CLIMATE RESILIENCE AND OPERATIONS & MAINTENANCE
OVERVIEW

- Climate change and extreme weather events
- Impacts of climate change on transportation systems management and operations (TSMO) and maintenance
- Why address climate change?
- Getting started: an adaptation framework
- Resources
Goal: Develop resources and guidance materials for operating agencies to better prepare for the impacts of extreme weather on transportation management, operations and maintenance.
KEY FINDINGS FROM SCOPING EFFORT

• Captured climate effects and began framing potential responses for:
  System Maintenance
  System Operations
  Travelers and Traveler Behavior
  Freight Transportation
Travelers and Traveler Behavior

- Increased exposure to hazardous driving conditions (e.g., flooding, road conditions, smoke from wildfires) and human health impacts
  
  Increased need for **timely, accurate, relevant and consistent** traveler information from TMC’s and private sector information service providers to support route & mode choice, departure times

  Less consistent mode split impacting day-to-day congestion and safety issues

  Potential mode shift to/from alternate modes, e.g., using transit, biking, or walking

  Increased emphasis on carpooling and teleworking to reduce impacts to highways
EFFECTS AND POTENTIAL RESPONSES:

• Increased frequency, duration and intensity of droughts; increased coastal and inland flooding
  Restricted access to ports and shipping channels for inland waterways
  Mode shift – e.g., from inland waterways to highways due to changes in reliability
• Increase in magnitude & duration of severe heat waves
  Mandatory freight diversion to more robust alternate routes
  Dynamic or seasonal restrictions for trucks or rail during times of high heat, reducing either acceptable speed or weight
  Policy and regulation changes to restrict truck size and weights
A CHANGING CLIMATE

- DOTs are already observing and responding to the impacts of climate change
- Accelerating climate change means more frequent or more intense weather events (e.g., large storms, changes in winter precipitation, heat waves)
- These events will have critically important ramifications on the planning, design and engineering, management, operations, and maintenance of transportation facilities and services

Extreme weather events are becoming more frequent and severe.
Anne Arundel County in Maryland received over ten inches of rain on August 12, 2014, washing out roadways.
Weather refers to the atmosphere state in a particular location at a particular time.

Extreme weather events refer to significant anomalies in temperature, precipitation and winds (e.g., heavy precipitation and flooding, heatwaves, drought, wildfires and windstorms (including tornadoes and tropical storms)).

Climate change refers to any significant change in the measures of climate lasting for an extended period of time.

Climate change includes major variations in temperature, precipitation, or wind patterns, among other environmental conditions, that occur over several decades or longer (e.g., a rise in sea level, increase in the frequency and magnitude of extreme weather events now and in the future).
Historical climate ≠ Future climate

- Because of climate change, historical climate is no longer a predictor of future climate
- Assumptions based on historical climate may need to be revisited
  - Expected timing of freeze/thaw, snow melt, vegetation growth
  - Rates of weather-related degradation
  - Weather conditions over asset lifetime
  - Optimal construction work times
CHANGES WILL BE NEEDED IN:

- System maintenance (e.g., inspection, frequency of repairs, need for “quick maintenance” patrols)
- System operations practices and strategies (e.g., more frequent diversion to more robust alternate routes)
- Travel behavior (e.g., motivation to use alternate modes of transport such as transit, biking, or walking)
- Freight transportation (e.g., dynamic or seasonal restrictions for trucks or rail during times of high heat)

Climate changes could result in:

- Loss of roadway capacity
- Loss of alternative routes
- Loss of situational awareness (due to power/communications outages)
- Inability to evacuate
- Loss of service life (due to faster deterioration)
- Increased safety risk
- Loss of economic productivity
- Reduced mobility

Landslide from heavy rain in August 2013.
Source: TN DOT
WHY ADDRESS CLIMATE CHANGE?

• Climate change presents a business risk for transportation agencies
  • *Not addressing climate change could put transportation agencies at greater risk than changing practices now*

• TSMO is the public face of extreme weather response

• Even though many agencies that are successful operators and maintainers of facilities, they still need to revisit their approach and practices given these changes
STAFF MAY BE ASKING…

• Over the last 20 years, we have gotten really good at managing winter storms. We will deal with whatever nature throws at us. **Do I need to plan for climate change?**

• My last few summers have resulted in a lot of delays in construction due to the heat. **Should I change how I bid out my projects?**

• Over the last 20 years, we’ve never had an ice storm, and I don’t typically budget for ice removal equipment. We got one last year. **Should I invest?**

• My maintenance budgets are typically insufficient, and I end up going over each year. **How can I plan ahead and better use my limited resources?**

• We worked well together during Hurricane Sandy, but there were still a lot of challenges. **What will help us be better prepared?**
GETTING STARTED:
AN ADAPTATION FRAMEWORK

Define Scope
- Articulate program goals and operations objectives
- Identify key climate variables
- Develop information on decisions sensitive to climate change

Assess Vulnerability
- Document existing capabilities (both technical and institutional)
- Collect and integrate data on past performance
- Develop climate inputs
- Characterize impacts and risks

Integrate into Decision Making
- Identify Performance Measures
  (tolerance for disruption)
- Identify Potential Adaptation Measures
- Evaluate and Select Adaptation Measures
  - Technical and political feasibility
  - Costs and benefits
  - Efficacy
  - Flexibility
  - Environmental and societal impacts
- Determine Improvements in Capabilities Necessary for Successful Implementation
  - Business processes
  - Systems and technology
  - Performance management
  - Culture
  - Organization and workforce
  - Collaboration

Monitor and Revisit
Develop New Objectives
DEFINE SCOPE

Articulate Program Goals and Operations Objectives

• Define what must be achieved to ensure resilient operations
  • Include expected level of performance during adverse weather
• Determine outcome-based operations objectives

Identify Key Climate Stressors

• Which climate change stressors or extreme weather events are projected to occur locally?
• Which climate change stressors or extreme weather events could affect TSMO and maintenance programs?
Develop Information on Decisions Sensitive to Climate Change

Decisions are climate-sensitive if their continued effectiveness could be compromised by projected changes in climatic conditions (e.g., changes in temperature, precipitation, weather patterns, and the frequency and intensity of extreme weather events)

<table>
<thead>
<tr>
<th>Climate-Sensitive Decision Areas</th>
<th>Specific Decisions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Plan for future workforce needs.</td>
<td>Determine the right level of workforce requirements and capabilities.</td>
<td>Operating agencies make a variety of workforce related decisions, including the number of staff required, their locations, and capabilities necessary to monitor, control, report and maintain the roadway system.</td>
</tr>
<tr>
<td>2. Plan for Operations and Maintenance investments.</td>
<td>Determine criteria to prioritize operational resource investments (including capital improvements).</td>
<td>Resource investments may include new capital improvements for operations and maintenance. They may also include investments for annual maintenance.</td>
</tr>
</tbody>
</table>
Document Existing Capabilities (both technical and institutional)

- Document current capabilities across the six areas of the Capability Maturity Framework (CMF):
  - Business processes
  - Systems and technology
  - Performance management
  - Culture
  - Organization and workforce
  - Collaboration
Identify Performance Measures

- Integrate climate change adaptation and resiliency into existing performance measures
- Adopt as stand-alone measures
- Consider whether existing measures will be achievable with a changing climate

Source: MnDOT
<table>
<thead>
<tr>
<th>Vulnerability</th>
<th>Response</th>
<th>Implementing Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased frequency of extreme events may require additional personnel to</td>
<td><strong>Short-term</strong>: Train staff on climate change and how this may affect their</td>
<td>TSMO, Maintenance, Emergency Managers</td>
</tr>
<tr>
<td>monitor, control, report, and respond to events</td>
<td>roles and responsibilities</td>
<td></td>
</tr>
<tr>
<td>Changes in long-term climate trends may also change seasonal work</td>
<td><strong>Medium-term</strong>: Increase availability of contract staff to assist during</td>
<td></td>
</tr>
<tr>
<td>requirements</td>
<td>extreme events</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Long-term</strong>: Hire additional staff to keep pace with increasing TSMO,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>maintenance, and emergency management needs</td>
<td></td>
</tr>
</tbody>
</table>
RESOURCES

- Guide developed to lead State/local DOTs and MPOs in adopting climate change adaptation strategies at the institutional, technical, and financial levels for their TSMO and maintenance programs.
- Available at: http://www.ops.fhwa.dot.gov/publications/fhwahop15026/index.htm
WHAT’S IN THE GUIDE?

- How to obtain buy-in
- Risk assessment checklists and guidance
- Climate change focused performance measures
- How to track progress over time
- Existing benefit-cost assessment tools
- Matrix of climate sensitive decisions
- Sample handout for workshop on climate risk
- Gap assessment for climate ready TSMO and maintenance
- Glossary of terms
For more information, please contact:

Laurel Radow
Traffic Incident and Events Management Team
Office of Operations
Federal Highway Administration (FHWA)
202-366-2855; Laurel.Radow@dot.gov

Paul Pisano
Road Weather and Work Zone Management
Office of Operations, FHWA
202-366-1301; Paul.Pisano@dot.gov

Robert Hyman
Sustainable Transport and Climate Change Team
Office of Planning, Environment and Realty, FHWA
202-366-5843; Robert.Hyman@dot.gov