Office of Infrastructure Protection

Homeland Infrastructure Threat and Risk Analysis Center

Risk Development and Modeling Branch

Presentation to the National Earthquake Hazards Reduction Program
Advisory Committee on Earthquake Hazards Reduction

November 23, 2009

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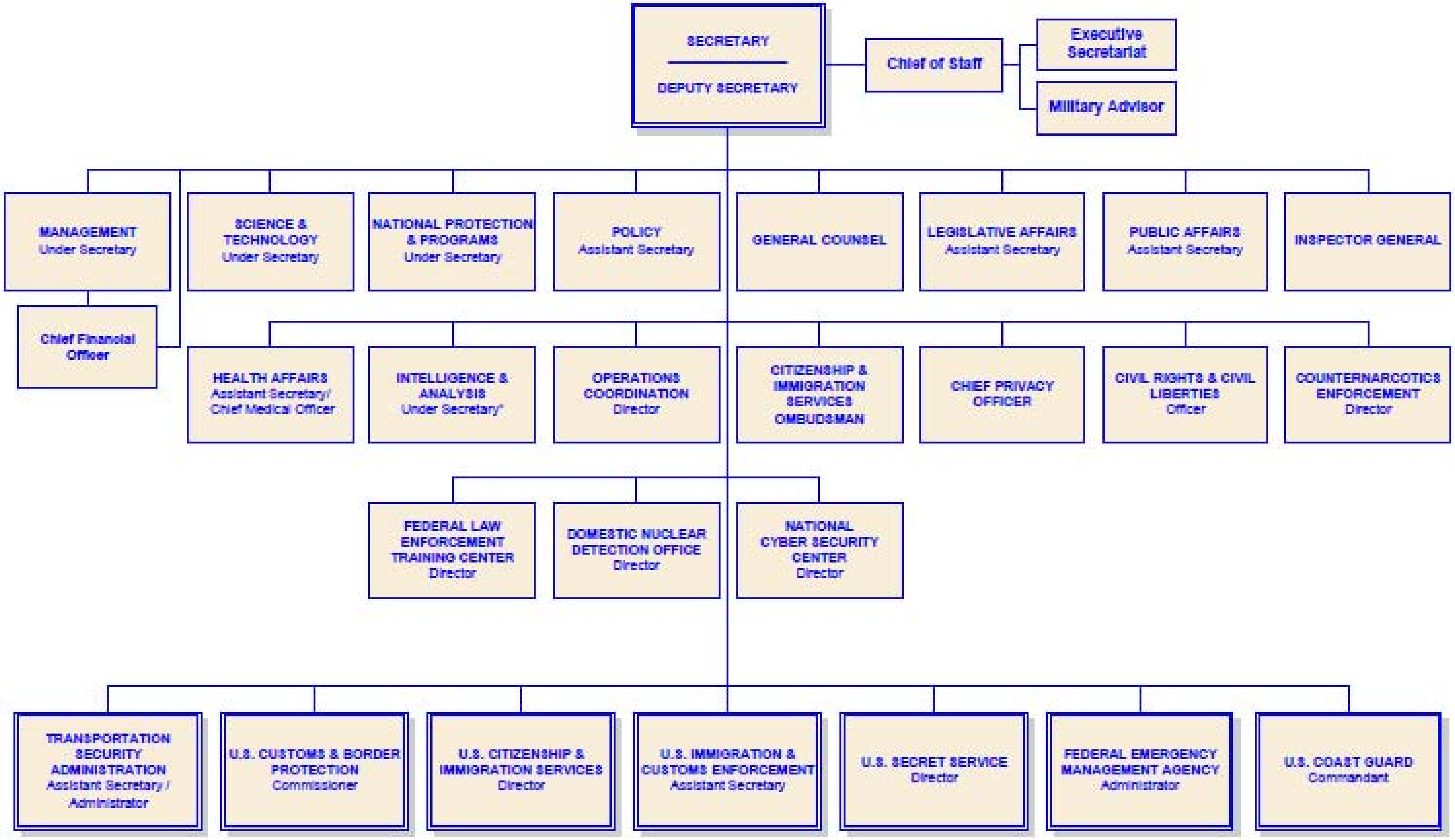
DHS Organization



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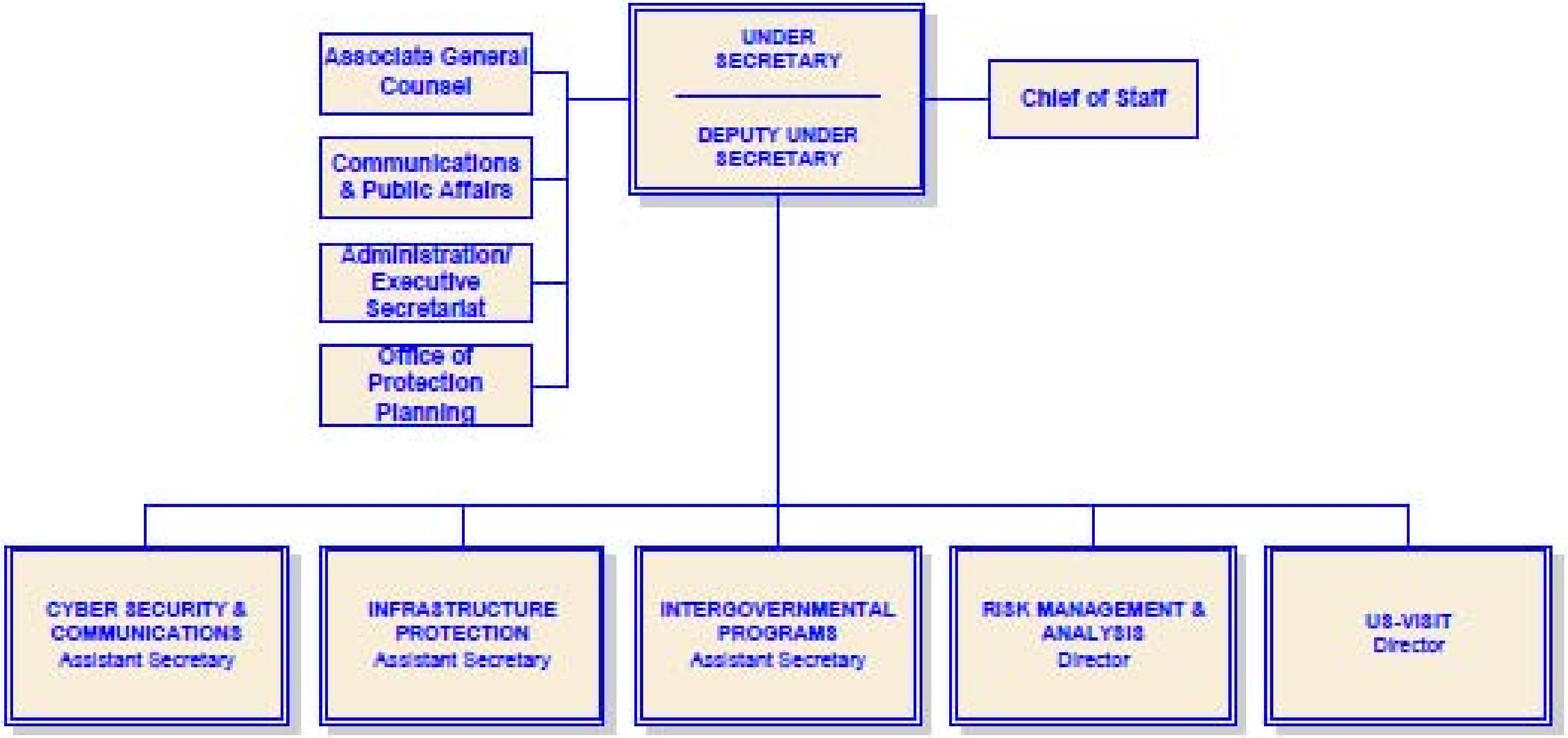
National Programs and Protections Directorate



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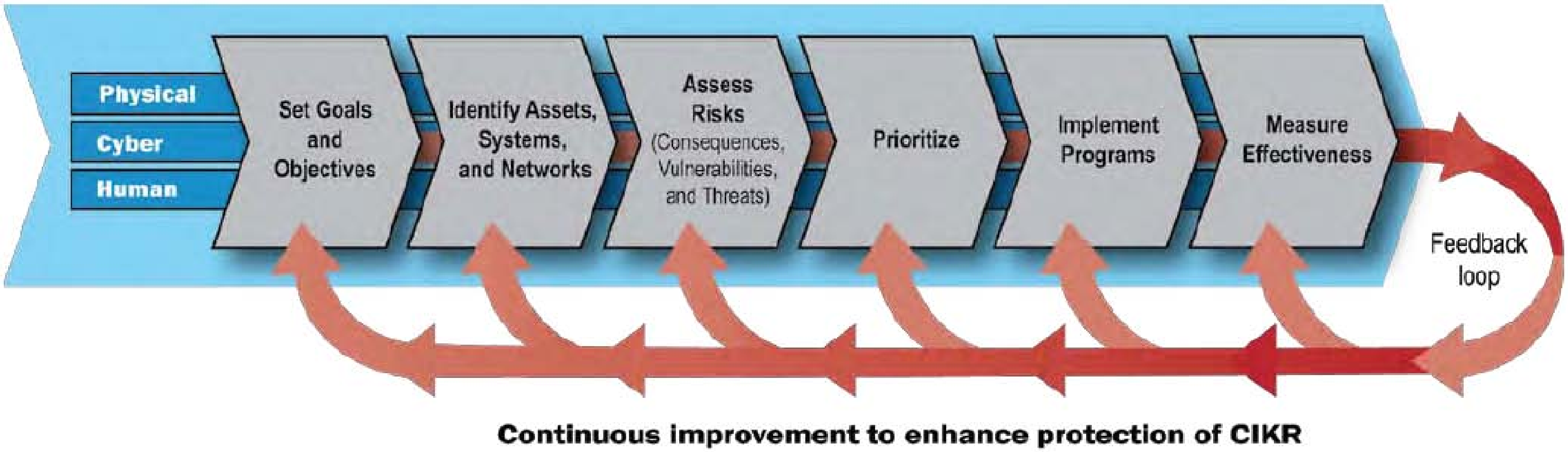
National Infrastructure Protection Plan



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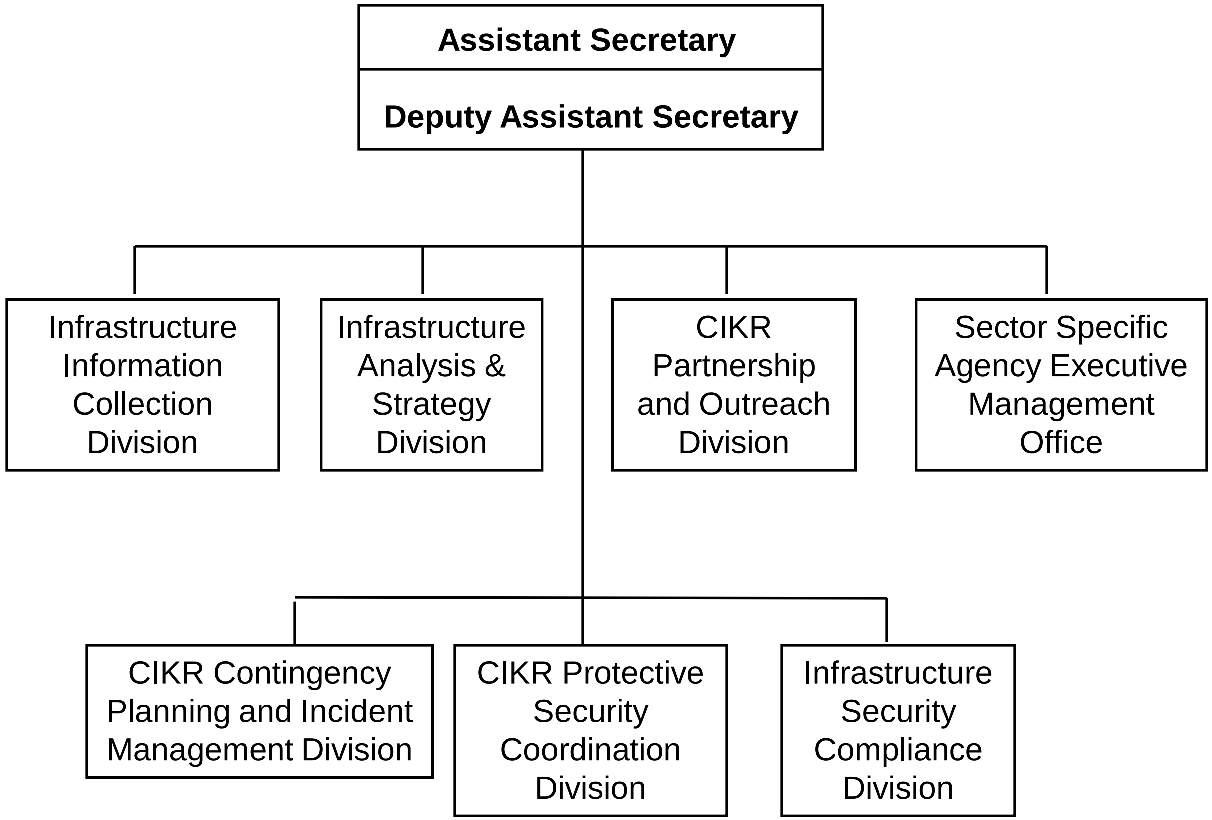


RDMB

- **The Risk Development and Modeling Branch (RDMB) develops critical infrastructure and key resources (CIKR) risk decision requirements and capabilities for Department of Homeland Security (DHS) Headquarters, DHS components, and National Infrastructure Protection Plan (NIPP) partners; and directs the National Infrastructure Simulation and Analysis Center (NISAC) program.**

- **RDMB works with stakeholders within DHS, the NIPP framework, and other Federal, State, and local jurisdictions to develop CIKR risk decision methodology in coordination with academic and world-class risk science organizations. Constant attention is given to scalability of methodology, analytics, doctrine, and solutions so that risk managers at all levels of jurisdiction can manage CIKR risk as part of an executable and holistic risk management program.**

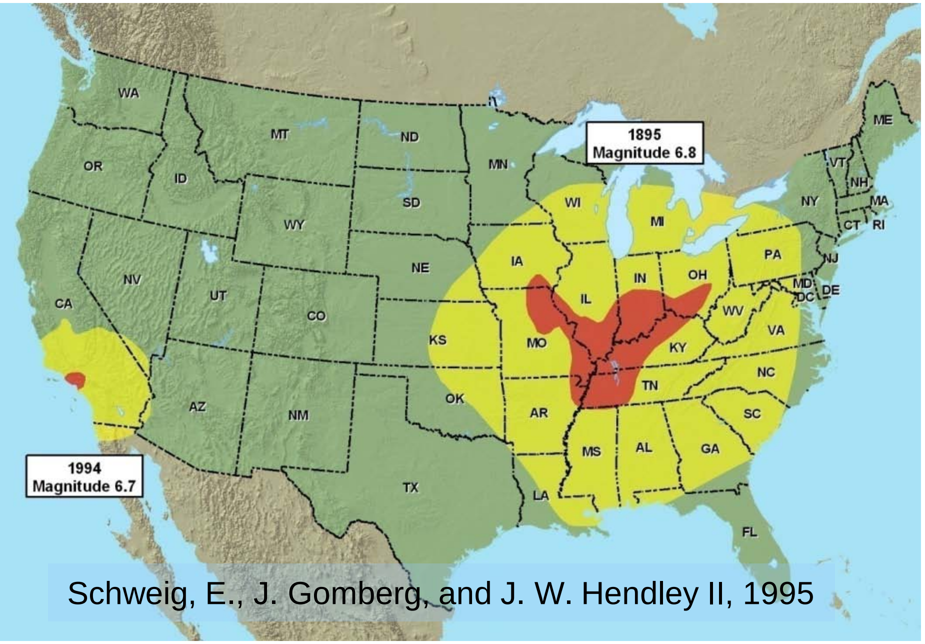
NISAC Authorities

- The Critical Infrastructures Protection Act of 2001
  - Recognized the need for modeling, simulation, and analysis of infrastructures and their interdependencies—first funding received for NISAC (in DOD)
- HR3162, The USA PATRIOT Act
  - Formally established NISAC “to serve as a source of **national competence** to address critical infrastructure protection and continuity through support for activities related to counterterrorism, threat assessment, and risk mitigation”
- HR5005, The Homeland Security Act of 2002
  - Transferred NISAC from DOE to DHS/IAIP
- S2845, Establishes the Director of National Intelligence (DNI)
  - Directs the DNI to establish a formal relationship, including information sharing, between the elements of the intelligence community and NISAC.
- HR5441, FY07 DHS Appropriations Bill
  - Formalized the expansion of NISAC by stating that NISAC shall serve as a source of national competence to address critical infrastructure protection and continuity and that each Federal agency and department with critical infrastructure responsibilities under HSPD-7 shall establish a formal relationship, including an agreement regarding information sharing, between the elements of such agency or department and NISAC

NISAC Earthquake Study: New Madrid Seismic Zone

- Multi-year study to evaluate potential impacts of major earthquakes in the New Madrid Seismic Zone (NMSZ) on infrastructures.
- Purpose: Improve national planning efforts by providing a better understanding of earthquake impacts on infrastructures at a regional to national level, the potential implications of those impacts on response and recovery, and identification of mitigation measures to reduce the impacts.

Comparison of the 1895 NMSZ earthquake with the 1994 Northridge (CA) Earthquake



Red: regions of minor to major damage to buildings
Yellow: regions in which shaking could be felt

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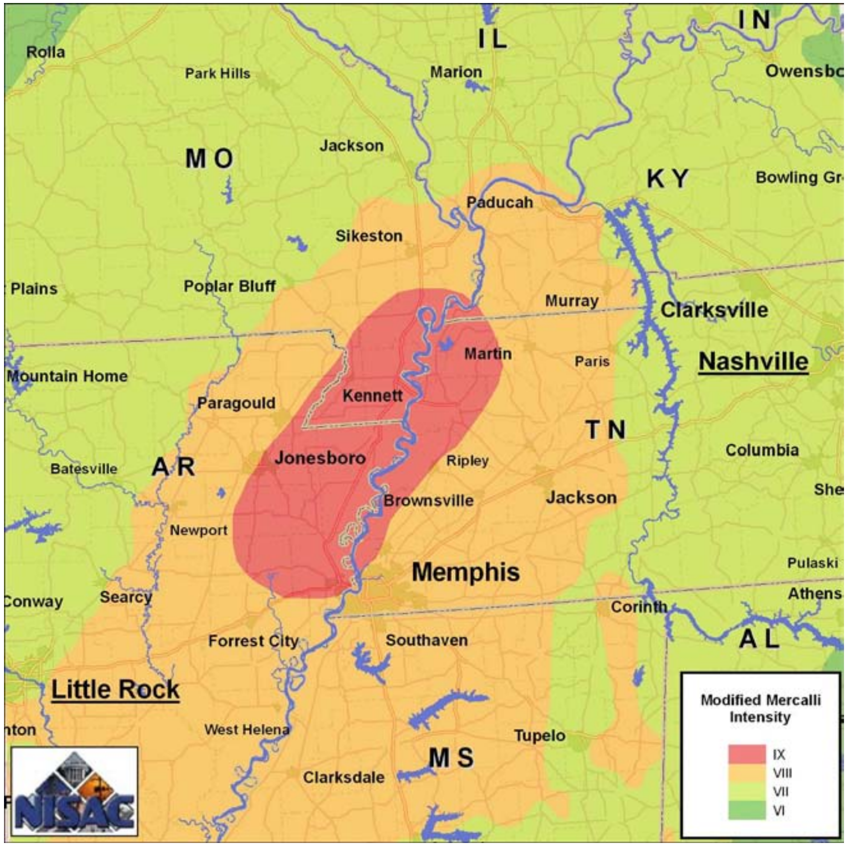
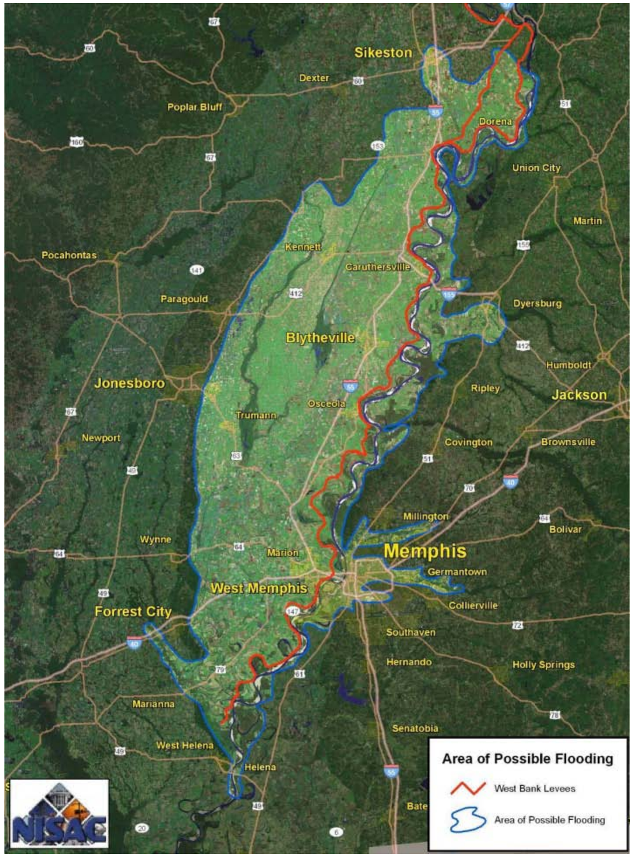
Collaboration and information sharing

- FEMA Planning Effort (US Geological Survey (USGS), Central U.S. Earthquake Center (CUSEC), Mid America Earthquake (MAE) Center
- Cambridge Energy Research Associates (CERA)
- Argonne National Laboratory

Earthquake planning scenario

Magnitude 7.7, epicenter northwest of Memphis, on January 3, 2009, at 4:00 am





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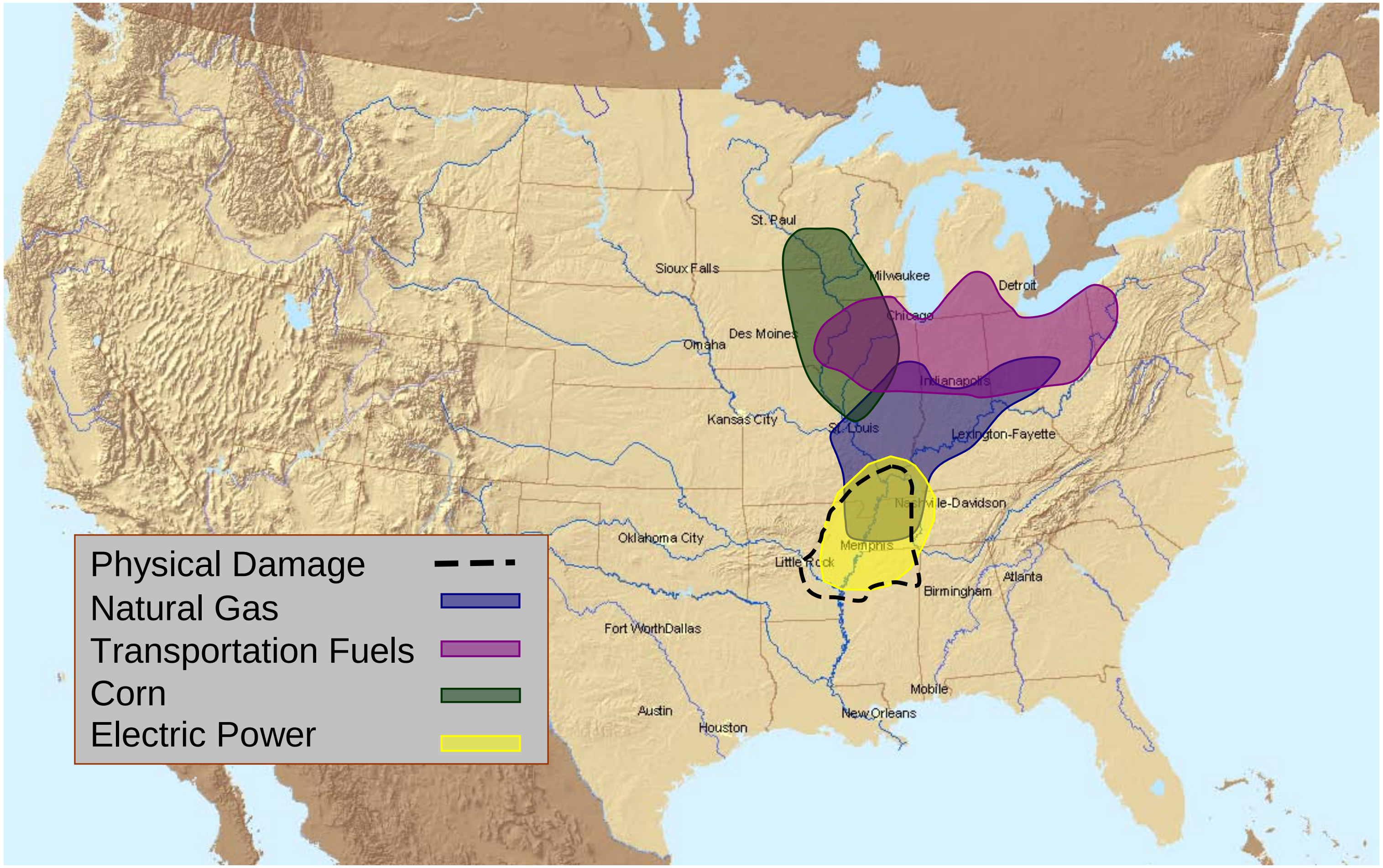
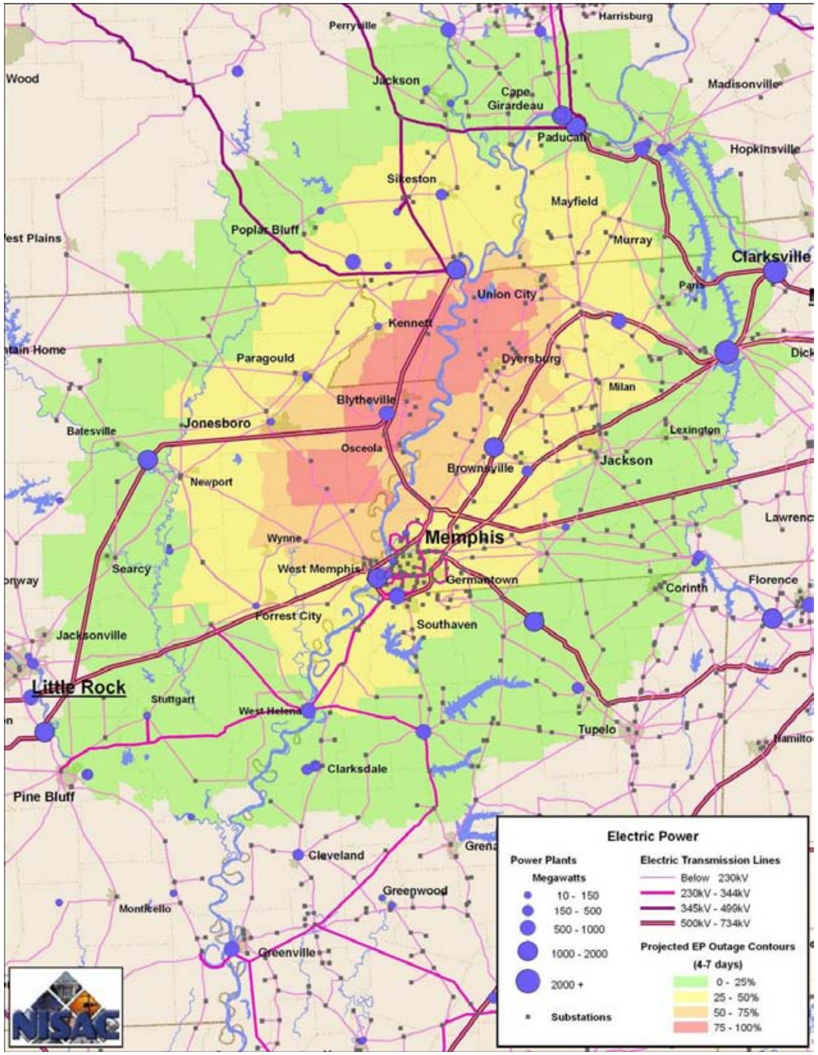
Provide insights about infrastructure degradation

Propagate infrastructure impacts beyond damaged region



Damage-based estimates: electric power outages

Electric Power example: Projected Power Outage Contours 4 to 7 days After Seismic Event

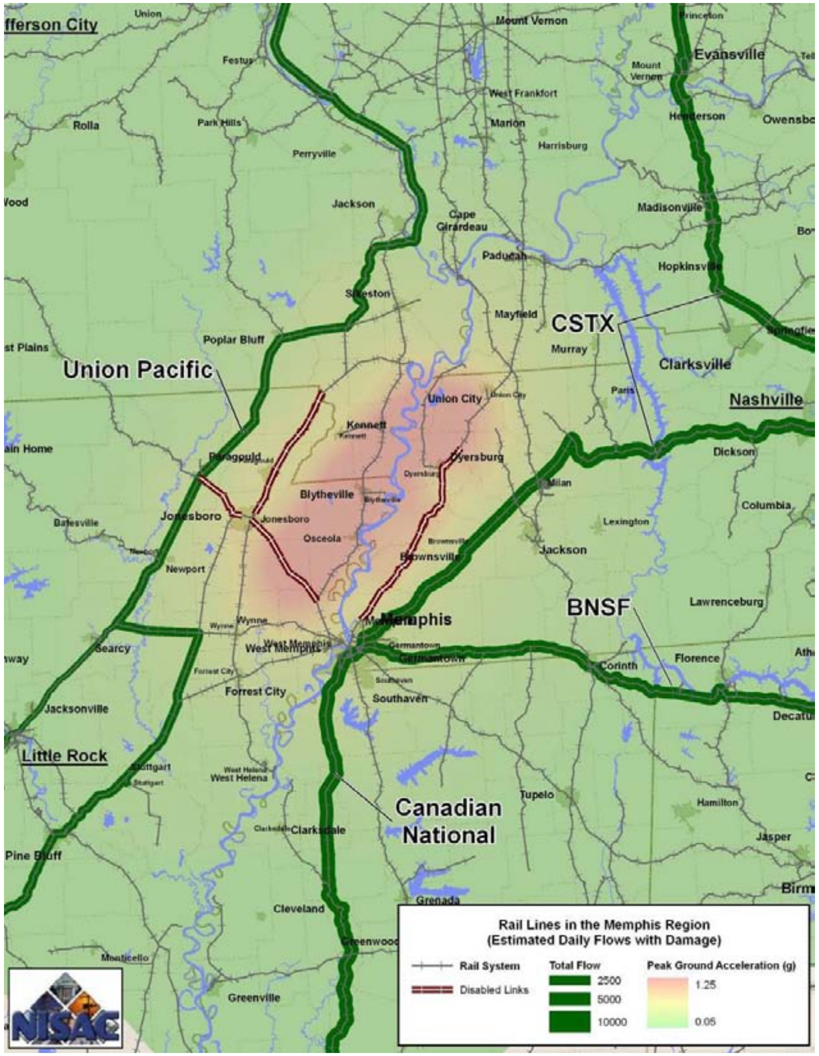


EPA HAZUS–MH model run results due to ground motion damage

Network optimization model: Transportation rail impacts

Estimated Daily Flows on Rail Lines in Memphis Area Following Disruption assuming shared right of way

NISAC Rail Network Analysis System (R-NAS) model run results



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Regionally-Aggregated Energy Models

- **Capabilities:**
  - Mass balance (flow in minus flow out equals change in storage)
  - Storage (thus dynamic behavior)
  - Use excess capacity
  - Demand elasticity
  - Dependable data available from EIA
  - Region-to-region transmission capacity and rerouting
  - Regional demand elasticity
- **Typical questions to be addressed:**
  - Are there regions of the country that could experience shortages? If so, when?
  - Will there be less gas available for power generation in some regions of the country due to demand for gas for heating in colder regions?

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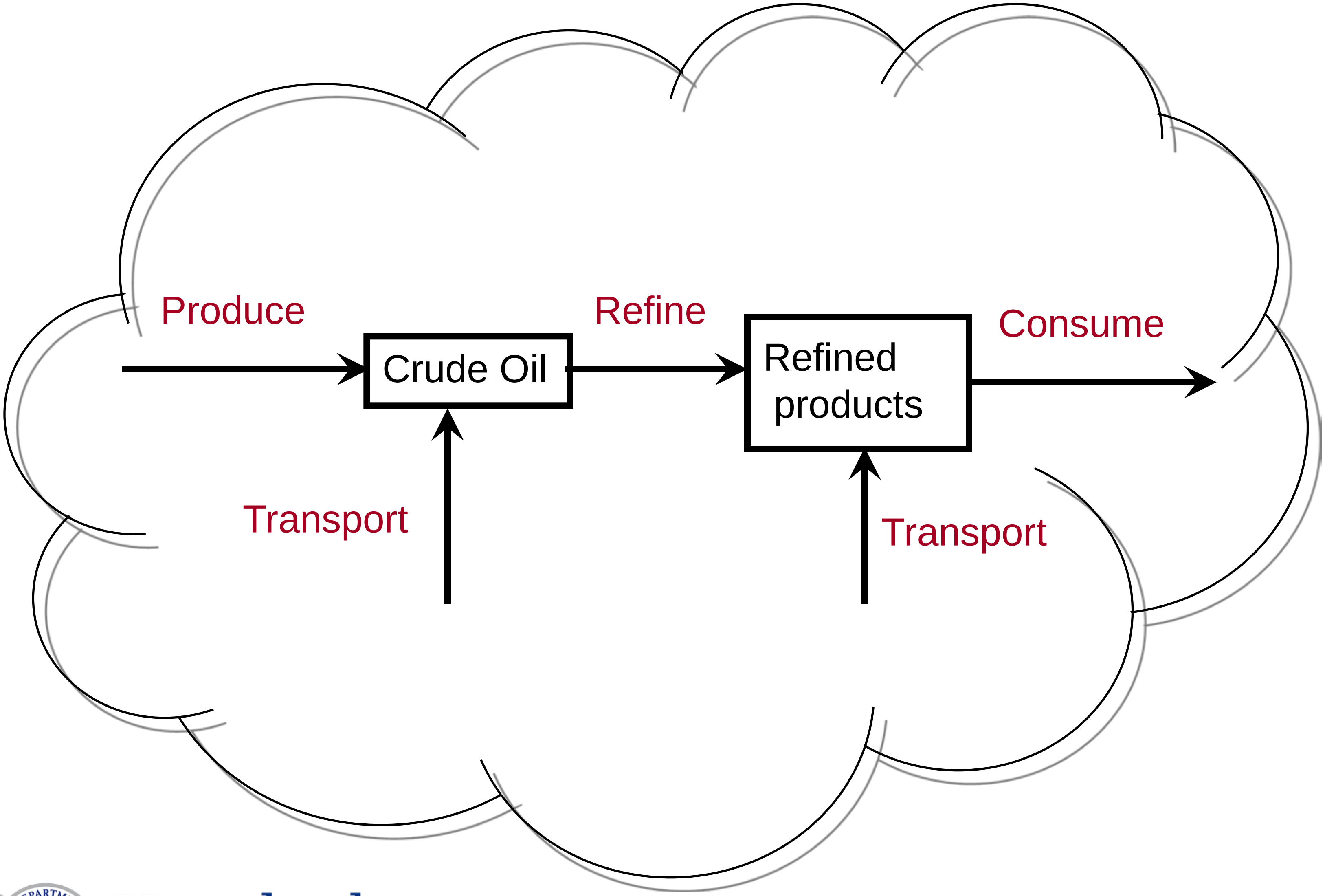
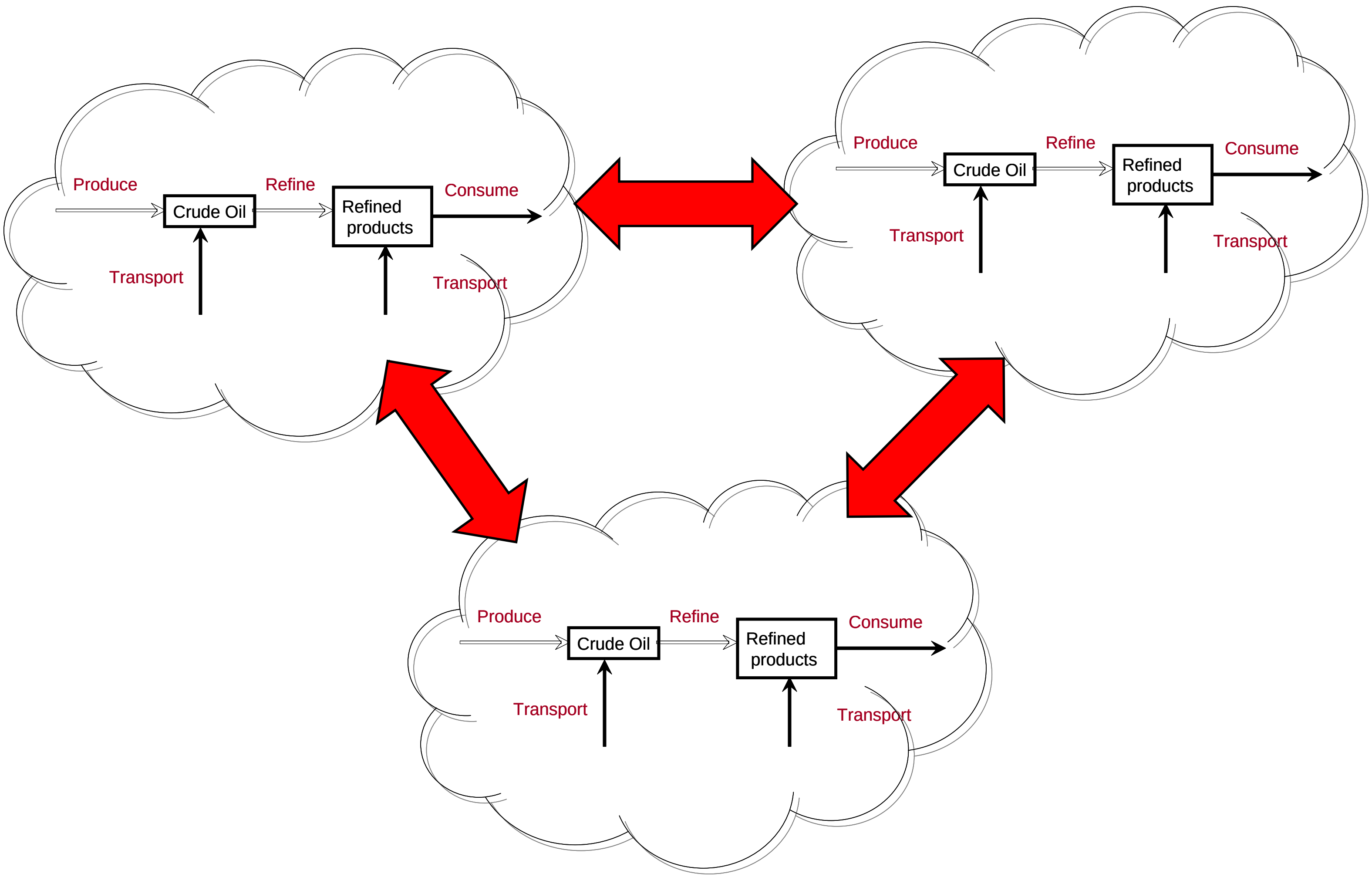
Dynamic Mass Balance Within a Region



Link Regions to Represent Spatial Variation



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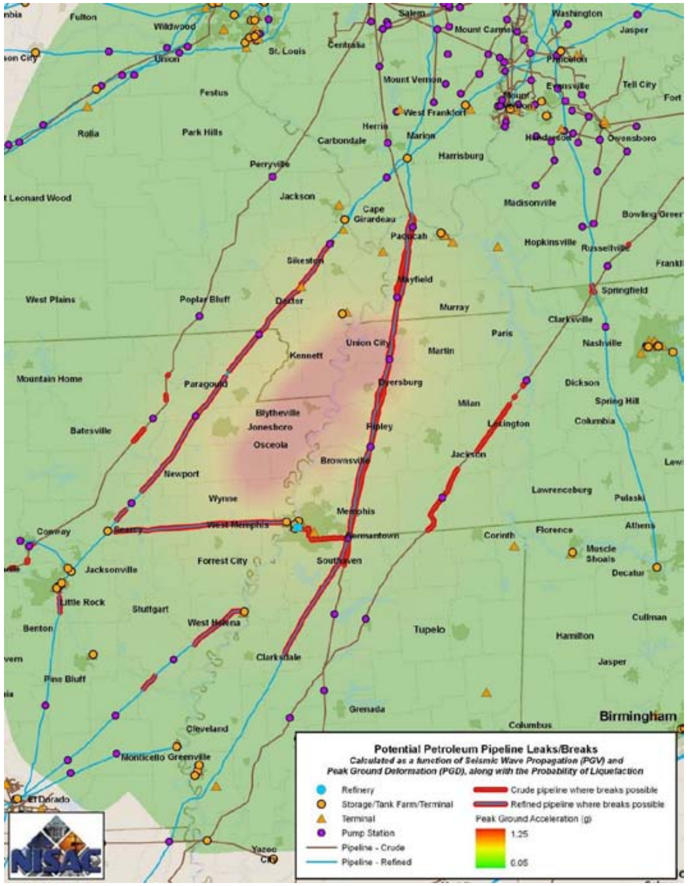
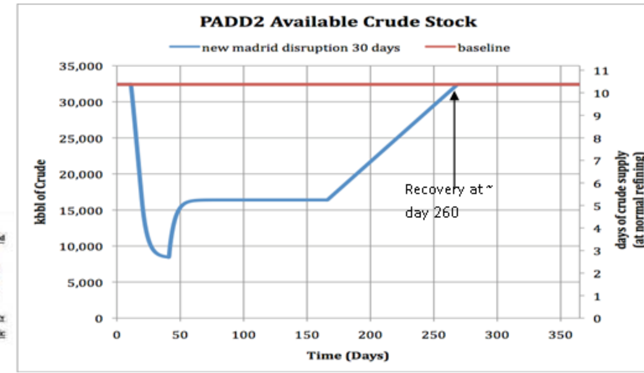
Stock-and-flow model: Petroleum supply degradation

Potential Petroleum Pipeline Leaks/Breaks

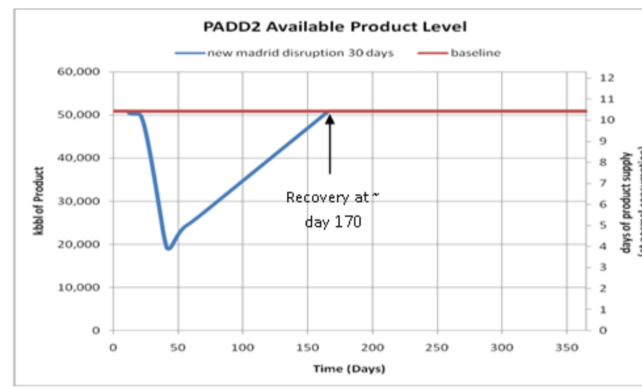


Petroleum Administration for Defense Districts (PADD)

PADD 2 Crude Stocks Over Time, Compared with Baseline



PADD 2 Petroleum Product Stocks Over Time, Compared with Baseline



NISAC national petroleum model

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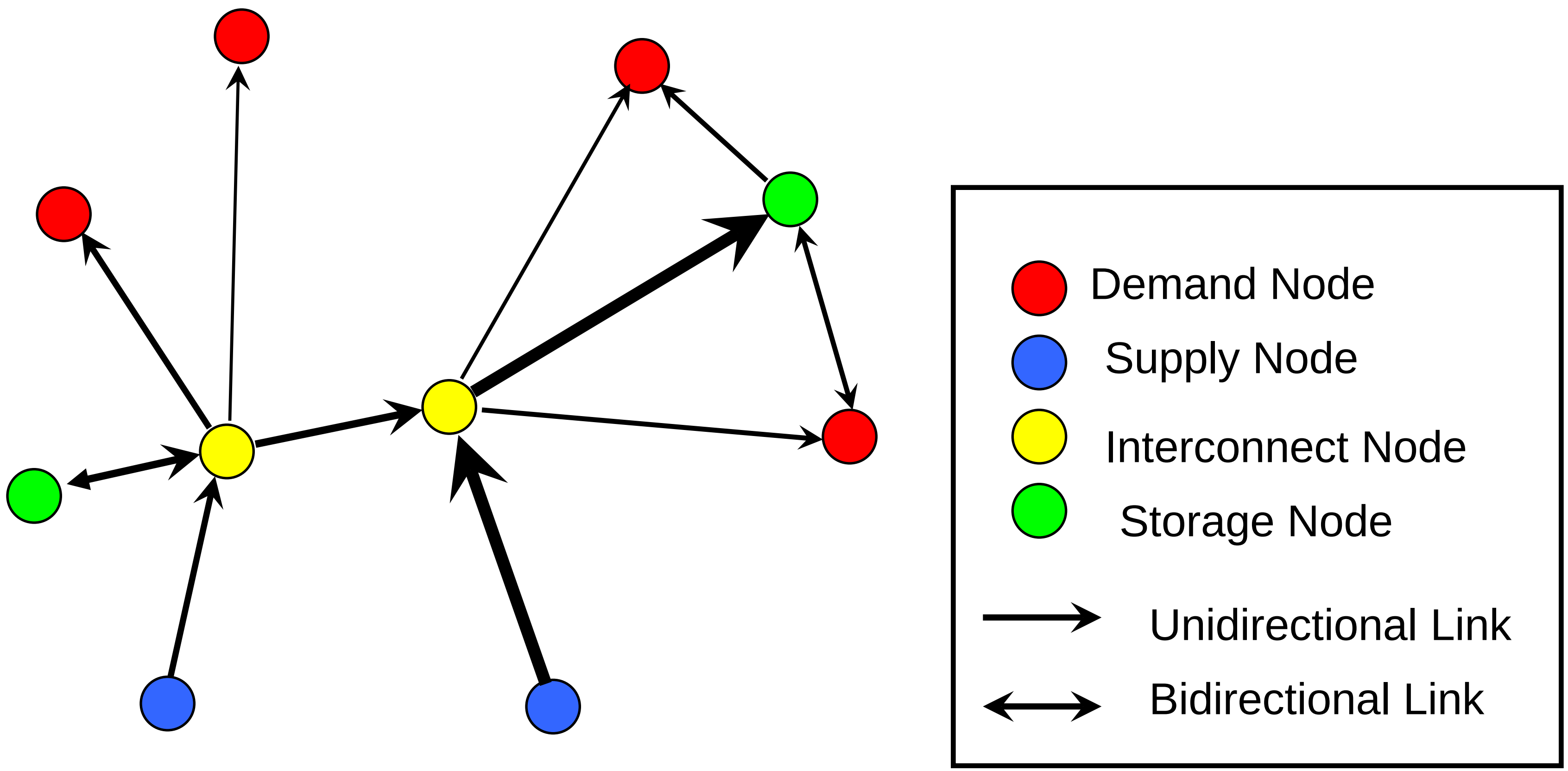
Natural Gas Network Model

- Uses a NISAC agent/network algorithm called the Gas Allocation Method (GAM)
- High spatial resolution (at the receipt/delivery point [RDP] level)
- Behavior of multiple actors at each RDP
- In selecting approach, we evaluated models from Argonne National Laboratory and Cambridge Energy Research Associates
- Data to populate this model less available than for the regionally aggregated models

GAM Representation of a Natural Gas Network



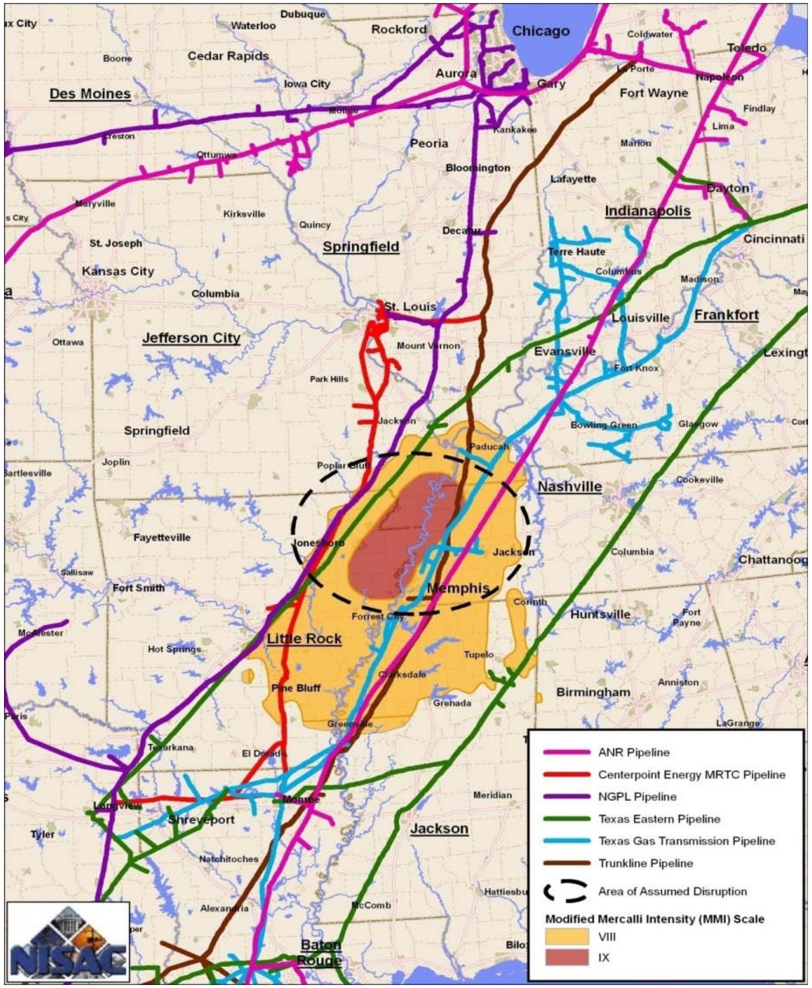
Increasing thickness of lines indicates increased pipeline capacities

Key assumptions and implications for NG analysis

- Assumptions:
  - Average (last 15 years) February temperatures.
  - Normal inventories in storage prior to event.
  - Market participants respond to spot market price change (no hoarding).
  - Power outages will not impact the supply of gas from processing plants.
- Implications:
  - Colder temperatures, hoarding, or reduced gas processing capacity increase the chances of shortage.
  - Therefore, it is prudent to take steps to increase system flexibility and decrease the likelihood of hoarding.

Agent-based network model: Natural gas supply

Natural Gas Pipelines relative to the Modified Mercalli Index (MMI) Hazard Map



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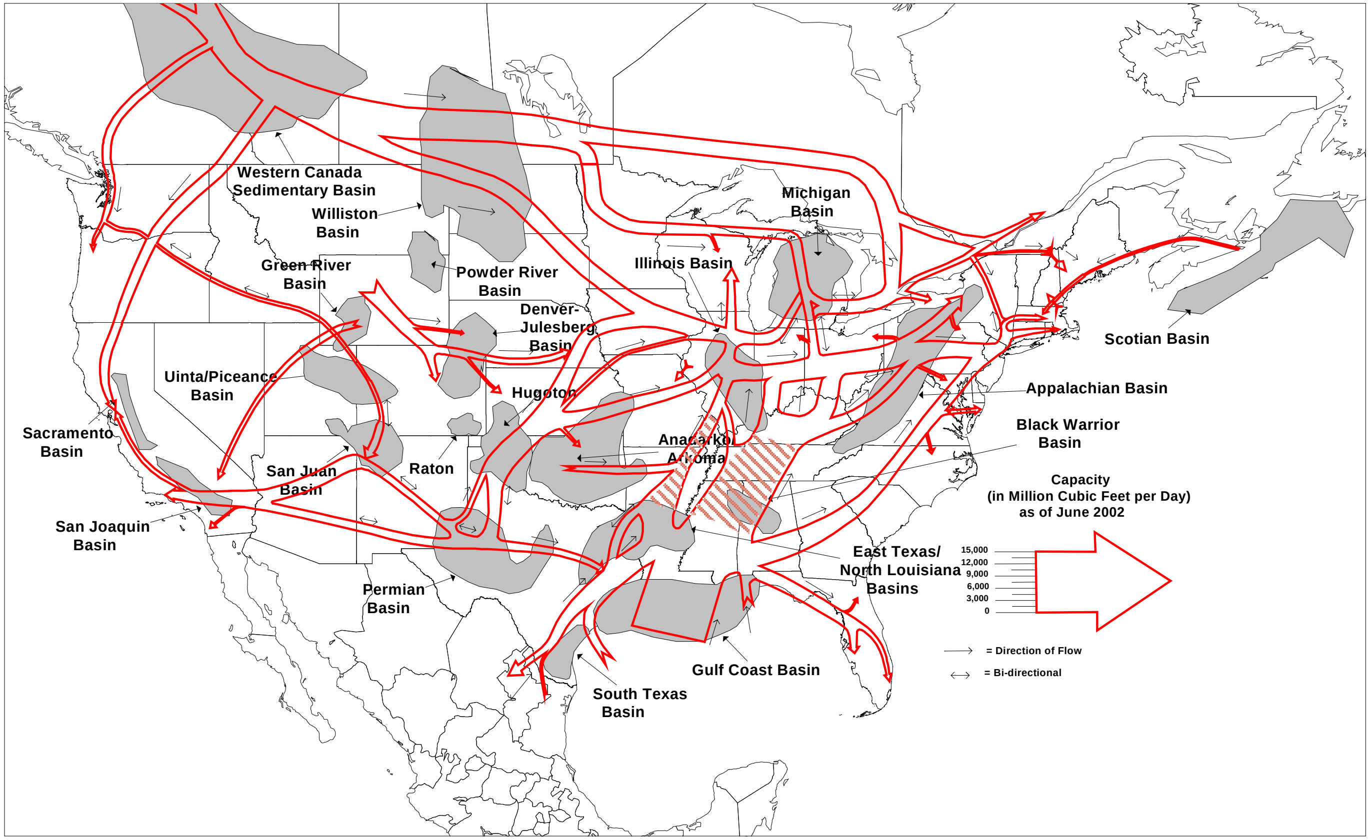
Large impact on natural gas pipeline systems



Mariner-Volpe, B., and W. Trapmann, 2003

North American natural gas production areas and pipeline capacities (red hashed area is capacity in NMSZ)

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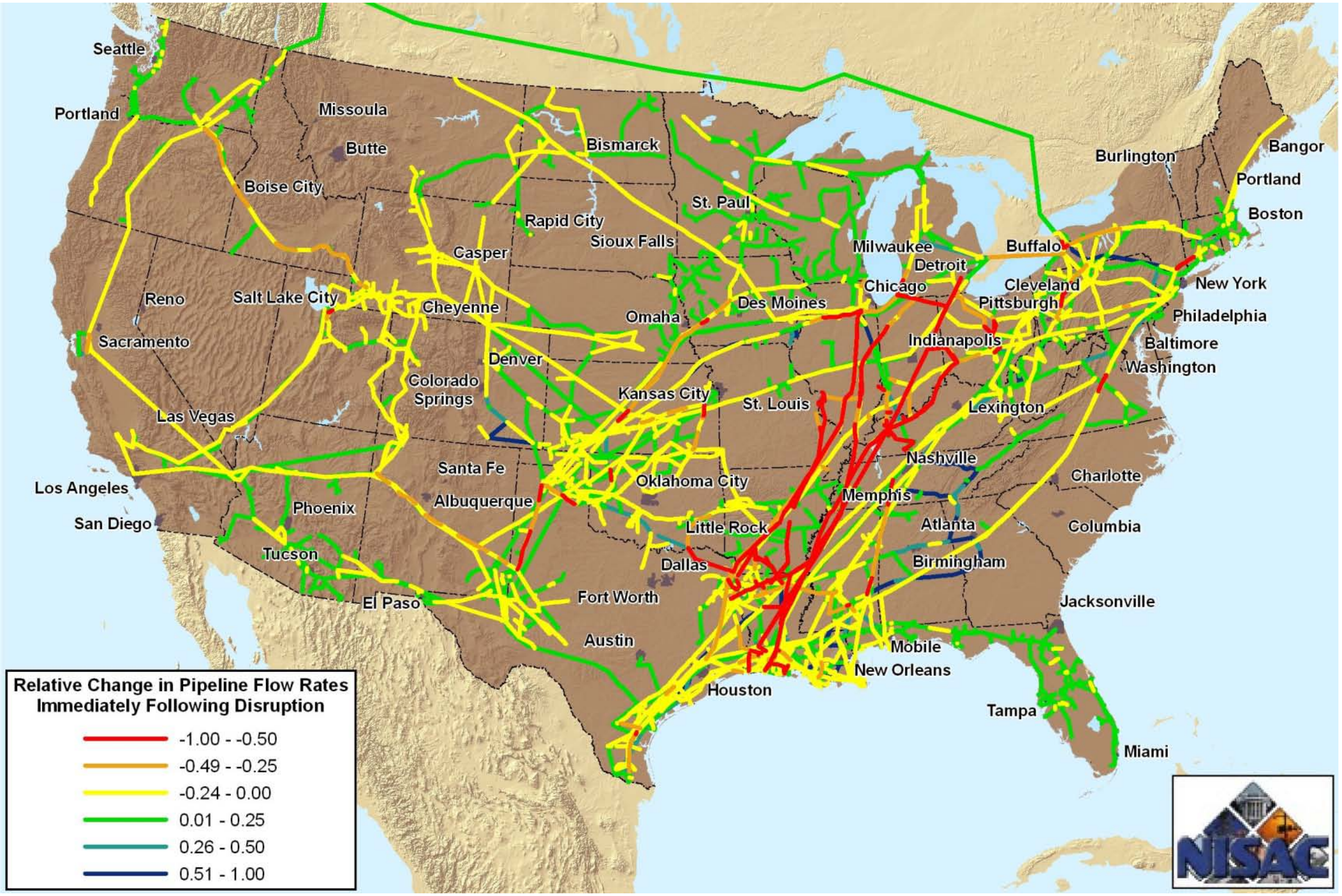
Agent-based network model: Changes in natural gas flow



NISAC Gas Allocation Method (GAM) Model

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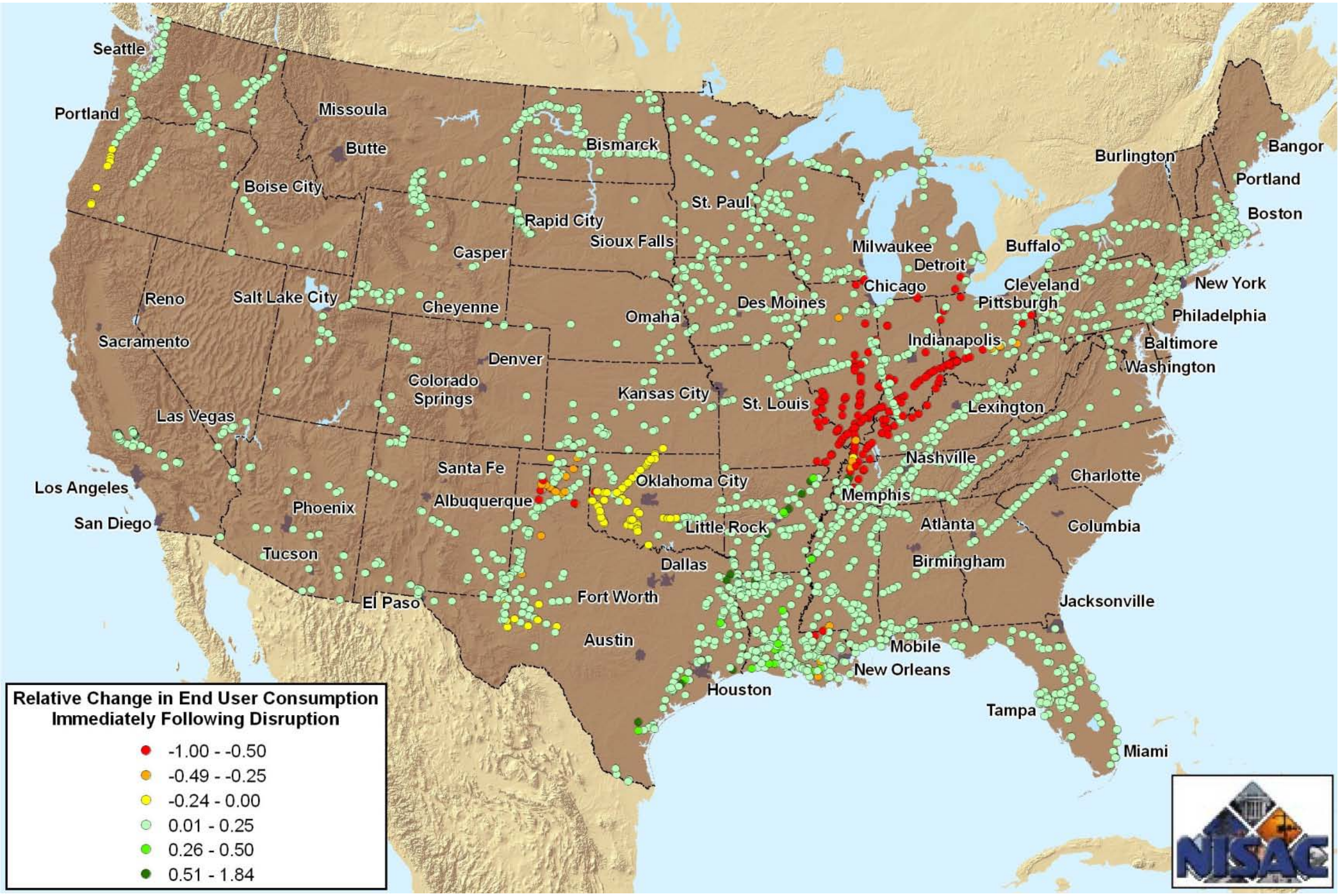
Agent-based network model: Changes in consumption



NISAC Gas Allocation Method (GAM) Model

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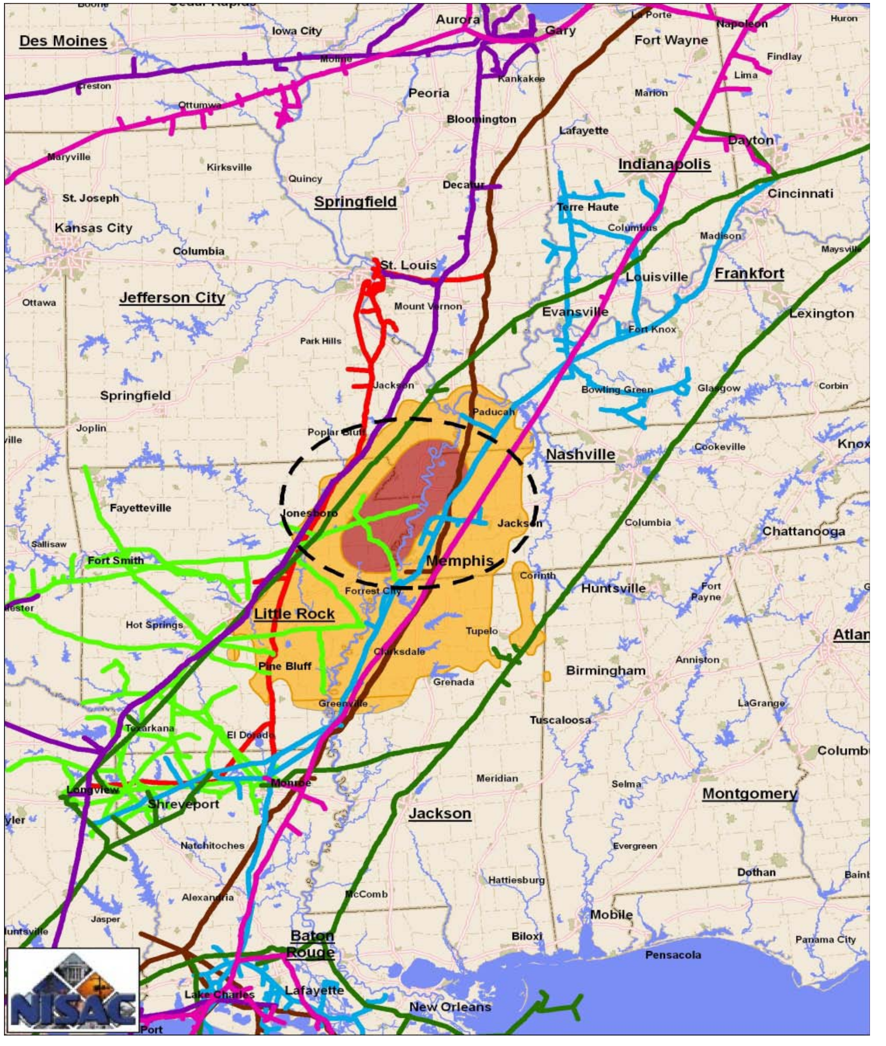
Sample Analytical Results for Natural Gas Transmission

- Supply reductions in western Tennessee with Memphis completely deprived of gas (perhaps this is not an immediate concern because the distribution system is also damaged)
- Supply reductions in eastern Missouri with St. Louis receiving little or no gas (St. Louis has not experienced physical damage)
- There is a transmission pipeline 75 miles north of St. Louis that is operating but does not serve St. Louis
- The robustness of the natural gas system could possibly be improved by making key pipeline segments bi-directional.



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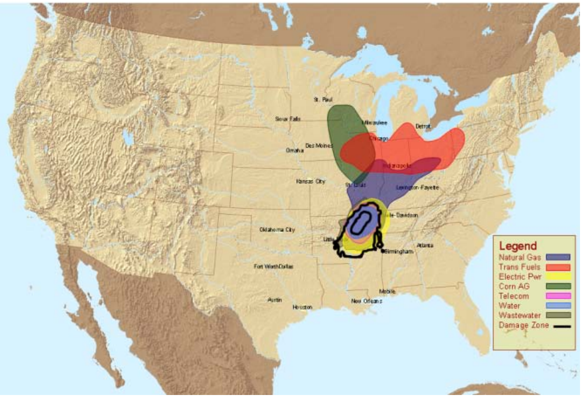
Selected NISAC natural gas mitigation recommendations

- Perform a cost-benefit analysis to determine where pipeline bi-directional capability would best increase flexibility:
  - Work with pipeline operators to understand their ability to backflow gas.
- Work with stakeholders to develop a plan of regional scope to facilitate effective use of storage and pipeline capacity following a major NMSZ event:
  - Price signals should remain the primary mechanism to encourage efficient use of stored gas and pipeline capacity.

Scenario-based all sector screening results

- Most infrastructures would sustain physical damage due to seismic event or flooding:
  - Electric Power – potential regional outages for up to 72 hours in Louisiana, Alabama, Tennessee, Kentucky, Missouri, Oklahoma, and Illinois.
  - Oil and Refined Products – the Midwest will likely experience a 20% reduction in fuel in the first 30 days, increasing to a 40% reduction if the disruption is 60 days or longer.
  - Telecommunications - approximately 200,000 households without wireline service (and an additional 700,000 at risk of service loss).
  - Ground and Air transportation – disruptions throughout the earthquake damaged region.
  - Mississippi River transportation – navigation disrupted on the order of a year, with national ramifications for agriculture, and global ramifications for food supply.



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