FHWA and Resilience to Climate Change & Extreme Weather

2014 TxDOT Transportation Planning Conference

Robert Kafalenos, FHWA
June 4, 2014

Photo: Culvert under Airport Boulevard (Mobile, AL)
Resilience to Extreme Weather and Climate Change

- **FHWA Goal**: Transportation system that continues to provide safe mobility under current and future conditions

- **Objective**: Systematic consideration of climate risk at transportation **system** and **project** levels.

- **Approach**:
  - FHWA funds can be used for adaptation activities
  - Research and Technical Assistance: Develop and share information and tools that State DOTs and MPOs can use to assess risk and improve resilience
  - GROW AMERICA would add consideration of resilience, adaptation
Systems Level Objective: Consideration in Transportation Planning, Asset Management

Key Product:
• Updated *Climate Change & Extreme Weather Vulnerability Assessment Framework* (2015)

Activities:
• Climate Resilience Pilots – round 2
• *Gulf Coast 2 (Mobile)*
• *Hurricane Sandy Follow-up and Vulnerability Assessment & Adaptation Analysis*
• *Central NM Climate Change Scenario Planning Project*
Project Level Objective: Consideration in Environmental Process, Preliminary Engineering, Design, Construction, Operations, Maintenance

Key Products:
• Updated engineering manuals, methods and processes

Activities:
• Engineering Assessments
  – Gulf Coast 2 (Mobile)
  – Hurricane Sandy Follow-up and Vulnerability Assessment & Adaptation Analysis
  – Transportation Engineering Approaches to Climate Resiliency
  – Climate Resilience Pilots
• HEC 25 - Vol 2: Highways in the Coastal Environment: Extreme Events
• Hydrology, hydraulic engineering research efforts, etc.
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
2013-2014 Climate Resilience Pilot Program

Pilots will use and build on FHWA’s *Climate Change & Extreme Weather Vulnerability Assessment Framework*

19 Pilots

- Tennessee
- Maine
- Michigan
- Arizona
- Alaska
- Connecticut
- Massachusetts
- CAMPO
- Broward MPO
- New York
- Iowa
- Maryland
- Minnesota
- California
- Oregon
- Washington
- Hillsborough MPO
- NCTCOG
- MTC (San Francisco)

- Vulnerability and/or adaptation
  - Asset management
  - Hydraulics, hydrology

- Broad geographic coverage, range of impacts
Primary Phase 2 Tasks

- Task 1: Identify critical transportation assets in Mobile (complete)
- Task 2: Identify climate effects, assess infrastructure sensitivity (complete)
- Task 3: Assess vulnerability of critical assets (Summer 2014)
- Task 4: Develop transferable risk management tools (Summer 2014)

Completed tasks: FHWA website

Phase 2 performed by ICF International (prime), Parsons Brinckerhoff, South Coast Engineers, and Texas A&M, with support from USGS and Katharine Hayhoe (Texas Tech)
Projected Climate Change in Mobile: Temperature and Precipitation

• **Increases in Temperature**
  – The number of heat events above **95°F** and **100°F** are projected to increase dramatically

![Projected average mean temperature (°F)]

• **Uncertain changes in Precipitation**
  – 100-year precipitation event is projected to be more intense in the future, though there is a wide spread of results across models
Sample of Storm Surge Analyses

- Scenarios based on historic hurricanes, with varying
  - Track
  - Intensity
  - Sea level rise

Hurricane Katrina Natural Path Scenario

Hurricane Katrina Shifted Path Scenario with 0.75 meter Sea-Level Rise
Using Indicators to Score Vulnerability

- $V = \text{Function of (E, S, A)}$
- Chose indicators to represent exposure, sensitivity, and adaptive capacity
  - Characteristics that could indicate an asset may or may not be vulnerable
- Averages of indicators drive scoring
  - Weighting
## Example Indicators

### Exposure
- **Temp** - Days above 95°F
- **24-hour precipitation**
- **Storm surge** height
- **Wind** speed exceeds threshold above which impacts may occur (yes/no)
- **Inundated by sea level rise** (yes/no)

### Sensitivity
- **Temp** - Pavement binder, traffic (roads)
- **Precip** - FEMA flood zones, ponding, surface permeability (all modes)
- **Storm surge** – Height & condition (bridges), electric signaling & soil type (rail), access (transit)
- **Wind** - Building height, materials, roof type; road sign or signal density (road and rail)
- **Sea level rise** – Drainage (air), protection (transit, roads)

### Adaptive Capacity
- **Speed to recover asset** – cost of improvement (bridges), identified as a priority in emergency planning (rail, air, transit)
- **Redundancy** - detour length (bridges, air), number of terminals/runways (air), ability to reroute (transit and rail), rail yard interchange utility (rail)
- **System disruption duration** (climate variable-specific)
## Highways Storm Surge Vulnerabilities

<table>
<thead>
<tr>
<th>Segment Name</th>
<th>Vulnerability Score (Least Extreme)</th>
<th>Vulnerability Score (Most Extreme)</th>
<th>Data Availability*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telegraph Road, from Downtown to Baybridge Road</td>
<td>3.2</td>
<td>4.0</td>
<td>92%</td>
</tr>
<tr>
<td>The Causeway (Battleship Parkway)</td>
<td>3.2</td>
<td>4.0</td>
<td>91%</td>
</tr>
<tr>
<td>I-10 Tunnel (Wallace Tunnel)</td>
<td>3.2</td>
<td>3.6</td>
<td>87%</td>
</tr>
<tr>
<td>SR-163 (Dauphin Island Parkway), from Island Road to Terrell Road</td>
<td>3.2</td>
<td>3.6</td>
<td>81%</td>
</tr>
<tr>
<td>I-10 Bridge across Mobile Bay</td>
<td>2.5</td>
<td>3.3</td>
<td>86%</td>
</tr>
<tr>
<td>Old Spanish Trail, between Cochrane Bridge and the tunnels</td>
<td>2.7</td>
<td>3.1</td>
<td>87%</td>
</tr>
<tr>
<td>Dauphin Island Bridge</td>
<td>2.6</td>
<td>3.0</td>
<td>100%</td>
</tr>
<tr>
<td>SR-188, where it crosses the river just North of Bayou la Batre</td>
<td>2.5</td>
<td>2.9</td>
<td>87%</td>
</tr>
<tr>
<td>Intersection of SR-188 and CR-59 (Bellingrath Road), near Fowl River</td>
<td>2.5</td>
<td>2.9</td>
<td>87%</td>
</tr>
<tr>
<td>SR-193 (Dauphin Island Parkway), from Dauphin Island Bridge to CR-188</td>
<td>2.5</td>
<td>2.9</td>
<td>92%</td>
</tr>
</tbody>
</table>
Storm Surge Vulnerability

- Highest where Mobile River meets Mobile Bay
- Low-lying coastal roads and bridges
- Location is biggest driver

Example: The Causeway (R10)
- 17-29 ft. of storm surge/waves
- Damaged in past, unprotected, low approach, low embankment
- High replacement cost
I-10 – Mileposts 24 to 25
Road Alignment Exposure to Storm Surge
Implications

• Consider environmental conditions over project life
  – Local road; Interstate; Major bridge

• Climate change will affect maintenance cycles, investment decisions on when/where to invest, reconstruct
  – Added uncertainty (e.g., multiple scenarios)
  – Expect higher maintenance and operations costs; potentially costlier designs

• Adaptation can save funding over the long term
  – Emphasize proactive strategies vs. reacting to “disaster”
  – Focus on solutions
Asset Management

• All State DOTs will develop asset management plans that address risks. Examples of risks:
  – Financial, Under-investment in maintenance, etc.
  – Economic
  – Seismic
  – Extreme weather
  – Climate change (worse and/or more frequent EWE, etc.) - accelerated deterioration cycles

• Virtually all 50 States have used Emergency Relief funds for weather related damage over the last decade
Technical guidance: HEC-25 Volume 2

- Highways in the Coastal Environment: Assessing Extreme Events
- Technical guidance, methods for incorporating extreme events and climate change into coastal highway designs
- Focus on sea level rise, storm surge, wave action
- Summer 2014
New Web Resource: Virtual Framework

- New web resource to house FHWA adaptation tools and resources
- Organized around the FHWA Vulnerability Assessment Framework
- Include guidance for each step, training videos, case studies, tools, and links to related resources
- Available mid-2014
Thank you

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

Sustainable Transport and Climate Change Team
FHWA Office of Natural Environment
Robert.Kafalenos@dot.gov