Protecting Infrastructure through Vulnerability Assessments

Asset Resiliency in the face of a Changing Climate

Washington State Department of Transportation

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

Federal Highways funded five tests of their climate assessment model

CALIFORNIA
WASHINGTON
NEW JERSEY
SAN FRANCISCO
HAWAI'I

FHWA risk assessment model
Washington State DOT’s Climate Assessment
Key Facts:

- FHWA $189,500 funds matched by state staff time
  - One of 5 national climate risk assessment pilots (2011)
- WSDOT test of the FHWA’s model leveraged:
  - Our asset management approach & cost/risk assessment tools
  - Pacific Northwest climate change data from UW
  - Field personnel intimate knowledge of current climate threats
- Easily replicable process
  - 14 workshops across state & simple Microsoft Excel & GIS tools
- Qualitative rankings for all state-owned assets!
  - State highway & interstate segments, ferry terminals,
  - State freight rail lines, state-managed airports

How did we do the statewide climate impacts vulnerability assessment?

Key Points:

- Internal WSDOT staff ranked our assets
  Local maintenance, bridge engineers, hydraulics, geotechnical, materials, project designer, planners, environmental staff
- Used our own asset risk assessment process combined the FHWA model
- Shared climate change information and why this was important & gathered info on current impacts from weather & tidal events
- We didn’t question the science or try to define likelihood - took as “100% Probability”

Workshop questions:

- “What keeps you up at night?”
- “What if it gets worse (given the climate scenario)?”
- “How resilient is our existing state system?”

We used our experience to gauge future impacts

Mount Rainier Kautz Creek 11-06-06

Only year-round road into and out of Park.

a new creek flowed down a service road, carving a channel through the park’s helipad

We’ve seen a 9 inch rise over 110 years
Step 1 – Define roadway segments

WSDOT Methodology

<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, roadside habitat loss, heat stress on signals, timing of construction work in extreme heat</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>

Primary climate drivers
- Temperature
- Precipitation
- Hydrologic shifts
- Sea level rise, Storm surge

Typically involves: (low AADT) non-NHS
Typically involves: (high AADT) non-NHS or medium AADT serves as an alternative for other state routes
Typically involves: NHS
Primary climate drivers: Can lead to impacts on... Expansion joints, pavement, rail tracks, roadside habitat loss, heat stress on signals, timing of construction work in extreme heat. Flooding of surface roads & tunnels, road washout, pump capacity, drainage. Soil instability, water supply, bridge and road support structures. Coastal erosion, coastal and upriver flooding, bridge footings, drainage, roadside stability, salt / corrosion.

Step 2 – Assess climate impact

What did we find?
- Climate change will intensify known threats
- Reinforces value of our current maintenance and retrofit programs
- Unique way to capture knowledge of field staff
- New awareness of combinations of climate risks / extreme events

Where can you find the results of WSDOT's climate change vulnerability assessment?
- General results are posted on-line
  - Our report to FHWA
  - NEPA/SEPA Guidance
- WSDOT employees
  - GIS layer
  - Narrative results
How are our folks starting to integrate vulnerability assessment results?

**Planning**
Bring awareness of the potential climate vulnerabilities of WSDOT facilities when doing route development plans or corridor studies.

**Design & Environmental Review**
Evaluate potential risks to a project during the environmental and design phase (follow WSDOT's NEPA guidance).

**Construction**
Look at potential for new issues: salt water corrosion, heat or precipitation changes for long-term impacts on materials.

**Maintenance & Operations**
Plan evacuation routes, hazard reduction, maintenance activities that may be affected by heat or extreme weather events.

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**Climate-Ready Highways: Incorporating what we know today with projected future**

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**Communicating “co-benefits” of current programs: Fish Passage/Habitat Connectivity Project**

- Provides Steelhead, Bull Trout, & resident trout with access to 13.7 mi of stream habitat.
- Provides deer with a safe crossing in one of our worst deer-vehicle collision areas.
- Uses 1.5 mi of fencing to funnel animals to the crossing.
- More Resilient US 97!

**From Disaster to Resiliency: Highlighting current practices that are effective adaptation strategies**

- Drilled shaft bridges like this one on I-90 near Gold Creek make those structures more resistant to high-velocity flooding.

**Skagit River Bank Restoration along SR 20**

- Drilled shaft bridges like this one on I-90 near Gold Creek make those structures more resistant to high-velocity flooding.
- Skagit River Bank Restoration along SR 20
- Above: Emergency fix November 2004
- Right: Long-term solution March 2014
- Engineered Log Jams combined with concrete dolos.
Ongoing Work: Skagit Basin Pilot (shows Climate Assessment Results and location of recent I-5 bridge collapse)

Building a climate-ready transportation system

Essential elements:
- Understand the climate forecast
- Assess our risks
- Integrate into planning and design
- Look for co-benefits
- Partner with others

What is Sound Transit?
- Multi-modal public transit agency serving Tacoma-Seattle-Everett region
- 28 million riders (and growing)
- Services operated via contractual partnerships with King County Metro, Pierce Transit, Community Transit, Amtrak, and Burlington Northern Santa Fe (BNSF)

What is the Sound Transit Climate Change Risk Reduction Project?
- Funded by the FTA
- One of 7 climate change adaptation pilot projects
- A partnership between Sound Transit, the UW Climate Impacts Group, and WSDOT – a first look for ST

For more information:
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- Sandy Salisbury, Headquarters Roadside and Site Development Manager 360-705-7240
- Mark Maurer, Highway Runoff Program Manager 360-705-7260

WSDOT’s website
http://www.wsdot.wa.gov/SustainableTransportation/adapting.htm

FHWA’s website
http://www.fhwa.dot.gov/environment/climate_change/adaptation/

Sound Transit Climate Risk Reduction Project
Lara Whitely Binder, UW Climate Impacts Group
Amy Shatzkin, Sound Transit
Carol Lee Roalkvam, WSDOT

October 17, 2014 | American Planning Association Washington Chapter Annual Conference
Sound Transit Climate Change Risk Reduction Project

**Project Objectives**

- Assess climate change risks to Sound Transit operations, assets, and long-term planning;
- Identify initial adaptation strategies and how to best integrate information into ST processes; and
- Provide a state-to-local testing ground for WSDOT’s pilot of the FHWA’s climate change vulnerability assessment methodology.

**Projected Changes in PNW Climate**

- Increasing average temps, more extreme heat events:
  
  Projected increase in average temp by mid-century: +4.3°F to +5.8°F (range: +2°F to 8.5°F) (Mote et al. 2013)

- Increasing winter precip, more extreme precip events:
  
  24-hour storm events in Seattle-Tacoma area projected to increase 14-28% by 2050s, relative to 1970-2000. (Rosenberg et al 2010)

- Increased flood risk west of the Cascades:
  
  More and larger fall/winter floods possible, compounded by sea level rise in coastal rivers and streams.

- Rising sea level:
  
  Sea level in Seattle projected to rise +24.3 inches (range: +4 to +56 in.) by 2100. (NRC 2012)

**What Do These Changes Mean for ST?**

- Environmental Mitigation
- Customer Facilities
- Sounder Link
- ST Express
- Environmental Mitigation

**Project Approach**

- Used existing research for regional climate projections
- Formed a ST climate adaptation advisory group
- Staff survey to establish baseline information on experience, perceptions about climate impacts on ST
- Facilitated workshops (~12) based on WSDOT approach:
  - Kick off events
  - Risk assessment & prioritization for facilities and modes
  - Identification of adaptation strategies (by mode)
  - Potential integration pathways (senior managers)
- Report development, Executive Team briefings, and dissemination

**Overarching Key Findings & Considerations**

1. Climate change exacerbates many existing issues already facing Sound Transit.
2. If, when, and how much climate change affects Sound Transit varies by mode, location, and the size and rate of projected change.
3. Overall, many impacts will likely be minor to moderate, although more significant impacts are possible.
4. Sound Transit already possesses some degree of climate resilience and capacity to address climate impacts.
**Lessons Learned: Approach**

- Drawing on existing research saved time, resources but was not always specific to geographic scale of interest.
- Advisory group provided senior-level buy-in (and push) for staff participation.
- Facilitated workshops provided:
  - "Real world" information;
  - More staff engagement and learning opportunities (climate change "ambassadors");
  - Opportunities to ground-truth findings

However...
- Needed more time for discussion
- Results are shaped by who is sitting at the table
- Limits to group size for this type of engagement (survey helped)
- Limited institutional history with climate and weather events – required people to think outside the box

**Potential Impacts Related to ST**

<table>
<thead>
<tr>
<th>Related to Temperature Increased potential for...</th>
<th>Related to Precipitation Increased potential for...</th>
<th>Related to Sea Level Rise Increased potential for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail buckling</td>
<td>Multistore and slope instability</td>
<td>Temporary flooding of low-lying areas</td>
</tr>
<tr>
<td>Heat stress on electrical and safety equipment</td>
<td>Larger and/or more frequent river and stream flooding</td>
<td>Permanent inundation of low-lying areas</td>
</tr>
<tr>
<td>Heat stress on overhead catenary system</td>
<td>Increased localized flooding due to more stormwater runoff or poor drainage</td>
<td>Higher tidal and storm surge reach</td>
</tr>
<tr>
<td>Heat stress on pavement, structures</td>
<td>Seepage due to higher groundwater tables</td>
<td>Erosion</td>
</tr>
<tr>
<td>Heat stress on landscaping and environmental mitigation sites</td>
<td>Summer drought</td>
<td>Drainage problems</td>
</tr>
</tbody>
</table>

**Prioritizing Potential Impacts and Services**

Two questions assessed:

1. Which climate change impacts matter more across all services?
2. Which services may become higher (or lower) adaptation priorities?

**Q2: Which services may become higher adaptation priorities?**

<table>
<thead>
<tr>
<th>Potential high adaptation priority services:</th>
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<tbody>
<tr>
<td>North Sounder</td>
</tr>
<tr>
<td>Edmonds and Mukilteo Sounder Stations</td>
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</table>

<table>
<thead>
<tr>
<th>Potential medium adaptation priority services:</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Sounder; Tuikwa and Kent Sounder stations</td>
</tr>
<tr>
<td>At grade or aboveground Link alignments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential low adaptation priority services:</th>
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<tbody>
<tr>
<td>ST Express</td>
</tr>
<tr>
<td>Environmental mitigation</td>
</tr>
<tr>
<td>Other customer facilities</td>
</tr>
<tr>
<td>Underground Link</td>
</tr>
</tbody>
</table>

**Sound Transit has many options for adaptation...**

- Raise sensitive ground-level infrastructure
- Add flexibility by building in capacity to relocation, raise, add higher capacity in future
- Build berms around sensitive ground-level infrastructure
- Modify design standards to provide higher level of flood & stormwater management, seepage management, heat impacts
- Increase visual & electronic monitoring of infrastructure in vulnerable areas
- Partner with communities to target problem drains/drainages
- Move or relocate infrastructure in hazard zones
- Modify drainage patterns to re-direct flows, improve drainage
- 70+ options identified

* Assumes size of the projected impact is at the high end of what would be expected
...And many opportunities for integrating climate change into agency processes

- Climate impacts may influence decisions including:
  - Policy setting
  - Environmental review
  - Strategic system planning
  - Preliminary engineering and final design
  - Operations and maintenance
  - Asset management
  - Intergovernmental relations

Acknowledgements and Thank You’s
- Leadership at Sound Transit, WSDOT, and CIG
- Amy Shatzkin (Sound Transit)
- Carol Lee Roalkvam (WSDOT)
- Mike Strong (Sound Transit GIS)
- Amy Snover, Ingrid Tohver, and Rob Norheim (CIG)
- The many Sound Transit directors, managers, and technical staff who participated in the workshops

The UW Climate Impacts Group
Science for climate resilience
- Linking science with public and private decision making
- Catalyzing decision-relevant climate science
  - Identifying emerging risks
  - Illuminating response options
- Supporting the interpretation and application of climate science
  - Local climate change information
  - Expert guidance on climate risk assessment & adaptation planning
  - Synthesis & assessment of emerging climate science

For more information:
- Lara Whitely Binder, CIG (lwb123@uw.edu)
- Amy Shatzkin, St (amy.shatzkin@soundtransit.org)
CIG/King County Adaptation Planning Guidebook

- Written by the CIG and King County, WA in association with ICLEI – Local Governments for Sustainability
- Written to compliment ICLEI’s “Climate Resilient Communities” Program
- Focused on the process (not a sector), and written for a national audience

http://cig.uw.edu/reports.shtml

Planning for Uncertainty

Look to implement

- “No regrets” strategies
  Provides benefits now with or without climate change
- “Low regrets” strategies
  Provide climate change benefits for little additional cost or risk
- “Win-win” or “Co-benefit” strategies
  Reduce climate change impacts while providing other environmental, social, or economic benefits

Closing Thoughts on Adapting to Climate Change

- Adapting to climate change is not a one-time activity.
- Plan for flexibility and robustness in the face of uncertain changes rather than counting on one approach: Natural variability will still occur.
- You do not have to “get it right the first time”. Look for the small accomplishments early on for building momentum.
- There is no “one-size-fits-all” approach to managing climate change impacts

Closing Thoughts on Adapting to Climate Change – cont’d

- Addressing non-climate stresses that contribute to climate vulnerability can go a long ways
- You will not have perfect information – we rarely do. Work on building more flexibility into decisions.
- Build your community’s institutional capacity as well as its physical and economic capacity
- Public education and engagement is critical.

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