NISAC

NATIONAL INFRASTRUCTURE SIMULATION & ANALYSIS CENTER

SAND2008-7921C

# National Infrastructure Simulation and Analysis Center (NISAC) Program Overview

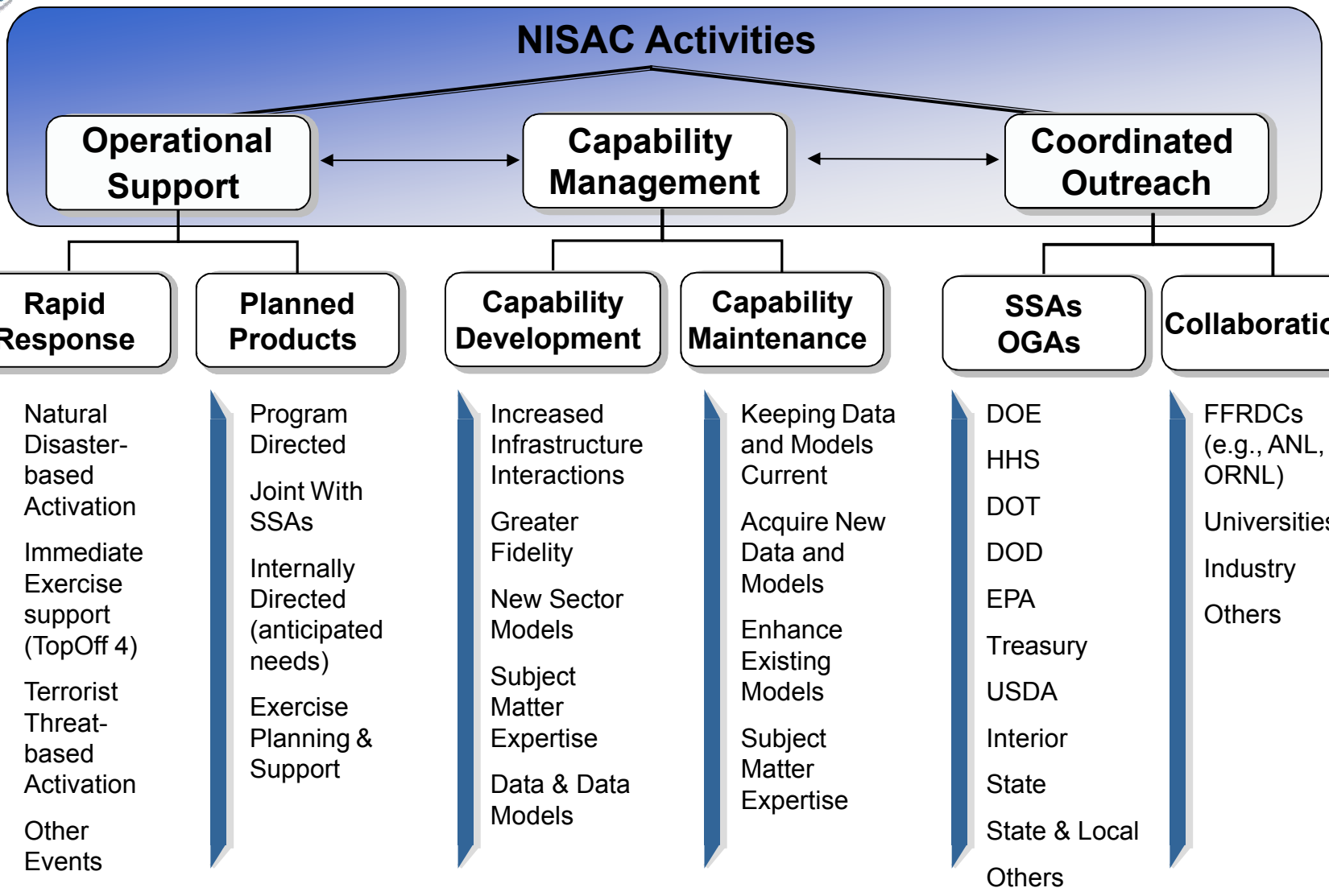
*Nancy Brodsky*
*SNL Lead for Fast Analysis and Simulation Team*
*November 2008*

# Who We Are and Our Mission

- 90 scientists & researchers from Sandia & Los Alamos National Laboratories; joint project; building on Kirtland AFB, New Mexico
- 2001 Patriot Act formally established NISAC, but around since 90s
- 2007 Homeland Security Approp. Act expanded NISAC mission
  - "**source of national expertise** to address **critical infrastructure protection…"**
  - … **counterterrorism, threat assessment, and risk mitigation**
  - … **natural disaster, act of terrorism, or other manmade disaster**
  - …**modeling, simulation, and analysis** … to **enhance preparedness, protection, response, recovery, and mitigation activities**."
  - Directs NISAC share with Federal agencies with departments with critical infrastructure responsibilities under HSPD-7 – NIPP partners

# What we want to know about infrastructures and their interdependencies is…

- Are there any time bombs?
- Are there any weak points we don't know about?
- Are certain systems, networks, parts of the country more at risk than others? Why?
- Have interdependencies increased the risks or have they changed them?
  - What conditions have to exist to cause cascading failures?
  - What size of event has to occur to initiate cascading failures?
- Are there trends in the evolution of the infrastructures toward more vulnerable conditions or configurations?
- Are we repeating any mistakes from the past or have we really learned from them?
- How do the risks to infrastructures impact national security?
- How can we reduce the risks to infrastructures?
  - Can we afford to reduce those risks?
  - Over what timeframe?


NISAC Activities
Operational Support
Capability Management
Coordinated Outreach
Rapid Response
Planned Products
Capability Development
Capability Maintenance
SSAs OGAs
Collaborations
Natural Disaster-based Activation
Immediate Exercise support (TopOff 4)
Terrorist Threat-based Activation
Other Events
Program Directed
Joint With SSAs
Internally Directed (anticipated needs)
Exercise Planning & Support
Increased Infrastructure Interactions
Greater Fidelity
New Sector Models
Subject Matter Expertise
Data & Data Models
Keeping Data and Models Current
Acquire New Data and Models
Enhance Existing Models
Subject Matter Expertise
DOE
HHS
DOT
DOD
EPA
Treasury
USDA
Interior
State
State & Local
Others
FFRDCs (e.g., ANL, ORNL)
Universities
Industry
Others

# Fast-Turn Analysis Examples

2008
- Hurricane Impacts (Gustav and Ike)
- Midwest Flooding
- National Level Exercise 2 - 08
- Transportation corridors analysis
- International asset analyses

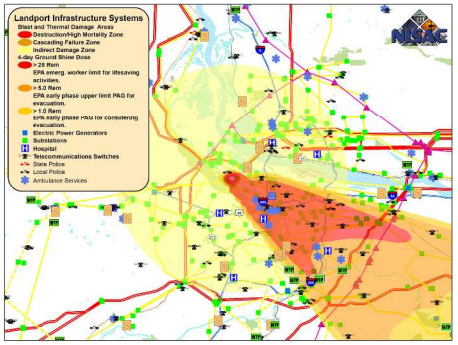
2007
- Minnesota oil pipeline explosion
- California wildfires
- TOPOFF IV
- I-35W Bridge Collapse
- Rail car TIH release scenario
- Ardent Sentry exercise support

2006
- Pre-Hurricane scenario analyses
- Detroit MSA chemical analysis
- International Energy impact analysis

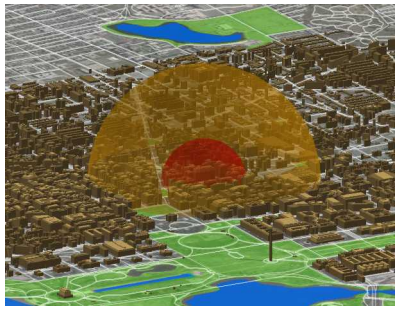
2005
- Hurricane Damage and Recovery (Dennis, Emily, Katrina, Rita, Wilma)
- Avian Influenza CATF Exercise Support
- Urban Area Security Initiative IV
- Transit tunnel analyses - London bombing
- Hazardous Chemical Transportation Policy

2004
- Hurricane Damage & Recovery (Frances, Ivan)
- Economic Impacts of 2003 BSE discovery

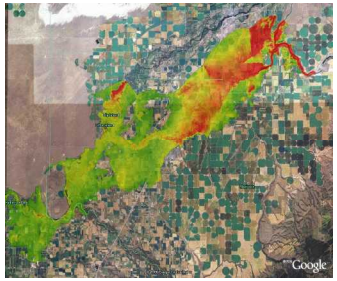
2003
- Hurricane Isabel Damage and Recovery
- Holiday Threat



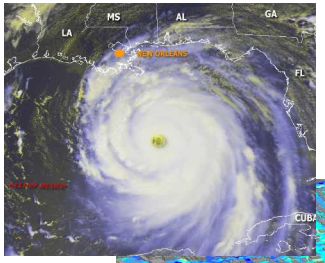

*Infrastructure and Population Impacts*

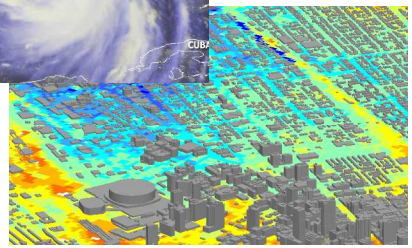


*Improvised Nuclear Device*

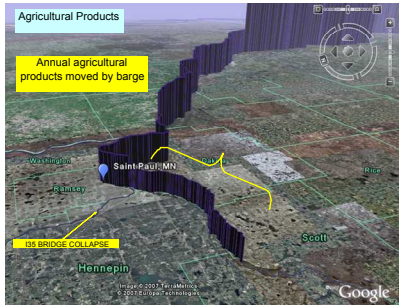



*Dam Break*



*Hurricane*




***Orange box indicates substantial chemical analysis component***

# Example Planned Analysis Products

2008
- Priority asset impact analyses
- Hurricane Scenario for Corpus Christi, Mid-Atlantic
- National Petrochemical Supply-Chain

2007
- Earthquake Impacts (California, New Madrid Seismic Zone)
- Petrochemical global supply-chain disruption impacts
- Long-term economic impacts of Hurricane Katrina
- Dam failure impacts – case studies
- Hurricane Scenarios for Savannah and North Florida

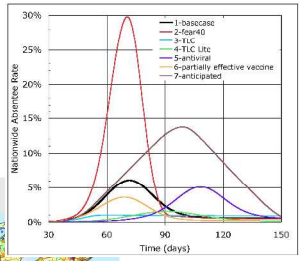
2006
- Pandemic Influenza Impacts and Mitigation Design
- National Hazards Mitigation
- Regional Economic Impacts
- Air Transportation disruption impacts
- Hurricane Scenarios for Mid-Atlantic, Mobile, Houston, Tampa, New York and Miami

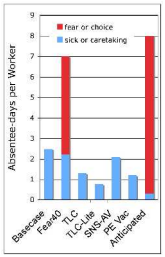
2003- 2005
- Gulf Coast infrastructure disruption impacts
- Pacific NW port security impacts
- National rail system asset disruption
- Chlorine transportation disruption
- Risk-based asset prioritization

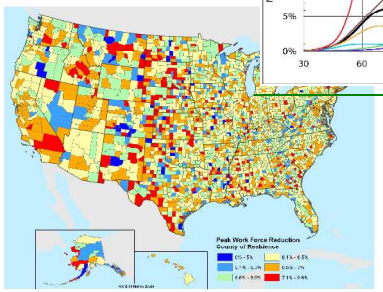
***Orange boxes indicate substantial chemical analysis component***

Key Results – Workforce

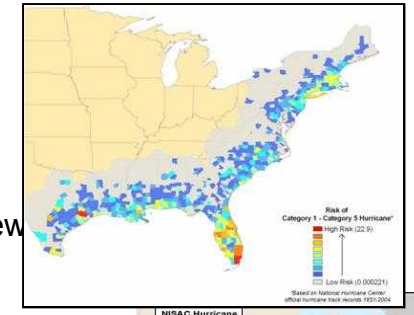
- Analysis quantified absenteeism impacts on infrastructures and economic sectors nationally by county

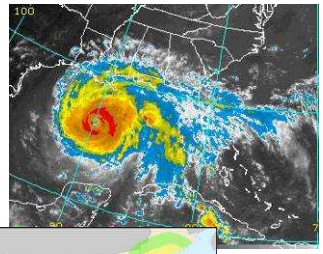


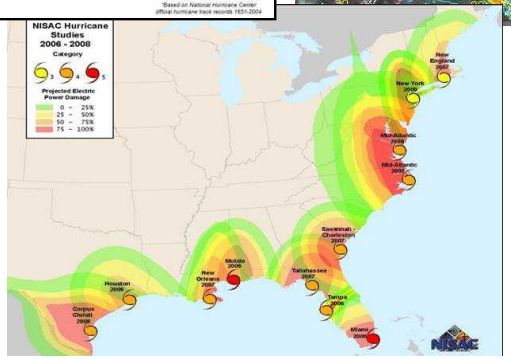




- Counties are impacted by absenteeism differently due to demographic differences (e.g., household size)



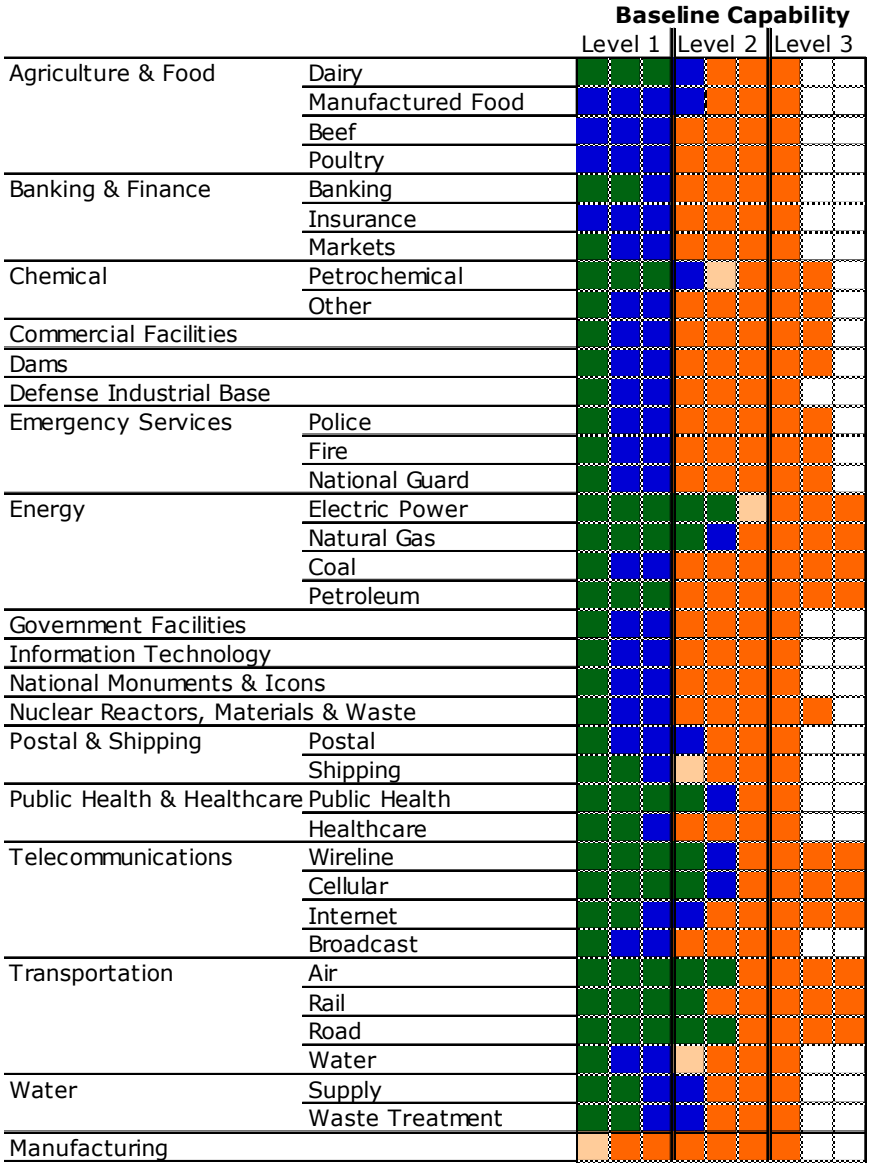


# Capability Development Strategy

| Highly Connected and Interdependent Infrastructures | Essential and Highly Dependent Infrastructures | Economic Sectors | Assets |
|---|---|---|---|
| • Energy<br>• Banking & Finance<br>• Telecommunications<br>• Transportation | • Health Care<br>• Ag & Food<br>• Water<br>• Government<br>• Chemical | • Residential<br>• Commercial<br>• Industrial | •Power lines<br>•Banks<br>•Central offices<br>• Bridges<br>•Many more… |
| Commerce and national economic security depend on these infrastructures | Human health and safety depend on these infrastructures | Source of demand and labor for infrastructures | Potential targets |

***Orange box indicates substantial chemical analysis component***

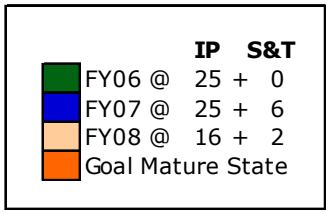
# Sector Modeling Capability




Level 1 - Initial screening capability (sector data, aggregate models, single asset or general operation models)

Level 2 - Enhanced screening and priority analysis capabilities (network models with limited asset level representation, intra-sector dependencies and confidence)

Level 3 – Mature screening and analysis capabilities (detailed, fully-featured, dependency, interdependency, large-scale system, nation-wide coverage and high-degree of confidence)



# Collaborations Throughout Government, Private Sector and Academia

University of Minnesota
USC – CREATE
University of Maryland
Cornell
Columbia
UC Berkeley
UC Santa Barbara
UCLA
UC Riverside
University of Washington
Rice University
University of Illinois at Urbana-Champaign
University of Utah
Carnegie-Mellon University
University of Texas at Austin
University of Washington
Virginia Tech
University of New Mexico
University of Arizona
MIT
Duke University
SUNY Albany
University of Nebraska
Illinois Institute of Technology
Ohio State
Georgia Tech

NSTAC
Goodyear
AON
RMS
SRI-C
Veterans Administration
AIR
Lucent/Alcatel
Microsoft Research
SAMSI
Bell Labs
Scalable Networks
Motorola
Metatech
Telcordia
Pacific Northwest Economic Region
Port of Portland
Port of Seattle
Portland METRO

Central European Bank
Bank of Finland
ETH Zurich
Nankai University
University of Vienna
DSO Singapore

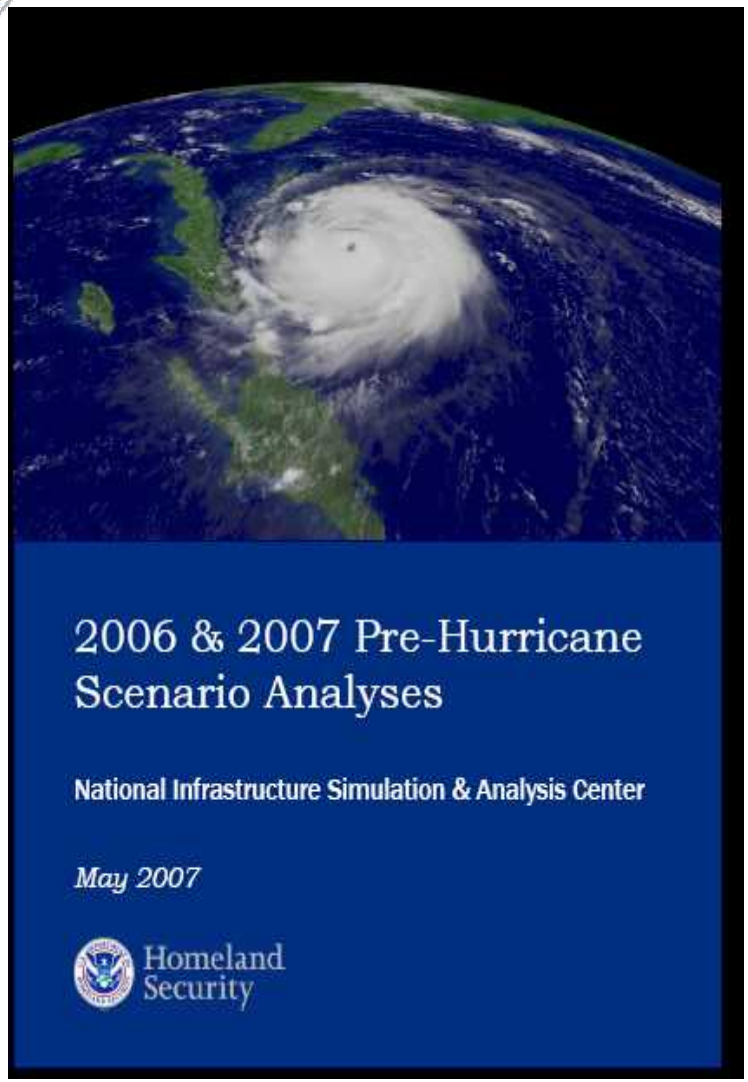
# Multiple Viewpoints

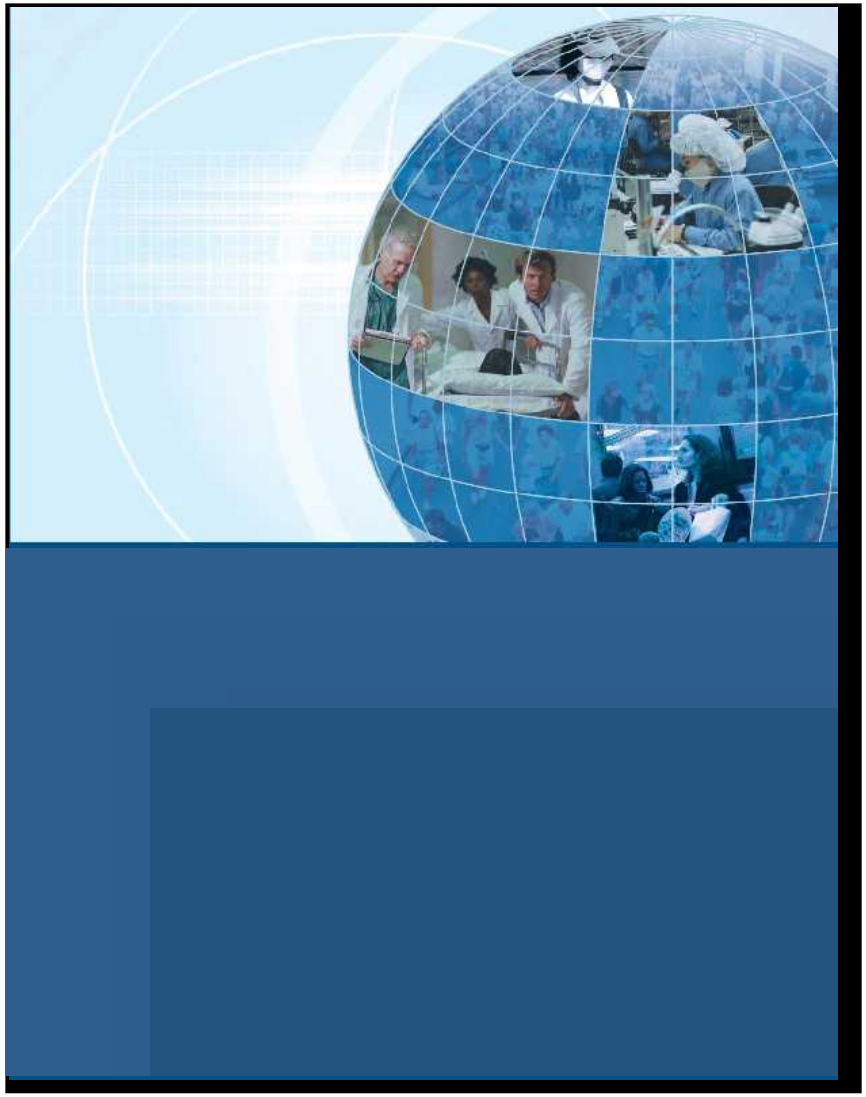
Realistic → Abstract

→ *Decreasing detail, computation and development time*

| Data on system elements | High-fidelity models - individual infrastructure elements | Systems models of aggregate supply - demand dynamics | Generic, highly abstracted network models |
|---|---|---|---|
| Only know what is measured or monitored - limited to specific set of conditions<br><br>**FASTMap**<br>**FAIT**<br>**REAcct** | Detailed simulation of changes in conditions or behaviors<br><br>**N-ABLE**<br>**R-NAS**<br>**ATOM**<br>**IEISS**<br>**MIITS**<br>**N-SMART**<br>**EpiSims**<br>**TRANSIMS**<br>**Loki-Natural Gas** | Effects of conditions and limitations on system operation<br><br>**Port Simulators**<br>**Petroleum**<br>**Natural Gas**<br>**Agriculture**<br>**TelecomOps**<br>**DamOps** | Simulation and identification of vulnerabilities of different network topologies to disruptions and effective mitigation<br><br>**Loki-Infect**<br>**Loki-Transaction**<br>**Loki-Power** |

# Recent NISAC Publications

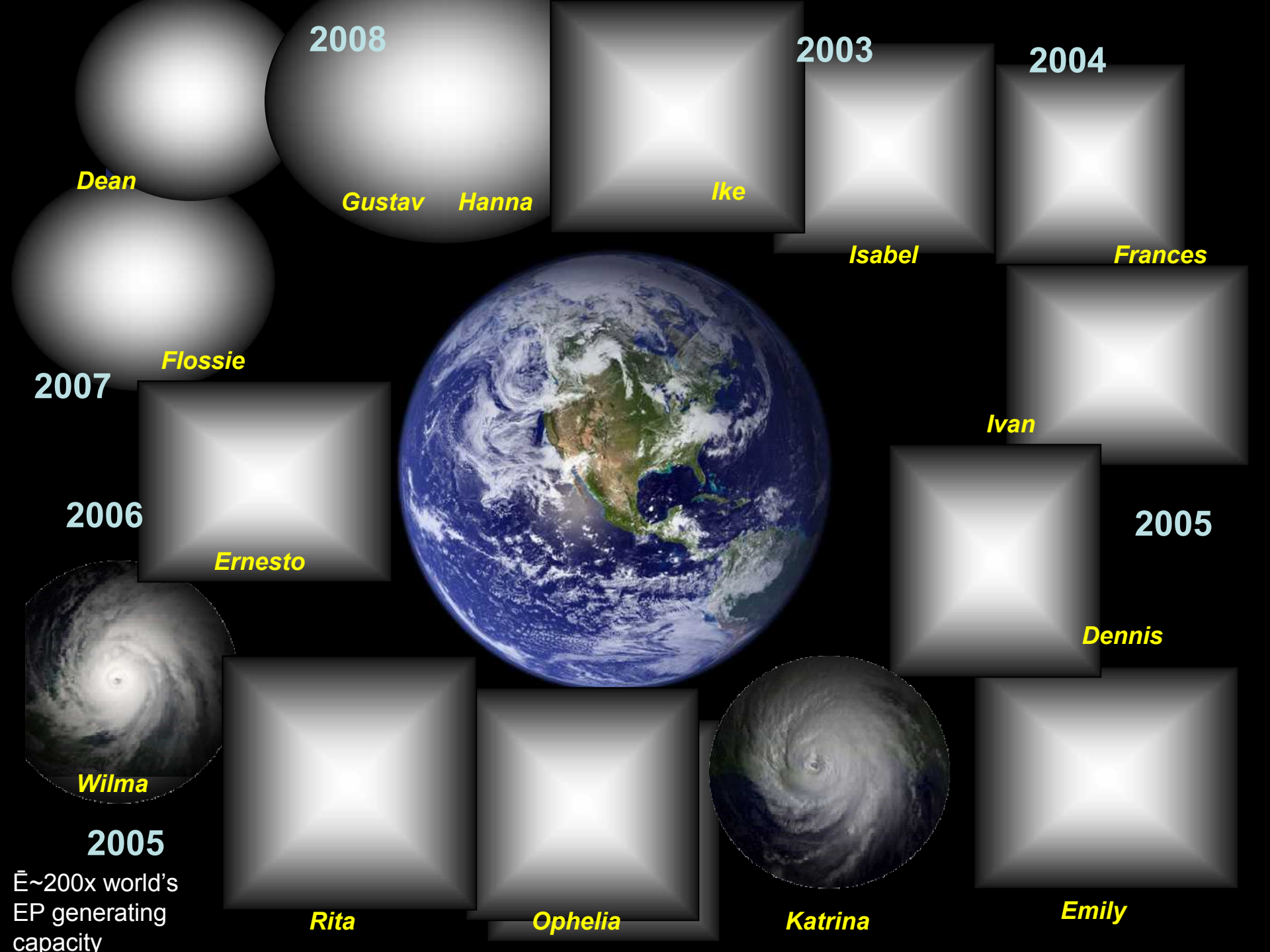


NISAC

# Impacts of NISAC Analyses

- Analysis results have been used in briefings for:
  - DHS Assistant Secretary of Infrastructure Protection, Robert Stephan
  - DHS Deputy Under Secretary for the National Protection and Programs Directorate, Robert Jamison
  - DHS Secretary Michael Chertoff
  - President Bush
- Analyses have been used in National security exercises
  - National Level Exercise (NLE) 2-08
  - TOPOFF III and IV
  - Ardent Sentry – Northern Edge (Hurricane) and IND (NuDet)
  - Senior Officials Exercise IV
- Analyses been requested for policy evaluation
  - TIH transportation analysis
  - Chlorine analysis
- Insights gained
  - Avian Influenza / Pandemic Influenza results
  - Rail transportation – importance of assets




Ē~200x world's EP generating capacity

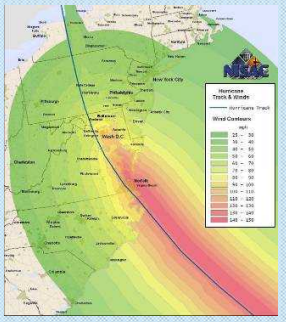
# Topics Covered in 48 Hour Report

- Storm/Event Data
- Storm Surge and Flooding
- Electric Power Damage and Restoration
- Population
- Energy
  - Electric Power
  - Natural Gas
  - Petroleum, Oil, and Lubricants (POL)
  - Nuclear Reactors, Material, and Waste
- *Chemical and Hazardous Materials*
- Telecommunications and Information Technology
- Highways and Highway Bridges
- Ports and Maritime Facilities
- Airports and System Impacts
- Rail Transportation Facilities and System Impacts
- Intermodal Transportation
- Emergency Services, Public Health, Healthcare, and Public Broadcast
- Key Interdependencies for Emergency Services
- Water Systems: Drinking Water and Waste Water Treatment Systems
- Dams
- Agriculture
- Critical Manufacturing
- Banking and Finance
- Economic Impacts

- Populations affected
- Economic impacts
- Infrastructure sectors and interdependencies
- Lists of important affected facilities

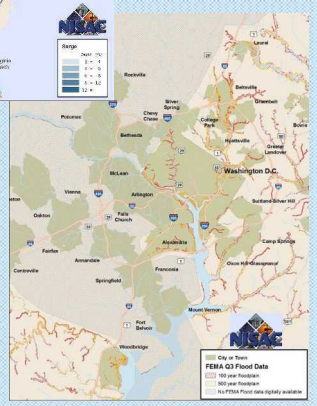
# Example Analysis Sequence

**Mid-Atlantic Scenario**

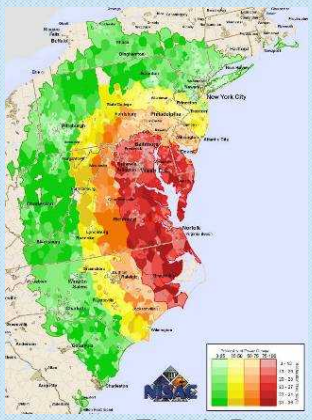


*Projected Wind Contours*

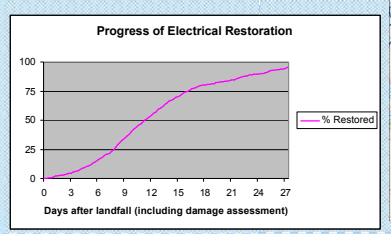
*Storm Surge and Flooding*



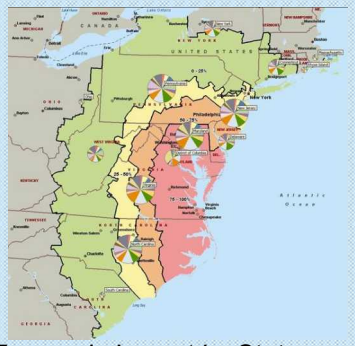
*Electric Power Outage Areas*



*Electric Power Restoration*



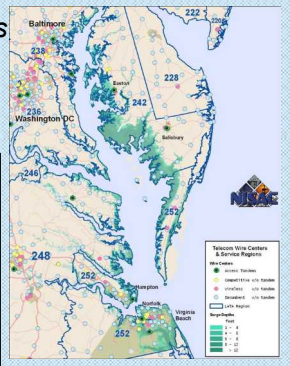

| Data | Infrastructure Modeling, Simulation, and Analysis | Consequence Assessment |
|---|---|---|
| • National Hurricane Center: storm data<br>  • Wind<br>  • Surge<br>• Flood maps<br>• Infrastructure information (asset locations, capacities, and so forth)<br>• Regional-/temporal-specific conditions and issues | Infrastructure outage/ restoration<br>• Assets/capacity outaged<br>• Economic impacts<br>• Sector-specific impacts<br>Dependency and interdependency analyses | • National, regional, and local impacts<br>• Short- and long-term impacts<br>• Impacts of infrastructure disruptions<br>• Commodity flow/supply chains |



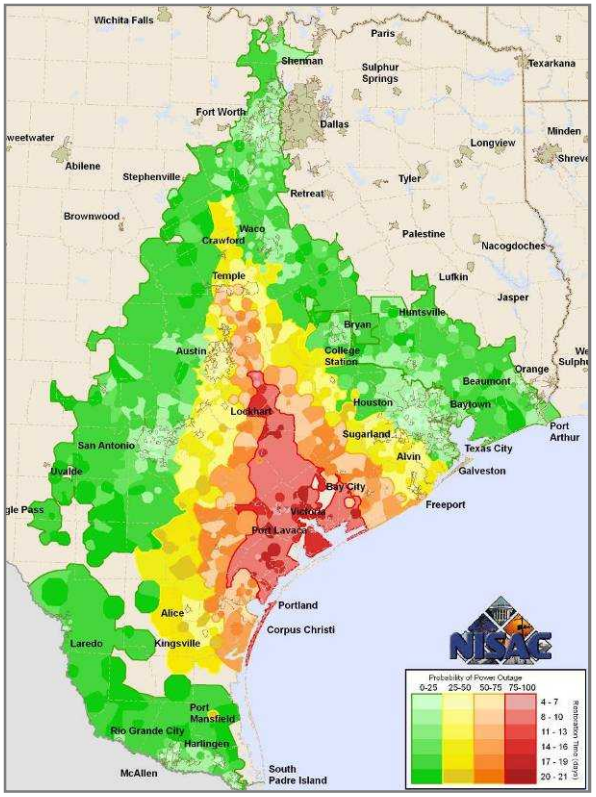
*Economic Impact by State and Industry*

*Affected Petrochemical Facilities*

*Telecommunications Assets in Surge*

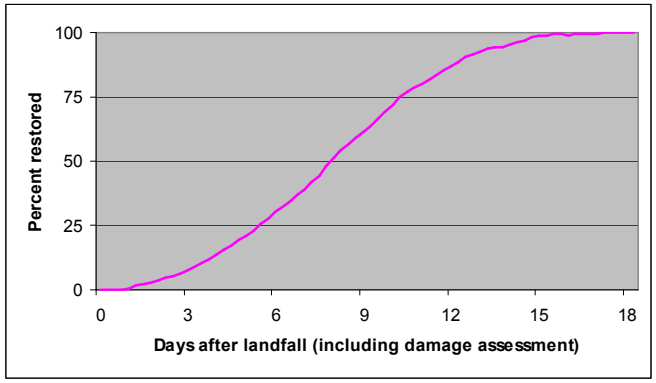


# Hurricane Ike Electric Power Outage and Restoration Projections

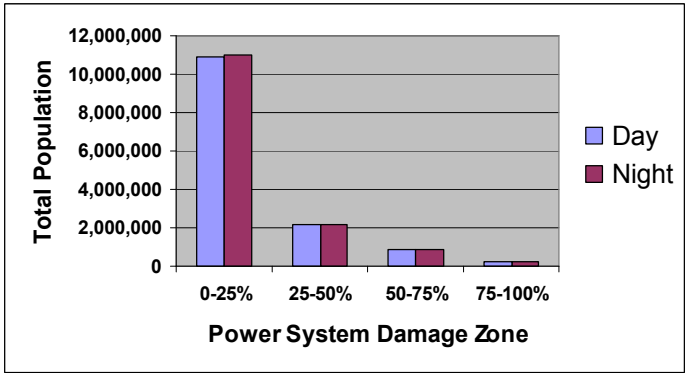



***Restoration priorities integrated with outage probability contours***

*Color indicates probability of outage; darker shades of each color indicate the area will take longer to restore*




- Adv 37:restoration in ~18 days
  - 12 days to 80% restoration
  - 2,839 substations potentially impacted; 16,498 MW outaged

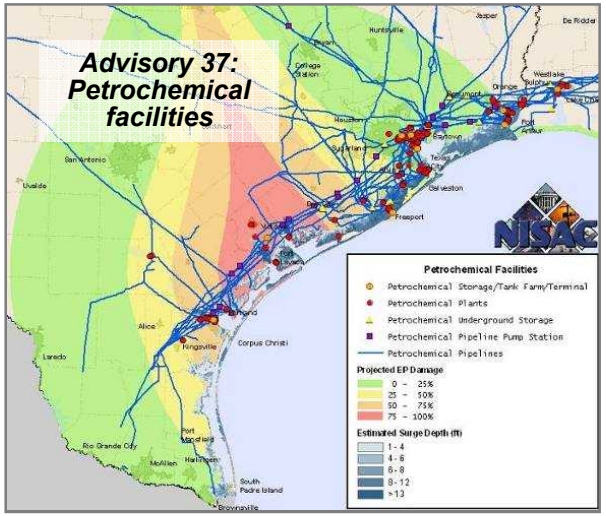


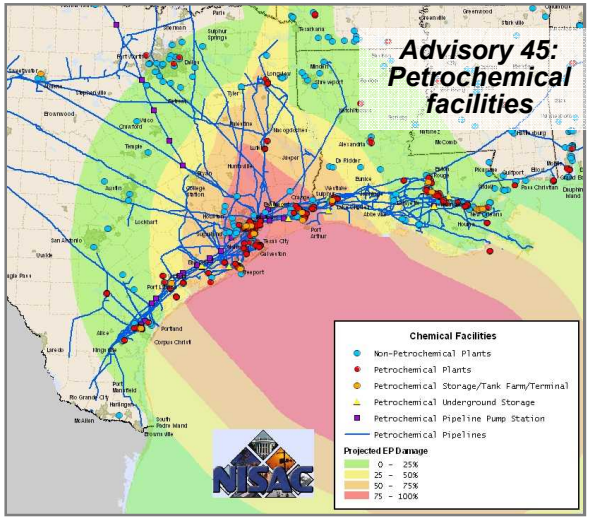

- Estimates continuously updated for new advisories

- > 14 million people within projected EP damage contours
- Approximately 250,000 people live in highest (75-100%) impact area

# Hurricane Chemical Analysis

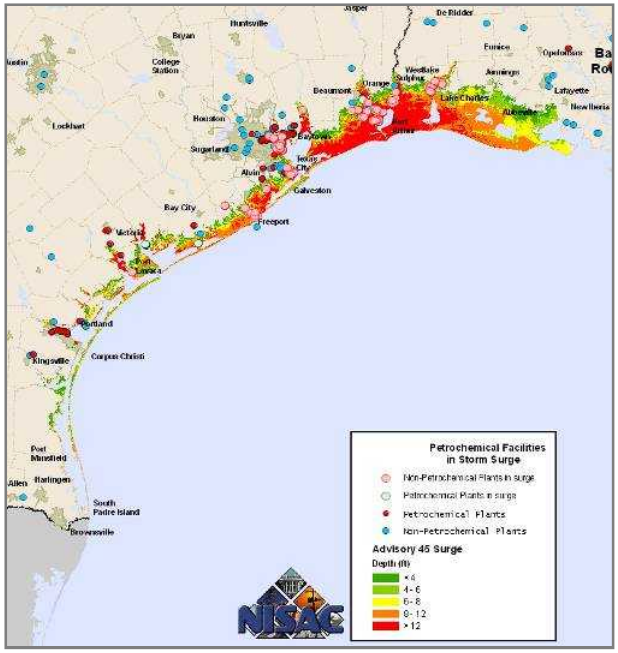
- Chemical Industries
  - Provide chemicals produced
  - NISAC identifies chemical manufacturing sectors with potential to disrupt high percentage of national total
  - Identify feedstocks of concern, impacts to the downstream supply chains
  - Identify the consumer products potentially affected
- Hazardous Materials
  - Provide hazardous chemical materials facilities in area
  - Concern: potential release of toxic chemicals, water reactive toxic inhalation hazards (TIH), impacts to public



# Chemical / Petrochemical Sector Impacts: Hurricane Ike

- Chemical facilities typically shut down 72 hours pre-landfall;
  - If undamaged, 1-2 weeks to resume operations
  - Water-damaged facilities will require weeks to months for repair/restart
- National production capacities of a significant number of primary and secondary petrochemicals are expected to be disrupted
- Chemical plants projected to be flooded and plants/chemical cross cut information were provided under separate covers

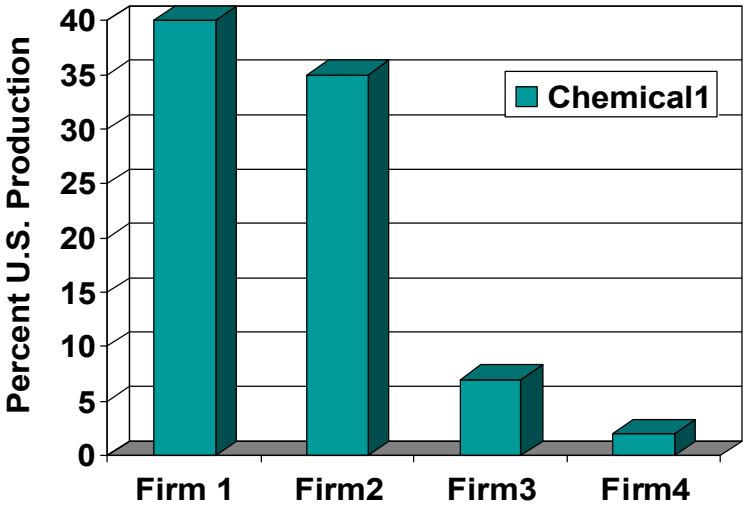



***Advisory 45: Chemical plants in surge***

- ***351 petrochemicals plants***
- ***126 non-petrochemicals plants***

# Projected Impacts to National Petrochemical Supply Chain: Hurricane Ike

- Base petrochemicals manufactured within the estimated 75-100% electric power outage area:
  - NISAC identifies those within the estimated high impact area that represent greater than 35% of total National production capacity
- NISAC identifies affected chemicals with fewest number of U.S. producers and the % of National production they represent. For example:
  - Chemical 1: 85%
  - Chemical 2: 80%
  - Chemical 3: 75%
  -
  -
  -
  - Chemical x: 35%

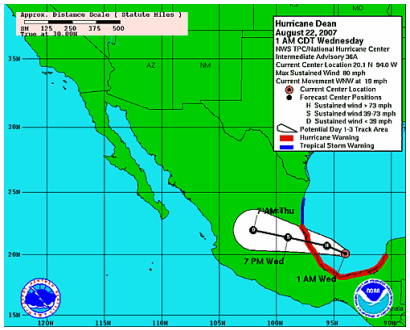



- Identification of a prominent feedstock
- Indentify intermediate product
- Identify consumer products impacts.

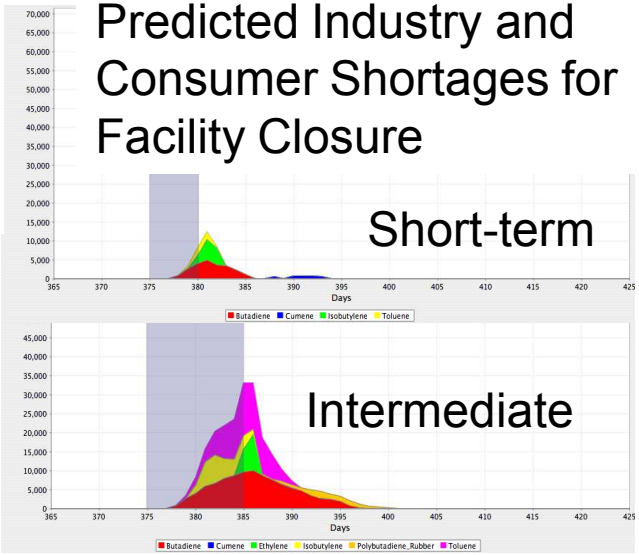
# Utilization of Longer-Term Efforts: Chemical Supply Chain Analysis

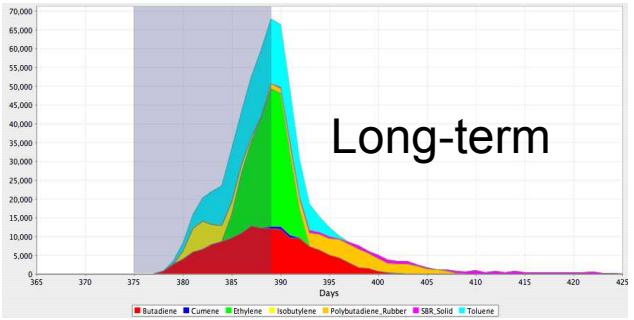
An analytical methodology that represents the chemical supply chain network, captures how a disruption to production or transportation impacts manufacturing and consumption.

Hurricane Dean, August 2007




Predicted Industry and Consumer Shortages for Facility Closure




Colors represent different chemicals

Results Confirmed Through Consultation with Industry:

- A relatively short closure of the PEMEX facility will cause some raw material availability concerns primarily for the tire and tire product industries
- Minimal effects elsewhere in the economy, even for longer durations
- Behavioral adaptations such a pre-storm surge in crude imports and the precautionary stockpiling of raw materials were not modeled
    - Results are therefore best viewed as illuminating short-term difficulties the industry will adapt to, rather than being predictive of catastrophic loss


NISAC