ADAPTATION TO CLIMATE CHANGE IN TRANSPORTATION OPERATIONS AND MAINTENANCE

Executive Decision Maker Briefing
OVERVIEW

• Climate change and extreme weather events
• Impacts of climate change on transportation systems management and operations (TSMO) and maintenance
• Why adapt to climate change?
• What does adaptation look like?
• Managing the business risk (an adaptation framework)
• Resources
A CHANGING CLIMATE

• State and local departments of transportation (DOTs) are already observing and responding to 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 more than 10 inches of rain on August 12, 2014, washing out roadways.
Phoenix, Arizona, broke 24-hour rainfall records with nearly 3 inches of rain on September 8, 2014, causing widespread flooding that closed Interstate highways.

Source: azcentral
EXTREME EVENTS IN 2014

Buffalo, New York, received over seven feet of snow November 17 - 21, 2014, stranding drivers in their cars.

Source: The Telegraph

Source: necn
California experienced a severe drought and thousands more wildfires than usual

Source: Fox News

Source: Daily News
Weather refers to the state of the atmosphere 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 refers to the weather conditions prevailing in an area over a long period of time (30 years or more)

- 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:

1. **System maintenance** (e.g., inspection, frequency of repairs, need for “quick maintenance” patrols)

2. **System operations practices and strategies** (e.g., more frequent diversion to more robust alternate routes)

3. **Travel behavior** (e.g., motivation to use alternate modes of transport such as transit, biking, or walking)

4. **Freight transportation** (e.g., dynamic or seasonal restrictions for trucks or rail during times of high heat)

RARE WEATHER EVENTS COULD BECOME INCREASINGLY FREquent

U.S. Selected Significant Climate Anomalies and Events
May and Spring 2015

AK was record warm for May with a temperature 7.1°F above average. The warmth was widespread with Barrow and Juneau being record warm.

Seven states across the West had a top 10 warm spring. CA had its warmest Jan-May on record, at 5.1°F above average.

The contiguous U.S. drought footprint shrank to 24.6%, the smallest since Feb 2011. Drought conditions improved across the Great Plains, but remain entrenched in the West.

CO, OK, and TX were record wet for May with widespread flooding. It was also the all-time wettest month for OK and TX. TX was record wet for spring.

HI had a mixed precipitation pattern during May with little change in drought conditions. Over 20% of the state is in drought.

The Northeast was warm and dry with drought developing. CT, MA, NH, and RI were record warm for May.

There were over 400 preliminary tornado reports during May, the most since Apr 2011. There were 7 tornado-related fatalities.

On May 10, Tropical Storm Ana made landfall in SC with sustained winds of 45mph. Ana is the 2nd earliest landfalling tropical cyclone on record for the U.S.

FL had its warmest spring on record with a temperature 4.6°F above average. GA had its 3rd warmest spring.

The average U.S. temperature during May was 60.8°F, 0.6°F above average. The spring U.S. temperature was 53.2°F, 2.2°F above average. May U.S. precipitation was 4.36 inches, 1.45 inches above average and the wettest month of any month on record. The spring precipitation total was 9.33 inches, 1.39 inches above average.

Please Note: Material provided in this map was compiled from NOAA’s State of the Climate Reports. For more information please visit: http://www.ncdc.noaa.gov/sotc.
Climate changes could result in:

- Reduced roadway capacity
- Loss of alternative routes
- Decreased situational awareness (due to power/communications outages)
- Inability to evacuate
- Shortened 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
CLIMATE CHANGE IS WIDENING AND SHIFTING WEATHER PROBABILITY DISTRIBUTIONS

Weather Probability Distribution

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 are successful operators and maintainers of facilities, they still need to revisit their approach and practices given these changes
• 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?**
Assessing Vulnerabilities

• Some transportation agencies have begun to assess their vulnerabilities to climate change
• Fewer have moved beyond vulnerability assessments and into adaptation planning
• Even fewer have implemented adaptation strategies and begun to evaluate their effectiveness

Focusing on Infrastructure

• Agencies have placed more emphasis to date on the implications of climate change for infrastructure planning, design, and engineering
• There has been less focus on TSMO and maintenance
Alabama experiences hurricanes, tornados, wet and dry cycles, and snow and ice events.

Pace and severity of weather events have increased in recent years, along with public expectations about levels of service.

Post-event recovery affects ability to perform regular operations.

Infrastructure damage disrupts regular operations.

CASE STUDY: ALDOT

- Renewed emphasis on emergency management (EM)
  - Created full-time EM position
  - Improved relationship with state EM agency
  - Increased recurring emergency training
- Focused on “smaller” solutions
  - Used portable Highway Advisory Radios (HARs)
  - Coordinated across and between divisions
  - Procured less specialized equipment
- Improved dissemination of road condition information in everyday and extreme events

• Climate change could compromise agencies’ ability to provide safe, reliable transportation

• Climate change could also lead to unexpected increases in maintenance costs over time, further straining already limited resources

• Transportation agencies provide a critical public service, especially during emergency situations

Source: Iowa DOT
From a TSMO perspective, adaptation responses are still not well defined

- TSMO is traditionally seen as reactive to conditions and short-term
- It will be necessary to incorporate the needs of climate change and extreme weather events into the routine policy and practice of TSMO and maintenance
RESPONSES MAY VARY IN THE SHORT, MEDIUM, AND LONG TERM

Short term
• Increase tracking of costs to respond to specific extreme weather events
• Establish a “rainy day” fund for unexpectedly bad years
• Train existing staff about the potential impacts of climate change and how it may affect their roles and responsibilities

Medium term
• Revise budgeting processes and protocols to account for recent trends
• Increase availability of contract staff to assist during extreme events
• Develop MOUs with other agencies for equipment and staff sharing during extreme weather events
WHAT’S NEEDED TO MANAGE THE BUSINESS RISK?

1. Leadership that acknowledges the risk and charts a course to prioritize addressing it
2. Programs that optimize for today’s extreme weather events to better prepare systems for a changing climate
HOW TO BEGIN TO MANAGE RISK:
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
EXAMPLE ACTIONS

- Determine how extreme weather events have affected performance in the past
- Identify thresholds where extreme weather affects TSMO, maintenance, and emergency management decisions, e.g.,
  - Establishing future workforce needs
  - Weather response budgeting
  - Setting operational objectives
- Review and update performance measures in light of extreme weather vulnerabilities

Flood-fighting efforts in Mount Vernon, WA.
Source: WSDOT
EXAMPLE ACTIONS (CONT.)

- Establish work order codes for weather events to improve tracking labor, equipment, and materials costs over time
- Require after-action reports with clear recommendations for improvement following extreme events
- Update emergency response plans to factor in potential for greater frequency of extreme weather events
- Improve cross-training across staff (including across operations, maintenance, and emergency management)

Source: Leidos

Source: MoDOT
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
FHWA VIRTUAL ADAPTATION FRAMEWORK

- Organized around FHWA Vulnerability Assessment Framework key steps
- For each key step, includes guidance, training videos, case studies, related resources, and tools
For national-level questions, please contact:

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THANK YOU!