Reinforcing Network Resilience to Support Equitable Disaster Evacuation

Project Number:

22MUTA59

Start Date:

04/01/2022

Principal Inverstigator(s):

Kate Hyun

University of Texas at Arlington

Lead Institution:

University of Texas at Arlington

Funding Source(s):

Tran-SET

University of Texas at Arlington

Total Project Cost:

$ 106,000

Enhancing network resiliency during emergencies

As one of the principal lifeline systems, transportation networks are crucial for evacuation during extreme weather events like hurricanes, and critical network links must remain intact. Since resilience of the transportation network during the evacuation saves lives and preserves existing infrastructure, one of the top priorities for decision-makers is to protect links to withstand a hurricane and restore links when disrupted. Researchers developed several performance metrics to evaluate the resilience of the network links based on their topology, transportation cost, and flooding risk. These measures translate into various network functionalities to support evacuation such as flexibility, reliability, or robustness. In a previous TranSET project, the research team investigated network resilience in the Gulf Coast regions and developed system vulnerabilities to identify critical network links for evacuation (TranSET #20PUTA28). While conducting the project, the team identified a significant gap between the current practices in disaster planning and recommendations made by scientific research. In particular, when evaluating network resilience for evacuation, practitioners use their regional knowledge to determine evacuation demand and traffic patterns while researchers rely on theoretic constraints and network topology to determine operational strategies that increase throughput. This study aims to develop a set of operational strategies that enhance network resilience during an emergency to support safe and timely evacuation.

Problem Statement

Climate change continues to intensify risks to individual families and communities. The Intergovernmental Panel on Climate Change reports that many cities in the U.S. will experience up to 25% increase in precipitation with higher frequency in the future. This implies that a previously defined 100-year storm event may be identified as a 20-year storm based on recent rainfall data. After Harvey, Texas government agencies and advocacy groups tried to identify and restore vulnerable transportation infrastructure as part of the post-disaster recovery process to

prepare for future hurricanes and other disaster events. This project will not only complement the existing effort but strengthen the synergistic impacts from enhancing network resilience by incorporating historical evacuation traffic movements into network operational strategy development. To prepare for and withstand disaster events, agencies need to conduct a pre-disaster network resilience assessment to understand the risks of link disruptions for road users and their evacuation behaviors. Knowledge of the demand and transportation resources available supports the development of optimal strategies to allocate resources and assistance for not only vulnerable populations but other communities to assist with coordinating pre-evacuation planning and facilitating a safe, fast, and efficient evacuation. This study will provide a thorough understanding of the evacuation behaviors and demands of all communities by leveraging smartphone-based location data, and develop operational strategies such as vehicle allocation, network capacity increases, and traffic control that regional and local agencies could adopt during the evacuation period.

Objectives

This study aims to develop a set of operational strategies that enhance network resilience during an emergency to support safe and timely evacuation. The framework will consist of three modules: (i) evacuation behaviors and traffic characterizations, (ii) operational strategy development and evaluation, and (iii) data visualization using user-friendly infographic and GIS architecture.

Intended Implementation of Research

The proposed research represents a timely and important consideration in transportation planning and infrastructure operation as it focuses on identifying resilient evacuation operations which change significantly during the disaster

times. As designated evacuation routes are responsible for ensuring safe and timely evacuation for all residents, in-depth knowledge on the evacuation. behavior including scheduling, routing, and destination choice by geographic area and sociodemographic characteristics will provide insight on how network disruptions affect the number of vehicles and their safety for evacuation. The proposed research will also provide advanced research experiences and technical skills to develop students as promising leaders in the transportation field. The research outcomes will be shared through several seminars and workshops in transportation and planning areas to support student engagement in the research development and reporting process.

Anticipated Impacts/Benefits of Implementation

The proposed project contributes to provide innovative and practical strategies for enhancing the resilience of evacuation operation and management in the region.

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.