Texas Department of Transportation

CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY REPORT

0-7095: Evaluating Streamflow Measurement at TxDOT Bridges

Background

The National Weather Service (NWS) has developed a National Water Model that forecasts flow on 100,000 miles of streams and rivers in Texas. Water flow is now like weather, continually forecast everywhere. Texas leads the nation in flood deaths, and more than half of these fatalities occur in cars. In October 2023, NWS initiated a real-time flood inundation mapping service for about half of Texas, plans to complete coverage of the state in FY25.

During flood events TxDOT is responsible for monitoring the condition of flooding of the road network, for implementing road closures authorized by law enforcement, for reopening roads once the flood has receded, and for inspecting bridges potentially impacted by flooding. TxDOT desires to be proactive rather than reactive in its flood operations – combining the activity of its Emergency Operations Centers and its field Maintenance staff in an effective way that anticipates the rise and fall of flood waters over a District or region.

Texas has about 25,000 span bridges over water in the National Bridge Inventory, twice as many as any other state. The National Water Model densified flood forecasting by a factor of about 200 compared to the number of forecast stream locations existing prior to its introduction. Densified forecasting requires densified measurement. The TxDOT bridge system is a natural platform on which to mount a densified stream gauge measurement system.

What the Researchers Did

The researchers installed 80 RQ-30 radar streamflow sensors on TxDOT bridges in Southeast Texas. These sensors provide continuous monitoring of water surface elevation, surface velocity and streamflow discharge. The gauges have a small footprint on a bridge, are solar powered, and communicate through the cell phone system. Data from all of the gauges is publicly accessible through the USGS National Water Information System, and is also being continuously ingested into the National Weather Service data system.

The researchers developed a prototype Flood Assessment System for TxDOT (FAST), which consists of a set of web map services that can support real-time decisions during flood events. Besides the maps coming from the NWS, the FAST maps include bridge warnings, flood inundation depth, and flood impact summarized over a region. These maps were validated through two large-scale flood emergency response exercises conducted in the Beaumont and Austin Districts.

What They Found

The researchers found that the RQ-30 gauges could be calibrated by comparing the discharge estimated directly by the gauge with field measurement of discharge using an Acoustic

Research Performed by:
Center for Transportation Research

Research Supervisor:
Dr. David Maidment, CTR

Researchers:
University of Texas at Austin: Paola Passalacqua, Matt Bartos, Sujana Timilsina, Jeil Oh, Andy Carter, Tim Whiteaker, Harry Evans, Christine Thies, Larry Jantzen
KISTERS: Matt Ables, Attila Bibok
Aqua Strategies: Barney Austin, Tim Osting.
US Geological Survey: Scott Grzyb, Jody Avant, Jon Thomas, Michael Nyman, Kristine Blickenstaff.

Project Completed:
10-31-2023

Doppler Current Profiler (ADCP). This method reduces the cost of calibration and operation of gauges compared to a traditional USGS full rating stream gauge station but is not applicable for low flows of less than 20 cubic feet per second.

The researchers were able to define a vertical profile of a bridge called a "bridge envelope" that includes the elevation profile along the bridge of the bridge deck, the bridge low chord, and the stream cross- section. They extracted such profiles automatically from the state-wide collection of Texas LIDAR data for about 37,000 bridges, and showed that it is feasible to connect this information to NWS flow forecasting to construct a prototype state-wide bridge warning service.

For the Austin District, researchers used a Geographic Information System map of roadway pavement extent as a template to filter the collection of LIDAR data points and produce a Road Elevation Model of 3.8 billion LIDAR points covering 38,000 miles of roads in the Austin District. They showed how this can be combined with hydraulic engineering modeling to calculate water depth on the road in precise detail at the scale of individual streets and roads, and in summary form for all flooded roads in a watershed.

What This Means

TxDOT now has a foundation of streamflow measurement and of flood map services that can be built out to form a fully operationally Flood Assessment System for TxDOT (FAST). The TxDOT RQ-30 stream gauge network is the largest in the United States and its development and operation over the past three years has enabled the US Geological Survey to gain operational experience in calibrating a large network of such gauges. The development of the state-wide Bridge Warning service, and the Road Elevation Model for the Austin District are a first for TxDOT and for Texas.

It should be noted that while the technical foundation for FAST has been developed, it is not yet an operational system and significant further development is needed, to extend the Road Elevation Model across the state, to automate road flood inundation mapping, to implement FAST within the TxDOT information infrastructure, and to collaborate with the NWS so that this information is used in flood forecasts briefings provided to TxDOT Districts and HQ.

For More Information

Project Manager:
Jade Adediwura, RTI Jade.Adediwura@txdot.gov
Research Supervisor:
David Maidment, CTR maidment@utexas.edu
Project Monitoring Committee Members:
RoseMarie Klee, Chris Henry, Abderrahmane Maamar-Tayeb, Trento Ellis, Andrew Lee, Joseph Goessling, Matthew Heinze, Jared Browder, Jennifer Lash, Ryan Eaves, Valerie Taylor, Edgar Cuellar, Brent Riley, Jianming Ma, Omar DeLeon

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research

Technical reports when published are available at
https://library.ctr.utexas.edu.

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.