



U.S. Department of Transportation
Federal Highway Administration

ADAPTATION TO CLIMATE CHANGE IN TRANSPORTATION OPERATIONS AND MAINTENANCE

Executive Decision Maker Briefing

CLIMATE
CHANGE





- 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

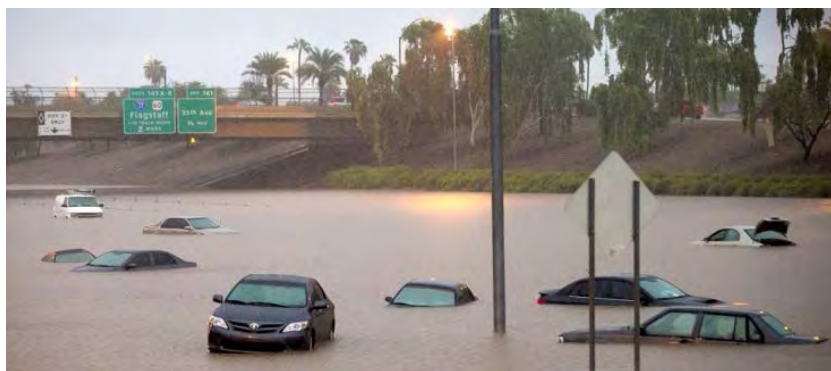


A CHANGING CLIMATE



U.S. Department of Transportation
Federal Highway Administration

- 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



Flooding in Phoenix in 2014.
Source:
<http://jimbakkershow.com/news/record-rainfall-causes-phoenix-flooding/>



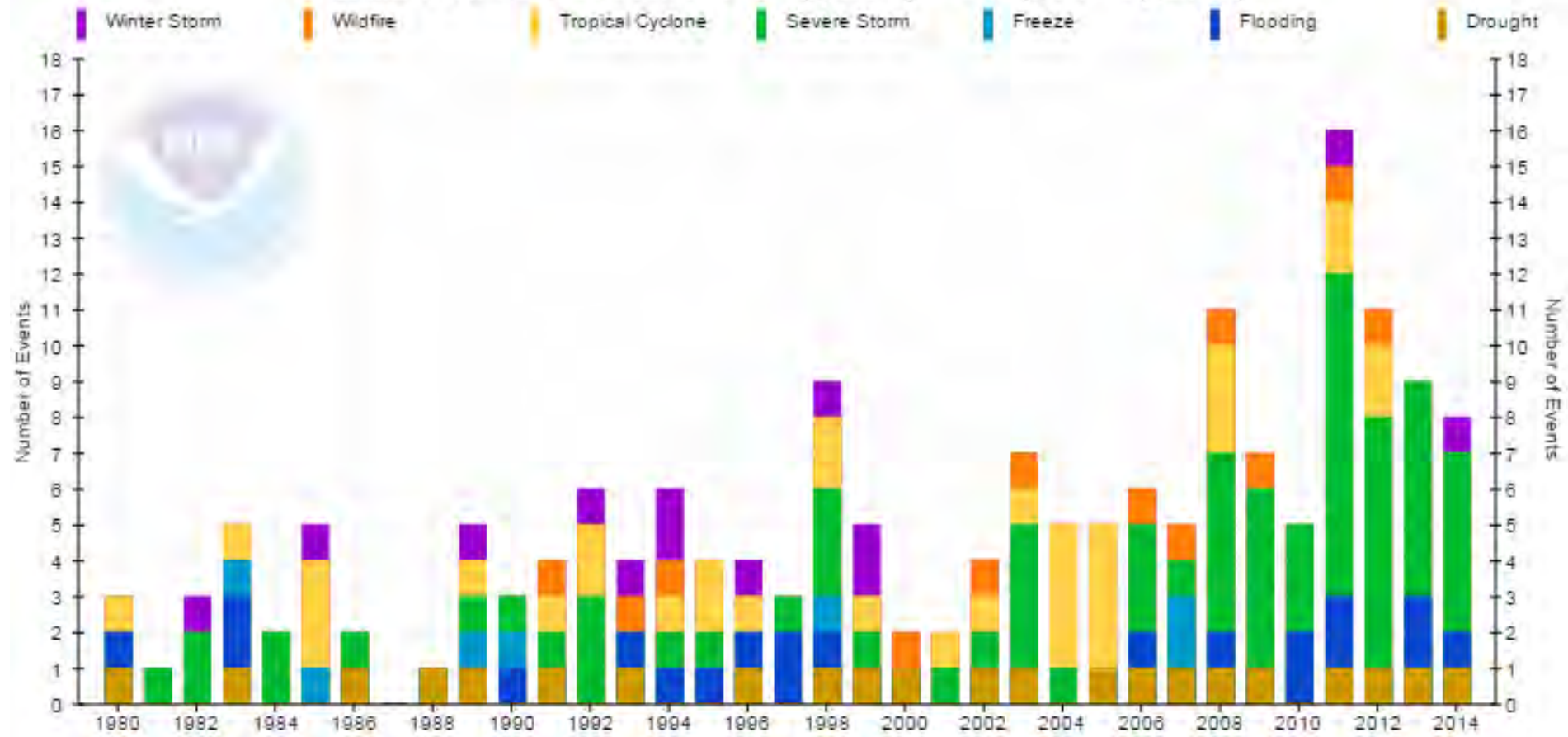
A CHANGING CLIMATE



U.S. Department of Transportation
Federal Highway Administration

Extreme weather events are becoming more frequent and severe

Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)



CLIMATE CHANGE



EXTREME EVENTS IN 2014



U.S. Department of Transportation
Federal Highway Administration



Source: *The Daily Record*



Source: *breakingnews.com*

Anne Arundel County in Maryland received more than 10 inches of rain on August 12, 2014, washing out roadways



EXTREME EVENTS IN 2014



U.S. Department of Transportation
Federal Highway Administration



Source: azcentral



Phoenix, Arizona, broke 24-hour rainfall records with nearly 3 inches of rain on September 8, 2014, causing widespread flooding that closed Interstate highways

**CLIMATE
CHANGE**



EXTREME EVENTS IN 2014



U.S. Department of Transportation
Federal Highway Administration

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



Source: *The Telegraph*



Source: *necn*



EXTREME EVENTS IN 2014



U.S. Department of Transportation
Federal Highway Administration

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)

THE PAST IS NO LONGER A RELIABLE PREDICTOR OF THE FUTURE



U.S. Department of Transportation
Federal Highway Administration

Historical climate ≠ Future climate

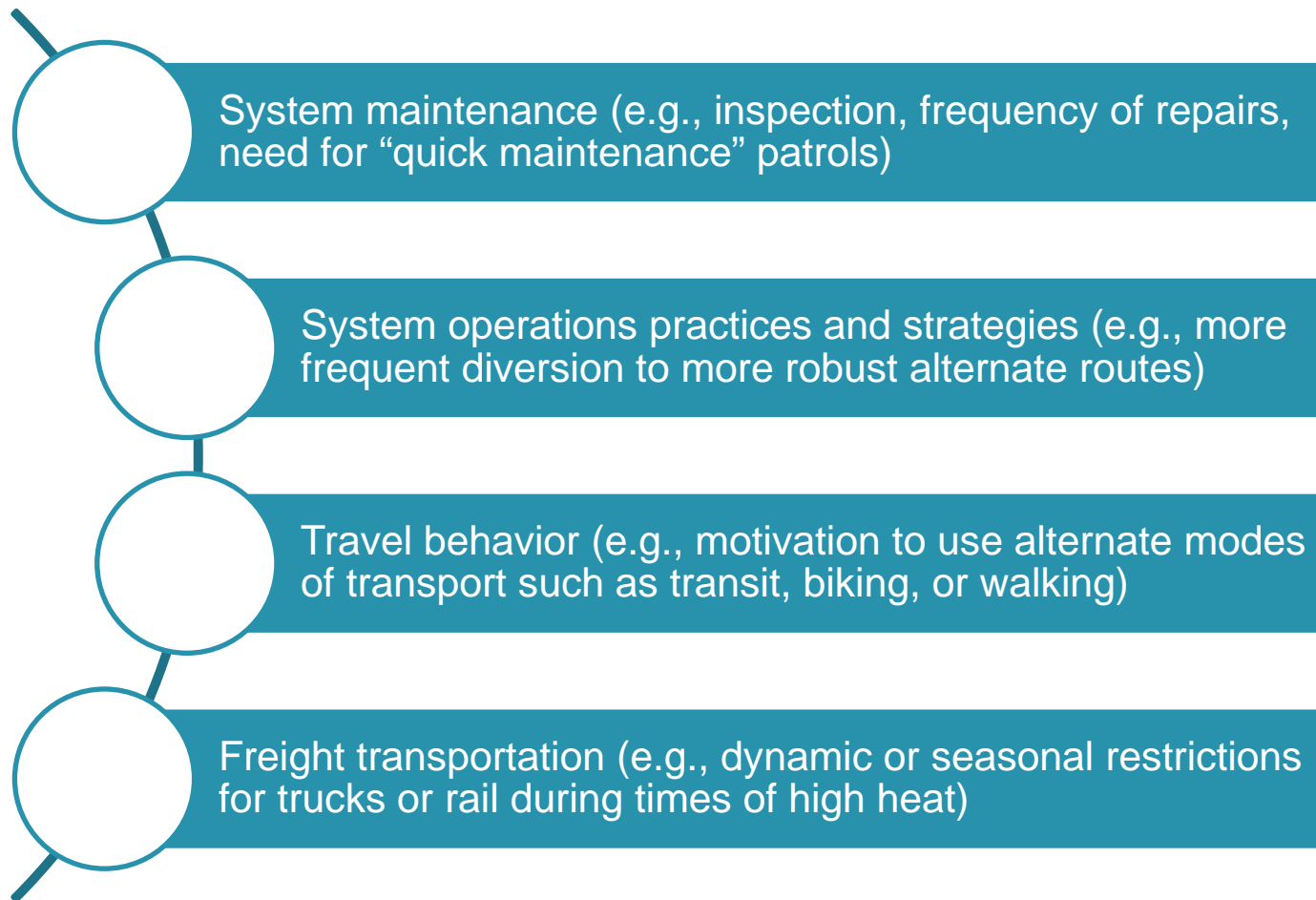
- Because of climate change, historical climate is no longer a predictor of future climate
- Assumptions based on historical climate may need to be revisited
 - Expected timing of freeze/thaw, snow melt, vegetation growth
 - Rates of weather-related degradation
 - Weather conditions over asset lifetime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



CHANGES WILL BE NEEDED IN:



U.S. Department of Transportation
Federal Highway Administration



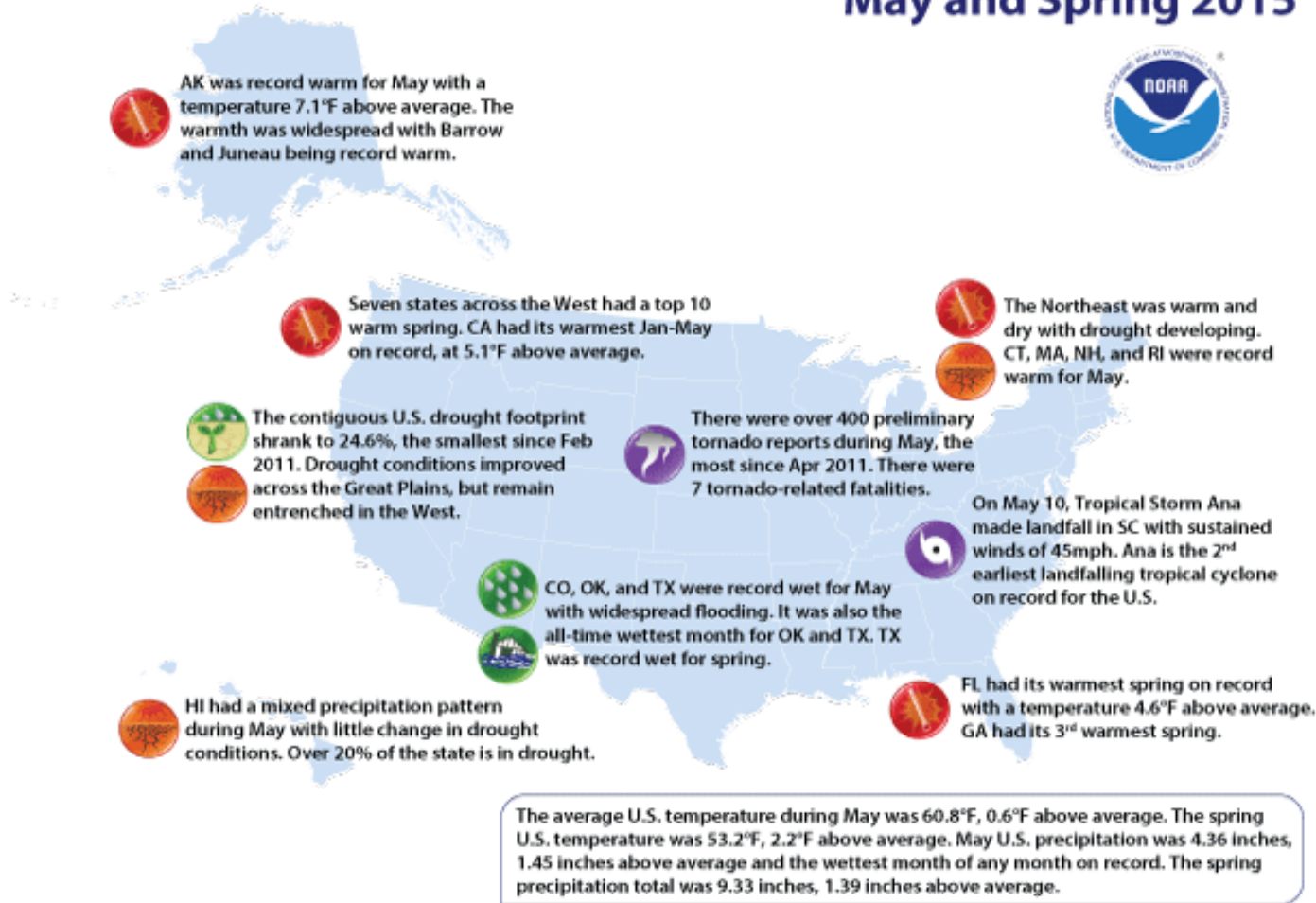
Source: FHWA, 2013, *Planning for Systems Management & Operations as part of Climate Change Adaptation*, available at: <http://ops.fhwa.dot.gov/publications/fhwahop13030/index.htm#toc>

RARE WEATHER EVENTS COULD BECOME INCREASINGLY FREQUENT



U.S. Department of Transportation
Federal Highway Administration

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



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



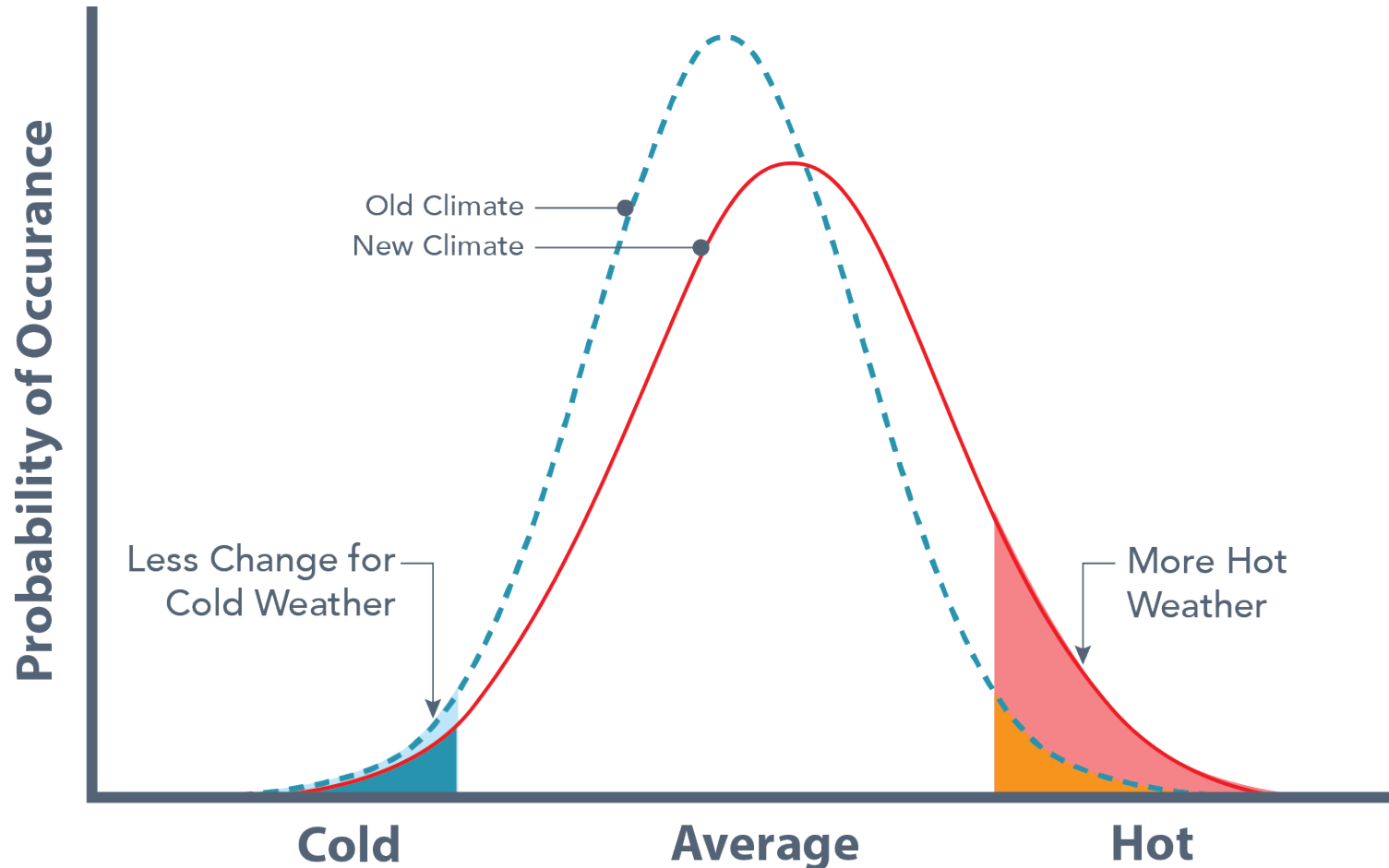
Landslide from heavy rain in August 2013.
Source: TN DOT

CLIMATE CHANGE IS WIDENING AND SHIFTING WEATHER PROBABILITY DISTRIBUTIONS



U.S. Department of Transportation
Federal Highway Administration

Weather Probability Distribution



Source: Huber, Daniel G. and Gullede, Jay. 2011. "Extreme Weather and Climate Change: Understanding the Link and Managing the Risk" Science and Impacts Program. Center for Climate and Energy Solutions: Arlington, VA. Available at: <http://www.c2es.org/publications/extreme-weather-and-climate-change>



WHY ADDRESS CLIMATE CHANGE?

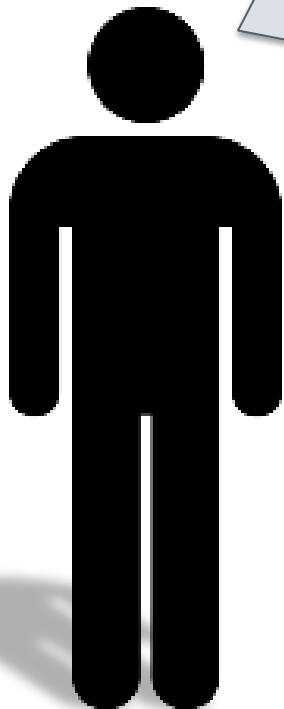


U.S. Department of Transportation
Federal Highway Administration

- 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



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?**

WHAT ARE TRANSPORTATION AGENCIES DOING THUS FAR?



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



CASE STUDY: ALDOT



U.S. Department of Transportation
Federal Highway Administration



Source: Conner, G. 2013. ALDOT Operations and Extreme Weather Events. Presentation at AASHTO 2013 Extreme Weather Events Symposium, May 22, 2013.

- 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

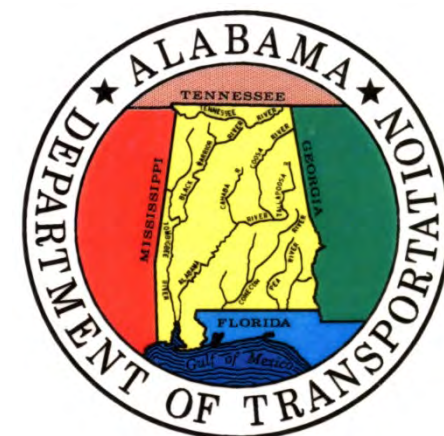


CASE STUDY: ALDOT



U.S. Department of Transportation
Federal Highway Administration

- 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



Source: Conner, G. 2013. ALDOT Operations and Extreme Weather Events. Presentation at AASHTO 2013 Extreme Weather Events Symposium, May 22, 2013.



THE RISK OF INACTION



U.S. Department of Transportation
Federal Highway Administration

- 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

CLIMATE
CHANGE



WHAT DOES ADAPTATION LOOK LIKE?



U.S. Department of Transportation
Federal Highway Administration

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



Snow plows waiting to be called into service on Staten Island, NY Source: Mark Bonifacio, NY Daily News

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

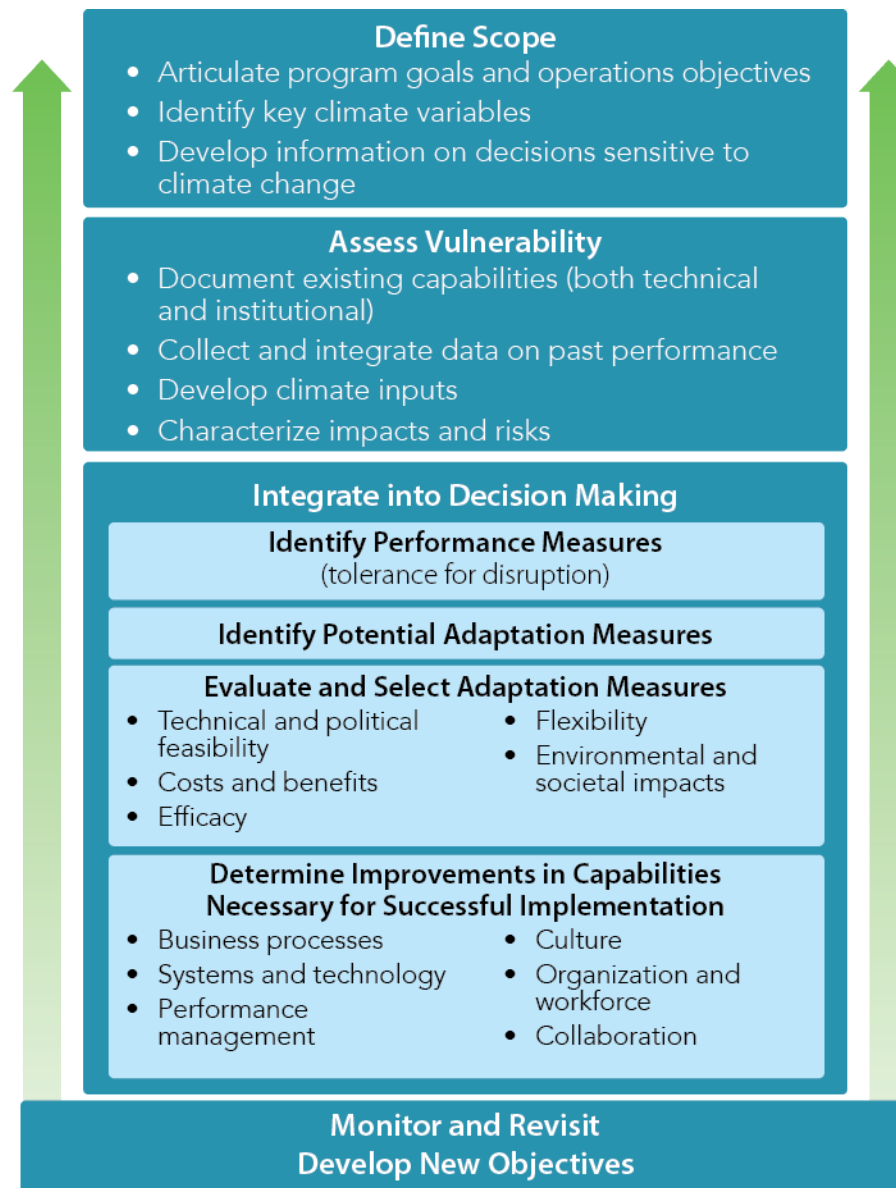
WHAT'S NEEDED TO MANAGE THE BUSINESS RISK?



U.S. Department of Transportation
Federal Highway Administration

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





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)

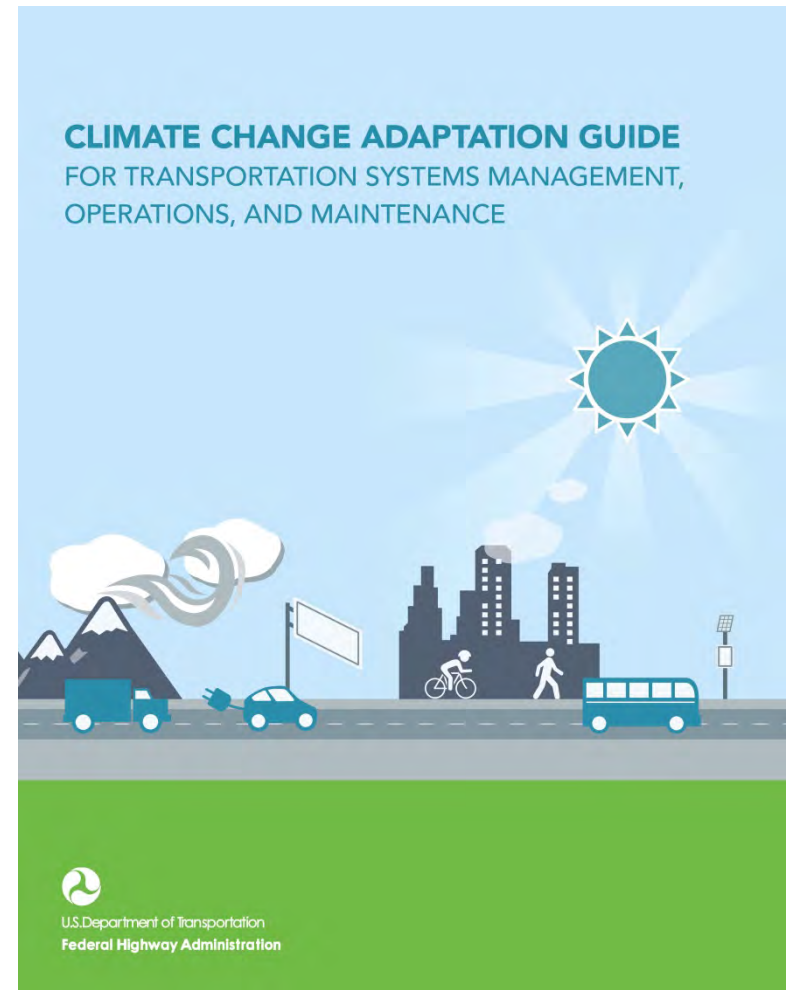


Source: MoDOT



Source: Leidos

- 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>





RESOURCES (CONT.)



U.S. Department of Transportation
Federal Highway Administration

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
- http://www.fhwa.dot.gov/environment/climate_change/adaptation/adaptation_framework/

Climate Change & Sustainability Adaptation

Virtual Framework for Vulnerability Assessment

This section of FHWA's Climate Change Adaptation website provides resources, tools, and guidance to help local and regional transportation agencies implement the Federal Highway Administration's (FHWA's) *Climate Change and Extreme Weather Vulnerability Assessment Framework*, a guide to assessing the vulnerability of transportation assets to climate change and extreme weather events.

The section's structure follows that of the framework as shown in the graphic below. Click on any area of the graphic to go to its corresponding module in the Virtual Framework site, or use the page list in the navigation bar at left to navigate through the modules. Each module includes an overview, a summary of key steps, an introductory video, and links to case studies, tools, and other resources. Several of the modules include tools developed by FHWA to help transportation agencies implement their assessments.

1. Define Scope

- Identify Key Climate Variables**
 - Climate impacts of concern
 - Sensitive assets & thresholds for impacts
- Articulate Objectives**
 - Actions motivated by assessment
 - Target audience
 - Products needed
 - Level of detail required
- Select & Characterize Relevant Assets**
 - Asset type
 - Status vs. planned
 - Data availability
 - Further distress

2. Assess Vulnerability

- Collect & Integrate Data on Assets
- Develop Climate Impacts
- Assess Asset Criticality (Optional)
- Identify & Rate Vulnerabilities
- Develop Information on Asset Sensitivity to Climate
- Incorporate Likelihood & Risk (Optional)

3. Integrate into Decision Making

- Incorporate into Asset Management
- Integrate into Emergency & Risk Management
- Contribute to Long Range Transportation Plan
- Assist in Project Prioritization
- Identify Opportunities for Improving Data Collection, Operations or Design
- Build Public-Support for Adaptation Investment
- Educate & Engage Staff & Decision Makers

Introductory Video

Overview of NEPA as Applied to Climate Change and Extreme Weather Vulnerability Assessment

This short video provides an overview of FHWA's Climate Change and Extreme Weather Vulnerability Assessment Framework, and describes the benefits of conducting a vulnerability assessment.

Recent Case Studies

- Washington State Department of Transportation Case Study**
In 2010, the Federal Highway Administration (FHWA) selected five pilot teams from across the country to test a climate change vulnerability assessment model. This report details...

Recent Tools and Documents

- NEX-DCP 30 Climate Data Viewer**
The NEX-DCP30 tool provides maps and summaries of historical and projected temperature and precipitation changes for the 21st century for the continental United States, at a...



CONTACT INFORMATION



U.S. Department of Transportation
Federal Highway Administration

For national-level questions, please contact:

[Speaker Name]

[Affiliation]

[phone]

[email]

Laurel Radow

Traffic Incident and Events Management Team

Office of Operations, 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



THANK YOU!