



National Infrastructure Simulation and Analysis Center (NISAC) Program Overview

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SNL Lead for Fast Analysis and Simulation Team

November 2008



Who We Are and Our Mission

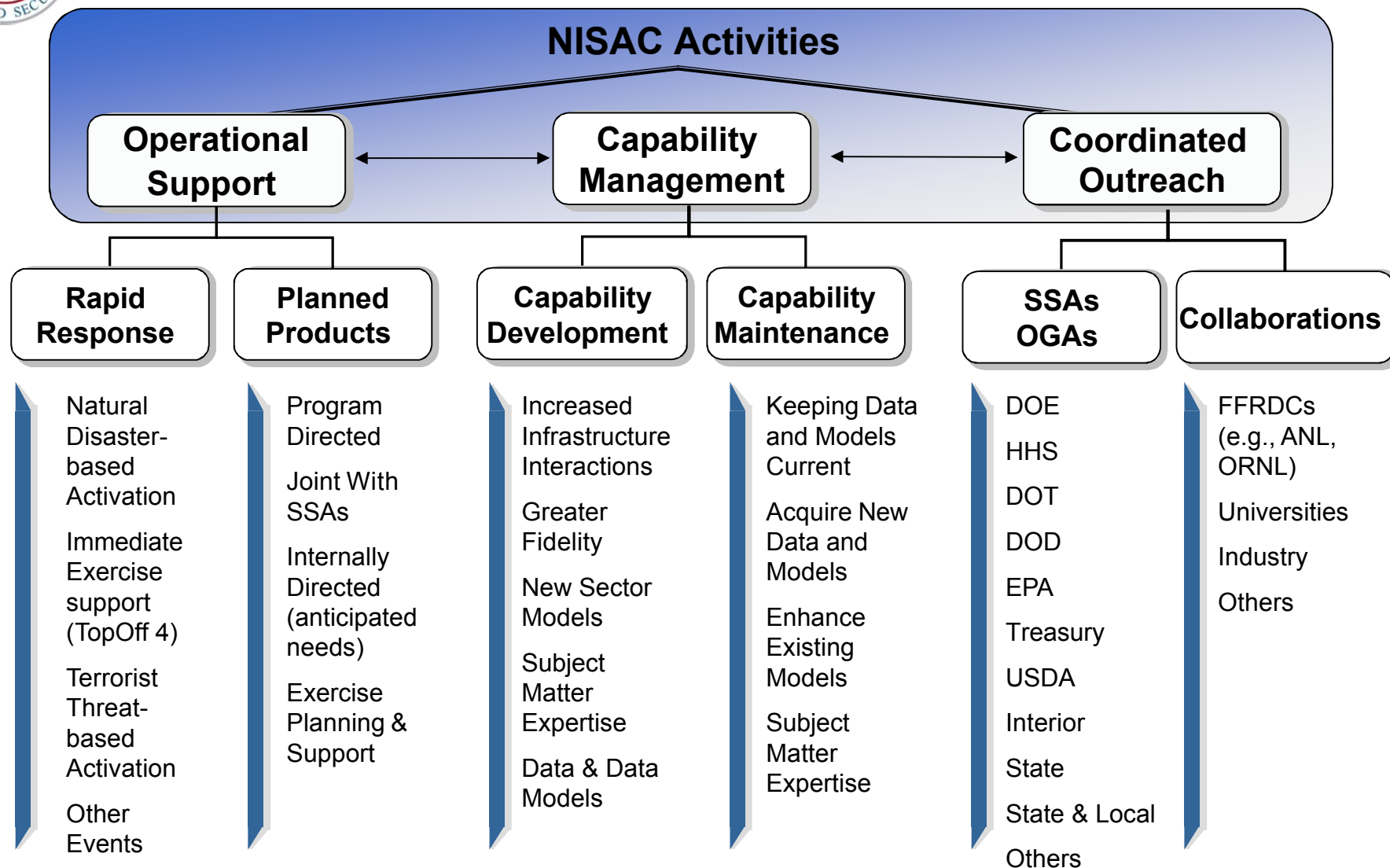
- 90 scientists & researchers from Sandia & Los Alamos National Laboratories; joint project; building on Kirtland AFB, New Mexico
- 2001 Patriot Act formally established NISAC, but around since 90s
- 2007 Homeland Security Approp. Act expanded NISAC mission
 - **“source of national expertise to address 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?







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

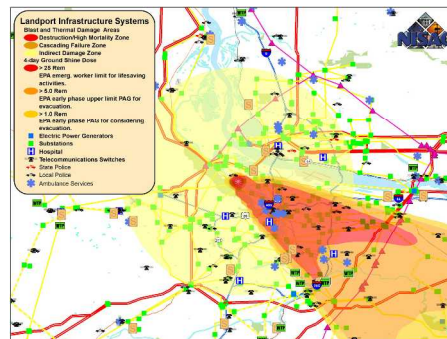
- Hurricane Damage and Recovery (Dennis, Emily, Katrina, Rita, Wilma)
- Avian Influenza CATF Exercise Support
- Urban Area Security Initiative IV
- Transit tunnel analyses - London bombing
- Hazardous Chemical Transportation Policy

2004

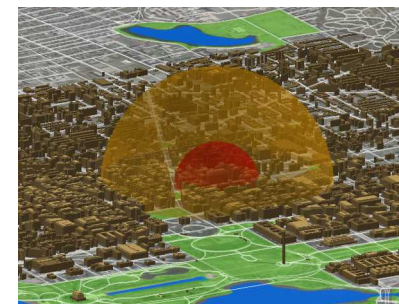
- Hurricane Damage & Recovery (Frances, Ivan)
- Economic Impacts of 2003 BSE discovery

2003

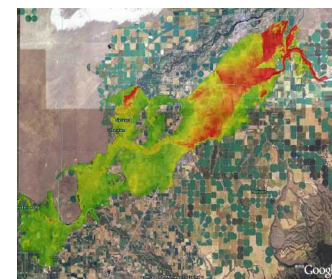
- Hurricane Isabel Damage and Recovery
- Holiday Threat



Infrastructure and Population Impacts



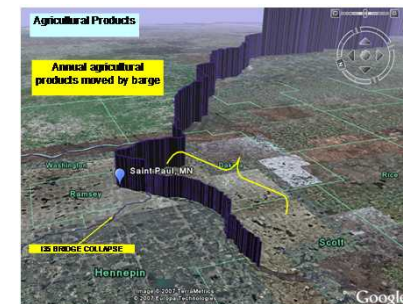
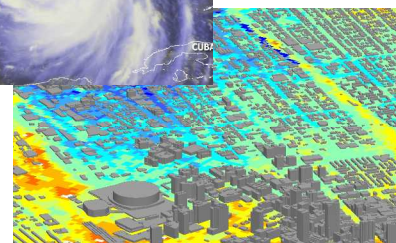
Improvised Nuclear Device



Dam Break



Hurricane



Orange box indicates substantial chemical analysis component



Example Planned Analysis Products

Key Results – Workforce

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

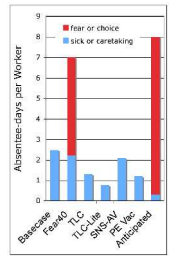
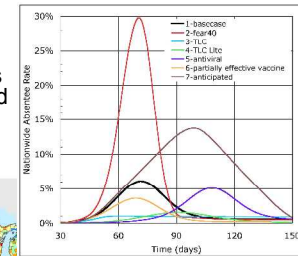
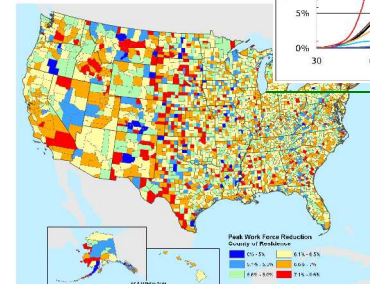
- Pandemic Influenza Impacts and Mitigation Design
- National Hazards Mitigation
- Regional Economic Impacts
- Air Transportation disruption impacts
- Hurricane Scenarios for Mid-Atlantic, Mobile, Houston, Tampa, New York and Miami

2003- 2005

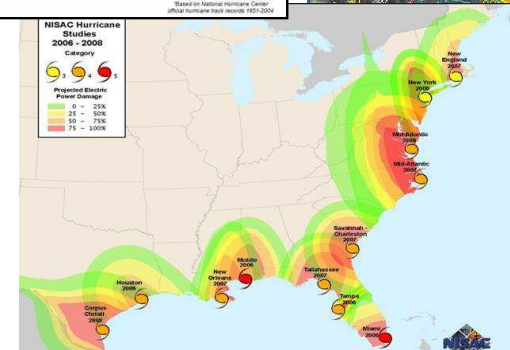
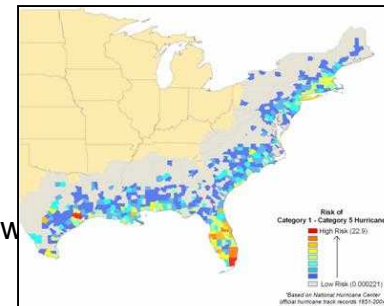
- Gulf Coast infrastructure disruption impacts
- Pacific NW port security impacts
- National rail system asset disruption
- Chlorine transportation disruption
- Risk-based asset prioritization

Orange boxes indicate substantial chemical analysis component

- 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

- Energy
- Banking & Finance
- Telecommunications
- Transportation

Commerce and national economic security depend on these infrastructures

Essential and Highly Dependent Infrastructures

- Health Care
- Ag & Food
- Water
- Government
- Chemical

Human health and safety depend on these infrastructures

Economic Sectors

- Residential
- Commercial
- Industrial

Source of demand and labor for infrastructures

Assets

- Power lines
- Banks
- Central offices
- Bridges
- Many more...

Potential targets

Orange box indicates substantial chemical analysis component



Sector Modeling Capability

		Baseline Capability		
		Level 1	Level 2	Level 3
Agriculture & Food	Dairy	Green	Blue	Orange
	Manufactured Food	Blue	Orange	Orange
	Beef	Blue	Orange	Orange
	Poultry	Blue	Orange	Orange
Banking & Finance	Banking	Green	Blue	Orange
	Insurance	Blue	Orange	Orange
	Markets	Green	Blue	Orange
Chemical	Petrochemical	Green	Blue	Orange
	Other	Green	Blue	Orange
Commercial Facilities		Green	Blue	Orange
Dams		Green	Blue	Orange
Defense Industrial Base		Green	Blue	Orange
Emergency Services	Police	Green	Blue	Orange
	Fire	Green	Blue	Orange
	National Guard	Green	Blue	Orange
Energy	Electric Power	Green	Blue	Orange
	Natural Gas	Green	Blue	Orange
	Coal	Green	Blue	Orange
	Petroleum	Green	Blue	Orange
Government Facilities		Green	Blue	Orange
Information Technology		Green	Blue	Orange
National Monuments & Icons		Green	Blue	Orange
Nuclear Reactors, Materials & Waste		Green	Blue	Orange
Postal & Shipping	Postal	Green	Blue	Orange
	Shipping	Green	Blue	Orange
Public Health & Healthcare	Public Health	Green	Blue	Orange
	Healthcare	Green	Blue	Orange
Telecommunications	Wireline	Green	Blue	Orange
	Cellular	Green	Blue	Orange
	Internet	Green	Blue	Orange
	Broadcast	Green	Blue	Orange
Transportation	Air	Green	Blue	Orange
	Rail	Green	Blue	Orange
	Road	Green	Blue	Orange
	Water	Green	Blue	Orange
Water	Supply	Green	Blue	Orange
	Waste Treatment	Green	Blue	Orange
Manufacturing		Green	Blue	Orange

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)

	IP	S&T
Green	FY06 @	25 + 0
Blue	FY07 @	25 + 6
Orange	FY08 @	16 + 2
Light Orange	Goal Mature State	



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
SAMS
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



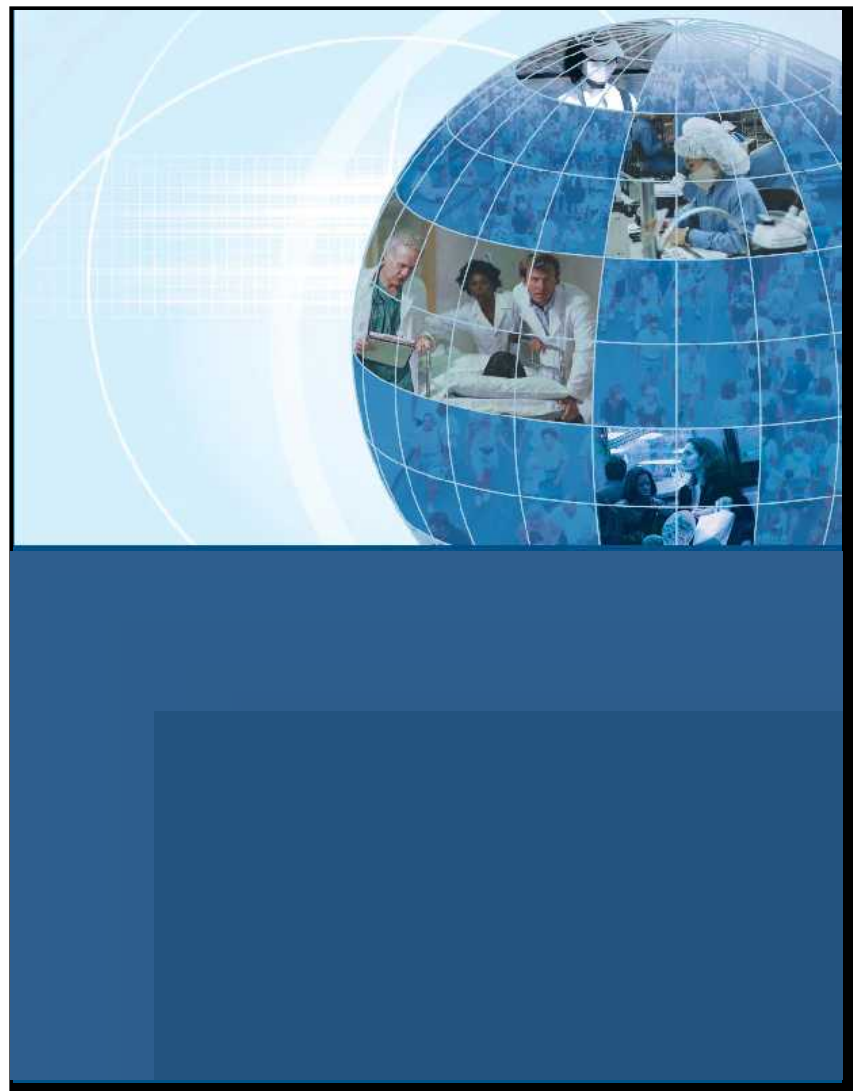
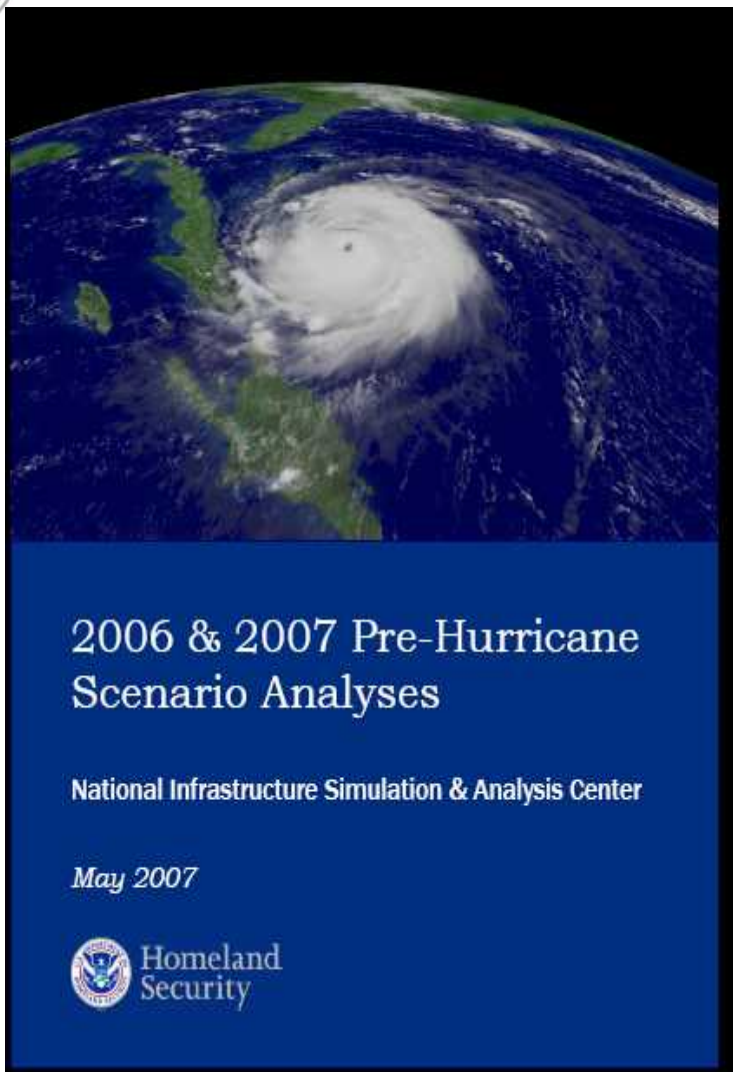
Multiple Viewpoints

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 FASTMap FAIT REAcct	Detailed simulation of changes in conditions or behaviors N-ABLE R-NAS ATOM IEISS MIITS N-SMART EpiSims TRANSIMS Loki-Natural Gas	Effects of conditions and limitations on system operation Port Simulators Petroleum Natural Gas Agriculture TelecomOps DamOps	Simulation and identification of vulnerabilities of different network topologies to disruptions and effective mitigation Loki-Infect Loki-Transaction Loki-Power



Recent NISAC Publications





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

2008

Dean

Gustav

Hanna

2003

Ike

2004

Isabel

Frances

Flossie

2007

2006

Ernesto

Ivan

2005

Dennis

Wilma

2005

Rita

Ophelia

Katrina

Emily



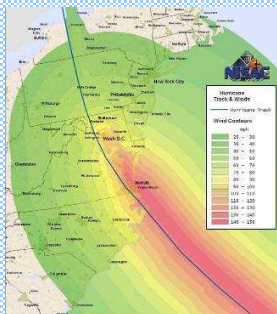
~200x world's
EP generating
capacity



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

Mid-Atlantic Scenario



Projected Wind Contours



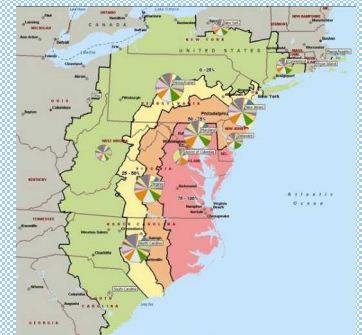
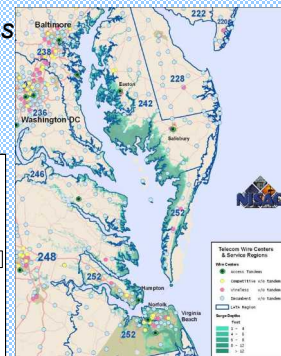
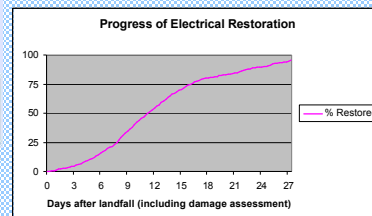
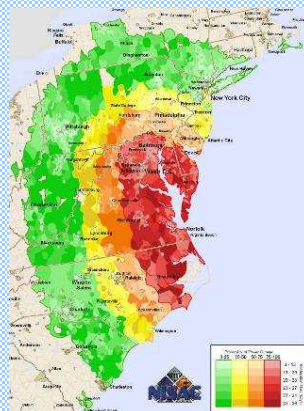
Storm Surge and Flooding



Electric Power Outage Areas

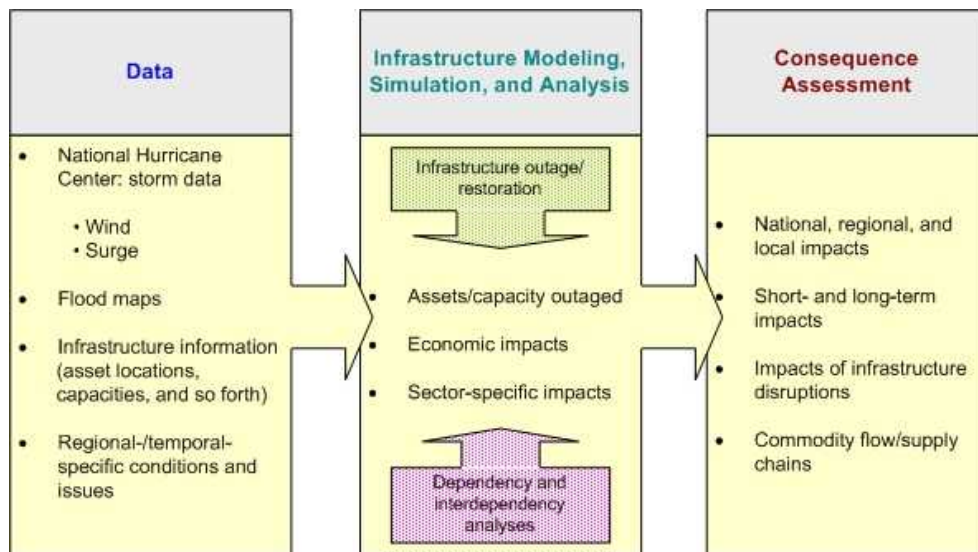


Electric Power Restoration



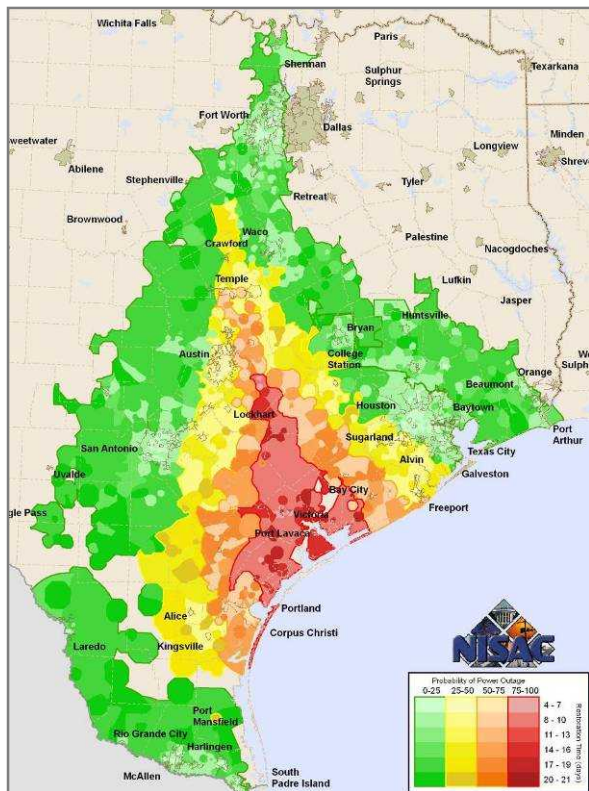
Economic Impact by State and Industry

Affected
Petrochemical
Facilities



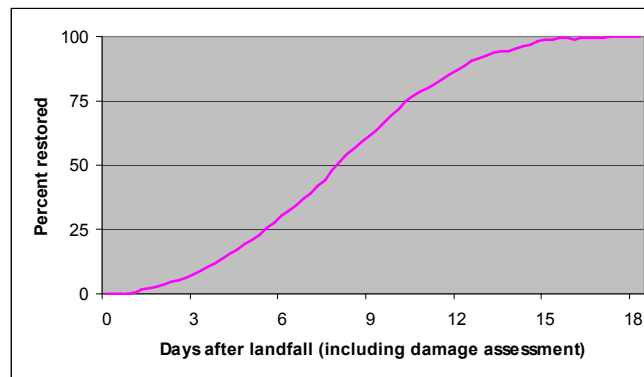


Hurricane Ike Electric Power Outage and Restoration Projections

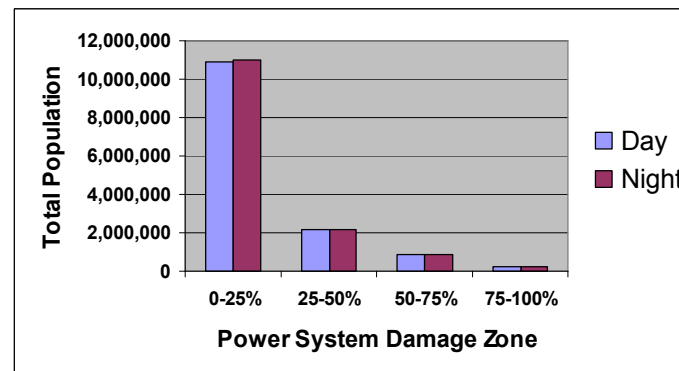


Restoration priorities integrated with outage probability contours

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

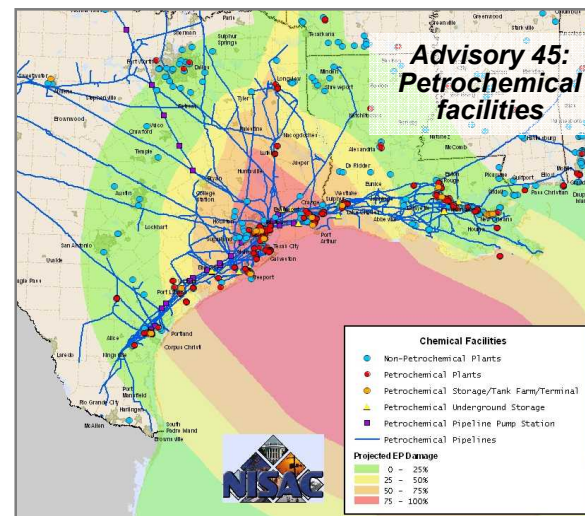
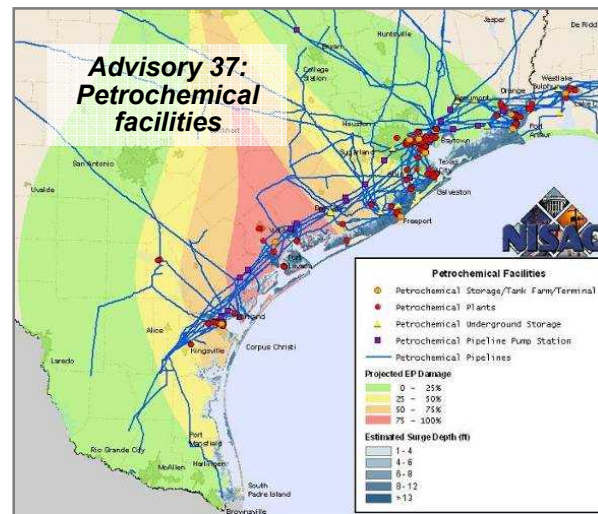
Hurricane Chemical Analysis

- 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

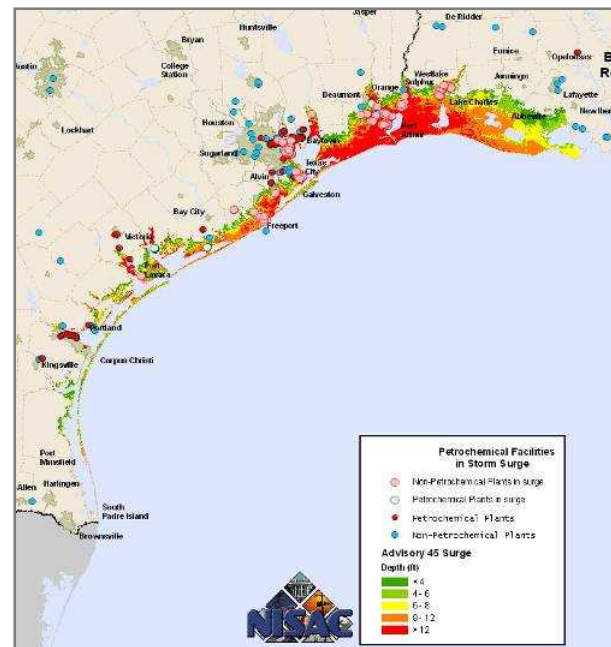
- Provide hazardous chemical materials facilities in area
- Concern: potential release of toxic chemicals, water reactive toxic inhalation hazards (TIH), impacts to public





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



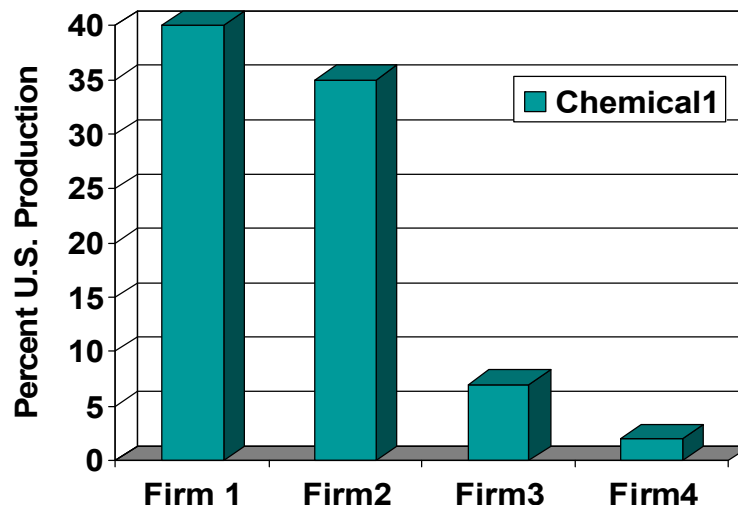
Advisory 45: Chemical plants in surge

- ***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
- Identify 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.

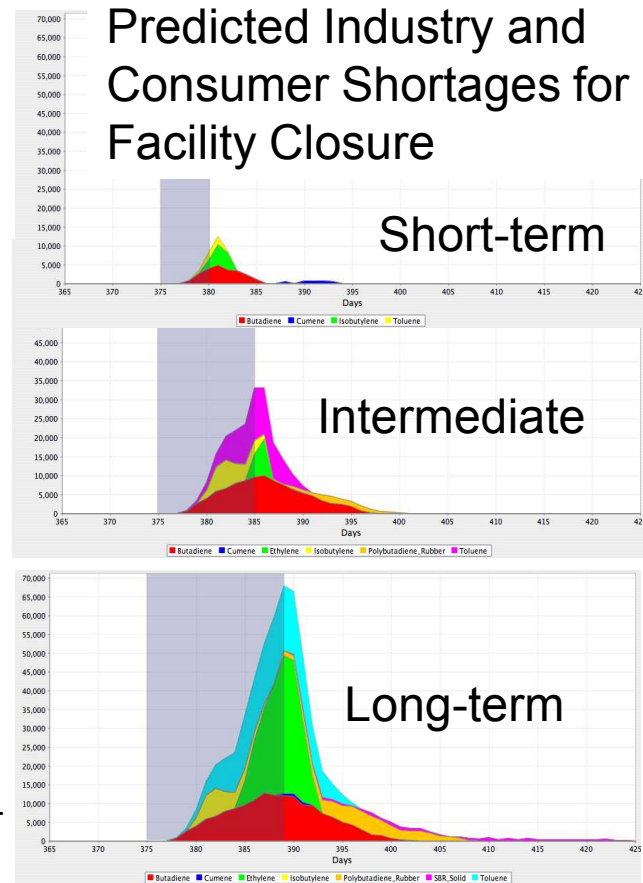
Hurricane Dean, August 2007



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 as 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

Predicted Industry and Consumer Shortages for Facility Closure



Colors represent different chemicals

