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

2019 Georgia Planning Association Fall Conference

October 2, 2019

ATLANTA REGIONAL COMMISSION
regional impact + local relevance

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Member of the SNC-Lavalin Group

Gresham Smith

transport STUDIO

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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Project Manager
Atlanta Regional Commission

Lawrence Frank

Project Manager
Atkins

Steve Bourne

Technical Lead
Atkins

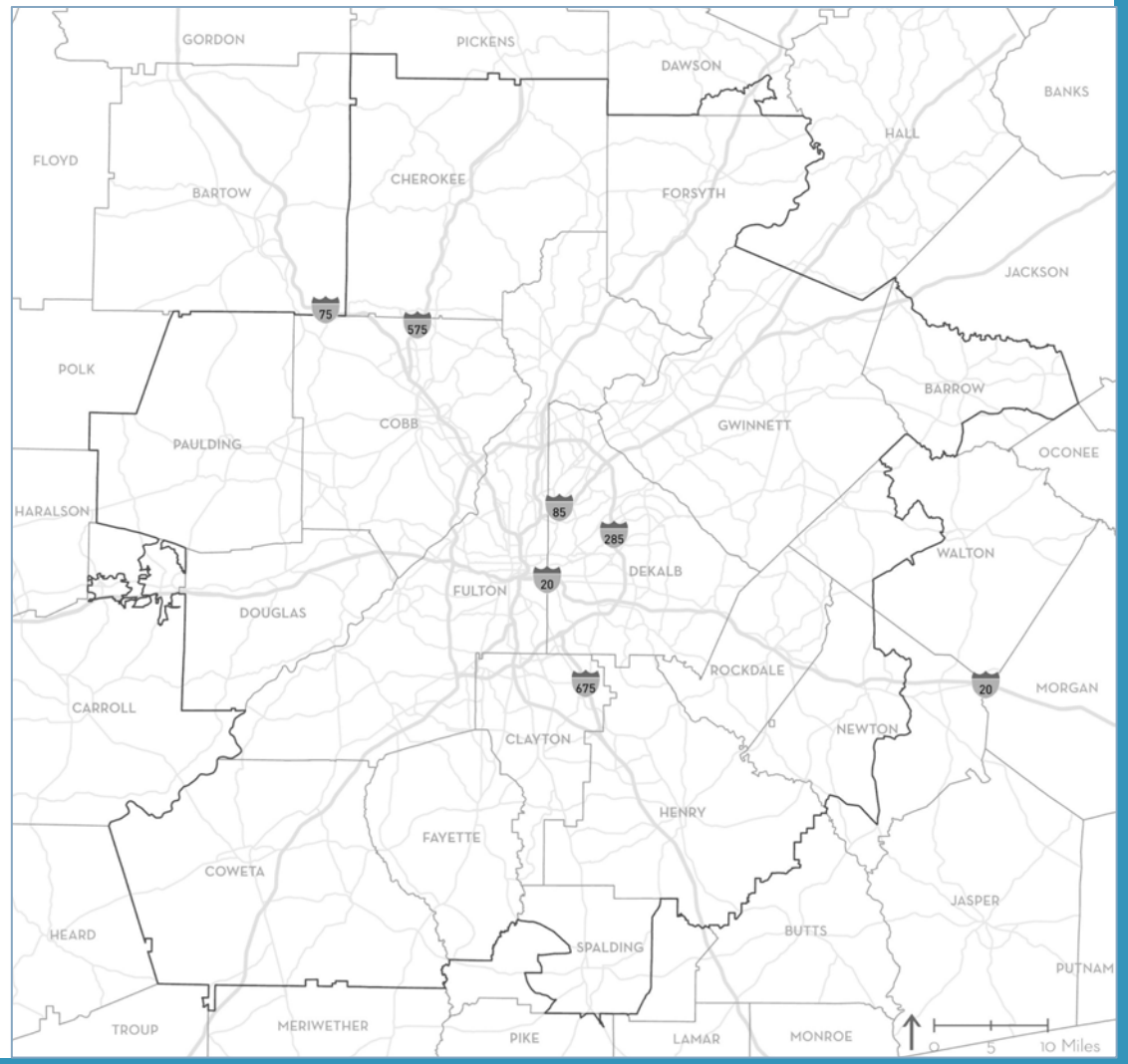
Megha Young

Data Analysis Lead
Gresham Smith

Background and Purpose of Project

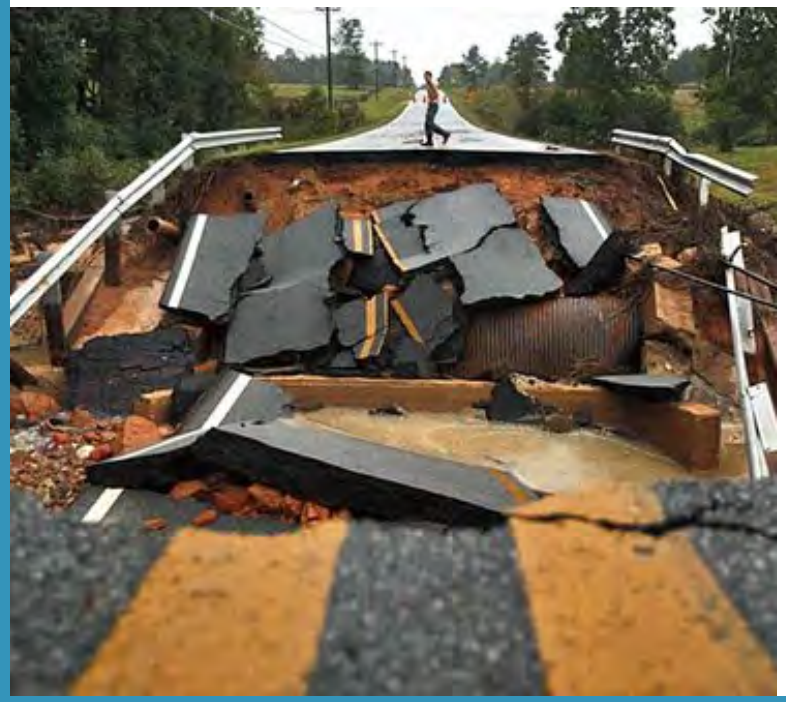
Atlanta Regional Commission (ARC)

- 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



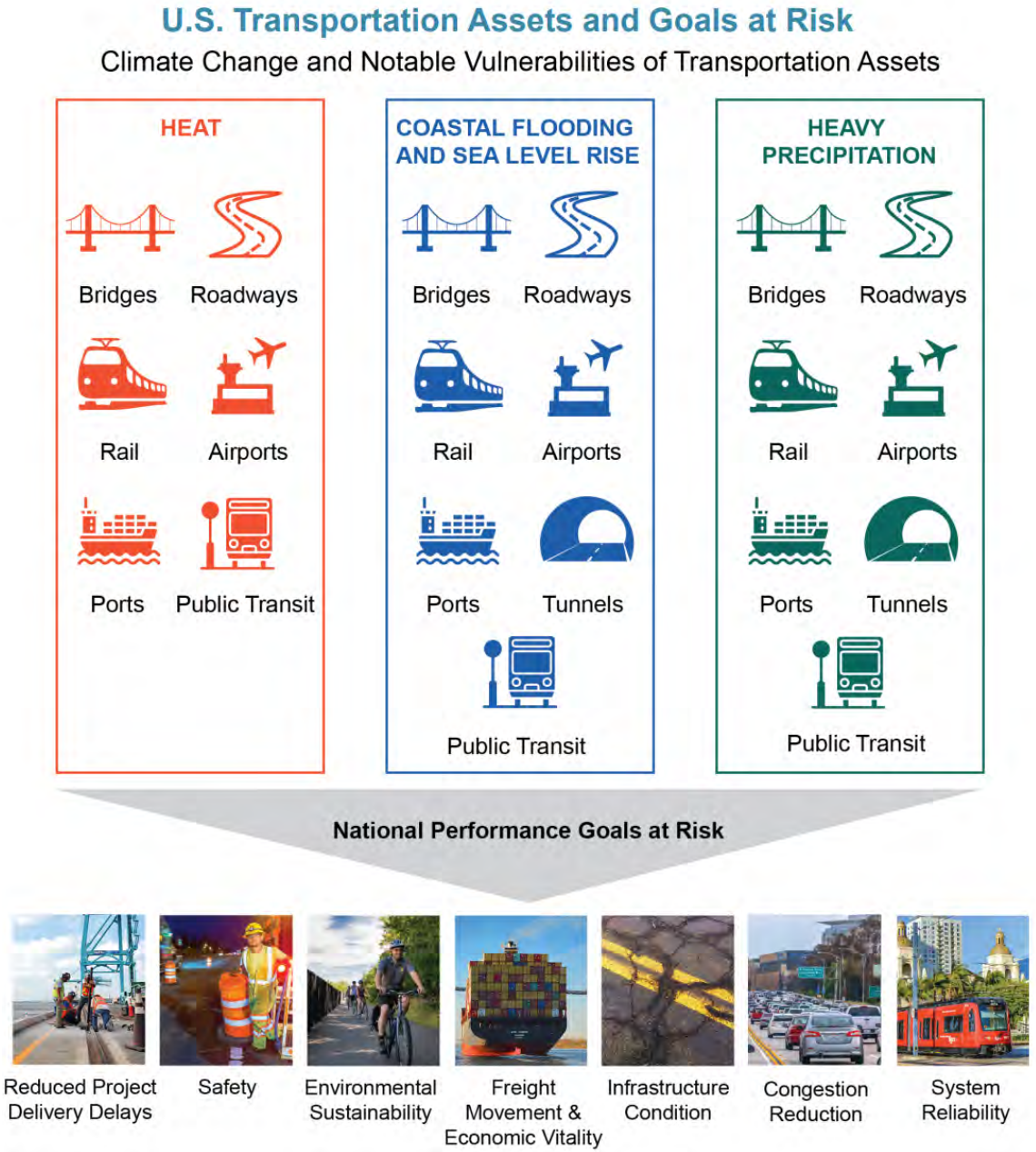
Why is ARC working in the resilience space?

- 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."



National Performance Goals

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

Table O2 – TIP Project Types and Key Criteria

Atlanta Region's Plan Vision	Performance Criteria	Project Types							
		Bicycle and Pedestrian	Trail	Roadway Asset Management & Resiliency	Roadway Expansion	Roadway Transportation Systems Management & Operations	Transit Expansion	Transit Asset Management and System Upgrades	Misc. Emissions Related Projects
World Class Infrastructure	Mobility & Congestion	✓	✓	✓	✓	✓	✓	✓	
	Reliability				✓	✓	✓		
	Network Connectivity	✓	✓	✓	✓	✓	✓		
	Multimodalism	✓	✓	✓	✓	✓	✓		
	Asset Management & Resiliency	✓[4]	✓[4]	✓	✓[4]	✓[4]	✓[4]	✓	
Healthy Livable Communities	Safety	✓	✓	✓	✓	✓	✓	✓	
	Air Quality & Climate Change	✓	✓		✓	✓	✓	✓[5]	✓
	Cultural & Environmental Resources	✓	✓	✓	✓	✓	✓	✓	
	Social Equity	✓	✓	✓	✓	✓	✓	✓	
	Land Use Compatibility	✓	✓				✓		
Competitive Economy	Goods Movement			✓	✓	✓			
	Employment Accessibility	✓	✓	✓	✓	✓	✓	✓	

TIP Project Evaluation

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

Table S2 – Criteria Weights by Project Type[13]

Criteria	Bike/Ped/Trail	Roadway Asset Management	Roadway Expansion & TSM&O	Transit Expansion	Transit Asset Management & System Upgrades[14]
Asset Management & Resiliency	-	14.9 %	-	-	24.4 % / 22.1 %
Mobility & Congestion	13.7 %	13.8 %	13.0 %	13.5 %	21.6 % / 19.6 %
Safety	14.5 %	14.4 %	13.4 %	8.5 %	13.6 % / 12.3 %
Network Connectivity	14.4 %	12.9 %	12.4 %	13.5 %	-
Reliability	-	-	12.1 %	12.0 %	-
Multimodalism	12.6 %	11.8 %	11.3 %	10.2 %	-
Employment Accessibility	10.4 %	10.2 %	10.3 %	11.6 %	18.6 % / 16.8 %
Land Use Compatibility	11.5 %	-	-	10.5 %	-
Social Equity	9.7 %	8.3 %	7.0 %	9.5 %	15.2 % / 13.8 %
Air Quality & Climate Change	6.3 %	-	7.3 %	6.5 %	0.0 % / 9.4 %
Goods Movement	-	8.1 %	7.8 %	-	-
Cultural & Environmental Sensitivity	6.8 %	5.5 %	5.3 %	4.1 %	6.6 % / 6.0 %

TIP Project Evaluation

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

TIP Project Evaluation

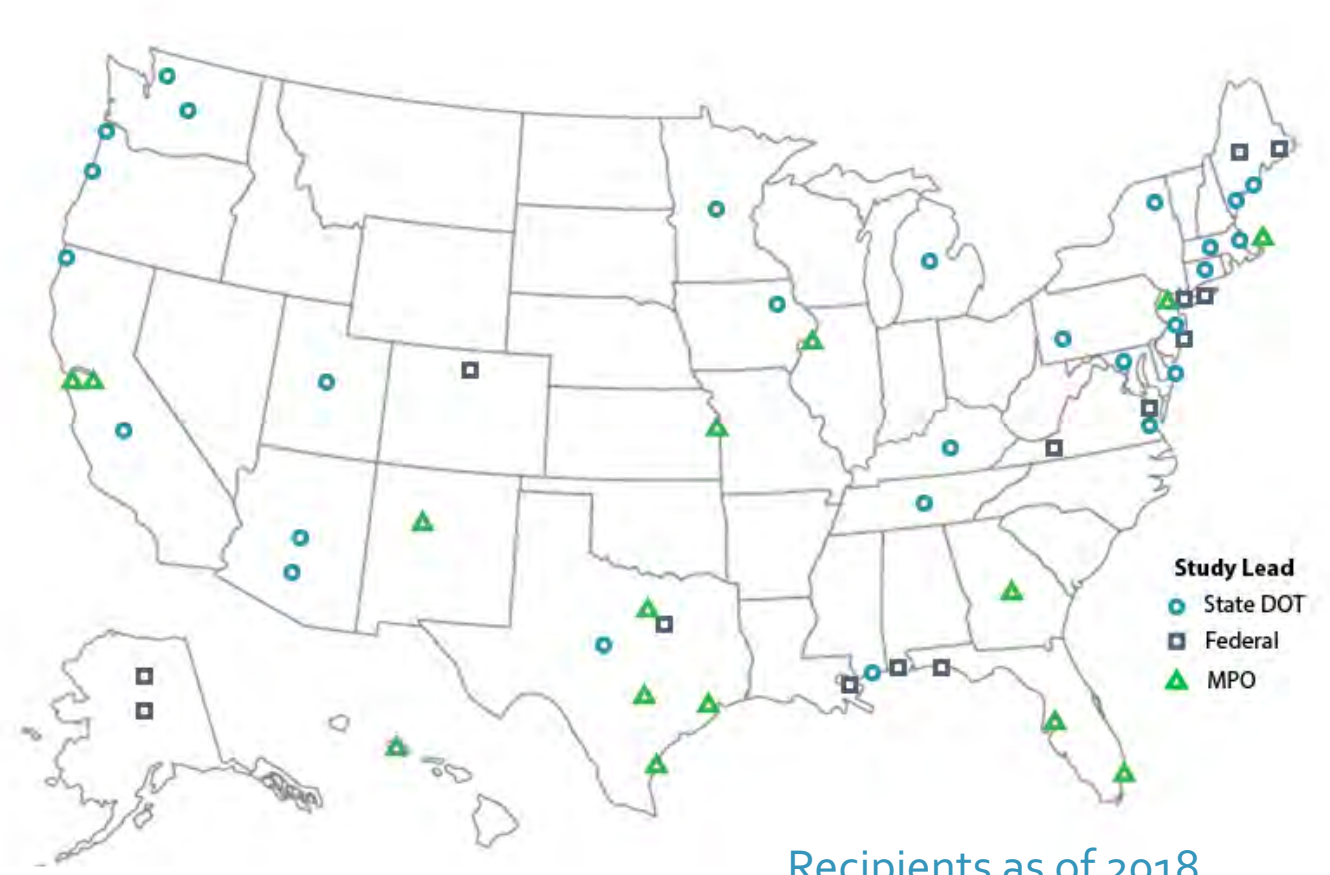
- One outcome of this project is developing climate-specific measure(s) for project evaluation

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

Measure	Metric	Nature of Metric	Sponsor Provided	Percent of Criterion Score
1) Project's Regional Emissions	1) Change in NO_x, VOC, & $PM_{2.5}$ emissions	Numerical; sum of three pollutants in kg/year	No	25%
	2) Change in greenhouse gas emissions $CO_2(e)$	Numerical; in kg/year	No	50%
2) Near Road Emissions Exposure	Is the project located in a $PM_{2.5}$ hotspot?	Yes/No	No	25%

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

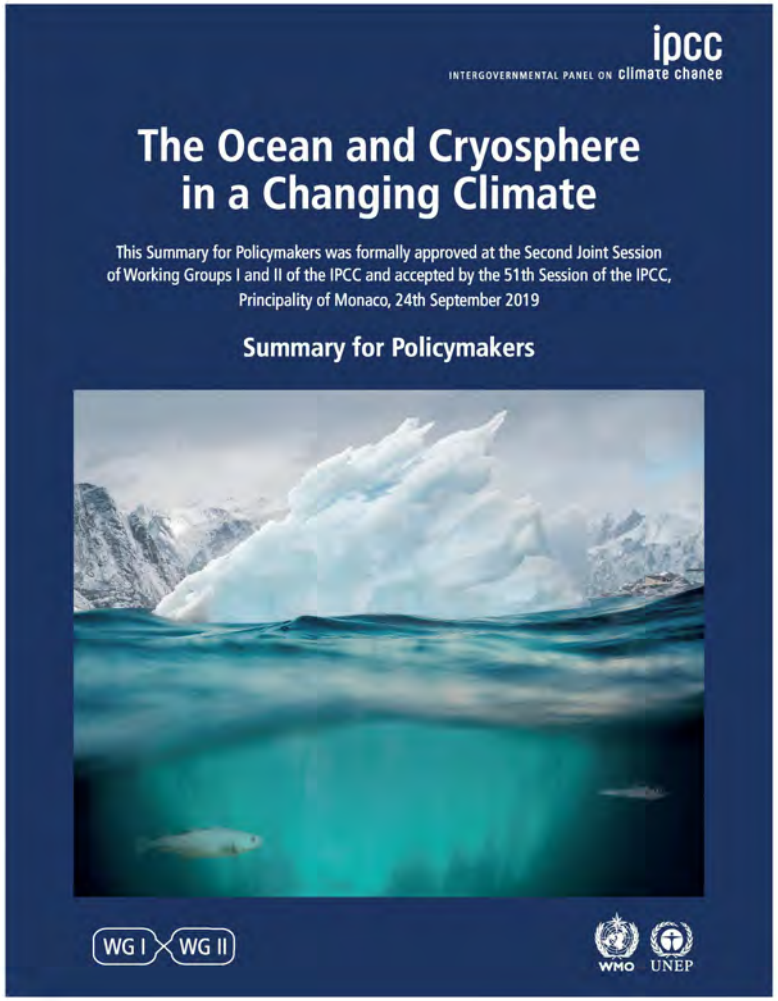
FHWA Pilot Program: Resilience And Durability To Extreme Weather

- ARC received grant in 2018
- Project Outcomes and Deliverables
  - City Simulator tool to simulate extreme flood and heat events – will helps 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?

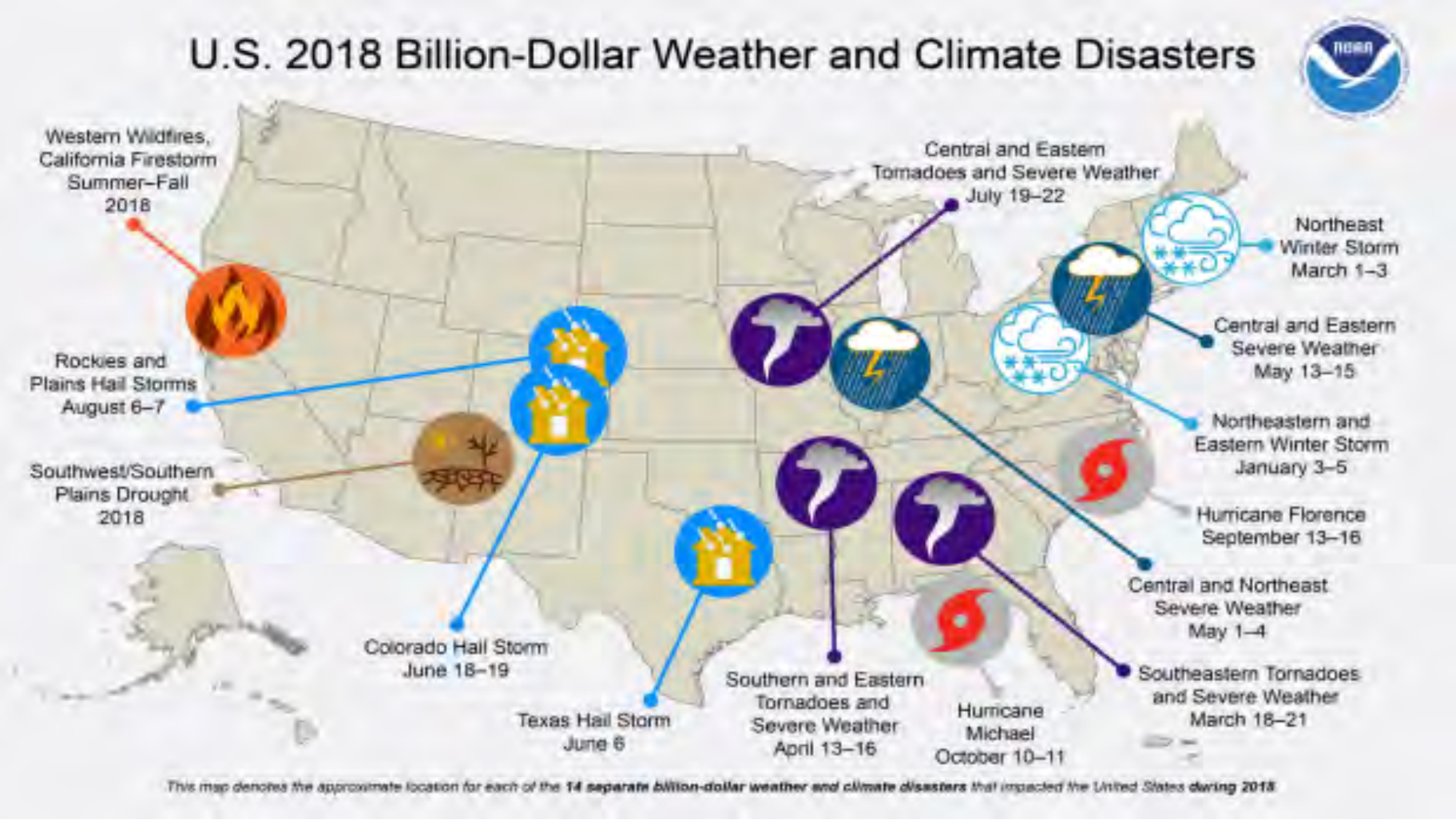
Climate Change and Extreme Weather

Climate Change Worldwide

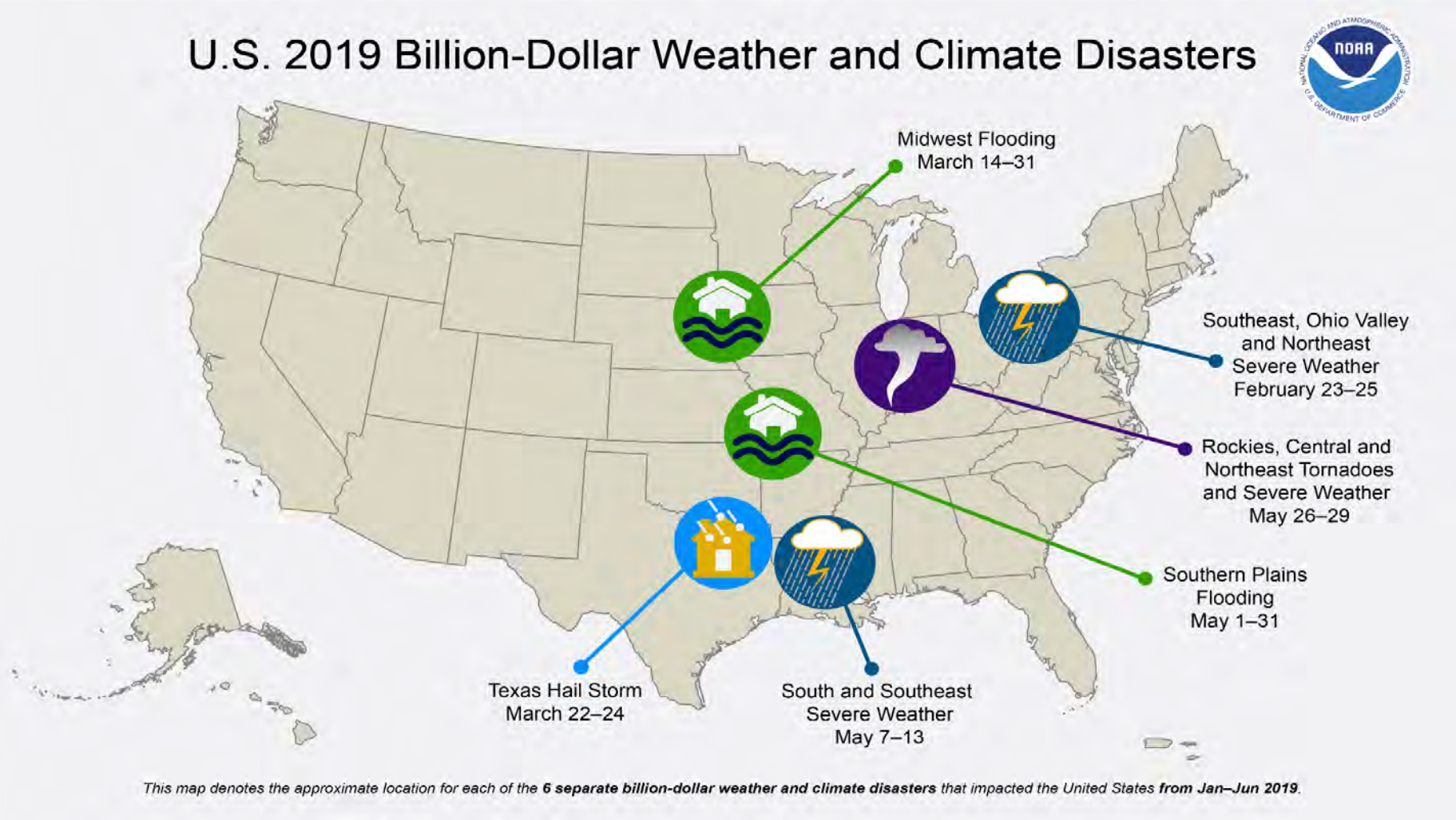
- Sea level rise accelerating (+ >3 ft by 2100) – will intensify storm surge events
- Rising greenhouse gas emissions will increase global temperature and evaporate more moisture from water bodies, contributing to drought conditions
- 100-yr floods predicted to become more frequent in several cities by 2050 (including Savannah); drought conditions will amplify flood events



Extreme Weather in the US (2018)



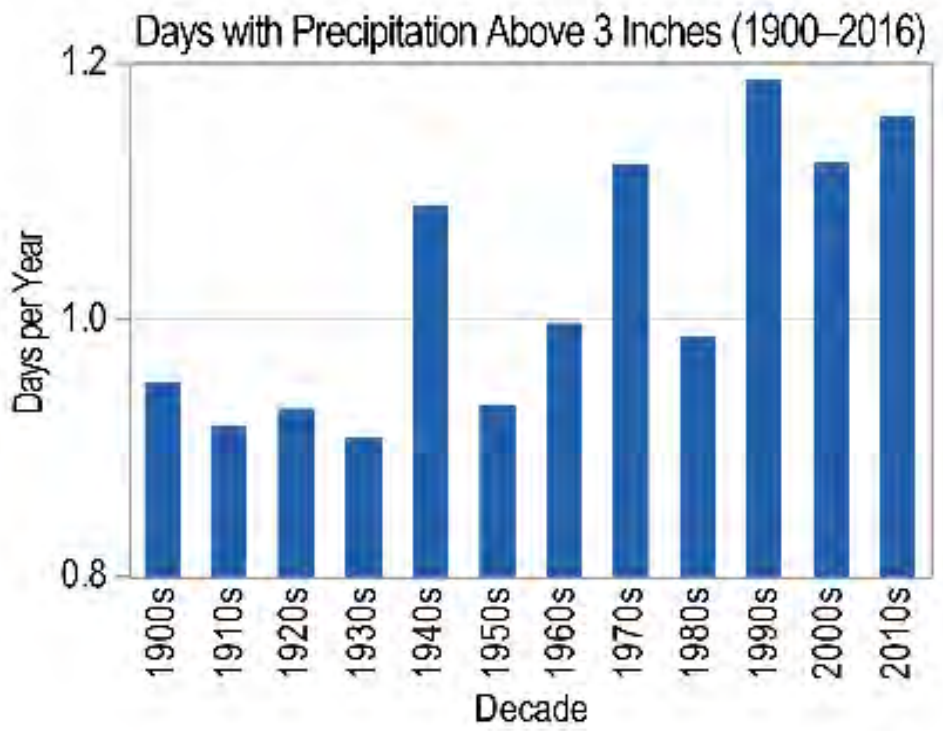
Extreme Weather in the US (2019)

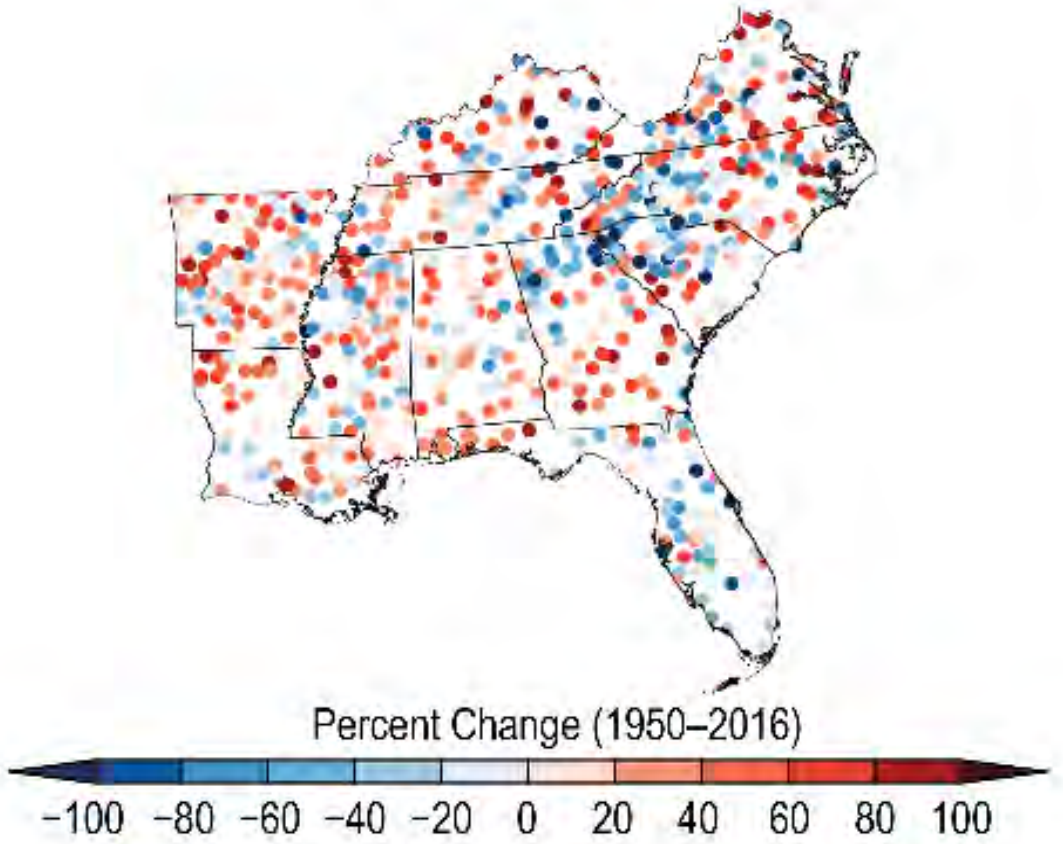


September 2009 Flood

- 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





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

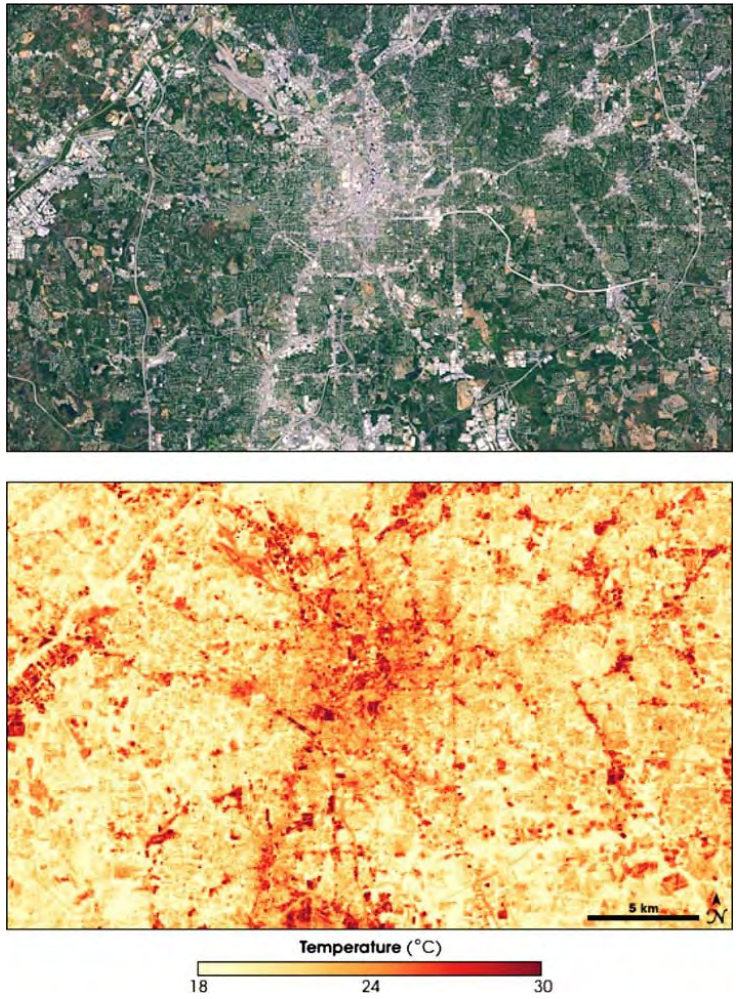


Photo source: Atlanta's Urban Heat Island under Extreme Heat Conditions and Potential Mitigation Strategies

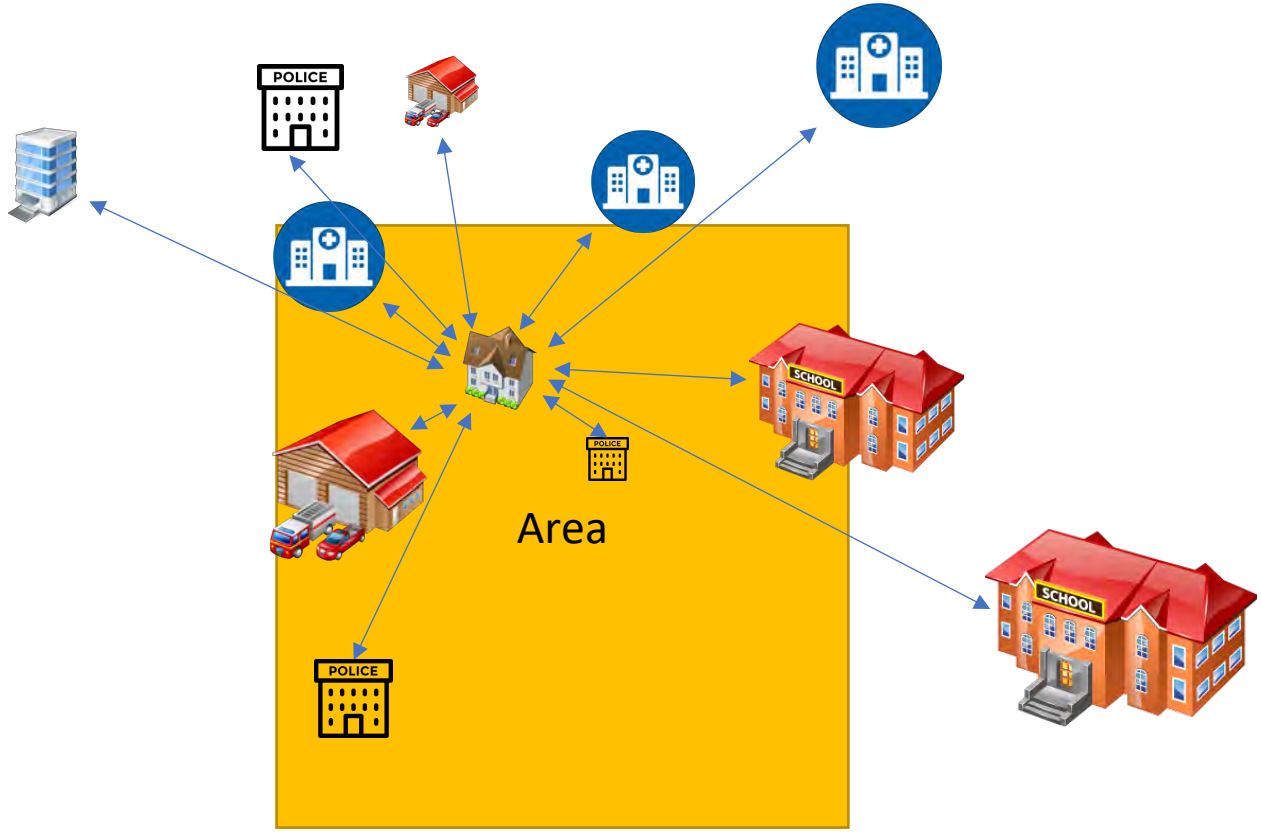
2006-2009 Drought

- 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

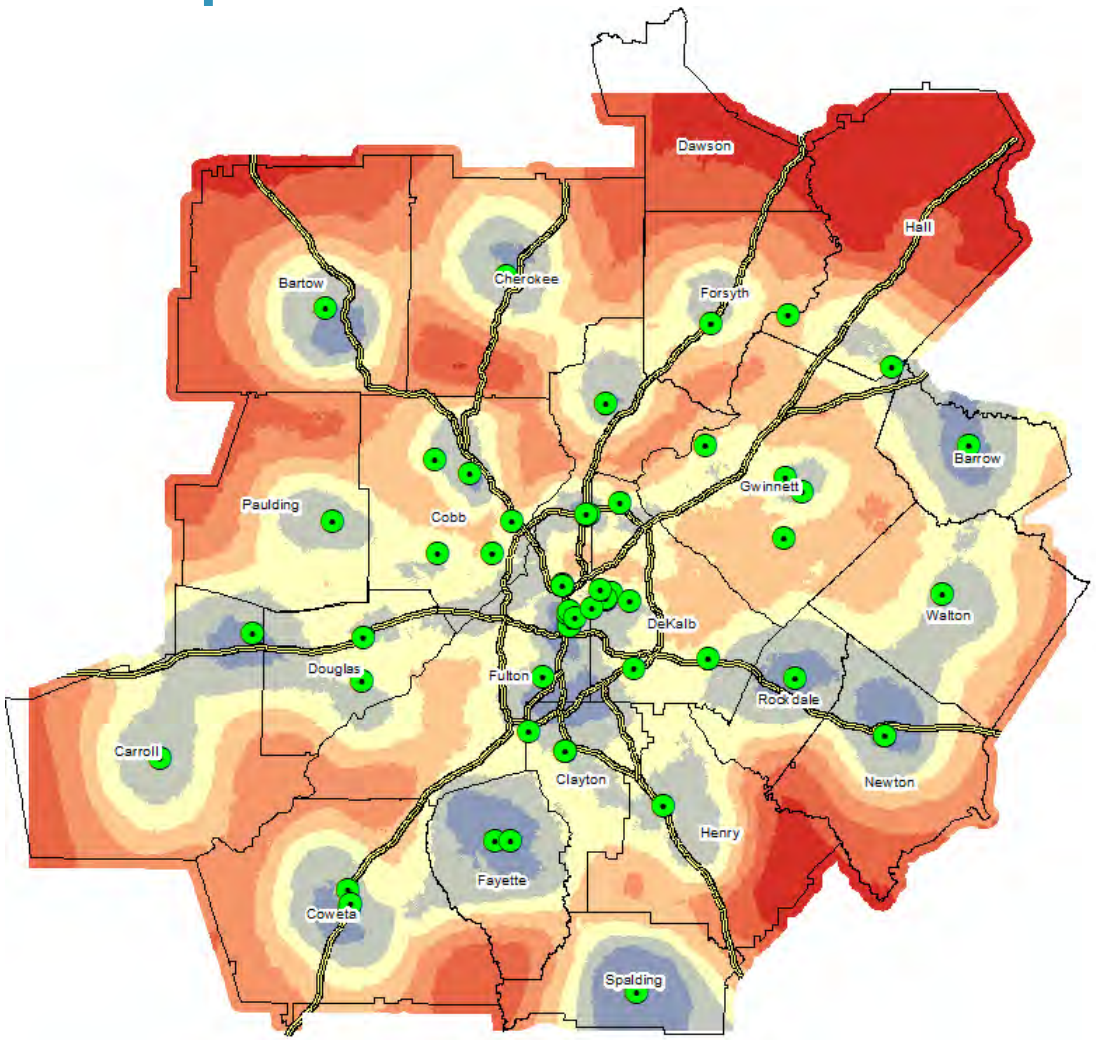
Photo source: www.news.gatech.edu

Regional Resilience Opportunities

Regional Resilience Opportunities



Hospitals



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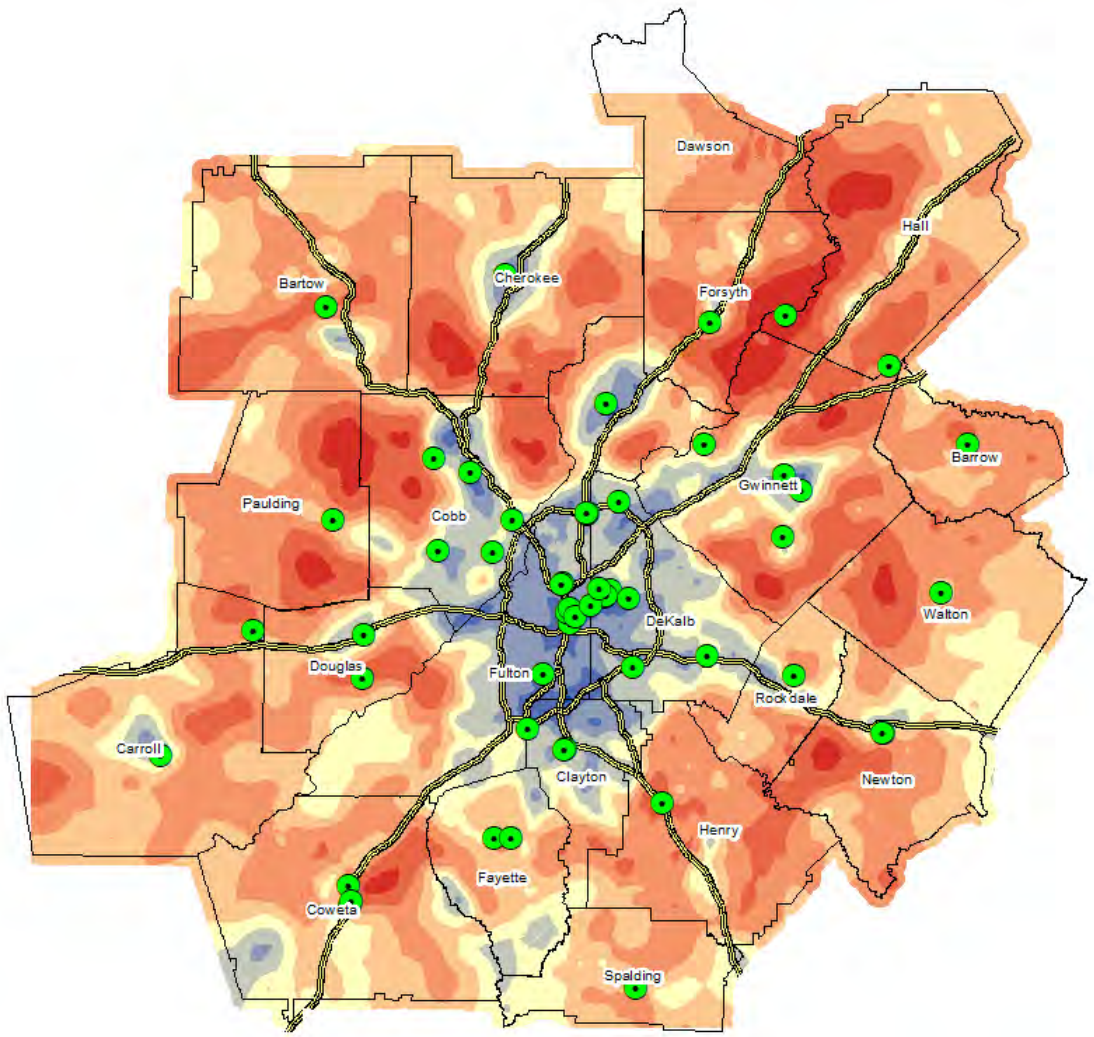
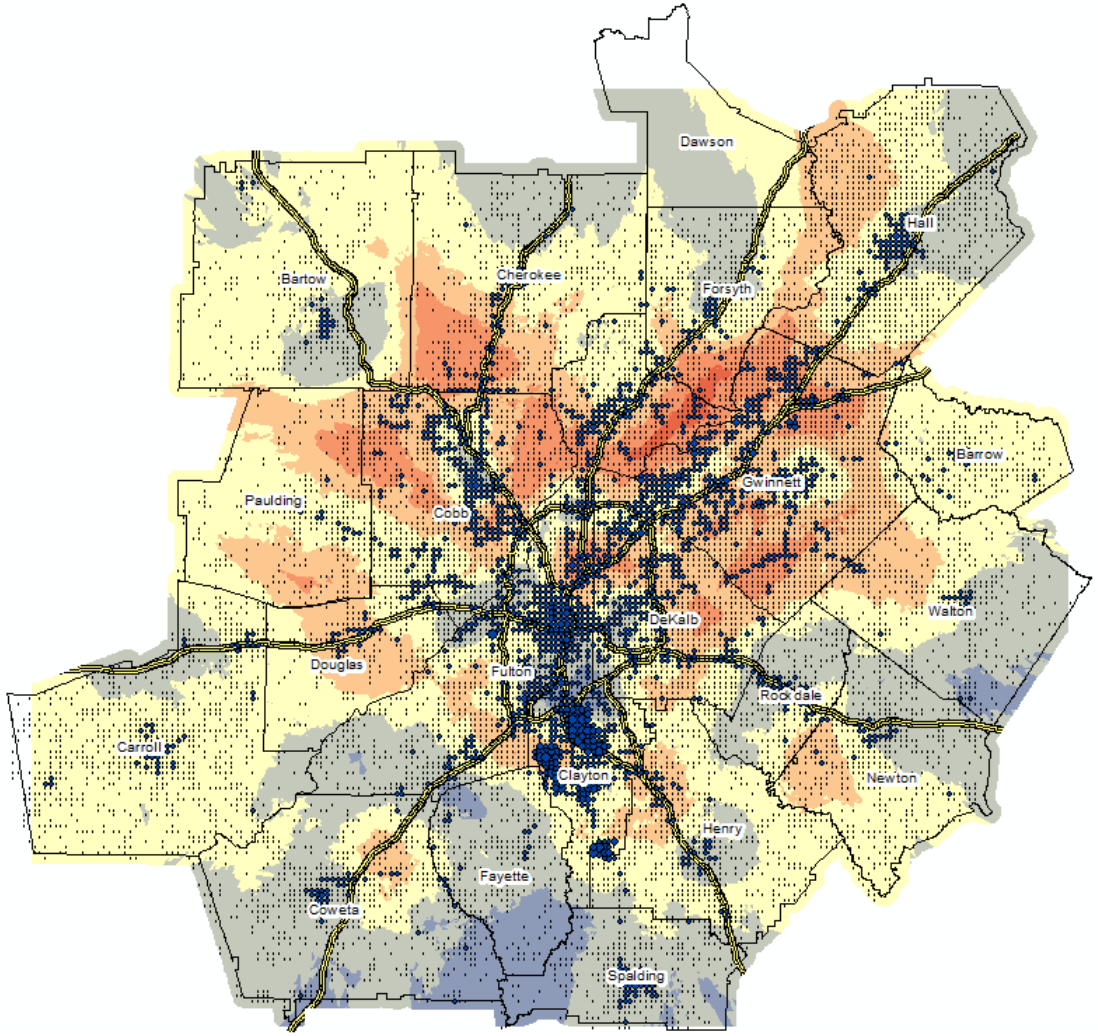


Transit

Meeting Demand

Not Meeting Demand

Commercial



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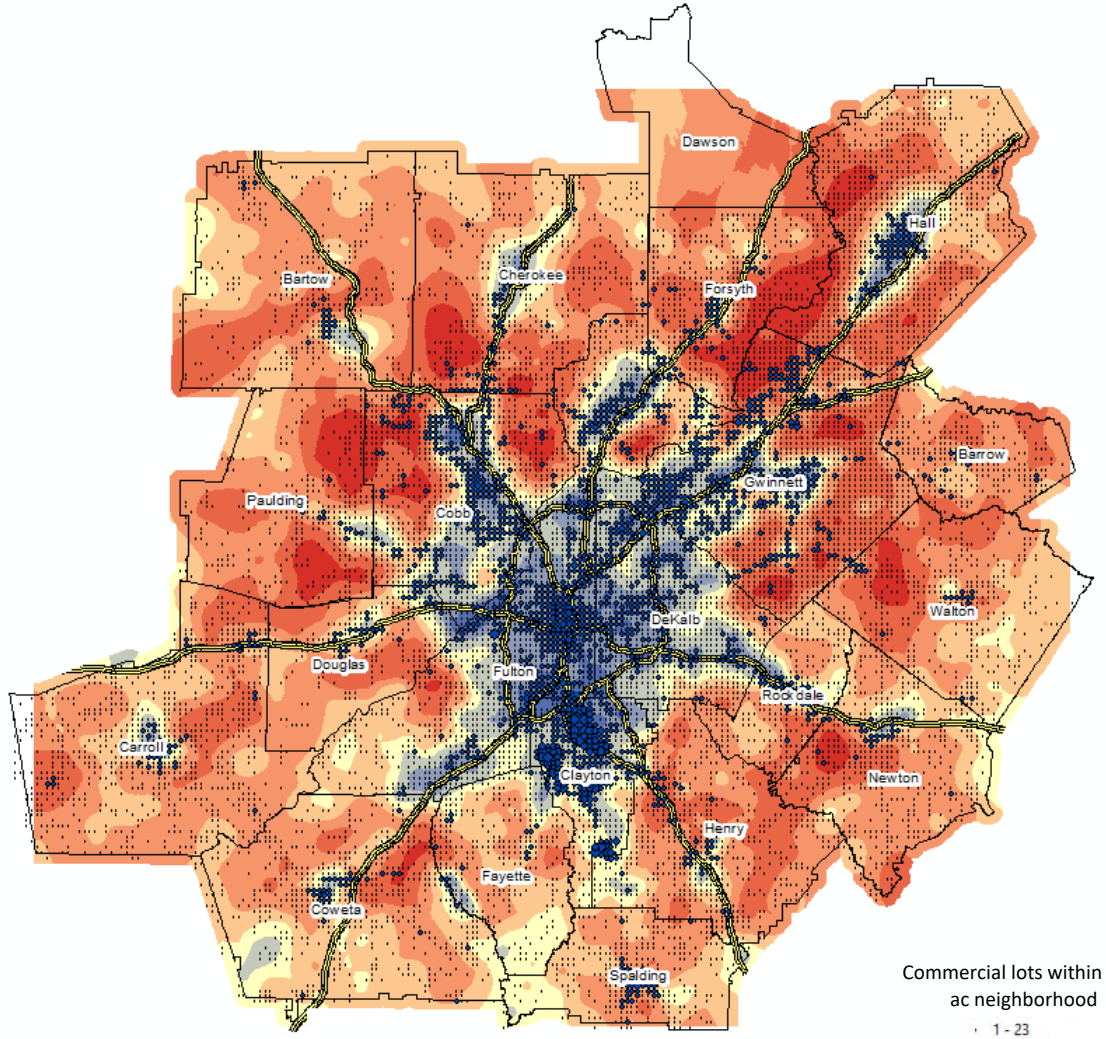


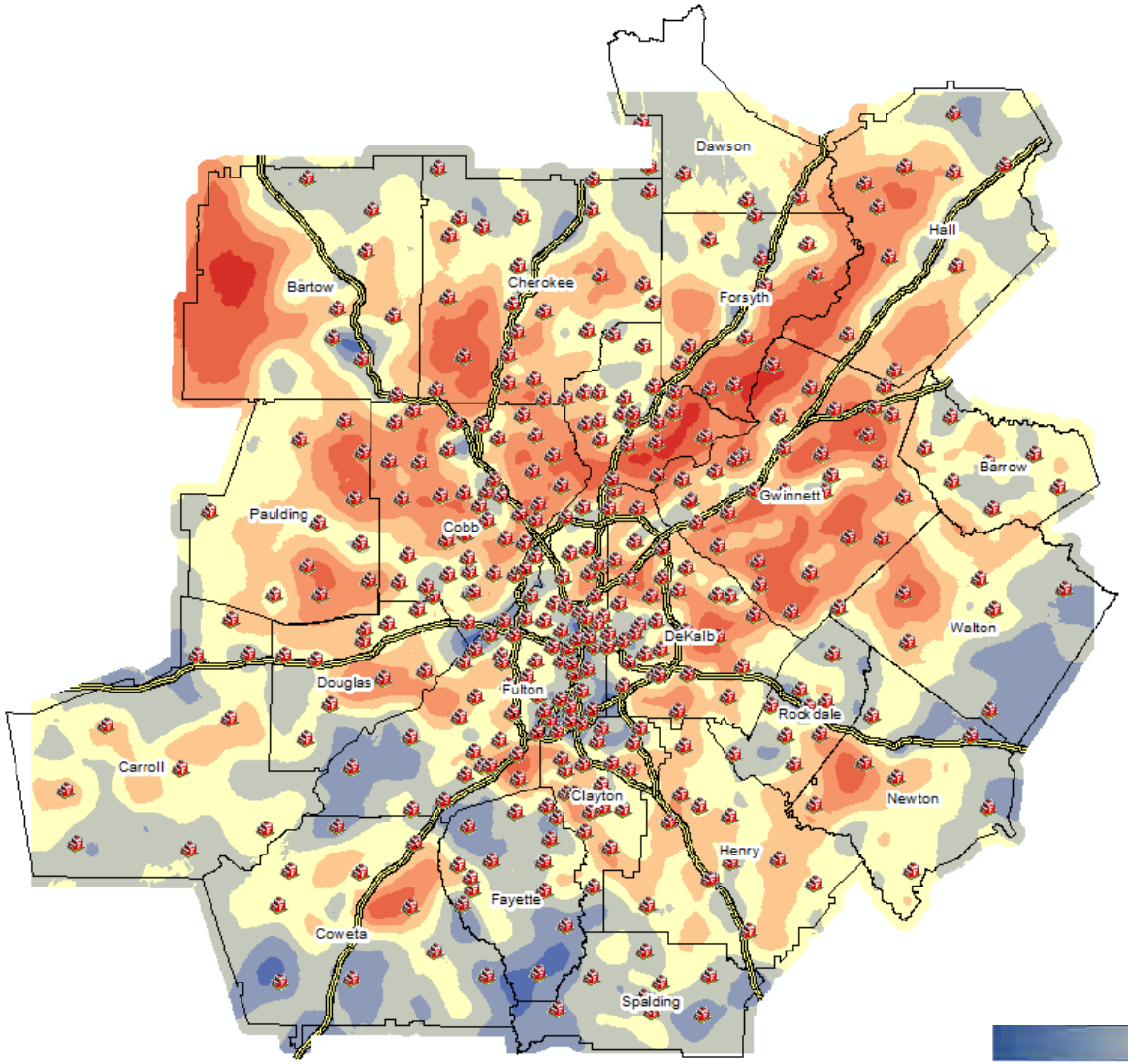
Transit

Meeting Demand — Not Meeting Demand

Commercial lots within 250-ac neighborhood

- 1 - 23
- 24 - 77
- 78 - 190
- 191 - 412
- 413 - 936

Fire Stations



Auto

Meeting Demand

Not Meeting Demand

Pilot Study

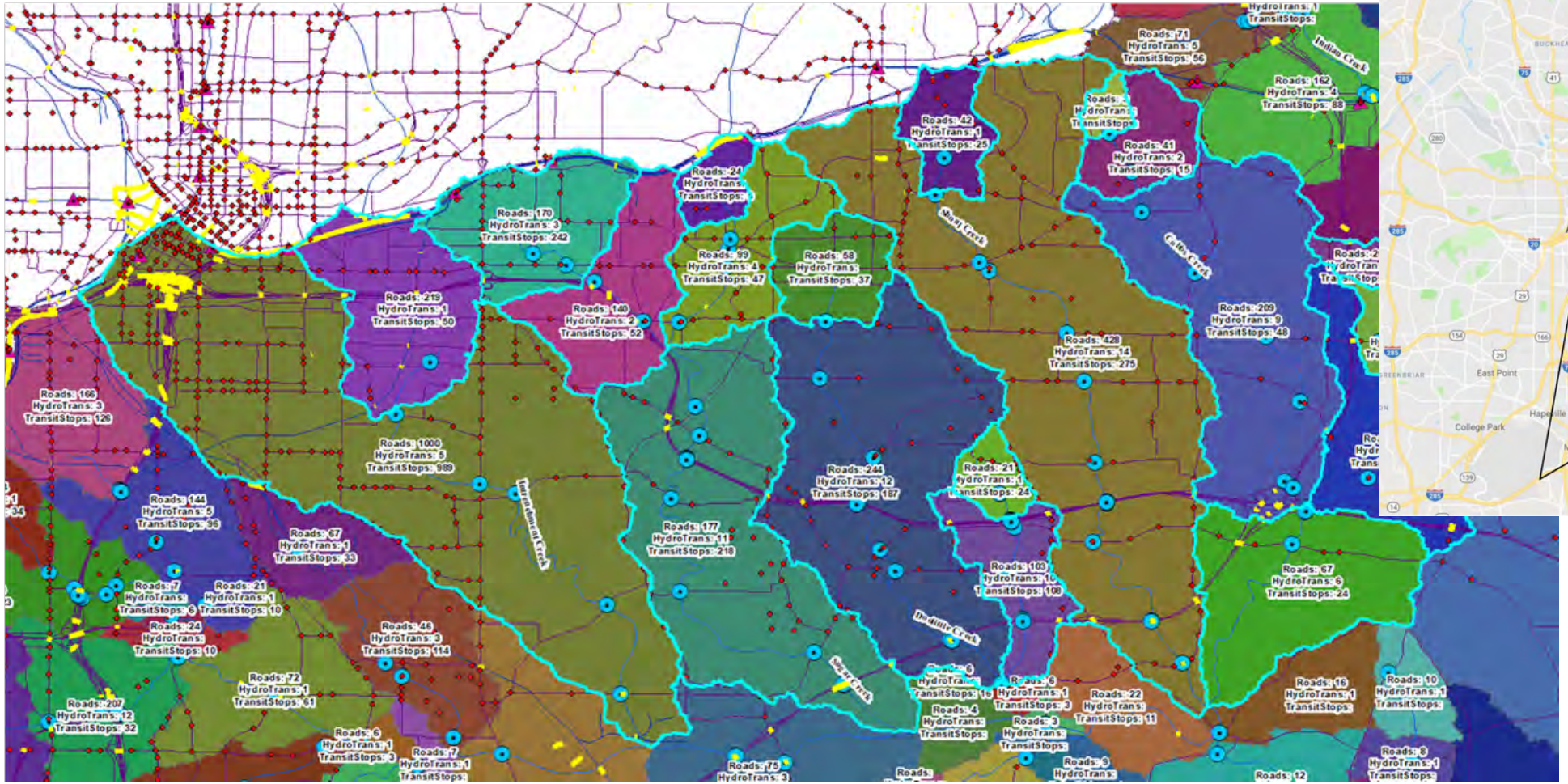
July 2012 Flood – Intrenchment Creek Watershed

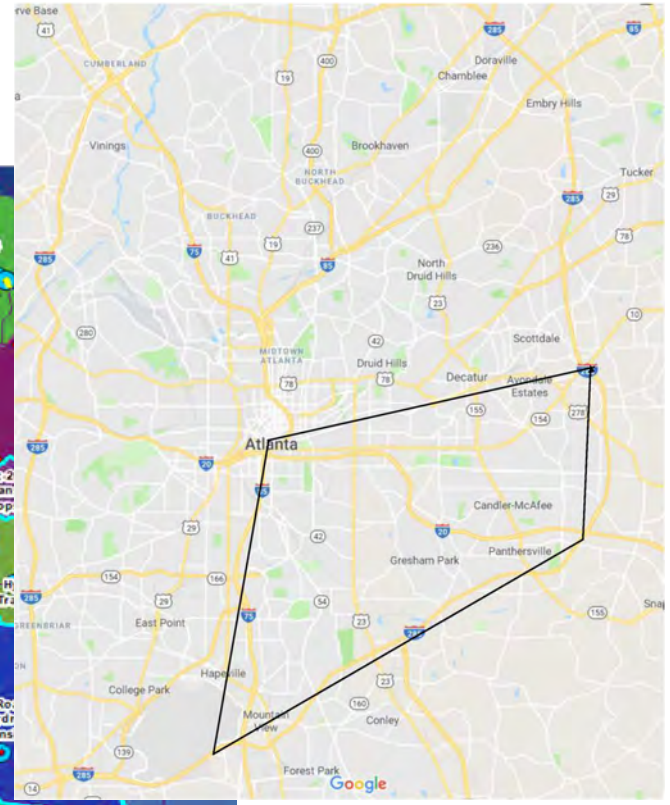
- Urban area with ongoing development – 60% impervious surface, prone to urban flooding
- 25-year, 4-hour storm event
- Damaged homes and vehicles, and compromised sewage system (raw sewage in floodwaters)
- One home in Peoplestown has flooded 4 times over 17 years
- Flooding likely to occur more frequently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

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Editor

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SDE

Base Year System | Scenario Builder | Simulation | Scenario Comparison

Green Infrastructure | Telecom | Coast | Power | Floodplain | Agents

Initial Setup | Buildings | Land | Roads | Transit | Stormwater | Water Supply | Wastewater

Explore | Create

Select Asset on Map

Show Stormwater Impact Footprint

1. Type	
SubType	
Type	Culvert
2. Identification	
3. Physical Properties	
4. Economic Properties	
5. Model Parameters	
6. Social Media	
Misc	
BuildQuality	
DamageCurve	
DamageTimeSeries	
DateBuilt	**1/1/1980**
DaysSinceLastEvent	**0**
DesignedUsingWellBriefing	**False**
Floodplain	**0**
HHSize	**0**
NumWorkers	**0**
RealEstateValueLossSeries	
SuperType	**StormwaterSystem**
TaxableValue	**0**
X	**-8800810**
Y	**4171600**

Name

ATKINS FUTURE PROOFING CITIES Simulator

Catalog

-8800271.999 4153072.087 Meters

Requirements for Forecasting Resilience

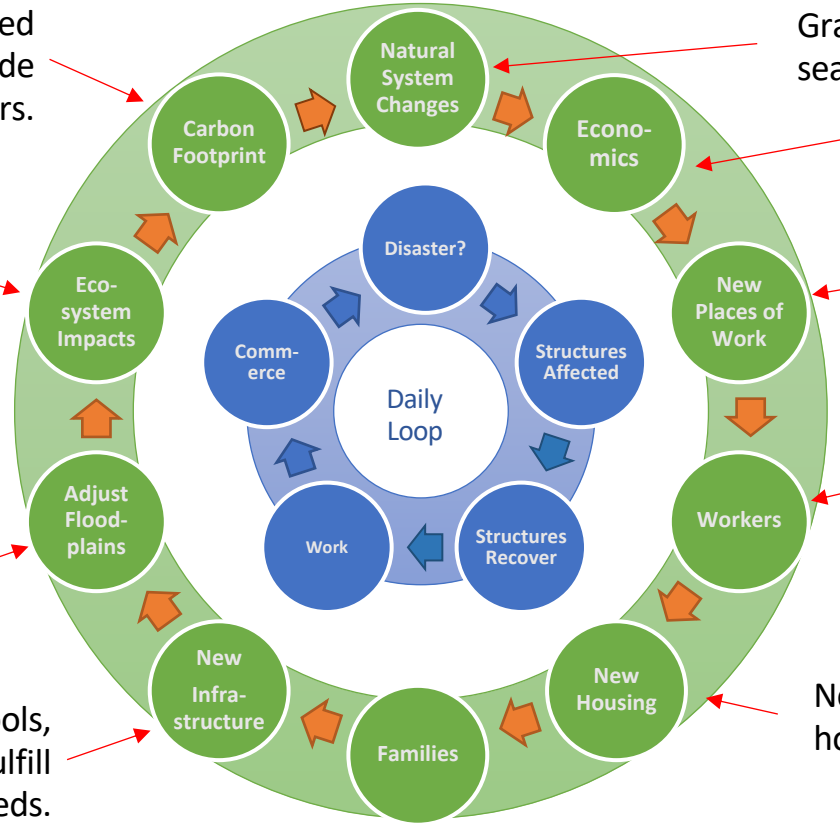
Carbon footprint evaluated from daily travel, city wide power usage, other factors.

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.



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.

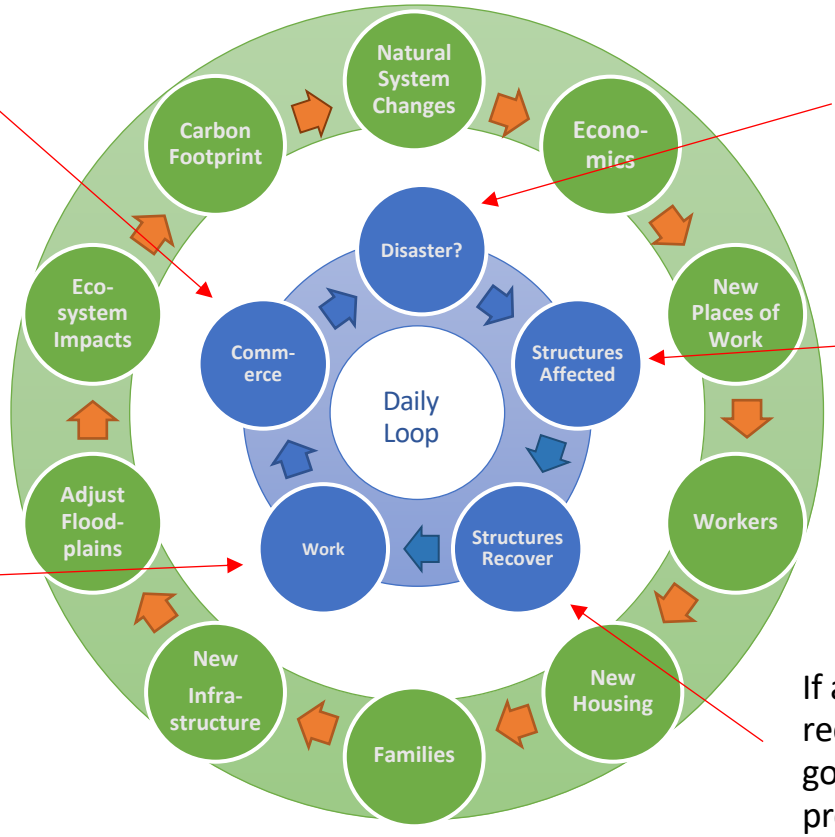
New workers receive housing, spouses, children.

Requirements for Forecasting Resilience

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

Yearly Loop (2019-2050)

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

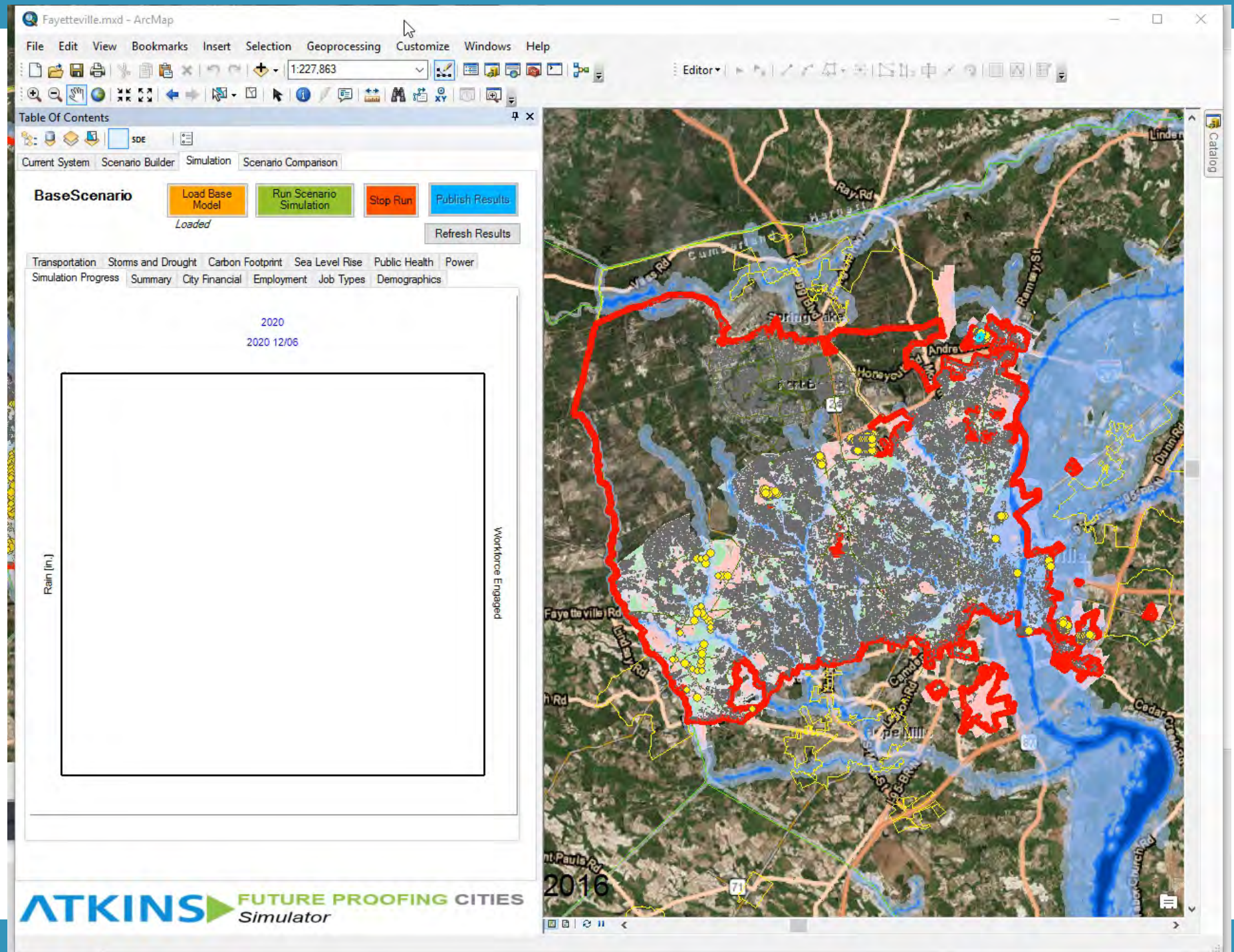


In each day of the year, a forecast determines if a disaster occurs.

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.


Fayetteville.mxd - ArcMap
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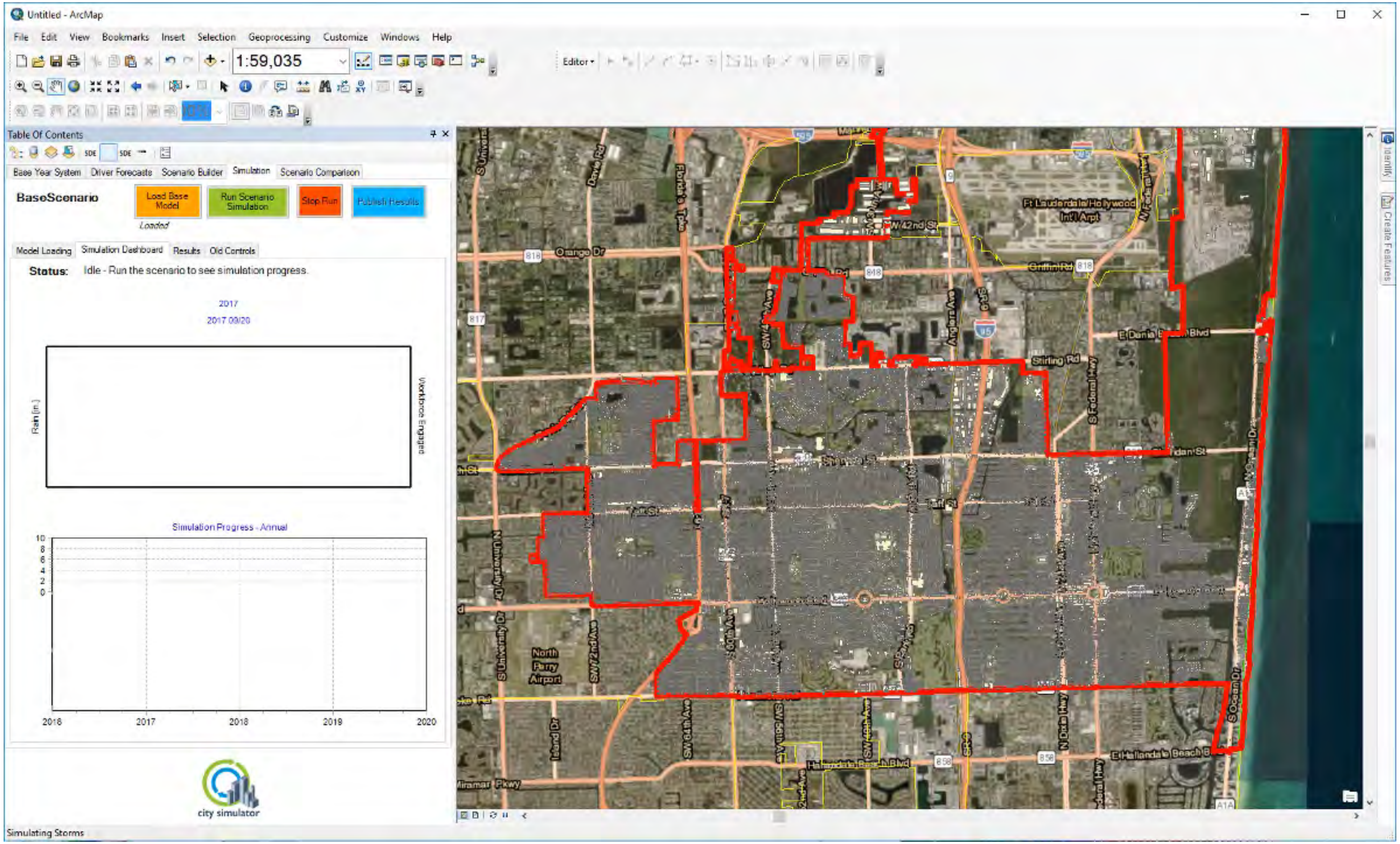
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Idle - Run the scenario to see simulation progress.
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2017 09/20
Rain (in.)
Workforce Engaged
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2018
2019
2020
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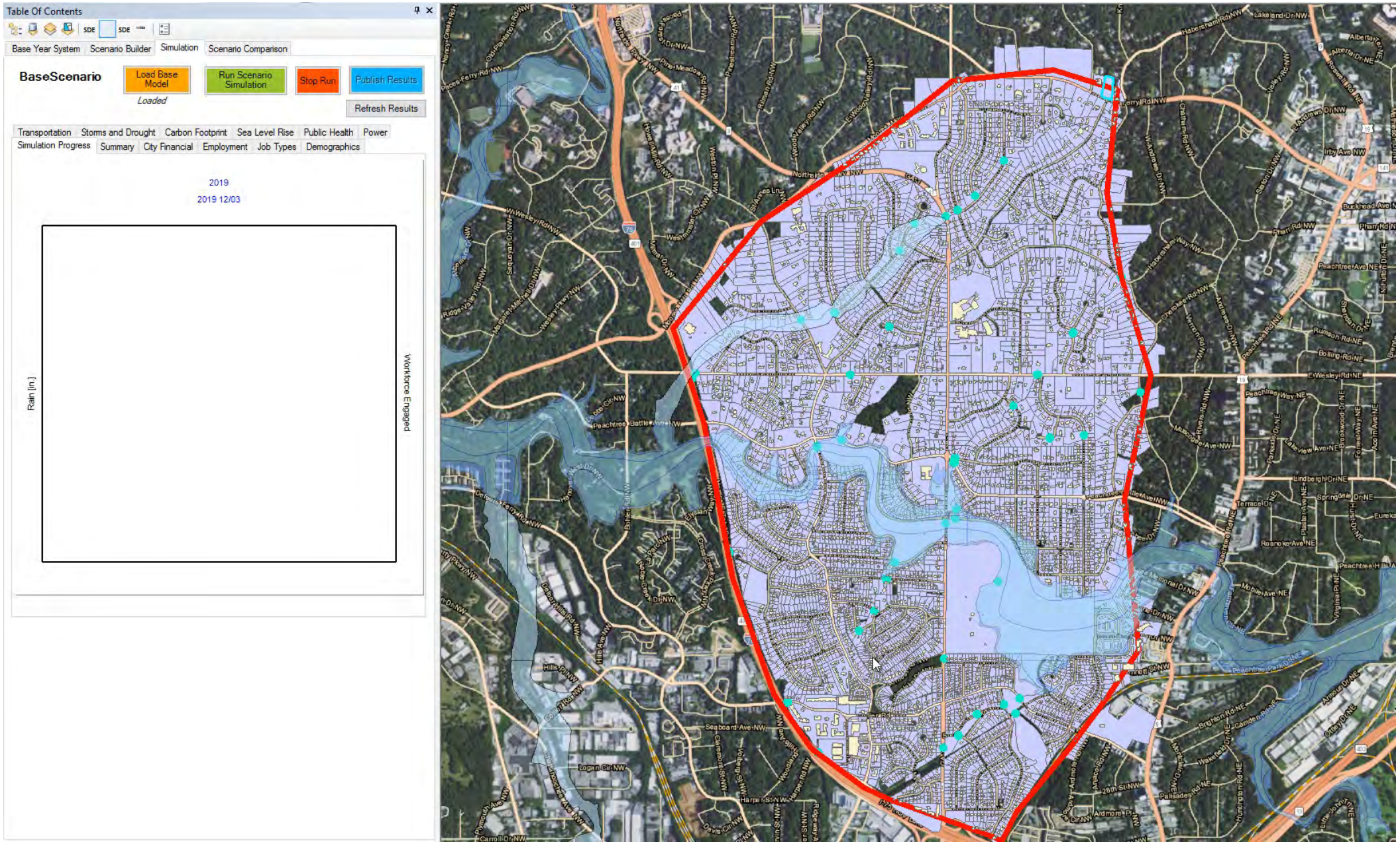
Simulating Storms
Ft Lauderdale/Hollywood Int'l Arpt
Orange Dr
Griffin Rd
W 42nd St
Stirling Rd
E Dania Beach Blvd
North Perry Airport
Miramar Pkwy
E Hallandale Beach Blvd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2019
2019 12/03
Rain [in.]
Workforce Engaged

Next Steps and Takeaways

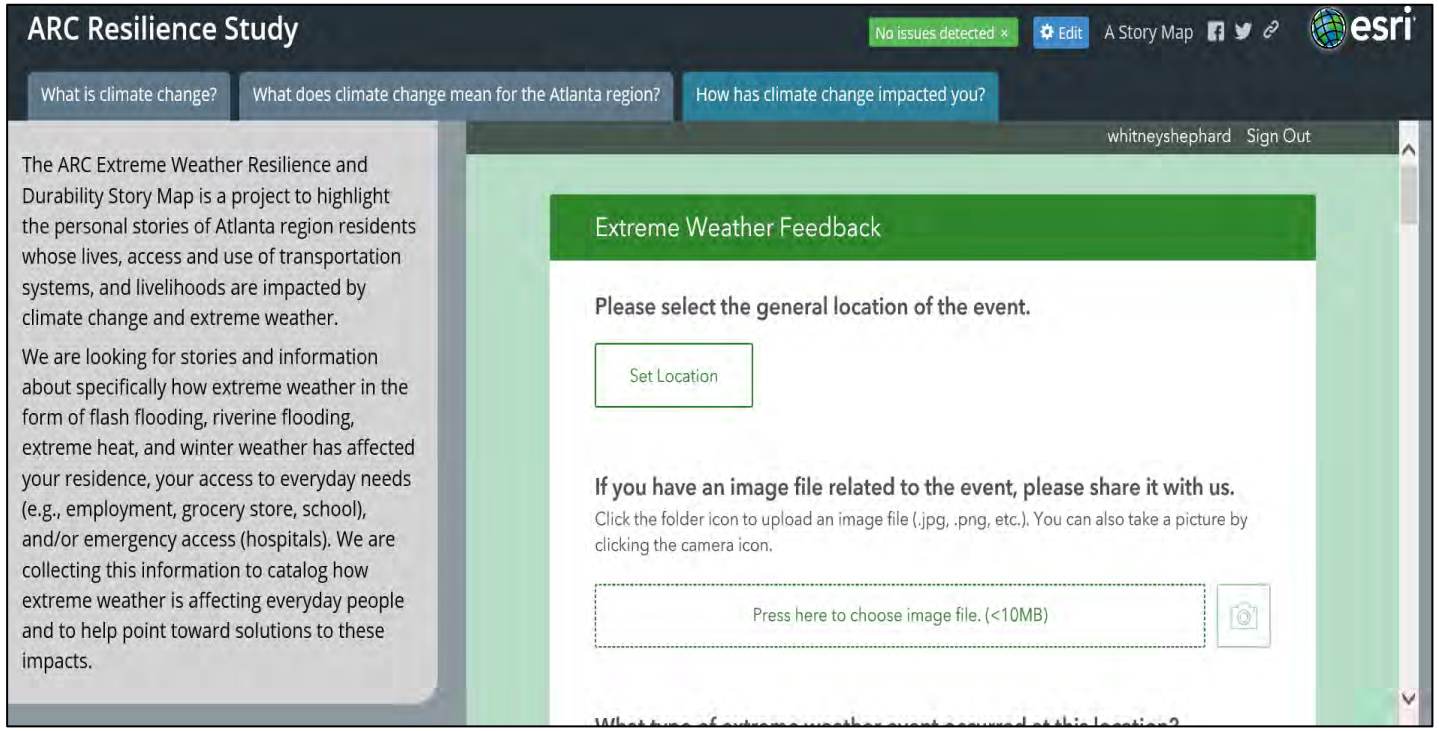
Impacts to Community

- 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)

https://www.fhwa.dot.gov/environment/sustainability/resilience/tools/

Questions?

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Thank you!