Transportation Engineering Approaches to Climate Resiliency (TEACR) Study

This research project provides needed information to a range of engineering disciplines on integrating climate considerations into transportation project development, including:

- Information on why, where, and how to integrate climate considerations into the project development process
- Practical information in related disciplines such as climate science and economics
- Lessons learned from project-level studies of engineering adaptation options.

The engineering disciplines addressed are coastal hydraulics; riverine flooding; pavement and soils; and mechanical and electrical systems. In addition to a synthesis report, the project developed engineering assessments of options for adapting a diverse set of transportation assets from around the country (including roadways, bridges, pavements, culverts, and slopes), to changes in precipitation, sea level, storm surge, heat, drought, and wildfire.

Synthesis of Recommendations and Approaches

- **Synthesis of Approaches for Addressing Resilience in Project Development**, July 2017 - This report synthesizes lessons learned and innovations from a variety of recent FHWA studies and pilots to help transportation agencies address resilience concerns at the asset level in engineering-informed adaptation studies.
  - Summary (PDF 1.5 MB).
  - Full Report (PDF 4.9 MB).

Planning to Build Resilience into Transportation Assets: Lessons Learned
(Transportation Research Record Journal article on the Synthesis report/TEACR project)
This article describes considerations for why, where, and how to integrate consideration of future environmental conditions into the project development process. It also discusses the types of projections that should be considered, and summarizes lessons learned from FHWA's studies and pilots that can be used to guide the process of developing asset-focused adaptation strategies.

TEACR Engineering Assessments

The Adaptation Decision-Making Assessment Process (ADAP) provides a framework used in the nine engineering assessments for generating the information needed to identify approaches to project design in the context of future environmental conditions.

Coastal

- Sea Level Rise and Storm Surge Impacts on a Coastal Bridge: I-10 Bayway, Mobile Bay, Alabama.
  - Summary (PDF , 653KB).
  - Full Report (PDF 2.6 MB)
- Barrier Island Roadway Overwashing from Sea Level Rise and Storm Surge: US 98 on Okaloosa Island, Florida.
  - Summary (PDF , 308KB).
  - Full Report (PDF 1.8 MB)
- Living Shoreline along Coastal Roadways Exposed to Sea Level Rise: Shore Road in Brookhaven, New York.
  - Summary (PDF , 335KB).

- Full Report (PDF 1.8 MB)

Pavement and Geotech

- Temperature and Precipitation Impacts on Cold Region Pavement: State Route 6/State Route 15/State Route 16 in Maine.
  - Summary (PDF , 317KB).
  - Full Report (PDF 3.3 MB)
- Temperature and Precipitation Impacts to Pavements on Expansive Soils: Proposed State Highway 170 in North Texas.
  - Summary (PDF , 531KB).
  - Full Report (PDF 2.6 MB)
- Precipitation and Temperature Impacts on Rock and Soil Slope Stability: Interstate I-77 in Carroll County, Virginia.
  - Summary (PDF , 1.1MB).
  - Full Report (PDF 4.1 MB)
- Addressing Environmental Conditions in the Design of Roadways Built on Permafrost.
  - Summary (PDF , 218KB).
  - Full Report (PDF 4.1 MB)

Riverine and Wildfire

- Wildfire and Precipitation Impacts to a Culvert: US 34 at Canyon Cove Lane, Colorado.
  - Summary (PDF , 282KB).
  - Full Report (PDF 11 MB)

Economics

- Comparison of Economic Analysis Methodologies and Assumptions: Dyke Bridge in Machias, Maine.
  - Summary (PDF , 506KB).
  - Full Report (PDF 2.6 MB)

Assessment of Key Gaps

- Assessment of Key Gaps in the Integration of Climate Change Considerations into Transportation Engineering (September 2014) - Reviews gaps in information and practice related to integrating climate change into transportation engineering and recommends a select set of gaps for further investigation in the remainder of the TEACR project. (PDF 1.2 MB)

Webinar Recordings

- **Approaches for addressing Resilience in Project Development** (September 28, 2017). This webinar focuses on three cross-cutting topics related to conducting engineering informed adaptation studies: integrating resilience into the project development process, understanding and applying climate science information, and using economic analysis to support decision-making. View the webinar recording.
- **Lessons Learned in Transportation Engineering Related to Coastal and Riverine Flooding** (October 5, 2017). This webinar presents lessons learned from case studies examining the effects of sea level rise, storm surge and wave impacts from extreme storms on coastal bridges and roadways. It also looks at effects of changing precipitation and wildfire on an inland riverine watershed. Adaptive design and overcoming challenges with uncertainty and climate data resolution are also discussed. View the webinar recording.
- **Lessons Learned in Transportation Engineering Related to Pavement/Soils and Mechanical/Electrical Vulnerabilities** (October 12, 2017). This webinar provides an overview of the impacts of extreme weather events and climate on pavement and soil and rock slopes within transportation corridors, and potential adaptation strategies to increase resilience of the transportation system. Overview of methods to adapt mechanical and electrical systems to climate stressors from sea level rise, storm surge, and increased precipitation, increase temperatures and high winds are also be presented. View the webinar recording.

Background

Future sea levels, temperature and precipitation patterns are expected to deviate from the historic record due to climate change, and much of today's transportation infrastructure could be at risk. As this aging infrastructure is rebuilt or upgraded, there are opportunities to take into consideration the changing climate and to plan and design this infrastructure to meet future conditions.

However, translating scientific climate projections into information applicable to engineers for project-level design and specifications has proven to be complex. At the same time, historical weather and climate may no longer indicate or predict behavior over the entire life of a transportation project. This weather and climate uncertainty can especially exacerbate consideration and analyses of natural hazards (i.e., flood levels, high intensity and/or duration rainfall, tropical and extra-tropical storms effects, extreme temperature events, and similar events and hazards) that typically are considered at some level during the design process. In light of these uncertainties in future natural hazards, engineers require some measure of guidance to properly design projects and apply asset management and performance measures to completed projects.

FHWA conducted the TEACR project to evaluate engineering approaches to assessing these hazards and develop a state of the practice set of solutions and methodologies that project sponsors across the nation can use in developing transportation infrastructure.

Contacts

For further information regarding the project, please contact:

Rob Kafalenos
Resilience Team
Robert.Kafalenos@dot.gov

Susan Jones
Hydraulics and Geotechnical Engineering Team
Susan.Jones@dot.gov

Journalists with questions about this project should call FHWA's Office of Public Affairs at 202-366-0660.