is a member of the St. Lucie County Resilience Planning Steering Committee. Participation with these groups help to coordinate on local climate and hazard issues.
Participation with regional climate collaboratives to learn about emerging science and coordinate adaptation and mitigation strategies	The Tampa Bay Regional Resiliency Coalition is an important resource for the Hernando/Citrus MPO, Hillsborough TPO, Sarasota/Manatee MPO, Pasco MPO, and Forward Pinellas . River to Sea TPO and Space Coast TPO serve as steering committee members of the East Central Florida Regional Resiliency Collaborative. The Southeast Florida Regional Climate Change Compact is an important resource for Broward MPO, Miami-Dade TPO, and Palm Beach TPA .
Utilizing resources and outputs from local studies and vulnerability assessments to inform long range plans	St. Lucie TPO used results of a county vulnerability assessment to update their previous assessment. Florida-Alabama TPO used local plans and vulnerability assessments to coordinate on local projects and inform their LRTP. Lee County MPO leveraged local and regional flood mitigation and resiliency studies to inform their LRTP and project prioritization. Collier MPO attended workshops and meetings for local and regional resiliency studies.
Engaging stakeholders through advisory groups and education	Sarasota/Manatee MPO developed a Transportation Resilience Advisory Group to give input on their vulnerability study and related resiliency efforts. Ocala-Marion TPO is developing a Resilience Guidance Paper to inform and engage committee members on resiliency.
Leveraging grant funding to support local and regional vulnerability assessments and training workshops	Sarasota/Manatee MPO was awarded a Federal Transit Administration grant to host a “All Hazards Recovery Plan Workshop” on developing an emergency recovery plan. Florida MPOs have participated in the FHWA Resilience Pilot Program to conduct assessments within and across MPOs: Hillsborough TPO (2013-14); Broward MPO, Miami-Dade TPO, and Palm Beach TPA - South Florida Vulnerability Assessment (2015); and Hillsborough TPO, Forward Pinellas, and Pasco County MPO - Resilient Tampa Bay Transportation (2019).

Notable Practice	Examples
Developing resiliency-specific funds to address resiliency needs	<p>North Florida TPO put aside funding for a Resilience Program to identify mitigation measures or design changes to improve transportation resiliency.</p> <p>Sarasota/Manatee MPO developed a \$75 million boxed fund to address flooding and protect critical infrastructure identified in their resiliency and vulnerability study.</p> <p>Hillsborough TPO developed an investment program for vulnerability reduction (e.g. stormwater and drainage).</p>
Focusing on drainage, maintenance, and prevention	<p>Gainesville MTPO highlights stormwater maintenance along local roadways conducted by Alachua County and the City of Gainesville as important preventative measures.</p> <p>Lee County MPO is building a dataset of roadways impacted by flooding issues to better track areas of repetitive flooding and prioritize transportation projects to mitigate the flooding.</p> <p>Forward Pinellas recognizes the importance of green infrastructure to mitigate stormwater impacts, improve water quality, and add visual appeal to projects.</p>
Consideration of inland impacts and migration	<p>Scenario Planning for MetroPlan Orlando’s 2045 MTP considered inland impacts of SLR and temperature increases in all four scenarios. One scenario focused on a rapid increase in population due to migration from coastal counties in Florida.</p>
Highlighting equity concerns	<p>Collier MPO and North Florida TPO both address social equity within their definitions of a resilient transportation system (see Table 2 on p. 10 for definitions).</p>
Developing planning frameworks and master plans to guide incorporation of resiliency into the transportation process	<p>Broward MPO Transportation Resiliency Framework Study aims to develop a framework for incorporating climate change preparedness into project planning, design, and construction. Eight vulnerable corridors are being studied for flood impacts and a toolbox of adaptation and mitigation strategies is being developed.</p> <p>Space Coast TPO Resiliency Master Plan will serve as a roadmap for addressing transportation resiliency in the region. The Plan will identify shocks and stressors impacting the transportation system, identify vulnerable corridors, and develop adaptation and mitigation strategies.</p>

6 Challenges

MPOs cited a number of challenges and subsequent needs in their resiliency planning efforts. The primary challenges cited were grouped into five categories: 1) funding, 2) institutional, 3) data and tools, 4) public support and leadership, and 5) guidance.

6.1 Funding

Funding was undoubtedly the biggest challenge cited by MPOs in their resiliency efforts. This includes a lack of overall funding, lack of eligible funding sources, and competing priorities.

- **Competing Priorities and Lack of Funding.** Nearly all interviewees discussed the challenges with funding constraints. Resiliency is only one priority amongst many competing issues: safety, capacity, system preservation and maintenance, economic development, and more. Funding for vulnerability assessments, resiliency studies, adaptation strategies, and mitigation projects must compete with these other critical priorities.
- **Tension between existing needs and future needs.** Funding for the backlog of existing projects and maintenance needs usually takes priority with the public, while building public support for future needs can be challenging. Some MPOs noted the public's lack of interest or understanding about the need to plan now for future climate impacts.
- A few MPOs mentioned the **impacts of the COVID pandemic** on their budgets, which has put further strain on meeting competing needs with limited resources.
- **Funding Eligibility.** Participants noted the challenge with matching resilience-related needs with eligible funding sources.

Need for Discretionary and Dedicated Resiliency Funding. Many participants indicated that a dedicated source of resiliency funds or discretionary funding sources would be hugely beneficial for conducting vulnerability assessments and resiliency corridor studies and developing plans and strategies. This funding may help reduce conflicts with other transportation system needs and dedicated resiliency funding could be used as a “carrot” to incentivize inclusion of resiliency strategies.

6.2 Institutional

MPOs described a variety of institutional challenges for resiliency efforts, primarily staff capacity, implementation, and coordination which are described below.

Staff Capacity

Resiliency planning is scientifically and technically complex, often involving substantial time to build knowledge around climate change issues and skill with the technical components (such as using scenarios, GIS mapping, and analysis). Across the state, MPOs vary in their organizational structure, staff size and resources. MPOs noted the lack of staff capacity and resources (financial, technical, time), which constrains their ability to pursue vulnerability assessments and develop resiliency plans and strategies. It is difficult for MPOs (especially the smaller ones) to commit time to these efforts.

MPO staff often wear many hats, and resiliency activities add another task on an already long to-do list. Often consultants are contracted to perform resiliency planning and analysis, but lack of financial resources can constrain this option.

Implementation and Coordination

MPOs are primarily planning organizations and hence constrained by their limited role in project implementation. MPOs rely on their local and state partners for implementation, but partners often have differing priorities, which may not emphasize resiliency needs.

At the FDOT District level, participants noted the lack of consistent policies for resiliency and no defined processes for incorporating resiliency strategies and project features. Another challenge was the lack of a “go-to” resiliency contact or point person at the district level to coordinate resiliency initiatives and features throughout project development.

Need to **designate a resiliency lead at each FDOT District** for coordination and continuity on projects involving resiliency features and state level guidance and policy. A resiliency lead would be **similar to designated leads such as for Safety, Bicycle-Pedestrian, and Traffic Operations.**

Ideas for Building Capacity and Sharing Information:

- Additional opportunities for **peer exchanges** to share information about what other MPOs are doing to advance resiliency efforts can build capacity on resiliency planning.
- **Cultivate resiliency champions** within MPOs and across other partnering organizations.
- Develop of a **contact list of MPO staff** knowledgeable or involved in resiliency efforts, maybe through MPOAC.

6.3 Data and Tools

Several themes emerged around challenges using data and tools to facilitate various aspects of the resiliency planning process for MPOs.

Climate Stressors and Impacts. As the focus of resiliency expands from primarily SLR and coastal flooding issues, MPO noted interest in data on other climate stressors and their impacts to the transportation system. In particular:

- Data on historic flooding locations and impacts (such as road closures)
- Future inland flooding models and precipitation projections
- Shoreline erosion and potential for erosion
- Increasing temperatures and extreme heat impacts
- Data on resilience metrics and how to track progress over time

Asset Data. High quality geospatial asset data is critical to the vulnerability assessment process and monitoring of impacts. Some MPOs noted challenges in working with data, including gathering data from multiple sources, standardizing data, and post-processing. For example, collecting municipal level GIS data for corridor studies and other needs can be time consuming and inconsistent across jurisdictions. A few participants mentioned municipal datasets that could aid resiliency planning, such as seawalls, stormwater and drainage infrastructure, and sidewalks (for public health/ heat analysis).

Centralized Data Access. A few participants expressed challenges with collecting data for vulnerability assessments and related studies and that a centralized repository would be useful.

Decision Making Tools. Participants noted several cases where decision support tools could help with resiliency planning needs such as cost-benefit analyses, evaluating climate scenarios, and facilitate screening of projects.

- Some participants noted difficulties with evaluating the **costs and benefits of resiliency mitigation and adaptation strategies**. Additionally, one participant noted the need to incorporate more than just economic data and property values in the cost-benefit evaluation, to ensure equitable consideration of all community and natural resources.
- Another participant expressed the desire for metrics or thresholds, such as the number of days per year flooded, that would indicate a road is no longer viable. This would also help inform resiliency investments.
- Many MPOs use FDOT's Environmental Screening Tool (EST) to screen LRTP projects. Several participants requested inclusion of SLR data and other resiliency data sets as they become available.

Technical Training and Workshops. Participants indicated that training on basic SLR and flooding issues could be helpful for MPO staff, elected officials, and the public.

6.4 Public Support and Leadership

Resiliency planning generally requires local and regional coalition building and political readiness to tackle climate issues. Local and regional governments and organizations are important partners in understanding and planning for climate change. Participants shared mixed perspectives on leadership and public support for engaging in climate change planning in their regions.

- Some MPOs noted positive leadership and public support enabling their resiliency efforts.
- Other MPOs were constrained by lack of leadership and public support for resiliency efforts. They noted the need to engage political leadership and get buy-in from elected officials to support prioritization of resiliency efforts. Several MPOs mentioned the public's lack of interest in planning now for future climate impacts and the tension between existing and future needs.
- Areas with low public and political support for climate issues constrain resiliency planning in a variety of ways. First, these local communities will likely not prioritize resiliency in their project needs and priorities. Next, the local communities will likely not conduct vulnerability assessments or other resiliency studies, which are important resources for informing LRTPs, particularly smaller MPOs, with limited staff and financial capacity.
- Transportation agencies face political and public divisions over the strategies proposed to address climate impacts. For example, some nature-based solutions, such as coastal dunes, proposed to protect oceanfront homes, may not be popular with residents who prefer open access to and non-obstructed views of the ocean. Also, forgoing improvements to problematic and repeatedly damaged roadways is politically difficult when that roadway provides critical access for tourism or for vocal residents. If these improvements are needed often, they can get expensive, further exacerbating the challenges of limited funding and competing priorities.

6.5 Guidance

Climate change and resiliency planning are scientifically and technically complex and emerging subjects that require special considerations. MPOs noted several challenges with aspects of resiliency planning such as addressing uncertainty and long-time horizons, defining resiliency, choosing climate scenarios, and selecting appropriate adaptation and mitigation strategies. These aspects are good candidates for developing further guidance.

Challenges Planning for Uncertainty and Long Time Horizons

Climate change presents unique problems due to its long term impacts and our uncertainty about the severity and timing of the impacts. These aspects give way to MPO organizations addressing existential questions, as they grapple with uncertainty and when and how to plan for retreat or disinvestment of assets. For example, participants noted the difficulty of planning ahead and grappling with uncertainty in the timing and severity of impacts. Additionally, participants noted the difficulty with determining when to stop investing in assets that will most likely be under water in the mid-century.

Defining Resiliency and Selecting Climate Scenarios, Adaptation and Mitigation Strategies

Participants noted challenges with defining resiliency and finding a consistent definition to use. Because the term resiliency has been widely applied to various contexts (e.g. climate change, sustainability, economic, emotional), it can be challenging to discuss and define. Participants noted the need to understand how the public interprets the concept of resiliency and also use deliberate definitions.

Multiple participants expressed the desire for a recommended set of SLR scenarios, which would lend clarity and credibility to the resiliency planning process. Some MPOs are using SLR scenarios recommended by a regional climate collaborative (e.g., Southeast Florida Regional Climate Change Compact), but not all MPOs are located in areas with these groups.

Another challenge for MPOs was identifying appropriate adaptation and mitigation strategies to address identified vulnerabilities. Participants were also seeking guidance on evaluating resilient materials and practices (e.g., use of asphalt versus concrete in changing conditions and environments, is burying utilities more resilient?).

Participants also expressed the desire for baseline resiliency approaches and standards across FDOT districts, that could be adapted to local contexts. Additionally, several MPOs referenced guidance developed by FDOT on emerging issues or special topics (such as CAVs and Complete Streets), that would be helpful to have on the topic of integrating resiliency. Finally, some participants suggested that design manuals be evaluated to determine if changing future conditions warrant inclusion.

7 Opportunities

Based on the challenges and needs indicated by MPOs, many opportunities exist to address these challenges and advance transportation resiliency planning in Florida. Below are some priority needs and actionable opportunities that can be pursued by MPOs, FDOT, and partnering organizations. Table 9 provides a matrix of the challenges and opportunities.

7.1 Funding

A dedicated source of resiliency funds or discretionary funding sources would be hugely beneficial for conducting vulnerability assessments, incorporating resiliency considerations into corridor studies, and developing resiliency plans and strategies. Dedicated resiliency funding may help reduce conflicts with other transportation system needs and could be used as a “carrot” to incentivize inclusion of resiliency strategies.

Fortunately, the new PROTECT Resilience Funding created through the BIL will provide Florida with \$348.9 million in formula funds and additional competitive discretionary funding. PROTECT provides planning grants to develop resilience improvement plans (RIP), conduct resiliency planning, develop data and tools for vulnerability assessments, and capacity building. For agencies that have a RIP, PROTECT provides an opportunity for a lowered federal match when applying for project funding. Efforts should include assisting MPOs with grant application support to pursue BIL funding opportunities and facilitating tools training to help MPOs complete vulnerability assessments and resilience improvement plans.

7.2 Institutional

Resiliency is still an emerging topic for some transportation agencies. Strengthening and clarifying roles and responsibilities at various levels (local, regional, state) could assist with better operationalization of resiliency planning and identification and implementation of adaptation and mitigation strategies.

- Need to **designate a resiliency lead at each FDOT District** for coordination and continuity on projects involving resiliency features and state level guidance and policy. A resilience lead would be **similar to designated leads such as for Safety, Bicycle-Pedestrian, and Traffic Operations**.
- Additional opportunities for **peer exchanges** to share information about what other MPOs are doing to advance resiliency efforts can build capacity on resiliency planning.
- **Cultivate resiliency champions** within MPOs and across other partnering organizations. Develop of a **contact list of MPO staff** knowledgeable or involved in resiliency efforts, maybe through MPOAC.

Table 9. Matrix of Challenges and Opportunities

Category	Challenge	Opportunities
Funding	Lack of overall funding, lack of eligible funding sources, and competing priorities.	Leverage PROTECT program funding for developing resilience plans, vulnerability assessments, data, tools; constructing resilience improvements; improving evacuation routes; protecting at-risk coastal infrastructure.
Institutional	Lack of staff capacity.	Regular peer exchanges to share information between MPOs and build capacity on resiliency planning. Develop of a contact list of MPO staff knowledgeable or involved in resiliency efforts.
	Difficulty with implementation and coordination.	Designate a resiliency lead at each FDOT District for coordination on projects involving resiliency and state level guidance/ policy.
Data and Tools	Time consuming to collect and vet data for vulnerability assessments. Need centralized data access.	Develop a centralized repository for transportation focused climate data , tools, guidance, and training opportunities. Add resiliency data to the Environmental Screening Tool to support screening of proposed projects.
	Difficulties with evaluating the costs and benefits of resiliency mitigation and adaptation strategies.	Develop or recommend cost-benefit analysis tools to evaluate resiliency investments in mitigation and adaptation strategies. Tool or metric to help identify triggers or thresholds for adaptation pathways and resiliency investments.
Public Support and Leadership	Lack of public support and political leadership for resiliency efforts and for planning for future impacts versus funding current needs.	Offer locally relevant examples and case studies to illustrate local impacts and build political and public support. Use messaging that is sensitive to the community. Increase education of the historical extreme weather events and impacts to build a longer memory of what has happened before in each region.
Guidance	Challenge with selecting appropriate climate scenarios and adaptation and mitigation strategies that match the vulnerable assets and areas.	Develop a framework for applying recommended SLR scenarios and suggested planning horizons. Develop guidance on integrating resiliency , similar to FDOT’s guidance on CAVs and Complete Streets. Develop a toolbox of adaptation and mitigation strategies to help identify appropriate strategies to match identified vulnerabilities.

7.3 Data and Tools

Below are opportunities to support resiliency data and tools:

- Develop or recommend existing **cost-benefit analysis tools** for evaluation of resiliency investments in mitigation and adaptation strategies. Some participants noted the need to incorporate more than economic data and property values in these tools to ensure equitable consideration of all community and natural resources.
- **More resiliency data within FDOT's Environmental Screening Tool (EST).** Many MPOs use the EST to screen LRTP projects. Several participants requested inclusion of SLR data and other resiliency data sets as they become available. UF GeoPlan Center is currently working on a project to address this need.
- Tool or metric to help identify triggers or thresholds for **adaptation pathways**. For example, develop a threshold, such as the number of days per year flooded, that would indicate when a road is no longer viable for continued maintenance.
- **Transportation Resiliency Data Clearinghouse.** A centralized repository for transportation focused climate data, tools, guidance, and training opportunities would facilitate resiliency planning efforts. While there are various websites that list climate data, tools, and guidance, there is no such resource that provides a curated climate or resiliency focused resources for transportation and community planning in Florida. The data gathering and vetting process can be lengthy, especially for those with little experience with climate-related datasets. Results of vulnerability assessments could also be housed here for quick access during the development of LRTPs and others plans. The forthcoming Florida Flood Hub, at the University of South Florida, may meet some of these needs, but the Hub is still becoming established.
- **Technical Training and Workshops.** Participants indicated that training on basic SLR and flooding issues could be helpful for MPO staff, elected officials, and the public. Also, some participants requested more training on the Sketch Planning Tool as the functionality is expanded. Partnership with universities and regional agencies could fill this need.

7.4 Public Support and Leadership

Below are needs and ideas for engaging the public and elected leadership to facilitate community discussions about planning for climate change:

- Recognizing that each region is socially and politically different, climate change education needs to be **relevant to the local communities**, with appropriate messaging, **local examples and case studies to illustrate local vulnerabilities**. A few participants

stressed the need to spend time developing appropriate messaging and how to present future scenarios to the public without scaring them away (e.g., some people shut down when viewing the worst case scenario).

- **Better education and communication of the historical context of extreme weather and climate change impacts.** This would include showing historical observations, trends, and extreme weather events to build a longer memory of what has happened before in their area. Many areas in Florida already experience the impacts of extreme weather, particularly from tropical storms and rain events. Newer residents to Florida may not yet conceptualize these events as a real threat or problem.
- For projects that increase resiliency, **documentation and pictures of these projects before and after completion** may help to illustrate tangible results and build public support for future projects.

7.5 Guidance

MPOs rely upon guidance to manage the competing and complex interests they are tasked with considering in their planning processes. Resiliency is still an emerging topic in some areas and many participants requested guidance to help them understand and operationalize resiliency practices. Additionally, guidance can provide credibility and confidence to the resiliency planning process where MPO staff are not climate experts, but need to rely upon vetted, credible sources of guidance and information to navigate issues with uncertainty and planning for long time horizons.

- Need **clear definition of resiliency** in the transportation context and **how to measure** resiliency.
- **Need guidance on choosing and applying climate scenarios**, especially SLR scenarios. State should provide a framework for applying a recommended a SLR scenario or set of scenarios and suggested planning horizons to be optionally used in the planning process. This would lend clarity and credibility to the resiliency planning process.
- Develop **baseline resiliency approaches and standards** that can be adapted to meet the unique needs of each FDOT district.
- Develop **guidance on integrating resiliency**, similar to FDOT's guidance on CAVs and Complete Streets.
- Develop a **toolbox of adaptation and mitigation strategies** to help identify adaptation and mitigation strategies to address identified vulnerabilities.

- **Guidance on resilient materials** (e.g., use of asphalt versus concrete in changing conditions and environments). Are concrete roads more resilient? Is burying utilities more resilient?
- Participants suggested that **design manuals** be evaluated to determine if changing future conditions should be reflected.

U.S. DOT Climate Action Plan

Many of the priority needs identified in this project are not unique to Florida and align with priority actions in the U.S. DOT Climate Action Plan (U.S.DOT, 2021). The Action Plan includes five priority adaptation actions (listed below) that DOT plans to implement to increase resilience and climate preparedness. Opportunities exist to align and leverage Florida’s resiliency planning needs with federal efforts, particularly with Actions 1, 2, and 5.

U.S. DOT Priority Adaptation Actions:

1. Incorporate Resilience into DOT Grant and Loan Programs. DOT will incorporate resilience criteria into DOT discretionary grant and loan programs (wherever appropriate) and may change Notices of Funding Opportunity to include project resiliency as part of the selection criteria.
2. Enhance Resilience Throughout the Project Planning and Development Process. Evaluate and update current regulations and guidance to incorporate resilience (where appropriate). Develop new guidance where needed. Update guidance on incorporating resilience throughout the planning and environmental processes for proposed actions, including transportation planning conducted by State DOTs and MPOs. May include external training provided to stakeholders.
3. Ensure Resiliency of DOT Facilities and Operational Assets. Lead by example and ensure that DOT facilities and operational assets are climate-change ready.
4. Ensure Climate-ready Services and Supplies. Lead by example and ensure climate-ready services and supplies. Examples include integrating adaptation criteria into the procurement process and contracts, examine options for innovative and novel products, designation of DOT supply chain managers and inclusion sustainability reviews, and required climate change training for all program managers and acquisition practitioners.
5. Improve Climate Education and Research on Resilience. Develop a strategy to increase climate change education among internal DOT employees and ensure continued research to help fill knowledge gaps and use of new technologies. Incorporate resilience into standard departmental training and staff performance plans.

8 Conclusion

Florida MPOs are engaging in diverse efforts to increase transportation resiliency to the impacts of climate change. In some areas, resiliency is still an emerging issue. In other areas, MPOs have been involved in resiliency planning efforts for almost a decade. Many regions benefit from concurrent local and regional climate initiatives to inform long range planning efforts.

From our review of 2045 LRTPs, most MPOs are in the beginning stages of addressing resiliency (setting goals and objectives and assessing vulnerability). Some MPOs aligned resiliency with existing goals, while others developed resiliency-specific goals or objectives. About 40% of Florida MPOs adopted resiliency-related evaluation criteria in their project prioritization and over 30% developed resiliency-related performance measures or targets. Some MPOs have made progress on identifying strategies to address known vulnerabilities, but many others need guidance. As MPOs advance their resiliency planning, implementation of strategies followed by monitoring and reporting will be important for evaluating the efficacy of resiliency strategies and informing future approaches.

Over half of Florida's MPOs have conducted or plan to conduct a vulnerability assessment, though only coastal MPOs. The availability of online tools and technical training, coupled with the FAST Act requirements and grant opportunities, have facilitated vulnerability assessments in coastal regions. Future inland flooding impacts and demographics shifts (from people moving away from the coast) are emerging areas of climate resiliency that are in need of addressing.

MPOs face a number of challenges in their resiliency planning efforts. Primary among them include lack of discretionary funding, coordination challenges and lack of capacity, need for centralized data and tools to evaluate resiliency strategies, lack of leadership and public support, and lack of guidance. Not surprisingly, the Team found that MPOs were resourceful in addressing resiliency, particularly by building and leveraging partnerships. MPOs have had notable successes with leveraging grant funding and partnerships for vulnerability assessments, building capacity on climate issues through participation with local and regional climate groups, leveraging and sharing resiliency resources, engaging stakeholders on resiliency issues, developing strategies to improve drainage, and developing funding strategies to address resiliency needs.

Despite the challenges, many actionable opportunities exist for advancing transportation resiliency planning in Florida. Priority actions include leveraging new resiliency funding through the PROTECT program; strengthening and clarifying roles to better operationalize resiliency planning; facilitating access to decision support tools to assist with project screening and cost benefit analysis; developing a centralized clearinghouse for transportation resiliency data, tools, and guidance; building public support and political buy-in for prioritizing resiliency; and

developing additional guidance to assist in applying climate scenarios, addressing uncertainty, and strategy identification and implementation.

Some of these actions are already underway in several FDOT research projects, including efforts to add resiliency data to EST and to incorporate other climate data, nonstationarity, and resiliency metrics into FDOT's business processes. Additional opportunities exist with the recent passage of Florida HB7053 Statewide Flooding and Sea Level Rise Resilience, which adds funding opportunities for local governments to conduct vulnerability assessments and requires FDOT to develop a resilience action plan. Next steps should look towards leveraging both state and federal efforts to advance the priority needs identified in this project.

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Appendix A. Transportation Vulnerability Assessments

Report Title & Web Link	MPO	Climate Stressors & Scenarios	Data & Tools
South Florida Climate Change Vulnerability and Adaptation Pilot Project (2015)	Broward MPO, Miami-Dade TPO, Palm Beach TPO	SLR: 1, 2, & 3 feet Current 100-year flood hazard areas Future flooding hotspots (based on elevation & proximity to 100-year flood zone)	UF GeoPlan Sea Level Scenario Sketch Planning tool, FEMA HAZUS
Extreme Weather and Climate Change Risk to the Transportation System in Broward County (2016)	Broward MPO	SLR: USACE (2013) High 2040, 2070 and IPCC AR5 Median Curve 2040, 2070 100-Year Storm Surge (Current) & 2040 RCP 4.5 Scenario	UF GeoPlan Sea Level Scenario Sketch Planning tool (SLR), UF Coastal Inundation and Decision Support System (storm surge)
Integrating Hazard Mitigation into Metropolitan Planning Organization Long Range Transportation Planning (2011)	Charlotte Punta Gorda MPO	SLR: 0.5 m, 1 m Cat 2 Storm Surge plus SLR Updated study w/ NOAA (2012) Intermediate and FEMA flood zones	GIS modeling, NOAA, UF GeoPlan Sea Level Scenario Sketch Planning Tool
Transportation Network's Vulnerability to Climate Change White Paper (2020)	Collier County MPO	SLR: NOAA (2017) Intermediate High - 2040, 2050	NOAA Sea Level Rise Viewer
Hillsborough County MPO: Vulnerability Assessment and Adaptation Pilot Project (2014)	Hillsborough TPO	SLR: USACE (2013) Intermediate & High - 2040, 2060 Storm Surge Cat 1 and 3 plus each SLR scenario.	NOAA SLOSH, FEMA Floodplains, UF GeoPlan Sea Level Scenario Sketch Planning Tool
Resilient Tampa Bay Transportation (2020)	Hillsborough TPO, Pasco County MPO, Pinellas County MPO	SLR: NOAA (2017) Int-Low and High - 2045 Storm Surge - Cat 1, 3, 4 SLR plus Surge (Cat 1 High, Cat 1 Int-Low, Cat 3 High, Cat 3 Int-Low) Precipitation - 9 inches/ 1 day; 33 inches/ 4 days	GIS modeling, NOAA SLOSH, PRISM

Report Title & Web Link	MPO	Climate Stressors & Scenarios	Data & Tools
Resiliency & Vulnerability Assessment (2019)	North Florida TPO	Current 100- and 500-year flood hazard areas (FEMA) Current storm surge: Categories 1, 2, 3	UF GeoPlan Sea Level Scenario Sketch Planning Tool (roads impacted by surge), FEMA (floodplains)
River to Sea TPO Sea Level Rise Vulnerability Assessment (2016)	River to Sea TPO	SLR: USACE (2013) Low, Intermediate & High – 2040, 2070, 2100	UF GeoPlan Sea Level Scenario Sketch Planning Tool
Resilient Volusia County (2017)	River to Sea TPO (Volusia County)	SLR: USACE (2013) Low, Intermediate & High – 2040, 2070, 2100 100-year coastal storm surge plus USACE SLR scenarios Hurricane Dora plus USACE SLR scenarios	UF GeoPlan Sea Level Scenario Sketch Planning Tool FEMA HAZUS-MH
Resilient Flagler County (2018)	River to Sea TPO (Flagler County)	SLR: USACE (2013) Low, Intermediate & High - 2040, 2070, 2100 100-year coastal storm surge plus USACE SLR scenarios	UF GeoPlan Sea Level Scenario Sketch Planning Tool FEMA HAZUS-MH
Space Coast TPO Sea Level Rise Vulnerability Assessment (2018)	Space Coast TPO	SLR: USACE (2013) Low, Intermediate & High – 2040, 2070, 2100	UF GeoPlan Sea Level Scenario Sketch Planning Tool; NOAA Sea Level Rise Viewer
Sea Level Rise Mapping (2019)	St Lucie TPO	SLR: NOAA (2012) Intermediate High - 2040, 2060, 2080, 2100	UF GeoPlan Sea Level Scenario Sketch Planning Tool, NOAA Coastal Flood Exposure Mapper
Transportation Asset/Service Vulnerability Assessment Update (2021) (pdf p. 56 – 83)	St. Lucie TPO	SLR: NOAA (2017) Int-High - 2040, 2070, 2100 Current 100-year, 500-year flood hazard areas (FEMA)	GIS Modeling, FEMA