

# Assessing the Vulnerability of Tennessee Transportation Assets to Extreme Weather



**Dr. Mark Abkowitz, Vanderbilt University**

**8<sup>th</sup> Annual Intermodal Conference**

**Memphis TN**

**October 7, 2014**

# MAP-21

*Moving Ahead for Progress in the 21st Century*



## **Requires states to**

- **Evaluate performance of roads, traffic congestion and freight**
- **Develop a risk-based asset management plan for the National Highway System**

**Assessing transportation asset vulnerability to extreme weather a key step in this process**

# The Problem

- Significant transportation impacts
  - Access to jobs
  - Business continuity
  - Social lifeline
  - Regional and national mobility



# The Need

- Statewide vulnerability assessment of transportation assets to identify *critical* assets *vulnerable* to extreme weather
- Vulnerability includes
  - Asset damage
  - Loss of use
  - Resilience



**Tennessee selected as FHWA Extreme Weather Pilot Project**

# Stakeholder Involvement

- **Tennessee Department of Transportation (TDOT)**
  - Division Directors appoint senior staff as project liaisons
  - Divisions (headquarters and regions) provide information
- **TEWTAP (Tennessee Extreme Weather and Transportation Adaptation Partnership)**
  - Comprised of endorsing organizations, other state and federal agencies, MPOs and transportation providers
  - Guide and advise project and review project results
- **Regional Focus Groups**
  - Public invited to four regional meetings
  - Obtain local/regional feedback
  - Obtain access to data



# Project Overview



**Project will make extensive use of color-coded GIS maps to visually display critical assets, extreme weather exposure, impacts and overall vulnerability**

# Asset Inventory

- Roads (interstate, state and U.S. highways)
- Rail (passenger and freight)
- Navigable waterways (rivers and locks)
- Intermodal freight terminals
- Airports
- Pipelines (oil and natural gas)
- Mass transit systems
- Support systems (traffic control centers, maintenance facilities)

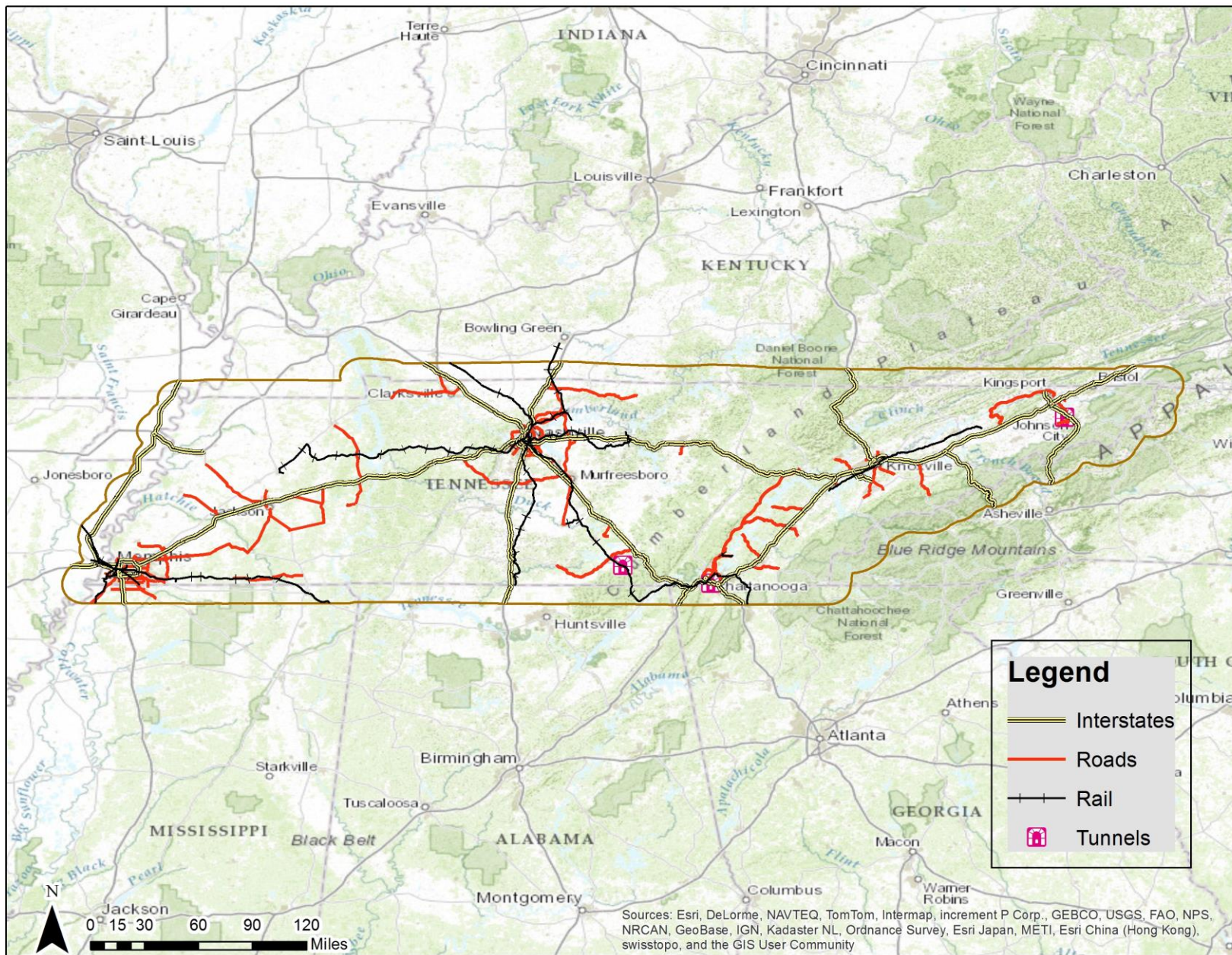


# Criteria for Determining Asset Criticality

- Volume of activity
- Strategic importance
- Use as emergency response resource
- Redundant capability
- Network connectivity
- Local knowledge and experience

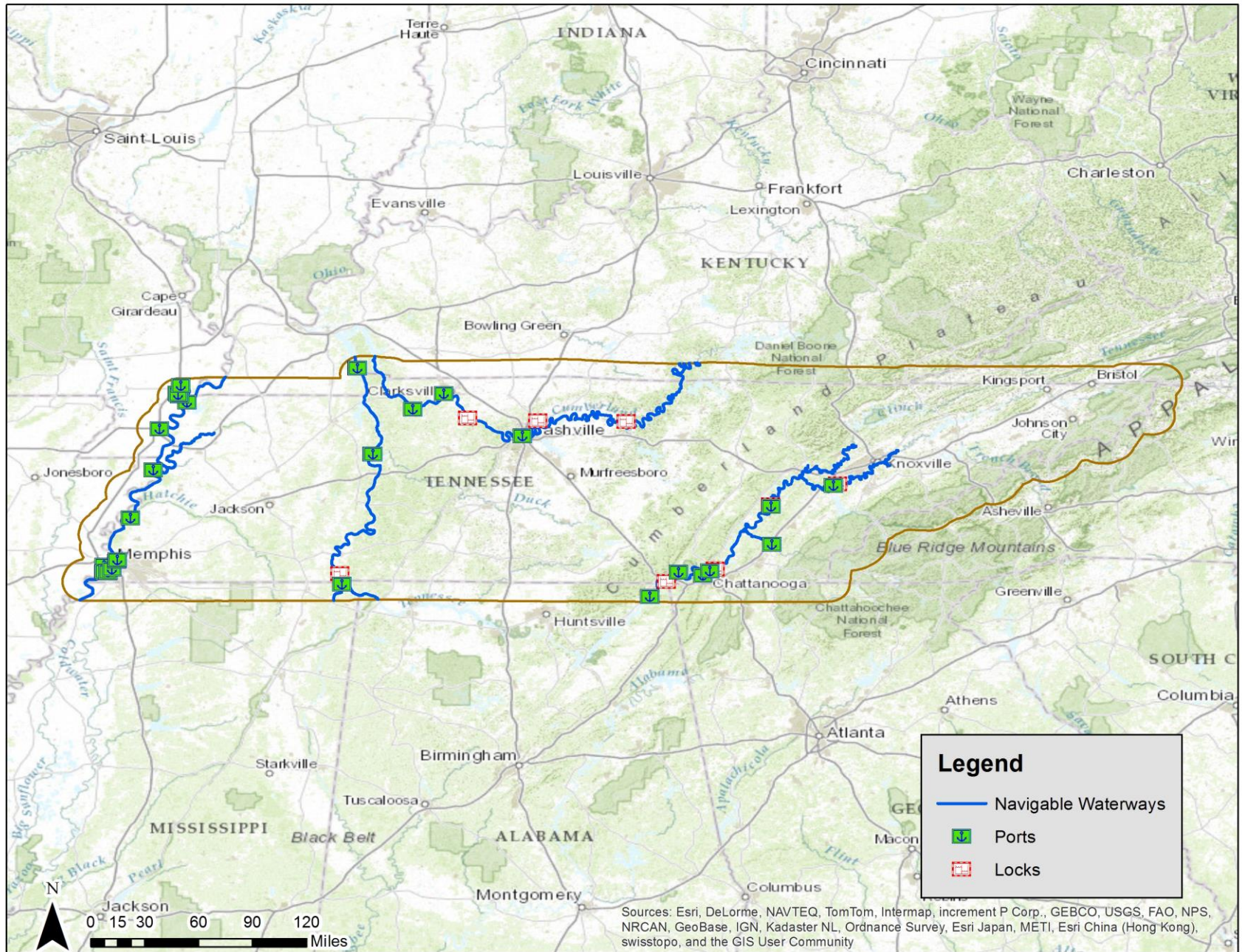


# Tennessee Critical Assets: Roads, Rail, and Tunnels

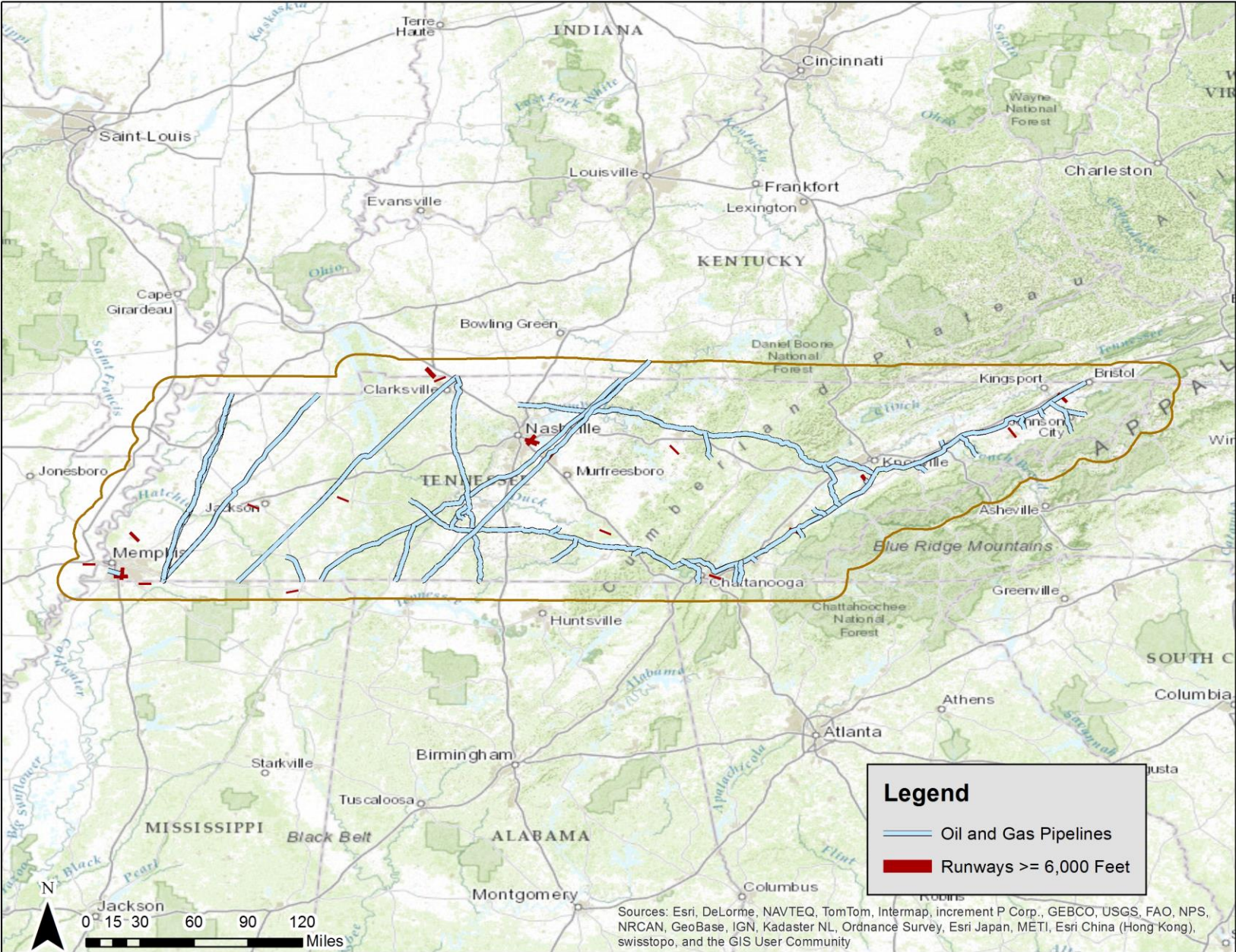




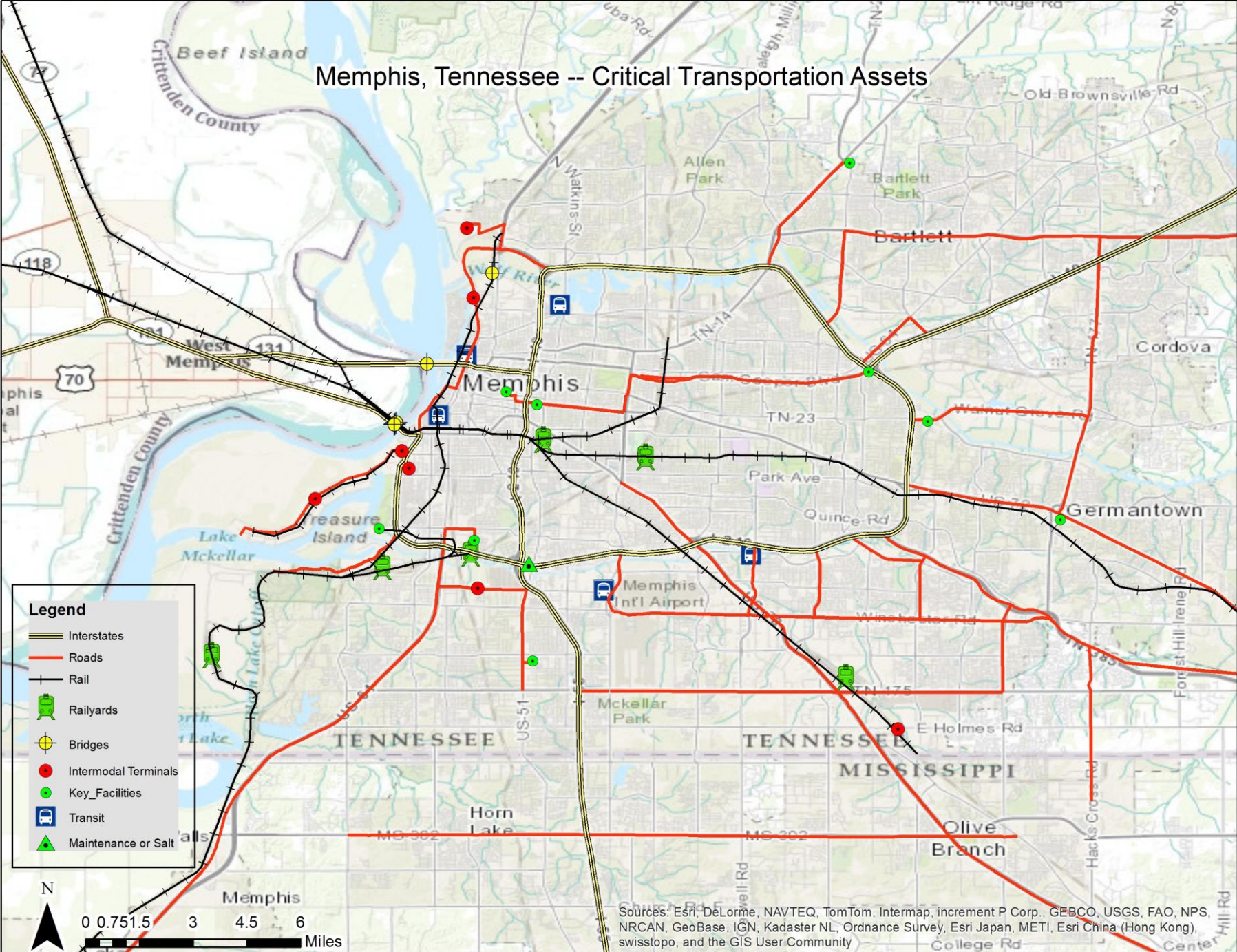
# Tennessee Critical Assets: Waterways



# Tennessee Critical Assets: Airports and Pipelines



# Memphis, Tennessee -- Critical Transportation Assets



**Legend**

- Interstates
- Roads
- Rail
- Railyards
- Bridges
- Intermodal Terminals
- Key\_Facilities
- Transit
- Maintenance or Salt

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

# Types of Extreme Weather Events

- Extreme temperatures (high and low)
- Heavy rain
- Drought
- Wind
- Tornado
- Ice
- Fog
- Snow



High temperatures



Ice



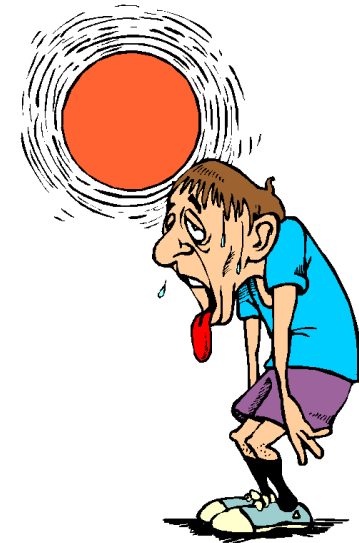
Heavy rains

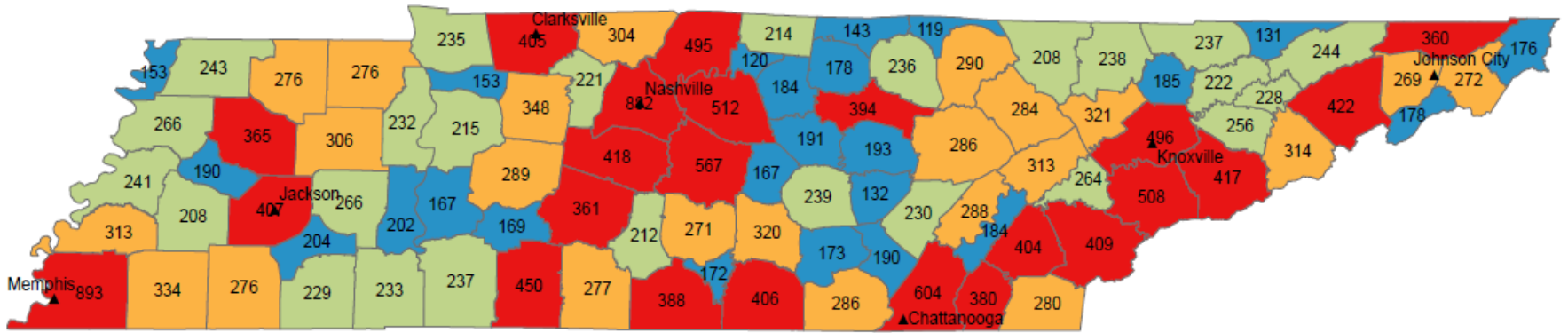


Wind

# Characterization of Extreme Weather Events

- Define extreme weather events based on thresholds that cause serious damage
- Determine portfolio of plausible extreme weather scenarios during study period (2015-2040)
- Historical weather data source
  - National Weather Service (NWS)
- Climate forecast model sources
  - World Climate Research Programme
  - University of Georgia
  - Federal Highway Administration



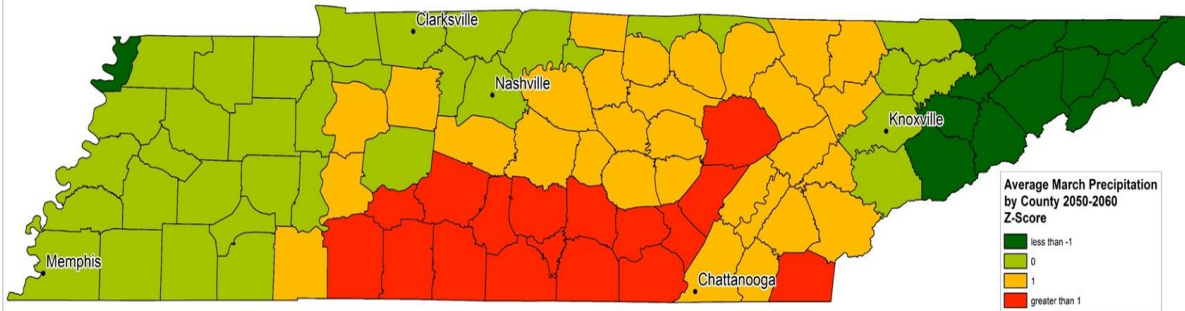


# Overall Historic Extreme Weather Events

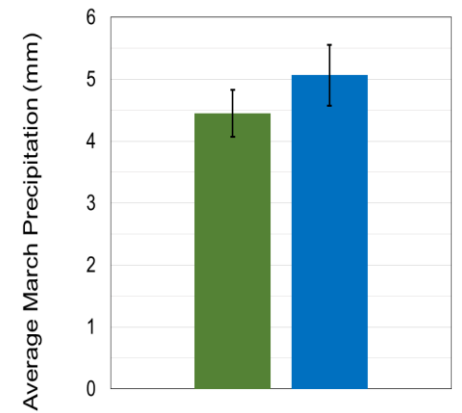


# Future Precipitation and Temperature by Tennessee County

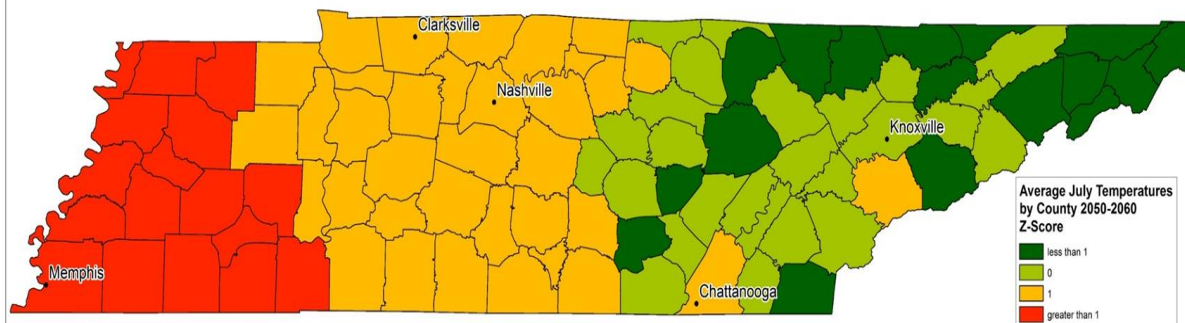
## Projected Precipitation Data By County



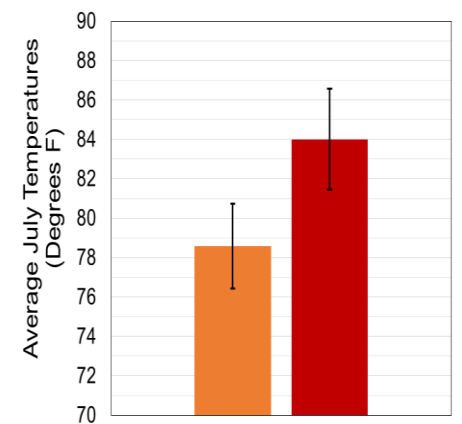
■ 2000-2010 ■ 2050-2060



## Projected High Temperature Data By County



■ 2000-2010 ■ 2050-2060







# Damage Potential and Resilience

- Asset damage caused by the extreme weather event in terms of repair/replacement cost
- Economic impact of loss of use due to delays/disruption
- Utilize maintenance records, anecdotal information and damage/loss models



Hannah River 2010



Stewart County Flooding April 2013



I-75 Single Lane 2012

**EXAMPLE**

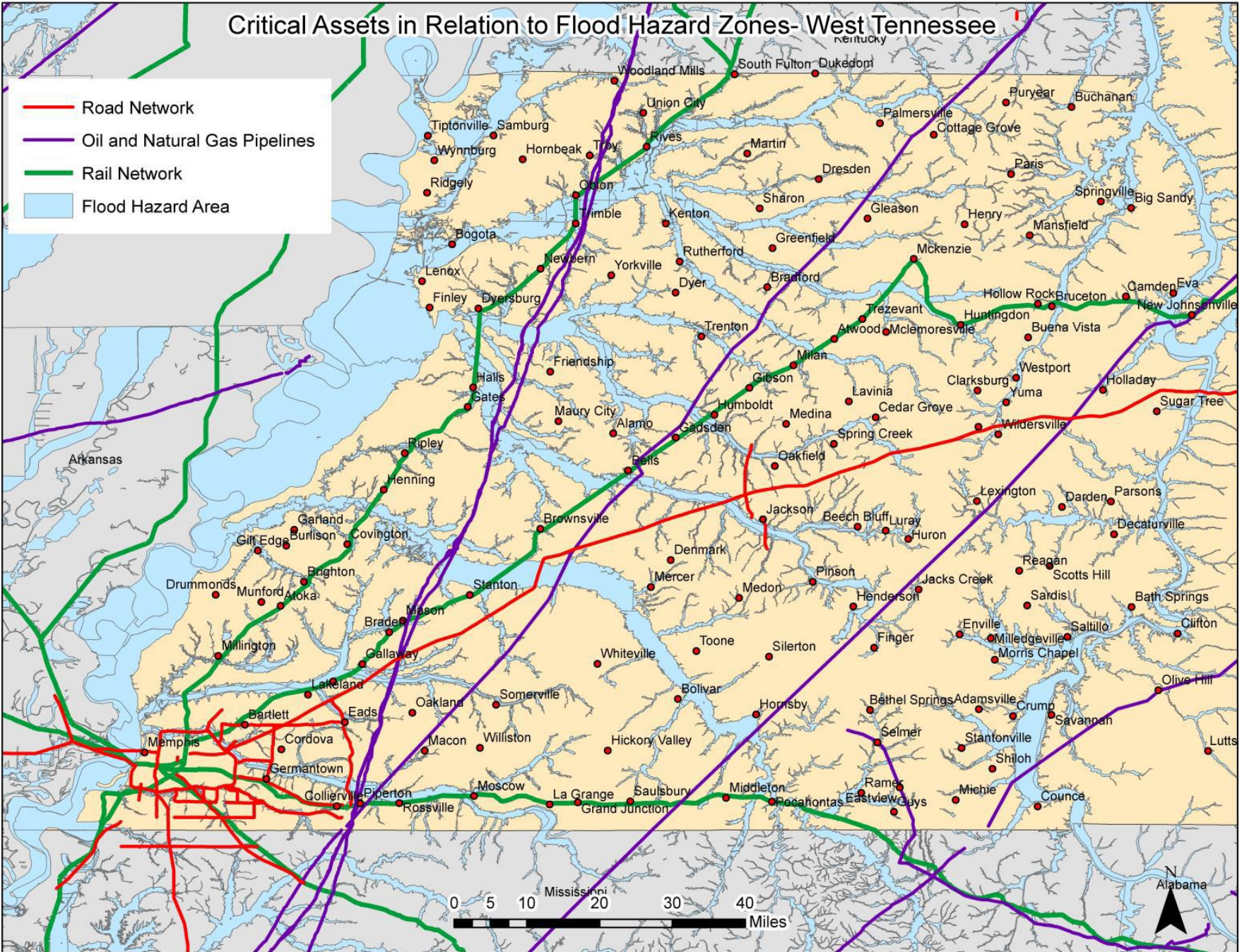
**Asset Type: Highways**

<b>Impact</b>	Catastrophic				
	Significant				
	Moderate				
	Nominal				
		Funnel Cloud/Dust Devil	F0/F1	F2/F3	F4/F5

**Extreme Weather Event: Tornado**

# Critical Assets in Relation to Flood Hazard Zones- West Tennessee

-  Road Network
-  Oil and Natural Gas Pipelines
-  Rail Network
-  Flood Hazard Area

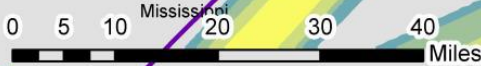
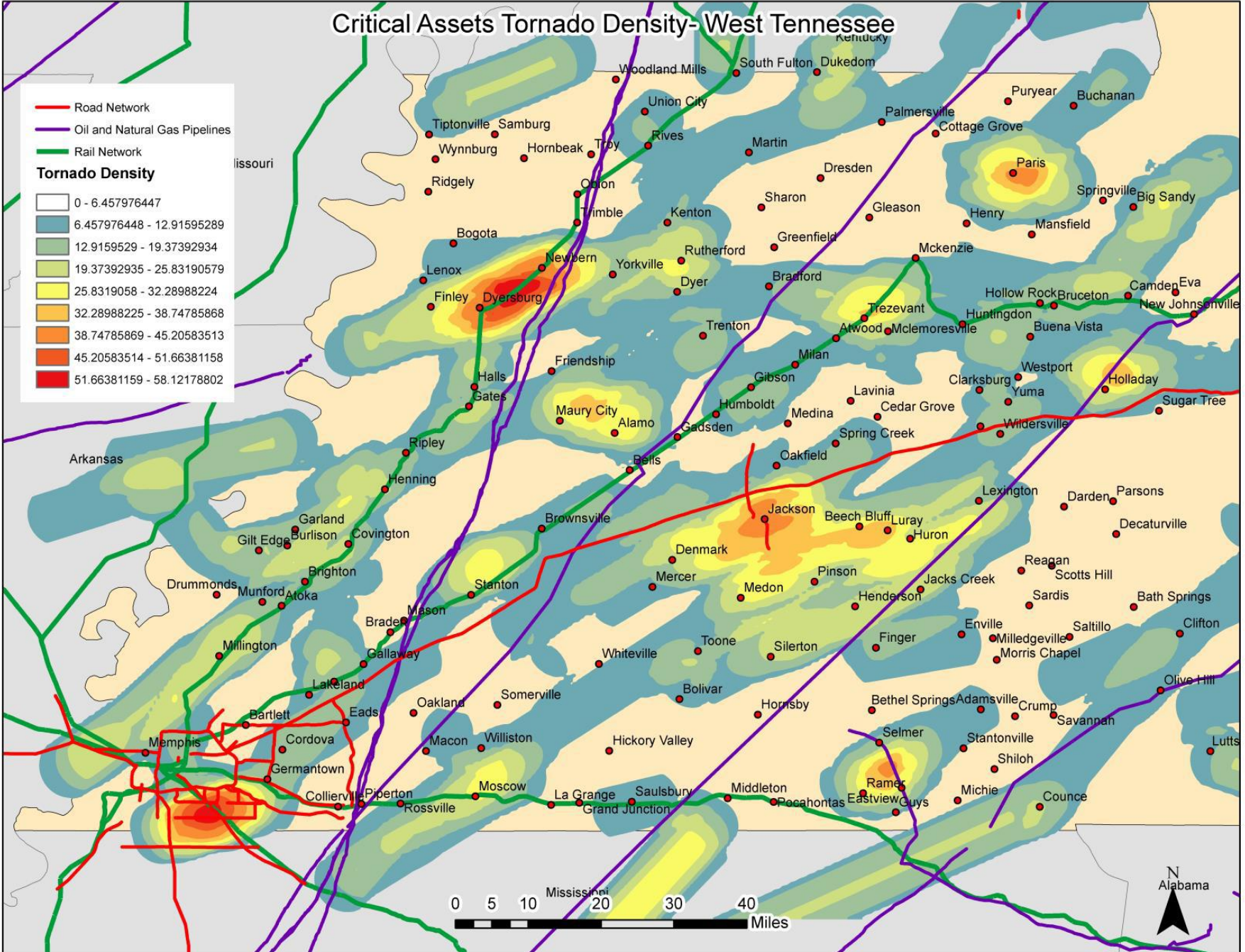


# Critical Assets Tornado Density- West Tennessee

— Road Network  
— Oil and Natural Gas Pipelines  
— Rail Network

**Tornado Density**

	0 - 6.457976447
	6.457976448 - 12.91595289
	12.9159529 - 19.37392934
	19.37392935 - 25.83190579
	25.8319058 - 32.28988224
	32.28988225 - 38.74785868
	38.74785869 - 45.20583513
	45.20583514 - 51.66381158
	51.66381159 - 58.12178802



# Ongoing Activities

- Complete development of extreme weather scenarios
- Assess damage/loss of critical assets to extreme weather scenarios
- Produce vulnerability “hot spot” maps
- Explore opportunities to assimilate project results into TDOT policies & procedures
- Prepare final report

Expected completion date: January, 2015



# Dissemination of Results

- Project is first step in determining what can be done to reduce transportation asset vulnerability to extreme weather events
- Will provide essential information for risk-based transportation asset management planning by TDOT, MPO's and others.
- Will create an important tool to:
  - Inform decision-makers
  - Promote “no regrets” planning





# Thank You!



**Dr. Mark Abkowitz**

**Phone: 615-343-3436**

[mark.abkowitz@Vanderbilt.edu](mailto:mark.abkowitz@Vanderbilt.edu)

**Leah Dundon**

**Phone: 615-428-0643**

[leah.a.dundon@Vanderbilt.edu](mailto:leah.a.dundon@Vanderbilt.edu)