Addressing Extreme Events at WSDOT and Beyond

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Assisted transportation agencies in assessing vulnerability and developing adaptation strategies as part of hydrologic and hydraulic analysis and design services.

Examples:

• Evaluating flood risk under potential extreme events and land use scenarios that combine changes in the frequency and magnitude of peak stream flows with sea level rise.

• Investigating effects of changes in precipitation, temperature regimes and design flows for the design of transportation infrastructure.
In October 2010, Federal Highways funded a pilot project which gave WSDOT a mechanism to understand how changes in our climate could effect WSDOT infrastructure and operations.

General Overview of pilot project:

1) Identify Assets
2) Determine criticality of the asset
3) Identify potential climate threats
4) Share results of study with variety of offices within the agency to assist with making informed decisions.
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
  - Understand and communicate current science
  - Scope: Consider impacts on all WSDOT assets (Highways, Ferries, State-owned Rail and Airports)
## 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>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></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:

- **Very low to low**
  - non-NHS
  - low AADT
  - alternate routes available

- **Moderate**
  - some-NHS
  - non-NHS
  - low to medium AADT
  - serves as an alternative for other state routes

- **Critical to Very Critical**
  - Interstate
  - Lifeline
  - some NHS
  - sole access
  - no alternate routes

*Courtesy of WSDOT*
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;

Courtesy of WSDOT
What are the Climate Threats?

• Discussed observed changes and extreme events with a variety of disciplines including: Maintenance, hydraulics, bridge, geotechnical, materials, environmental staff, etc

• Key Questions:
  • “What keeps you up at night?”
  • “What if it gets worse (given the scenario)?”
  • “How resilient is our existing system?”

• WSDOT’s experts ranked all WSDOT assets
### Workshops: How might climate impact assets?

<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>

Courtesy of WSDOT
What did WSDOT find?

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

Courtesy of WSDOT
Statewide Results

Assumed 2 foot sea level rise

Courtesy of WSDOT
Using Vulnerability Information to Inform Decisions

Takeaways

• There is not a consistent way for how to use vulnerability information in design

• Typically happens on a project-by-project basis

• Trade off between other agency strategic goals (e.g. is designing for an extreme event practical design?)

• Not all sites or extreme events are the same. Need to understand your site and cost of “failure”

• Not adequate data (intensity data) for design at local scale (e.g. highway drainage, storm drains, etc)
Bridge Engineering Information System (BEISt)

This site provides access to inventory data, plans, rating reports, inspection reports, photographs, and related files for bridge structures in the WSDOT bridge inventory. This inventory of bridge structures includes some locally owned agency structures.

There are over 8,500 bridge structures in this database, therefore it is necessary to provide information about the structures of interest to reduce the list to a displayable level. Please provide one or more pieces of information about the structure(s) you are interested in:

- Structure ID
- Bridge Number
- County
- Contract Number
- Route
- Milepost Range

Search  Reset  Show Map  Hide Search Criteria
Mud Bay Bridge (101/508E)

Bridge Number 101/508E
Structure Identifier 0005677A
Location 1.3 S JCT SR 8
Route 00101
Mile Post 362.83
Feature Intersected MUD BAY
Facilities Carried US 101
Region OL
Owner Washington State

Operating Rating Tons 56
Inventory Rating Tons 34
Min Over Deck 99' 99"
Min Under Bridge 0"
Sufficiency Rating 80.42
Year Built 1958
Year Rebuilt SD/F0 N/A

Inspections Performed

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<thead>
<tr>
<th>Report Type</th>
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<th>Insp Freq</th>
<th>Insp Typo</th>
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<tbody>
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<tr>
<td>Equipment</td>
<td>2010-05-12</td>
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<td></td>
</tr>
</tbody>
</table>

MUD BAY Image
Mud Bay Bridge (101/508E) As-Builts
Mud Bay Bridge (101/508E) As-Builts

ELEVATIONS

STATIONING

1957 AS-BUILT G/L ELEV.  1992 U/S G/L ELEV.  RAIL ELEV.
Mud Bay Bridge (101/508E)
SR 4 – Pete’s Creek Culvert

water resource specialists
Emergency protection being placed at the west abutment of Bitter Creek Bridge shortly before the bridge was washed out (September, 2011).
NHC participates in the development of national and international downscaled projections of climate and hydrology

Several NHC professionals are familiar users of U.S.-wide datasets of downscaled climate and hydrology.

Some examples:

- NASA’s high resolution (800 m) statistically-downscaled climate projections
- USGS’s statistically- and dynamically-downscaled climate projections
- NARCCAP’s dynamically-downscaled climate projections
- U. Idaho’s statistically-downscaled climate projections
- USBR (and others) hydrologic projections
- EPA’s hydrologic projections

NHC also has experience generating downscaled projections of climate and hydrology for specific watersheds, using state of the art hydrologic models.
Evaluate future flood frequency using extreme value analysis of projected streamflows corresponding to 3 different climate scenarios.
Bridging the Gap

- Climate Scientists
- Design of Extreme Events
- GCM (Large Scale)

Definition of Extreme Event

- Hydraulic Engineers and Hydrologists
- Practical Design
- Highway Infrastructure (Typically small scale)
Questions?

For more information:
http://www.nhcweb.com/services/climate-change.asp

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