SAND2008-1139C

Regional Asset and System Analyses Models

Earthquake Hazards in the Central United States

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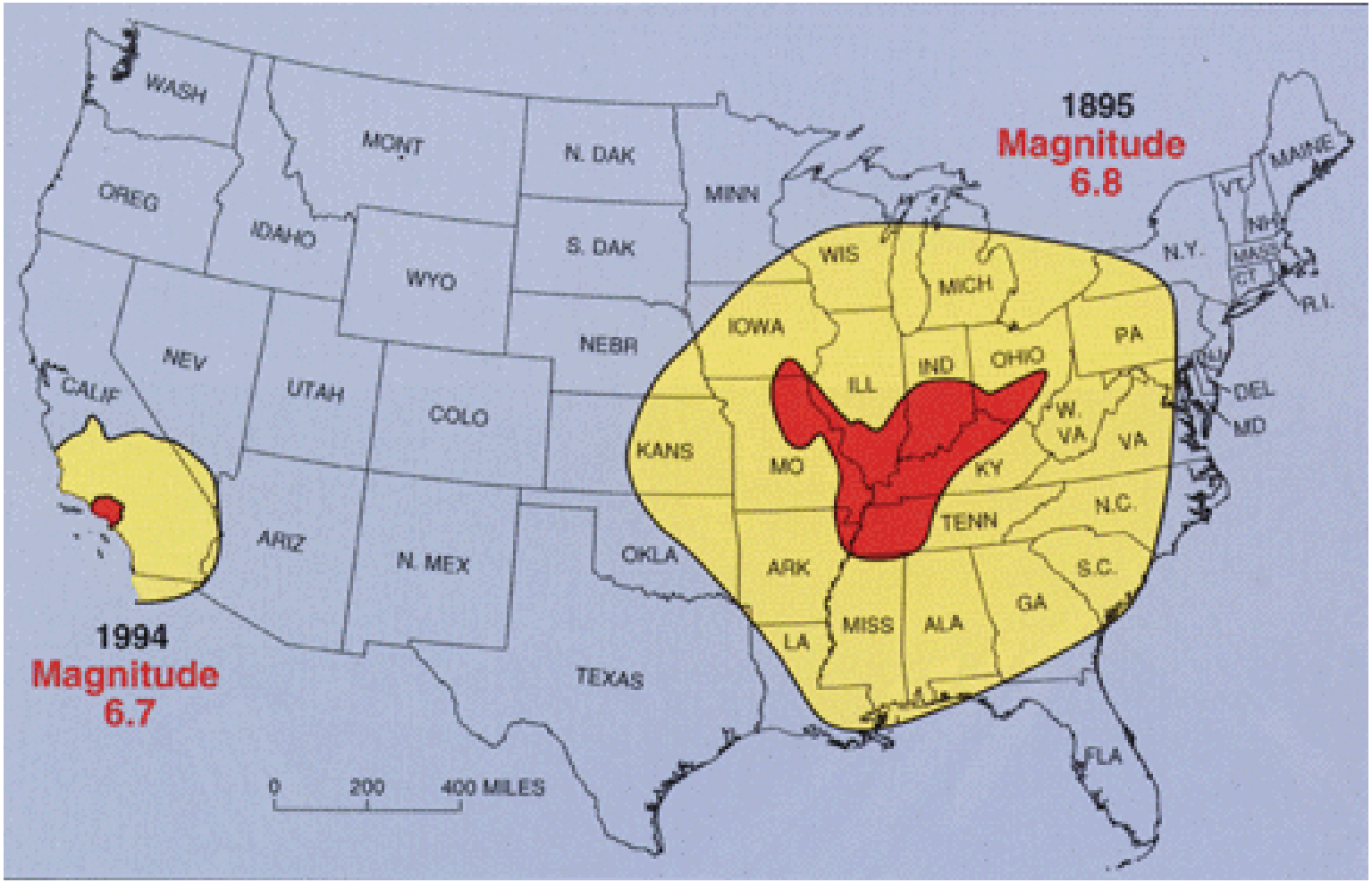
Earthquake Hazard in the Central United States

- Physical, social, and economic disruption to a population of 30 million people, including Memphis, St. Louis, and many mid-sized towns.

- Large impact expected because:
  - The area impacted would be about ten times larger than the area impacted by a similar magnitude California earthquake.
  - Thick, unconsolidated, saturated sediments along the Mississippi River Valley amplify shaking and could liquefy.
  - Many structures are not designed to withstand earthquakes.

- There is 25-40 percent probability of a magnitude 6.0 or greater earthquake occurring in the New Madrid region in the next 50-years. (USGS, Center for Earthquake Research and Information)

New Madrid Earthquakes Impact Large Region



Critical Infrastructures Likely to be Damaged

- This region is a major transportation and communications corridor:
  - Crude oil, refined product, and natural gas pipelines.
  - Barge traffic on the Mississippi could be disrupted for a long time (critical for coal and agriculture products).
  - Highways, bridges, rail lines, and airports.
  - Telecommunications trunk lines
- Electric Power Generation and Transmission Disrupted
- Hazardous Material Spills

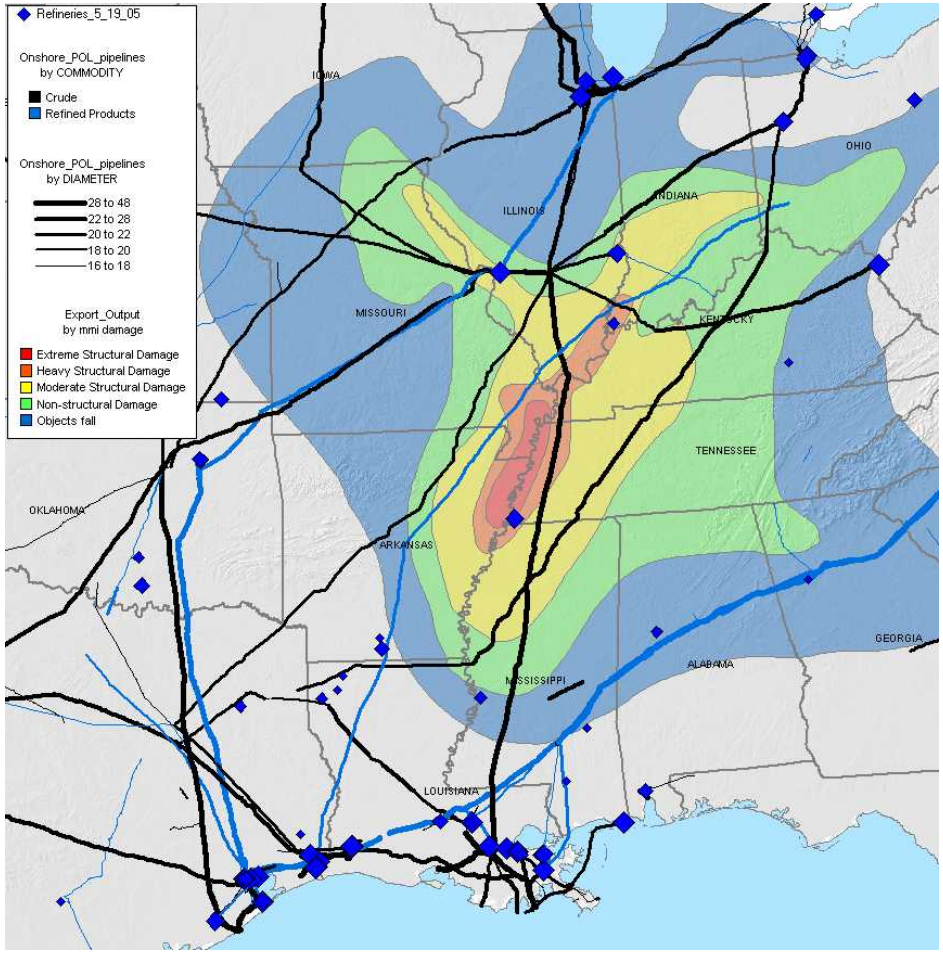
NISAC Objective

- Our objective is to assist hazard planning at the national and regional levels, and to identify potential mitigation strategies.

- We will use data models, infrastructure models, and transportation network models to:
  - Evaluate how infrastructure damage within the New Madrid region could cascade to other regions of the U.S.
  - Estimate consequences in terms of availability of life-line services.
  - Provide situational awareness by identifying specific infrastructure assets that could be damaged.

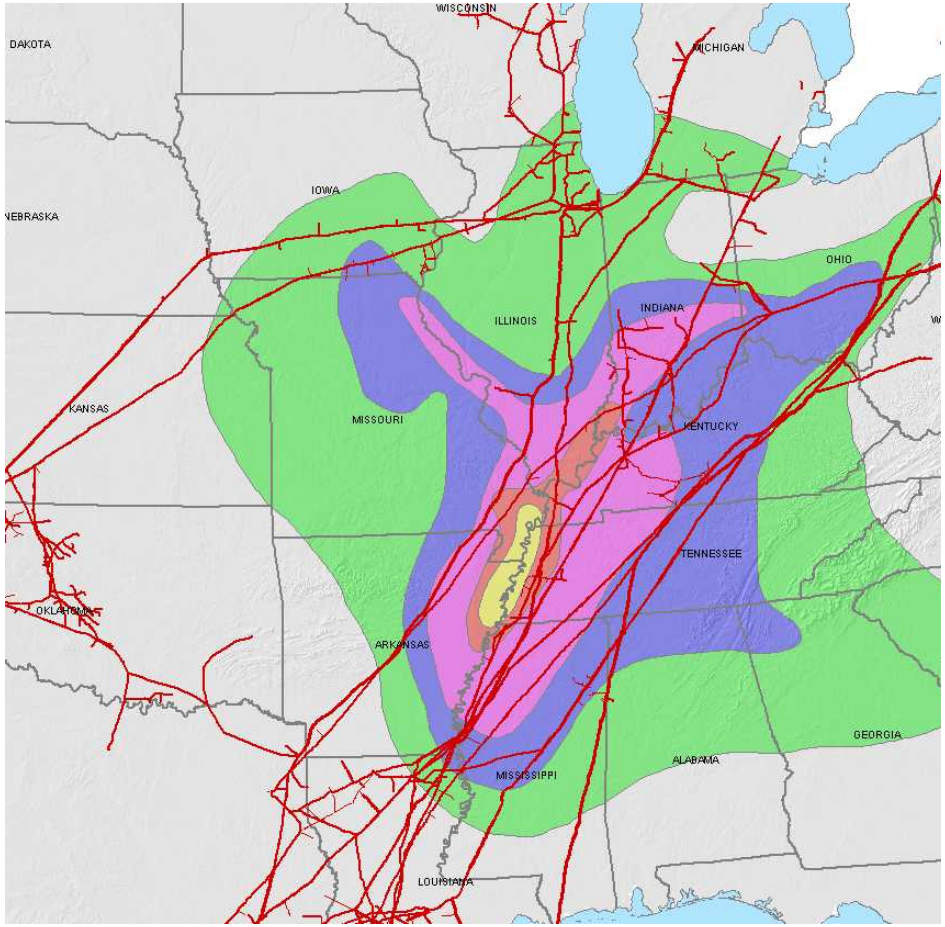
- We will partner with other organizations that provide seismic hazard analysis and seismic-engineering analysis.

Petroleum Sector



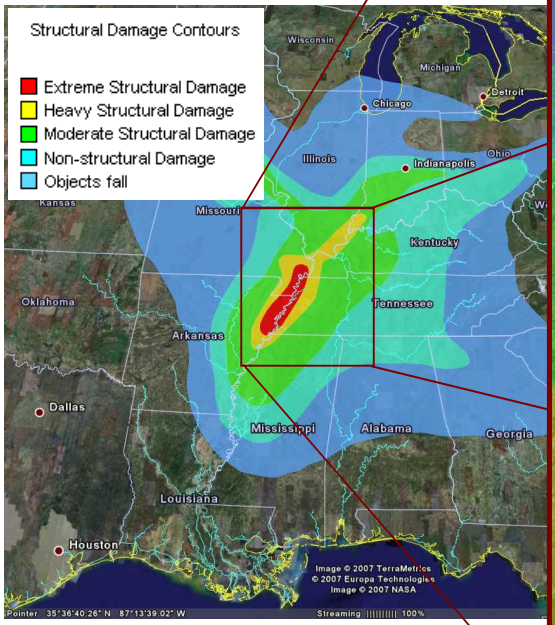
- Assume pipelines in yellow contour and greater will rupture
- No impact on Northeast
- For Midwest
  - 1.7m bpd less crude
  - 1.3m bpd less product
  - Together, this would mean a 60% reduction in product supply
- Where crude pipelines may be restored in weeks, refineries may continue operating for days on crude in storage
  - However, if the power grid fails where the Midwest refineries are located, there would be a hard shutdown of the refineries
    - The 60% reduction in supply would then be immediate

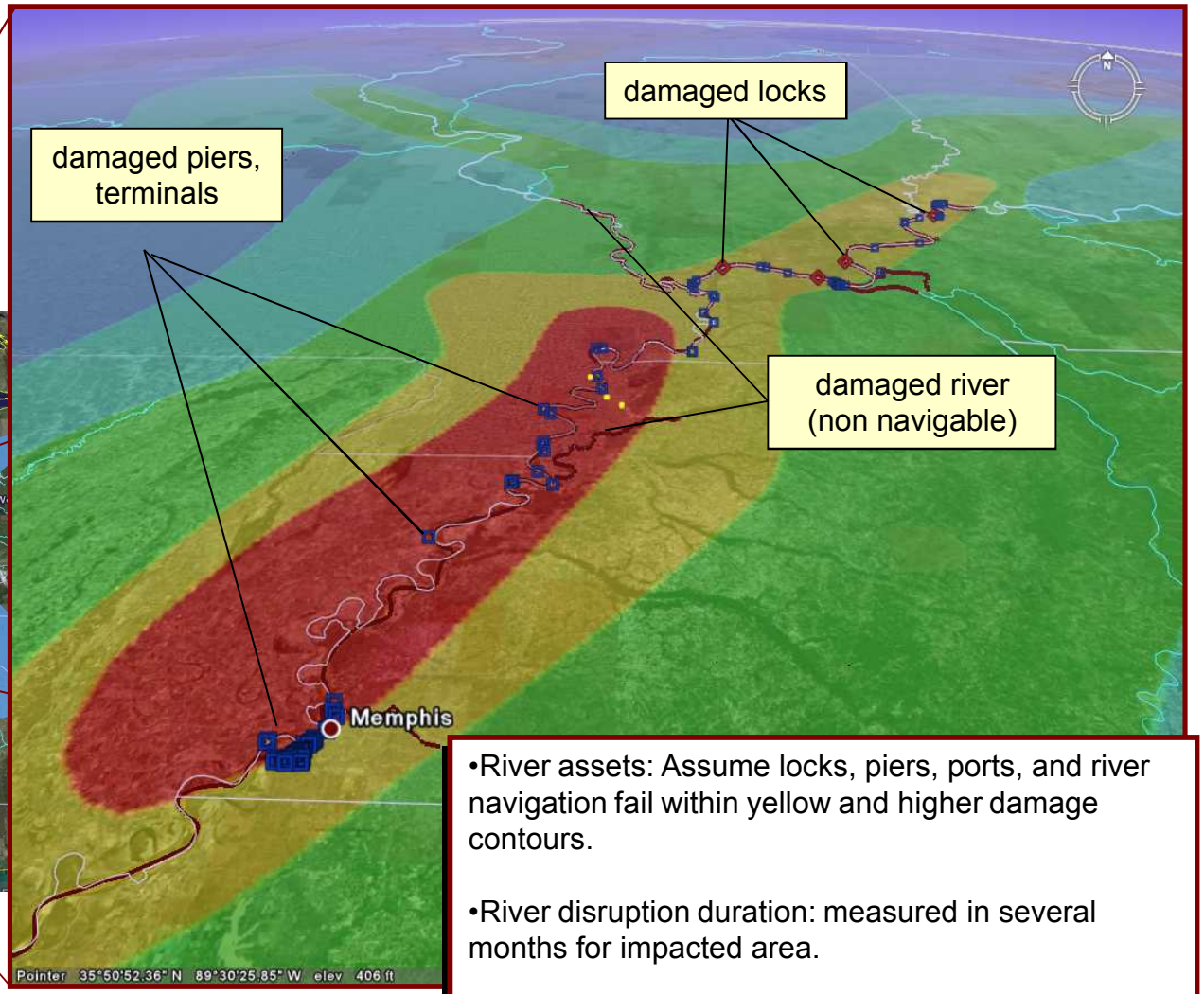
Natural Gas Sector



- Assume pipelines in the two zones of highest damage will rupture
- About 30% of capacity to Chicago area will be lost
  - If in summer, can likely maintain normal supply
  - If in winter, deep cuts in consumption would be necessary
- About 15% of capacity to deliver to Ohio will be lost
  - The impact to the Northeast will also depend on season, but the ability to replace lost volumes is greater
    - Volumes can be increased on piplines moving gas East, as well as those moving gas South

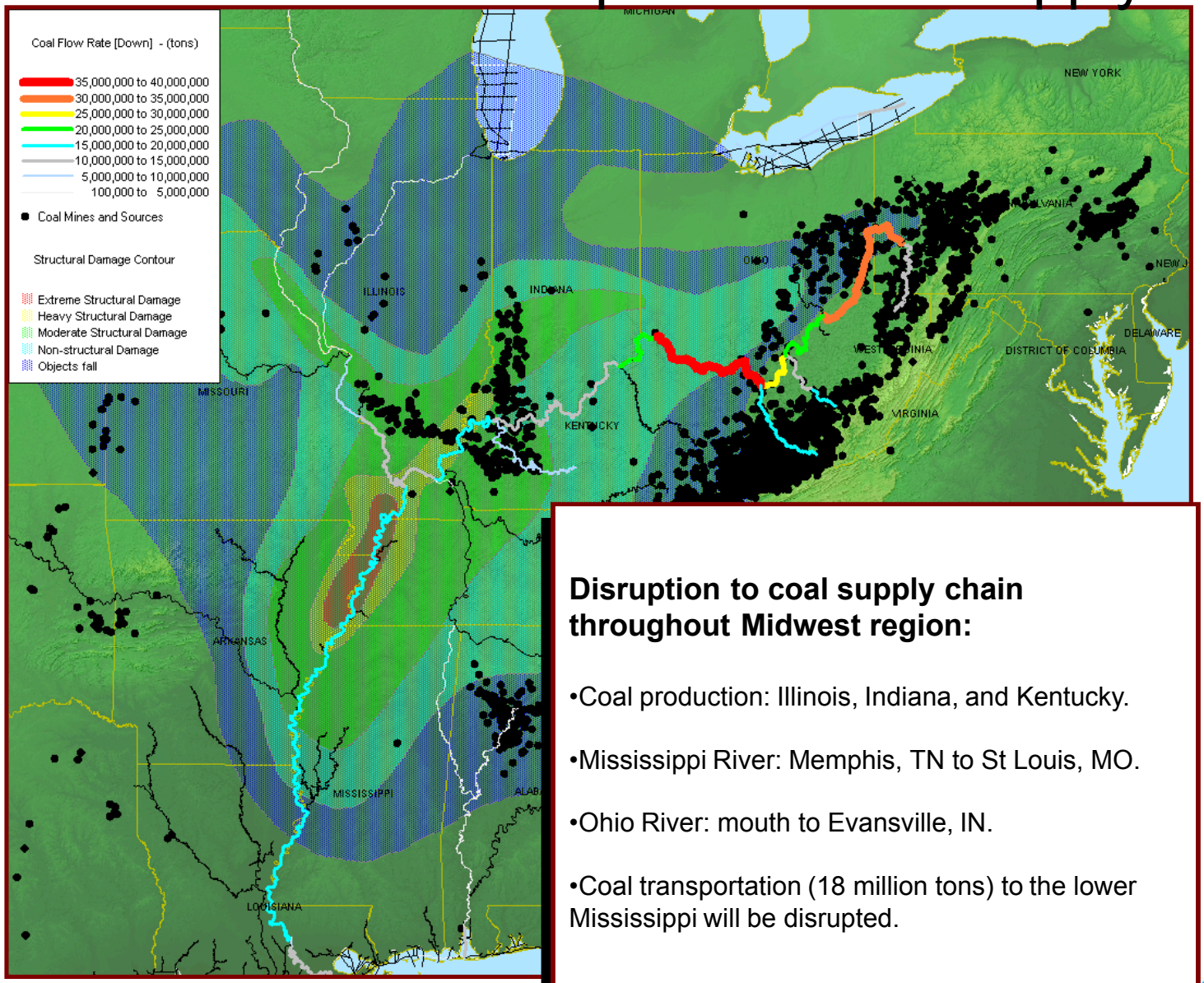
Damage to Waterways Network





- River assets: Assume locks, piers, ports, and river navigation fail within yellow and higher damage contours.
- River disruption duration: measured in several months for impacted area.

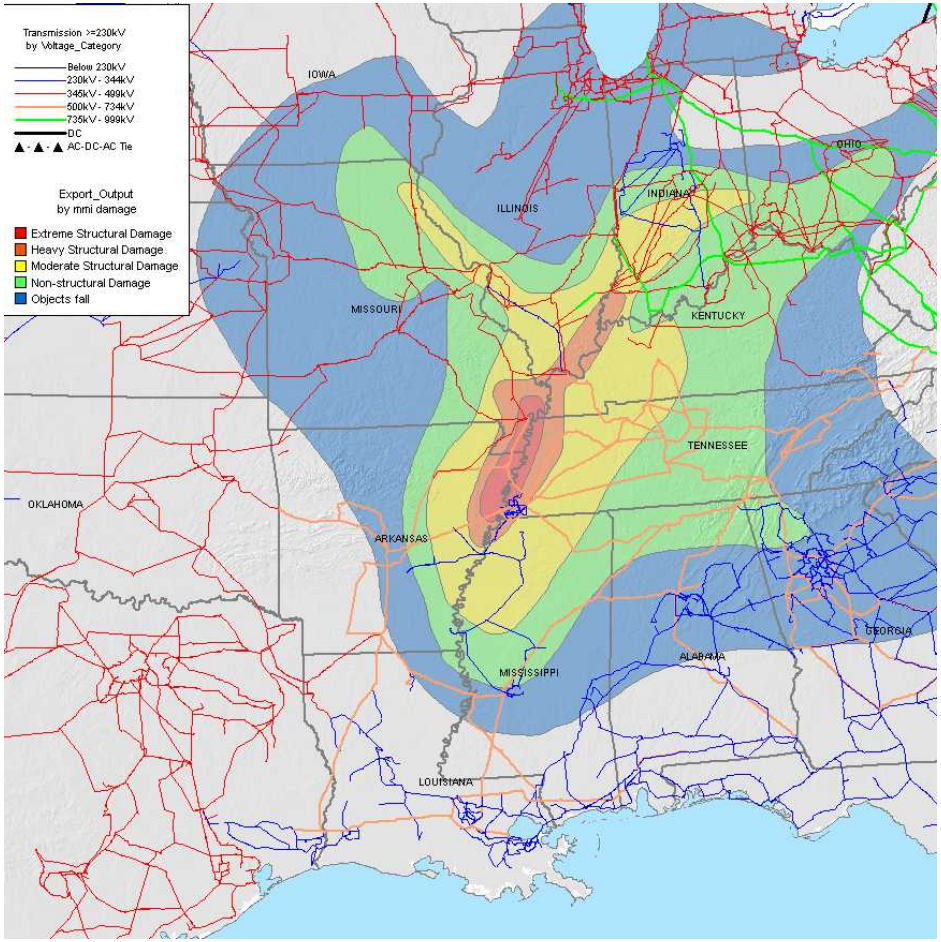
Impact on Coal Supply Chain



Disruption to coal supply chain throughout Midwest region:

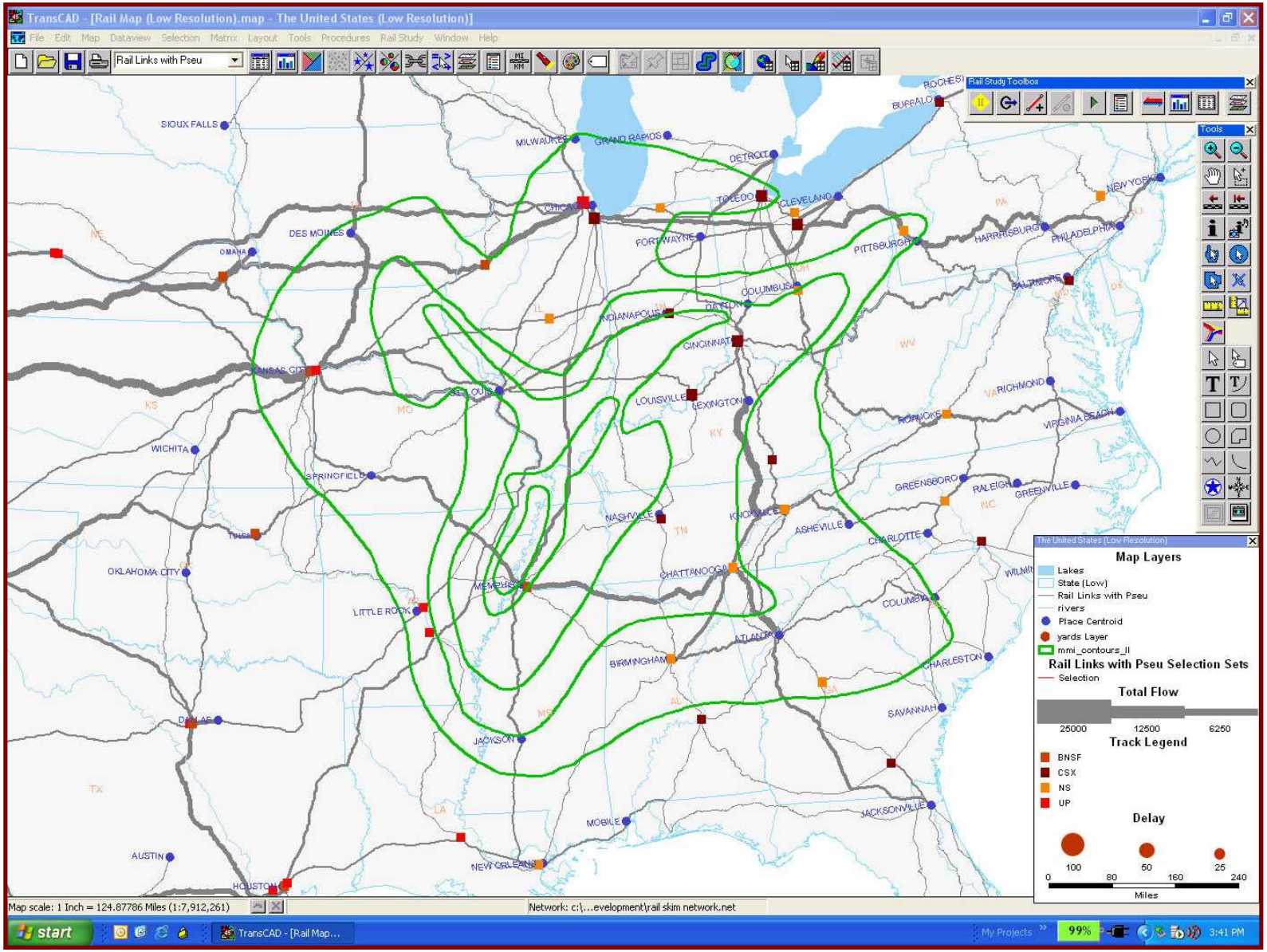
- Coal production: Illinois, Indiana, and Kentucky.
- Mississippi River: Memphis, TN to St Louis, MO.
- Ohio River: mouth to Evansville, IN.
- Coal transportation (18 million tons) to the lower Mississippi will be disrupted.

Electrical Power Sector



- Assume major substations in yellow contour and higher fail
- As power lines in area carry large loads, the power system could probably not adjust quickly enough to their loss
  - there would likely be an outage that spreads beyond the area of immediate damage
- As there is sufficient generation in each state, not all HV substations would have to be repaired for power restoration to take place
  - Likely outage time for areas outside those immediately damaged: 1 to 2 weeks

Impacted Rail Network



2007 Analysis

- Performed survey of impacts to energy and transportation infrastructures
- Concluded that disruption to oil and natural gas transmission pipelines could cause severe impacts:
  - Capacity to serve the Chicago area with natural gas could be reduced by about 25 percent; capacity to serve the northeast U.S. could be reduced by 10 to 20 percent
  - Possibly a 60 percent shortage in transportation fuels in the central U.S.
  - Possible short-lived (perhaps a week) electric-power blackout over much of eastern U.S.

2007 Department of Homeland Security Report

NISAC Infrastructure Analysis:

Impact of a large earthquake in the New Madrid seismic zone on national energy infrastructure

31 December 2007

2008 Plans

- Use an agent/network modeling approach to better predict regions impacted by damage to pipelines
- Use an agent-based microeconomic model for analysis of economic resilience
- Continue to collaborate with emergency-response planners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