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U.S. Department of Transportation
Federal Highway Administration

FHWA Climate Resilience Pilot Program:

North Central Texas Council of Governments

The Federal Highway Administration's (FHWA)'s Climate Resilience Pilot Program seeks to assist state Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPOs), and Federal Land Management Agencies (FLMAs) in enhancing resilience of transportation systems to extreme weather events and climate change. In 2013-2015, nineteen pilot teams from across the country partnered with FHWA to assess transportation vulnerability to extreme weather events and climate change and evaluated options for improving resilience. For more information about the pilot programs, visit: **http://www.fhwa.dot.gov/environment/climate_change/adaptation/**.

North Central Texas Council of Governments

The North Central Texas region is rapidly growing, placing increasing demand on the region's complex, multi-modal transportation network. The region's long range transportation plan, Mobility 2035: The Metropolitan Transportation Plan for North Central Texas – 2013 Amendment, projects an approximate 45 percent increase in population, 55 percent increase in vehicle miles of travel, and increased demand on passenger rail and airports. Extreme weather events will add an additional stress on the transportation system. The region is already experiencing disrupted mobility and levels of services on highway and rail networks due to extreme weather. The North Central Texas Council of Governments (NCTCOG), in cooperation with the City of Dallas, Fort Worth Transportation Authority, and the University of Texas at Arlington, conducted a study to assess how future climates will affect existing and planned transportation infrastructure.

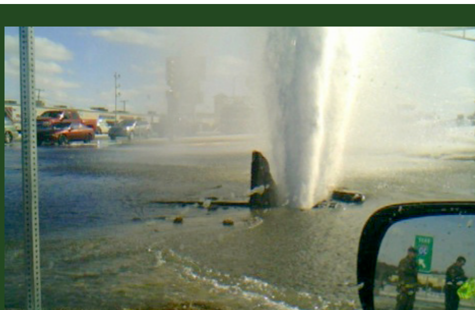
Scope

The study focused on roads, passenger rail, and the 19 airports in Dallas and Tarrant Counties. In recognition of the substantial anticipated change in demand for transportation infrastructure, the project team evaluated vulnerability of both current and projected mobility.

Based on consultation with project partners about major climate stressors for North Central Texas, the project team decided to focus the analysis on extreme heat, rainfall and flooding, drought, and the urban heat island effect.

Objectives

- Assess and categorize vulnerabilities of vital transportation assets.
- Determine potential effects of impacted segments or facilities on asset performance, mobility, economy, and quality of life.
- Develop and pilot an assessment process that can be replicated throughout the NCTCOG region, Texas, and in other Great Plains States that experience similar climatic, geologic, and hydrologic conditions.



Drought and extreme heat causes roadway and utility rupture in Fort Worth, Texas. Photo credit: CBSDFW.com.

Flooding impacts in Dallas, Texas. Photo credit: NCTCOG.

Once-submerged bridge reappears as drought impacts a lake in Rowlett, Texas. Photo credit: Dallas Morning News.

Approach

Collect and process climate data. The project team worked with partners to collect climate data and conduct a detailed review of the local and regional historical climate information and downscaled future data. The future projections for 2050 and 2100 were based on one climate model using the RCP8.5 (business as usual) emission scenario. The analysis used a Geographic Information System (GIS) to map the Federal Emergency Management Agency (FEMA) 100-year floodplain and temperature. Additionally, the team collected data on urban heat island effects and local soil and hydrology. Data on soil moisture served as a proxy for drought when evaluated in the context of rainfall and temperature.

Collect and process asset data. Data on existing infrastructure primarily came from NCTCOG's existing inventories, which had been compiled from the region's various transportation providers. The team also worked with project partners to collect specific details on assets, such as pavement ratings and design specifications. Future projections of transportation infrastructure location and capacity were based on the Mobility 2035 Plan – 2013 Amendment. The team assembled the geospatial data for the assets using GIS software.

Determine critical assets. To identify critical assets, the project team used a capacity-based approach that focused on the level of usage. The criticality assessment was based primarily on current and projected annual average daily traffic (AADT) for roadway segments, annual ridership for passenger railway segments, and annual passenger boarding for airports. The team used the current and projected usage data to categorize criticality for the roadway segments and railway segments on an asset-specific scale of 1 to 5. Criticality of airports was categorized on a scale of three instead of five because of the large differences in passenger boarding between the major airports and smaller airports. The team also mapped the criticality scores for the current and future timeframes.

Identify critical assets within the floodplain. The analysis overlaid the FEMA 100-year floodplain with the criticality scores of projected usage for all asset categories to get a sense of the likelihood of the potential for exposure to flooding. The study assumed adaptive capacity was constant due to the lack of sufficient information.

Assess heat risk. The assessment of vulnerability to heat focused on summer temperatures, given that the regional climate projections indicate significant increases in mean and daily extreme temperatures during the summer season. The team assessed the temperature-related risk on transportation infrastructure using a matrix which considers the likelihood of failure, based on temperature class, and potential consequences, based on criticality (see Figure 1). Then, the assessment overlaid maps of mean summer temperature for the years of 2050 and 2100 with the network of critical assets. The team used the matrix and the maps to determine heat risk of high, medium, and low for the assets. Vulnerability to urban heat island effects was also evaluated.

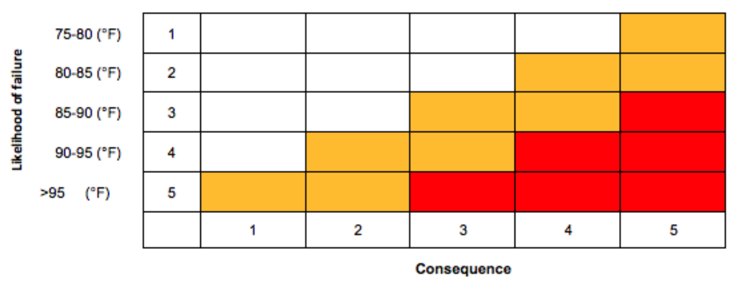


Figure 1. Heat risk assessment matrix categorized into low risk (white), medium risk (orange), and high risk (red).

Assess broader consequences. The team qualitatively assessed the potential consequences to mobility, society, and the economy if each of the asset categories were disrupted or failed as a result of the climate hazards.

Key Results & Findings

Projected climate and impacts. North Central Texas is projected to experience more extreme weather, which has the potential to disrupt or damage infrastructure; stress financial constraints; and reduce mobility, access, and safety in the region. Mean August temperatures are projected to reach 94°F by 2041-2050 and daily extremes could likely exceed 120°F under the business as usual scenario. Additionally, the increase in temperature compounded by a projected decrease in annual rainfall may reduce soil moisture, which could cause pavement cracking and stresses on bridges and culverts. The team also found that recent studies indicate a correlation between the urban heat island effect and drought severity, affecting soil moisture. A projected 40% increase in severe thunderstorms during the spring season will likely lead to a higher risk of transportation disruption from high winds and flooding.

Potential for damage from flooding. The team found that some of the critical infrastructure located within the floodplain may not be directly exposed or sensitive to flooding and is dependent on conditions such as elevation, local drainage or runoff characteristics, and engineering factors.

Roads. The results indicate that 636 miles of roads have the potential to be inundated by a 100-year flood. Approximately 17 miles of road segments in the floodplain are of "high" criticality. That total length is estimated to increase to 44 miles for 2035 as AADT is projected to increase (and, thus, more miles would be classified as critical).

Rail. By 2035, 39 miles of railway segments have the potential to be impacted by intense precipitation events that could generate a 100-year flood (see Figure 2).

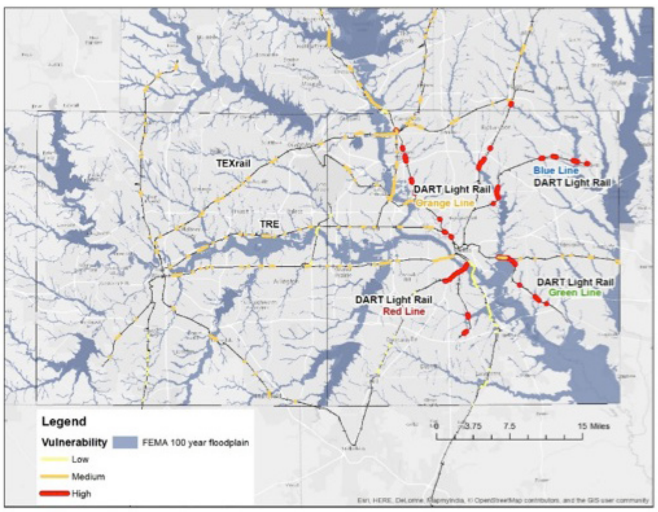


Figure 2. Critical railways located within the 100-year floodplain in Dallas and Tarrant Counties for 2035. Red areas indicate "high" criticality segments.

Airports. The majority of the airports are not expected to be inundated by a 100-year flood. However, extreme precipitation and severe storms may impact airport service-related operations such as airport closure and delays in passenger and cargo loading. Furthermore, accessibility to the airports via the regional roadway and passenger rail network is more likely to be impacted, thus influencing airport operations.

Potential for damage from extreme heat.

Roads. The vulnerability assessment found that recent impacts from climate change, extreme weather events, and urban heat island effects contribute to pavement deterioration. For example, pavement distress caused by a heat wave and drought in 2011 cost the state department of transportation $26 million in additional statewide maintenance activities that year. The pilot team considered the link between extreme weather events and the asset management process. The City of Dallas regularly assesses street conditions and assigns Pavement Condition Index (PCI) ratings, based on the extent and severity of pavement distress, which are recorded into a database system to track conditions and maintenance investments. However, the database system is currently not configured to directly indicate street degradation or failures from climate stressors.

> "Past extreme weather events like severe thunderstorms, flooding, or ice have severely impacted the transportation infrastructure of the Dallas-Fort Worth area."
>
> – NCTCOG Pilot Team

Rail. The heat risk assessment finds that the length of rail tracks classified as "high risk" is expected to increase from 17.4 miles under temperature projections for 2050 to 87.2 miles in 2100.

Airports. Temperature projections indicate that the airports near the urban centers (e.g., Dallas Love Field airport) tend to have higher mean temperatures than the airports located away from the urban centers (see Figure 3).

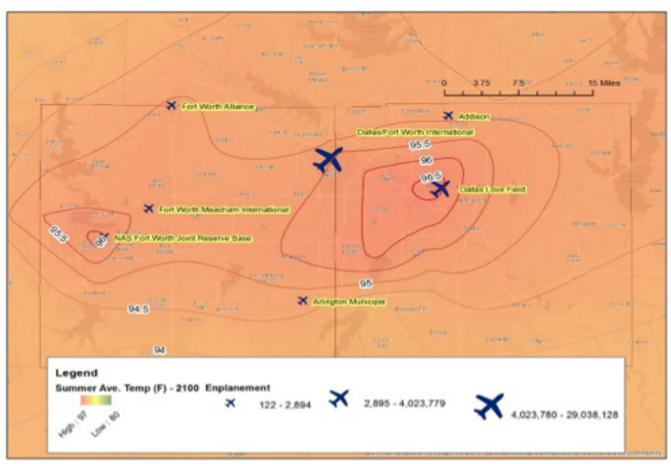


Figure 3. Critical airports vulnerable to summer temperature projections for 2100 in Dallas and Tarrant Counties. The size of the airplane icons indicate airport enplanement, which was used to determine criticality.

Lessons Learned

Set up the analysis to collect only the most essential data. The project team found that the size and complexity of the transportation system in the study area presented challenges of working through a twelve-county metropolitan planning area, more than 230 local government units, and multiple transportation providers in order to obtain the level of information needed for the study in consistent formats. Furthermore, although most existing data sets can be plentiful, not all vital questions can be answered without significant research through the data.

Timeframes of climate change projections may not align with projections of future demand for transportation infrastructure. The Mobility 2035 Plan – 2013 Amendment provides the longest projection available for vehicle volumes and rail ridership and is a unique way to incorporate anticipated usage of transportation assets to assess vulnerability in a region, particularly where significant growth is expected. The team recognizes, however, that there is a lag in the time horizon between the projected criticality of the transportation assets (2035) and the study's climate change projections (2050 and 2100).

Next Steps

Integrate study findings into planning. Use the pilot study results and strategies to affect greater linkages of asset management and infrastructure resiliency into both project-level and Metropolitan Transportation Plan (MTP) planning processes. In particular, integrate vulnerability assessment parameters into project development and prioritization for subsequent MTP updates.

Improve monitoring of weather-related stresses. Document the impacts on the region's transportation infrastructure.

Link study findings to engineering factors. Consider how extreme weather events may impact, for example, the range of normal operations or threshold of endurance. Asset management pilot studies underway along the Interstate Highway (IH) 20, IH 30, and IH 35W corridor in Parker and Tarrant Counties (west and south of Fort Worth), as well as the IH 35E corridor in Ellis County (south of Dallas), are investigating these effects.

Conduct an expanded, detailed assessment. More detailed investigations throughout the 12-county North Central Texas region can utilize high-resolution radar precipitation data from an ongoing NCTCOG project.

For More Information

Final report available at:
www.fhwa.dot.gov/environment/climate/adaptation/2015pilots/

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