

AASHTO 2015 EXTREME WEATHER SESSIONS

SUBCOMMITTEE ON DESIGN

INTEGRATING EXTREME EVENTS AND CLIMATE CHANGE INTO DESIGN

THURSDAY, SEPTEMBER 24

1:00 PM – 3:00 PM

SEATTLE, WA

SESSION SUMMARY

This session took the form of a “mini peer exchange” focusing on how DOT’s integrate information on extreme weather events and climate change into design. Michael Kennerly of the Iowa Department of Transportation (DOT) introduced and facilitated the session. Attendance at the session included members from the Subcommittee of Design (SCOD) as well as the SCOD Technical Committee on Hydrology and Hydraulics (TCHH). This document provides a brief summary of the presentations and discussion that followed.

Presentations

Andrea Hendrickson, Minnesota DOT: Flash Flood Vulnerability and Climate Adaptation Pilot Project

Andrea Hendrickson, the State Hydraulic Engineer for the Minnesota DOT (MnDOT), presented on MnDOT’s recently completed, FHWA-funded, pilot project in two of its transportation districts. The project included a system-wide assessment of how the trunk highway network in the districts is at risk from flash flooding and a facility-level analysis of adaptation strategies for selected vulnerable facilities. Through the project, MnDOT learned that most projected changes in flooding through mid-century tend to be within MnDOT’s safety margins. Where adaptation is necessary, MnDOT found that relatively small adaptations would be most cost-effective (e.g., upsizing culverts rather than replacing culverts with bridges).

MnDOT dealt with several challenges throughout the project, including compiling data from numerous datasets and obtaining hydrologically-corrected LiDAR elevation data. Additional challenges include the time, money, and expertise needed to conduct an adaptation analysis (including expertise often not housed within DOTs); data availability; difficulty translating climate model data into hydrological projections; and difficulty of accounting for pre-existing resilience of natural and built systems. Andrea noted that nationally accepted design procedures that consider climate change impacts would be very helpful in giving DOT engineers the confidence to adapt.

Casey Kramer, Northwest Hydraulic Consultants, Addressing Extreme Events at WSDOT and Beyond

Casey Kramer, the former State Hydraulic Engineer for Washington State DOT (WSDOT), presented a general process for thinking about climate change impacts in design, with four overarching steps, all with the goal of preserving assets in a changing environment: 1) identify assets, 2) determine criticality,

3) identify potential climate threats, and 4) share results with people in the agency. This is the process WSDOT used to conduct a statewide flooding vulnerability assessment through a 2011 FHWA-funded pilot project. WSDOT brought together agency staff working in policy, maintenance, geotechnical engineering, bridges, and other disciplines to gather information and share the results of the project. Coordination across departments was one of the most valuable components of the project. WSDOT also drew on its Bridge Engineering Information System (BEIS) to gather valuable data for the vulnerability assessment. Overall, the project reinforced the value of WSDOT's current maintenance and retrofit programs, and coordination across departments. It also captured staff knowledge in reducing weather vulnerabilities. WSDOT management responded well to the project, because it was really about understanding their assets better and aligning departments—climate change was just the driver.

Moving forward, there is still no consistent way for using vulnerability information in design. In part, this may be because there is no “one size fits all” procedure—it is dependent on site and agency context. In addition, climate models are still able to provide only a partial sense of how the climate may change—at least not at design scales needed, for example, for highway drainage. As discussed at length at an earlier TCHH meeting, there is still need to “bridge the gap” between climate science and engineering design, including use of consistent terminology, enhanced communications between engineers and climate scientists, and outreach materials for transportation engineers to understand the difference between climate models. NCHRP 15-61 (“Applying and Adapting Climate Models to Hydraulic Design Procedures”) is forthcoming and should help bridge this gap.

Jake Keller, Parsons Brinckerhoff, The Engineering Assessment Process Used in the Gulf Coast Study, Phase 2

Jake Keller presented on the 11-step process for incorporating climate change into engineering analyses that was developed under the U.S. Department of Transportation's Gulf Coast Study Phase 2. The project was an early foray into providing guidance on how to incorporate climate change projections into transportation engineering design. The project team used 11 case studies in Mobile, Alabama to develop and test a systematic assessment process to evaluate climate vulnerabilities and to develop and compare adaptation strategies, at the facility level. The case studies spanned transportation facility types (culverts, bridges, pavement, piers, and rail) and climate stressors (heavy precipitation, sea level rise, storm surge, and extreme heat).

The project identified challenges and strategies for applying climate data to design questions, addressing the uncertainty inherent in future climate scenarios, and assessing the costs and benefits of adaptation strategies. Through the process, the team learned that climate data can be localized and used in engineering assessments, but using a “scenario planning” approach is critical to doing so. Nevertheless, several challenges remain. For example, making the case that adaptation is a pressing issue, overcoming the perception that there is too much uncertainty in climate projections to take action, unfamiliarity with risk-based engineering approaches, and high up-front costs of analyses and adaptation actions.

Discussion

Karuna Pujara, Maryland DOT, TCHH Chair

Karuna Pujara, Chair of TCHH, shared several key needs and questions that TCHH has identified around the topic of adapting to climate change and extreme weather events:

TCHH-identified Needs:

- Consistent set of definitions between climatologists and engineers to ensure no misunderstandings.
- Techniques for using risk-based decision-making in design/engineering (DOTs are used to doing it for traffic analysis, level of service, etc., but not design).
- Nationally-accepted framework for incorporating climate change information – engineers need boundaries and a framework to help through an otherwise overwhelming problem.
- Additional dialogue within the engineering community about how to incorporate climate change into design and make good decisions: do we need a new paradigm? What would that look like?
- How should we handle situations when regulatory processes demand you assume stationarity¹?
- Better understanding of the cost implications of climate change adaptation – would changing drainage significantly increase the cost of projects?
- Ways to overcome staff time, resource, and expertise limitations. For example, DOTs don't have economists on staff and don't have the computers necessary to analyze lots of climate data.

Group Discussion

- Transportation agencies will need to move toward a more integrated, holistic approach to increasing resilience (to extreme weather, climate change, and other stressors). Design is part of the solution, but not the only one.
- There is a fundamental change going on in the hydrologic and hydraulic design world from stationarity to non-stationarity.
- Changing drainage design and up-sizing culverts poses several challenges: it takes longer for management to make decisions, requires different kinds of expertise, and can have larger ramifications for water movement in the watershed—therefore, it needs to be a community-based process. Changes in flooding in one area may simply move the problem downstream.
- **How do we move forward?**
 - New NCHRP project (15-61) is a good opportunity and will help build a foundation – it would be very valuable to have a member of SCOD or SCOE on the Panel
 - Publish AASHTO factsheets that provide leadership-level guidance – to raise awareness of these issues and the work that is ongoing
 - Continue this dialogue

¹ Stationarity - a process in which the statistical parameters (mean and standard deviation) of the process do not change with time

- **What gaps are present?**
 - Confidence. Need to build consensus and confidence on how to handle these issues in the engineering community. Adapting to climate change requires so many assumptions, it's hard to have the total confidence that we're using things in the proper way—we should build consensus within the engineering community about what guidelines, procedures to use.
 - How does practical design fit with climate resilience?

Needs Summary

Action Items for AASHTO

- Have a member of SCOD or SCOE serve on the NCHRP 15-61 Panel (“Applying and Adapting Climate Models to Hydraulic Design Procedures”).
- Publish AASHTO factsheets that provide leadership-level guidance – to raise awareness of these issues and the work that is ongoing.
- Coordinate with FHWA about its ongoing work in this area (e.g., Transportation Engineering Approaches for Climate Resilience (TEACR), HEC-17, HEC-25). Engage SCOD, TCHH, and other relevant AASHTO committees in this effort. Make sure they're engaged in the process and aware of the results.

Longer-Term Needs

- Consistent set of definitions between climatologists and engineers to ensure no misunderstandings.
- Nationally-accepted framework for incorporating climate change information—engineers need boundaries and a framework to help through an otherwise overwhelming problem, as well as confidence in their approach. **Note:** FHWA is working on this now through the Transportation Engineering Approaches for Climate Resilience (TEACR) project, HEC-17, HEC-25, and others. AASHTO should coordinate with FHWA to engage relevant committees in this effort, and make sure they are engaged in the process and aware of the results.
- Techniques for using risk-based decision-making in design/engineering (DOTs are used to doing it for traffic analysis, level of service, etc., but not design).
- How does practical design fit with climate resilience?
- Additional dialogue within the engineering community about how to incorporate climate change into design and make good decisions: do we need a new paradigm? What would that look like?
- How should we handle situations when regulatory processes demand you assume stationarity?
- Better understanding of the cost implications of climate change adaptation – would changing drainage significantly increase the cost of projects?
- Better ways to understand the cost of failure.

- Ways to overcome staff time, resource, and expertise limitations (e.g., DOTs don't have economists on staff and don't have the computers necessary to analyze lots of climate data).
- Ways to overcome the perception that future climate projections are too uncertain to warrant action; identifying key entry points to adaptation.