Climate Change and Extreme Weather Vulnerability Assessments
AASHTO Extreme Weather Events Symposium
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Vulnerability

The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Definition from America's Climate Choices: Panel on Adapting to the Impacts of Climate Change, National Research Council, (2010).
Risk

A combination of the magnitude of potential consequence(s) of climate change impacts(s) and the likelihood that the consequence(s) will occur.

Definition from America's Climate Choices: Panel on Adapting to the Impacts of Climate Change, National Research Council, (2010).
Climate Change and Extreme Weather Vulnerability Assessment Framework

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
     - Existing vs. planned
     - Data availability
     - Further delineate

2. Assess Vulnerability
   - Collect & Integrate Data on Assets
   - Develop Climate Inputs
   - Develop Information on Asset Sensitivity to Climate
   - Assess Asset Criticality (Optional)
   - Identify & Rate Vulnerabilities
   - 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 Designs
   - Build Public Support for Adaptation Investment
   - Educate & Engage Staff & Decision Makers

The Federal Highway Administration’s Climate Change & Extreme Weather Vulnerability Assessment Framework

December 2012
Vulnerability Assessment Framework

1. Define Project Scope
   • Objectives
   • Relevant Assets
   • Climate Variables

2. Assess Vulnerability
   • Climate Inputs
   • Asset data, criticality, sensitivity
   • Vulnerabilities, risk

3. Integrate Vulnerability Into Decision Making
ARTICULATE OBJECTIVES

- What actions are motivated by the assessment?
- Who is the target audience?
- What products are needed?
- What level of detail required?

MTC Pilot Study Area
Defining Project Scope

Select & Characterize Relevant Assets

- Asset type
- Existing vs. planned
- Data availability
- Further delineate
  - Critical assets?
  - Owned or managed assets?

Washington State Highways
Defining Project Scope

**Identify Key Climate Variables**

- Climate impacts of concern
- Sensitive assets & thresholds for impacts
Assessing Vulnerability

- **Assess Vulnerability**
  - Develop Climate Inputs
  - Collect and Integrate Data on Assets
  - Assess Asset Criticality
  - Develop Information on Asset Sensitivity to Climate
  - Identify and Rate Vulnerabilities
  - Incorporate Likelihood and Risk
Assessing Vulnerability

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Digital elevation map from USGS high-resolution LiDAR
Assessing Vulnerability

• Assess Vulnerability
  ▪ Develop Climate Inputs
  ▪ Collect and Integrate Data on Assets
  ▪ Assess Asset Criticality
  ▪ Develop Information on Asset Sensitivity to Climate
  ▪ Identify and Rate Vulnerabilities
  ▪ Incorporate Likelihood and Risk

Steps to establish Qualitative (QL) Criteria for the CRITICALITY of the Asset

#1 Determine and record Roadway Classification of the asset:
- Interstate, National Highway System (NHS), non-NHS
- “Lifeline” routes

#2 Determine and record traffic volumes for the asset.

#3 Determine and record the availability of alternate routes (availability of redundancy for the asset at risk).

#4 Based on the above objective information for three key features, and augmented with subjective judgment regarding the utility of the asset, make an assessment of the criticality of the asset. An example scoring system of the criticality of the asset is provided below:

<table>
<thead>
<tr>
<th>Criticality of asset</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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Notice that along with the qualitative terms there is an associated scale of 1 to 10, this is to serve as a facilitation tool for some people who may find it useful to think in terms of a numerical scale – although the scoring by each individual is of course subjective. The scale is a generic scale of criticality where “1” is very low (least critical) and “10” is very critical.

Typically involves:
- non-NHS
- low AADT
- alternate routes available

Typically involves:
- some NHS
- non-NHS
- low to medium AADT
- serves as an alternative for other state routes

Typically involves:
- Interstate
- Lifeline
- sole access
- no alternate routes

WSDOT’s criticality rating scale
Assessing Vulnerability

- Assess Vulnerability
  - Develop Climate Inputs
  - Collect and Integrate Data on Assets
  - Assess Asset Criticality
  - Develop Information on Asset Sensitivity to Climate
  - Identify and Rate Vulnerabilities
  - Incorporate Likelihood and Risk
Integrate Results into Decision Making

- Identify, analyze, and prioritize adaptation options;
- Incorporate assessment results into programs and processes.

**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 Designs**
**Build Public Support for Adaptation Investment**
**Educate & Engage Staff & Decision Makers**
Climate Resilience Pilot Program

Use and build on FHWA’s *Climate Change & Extreme Weather Vulnerability Assessment Framework*

- 19 total projects
- Vulnerability and Adaptation Pilots
- Broad geographic coverage and range of impacts
- Will further the state of practice in the emerging area of resilience to climate changes
- FHWA will use lessons learned to turn the vulnerability assessment framework into an adaptation and resiliency framework

14 DOT-Led Pilots

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<tr>
<th>Tennessee</th>
<th>New York</th>
<th>Massachusetts</th>
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<tr>
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2013-2014 Pilot Locations
Example 2013-2014 Pilots

Arizona DOT
- Extreme surface temps
- Floods
- Dust storms
- Species Migration

Michigan DOT
- Lake effect and climate change
- Improve statewide, systematic approach to addressing risk

MnDOT
- Flash Flooding
- Asset Management

MassDOT
- Impacts to the Central Artery
- Solutions
Thank You

For more information:

www.fhwa.dot.gov/environment/climate_change/