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U.S. Department of Transportation
Federal Highway Administration

# FLMA Southeast Region Climate Change Transportation Tool

The Federal Highway Administration (FHWA) partnered with two Federal Land Management Agencies (FLMAs)—the U.S. National Park Service (NPS), and the U.S. Fish and Wildlife Service (U.S. FWS)—in a project to develop a tool to help agencies manage their transportation assets in the face of climate change. Major project components include: (1) a synthesis report of FLMA climate change efforts and current best practices; (2) a Southeast Region Climate Change and Transportation Tool to help National Parks and National Wildlife Refuges assess climate vulnerabilities and develop adaptation strategies; and (3) workshops at four pilot units (two Parks and two Refuges) to test best practices and tool components.

The project resulted in data-driven vulnerability assessments for each Park and Refuge in the region, based on information from national hazard datasets and Park and Refuge asset management systems. Regional managers can use the results to identify Park and Refuge units that could benefit from a more detailed assessment of their transportation system's and assets' vulnerability and to get a sense of the total number, value, and types of vulnerable assets. Individual Park or Refuge unit managers can use the results to better understand the vulnerability of individual assets and their transportation system as a whole. The tool provides units with the option to refine the data-driven vulnerability assessment results using institutional or on-the-ground-knowledge of their assets. The tool also provides guidance on a series of exercises designed to help units move from the assessment of vulnerabilities into the adaptation planning process.

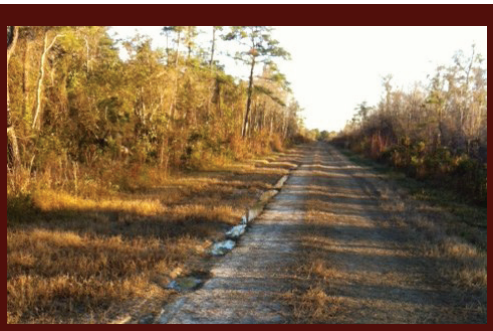
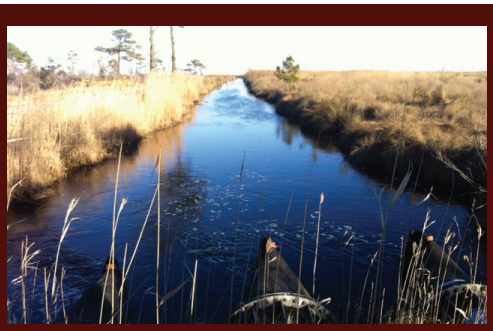
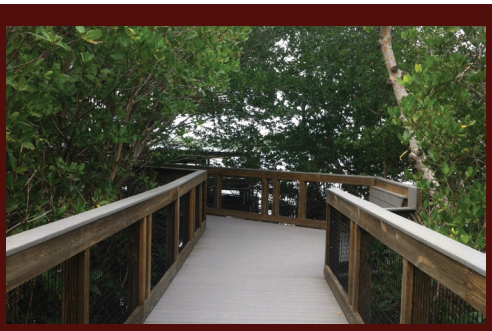
## Objectives

- Understand and synthesize climate change mitigation and adaptation best practices already being deployed by U.S. FWS, NPS, and FHWA
- Recommend best practices for integrating climate change into FLMA Long Range Transportation Plans (LRTPs)
- Develop tools that support FLMA units in managing climate change and provide regional staff with an overview of vulnerability across units
- Work with Park and Refuge units in the Southeast Region to test the tools and pilot best practices

## Approach

**Synthesize best practices.** The project team conducted a series of interviews and detailed research to identify existing and best practices within FLMAs related to assessing climate change-related vulnerability, scenario planning, developing and evaluating adaptation strategies, and reducing greenhouse gas emissions. A synthesis report highlighting key findings informed the subsequent development of a tool to address needs identified and facilitate the implementation of best practices.

**Develop vulnerability assessment tool.** The *vulnerability assessment tool* determines a default vulnerability score for each asset to three climate stressors: inland flooding, coastal flooding, and wildfire. These stressors are by no means the only stressors to affect Parks and Refuges, but were selected because they

Transportation infrastructure evaluated for vulnerability at Alligator River National Wildlife Refuge (left and middle) and Ding Darling National Wildlife Refuge (right). Photo credit: Cassandra Snow (ICF International).

affect a range of units and readily available exposure data existed. The tool also covers landslide vulnerability at one of the pilot parks (Cumberland Gap National Historic Park). The tool generates a default vulnerability score based on a data-driven, indicator-based approach that relies on national datasets and existing U.S. FWS and NPS asset databases, requiring no data collection by the unit staff. The tool accounts for asset locations relative to the climate hazards and evaluates data on characteristics of assets (e.g., condition, material, importance) that serve as indicators of whether the assets may be vulnerable to the climate hazards. Each indicator corresponds to one of the three components of vulnerability: ***exposure*** (whether the asset experiences a stressor); ***sensitivity*** (whether the asset may be damaged or disrupted by the stressor); and ***adaptive capacity*** (the ability of the system to cope with damage or disruption to the asset).

The tool calculates a default vulnerability score on a scale of 1–4 (where 4 represents the highest vulnerability) derived from a weighted average of indicator ratings. These scores were then assigned a qualitative term (Low, Medium, or High) to simplify discussions. Unit users can review and refine the default vulnerability ratings using their professional judgment to ensure the vulnerability assessment can inform local decision-making. Regional users can set a standardized approach across units by altering the weights associated with the indicators based on their planning needs and priorities.

**Develop adaptation planning tool.** The *adaptation planning tool* is structured as a series of exercises designed to take place in a workshop or other type of collaborative setting. The exercises help users begin adaptation planning to address the biggest vulnerabilities identified through the vulnerability assessment. The exercises first walk users through key questions to set the context for adaptation planning (e.g., What are the goals of the transportation system? What are the most critical assets?). The tool then provides guidance in the form of workshop materials and worksheets to assist users in an exercise to develop and compare proactive and reactive adaptation scenarios to protect their vulnerable assets. Finally, the exercises also help users qualitatively evaluate adaptation strategies in terms of their relative costs, feasibility, and fit within existing systems.

**Test and refine tools through pilot workshops.** The project team hosted day and a half-long planning workshops to test the tool at four units: Alligator River National Wildlife Refuge, J. N., "Ding" Darling National Wildlife Refuge, Cumberland Gap National Historic Park, and Everglades National Park. At each workshop, unit staff reviewed the default vulnerability results and participated in exercises to refine the vulnerability scores. Through this process, unit staff identified their most vulnerable transportation assets and gained a better understanding of factors that drive vulnerability at their unit. They then used the exercises in the adaptation planning tool to identify and evaluate relevant adaptation strategies and consider how those strategies could fit into existing processes.

### Data-Driven Default Vulnerability Assessment

The default vulnerability assessment for Parks and Refuges in the Southeast Region is based on indicators developed using publicly available geospatial hazard layers and asset management systems.

| Indicator | Applicable Stressor |
|---|---|
| **Indicators of Exposure** | |
| 100-year and 500-year FEMA flood zones | ● |
| USGS LANDFIRE Fire Regime Group | × |
| Elevation | ◊ |
| Coastal Vulnerability Index | ◊ |
| **Indicators of Sensitivity** | |
| Facility Condition Index | ● ◊ × |
| Remaining Service Life | ● ◊ × |
| Pavement Condition Rating | ● ◊ × |
| Pavement Type | ● ◊ |
| Material Type | × |
| Bridge Scour Condition | ● ◊ |
| Movable Components on Bridge | ◊ |
| **Indicators of Adaptive Capacity** | |
| Current Replacement Value | ● ◊ × |
| Asset Priority Index | ● ◊ × |
| Historic Status | ● ◊ × |
| Detour Length | ● ◊ × |
| Average Daily Traffic | ● ◊ × |
| **● Inland Flooding ◊ Coastal Flooding × Wildfire** | |

| Refuge Code | Refuge Name | Percent of Total Assets Rated Highly Vulnerable | | | |
|---|---|---|---|---|---|
| | | Inland Flooding | Coastal Flooding | Wildfire | All Hazards |
| 1 | Refuge A | 77% | 17% | 44% | 21% |
| 2 | Refuge B | 75% | 25% | 19% | 25% |
| 3 | Refuge C | 74% | 5% | 22% | 10% |
| 4 | Refuge D | 70% | 41% | 45% | 40% |
| 5 | Refuge E | 67% | 0% | 6% | 0% |
| 6 | Refuge F | 66% | 0% | 6% | 2% |
| 7 | Refuge G | 64% | 0% | 36% | 0% |
| 8 | Refuge H | 60% | 40% | 40% | 40% |
| 9 | Refuge I | 60% | 20% | 40% | 30% |
| 10 | Refuge J | 60% | 0% | 0% | 0% |
| 11 | Refuge K | 52% | 10% | 32% | 14% |
| 12 | Refuge L | 52% | 0% | 0% | 0% |
| 13 | Refuge M | 51% | 0% | 18% | 0% |
| 14 | Refuge N | 51% | 0% | 3% | 0% |
| 15 | Refuge O | 50% | 0% | 17% | 0% |
| 16 | Refuge P | 48% | 0% | 22% | 0% |
| 17 | Refuge Q | 46% | 0% | 0% | 0% |
| 18 | Refuge R | 46% | 0% | 35% | 0% |
| 19 | Refuge S | 43% | 0% | 3% | 0% |
| 20 | Refuge T | 43% | 0% | 7% | 0% |
| 21 | Refuge U | 42% | 8% | 25% | 8% |

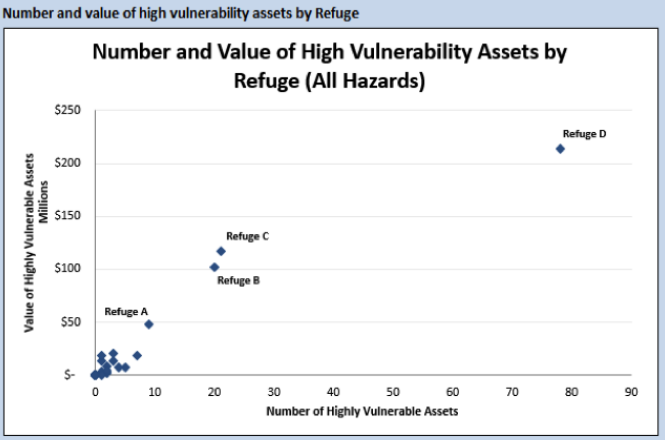



Figure 1: Default vulnerability assessment results across the Southeast Region

**Finalize tools.** Based on the feedback gathered at the workshops, the project team refined the underlying methodology used in the vulnerability assessment tool to derive the default scores. For example, the team adjusted the indicators used, which indicators were weighted more heavily than others, and how indicator values translated to scores (e.g., how to rate "poor" condition on a scale of 1-4).

## Key Results & Findings

The project resulted in a preliminary data-driven vulnerability assessment to the three stressors evaluated, covering the transportation assets in all Park and Refuge units across the Southeast Region. The assessment covers 5,858 assets in 58 Parks and 5,197 assets in 121 Refuges.

Of these assets, 24% were found to be highly vulnerable to at least one of the three stressors. The full vulnerability assessment results are available to Southeast Region regional and unit managers.

The results are presented to the tool users in a variety of ways including a rank-ordered list of the most vulnerable assets, overview graphs of the total number and value of vulnerable assets, and cross- reference between vulnerable assets and assets that a Park or Refuge has identified as extremely valuable to operations (see Figure 1). The regional-level results provide information on the most highly vulnerable Park and Refuge units to the stressors evaluated (as indicated by the number and value of vulnerable assets managed by each). The unit-level results highlight the most critical and vulnerable assets at the unit.

The adaptation tool components work alongside pre-existing mitigation tools to assist units with reducing greenhouse gas emissions in the Southeast Region Transportation and Climate Change Toolbox (see Figure 2).

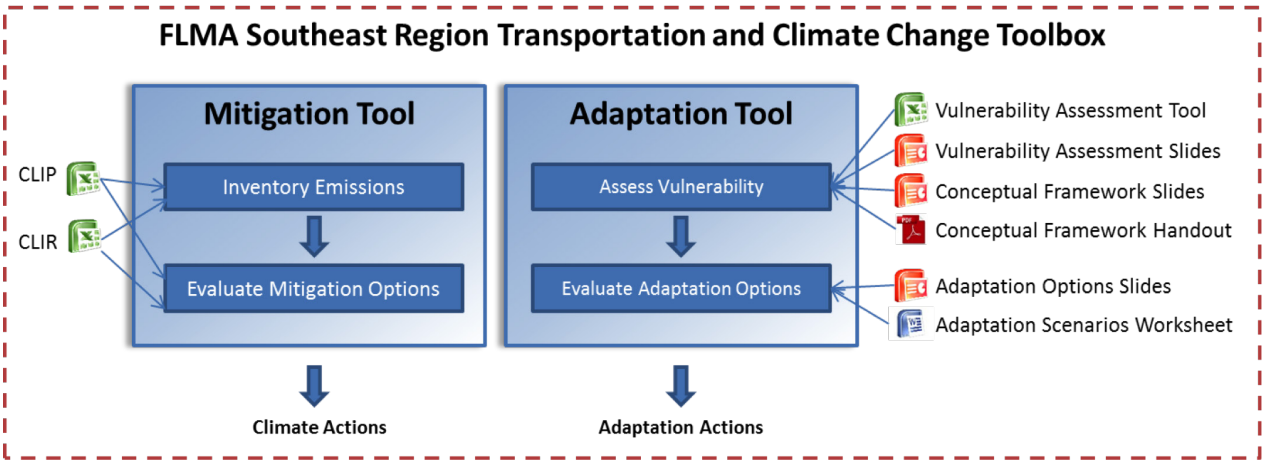



Figure 2: Diagram of the FLMA Southeast Region Transportation and Climate Change Toolbox

## Lessons Learned

This research project revealed several lessons about ways to effectively and efficiently assess vulnerability and use that information to increase resilience.

### Vulnerability Assessment

- The vulnerability assessment tool methodology is based on the premise that vulnerability is a function of exposure, sensitivity, and adaptive capacity. These components are abstract and can be difficult to grasp, but provide a useful way to think about vulnerability within a unit once explained and internalized. The vulnerability assessment tool provides an effective means of doing this.
- An indicators approach is useful as a way to minimize staff time and quickly leverage existing data as a starting point for understanding vulnerability.
- Exposure is more difficult to evaluate cheaply and effectively than sensitivity and adaptive capacity.
- There is a need to continue to test and evaluate the effectiveness of specific vulnerability indicators.
- There is a need to eventually expand the scope of the vulnerability assessment to cover more climate stressors that affect Park and Refuge assets.

### Adaptation Planning

- Adaptation planning is site- and context-specific. The workshops demonstrated the value of institutional knowledge in both identifying and evaluating adaptation strategies (including considerations of lifecycle costs, expected lifetime of assets, NEPA implications, impacts on natural and cultural resources, and responsiveness to individual agency missions).

## Recommendations for Next Steps

Possible future actions include expanding the scope of the tool to cover other Regions and additional climate stressors; continuing to incorporate new data sources into the analysis; further vetting and testing the accuracy of the default vulnerability assessment approach and selected indicators; expanding the functionality of the tool; and further developing the adaptation component of the toolbox (e.g., building a cost calculator and a database of adaptation case studies).

## For More Information

**Resources:**
Synthesis Report of FLMA Climate Change Efforts

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