Washington State DOT’s Vulnerability Assessment: Asking the “Climate Question”

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Washington State Coastal Hazards and Sea Level Rise Workshop
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Washington Climate Change impacts assessment

• Funded by the Washington State Legislature

• Published in 2009

• Comprehensive report on climate change impacts in Washington

• Downscaled from global climate models

• Detailed data and technical support available
Projected Increases in PNW Temp

- Changes relative to 1970-1999:
  - +7.2°F (3.6°C)
  - +10.8°F (6.0°C)
  - +14.4°F (7.9°C)

- Rate of change per decade expected to be 3x greater through mid-21st century.

- Choice of emissions scenario matter more after 2050s.

- Mote and Salathé, 2009.
FHWA risk assessment model

Inventory of Assets
- Develop inventory of assets
- How important is each asset?

Climate Information
- Gather climate information (observed and projections)
- What is the likelihood and magnitude of future climate changes?

Risk
- Low vulnerability
  - Is the asset vulnerable to projected climate effects?
    - High or medium vulnerability
      - What is the likelihood that future stressors will measurably impact the asset?
      - What is the consequence of the impact on the asset?
    - Low risk
      - What is the integrated risk?

Monitor and revisit as resources allow

Existing data sets

Existing inventories

Existing priorities, evaluation tools
Goal: Preserve assets in a changing environment

- **Apply an asset management approach**
  - Be ready for severe weather events *and* long-term changes in site conditions
  - Inform long-term decisions
  - Build resilience where possible

- **Conduct a statewide vulnerability assessment**
  - Test-drive the FHWA model
  - Understand and communicate current science
  - Scope: Consider impacts on our all WSDOT assets
    - Highways, Ferries, State-owned Rail and Airports

Washington State Department of Transportation
Our approach used internal experts

- Local maintenance, bridge preservation, hydraulics, geotechnical, materials, project development, planners, environmental staff
- Workshop format (similar to cost/risk assessments)
- Share climate change information and why this was important – stressed what is happening now (observed)
- Questions:
  - “What keeps you up at night?”
  - “What if it gets worse (given the scenario)?”
  - “How resilient is our existing system?”
### Step 1 – How critical is the asset?  
**WSDOT Methodology**

<table>
<thead>
<tr>
<th>Very low to low</th>
<th>Moderate</th>
<th>Critical to Very Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Criticality of asset**

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:**

<table>
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<tr>
<th>Very low to low</th>
<th>Moderate</th>
<th>Critical to Very Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>non-NHS</td>
<td>some-NHS</td>
<td>Interstate</td>
</tr>
<tr>
<td>low AADT</td>
<td>low to medium AADT</td>
<td>Lifeline</td>
</tr>
<tr>
<td>alternate routes available</td>
<td>serves as an alternative for other state routes</td>
<td>some NHS sole access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no alternate routes</td>
</tr>
</tbody>
</table>
### Step 2: How might climate impact that asset?

<table>
<thead>
<tr>
<th>Primary climate drivers</th>
<th>Can lead to impacts on...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Expansion joints, pavement, rail tracks, construction periods, habitat projects, electrical equipment</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Flooding of surface roads &amp; tunnels, road washout, pump capacity, drainage</td>
</tr>
<tr>
<td>Hydrologic shifts</td>
<td>Soil instability, water supply, bridge and road support structures</td>
</tr>
<tr>
<td>Sea level rise, storm surge</td>
<td>Coastal erosion, coastal and upriver flooding, bridge footings, drainage, roadside stability, salt / corrosion</td>
</tr>
</tbody>
</table>
We used our experience to gauge future impacts

Scour and damage to structures - Just off US 12 Davis Creek
Oct. 4, 2009: Dust storm closes I-90 between Moses Lake and Ritzville
Seattle Sea Level Rise

Source: NOAA

Data with the average seasonal cycle removed
Higher 95% confidence interval
Linear mean sea level trend
Lower 95% confidence interval

Seattle, WA 2.06 +/- 0.17 mm/yr

Meters

Washington State Department of Transportation
SLR Methodology

• Collected Lidar data on as much of the coast as was possible
  – Puget Sound Lidar Consortium (“horizontal scale of 1:12,000 (1 inch = 1,000 feet) or smaller and vertical accuracy on the order of a foot”)
  – FEMA Project (Absolute Acc .05m (.15ft))
  – 2006 USGS Project (Hor. 1m, Vert. 18.5cm)
  – NOAA Digital Coast (produced a 30 meter Raster)
Seattle Ferry Terminal – Example of Misleading Information
Mulkilteo Ferry Terminal 2 and 4 foot Sea Level Rise
Complete catastrophic failure
Results in total loss or ruin of asset. Asset may be available for limited use after at least 60 days and would require major repair or rebuild over extended period of time. “Complete and/or catastrophic failure” typically involves:
- Immediate road closure;
- Disruptions to travel;
- Vehicles forced to re-route to other roads;
- Reduced commerce in affected areas;
- Reduces or eliminates access to some destinations;
- May sever some utilities located within right-of-way;
- May damage drainage conveyance or storage systems.

Temporary operational failure
Results in minor damage and/or disruption to asset. Asset would be available with either full or limited use within 60 days and may have immediate limited use still available.
“Temporary Operational Failure” typically involves:
- Temporary road closure, hours to weeks;
- Reduced access to destinations served by the asset;
- Stranded vehicles;
- Possible temporary utility failures.

Reduced capacity
Results in little or negligible impact to asset. Asset would be available with full use within 10 days and has immediate limited use still available. “Reduced capacity” typically involves:
- Less convenient travel;
- Occasional/brief lane closures, but roads remain open;
- A few vehicles may move to alternate routes;

Figure 2.1 Photo depictions of qualitatively assessed climate change consequences
What did we find?

- Intensifies known threats
- Reinforces value of our current maintenance and retrofit programs
- Some surprises
- Unique way to capture knowledge of field staff
Lessons Learned

• Asset data may be available, but it may not be compatible across assets
• Climate data may be available, but it may need processing before you can use it
• Workshop participants responded well to the question, ‘What keeps you up at night?’
• Focus on extreme events now and talk about those being more common in future.
WSDOT’s study of climate impacts vulnerability

- Workshops across the state to evaluate all WSDOT Assets
- Map and communicate results
- Develop strategies
- Integrate into asset management paths

2011

2012

2013
Jan. | June
We want to illustrate current practices that are effective adaptation strategies

From disaster to resiliency

Drilled shaft bridges like this one on I-90 near Gold Creek make those structures more resistant to high-velocity flooding.
Adapting to a changing climate
Statewide study of climate-related infrastructure risks

Our climate is changing. Demand for transportation resources continues to grow. Keeping state-owned and managed infrastructure safe and operational is key to a growing economy and building a more resilient and sustainable transportation system.

Protecting infrastructure, freight routes and keeping drivers safe for the long-haul
Our economy and quality of life can take serious hits when intense weather floods interstates, closes critical bridges and brings relentless snow to our mountain passes. The past has shown how storms can wreak havoc on our daily lives and prevent goods and services getting to customers.

WSDOT’s job is to keep the state’s transportation system safe and operational. This means planning and preparing to protect and manage our vital roads, bridges, ferry terminals and other facilities that could be vulnerable to severe weather. We must be resilient and adapt to future environmental conditions. Thanks to a $189,500 Federal Highway Administration (FHWA) national pilot project grant, WSDOT was able to complete the groundwork on assessing how our state-owned and operated transportation assets may fare under extreme weather changes.

WSDOT pilots infrastructure vulnerability assessment
We conducted workshops with our field staff from across the state to assess the vulnerability of our highways, ferry terminals and other infrastructure to changes in our climate and weather extremes. We presented the participants with climate scenarios such as extreme temperatures and sea-level rise, asking “What would be the likely impact on our facilities?” The results from each workshop were used to create a series of planning-level maps.

USDOT Climate Change Policy
In addition to the federal dollars from the FHWA pilot project, United States Department of Transportation (USDOT) policy supports climate adaptation efforts. In a June 2011 policy statement, U.S. Transportation Secretary Ray LaHood directed USDOT agencies (such as the Federal Highway and Transit Administrations) to consider climate change impacts on current systems and future investments.

The USDOT climate change policy statement further states that “planning for climate adaptation assists State and local transportation agencies, and DOT, to identify how climate change is likely to impact their ability to achieve their mission, continue operations, and to meet policy and program objectives.”

http://www.wsdot.wa.gov/SustainableTransportation/adapting.htm