FHWA-HEP-17-002

U.S. Department of Transportation
Federal Highway Administration

Genesee-Finger Lakes Regional Critical Transportation Infrastructure Vulnerability Assessment

Overview

A series of recent severe weather events, including Hurricane Irene and Tropical Storm Lee, revealed vulnerabilities in New York State's transportation system. Future extreme weather events are expected to place greater strain on regional transportation infrastructure, driving up operations, maintenance, and repair costs. In response to these events, the Genesee Transportation Council (GTC), the Metropolitan Planning Organization (MPO) for the Greater Rochester region, completed an assessment of potential vulnerabilities of critical regional transportation infrastructure to natural and human-caused hazards in June 2016. This project was the first systematic region-wide attempt to assess the vulnerability of the transportation network. Figure 1 shows an example of damage to the transportation infrastructure in the region.

The assessment followed the Federal Highway Administration (FHWA) Climate Change and Extreme Weather Vulnerability Assessment Framework to identify critical infrastructure and assess infrastructure exposure, sensitivity, and vulnerability to the various hazards.

Figure 1. Example of damage to transportation infrastructure from natural hazards in New York. Source: GTC 2016

Based on the hazard vulnerabilities, the project identified a broad range of strategies to reduce the impacts of hazards, including strategies related to planning and policy, communication, design and construction, and operations. The project also identified possible funding sources for adaptation strategies. FHWA and the Federal Transit Administration (FTA) provided financial assistance through the GTC.

Scope

This project focused on the nine-county Genesee-Finger Lakes Region of New York, including Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates Counties (see Figure 2). The regional policy basis for the project was the GTC Long Range Transportation Plan 2035, which identifies planning for the impacts of climate change as one of six emerging opportunities and issues the region will face over the next 25 years.

The assessment focused on vulnerability of critical transportation assets in three categories: roads, bridges, and facilities. The project assessed the vulnerability of these assets to natural and human-caused hazards, including: flooding, severe storms, high winds, extreme temperature, frequent freeze/thaw cycles, landslides, land subsidence, earthquakes, hazardous materials spills, terrorist attacks, sabotage, structural collapse, highway crashes, and derailments.

Figure 2. Map of the nine-county project area. Source: GTC 2016

Objectives

- Identify critical transportation assets in the region.
- Profile the natural and human-caused hazards that have the potential to impact critical transportation assets.
- Identify vulnerability of critical transportation assets to the hazards.
- Propose strategies for preventing and/or mitigating the impacts of hazard events on the critical assets.
- Provide information that can be used to help develop new projects that can address multiple agency objectives, including mitigating hazard impacts and safeguarding public interests. An output of this project is a set of three Excel databases that agencies can use to conduct more localized vulnerability assessments.

Approach

Inventory critical regional transportation assets. The project team compiled an inventory of critical assets based on information collected from existing plans and studies, stakeholder input from a project Steering Committee, and follow-up information from state, county, and local agencies. The study included the following critical transportation assets in the inventory:

- Roadways consisting of a functional classification of "Minor Collector" or greater;
- Bridges along the regional roadway network;
- Emergency response facilities;
- Highway garages, fueling depots, and staging areas;
- Traffic and transit operations centers; and
- Emergency operations facilities.

Develop hazard profiles. The project team reviewed existing plans and studies, including plans from the State Division of Homeland Security and Emergency Services, the New York State Hazard Mitigation Plan, and individual county All-Hazard Mitigation Plans. For each hazard, the team used historical data to determine its geographic extent, potential impact to critical transportation, and historical occurrence. The resulting hazard profiles include a textual description explaining each hazard along with a geographical representation that identified where the hazard is known to occur.

The approach relied heavily on data from emergency management and hazard mitigation plans within the region to identify asset exposure and characterize hazards. Specific data on the anticipated impacts of climate change on the geographic extent of the profiled hazards were unavailable within existing resources, but the data on historical exposure was sufficient to begin preparing to increase resilience to all hazards, including those exacerbated by climate change.

Score assets for vulnerability. The team scored all critical transportation assets for vulnerability. The scoring methodology weighted ratings for each of the following components: criticality (20%), sensitivity (45%), exposure (25%), and local input (10%). The scoring methodology varied for each asset type (roads, bridges, and facilities). For example, the vulnerability scores for facilities were based on the variables shown in Table 1, scored from 0 to 5. Additional details on the scoring methodology can be found in the final report.

Table 1. Vulnerability assessment scoring variables for facilities. Source: Adapted from GTC 2016

Vulnerability Component	Variable (by segment)
Criticality	Does the facility play a role in the function of the regional transportation system?
	Does the facility play a part in the preparation for or response to hazard events?
Sensitivity	Identified as being impacted or having the potential to be impacted by hazards
	Proximity of nearest similar facility
Exposure	Located in a floodplain
	Exposure to flooding (flash flood, poor drainage, seasonal, etc.)
	Exposure to snow storms
	Exposure to high winds
	Landslide susceptibility
	Spectral acceleration of soils
	Exposure to sink hole (Karst Topography)
	Exposure to terrorist attacks/sabotage (based on input of likely targets)
Local Input	Identified in a local plan or local expertise indicates that asset is vulnerable to existing or future hazards

Each asset received a score for its overall vulnerability across all hazards, as well as a categorical (e.g., low, moderate, high) vulnerability rating. The project team then mapped the results in a geographic information system (GIS) (see Figure 3). In addition, GTC created Excel databases with results from the project to allow users to conduct a query to identify assets by county or by jurisdiction, enabling the databases to become working documents.

Identify hazard mitigation strategies. Finally, the project team identified hazard mitigation strategies to prevent or mitigate impacts from potential natural and human-caused hazards. Strategies fell into the following categories: Planning and Policy; Communication, Education, and Awareness; Infrastructure and Construction; Natural and Land Resource Protection; and Operations and Maintenance.

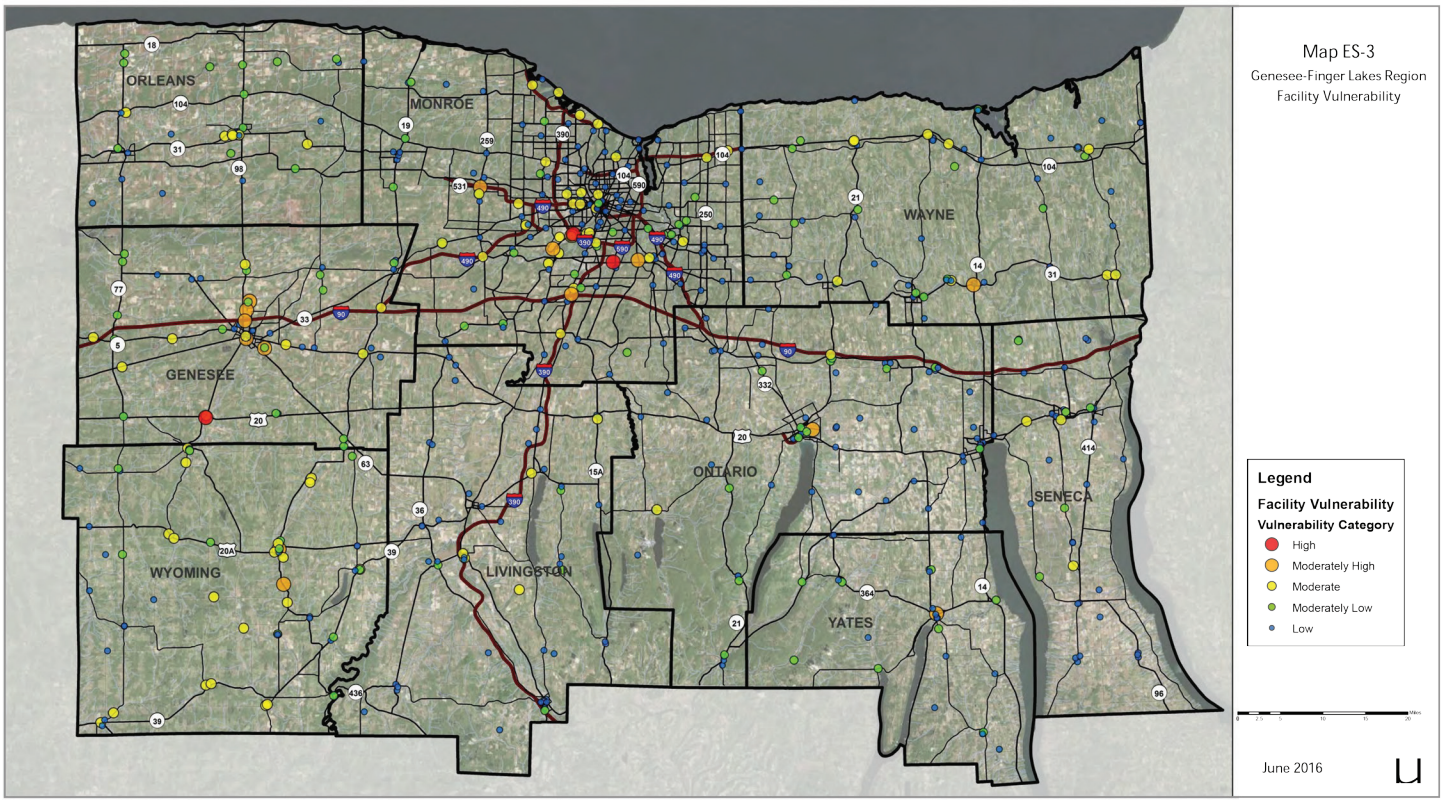

Figure 3. Map of Genesee-Finger Lakes Region facility vulnerability. Red dots indicate high vulnerability. Source: GTC 2016

Key Results & Findings

Critical transportation infrastructure vulnerability: Overall, the assessment identified 91 roadway segments, 20 bridges, and 18 facilities with "high" or "moderately high" vulnerability.

County-by-county hazard profiles: In addition to the asset-specific results, this project resulted in a series of county-by-county hazard profiles, each of which summarizes the key threats for the county. These profiles build on each county's All-Hazard Mitigation Plan using stakeholder input to identify hazards that pose the greatest risk to critical transportation assets in each county. For example, the Seneca County profile identifies flooding as the single greatest hazard for the county, as annual heavy rains create flash floods in low-lying areas. Across the region, the common hazards that were identified as being a significant risk were flooding, severe storms, and hazmat in transit spills.

Hazard mitigation strategy toolbox: The toolbox identifies a broad range of options that can be employed to prevent or minimize the impacts of natural and human-caused hazards on transportation assets. Strategies are categorized as Planning and Policy; Communication, Education, and Awareness; Infrastructure and Construction; Natural and Land Resources Protection; or Operations and Maintenance. Strategies range from facilitating inter-agency

coordination throughout the region to performing vegetation management to minimize damage from downed tree limbs. Given the limited availability of funding for transportation infrastructure projects, an emphasis was placed on cost-effective strategies that could be integrated into an agency's Transportation Improvement Program (TIP) application for project funding.

Compilation of potential funding sources: The vulnerability assessment also includes a table of potential funding sources for the hazard mitigation strategies. For example, the Federal Emergency Management Agency (FEMA) National Flood Insurance Program provides grants to assist communities in complying with floodplain management requirements, and the U.S. Department of Transportation FHWA Emergency Relief Program provides funding for the repair or reconstruction of Federal-aid highways that have suffered damage from natural disasters.

Possible Future Analysis

The Genesee Transportation Council recognizes the value of planning ahead for climate change by looking at the impacts of multiple hazards on transportation infrastructure. This vulnerability assessment used available data sources, including historical hazard data, to start the process of planning for climate change by identifying strategies for increasing transportation asset resilience. Building on this analysis, there is a continued need to collect, analyze, and understand how climate change will influence hazard impacts in the future.

For More Information

Resources:

Genesee-Finger Lakes Regional Critical Transportation Infrastructure Vulnerability Assessment

Long Range Transportation Plan for the Genesee-Finger Lakes Region: 2035

Federal Highway Administration Climate Change and Extreme Weather Vulnerability Assessment Framework

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