Project 0-7079
Establish TxDOT Transportation Resilience Planning Scorecard and Best Practices Project Kickoff Meeting

Mar 30, 2021

Project Summary

- Increasing Frequency of Extreme Events
- Urgent Needs for Improving Transportation Resilience
- Research Goal
  - Creating foundational knowledge and tools for transportation resilience planning and decision making
- Research Objectives
  - Evaluate the current state of practice, needs, gaps, and priorities related to transportation resilience;
  - Implement vulnerability and resilience assessment on the state road networks;
  - Develop a transportation resilience scorecard;
  - Identify transportation resilience best practices and measures;
  - Present research outcomes in a guide document;
  - Provide transportation resilience training (e.g., workshop and webinars)

Research Results

Task 2: State-wide Transportation Resilience Interview

❖ *Interviews are conducted to understand **the state of practice, needs**, **and gaps** related to transportation resilience.*

Interviewees

- Obtained IRB for the interviews
- Responsible staff from a range of organizations including, **TxDOT** (9), **MPOs** (11), **FHWA** (3), and **NCTCOG** (1) are contacted to participate to the interviews.
- The interviewees are selected from **diverse roles** and various locations around Texas

Interviewees

- **TxDOT**: San Antonio, Odessa, Waco, Corpus Christi, Houston, El Paso, Atlanta, San Angelo, Rio Grande Valley (Pharr), Fort Worth, Austin, Houston
- **MPO**: Alamo Area, Rio Grande, Valley, Capital Area, Houston

Interview's Outcomes

- Completed the interview process, including the interview with 25 personnel from various organizations all around Texas.
- The analysis was categorized into three topics: Topic 1: Current state of practice, Topic 2: Challenges in implementation of resilience, Topic 3: Needs and Gaps

Research Results

Task 2: State-wide Transportation Resilience Survey (in progress)

❖ *Statewide survey is conducted to understand the **current needs**, **practices, and gaps** related to transportation resilience.*

Survey composition

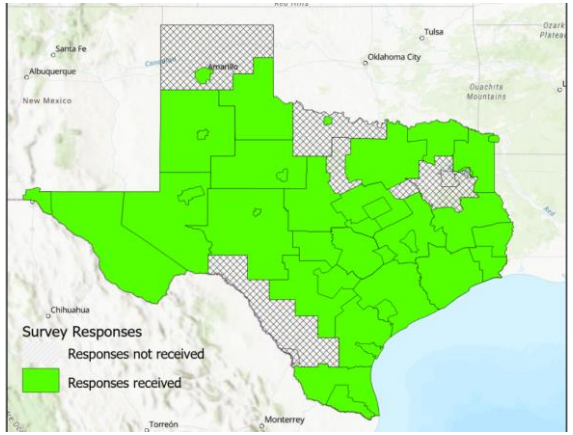
- Questions were formulated based on responses received from interviews
- Survey comprises of four sections of 1) Introduction 2) Hazards and recent events 3) current state of practice 4) desired measures

Survey distribution

- Disseminated electronically to about 200 potential respondents from 26 Feb till Mar. 26, 2021
- Identified based on interview shortlist, Texas resiliency workshop attendees (10 Dec 2020), and suggestions from survey respondents
- Organizations included - TxDOT, MPOs, NMDOT, and NCTCOG

Survey deployment

- 58 responses received (as of March 26) covering 19/25 districts and 14/23 MPOs



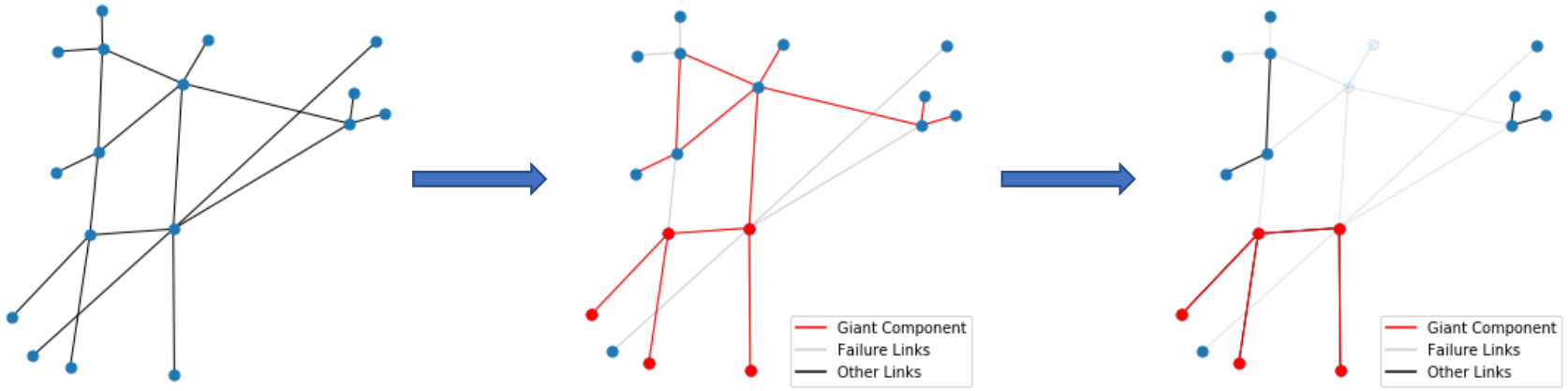
Research Results

Task 3: Vulnerability and Resilience Assessment of State Road Infrastructure Networks: Percolation Analysis

Create the Network → Delete partial failure links based on different **criteria**. → Find the giant component and plot the percolation figures.

- Node degree;
- Weighted degree;
- Link betweenness

- Critical q value
- Critical transition



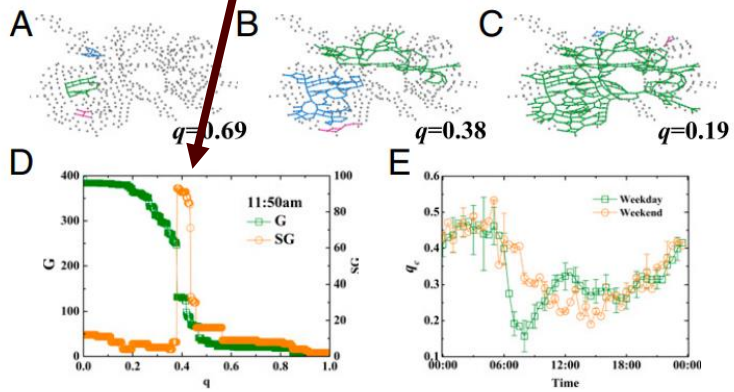


Figure 1*

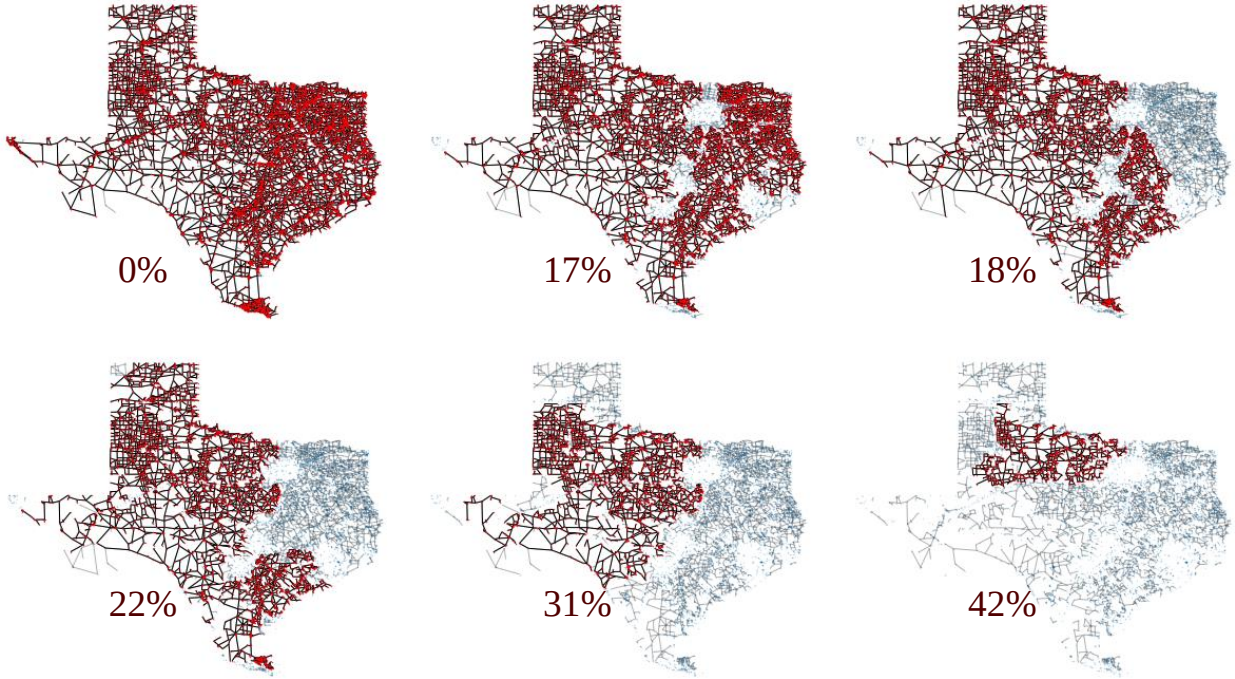
* Li, D., Fu, B., Wang, Y., Lu, G., Berezin, Y., Stanley, H. E., & Havlin, S. (2015). Percolation transition in dynamical traffic network with evolving critical bottlenecks. *Proceedings of the National Academy of Sciences*, *112*(3), 669-672.

Research Results

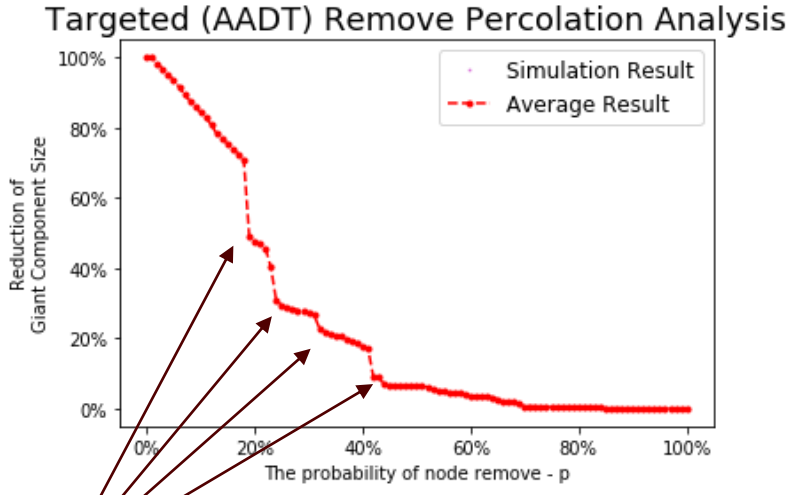
State-Level Analysis

Conduct percolation analysis based on AADT:

- Delete the link from high AADT to low AADT.
- Find the critical transitions.
- Point out the percolation pattern.



Giant Component under different node remove

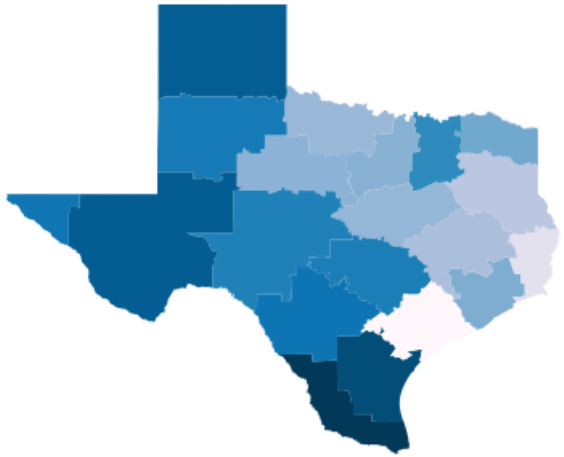


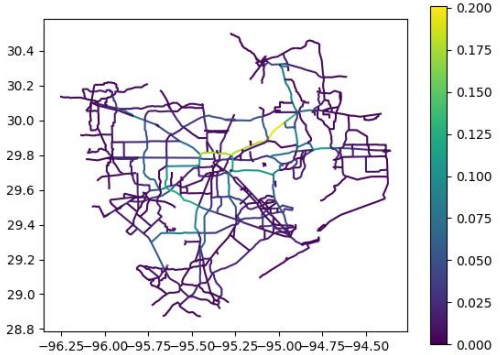
Critical Transitions

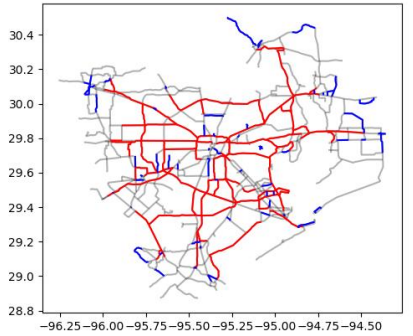
Research Results

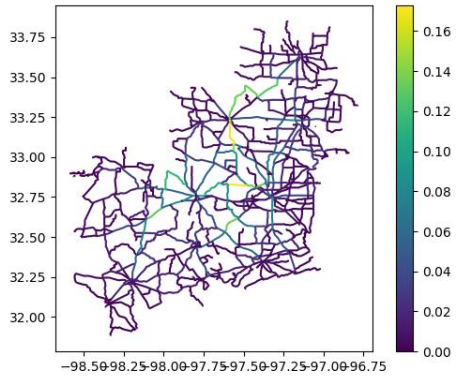
District-Level Analysis

- Group the road network into **district level**.
- Calculate the **link betweenness**:
  - The **higher** betweenness a link is, the more **important** it is in the entire network*.
- Since the result is skewed, we highlighted the **top 20%** and the **lowest 20%** links.

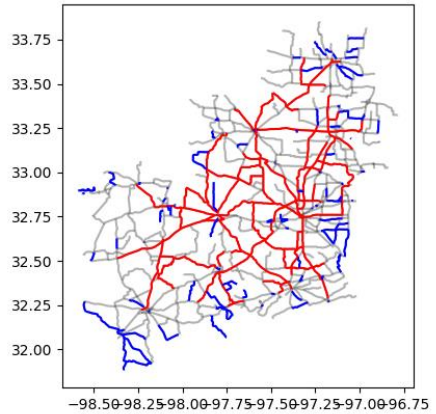








Edge Betweenness

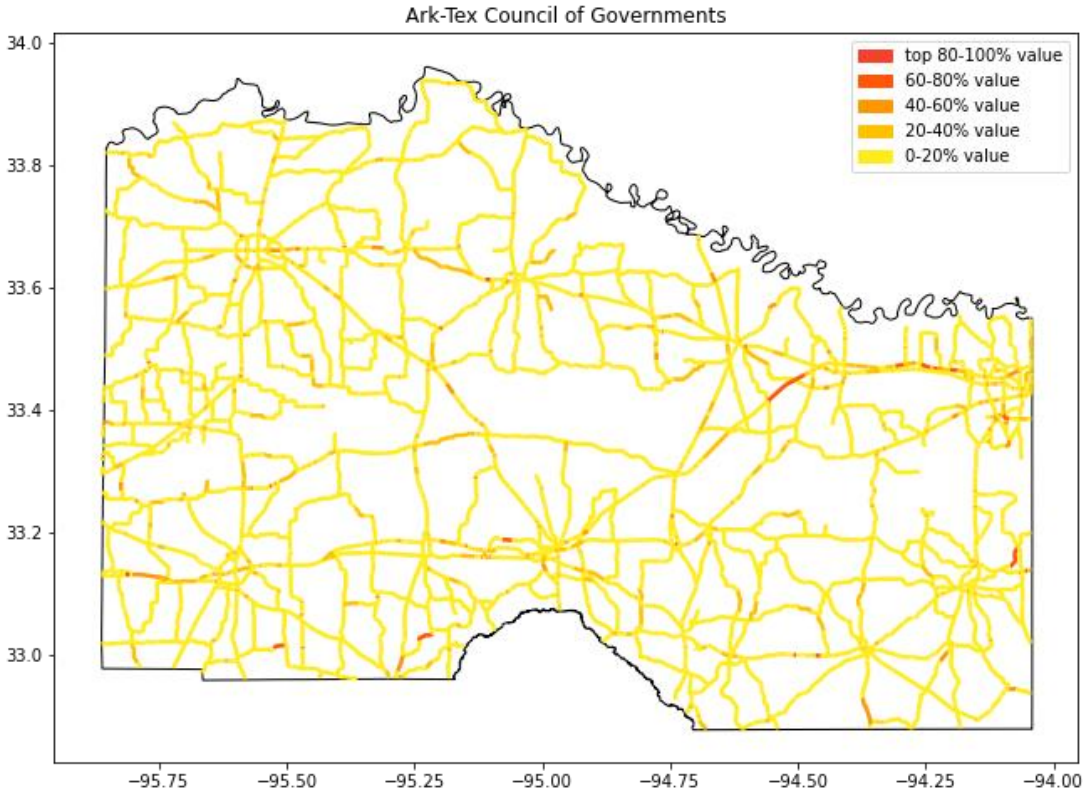


Red line – Top 20% Links
Blue line – Lowest 20% Links

Research Results

Task 3: Accessibility to critical facilities and infrastructure interdependence

- ➔ District level road segment criticality based on proximity to 8 essential facilities
- ➔ Classified into 5 categories: red and yellow represent the top 20 percentile and bottom 20 percentile respectively



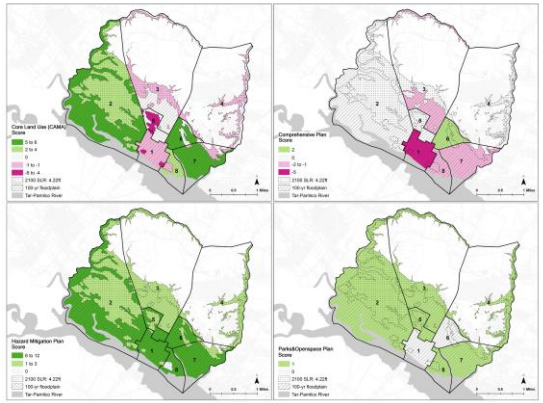
Research Results (in progress)

Task 4: Develop Transportation Resilience Scorecard

- The transportation resilience scorecard will have two main components.
  1. Multiple plan evaluation
  2. Resilience characteristics achievement level assessment

Select multiple transportation plans → How transportation plans address vulnerability and improve redundancy → How transportation plans affect infrastructure resilience

Outcome of Task 3



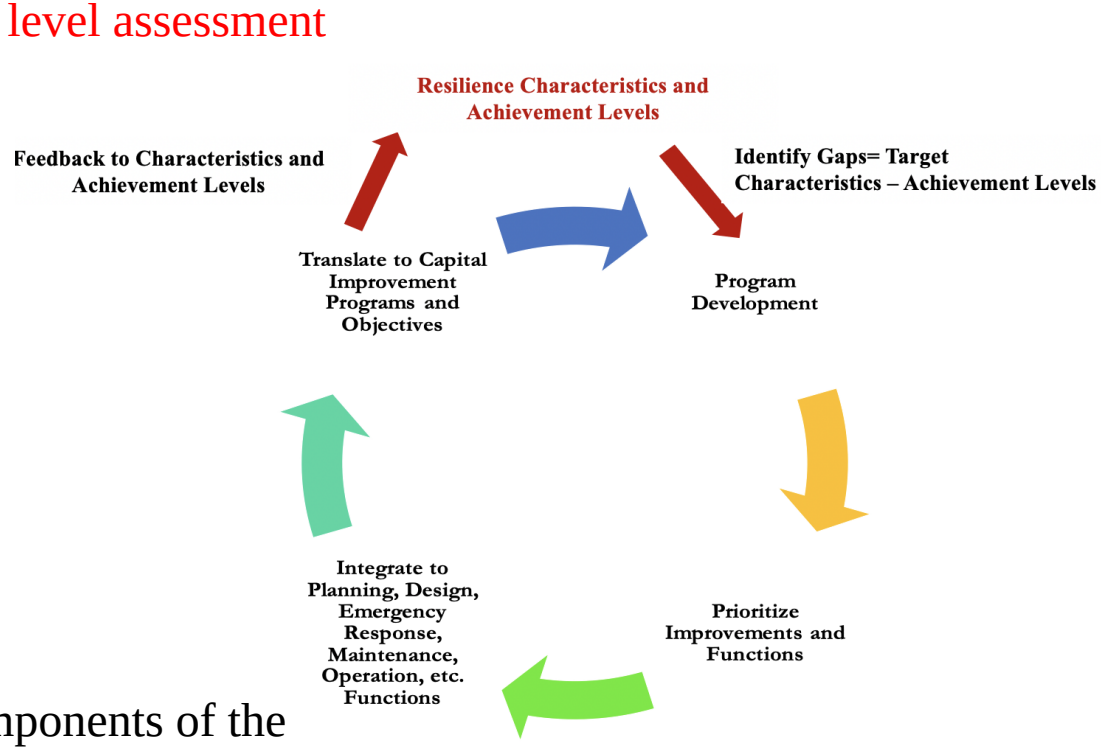
Research Results (in progress)

Task 4: Develop Transportation Resilience Scorecard

- The transportation resilience scorecard will have two main components.
  1. Multiple plan evaluation
  2. Resilience characteristics achievement level assessment

Resilience Characteristic	Achievement Level
Expected service disruptions and restoration of upstream and downstream transportation systems are evaluated	1: No information is collected regarding disruptions and restoration of upstream and downstream transportation systems.
	2: Plans have been developed to evaluate disruptions and restoration of upstream and downstream transportation systems.
	3: Scenario analysis has been implemented; disruptions and restoration of transportation systems have been determined.
	4: Disruptions and restoration of transportation systems have been determined and strategies have been implemented to mitigate the impacts.

Resilience Characteristic	Achievement Level
Future hazard impacts and vulnerabilities are determined	1: No information is collected regarding future hazard impacts and vulnerabilities.
	2: Plans have been developed to evaluate future hazard impacts and vulnerabilities.
	3: Scenario analysis has been implemented; future hazard impacts and vulnerabilities have been determined.
	4: Future hazard impacts and vulnerabilities have been determined and strategies have been implemented to mitigate the impacts.



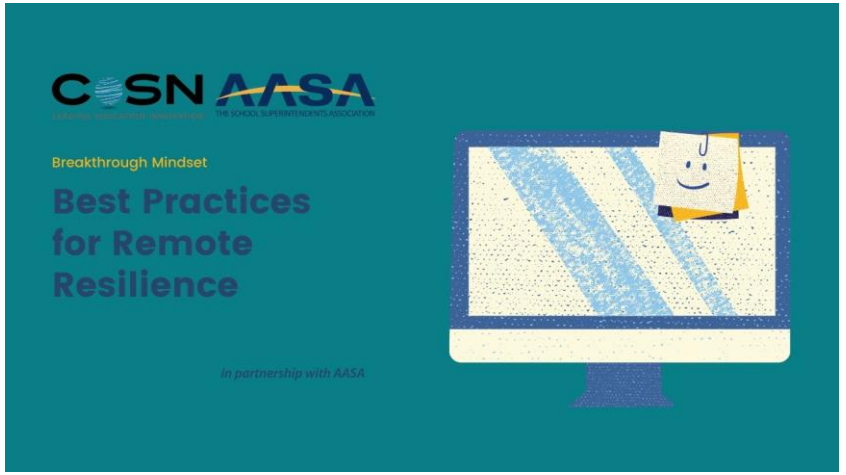
Expected Delivery: TM4, a summary of critical components of the transportation resilience scorecard.

Research Results (in progress)

Task 5: Transportation Resilience Best Practices and Measures

Scope of work

- Establish comprehensive resilience measures and best practices for transportation network in the state
- Determine required data to calculate resilience measures
- Identify gaps in data availability to the stakeholders to measure resilience
- Categorize best practices based on their usage in different tasks (i.e., transportation planning, emergency management, and etc.)



Questions?

Contact: Ali Mostafavi (TTI)
Email: amostafavi@civil.tamu.edu
Phone No.: 979-845-4856

TEXAS A&M UNIVERSITY