Uncovering Mobility during Flood Events and Access to Critical Facilities

Researchers at Rice University develop models and methods to help improve situational awareness of flood impacts on transportation infrastructure and access to critical facilities…

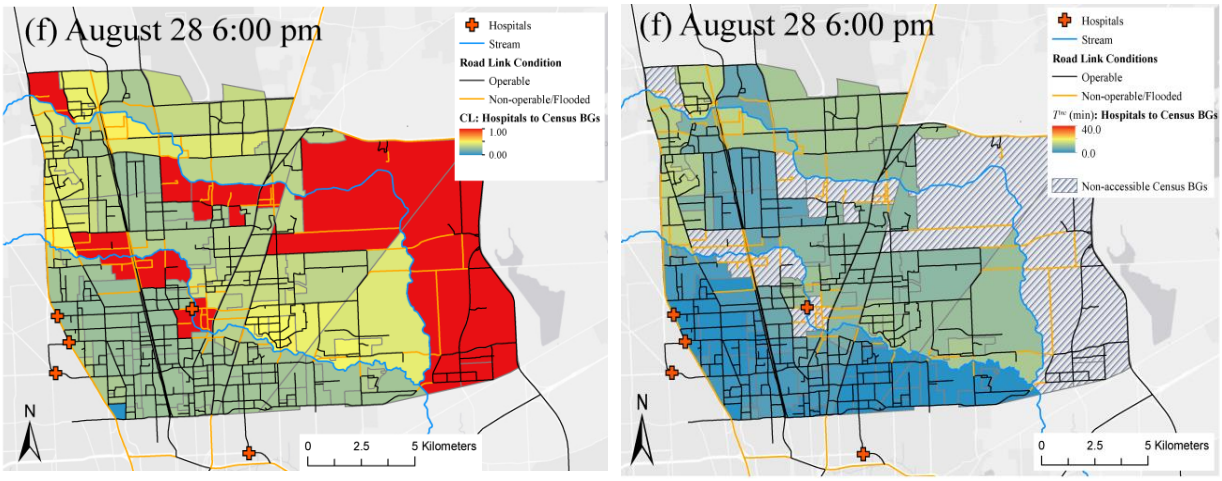
RESEARCH HIGHLIGHT

Flood events associated with severe rainfall or coastal storms have the potential to hamper the functionality of road transportation networks. In the short term, overtopped bridges and inundated roadways render key routes impassible. In the long term, potential damage, washout and debris can extend the impacts on the community. Ongoing research at Rice University by Prof. Jamie Padgett in collaboration with Prof. Phil Bedient in the SSPEED Center seek to address these challenges of mobility and accessibility during flood events. A particular focus of this research is to develop methods to reveal the immediate and time-evolving impacts of flooding on transportation mobility around a city including access to critical facilities, like hospitals. This work also aims to develop practical tools to improve situational awareness, with near real time predictions of flood impacts, route safety and transportation accessibility during a flood event.

HYBRID METHOD TO PREDICT ACCESSIBILITY: THE CASE OF HARVEY

Using data from Hurricane Harvey, a hybrid method for predicting accessibility was developed that leverages state-of-the-art hydrologic and hydraulic modeling, observation data as reported by authorities, and transportation infrastructure performance and network analyses. This work can help to uncover the:

- Evolution of mobility in terms of road network disruption and recovery patterns during an event like Harvey
- Emergency response accessibility between impacted neighborhoods and critical facilities (e.g. fire stations and hospitals)
- Populations most affected by mobility loss and correlations with social vulnerability



Example maps of the average connectivity loss (left) and travel time increase (right) between hospitals and census block groups due to Hurricane Harvey floods for one snapshot in time.

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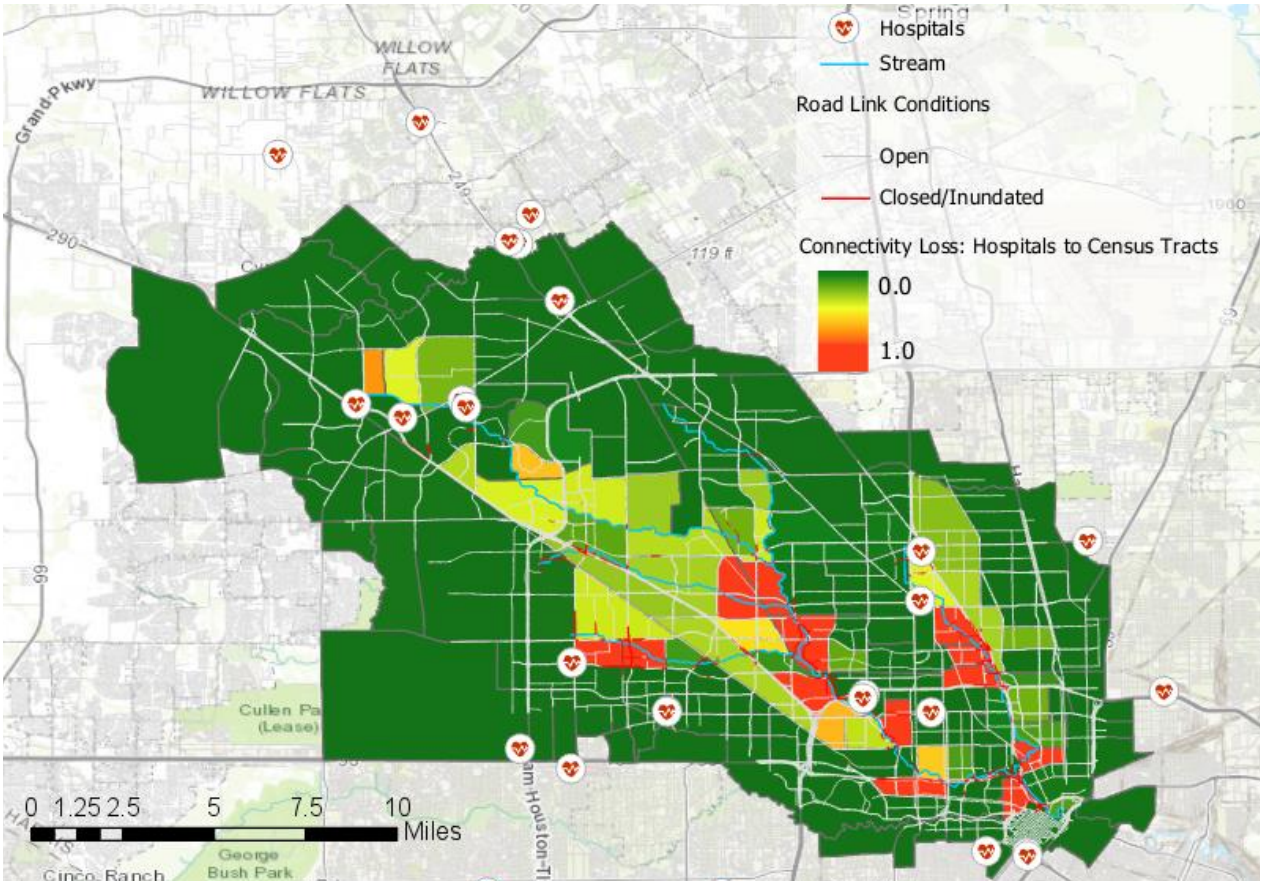
The Potential for the Future…

COUPLING FLOOD ALERT WITH TRANSPORTATION ACCESSIBILITY AND EMERGENCY RESPONSE

Ongoing work provides the framework for near real-time flood alert coupled with transportation accessibility. Specifically we aim to connect flood alert systems with transportation infrastructure system performance, mobility and emergency service accessibility models. Beyond providing flood inundation warnings from systems like the Flood Alert System for White Oak Bayou (FAS-WO), future systems can provide near real-time estimates of the impact on transportation infrastructure and access to hospitals or affected citizens.



Example map revealing estimates of roadway inundation alongside connectivity loss between census tracts and hospitals. Spatial analysis couples output from flood alert system with accessibility models.

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Coupling Flood Alert with Mobility

FROM NEAR REAL-TIME RADAR DATA TO ROADWAY ACCESSIBILITY MEASURES

The coupled flood alert system leverages state of the art flood modeling, near real-time NEXRAD rainfall data, spatial and network analysis, and census data to generate accessibility measures. Accessibility measures quantify flood-related road transportation accessibility disruptions between critical facilities and geographical units like census tracts.

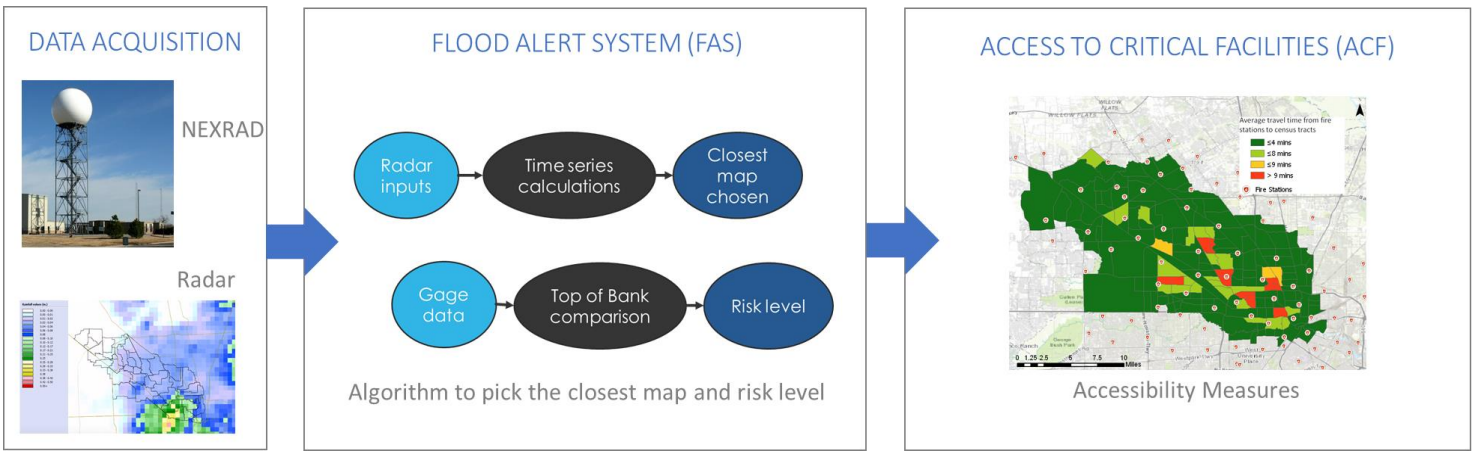

Figure showing the workflow of the coupled flood alert system. Real-time radar rainfall data is used to identify the pertinent scenario from pre-delineated map libraries quantifying accessibility impacts.

APPLICATIONS

During a storm, the framework facilitates identification of flooded road links in near real-time. This information can be used to identify routes for evacuation and emergency response. In addition to identifying communities with high connectivity loss to critical facilities such as hospitals and fire stations, the framework also estimates the average travel time to the community for emergency response. Such information can inform pre-event planning regarding siting of facilities, infrastructure risk mitigation efforts, and emergency response activities. Finally, since the framework employs pre-delineated map libraries, it is computationally inexpensive and robust for real-time application.

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