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National Infrastructure Simulation and Analysis Center (NISAC) Overview

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U.S. DEPARTMENT OF ENERGY | NNSA

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NISAC History & Mission

- The National Infrastructure Simulation and Analysis Center (NISAC) is
  - A program of the DHS Office of Cyber Infrastructure Analysis (OCIA)
  - Established under The USA PATRIOT Act of 2001
  - A collaboration between national laboratories
    - Sandia National Laboratories
    - Los Alamos National Laboratory
    - Pacific Northwest Laboratory (added in 2015)
  - The work of 40 – 50 researchers

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Los Alamos

NISAC Modeling and Analysis Goals

Provide fundamentally new modeling and simulation capabilities for the analysis of critical infrastructures, their interdependencies, vulnerabilities, and complexities

Aiding decision makers with

- *policy assessment,*
- *mitigation planning,*
- *education & training,*
- *near real-time assistance to crisis response organizations*

Why We Model

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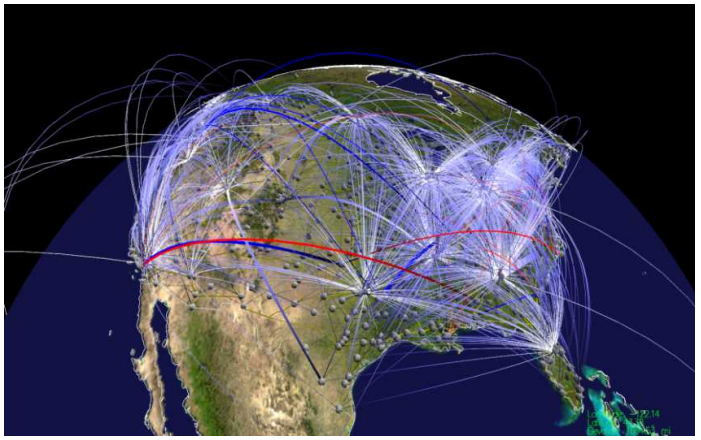
- **The domains in which we work are:**
  - Large
  - Complex
  - Dynamic
  - Adaptive
  - Nonlinear
  - Behavioral

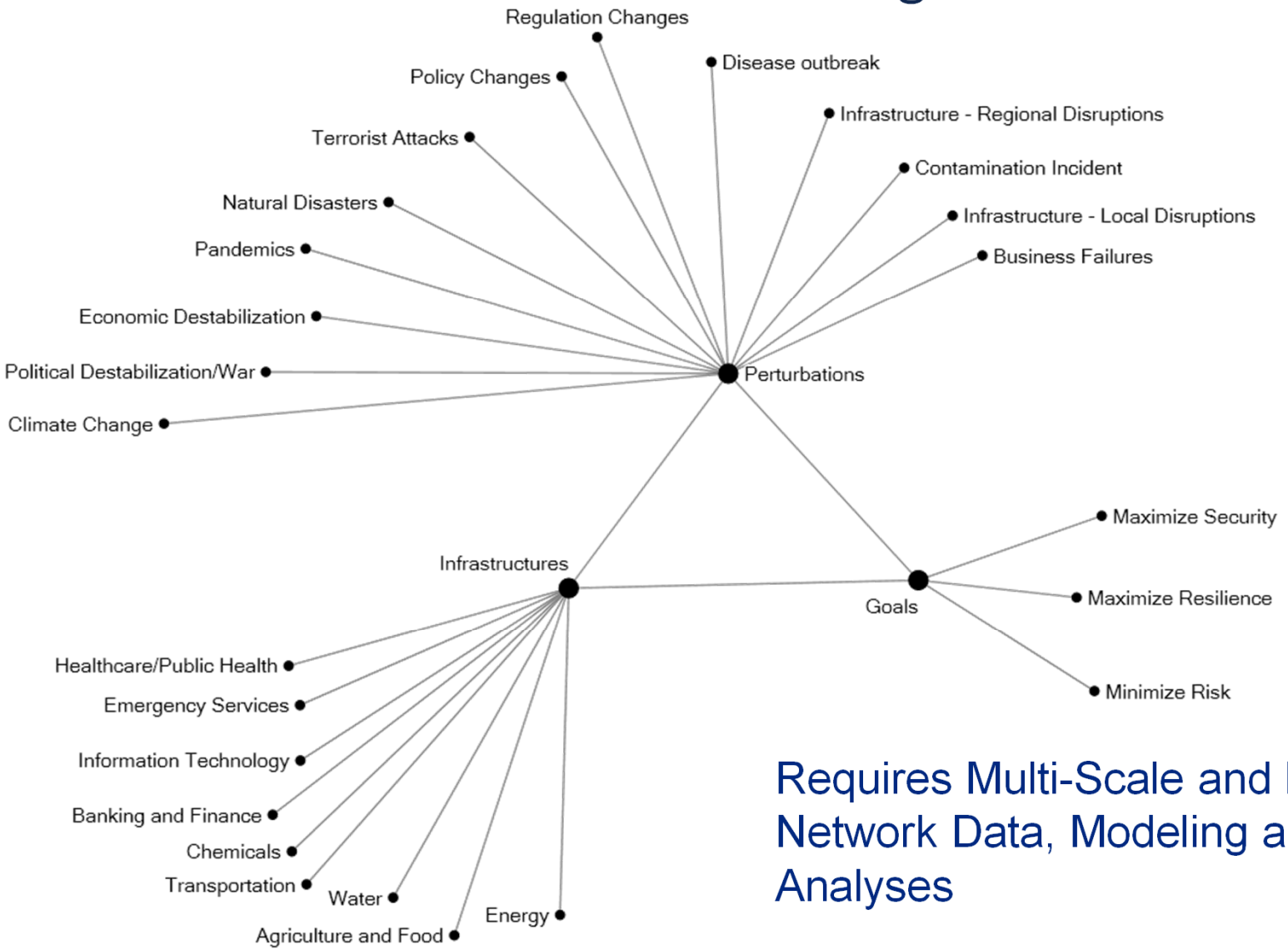


Agent-based supply chain disruption model

- **Too complex for mental models to be effective decision tools**
- **Identify when/where things break, and any cascading effects**
- **Quantifying consequences of disruptions in very complex systems**
  - Acute: Sudden but temporary loss of a assets or function due to attack, accidents or natural disasters
  - Chronic: Gradual change in condition (environment, infrastructure supply or demand for infrastructure services) due to changing stresses, population dynamics, innovations, aging infrastructure

Model to gain insight – experiment with the model not the system

Long-term Applied Research Goal: Understand Infrastructure Risks and Engineer Solutions



Requires Multi-Scale and Multi-Network Data, Modeling and Analyses

Energy – Petroleum Fuels:
Crude Oil and Refined Products Interacting Networks

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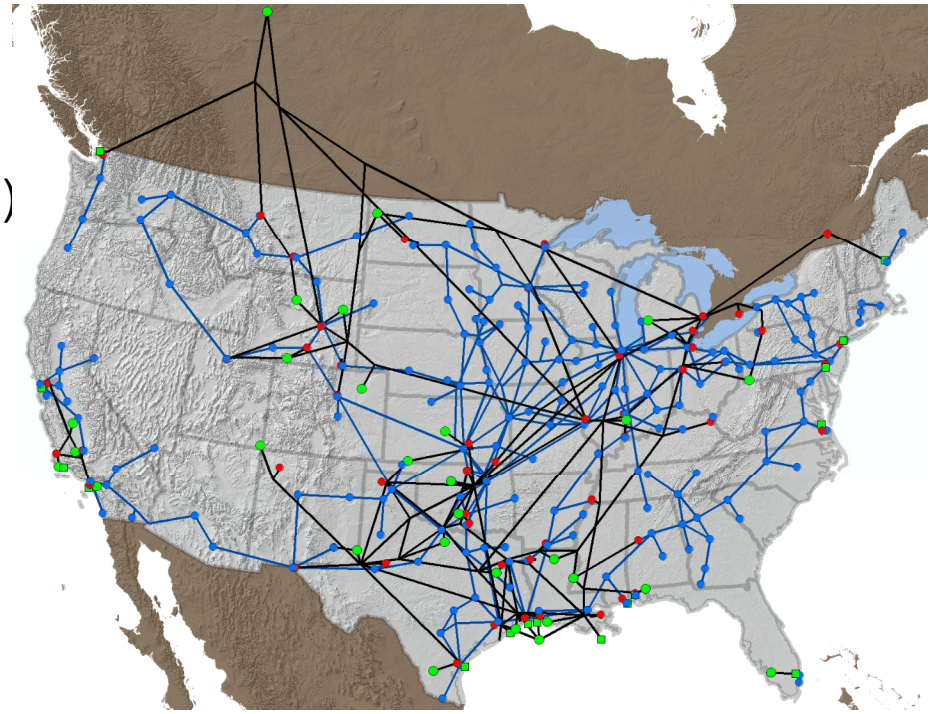
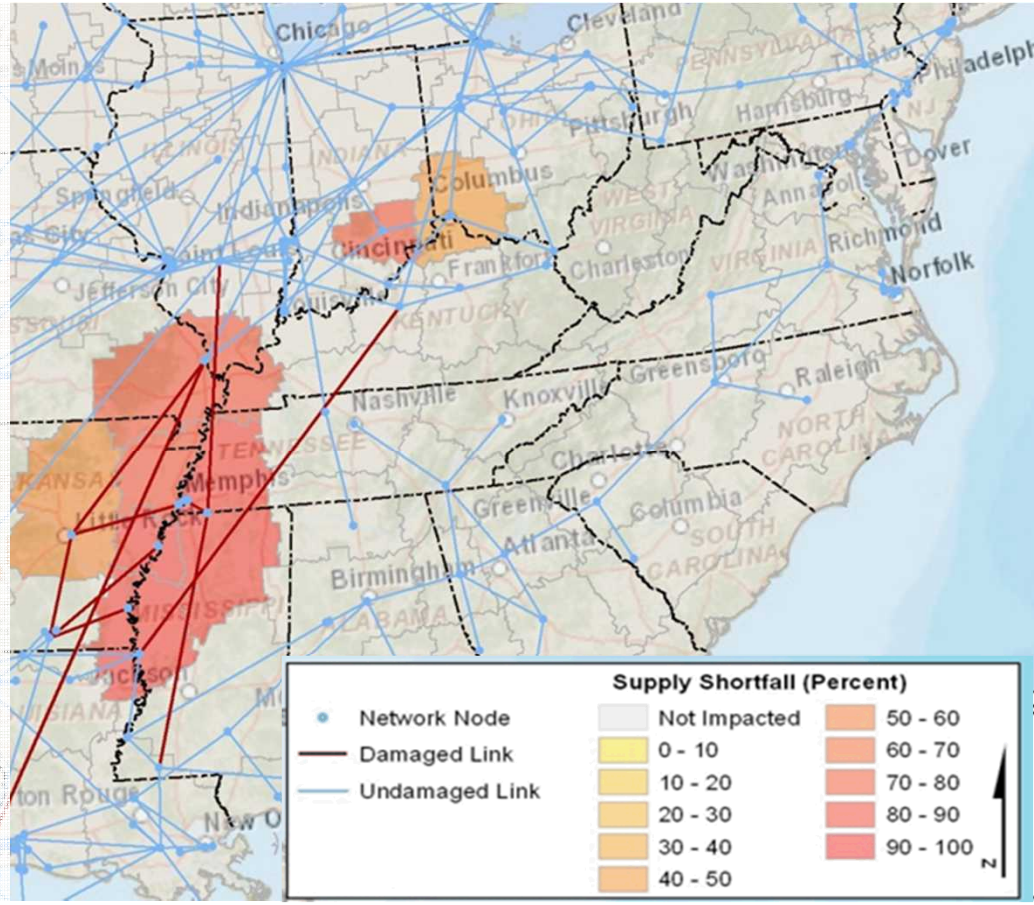
- Goals:
  - understanding risks of specific incidents (hurricanes, earthquakes, equipment failures)
  - identifying effective risk mitigations
- Approach:
  - incident and scenario-based analyses
  - national network flow dynamics model



For references and contact information see:
http://www.sandia.gov/nisac

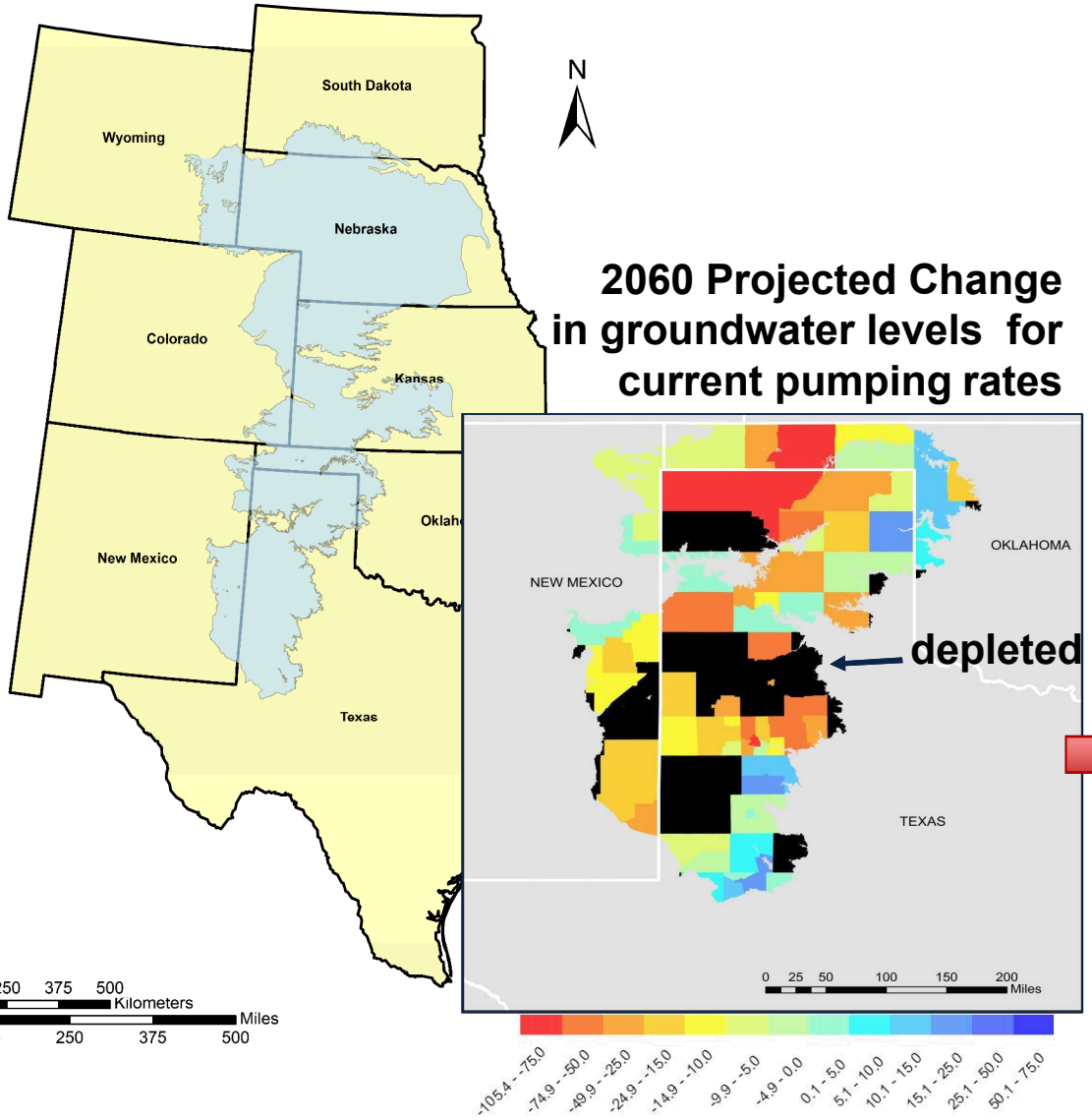
Example Scenario: Central U.S. Earthquake

- The New Madrid Seismic Zone (NMSZ) stretches along the Mississippi River Valley from southern Illinois to Memphis
- A cluster of very powerful earthquakes occurred during the winter of 1811–1812.
- The U.S. Geological Survey estimates a 7 to10 percent chance of earthquakes with magnitudes equivalent to the 1811–1812 quakes occurring in any 50-year period *
- A similar cluster of earthquakes occurring today would cause extensive damage to oil and gas transmission pipelines



*(USGS, Center for Earthquake Research and Information Fact Sheet 2006-3125).

High Plains Water Resource Risks



Reduction in Corn, Grain Sorghum and Cotton Crop Yields: 22-37% for irrigated and dryland farming

Economic impact is most significant for NM (-0.1% GDP)

Chemical Supply Networks (with interdependencies)

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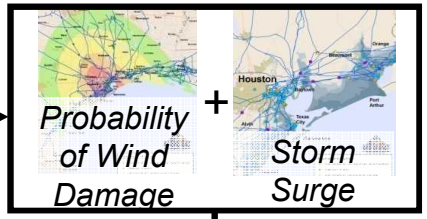
Example – Hurricane Impacts on Petrochemical Supplies

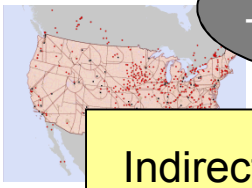


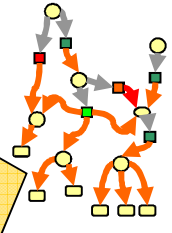
Disrupted Refineries

Disrupted Petrochemical Plants

Disrupted NG Compressors/Stations

Service Territories



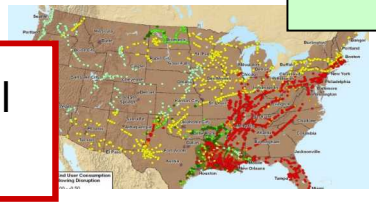


Petrochemical Network Model

Gas Network Model

Indirectly Disrupted Petrochemical Plants

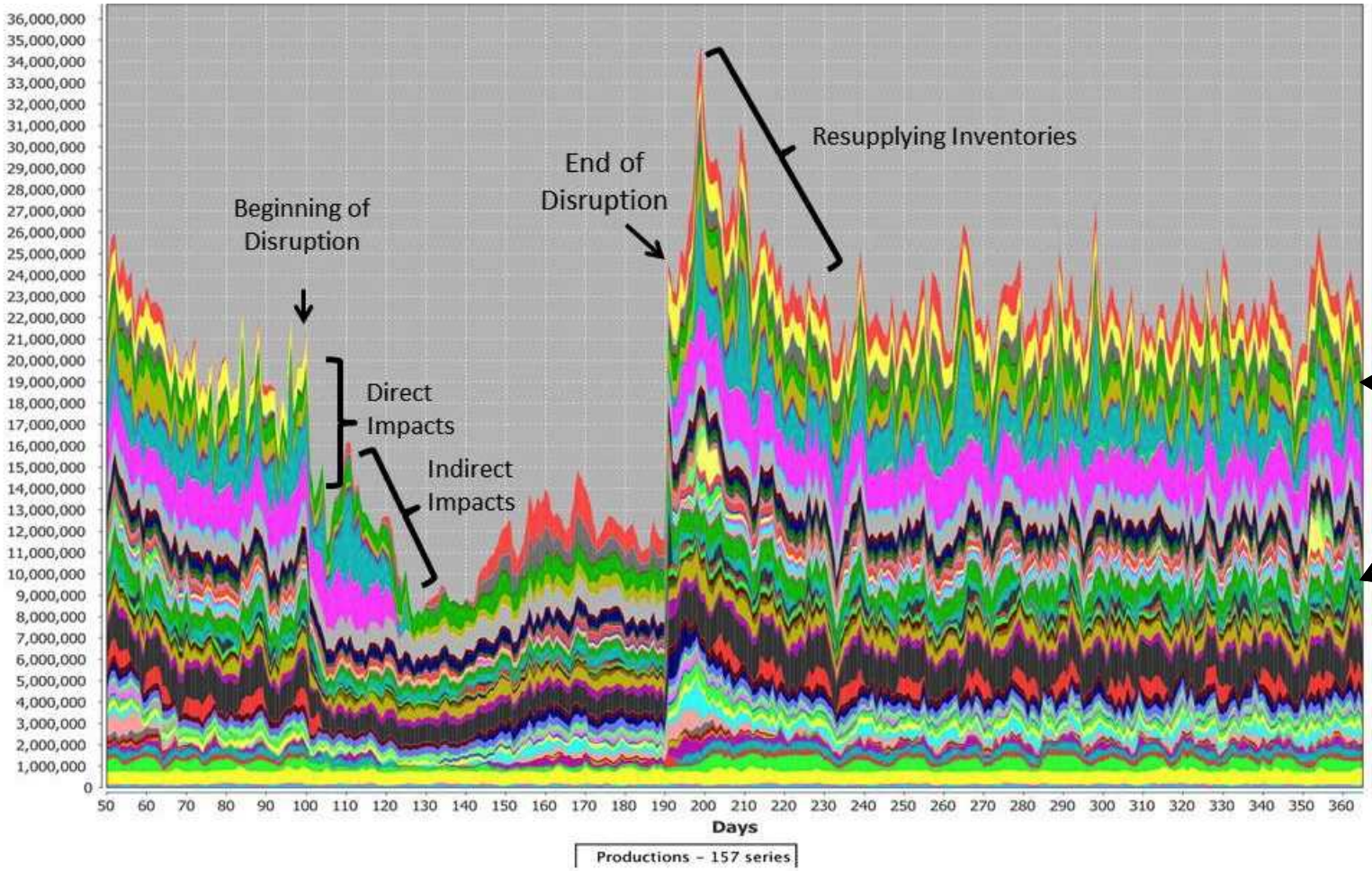
Indirectly Disrupted Petrochemical Plants



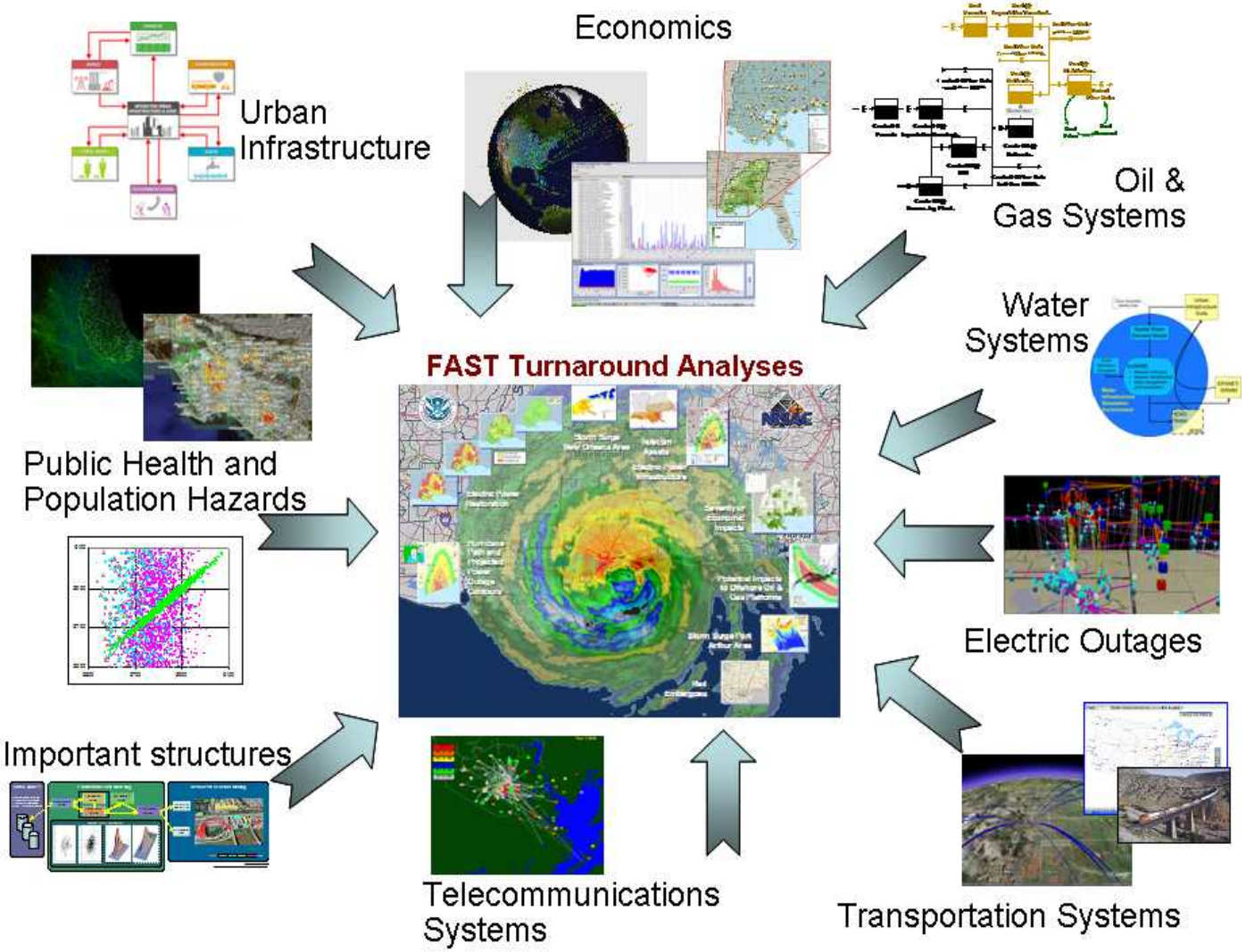
Petrochemical Shortfalls

For more information see the following websites:
http://www.sandia.gov/CasosEngineering
http://www.sandia.gov/nisac/chemical.html

Example: Houston Hurricane National Impacts on inventories



Hurricane Impacts Analysis
Integration of Multidisciplinary Skill Sets & Expertise



Program Capabilities

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- Interdependencies and System Modeling

  Interdependencies and system modeling capabilities provide the foundation for all products including asset prioritization, natural disaster planning and other impact analyses.

- Economic and Human Consequences

  A mixture of proprietary commercial software and in-house modeling and simulation capability to provide first-in-class estimates of population and economic impacts.

- Asset and Facility Operations Modeling

  Representation of likely infrastructure operator responses to external events and the operational impacts of those responses.

- Fast Integrated Hazards Analysis / Integrating Architecture

  A common integrated simulation environment provides consistent consequence estimates across event analyses and to expand event scenarios to multiple cascading events.