

Coupled Situational Awareness System to Improve Transportation Infrastructure Performance during Extreme Events

Project Number:

21SAUTSA02

Start Date:

08/01/2021

Principal Investigator(s):

Hatim Sharif

University of Texas at San Antonio

Lead Institution:

University of Texas at San Antonio

Funding Source(s):

Tran-SET

University of Texas at San Antonio

Total Project Cost:

\$ 117,763

Evaluating and enhancing the performance of the transportation infrastructure during recent extreme flooding events in Texas

The dense road networks and numerous low water crossings throughout Texas may be contributing to the higher recurrence rates of floods that pose a danger to vehicles. A timely issue that should be addressed by researchers is the compounding of disaster. Flooding can be combined with other life-threatening occurrences such as power loss and interruptions of health and emergency services. The Covid-19 pandemic is the latest example of compounding disasters due to its significant impact on the medical and emergency services and the lockdown requirements that can greatly restrict mass evacuation and mass sheltering that might become necessary during a flooding event. When the flooding occurs, most of the major creeks/bayous/streams in east Texas overflow their banks inundating neighborhoods, overtopping bridges, and rendering key routes impassable. During these events, rescue requests from the stranded communities overwhelm the emergency response facilities; impassable roadways and the paucity of reliable information on the affected areas and their accessibility hamper emergency response operations, causing several detours and delays that put both the responders and evacuees at risk. This research presents a novel framework for improved situational awareness during extreme flooding events by combining a flood inundation model with a transportation infrastructure performance assessment tool. The flood inundation model will be driven by realtime radar rainfall data in an efficient manner. The road network work model will use land use, census data, locations of critical facilities, and a spatial analysis tool. The proposed framework will be tested on watersheds in Houston and San Antonio, Texas.

eastern Texas. When the flooding occurs, most of the major bayous (rivers) in east Texas overflow their banks inundating neighborhoods, overtopping bridges, and rendering key routes impassable. During these events, rescue requests from the stranded communities overwhelm the emergency response facilities; impassable roadways and the paucity of reliable information on the affected areas and their accessibility hamper emergency response operations, causing several detours and delays that put both the responders and evacuees at risk. In addition to exposing the vulnerabilities of transportation infrastructure, recent major storms demonstrated the need for tools that can facilitate deployment of disaster response resources before the flooding occurs, help identify the vulnerable population and affected communities, enable mitigation of potential flood-related connectivity issues between neighborhoods and critical facilities, and identify clear routes for emergency response. The impacts of road flooding are broader and go beyond simple economic aspects as it effects on population mobility and travelers' safety. Furthermore, flooding represents a serious threat for the durability of road infrastructures. Hence, road flooding is an undesirable naturally occurring phenomenon that often results in damaging and costly impacts on both the transportation infrastructure and motorist/public safety.

Objectives

The main objectives of this study are:

- to evaluate the performance of the transportation infrastructure during recent extreme flooding events in Texas
- to develop a coupled system to include flood inundation modeling and assessment of the performance of the transportation network
- to validate the coupled system through hindcasting of recent extreme flooding events and assess the ability of the system to accurately identify and locate the disruptions of the operation of the

Problem Statement

In recent years, the frequency and intensity of hurricanes and tropical storms have detrimentally increased in Texas and Region 6 in general. Similarly, resulting flash flooding has increasingly become a common occurrence. For instance, the years 2015, 2016, 2017, 2019, and 2020 all witnessed devastating storms in Houston and



road network and provide real-time information that can be used by first

Intended Implementation of Research

The proposed research includes collecting and analyzing data from different sources including site visits. Other tasks include analysis and synthesis of safety information and spatiotemporal analysis, hydrologic and hydraulic modeling, traffic network analysis, and reporting. The research findings will be conveyed in the form of a list of recommendations, a technical brief, an educational PowerPoint presentation targeting local communities, and a final report. The project tasks will be implemented in consultation with Houston and San Antonio traffic engineers and other interested entities within Region 6. To enhance and facilitate engagement of the students in the classrooms across Tran-SET consortium, the research team will require that faculty involved in all research projects engage the college students they teach each semester by including an in-class activity surrounding their research topic.

Anticipated Impacts/Benefits of Implementation

A major outcome of this project is evaluation of the performance of transportation network in Texas during recent flooding events in order to meet transportation departments' goals and objectives of transportation safety in urban areas. A new, low-budget situational awareness system to be deployed during extreme flood events. Also, the approach will help traffic engineers integrate the develop situational awareness technology into traffic control systems, identify and analyze roadways safety problems and opportunities, select the most effective strategies to address them and evaluate the priority of proposed improvements. Furthermore, the developed approach will allow the research team to determine ways to address traffic safety and flow issues in real-time and provide the safest possible solutions for motorists and members of the local communities.

Web links

- Tran-SET's website
<https://transet.lsu.edu/research-in-progress/>

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit [our website](#), LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.

