Extreme Weather and Infrastructure Resilience

BI-STATE REGIONAL COMMISSION

FHWA PILOT PROJECT

GENA MCCULLOUGH, ASST. EXECUTIVE/PLANNING DIRECTOR

U.S. Department of Transportation
Federal Highway Administration
FHWA Resilience and Durability to Extreme Weather Pilot Program

2018 Resilience Pilots
Purpose of the Grant

• Conduct vulnerability assessment
• Determine strategies to mitigate impacts

“Resilience Triangle”
Quad Cities, Iowa/Illinois

5 Mississippi River Bridges + Rock River Crossings

4 Interstates, 5 U.S. Highways, 10 State Highways

3 Railroads – Class I & II

24 Barge Terminals

2 Locks/Dams

3 Public Transit Systems + Multiple On-Demand Private Providers & Taxis Services

2 Airports

2 National Trails
Vulnerability Assessment

- Structured process
- Ways to use results in practice
- Examples from other similar projects
- Links and references to related resources and tools
Project framework

- Develop an Advisory Committee
- Secure data
- Access vulnerability and adaptation options
- Determine priorities and opportunities to incorporate adaptation
- Integrate assessment

[Diagram of Vulnerability Assessment and Adaptation Framework]

**Set Objectives and Define Scope**
- Articulate Objectives
- Define Study Scope
- Select and Characterize Relevant Assets
- Identify Key Climate Variables

**Compile Data**
- Asset Data
- Riverine Hydrology
- Temperature & Precipitation Projections
- Coastal Hydrology

**Assess Vulnerability**
- Stakeholder Input
- Indicator-Based Desk Review
- Engineering-Informed Assessment
- Consider Risk

**Analyze Adaptation Options**
- Multi-Criteria Analysis
- Economic Analysis

**Incorporate Results into Decision-Making**
- Transportation Planning
- Environmental Review
- Engineering Design
- Transportation Systems Management and Operations
- Asset Management
Stakeholders

Environmental/Other
- NOAA-NWS, State Climatologists
- Corps of Engineers, NRCS, DNR/IEPA
- Industry, Health Depts., Universities

Transportation
- FHWA, State DOTs, County & City Engineers/Planners, EMAs
- Transit, Railroads, Airports, Trails Interests

Policy and Adaptation
- Planning Advisory Group
- Transportation Technical and Policy Committees
Summary of data trends

- FEMA Flood Risk Report
- CMIP Climate Data Processing Tool
- National Climatic Data Center
- FHWA, IL DOT, IA DOT
- Midwest Regional Climate Center
- US Geological Survey
- National Weather Service

- Increased variability
  - Floods, tornadoes, storms

- Increased precipitation
  - Frequency
  - Volume

- Increased disruptions for transportation networks
  - Impacts CAN be reduced through adaptive actions

# of IL Winter Days with Precipitation ≥ 1 inch
Source: MRCC
Variability vs. Trend and Extremes

Trend

Variability

Extremes
Climate Change (Trend)

Need to acknowledge and consider in planning. The rules of the game are changing now.
Billion-Dollar Disasters

1980-2019 Year-to-Date United States Billion-Dollar Disaster Event Frequency (CPI-Adjusted)

Event statistics are added according to the date on which they ended.

Statistics valid as of April 9, 2019.
Future Climate
Hazards today and in the future

Heat
Flood, river and flash
Drought
  ◦ Wildfires (rare)
Winter Storms
Severe weather
  ◦ Tornadoes, hail, damaging wind
Hurricanes? Coastal Flooding?

These are confounded with an increase in social vulnerability.
Extreme weather in the Quad Cities

- River flooding
- Flash flooding
- Combined storms
  - Hail
  - Lightning/thunder
  - High winds
- Severe winter storm
- Extreme heat
- Tornadoes
Local Trends 1900-2018
Record Crests
22.70 ft on 5/2/2019 1st
22.63 ft on 7/09/1993 2nd

Records for Consecutive Days above Flood Stage
96 days: 2019 – 3/15 to 6/18
43 days: 2011 – 3/29 to 5/10
Data sharing

- City inundation data?
- Storm surge backup on the Mississippi?
- Late season floods?
- Straight line winds?
- Main routes that have underground power lines?
- Extreme heat?
- Other?

Source: Climate Change Impacts in Iowa: Report to the Governor and Assembly, 2010
Prioritizing Assets

**Criticality assessment** = involves identifying the most critical elements of the transportation system for analysis, using quantitative and qualitative data.

**Vulnerability assessment** = what critical facilities/infrastructure are more vulnerable to disruptions or likely to be impacted by extreme weather, *now and in the future*?

**Adaptation options** = strategies that can increase resilience of the regional transportation system.
Critical Infrastructure & Facilities

- Evacuation gathering sites
- Public works facilities
- Transit hubs
- Transit transfer points
- Rural transit operations
- Airports
- Port facilities
- Railyard
Stakeholder Survey & Interviews
Stakeholder Workshop

- Vulnerability assessment
- Adaptation options
Criticality Assessment

**Criticality assessment** = involves identifying the most critical elements of the transportation system for analysis, using quantitative and qualitative data.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Data Source</th>
<th>Virginia DOT</th>
<th>North Jersey Transportation Planning Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of use</td>
<td>Traffic volume</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk of flooding</td>
<td>Elevation relative to sea level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special route locations</td>
<td>Maintenance priority routes &amp; evacuation routes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Importance of destinations</td>
<td>Jobs and population density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnitude of connections</td>
<td>Traffic volume and ridership</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency routes</td>
<td>Evacuation routes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Refining Criticality Criteria

**Stakeholder & Transportation Technical Committee Input**

What is critical to our region’s transportation system?

- High use areas/routes
- Land use/destinations of importance
  - i.e. RI Arsenal, densely populated areas
- Mississippi River crossings
- Medical/emergency routes
  - i.e. hospital access
- Redundancy throughout network
- Economic vitality
  - i.e. access to large employers
## Data Input for Weighted Sum Overlay Analysis

### Bridges (AADT)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Manual Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1,000</td>
<td>1</td>
</tr>
<tr>
<td>1,001 – 10,000</td>
<td>2</td>
</tr>
<tr>
<td>10,001 – 25,000</td>
<td>3</td>
</tr>
<tr>
<td>25,001 – 40,000</td>
<td>4</td>
</tr>
<tr>
<td>&gt; 40,000</td>
<td>5</td>
</tr>
<tr>
<td>Pedestrian access bridge</td>
<td>1</td>
</tr>
</tbody>
</table>

### IL Roadways (AADT)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Natural Breaks Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 - 4,250</td>
<td>1</td>
</tr>
<tr>
<td>4,251 – 9,400</td>
<td>2</td>
</tr>
<tr>
<td>9,401 – 17,900</td>
<td>3</td>
</tr>
<tr>
<td>17,901 – 32,600</td>
<td>4</td>
</tr>
<tr>
<td>32,601 – 69,700</td>
<td>5</td>
</tr>
</tbody>
</table>

### IA Roadways (AADT)

<table>
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<tr>
<th>Classification</th>
<th>Natural Breaks Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 - 3,520</td>
<td>1</td>
</tr>
<tr>
<td>3,521 – 8,900</td>
<td>2</td>
</tr>
<tr>
<td>8,901 – 17,100</td>
<td>3</td>
</tr>
<tr>
<td>17,101 – 30,000</td>
<td>4</td>
</tr>
<tr>
<td>30,001 – 72,000</td>
<td>5</td>
</tr>
</tbody>
</table>

### Access to Critical Facilities

- All access road segments

### Access to Major Employers

- All access road segments

### Bettendorf Transit (Ridership)

<table>
<thead>
<tr>
<th>Natural Breaks Classification of Avg. Weekday Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 76</td>
</tr>
<tr>
<td>77 - 95</td>
</tr>
<tr>
<td>96 - 111</td>
</tr>
</tbody>
</table>

### Davenport Transit (Ridership)

<table>
<thead>
<tr>
<th>Natural Breaks Classification of Avg. Weekday Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 110</td>
</tr>
<tr>
<td>111 - 186</td>
</tr>
<tr>
<td>187 - 302</td>
</tr>
</tbody>
</table>

### MetroLink Transit (Ridership)

<table>
<thead>
<tr>
<th>Natural Breaks Classification of Avg. Weekday Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 634</td>
</tr>
<tr>
<td>635 – 1,545</td>
</tr>
<tr>
<td>1,546 – 2,518</td>
</tr>
</tbody>
</table>
Result of Weighted Multi-criterion Analysis Using Criticality Criteria

Legend
Criticality Weighted Score
- 4 - 7
- 8 - 12
- 13 - 17
- 18 - 21

Source: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Criticality & Stakeholder Identified Vulnerability Areas

Legend
Criticality Weighted Score
- 4 - 7
- 8 - 12
- 13 - 17
- 18 - 21

Stakeholder Input
TYPE_
- Flood
- Freeze/Thaw
- Ice/Snow
- Other
- Wind

Source: Esri, HERE, Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCan, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Areas Deemed both Critical and Vulnerable to Flooding

- Duck Creek crossings
- Drainage issues and ponding
- Creek & Rock River cause road closures
- I280 Flooded on/off ramp
- Potential I74 inundation
Focus for Adaptation Options Prioritization

• Most at-risk
  • Corridors
  • Hot spots
• Already Planned Projects
• Asset by State or Jurisdiction
• Combination

Priority Segments for Adaptation Options Review
## Review Priorities by Potential Solutions

<table>
<thead>
<tr>
<th>Advisory</th>
<th>Control</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligent Transportation System (ITS)</td>
<td>Variable speed limits</td>
<td>Green infrastructure</td>
</tr>
<tr>
<td>Motorist alerts</td>
<td>Vehicle restrictions</td>
<td>Levee construction (traditional and living)</td>
</tr>
<tr>
<td>Communication &amp; Outreach Plan</td>
<td>Route restrictions</td>
<td>Culvert sizing</td>
</tr>
<tr>
<td>Road side active warning systems</td>
<td>Road-surface treatments</td>
<td>Road/bridge elevation</td>
</tr>
</tbody>
</table>

(Asam et. al., FHWA, 2015)
Other Policies and Procedures

- Climate and emissions policies
- Emergency Management
- Mitigation Measures
- Disinvestment
- Solutions with co-benefits
- Environmental Justice and Equity
# Incorporating into Transportation Planning Process

**LRTP**

**Extreme Weather Resilience Objective**

- Develop objective for LRTP – policy statement
- Incorporate Adaptation Priorities in chapters
- Consider resilience review for planned projects

**TIP**

**Resilience Discussion & Project Selection**

- Recognize resilience in TIP – use environmental maps to highlight vulnerabilities
- Review selection criteria to incorporate resilience

**Technical Asst.**

**Resilience in Project Development Process**

- Write grants for priority resilience projects
- Work with local jurisdictions during project development process to incorporate adaptation options into project development
Next Steps & Lesson Learned

Priorities and Opportunities for Adaptation

+ Integrate Results & Recommendations

Jun.-Sep. 2020

- Criticality Mapping Analysis - Finalize
- Adaptation Strategies Draft to MPO Technical Committee and Advisory Committee
- Draft Resilience Study Report & Recommendations for the LRTP
- Final Report to FHWA

Lessons Learned – Peer Exchange

- Growing Staff Capacity in Climate
- Data Integration
- Valuing Resilience
- Proactive Collaboration
- Mainstreaming Resilience
- Resilience Informed Planning
Questions?

GENA MCCULLOUGH

GMCCULLOUGH@BISTATEONLINE.ORG