FHWA-HEP-16-071

FHWA Climate Resilience Pilot Program:

Capital Area Metropolitan Planning Organization (CAMPO)

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 evaluate options for improving resilience. For more information about the pilot programs, visit: **http://www.fhwa.dot.gov/environment/climate_change/adaptation/**.

The Capital Area Metropolitan Planning Organization (CAMPO) covers a six-county region in Central Texas that includes the City of Austin. The area is rapidly growing, and extreme weather events—notably floods, droughts, extreme heat, wildfire, and extreme cold—are an added stressor on the region's multi-modal transportation system. For this project, CAMPO partnered with the City of Austin's Office of Sustainability to assess vulnerabilities to critical transportation assets in the region. The project team held a criticality workshop to identify nine critical assets; then the team used available data and local expertise to assess the extreme weather risks to those nine assets. The project helped launch an ongoing multi-agency working group on resiliency in the region, and the results have been incorporated into the 2040 CAMPO Long Range Transportation Plan (LRTP).

Scope

The project focused on vulnerability of multimodal transportation infrastructure in the six-county CAMPO area to flooding, drought, extreme heat, wildfire, and extreme cold (icing). Through a criticality workshop, the project team selected nine critical assets for study, and evaluated the vulnerability of those assets to changes in the climate stressors as projected to occur in the mid-21st century (2041-2060). The selected assets included roadways, bridges, and a rail line.

Objectives

- Assess the potential vulnerability of a limited selection of critical transportation assets in the CAMPO region to the effects of extreme weather and climate change.
- Highlight lessons learned in the process.
- Outline potential next steps toward enhancing the resilience of the region's transportation infrastructure.

Damage to RM 2222 at the Bull Creek crossing due to overnight flooding September 7-8, 2010 (Tropical Storm Hermine). Photo credit: Austin American-Statesman.

Traffic delays on Loop 360 due to road closure at RM 2222. Photo credit: Austin American-Statesman.

Severe pavement crack on Hamann Lane in Travis County during a drought in 2005. Photo credit: Scott Lambert, PE, Pavement Management Engineer, Travis County.

Approach

Data Collection. At the outset of the project, the project team compiled available data on the location and other attributes of transportation assets in the CAMPO area using a Geographic Information System (GIS). Data points collected included transportation infrastructure locations (roads, bridges, rail, public transit, and airports), current and projected future congestion, freight corridors, activity centers, and combined population and employment density. These data helped provide an overview of the study area, informed the criticality assessment, and also informed the type of data available for the later vulnerability assessment. In the process, the team also established data quality controls and identified data gaps.

Criticality Assessment and Asset Selection. The project team convened a workshop of regional stakeholders to identify a shortlist of assets that, if taken out of service due to extreme weather, would likely result in significant impacts to the CAMPO region. In selecting assets for further study in the vulnerability assessment, workshop participants sought to identify assets that were critical to the region, were potentially vulnerable to climate stressors (based on preliminary stakeholder judgment), and represented the diverse transportation modes and geographies within the study area. The team ultimately selected nine assets for further study.

Sensitivity Thresholds. The team also conducted a series of interviews with local experts and engineers to establish at which thresholds specific extreme weather stressors are most likely to disrupt, deteriorate, or damage the transportation system. Thresholds included those based on design specifications as well as empirical, or observed, thresholds at which damage had occurred in the past. The goal of this exercise was to help the project team identify which climate variable projections to gather and use for the subsequent vulnerability assessment.

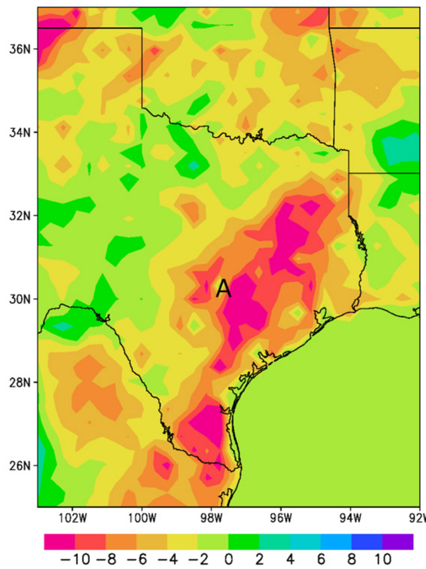

Figure 1. Projected % change in average summer soil moisture (1981-2000 to 2041-2060). Source: WRF

Exposure Indicators	Sensitivity Indicators	Adaptive Capacity Indicators
Flooding		• Whether asset is part of an evacuation route • Asset criticality • Functional Classification • Annual Average Daily Traffic • Truck traffic volume • Detour length
• Modeled available freeboard for future rain event, or vertical proximity to 100-year floodplain, or demonstrated past exposure (depending on data availability)	• 24-hour precipitation design threshold • Scour critical status (bridges) • Average inundation velocity associated with future rain event • Wildfire threat	
Drought		
• Projected change in average summer soil moisture	• Soil Plasticity Index	
Extreme Heat		
• Projected change in number of days per year ≥ 100° F • Projected change in average seven-day maximum temperature	• Pavement binder • Truck traffic volume	
Wildfire		
• Wildfire threat (TxWRAP) • Projected change in average summer soil moisture	• Wildfire sensitivity rating • Values Response Index*	
Extreme Cold		
• Projected change in number of "ice days" (days with both freezing temperatures and non-trace precipitation) per year	• Whether roadway is elevated	

* Values Response Index is defined by TxWRAP as "the potential impact of a wildfire on values or assets."

Table 1. Highway vulnerability indicators used in VAST analysis, categorized into the three components of vulnerability: exposure, sensitivity, and adaptive capacity.

Establishing thresholds also helped the team interpret climate projections in terms of their potential impacts on infrastructure. For example, asphalt pavements in the study area typically use a pavement binder that is designed to withstand an average seven-day maximum ambient temperature of roughly 108°F. As a result, the team gathered climate model projections for annual average 7-day maximum temperature to determine whether that threshold might be exceeded in the future.

Climate Data and Flood Modeling. The project team then gathered projections of how relevant climate variables (e.g., heavy precipitation events, soil moisture, and extreme temperatures) might change by the mid-21st century. The team leveraged previous peer-reviewed academic research to generate projections using the Weather Research and Forecasting (WRF) regional climate model (RCM). In addition, the team input RCM projections of heavy precipitation changes into a local hydrological model—the City of Austin Flood Early Warning System—to estimate how potential changes in heavy rain could affect flooding extent, top width, flow rate, depth, average velocity, and cross sectional area.

Vulnerability Assessment. Finally, the project team assessed the vulnerability of the nine critical assets to each climate stressor using a combination of the U.S. DOT Vulnerability Assessment Scoring Tool (VAST) and stakeholder focus groups. The project team used data collected earlier in the study as indicators of vulnerability (see Table 1) to generate preliminary risk ratings for each asset and stressor using VAST. Then, the team presented preliminary ratings and associated rationales to expert focus groups and adjusted the initial VAST results as needed.

Asset	Flooding	Drought	Heat	Wildfire	Extreme Cold
MetroRail Red Line at Boggy Creek	Moderate-High	Inconclusive	Moderate	None	Low-Moderate
SH 71E at SH 21	High	Moderate-High	Low-Moderate	Moderate-High	Low-Moderate
I-35 at Onion Creek Parkway	Low	None	None	Moderate-High	Low-Moderate
US 290W/SH 71 - Y at Oak Hill	Moderate	Moderate	None	High	Low
Loop 360/RM 2222	Moderate	Moderate	None	High	Low-Moderate
FM 1431 at Brushy Creek/Spanish Oak Creek	None	Moderate	Low	Moderate-High	Low
US 281 and SH 29 Intersection	Moderate-High	Low	Low	Moderate	Low
US 183 north of Lockhart	Low-Moderate	High	Low-Moderate	Moderate-High	Low-Moderate
SH 80 (San Marcos Highway) at the Blanco River	Moderate	Low	Low	Moderate	Low

Table 2. Summary of risk rating results across assets and climate stressors.

Key Results & Findings

The analysis highlighted a handful of key potential climate-related risks to critical CAMPO assets that may merit more detailed investigation or consideration of adaptive measures (see Table 2). Across assets studied, wildfire presents consistently high risk, while flooding and drought risk are more localized. The CAMPO area is notable for its high plasticity soils, which expand and contract with changes in soil moisture. Thus, drought can have serious impacts for infrastructure if built over high plasticity soils.

Icing and heat, on the other hand, are relatively low risks. Icing presents low risk because of the infrequency of occurrence in Central Texas (and projected to become even less frequent), whereas extreme heat is common (and projected to increase in frequency), but the transportation infrastructure analyzed is designed to accommodate high temperatures.

Growth and other non-climate stressors can significantly influence extreme weather impacts. The sensitivity component of the vulnerability assessment factors in other, non-climate stressors—the growth of heavy truck volumes or the expansion of impervious surface, for example. In some cases, these stressors serve to amplify a primarily climate-related impact, but in many instances the non-climate stressor is a significant—or even primary—driver of risk.

The project team developed risk summary fact sheets for each asset that explain the extreme weather risks it faces. Each fact sheet included a risk matrix for the asset (Figure 2).

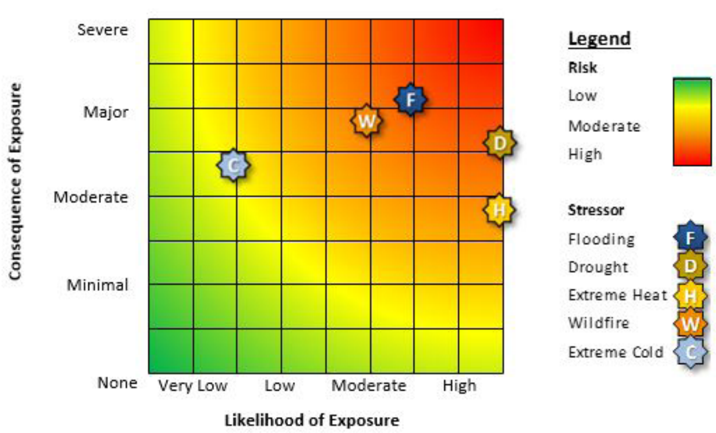

Figure 2. Example Risk Summary Matrix for SH 71E at SH 21. Flooding and drought present the greatest risks to this asset, while wildfire and extreme heat present moderate risks. Though flooding is projected to occur less often than drought, it would have greater consequences for the asset.

Lessons Learned

Partner with municipalities and coordinate across sectors. The collaboration between CAMPO and the City of Austin was successful, as were the multidisciplinary partnerships forged with agencies like the City of Austin Fire Department and Public Works Department.

The nature of inland extreme weather and climate challenges may differ from those faced by coastal communities. Compared with the potentially catastrophic, often regional effects of storm surge on coastal communities, the extreme weather and climate risks faced by the CAMPO region are generally relatively localized and situational (such as flooding or wildfire) or more gradual and incremental (such as the effects of drought). In line with this realization, two sets of potentially appropriate regional responses emerged: the incorporation of these risks into asset management frameworks and into emergency response plans.

Critical assets may not be the most vulnerable assets. The critical assets selected for evaluation are mostly higher functional classification roadway facilities, which, generally, are more robustly designed (e.g., to withstand more substantial flooding events) and more reliably maintained. Local and county roadways may therefore exhibit greater sensitivity to extreme weather stressors. In the CAMPO region, legacy roadways in rapidly urbanizing or industrializing areas, in particular, may warrant investigation.

Growth and other non-climate stressors can significantly influence extreme weather impacts. Other, non-climate stressors, such as the growth of heavy truck volumes or the expansion of impervious surface, can amplify a primarily climate-related impact. Moreover, in many instances the non-climate stressor is a significant—or even primary—driver of risk.

Next Steps

Following the project, CAMPO and the City of Austin held a successful inaugural Extreme Weather Resiliency Symposium in December 2014 and expect to form a multi-agency working group to continue the peer learning process and build on the momentum of this project. In addition, the 2040 CAMPO LRTP incorporated findings from the project—particularly the need to improve planning for wildfire evacuations—as a planning consideration alongside issues such as system preservation, freight movement, and environmental justice.

Additional recommended next steps for CAMPO and the City of Austin include:

- Expand collaboration with other City of Austin departments and other cities and agencies across Texas;
- Expand the assessment to cover more city and county roads, especially lower functional class roads that may be more vulnerable;
- Extend the assessment time horizon beyond the 25-year period selected in relation to the 2040 CAMPO LRTP; and
- Evaluate and implement adaptation options for the critical, vulnerable assets.

For More Information

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

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