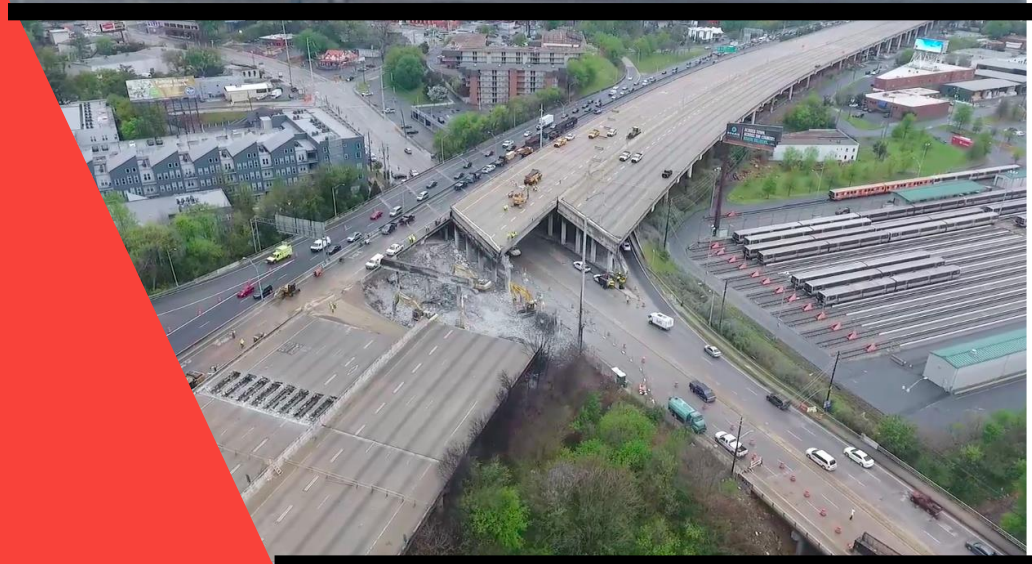
Planning for Resilient Communities

December 2017



From, Rebecca Van Dyke | Prerna Singh
Brianna Bolen | Sage Roberts
Nathan Foote | Ran Xu, Assessing Georgia's Emergency Infrastructure Repair Policies and Procedures

Program

9:00 - 9:15 Introductions and Purpose

9:15 – 10:00 Introduction to System Resilience

- Definition and Benefits of Planning Ahead
- Hazards and Impacts for the Atlanta Region
- Examples from Across the Country

10:00 – 10:30 John Hibbard, Director of Operations, GDOT, Responding to (and Learning from) Transportation System Disruptions

10:30 – 10:45 Break

10:45 – 11:30 Presentation of ARC Vulnerability Assessment Framework and Next Steps

- Incorporating Resilience into Regional & Local Planning
- Application to Different Transportation Modes
- Linkages to Planning and other Policy Issues

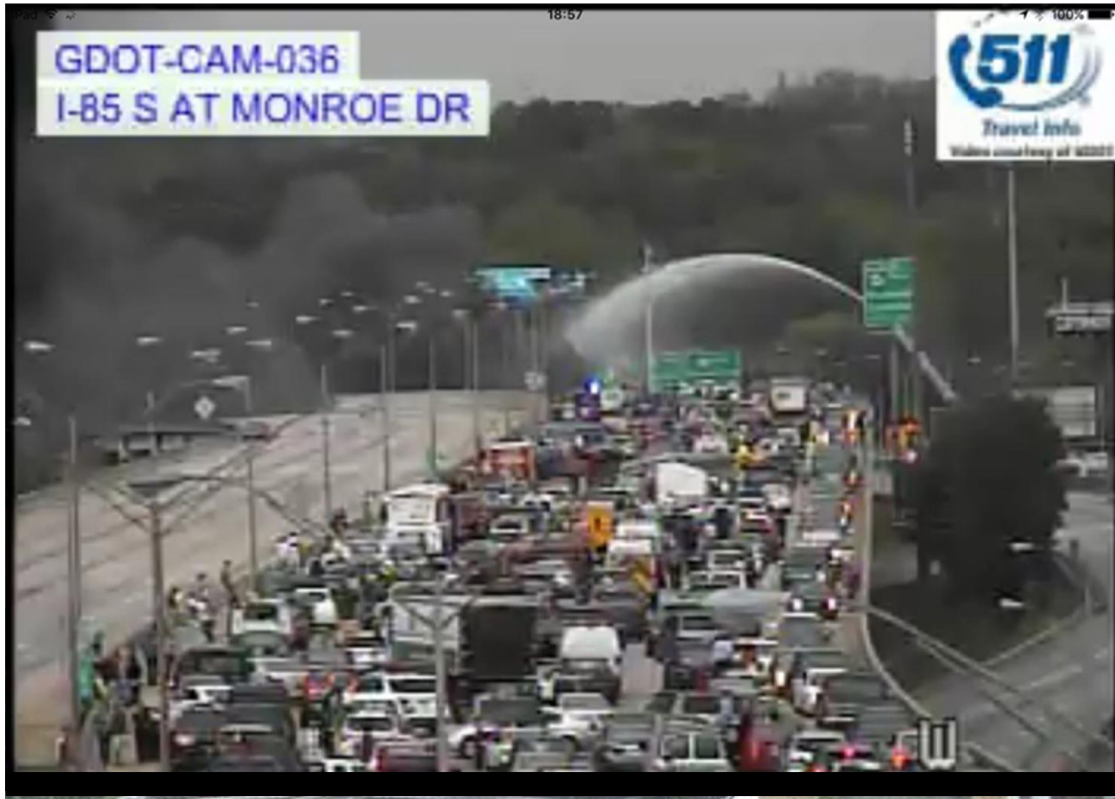
11:30 – 11:55 Paul Schramm, CDC – Climate Resilience and Public Health

11:55 – Noon Wrap Up

What is resiliency?

AASHTO DEFINITION:

The ability to prepare and plan for, absorb, recover from, or more successfully adapt to adverse events.



What are the Greatest Concerns for the Atlanta Region's Resilience?

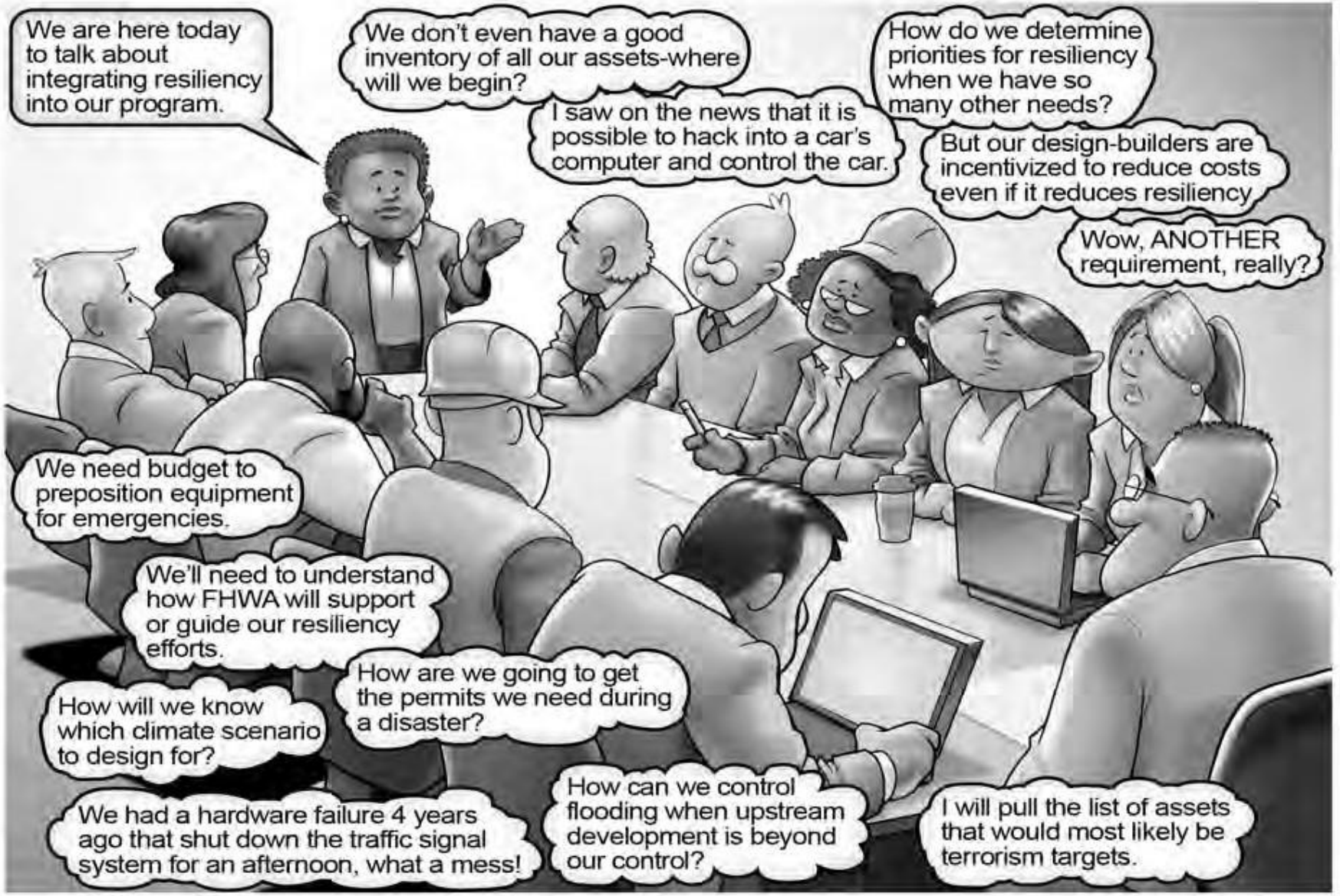
- Income inequality & social mobility
- Terrorism/accidents
- Extreme weather
- Climate change
- Water supply
- Economic diversity

The Rockefeller Foundation 100 Resilient Cities

SHOCKS AND STRESSES

- AGING INFRASTRUCTURE
- CYBER ATTACK
- DROUGHT
- ECONOMIC INEQUALITY
- INFRASTRUCTURE FAILURE
- RAINFALL FLOODING
- TERRORIST ATTACK

Just for transportation…..



Courtesy of WSP USA, Inc.

WHY? Or, What are the Benefits of Considering Resiliency in Planning?

- Reliable and efficient transportation system
- Likely to become more important in future
- Places emphasis on physical “connections” (cascading effects, dependencies, etc.)
- Places emphasis on institutional “connections”
- Broader implications to other policy areas
- Federal requirements

“Climate change could end cheap credit for Georgia, local governments, Moody’s reports.”

--- David Pendered, SaportaReport, December 4, 2017

“Governments that are at risk for higher risks of climate shock are asked to explain how they are prepared to deal with the weather events associated with climate shocks.”

FAST Act - Resilience Planning

- 49 US Code § 5303
  - It is in the national interest –
    - To encourage and promote the safe and efficient management, operations, and **resilient** development of surface transportation systems…

local relevance + regional impact

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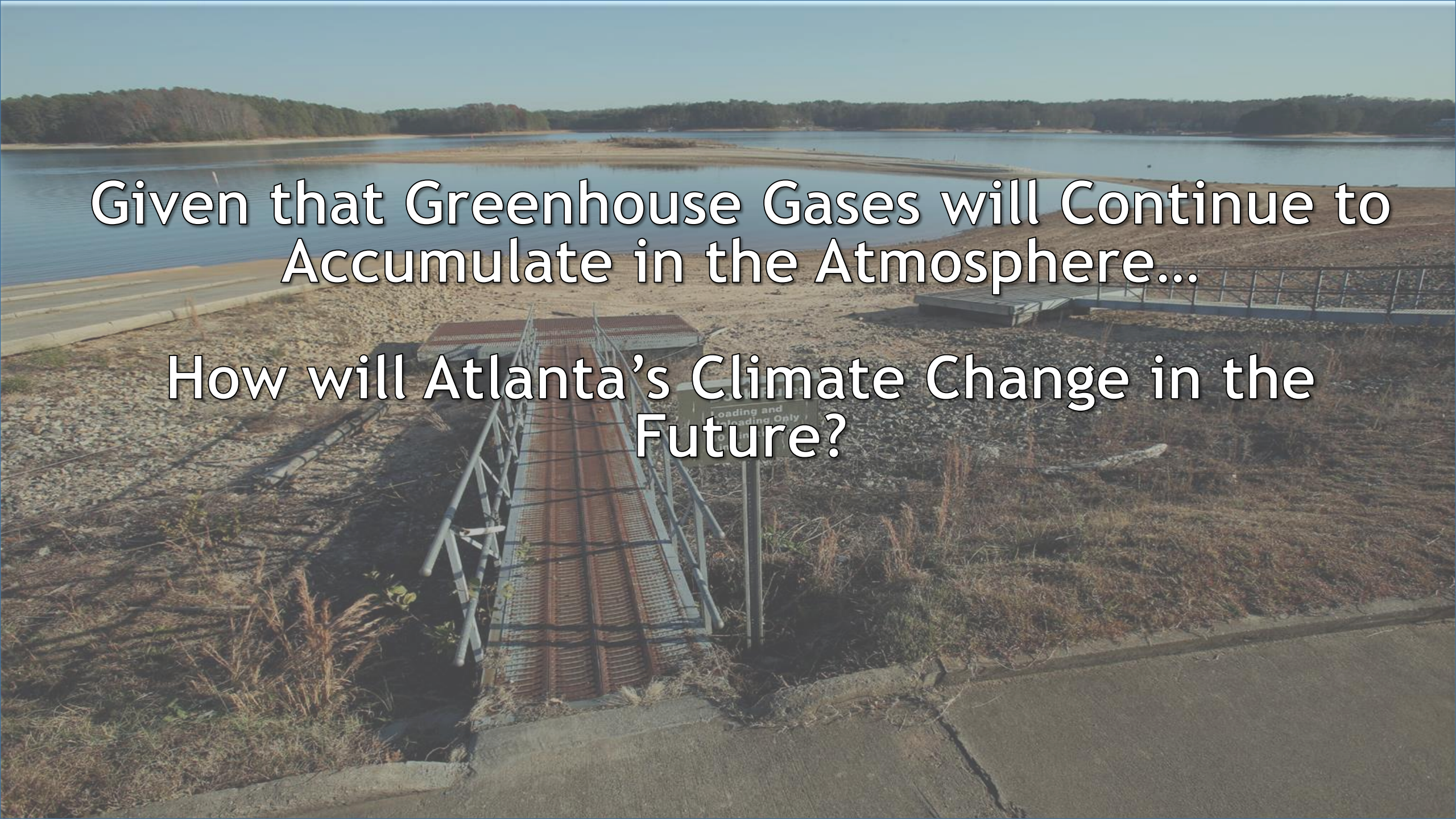
How is the US DOT Incorporating Resilience into Transportation Planning?

- Federal rules focus on the need to address system resilience by urging a reduction of natural disaster vulnerability

- USDOT is working with States and MPOs to:
  - Assess vulnerabilities
  - Consider resilience in the transportation planning process
  - Incorporate resilience in asset management plans
  - Address resilience in project development and design
  - Optimize operations and maintenance practices


Given that Greenhouse Gases will Continue to Accumulate in the Atmosphere…
How will Atlanta’s Climate Change in the Future?

What do Climate Models Say about Future Temperatures in the Atlanta Region?

local relevance + regional impact

Timeline	Days Above 92 °F	Consecutive Days above 92 °F
Baseline – Historic	18	7
2020-2050	51	19
2040-2070	64	31
2070-2099	84	50

Timeline	5th Percentile Temperature	Avg. Number of Days Below Freezing
Baseline – Historic	24°F	61
2020-2050	25°F	49
2040-2070	26°F	43
2070-2099	29°F	33

Factoids - Warmth

- In the 2010s Atlanta's seen an average of 32.4 days/year above 92°F
- 2007 GA Drought saw August with 28 days above 90°F
- By the end of the century our summer climate could be more like Houston, TX

Factoids - Cold

- Less extreme cold events will impact the plants that grow in our region - Atlanta region's hardiness zone has increased by 1 since 1990 (from 7 to 8)
- Days per year with a freeze will drop by half by the end of the century to around 33 (similar to Tallahassee, Florida)

What do Climate Models Say about Future Precipitation in the Atlanta Region?

local relevance + regional impact

Timeline	Avg. Total Annual Precipitation	Very Heavy Precipitation Events per Year
Baseline – Historic	52”	10.6
2020-2050	54”	11.9
2040-2070	54”	11.9
2070-2099	54”	12.1

Factoids - Precipitation

- In general, all emission scenarios think our region will tend to be wetter
- More large winter rainfall storm totals (1.5 times baseline)
- 10-20% more very heavy precipitation events annually
- About 50% more extreme precipitation events annually

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How Do These Changes Impact People?

Impacts of Extreme Weather on Transportation

local relevance + regional impact

- Aviation
  - Temperature impacts weight of plane at take-off
  - Tarmac can melt

- Roads
  - Change in freeze/thaw cycle → maintenance
  - Roadways can buckle and wash out
    (2009 West Atlanta Flood)

Douglas County Post Road 1 mile South of I-20

- Rail/Transit
  - Rail can buckle in extreme heat
  - Transit agencies run less frequent trains in extreme heat

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Impacts of Extreme Weather on Communities

- Public Health
  - Heat-related illness
  - Migration of people and disease

- Economic Competitiveness
  - Loss of crops & change in growing season
  - Loss of tourist land & infrastructure

local relevance + regional impact

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North Carolina

October, 2016, Hurricane Matthew

Forecasters were caught off guard…expecting mostly a wind event with impacts limited to coastal areas.

Greenville, North Carolina
2016

North Carolina

- **8 inches** of rainfall caused rivers and basins to flood quickly
- **1,600** roads were flooded
- **Several dams** in the state were threatened as a result of the rainfall and erosion
- The storm resulted in **26 fatalities**, many involving individuals who drowned in automobiles
- Property damage in the state was estimated at **$1.6 billion**

Nashville, North Carolina
2016

North Carolina

- Coordinating and planning for road detours is a challenge, as in-car GPS routing systems do not recognize state detours
- Road detour signs and barriers were ignored by some drivers, leading to drownings in certain cases
- Interdepartmental and inter-agency communication and coordination across the state is key
- Agreements and policy coordination essential

Fayetteville, North Carolina
2016

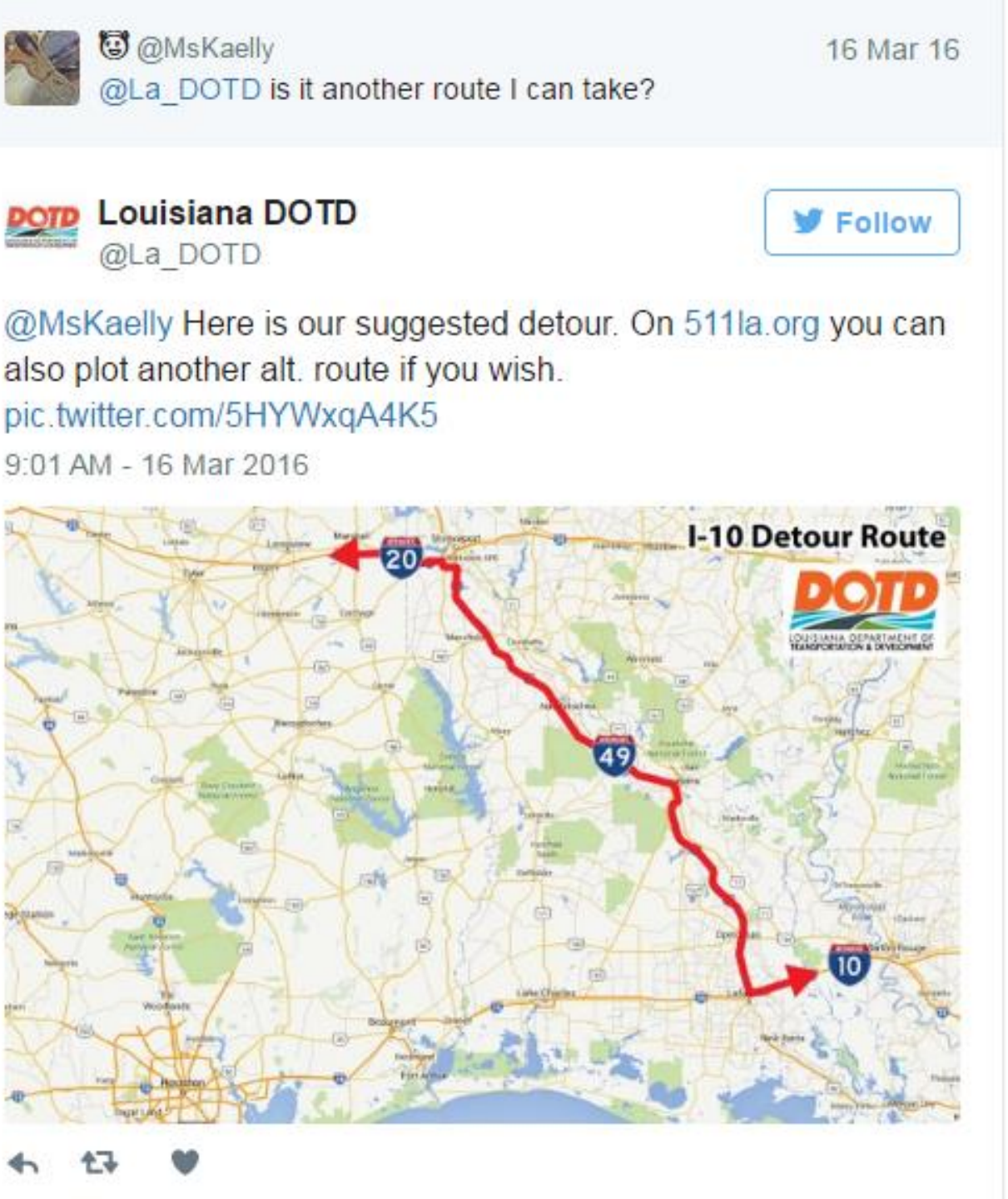
Louisiana

Major 500- and 1,000-year floods in 2016 caused rivers throughout the state to reach record levels as rainfall exceeded 2-3 inches per hour, and nearly two feet in total in some areas.

Denham Springs, Louisiana
2016

Louisiana

- **58 parishes** were declared disaster areas
- In 2016, **every interstate** in Louisiana **was closed** at some point
- Flooding of the Sabine River **closed I-10 for days** at the Texas / Louisiana border; no nearby alternate routes → lengthy detours
- Significant development in flooded areas ---impacts worse



Louisiana

- Communicating to the public via social media is imperative. “Old ways” like radio less effective
- Many LaDOTD staff experienced personal emergencies, which strained the DOT’s capacity to respond
- Relationships with other federal agencies (not just DOT) are important for disaster planning and response

Baton Rouge, Louisiana
2016

Cross Cutting Findings

We found three key categories:

EMERGENCY RESPONSE

Roseau Flood Risk Management
Montana, 2015

PLANNING AND DESIGN

Charlotte Hurricane Irene Response
North Carolina, 2011

EXTERNAL COORDINATION

Clearing taxiways at Atlanta Airport
Georgia, 2014

Transportation Planning and Resilience

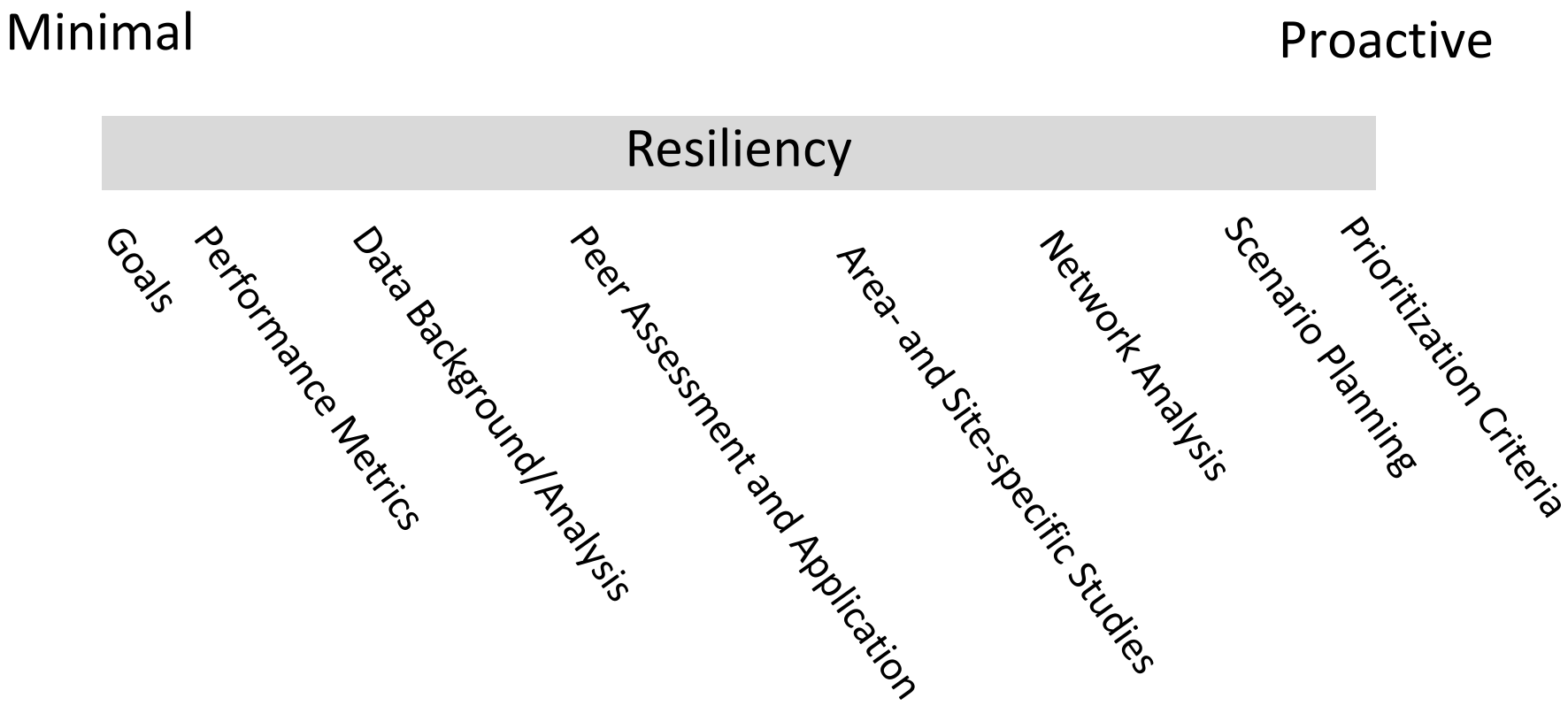
Relationship Between Resiliency and Transportation Planning

- Resiliency as a trend/factor in future system performance (scenarios)
- …… as part of the vision of a resilient and sustainable transportation system
- …… as reflected in system performance measures
- …… as part of defining state or regionally significant parts of the network (redundancy)

Relationship Between Resiliency and Transportation Planning

- Resiliency as helping to define parts of the study area where special consideration might be necessary during project development process
- …… as part of the data collection and analysis process
- …… as part of the evaluation and project prioritization process
- …… as part of the system performance monitoring effort

Considering Resilience in Planning and Policy



South Florida…Broward, Miami-Dade, Palm Counties

Transportation Planning and Prioritization

- Plan goals statement and prioritization criteria
- Performance measures
- Tools

Rehabilitation or Reconstruction of Existing Facilities in High Risk Area

- Road and transit design approaches and standards
- SLR as a “given”
- Drainage systems
- Asset and maintenance management systems

South Florida…Broward, Miami-Dade, Palm Counties

New Facility on New ROW in High Risk Areas

List above plus, realignments or relocation

Operations and Maintenance

Detour routes

Emergency response strategies

Harden assets

Maintain drainage systems

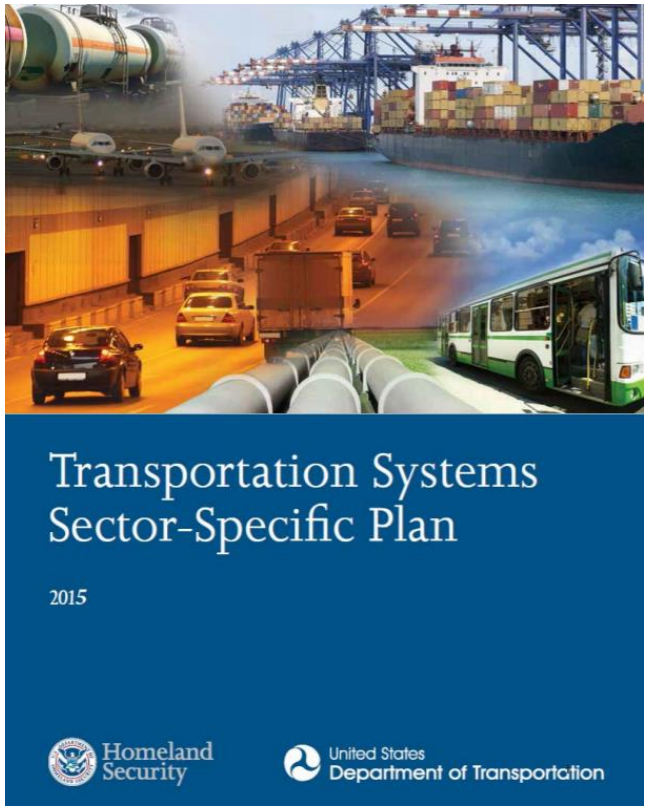
Responding to (and Learning from) Transportation System Disruptions

John Hibbard, Director of Operations,
Georgia Department of Transportation

NIST Community Resilience Planning Guide

Community resilience is the ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions.

Department of Homeland Security – Critical Infrastructure



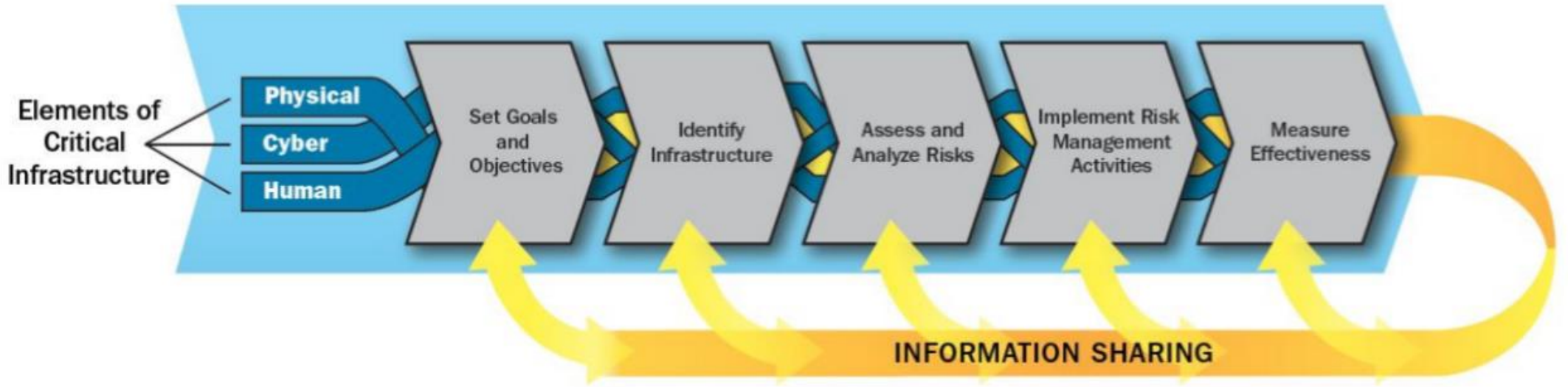
Goal 1: Manage the security risks to the physical, human, and cyber elements of critical transportation infrastructure.

Goal 2: Employ the Sector's response, recovery, and coordination capabilities to support whole community resilience.

Goal 3: Implement processes for effective collaboration to share mission-essential information across sectors, jurisdictions, and disciplines, as well as between public and private stakeholders.

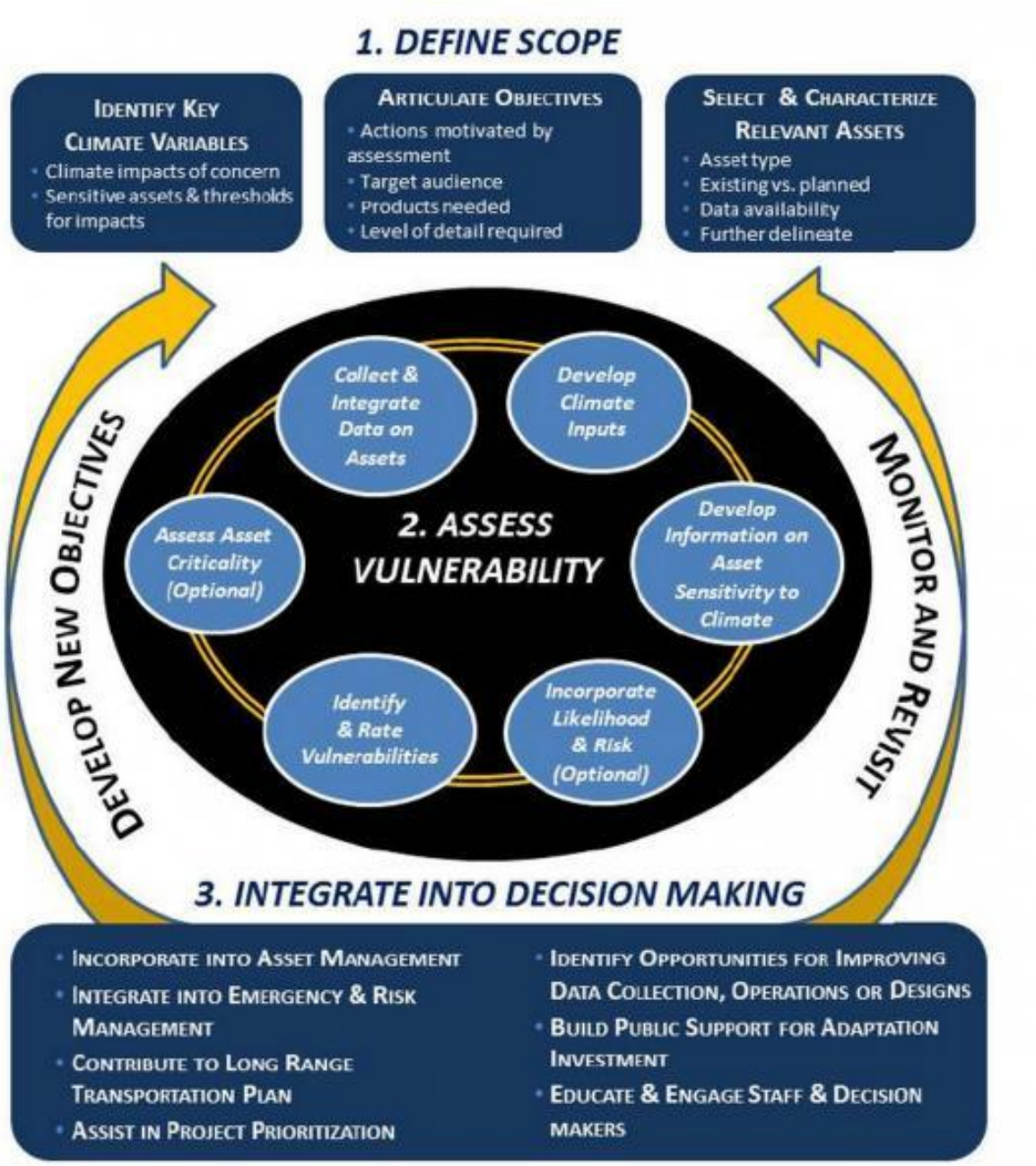
Goal 4: Enhance the all-hazards preparedness and resilience of the global transportation system to safeguard U.S. national interests.

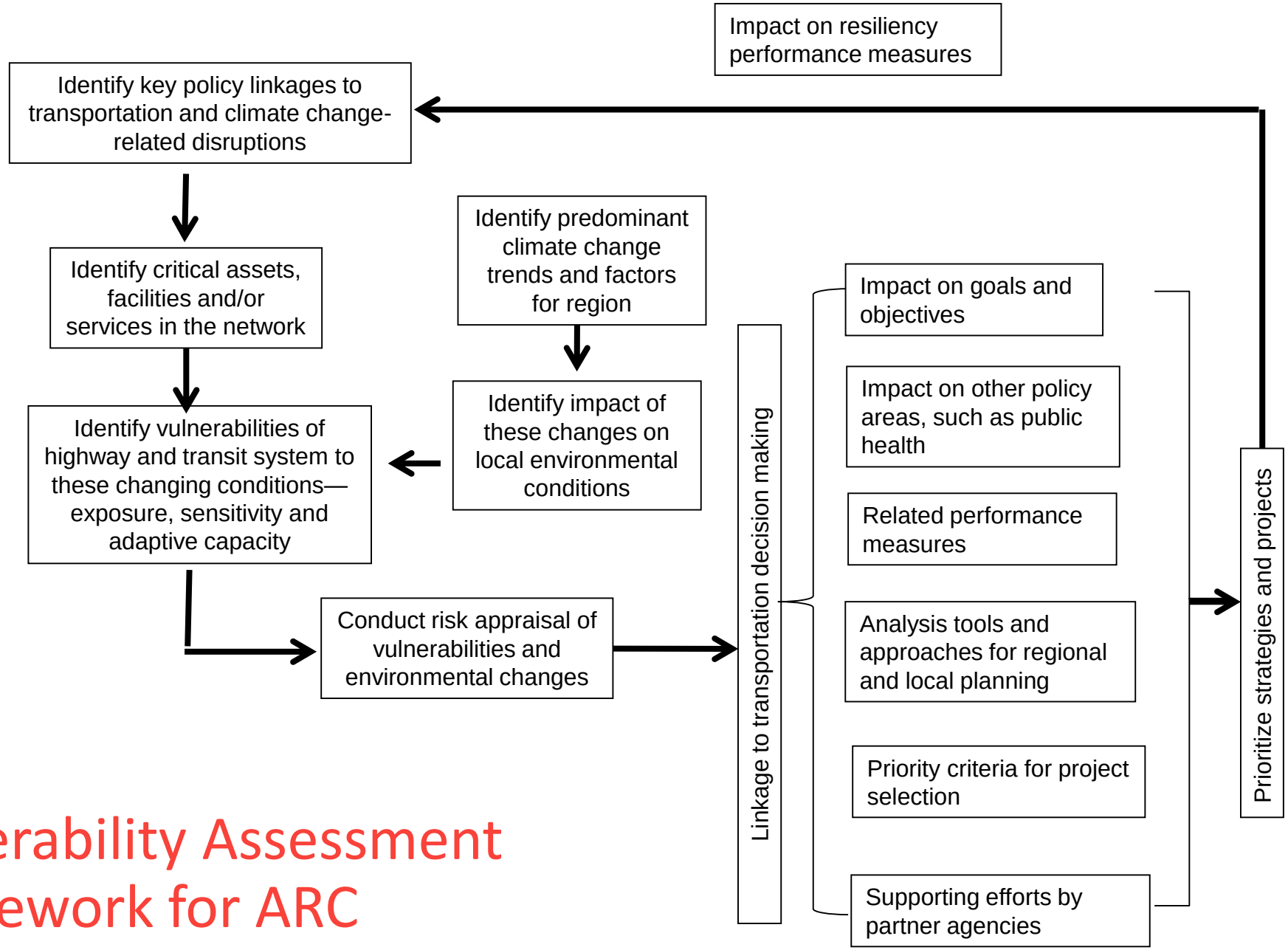
Department of Homeland Security – Critical Infrastructure



Critical Infrastructure Risk Management Framework (RMF)

FHWA Vulnerability Assessment Framework





Vulnerability Assessment Framework for ARC

Identify Key Policy Linkages to Transportation and Climate Change-related Disruptions

Hillsborough County MPO (Tampa)

Nashville Area MPO --- Vision

Middle Tennessee is resilient to the climate and non-climate stressors facing the region. Government, business, the natural and built environment, and people are minimally impacted by these risks, and the region supports livable, prosperous, sustainable, and diverse communities.

“Success would mean that regional and community leaders across all sectors and jurisdictions prioritize and sustain collaborative action for climate resilience.”

http://www.nashvillempo.org/docs/BuildingResilience_DRAFT.pdf

Nashville Area MPO

Goal 1: The region implements preemptive adaptation measures and responses to extreme weather events that are planned, coordinated, and timely.

Goal 2: The leaders and residents of the region value and protect water resources and prioritize improved water quality and conservation for the benefit of human and natural systems.

Goal 3: The region's growth and development promotes equitable prosperity and is sustainable for people and natural resources.

Goal 4: The region's leaders and organizations work collaboratively and effectively in all resilience actions.

http://www.nashvillempo.org/docs/BuildingResilience_DRAFT.pdf

Goal 1: The region implements preemptive adaptation measures and responses to extreme weather events that are planned, coordinated, and timely.

1. Conduct detailed transportation infrastructure vulnerability assessment to extreme weather within the MPO planning area. MPO, TDOT, FHWA, VU
2. Map service gaps of storm shelters throughout the region. MPO, OEMs, the Red Cross, TSU
3. Ensure that all emergency response and hazard mitigation plans consider the impacts of climate change to the region and are including this information in their plans. MPO, OEMs
4. Participate in decision making process for flood wall for downtown Nashville. TBD
5. Conduct heat mapping for urban areas. MPO, TPL
6. Conduct workshops for vulnerable populations on emergency preparedness and access to services. SEARS, OEMs, TIRRC, the Red Cross
7. Develop climate metrics for MPO evaluation of proposed transportation projects. MPO, TDOT, FHWA
8. Ensure adequate maintenance of existing transportation infrastructure.

http://www.nashvillempo.org/docs/BuildingResilience_DRAFT.pdf

Relationship Between Resiliency and Transportation Planning

Puget Sound Regional Commission

“Resilience and Sustainability”

Identify Critical Assets, Facilities and/or Services in the Network

Critical Assets in Tampa

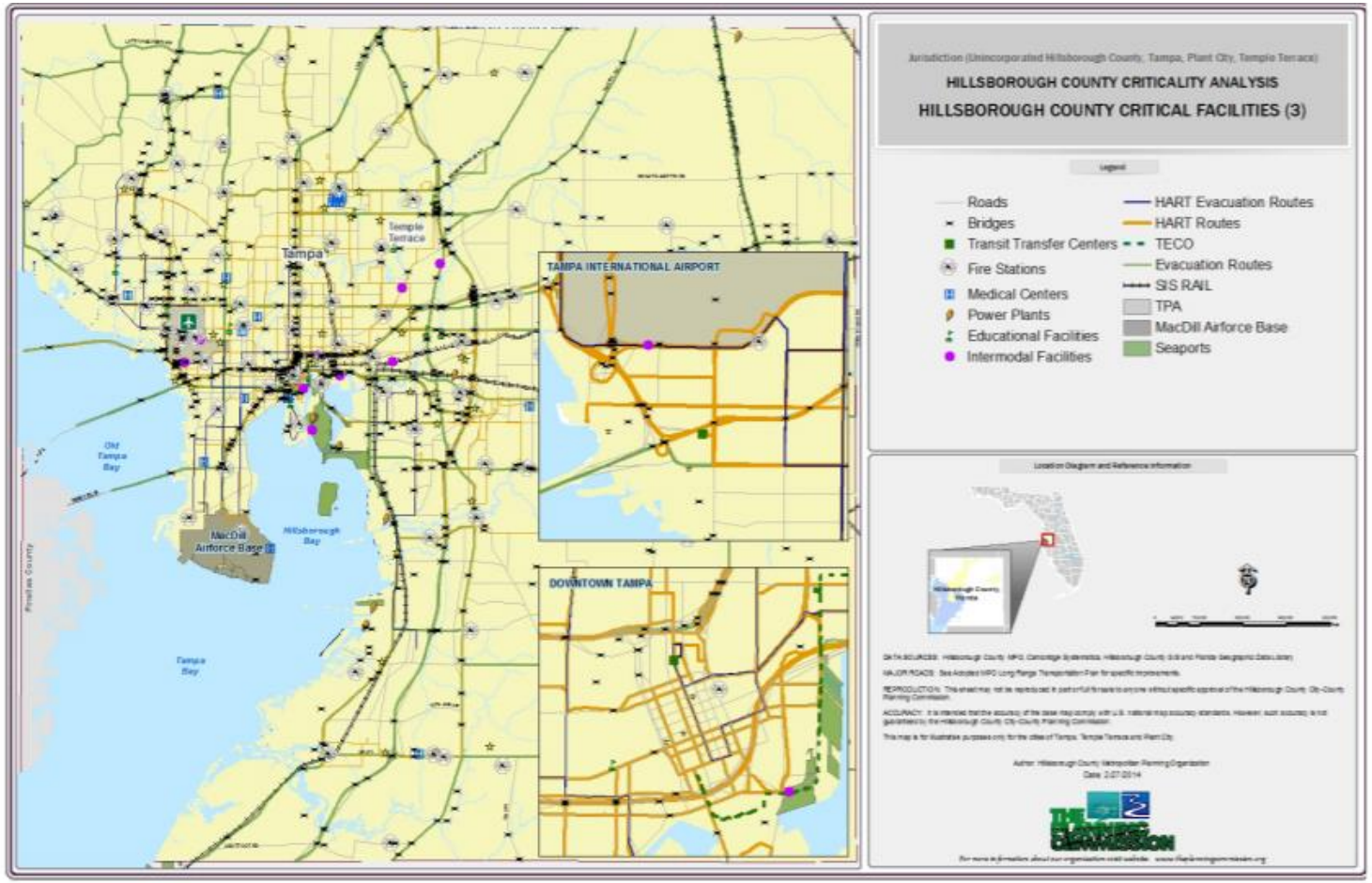


Figure 1. Image from Transportation Asset Geodatabase

Identify Vulnerabilities of Highway and Transit System to These Changing Conditions—Exposure, Sensitivity and Adaptive Capacity

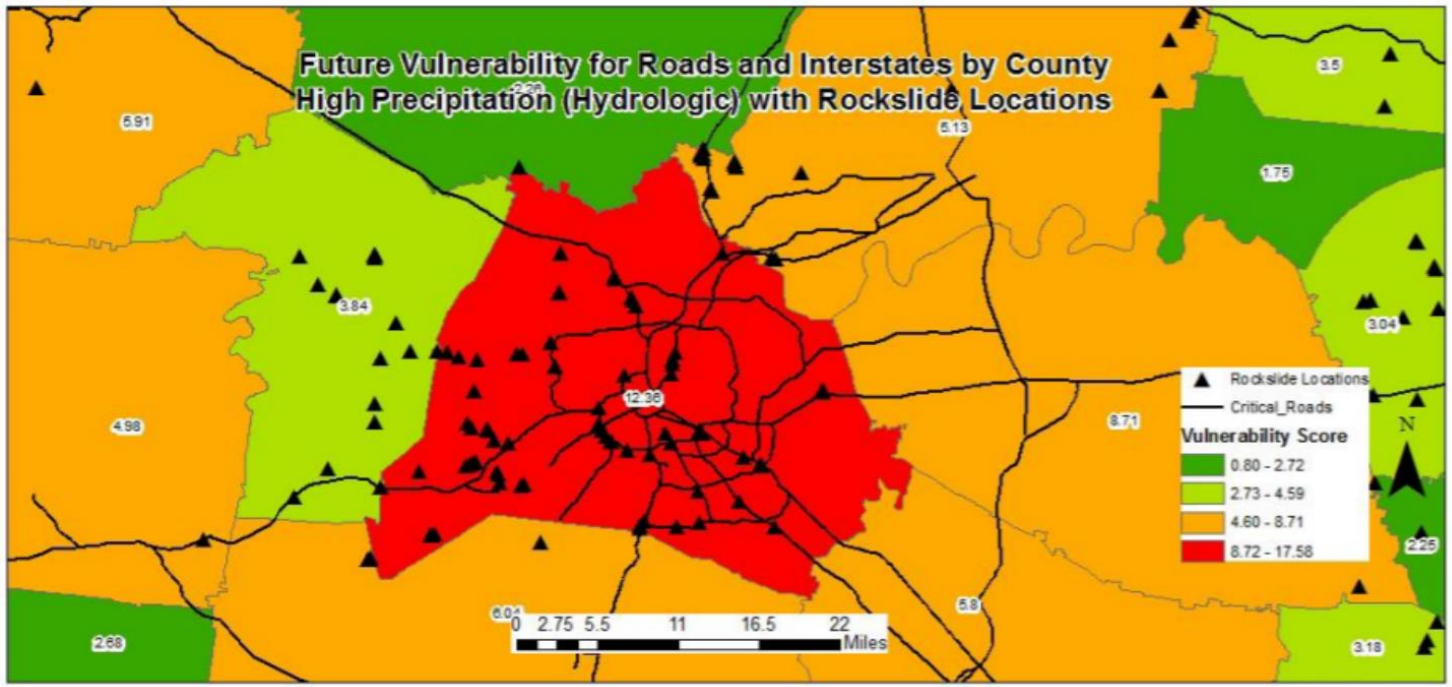


Figure 15: Future vulnerability for critical roads to hydrologic events & rockslides

Source: TDOT vulnerability report, p. 33

Nashville Area MPO

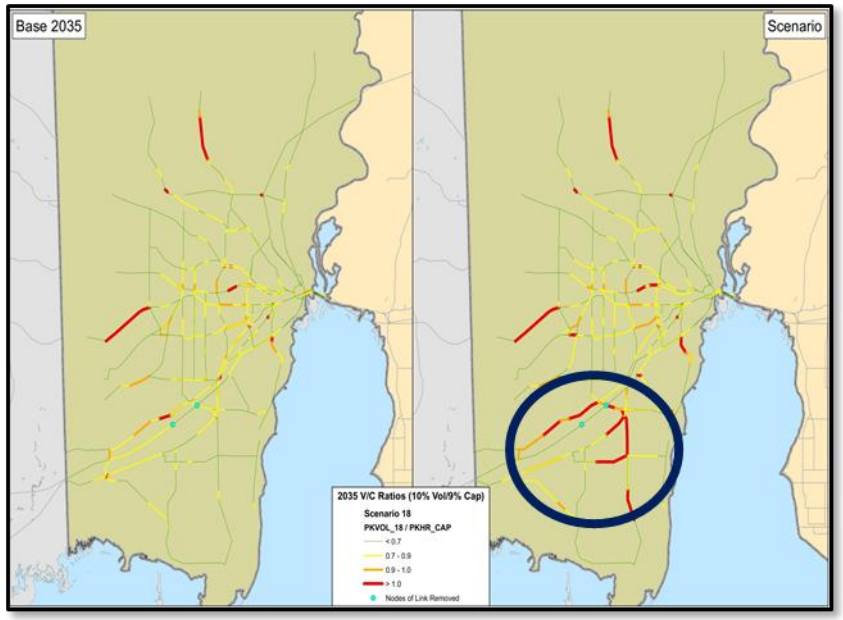
http://www.nashvillempo.org/docs/BuildingResilience_DRAFT.pdf

Extreme Weather Sensitivity Thresholds in Austin, Texas

Impact	Modes Affected	Threshold
Flooding	Highways, Rail, Transit	General flood risk increases when >2" in less than 12 hours; Rural roads >3.44" in 24 hours; principal arterials >7.64" in 24 hours; Major highways >10.2" in 24 hours
Pavement cracking or other deterioration	Highways, Aviation	Extended temps. >100 °F; average 7-day max. temp >108 °F; drought lasting longer than 14 days; alternating wet and dry weather patterns; extremely wet conditions for >1 month; temps. < 50 °F
Thermal misalignment	Rail	Risk increases when surface temps. >100 - 115°F
Air conditioning stress and failures	Rail, Transit, Aviation	Temps. >100 °F
Limited ability for maintenance and construction work	Highways, Rail, Transit	Temps. >100 °F
Icy, unsafe road conditions	Highways	Surface temps < 32 °F and precipitation (any)
Damage to switches	Rail	Surface temps < 32 °F and (precipitation > 3/16" of ice)
Wildfire	Highways, Rail, Transit	Drought index > 575; relative humidity <20%; winds > 15-20 mph; La Nina conditions favoring wildfire outbreaks

Mobile, AL – Identifying Vulnerabilities

Highway Assessment Included “Redundancy” Test



Applied Forecasting Model

1. Tested loss of 18 selected links in highway network
2. Based on V/C ratios for peak hour
3. Determine whether remainder of system can accommodate travel patterns

Identify Predominant Climate Change Trends and Factors for Region

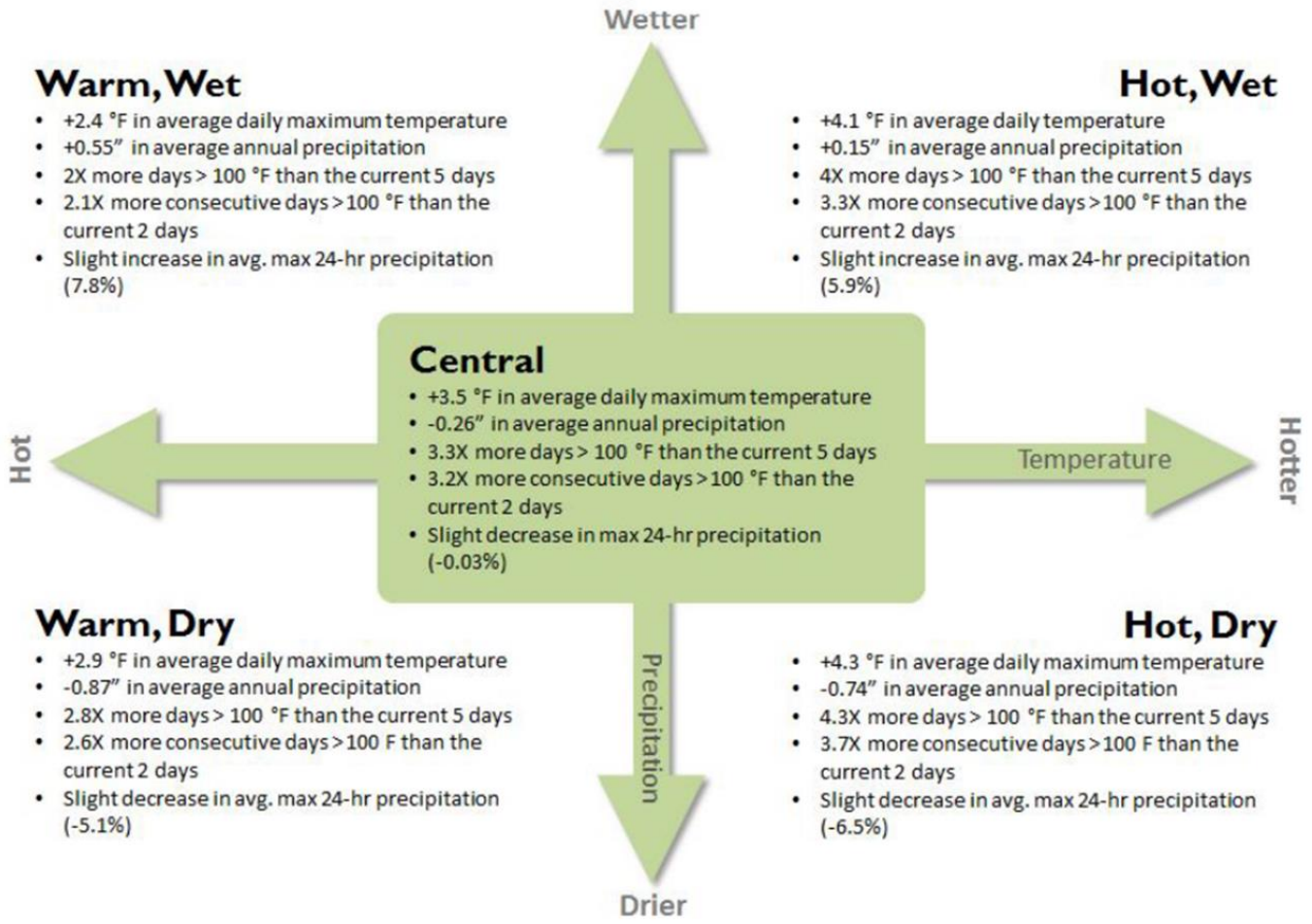


Figure 3. Summary of Climate Change Futures for the Year 2040 for Central New Mexico. Source: Volpe Center.

Albuquerque, New Mexico

Implications for the Region

- Transportation-related
  - Higher maintenance costs (e.g., faster pavement deterioration)
  - Construction and operations implications (e.g., shorter construction season)
  - More damage from extreme events (e.g., flash floods, wildfires, and landslides)
- Land Use/Regional Planning
  - More frequent water shortages
  - Greater power demand
  - Higher vulnerability for development near riparian areas/on the urban-wildland interface

Mid-Region Council of Governments

Example Application – Bridge over River

Identify predominant trends and factors for region

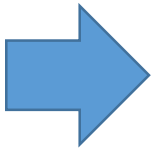
- Precipitation
- Heat
- Terrorist attack
- Major crash

Identify impact of these changes on local conditions

- Precipitation → Flooding?
- Heat → Locally high temperatures over extended period
- Terrorist attack → Destructive capability
- Major crash → Lengthy closure

Example Application – Bridge over River

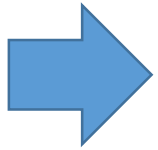
Identify vulnerabilities of highway and transit system to these changing conditions—exposure, sensitivity and adaptive capacity



- Precipitation ➔ Deck overtopping? Scour? Bank erosion?
- Heat → Materials resiliency?
- Terrorist attack → Level of blockage and ability to still serve traffic/system redundancy
- Major crash → Lengthy closure/system redundancy

Example Application – Bridge over River

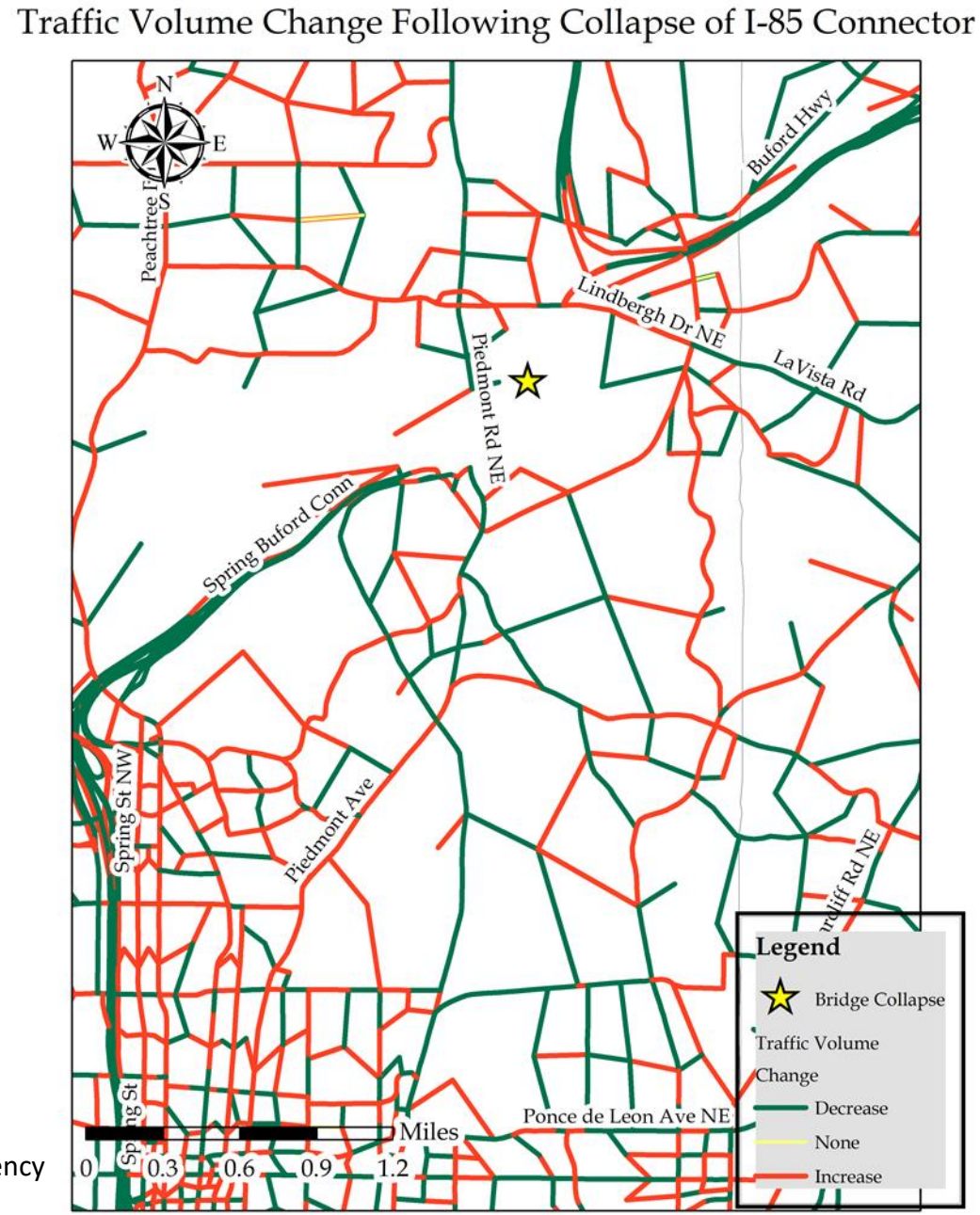
Conduct risk appraisal of vulnerabilities and changes



Likelihood of event
Person and vehicle trips on facility
Person and vehicle trips on system
Freight movement
Economic role and function
Community impact
Public safety impact
Etc.

Risk Appraisal

I-85 Bridge Deck Collapse



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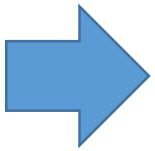
Example Application – Bridge over River

Linkage to transportation decision making



Impact on goals and objectives

- Related performance measures
- Priority criteria for project selection

Analysis tools and approaches for regional and local planning

Impact on other policy areas, such as public health

Supporting efforts by partner agencies

Performance Measures

Federal Requirement

Percent of the Person-Miles Traveled on the Interstate That Are Reliable

Percent of the Person-Miles Traveled on the Non-Interstate NHS That Are Reliable

Truck Travel Time Reliability (TTTR) Index

Annual Hours of Peak Hour Excessive Delay Per Capita Percent of Non-SOV Travel

Performance Measures

System Characteristics

- Condition data (risk-based asset management)
- Designated detour routes
- Number of critical assets with low risk scores
- Continuity of service plan updates
- Incident response rates
- Probability of failure (Seattle ferry system)
- Others?

Linkage to Other Policy Areas

Climate Resilience and Public Health

Paul Schramm, CDC

Thank you

wsp