5-9053-01: Enhancing Road Weather Management during Wildfires and Flash Floods through New Data Collection, Sharing, and Public Dissemination Technologies

Background

Wildfires, flash floods, freezes, and other types of extreme weather events have a significant impact on safety and mobility throughout Texas. The Texas Department of Transportation (TxDOT) plays a critical role in enabling effective inter-agency coordination for the evacuation of affected residents, as well as the delivery of necessary resources in emergency conditions. Operating TxDOT roadways in the safest way feasible is crucial: deaths caused by frozen or flooded roadway conditions can be prevented if receptive travelers are better informed and prepared.

This project addresses two objectives: 1) identify the challenges, benefits, and strategies for data collection and sharing to maximize TxDOT's ability to improve responses to extreme weather events; 2) explore new methods and technologies to find effective ways to disseminate weather-related roadway information to the public.

What the Researchers Did

To achieve these objectives, CTR researchers looked at freezing, flooding, and wildfire use cases in both rural and urban environments through a lense of these three tools:

1. **Best practices** were identified via a literature search and stakeholder input

2. **A data catalog** was built to curate multidisciplinary data sources that may benefit roadway operations or post-event analysis.

3. **Sensor technologies** were evaluated for their potential to help with operational decision-making and information dissemination.

CTR researchers looked at methods and sensing devices for mobile temperature monitoring, weather recording, flood detection, ground surface ice characterization, and fire/pollution detection. In-depth evaluation allowed researchers to understand capabilities and share data with practitioners. However, the prospect of specifying, ordering, and deploying sensors also highlighted a number of technical challenges that required careful attention. Findings, lessons learned, live sensors, and data analytic techniques were demonstrated in two workshops with the motivation of familiarizing practitioners on key concepts needed for conducting a successful sensor deployment and data analytics practice.

What They Found

Among best practices, the researchers found that collaboration is paramount for successful inter-agency response to emergency events. Meanwhile, mobile technologies and social media complement traditional outlets such as dynamic message signage. In leveraging new technology, roadway

Research Performed by:
Center for Transportation Research

Research Supervisor:
Chandra Bhat, CTR

Researchers:

Christian Claudel	Natalia Ruiz-Juri
Kenneth Perrine	Tian Lei
Kamryn Long	Abduallah Mohamed
Kamran Khan	Jonathan Butler

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authorities must be resilient and responsive to failure of communications infrastructure. Privacy of sensitive information is of concern to the public, but also to agencies that want to ensure a level of data quality. Finally, performance metrics help assess the success of a sensor deployment, as well as justify new purchases and expansions.

In creating the data catalog, CTR researchers found that stakeholders were interested in how the prototype catalog could assist in data sharing and inter-agency discovery, but would require active, ongoing curation and governance of the catalog.

For sensors, each set of agency needs lends itself to different kinds of sensor choices and deployment strategies, whether they be isolated, along a corridor, or scattered over a wide area. Some new sensor technologies are far less expensive than legacy counterparts, but also incur a shorter life cycle. For data generated from sensors, researchers experimented with novel ways of combining datasets: for example, visualizing work zone trailer data with weather station data to understand the impact of rainfall through a construction zone. Practitioners have more immediate resources for accurately responding to extreme weather events and other challenges.

What This Means
Through this work, paths for achieving concrete implementation within TxDOT have become clear, motivated by needs for cost reduction, transferability, and improvement of safety:

- Sensor data and outputs from decision support systems need to be integrated into the TxDOT IT architecture and existing software systems (e.g., Lonestar ATMS). This not only allows for safe and secure operation, but it also allows for access where the data is needed the most, especially in emergencies.

- The data needs to be archived and accessible for analysis and validation purposes. This should be integrated with TxDOT Information Management Division's "data lake" efforts.

- Methods for improving the coverage and reliability of sensor data should be refined to detect sensor faults and failures, and to maintain a quality suitable for decision-making and forecasting.

- Well-defined performance metrics help in understanding the reliability and value of a sensor network, as well as to justify the expense for future expansion.

- Processes need to be developed further for more widely disseminating relevant information and data to the traveling public. While mobile technologies continue to emerge, much of the work lies in streamlining data pipelines and decision-making processes within TxDOT roadway operations and partnering agencies.

By working toward these outcomes, TxDOT can be poised to make better-informed roadway operation decisions during times of extreme weather, share more data among agencies and departments, and inform the traveling public more broadly in impactful ways. Ultimately, the bottom line is to improve safety, reduce costs, and increase effectiveness.