Texas Department of Transportation

Texas A&M Transportation Institute

PROJECT SUMMARY REPORT

0-7191: Systematic and Quantitative Approaches to Assess the Probability of Extreme Weather and Resilience Risks for TxDOT Highways and Bridges

Background

Texas has increasingly experienced flooding and other extreme weather hazards that threaten the safety and performance of its transportation network. The passage of the Infrastructure Investment and Jobs Act further emphasizes the need for state transportation agencies to explicitly incorporate climate resilience and extreme weather risk into transportation asset management plans (TAMPs). The objective of this project was to develop a systematic and quantitative framework for assessing flood-related risks and resilience for Texas highways and bridges, and to provide methods that can be integrated into the Texas Department of Transportation's (TxDOT's) upcoming 2026 TAMP.

What the Researchers Did

The research team undertook a multi-phase study to build a flood-based risk and resilience assessment framework:

- Reviewed peer state TAMPs and literature to identify current practices, gaps, and opportunities for integrating resilience.
- Selected flooding as the primary disturbance agent for analysis, given its significance in Texas and the availability of statewide flood models.
- Developed and applied geographical information system–based methods using Texas Water Development Board (TWDB) flood exposure datasets to quantify flood depth, extent, and frequency across multiple return periods and future climate scenarios.
- Conducted risk assessments at the roadway and district levels, overlaying TxDOT asset data with TWDB flood maps to estimate exposure of pavements and bridges.
- Modeled chronic impacts of flooding on pavement life cycles, creating fragility curves for different pavement types and integrating flood effects into maintenance and rehabilitation cost projections.
- Assessed bridge risks by combining flood depth data with elevation and structural information, highlighting challenges of digital elevation model–based flood mapping for bridge decks.
- Explored adaptation strategies and proxy indicators that could support decision-making, including the use of LIDAR-based elevation data and natural infrastructure approaches.

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Project Completed:
8-31-2025

What They Found

The study produced several important findings:

- Flooding is the most significant climate-related risk to Texas transportation infrastructure, with acute and chronic effects on pavements and bridges.
- The newly released TWDB flood data provide statewide, high-resolution depth maps that offer substantial improvements over traditional Federal Emergency Management Agency maps though accuracy depends on complementary asset elevation data.
- Pavement vulnerability varies by design type, with surface-treated pavements most susceptible to chronic flood damage and rigid pavements generally more resilient.
- Case study analysis confirmed measurable deterioration of pavements due to repeated flooding, underscoring the need to integrate flood risk into life-cycle planning.
- The team developed risk assessment methods that can be scaled statewide, supporting district-level comparisons and prioritization of resilience investments.
- Collaboration between TxDOT and TWDB is critical to ensure ongoing access to reliable flood risk data and integration into asset management processes.

Overall, this project delivered a quantitative risk and resilience assessment framework that enables TxDOT to better identify vulnerable assets, project long-term costs of flood damage, and incorporate resilience into its 2026 TAMP.

What This Means

This project provides TxDOT with a quantitative framework and practical tools to integrate flood resilience into transportation planning and asset management. The tools and findings can be used to:

- Support TAMP development by incorporating flood risk and resilience into life-cycle cost analysis, risk management, and investment strategies.
- Prioritize maintenance and adaptation investments by identifying vulnerable pavements and bridges at both district and state levels.
- Inform design and rehabilitation practices by incorporating fragility curves and resilience metrics for different pavement types.
- Enhance cross-agency collaboration by leveraging TWDB flood data for ongoing resilience planning.

In sum, this project equips TxDOT with a science-based, scalable methodology to anticipate, quantify, and mitigate flood risks, ensuring that resilience becomes a measurable and actionable component of Texas transportation asset management.

For More Information

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www.txdot.gov
Keyword: Research

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This research was sponsored by the Texas Department of Transportation and the Federal Highway Administration. The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented here. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. Trade names were used solely for information and not for product endorsement.