Planning for Extreme Weather: Assessing Transportation Vulnerability on a Regional and Local Scale

2019 Georgia Planning Association Fall Conference
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Agenda

• Background and Purpose of Project
• Global and Regional Trends in Climate Change and Extreme Weather
• Regional Resilience Opportunities
• Introduction of Pilot Area and Demonstration of City Simulator Tool
• Next Steps & Takeaways
• Q & A
Introductions

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Background and Purpose of Project
Atlanta Regional Commission (ARC)

- 20-county MPO with population of nearly 6 million residents, covering 2,645 square miles
- Administers federal transportation dollars for the region
Why is ARC working in the resilience space?

Resilience is already an issue in the Atlanta region
Why is ARC working in the resilience space?

- As climate continues to change, we should *expect more extreme weather events*.

- These extreme weather events *threaten investments* ARC and our partners have made and will make in the transportation system, and *threaten to disrupt* transportation services that people throughout the region rely on.

- *Understanding our transportation vulnerabilities* will help ARC make conscientious investments, improve quality of life, and ensure that the impacts of climate change do not disproportionately burden environmental justice communities.
The FAST Act (2015)

- Federal law that provides long-term funding for surface transportation infrastructure planning and investment
- Focuses on the need to address system resilience by urging a reduction of natural disaster vulnerability, including reducing or mitigating stormwater impacts on surface transportation

“It is in the national interest... to encourage and promote the safe and efficient management, operations, and resilient development of surface transportation systems.”
U.S. Transportation Assets and Goals at Risk
Climate Change and Notable Vulnerabilities of Transportation Assets

HEAT
- Bridges
- Roadways
- Rail
- Airports
- Ports
- Public Transit

COASTAL FLOODING AND SEA LEVEL RISE
- Bridges
- Roadways
- Rail
- Airports
- Ports
- Tunnels

HEAVY PRECIPITATION
- Bridges
- Roadways
- Rail
- Airports
- Ports
- Tunnels

National Performance Goals at Risk

Reduced Project Delivery Delays
Safety
Environmental Sustainability
Freight Movement & Economic Vitality
Infrastructure Condition
Congestion Reduction
System Reliability

National Performance Goals

National Performance Goals at Risk
Strong history of regional planning for resilience

2010 – 2012: Focus on Mitigation

• How can we reduce greenhouse gases?

2012 – now: Pivot to Adaptation – Criticality and Vulnerability

• 2016: ARC & FHWA Climate Resilience Peer Exchange
• 2017: ARC Vulnerability and Resiliency Framework
• 2018: FHWA Resilience and Durability Pilot Project
• 2019 – 2020: TIP Project Evaluation Framework – Climate Change Criteria
TIP Project Evaluation

• We want to codify a transportation system that considers mitigating and adapting to climate change.
TIP Project Evaluation

- We want to codify a transportation system that considers mitigating and adapting to climate change

TIP Project Evaluation

- One outcome of this project is developing climate-specific measure(s) for project evaluation.

Table RC9 – Metrics for Evaluating the Roadway Expansion Air Quality & Climate Change Criterion

<table>
<thead>
<tr>
<th>Measure</th>
<th>Metric</th>
<th>Nature of Metric</th>
<th>Sponsor Provided</th>
<th>Percent of Criterion Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Project’s Regional Emissions</td>
<td>1) Change in NOx, VOC, &amp; PM$_{2.5}$ emissions</td>
<td>Numerical; sum of three pollutants in kg/year</td>
<td>No</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>2) Change in greenhouse gas emissions CO$_2$(e)</td>
<td>Numerical; in kg/year</td>
<td>No</td>
<td>50%</td>
</tr>
<tr>
<td>2) Near Road Emissions Exposure</td>
<td>Is the project located in a PM$_{2.5}$ hotspot?</td>
<td>Yes/No</td>
<td>No</td>
<td>25%</td>
</tr>
</tbody>
</table>
FHWA Pilot Program: Resilience And Durability To Extreme Weather

• ARC awarded FHWA grant to:
  • Integrate resilience and durability into agency practices
  • Use available tools and resources to assess the vulnerability and risk of transportation projects or systems; and
  • Deploy a resilience solution and monitoring performance

Recipients as of 2018
FHWA Pilot Program: Resilience And Durability To Extreme Weather

• ARC received grant in 2018

• Project Outcomes and Deliverables
  • City Simulator tool to simulate extreme flood and heat events – will help ARC and our partners determine which transportation assets that are most vulnerable to extreme weather attributed to the combined effects of urbanization and climate change
  
  • Policy: What measure or measures can ARC incorporate into the TIP Project Evaluation Framework and other planning processes to account for climate change impacts on the transportation system?
Climate Change and Extreme Weather
Climate Change Worldwide

• Sea level rise accelerating (+ >3 ft by 2100) – will intensify storm surge events

• Rising greenhouse gas emissions will increase global temperature and evaporate more moisture from water bodies, contributing to drought conditions

• 100-yr floods predicted to become more frequent in several cities by 2050 (including Savannah); drought conditions will amplify flood events
Extreme Weather in the US (2018)

This map denotes the approximate location for each of the 14 separate billion-dollar weather and climate disasters that impacted the United States during 2018.
Extreme Weather in the US (2019)

U.S. 2019 Billion-Dollar Weather and Climate Disasters

This map denotes the approximate location for each of the 6 separate billion-dollar weather and climate disasters that impacted the United States from Jan–Jun 2019.
September 2009 Flood

- 10-20 in rain over several hours in core of Atlanta region
- Sweetwater Creek rose to 20 ft above flood stage
- Impacts:
  - Numerous roads, bridges and homes destroyed
  - Flooding at two wastewater treatment plants discharged sewage into Chattahoochee River
  - 11 fatalities
  - $250M estimated damage
Historic Change in Heavy Precipitation

Days with Precipitation Above 3 Inches (1900–2016)

Decade

Percent Change (1950–2016)
August 2007 Extreme Heat Event

- August 2007 was hottest month on record in Atlanta, with several days of record-high temperatures
- Two known fatalities
- Public health impacts - contributes to poor air quality and causes heat-related illnesses and deaths
- Urban heat island effect raises effective temperature
- Those who rely on walking, biking, transit are most greatly impacted

Photo source: Atlanta’s Urban Heat Island under Extreme Heat Conditions and Potential Mitigation Strategies
2006-2009 Drought

• 20 months of extreme or exceptional drought intensity in Atlanta

• All-time record low lake and river levels

• Lake Lanier is main source of drinking water for region – reached record low of 1050 ft (Dec 2007), which is 20 ft below normal

• Conservation actions became mandatory across state after 2007, which saw lowest annual rainfall state since 1954

Photo source: [www.news.gatech.edu](http://www.news.gatech.edu)
Regional Resilience Opportunities
Regional Resilience Opportunities
Hospitals

Auto

Transit

Meeting Demand
Not Meeting Demand
Commercial lots within 250-ac neighborhood

Meeting Demand

Not Meeting Demand
July 2012 Flood – Intrenchment Creek Watershed

- Urban area with ongoing development – 60% impervious surface, prone to urban flooding
- 25-year, 4-hour storm event
- Damaged homes and vehicles, and compromised sewage system (raw sewage in floodwaters)
- One home in Peoplestown has flooded 4 times over 17 years
- Flooding likely to occur more frequently as drought/intense rainfall events become the norm

Photo source: Peoplestown.org
Pilot Study Area

20 watersheds, 3248 Road Segments, 83 HydroTrans Intersections, 2411 Transit Stops
Requirements for Forecasting Resilience

• Capture *interacting systems*
  • (Economy, People, Infrastructure, Natural)

• Include *business-as-usual as well as disasters*

• Include *climate change* effects

• Allow for *proposed strategies* and measures their effect

• Long enough time line to measure *return on investment*

• Accessible to communities in a *Planning Context*
City Information Model

- Agents
- Parcels
- Buildings
- Political Boundaries
- Roads
- Stormwater
- Power
- Telecom
- Soils
- Ocean/Land
- Floodplains
- Census Block Groups

Fayetteville, NC
Requirements for Forecasting Resilience

- Gradually changing threats like rising sea level 3mm per year.
- Percentage growth in economy year over year.
- New commercial buildings are added based on growth rate.
- Buildings receive an array of businesses with an array of jobs; new jobs are filled by immigrants or population entering workforce.
- New workers receive housing, spouses, children.

- Carbon footprint evaluated from daily travel, city wide power usage, other factors.
- Impacts to ecosystem evaluated.
- Yearly Loop (2019-2050)
- Urbanization impact to floodplains is evaluated.
- Roads, utilities, schools, churches, are added to fulfill new populations’ needs.

Carbon Footprint

Eco-system Impacts

Adjust Floodplains

New Infrastructure

Families

New Housing

Disaster?

Daily Loop

Natural System Changes

Economics

New Places of Work

Workers

Structures Recovered

Structures Affected

Commerce

Work

New

Percentage growth in economy year over year.
Requirements for Forecasting Resilience

- Citizens conduct commerce throughout the day (grocery shopping, etc). This is also tracked.

- For workers whose place of work and residence are not in recovery, the commute and daily work activities are tracked.

- In each day of the year, a forecast determines if a disaster occurs.

  Structures affected by the disaster are identified through flood models, storm surge models, earthquake risk models, etc.

  Damage to structures is estimated using damage curves that equate severity of disaster to cost of damage.

  If a structure is affected, a recovery curve is established that governs whether the structure is productive or not in the future.
Next Steps and Takeaways
Impacts to Community

- Will overlay resilience opportunities map with special flood hazard areas to assess vulnerability of community and assets to flooding
- What are impacts to environmental justice populations?
- What are impacts to critical transportation assets?
  - Interstate highways and arterials
  - Bridges
  - Transit stations and major transit routes
  - Assets and services that provide access to critical facilities – hospitals, government centers, fire stations, etc.

Photo source: Flickr – Greg Reihing
Stakeholder and Public Outreach

- Presentations to ARC Transportation Coordinating Committee (TCC)

- ArcGIS StoryMap
  - Will allow public and stakeholders to provide feedback on where they have observed resilience issues in the region

- Ongoing coordination with counties and cities, as well as state agencies
Future Pilot Studies

• Resilience opportunities map will highlight areas for future potential pilot studies by ARC
• ARC will work with counties and cities to identify areas for more in-depth analysis
• Will consider population density, areas with greater demand for resiliency, environmental justice populations, and where there are concentrations of critical assets
Future Partners

- Local counties and cities
- GDOT Internal Resilience Group
- Georgia Tech
Resources

FHWA – Climate Change Adaptation

- CMIP Climate Data Processing Tool
- Guide to Assessing Criticality in Transportation Adaptation Planning
- Sensitivity Matrix
- Vulnerability Assessment Scoring Tool (VAST)

Questions?

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Thank you!