Assessing Transportation Asset Vulnerability to Hazard Impacts in the Genesee-Finger Lakes Region

Joseph M. Bovenzi, AICP    Frederick A. Frank, LEED AP BD+C
AMPO Annual Conference – Savannah, Georgia
October 18, 2017
New York State Metropolitan Planning Organizations

Source: New York State Association of Metropolitan Planning Organizations (NYSAMPO)
Planning for Hazard/Climate Change Impacts

- Long Range Transportation Plan 2035
  - Emerging Opportunities and Issues – The Impacts of Climate Change: Mitigation and Adaption
    - Lessen the expected impacts of climate change on transportation infrastructure by reducing GHGs
    - Evaluate the vulnerability of critical infrastructure to ensure hazard impacts are accounted for in design and operations

- Unified Planning Work Program
  - Task Number 5750 – Genesee Finger Lakes Regional Critical Transportation Infrastructure Vulnerability Assessment
Study Purpose and Background

- **Purpose**
  - Determine the vulnerability of critical transportation assets to natural and human-caused hazards
  - Propose solutions for preventing and/or reducing hazard impacts on those assets

- **Background**
  - No previous region-wide assessments
    - Need to understand *system* vulnerabilities in addition to *asset* vulnerabilities
  - Limited funds for transportation infrastructure projects
    - Inform programming of scarce federal funds
Study Purpose and Background (continued)

- **Background**
  - **Broad scope**
    - Includes infrastructure (roads, bridges, culverts) and facilities (operations centers, highway garages, fuel storage)
  - **Build on Climate Change adaptation initiatives**
    - Extreme weather events drive up operations, maintenance, and repair costs
Participants

- New York State Department of Transportation
- New York State Thruway Authority
- New York State Police
- Rochester Genesee Regional Transportation Authority
- County and City of Rochester Agencies:
  - Highway/Public Works
  - Emergency Management
  - Planning
  - Law Enforcement
Critical Transportation Assets

- Assets which are essential to the functioning of a community’s transportation system
  - Support Safety, Efficiency, and Reliability

- Four categories:
  - Infrastructure – *Roads, Bridges, Overpasses, Tunnels, Culverts*
  - Facilities – *Operations Centers, Highway/Public Works Garages, Fuel Storage, Transit Garages, Police/Fire Stations*
  - Equipment – *Traffic Signals, Signage, ITS Field Devices, Communications Network, Fleet Vehicles*
  - Personnel – *Employees, Contractors, Vendors*
Resiliency

- Ability to adapt to changing conditions and prepare for, withstand, and rapidly recover from disruption

- Enhance assets to a “New Normal”
Vulnerability

- Physical feature or operational attribute that renders an asset open to deliberate harm or susceptible to a hazard
  - Location
  - Design
  - Operation

- Vulnerability Assessment – Process of identifying system/asset vulnerabilities
Transportation Vulnerability Assessment Process

1. Identify a community’s or region’s critical transportation assets (Inventory Assets)

2. Identify the natural and human-caused hazards that can impact that critical assets (Hazard Extents)

3. Understand the consequences of hazard events on your transportation assets (Hazard Impacts)

4. Prioritize transportation assets that are most vulnerable to hazard events (Prioritize Assets)

5. Develop strategies to avoid or minimize impacts to vulnerable assets (Strategies)
Inventory – Critical Transportation Infrastructure

- Roads
- Bridges
- Culverts
- Railroads
- DPW Garages
- Operations Centers
  - Traffic
  - Transit
- Emergency Management Facilities
- Hospitals
- Police/Fire
- National Guard
Identify and Profile Hazards

Natural
- Floods
- Winter Weather
- Severe Storms
- Landslides
- Seismic Activity
- Sinkholes
- Extreme Temperatures
- Wildfire

Human-Caused
- Structural Failure
- Fire
- Hazardous Material Spills
- Roadway accidents
- Derailments
- Sabotage/Acts of Terrorism
Wayne County: Asset Vulnerability

Legend

- Bridges/ Culverts Impacted by Hazards
- Roadways Impacted by Hazards
- Ginna Plant
- Police and Fire
- NY State Police
- Hospitals
- Highway Garage
- Bridges
- Weight and/or Height Restricted Bridges
- NYSDOT Communication Towers
- NYSDOT Facilities and Staging Areas
- NYSTA Facility
- Transit Operations Centers
- Traffic Operations Centers
- County Emergency Operations

NYS Dam Classification
- Intermediate Hazard
- High Hazard

Regional Major Road Network
Functional Classification
- Interstate
- Arterial
- Collector
- Railroads
- Wetlands
- Floodplains
- Water Bodies
When is a Transportation Asset Vulnerable?

Four Key Factors:

- **Sensitivity** – Can the transportation system operate with this asset impacted?
- **Likelihood** – What is the likelihood/frequency of a hazard impacting the asset?
- **Exposure** – Is the asset exposed to multiple hazards and for long durations of time?
- **Consequence** – What is the severity of the hazard impact on the asset?
# Vulnerability Assessment Scale

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insignificant = 1</strong></td>
<td><strong>Minor = 2</strong></td>
<td><strong>Moderate = 3</strong></td>
<td><strong>Major = 4</strong></td>
<td><strong>Catastrophic = 5</strong></td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>Partial closure, no detour needed</td>
<td>Partial closure, minor detour needed</td>
<td>Full closure but available detours</td>
<td>Full closure, few detours</td>
</tr>
<tr>
<td><strong>Likelihood</strong></td>
<td>Occurs once every 25 years</td>
<td>Occurs once every 10 years</td>
<td>Occurs once every 5 years</td>
<td>Occurs once per year</td>
</tr>
<tr>
<td><strong>Exposure</strong></td>
<td>Hazard duration less than 1 hour</td>
<td>Hazard duration a couple hours</td>
<td>Hazard duration 1 day</td>
<td>Hazard duration 2-3 days</td>
</tr>
<tr>
<td></td>
<td>Very localized (partial impact of single asset)</td>
<td>Localized (full impact of single asset)</td>
<td>Scattered (multiple assets impacted)</td>
<td>Widespread (all assets in a geography are impacted)</td>
</tr>
<tr>
<td><strong>Consequence</strong></td>
<td>Delays or loss of operations/ use up to 30 minutes</td>
<td>Delays or loss of operations/ use up to one hour</td>
<td>Loss of operations/ use up to two days</td>
<td>Loss of operations up to 30 days</td>
</tr>
<tr>
<td></td>
<td>A few minor injuries</td>
<td>Some minor injuries</td>
<td>Multiple injuries requiring hospitalization</td>
<td>Multiple severe injuries and/or a single fatality</td>
</tr>
<tr>
<td></td>
<td>Financial impact</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Vulnerability Assessment Scale

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insignificant</strong> = 1</td>
<td><strong>Minor</strong> = 2</td>
<td><strong>Moderate</strong> = 3</td>
<td><strong>Major</strong> = 4</td>
<td><strong>Catastrophic</strong> = 5</td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Partial closure, no detour needed</td>
<td>Partial closure, minor detour needed</td>
<td>Full closure but available detours</td>
<td>Full closure, few detours</td>
<td>Full closure, extensive detours, transportation system fails</td>
</tr>
<tr>
<td>Likelihood</td>
<td>Occurs once every 25 years</td>
<td>Occurs once every 10 years</td>
<td>Occurs once every 5 years</td>
<td>Occurs once per year</td>
<td>Occurs more than once per year</td>
</tr>
<tr>
<td>Exposure</td>
<td>Hazard duration less than 1 hour</td>
<td>Hazard duration a couple hours</td>
<td>Hazard duration 1 day</td>
<td>Hazard duration 2-3 days</td>
<td>Hazard duration 3+ days</td>
</tr>
<tr>
<td></td>
<td>Very localized (partial impact of single asset)</td>
<td>Localized (full impact of single asset)</td>
<td>Scattered (multiple assets impacted)</td>
<td>Widespread (all assets in a geography are impacted)</td>
<td>Widespread impacts to all assets</td>
</tr>
<tr>
<td>Consequence</td>
<td>Delays or loss of operations/use up to 30 minutes</td>
<td>Delays or loss of operations/use up to one hour</td>
<td>Loss of operations/use up to two days</td>
<td>Loss of operations up to 30 days</td>
<td>Loss of operations/use exceeding 30 days</td>
</tr>
<tr>
<td></td>
<td>A few minor injuries</td>
<td>Some minor injuries</td>
<td>Multiple injuries requiring hospitalization</td>
<td>Multiple severe injuries and/or a single fatality</td>
<td>Multiple severe injuries and/or fatalities</td>
</tr>
</tbody>
</table>

Financial impact
Example of Prioritized Road Segments

Legend

Roadway Vulnerability

Vulnerability Category

- High
- Moderately High
- Moderate
- Moderately Low
- Low
Empire Blvd. (NYS Route 404)
Example of Prioritized Bridges

Legend
Bridge Vulnerability
Vulnerability Category
#* High
#* Moderately High
#* Moderate
#* Moderately Low
#* Low
Example of Prioritized Facilities
Hazard Mitigation Strategies

- Five Categories:
  - Planning and Policy
  - Communication, Education, and Awareness
  - Infrastructure and Construction
  - Natural and Land Resource Protection
  - Operations and Maintenance
Planning and Policy Strategies

- Interagency/inter-municipal coordination and resource sharing
- Implement ITS/TSMO plan recommendations
  - Communications
  - Preparedness and Response
- Incorporate flood mitigation strategies into agency and local planning efforts
- Areas for additional investigation:
  - Watershed planning
  - Downstream hazard studies
Communication and Education Strategies

- Education and Awareness
  - Training classes
  - Public outreach
- Improve flood risk assessment data
  - Update and publicize flood maps
- Publicize hazard mitigation techniques
Infrastructure and Construction Strategies

- Green infrastructure
  - Rain gardens, permeable pavements, bioswales
- Relocation and elevation of critical infrastructure
- Improving stormwater drainage capacity and functionality
- Slope stabilization

FEMA/Adam DuBrowa
Natural/Land Resource Protection Strategies

➢ Protect and restore natural floodplains
  q Protect, enhance, and integrate natural landforms that mitigate flooding into transportation infrastructure

➢ Create and preserve floodplain, open space, wetland, and spill areas
Operations and Maintenance Strategies

- Maintenance of drainage systems and flood control structures
  - Replace undersized culverts
- Debris maintenance
  - Clear debris from drainage ditches, catch basins, culverts, etc.
Lessons Learned

- The planning process is as important as the final report because it develops partnerships and builds consensus to advance strategies
  - Interagency and inter-municipal coordination and cooperation
- Integrate vulnerability-related considerations into the transportation infrastructure investment decision-making process
- Integrate Vulnerability Assessment findings into the local land use and policy decision-making process
FHWA Case Study

- GTC’s Vulnerability Assessment was featured as an FHWA case study on resiliency planning

Availability:
- FHWA Website
- Environment
- Sustainability
- Resilience
- Case Studies

Publication Number: FHWA-HEP-17-002
What’s Next?

- Integrate findings into investment decision-making process
  - Multi-year highway & bridge plan
  - TIP
- Develop Local Bridge Vulnerability Assessment
- Regional Flood Model
  - Better understand flood impacts
Success

Failure

GENESEE TRANSPORTATION COUNCIL
50 West Main Street-Suite 8112
Rochester, NY 14614
www.gtcmpo.org
@gtcmpo