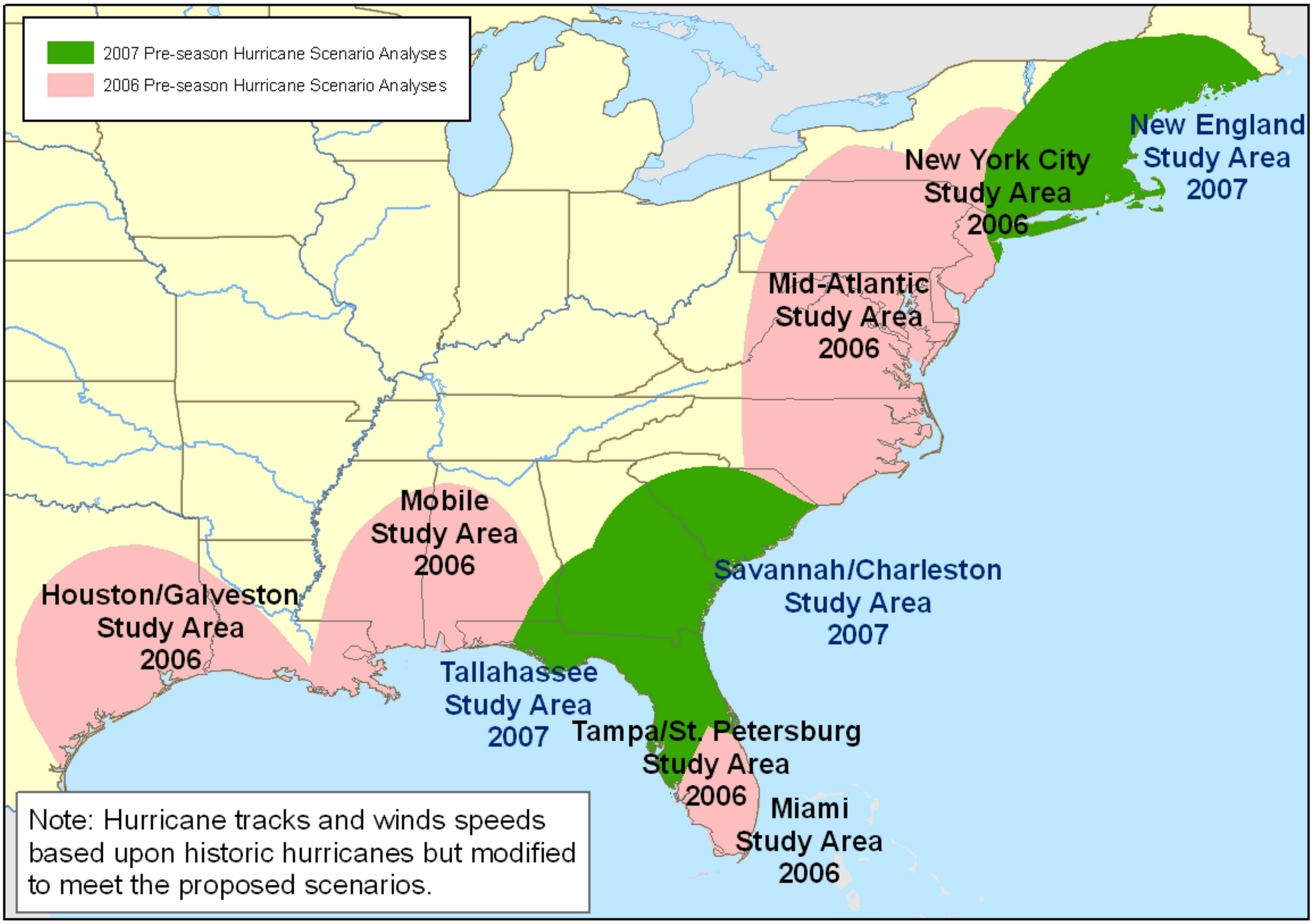

2006 & 2007 Pre-Hurricane Scenario Analyses

Executive Summary

May 2007

Homeland Security

National Infrastructure Simulation & Analysis Center

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2006 & 2007 Pre-Hurricane Scenario Analyses

1 Introduction

The National Infrastructure Simulation and Analysis Center (NISAC) is a modeling, simulation, and analysis program comprised of personnel in the Washington D.C. area as well as at the Sandia and Los Alamos National Laboratories. NISAC is mandated by Congress to be a "source of national expertise to address critical infrastructure protection" research and analysis. NISAC prepares and shares analyses of critical infrastructure and key resources (CI/KR) including their interdependencies, vulnerabilities, consequences, and other complexities under the direction of the Office of Infrastructure Protection, Infrastructure Analysis and Strategy Division.

In this effort, a series of scenario analyses were conducted for 9 simulated hurricanes, making landfall in regions at high risk due to hurricanes. The risk-based selection approach was based on historic hurricane activity from the period 1851-2004[1], the population at risk, and potential infrastructure impacts. Figure 1 depicts the overall risk posed by hurricane strikes.

The overall risk was calculated by multiplying a likelihood factor by a consequence factor. The likelihood factor is a measure of the probability of a hurricane impacting that area, based upon the historical frequency of hurricanes. The infrastructure consequence was calculated by developing a wind damage contour for each historical hurricane path, based upon its intensity, and then summing these damage contours. A consequence factor was developed as a function of population living in each county. The result is a map of hurricane risk at the county level. The higher risk counties, colored in yellow, orange, and red, are areas where there could be high financial costs, major damage to key infrastructures, and large population displacement resulting from a major hurricane making landfall in that area.

[1] When this risk map was created, 2005 hurricane information was not finalized.

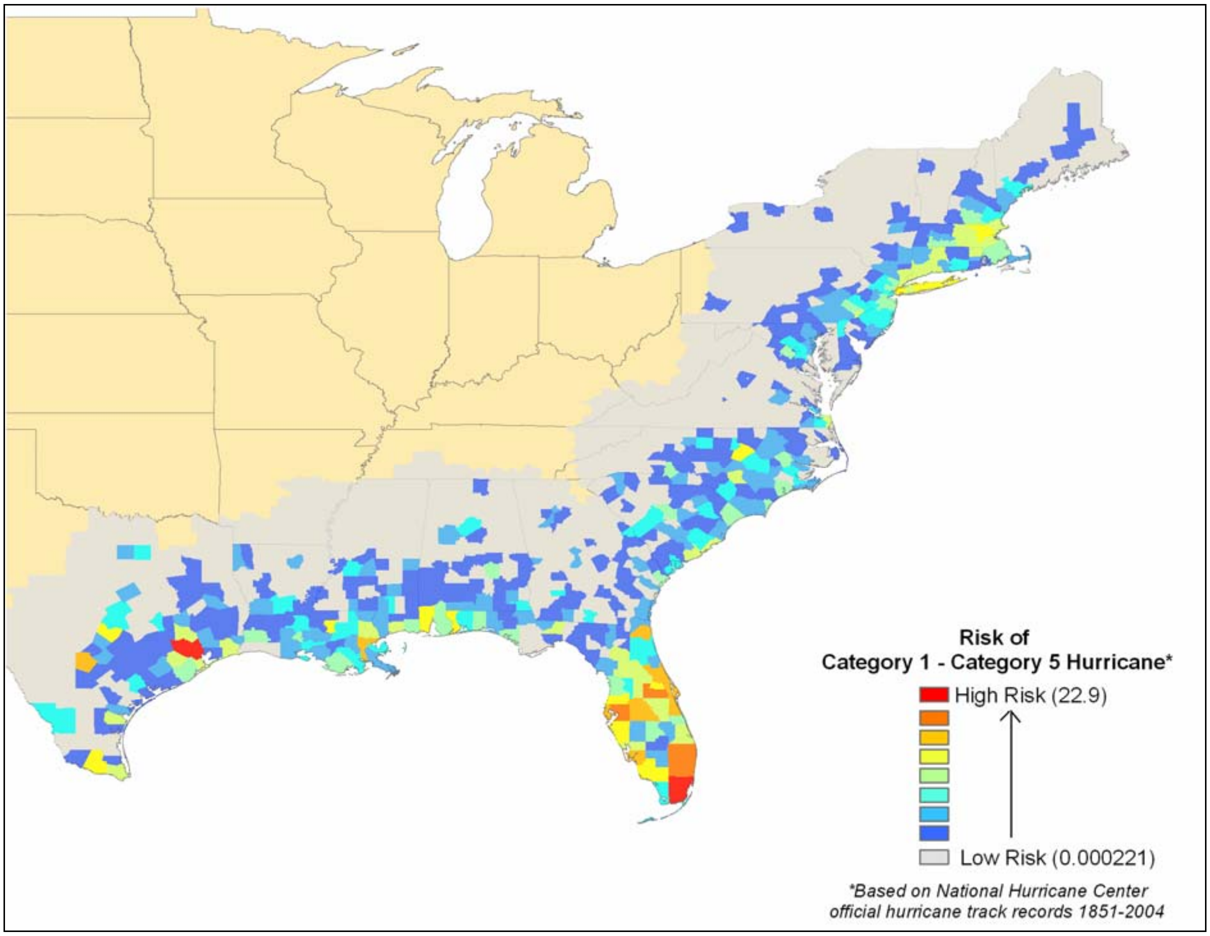

Figure 1-1: Integrated hurricane risk based on probability of occurrence, population density, and potential damage to infrastructure

For the scenarios, hurricane strengths for each location were selected at the upper end of the possible range for the region. These "worst case" strengths were chosen, rather than typical or expected strengths, to enhance identification of problems and issues during the scenario analysis. The 9 impact zones analyzed are shown in Figure 2. 6 higher-risk areas were analyzed in 2006, and 3 additional areas were analyzed in 2007. NISAC is currently updating its databases for the New Orleans region based on post-Katrina assessments and is reassessing its hurricane swath analysis. Other CI/KR database updates will periodically be considered in swath recalculations.

NISAC selected the hurricane study locations to cover the highest risk zones (e.g., southern Florida and Houston), areas of high population density (e.g., New York and Washington D.C.) and regional concentrations of infrastructure activity (e.g., oil and gas production, government, and financial).

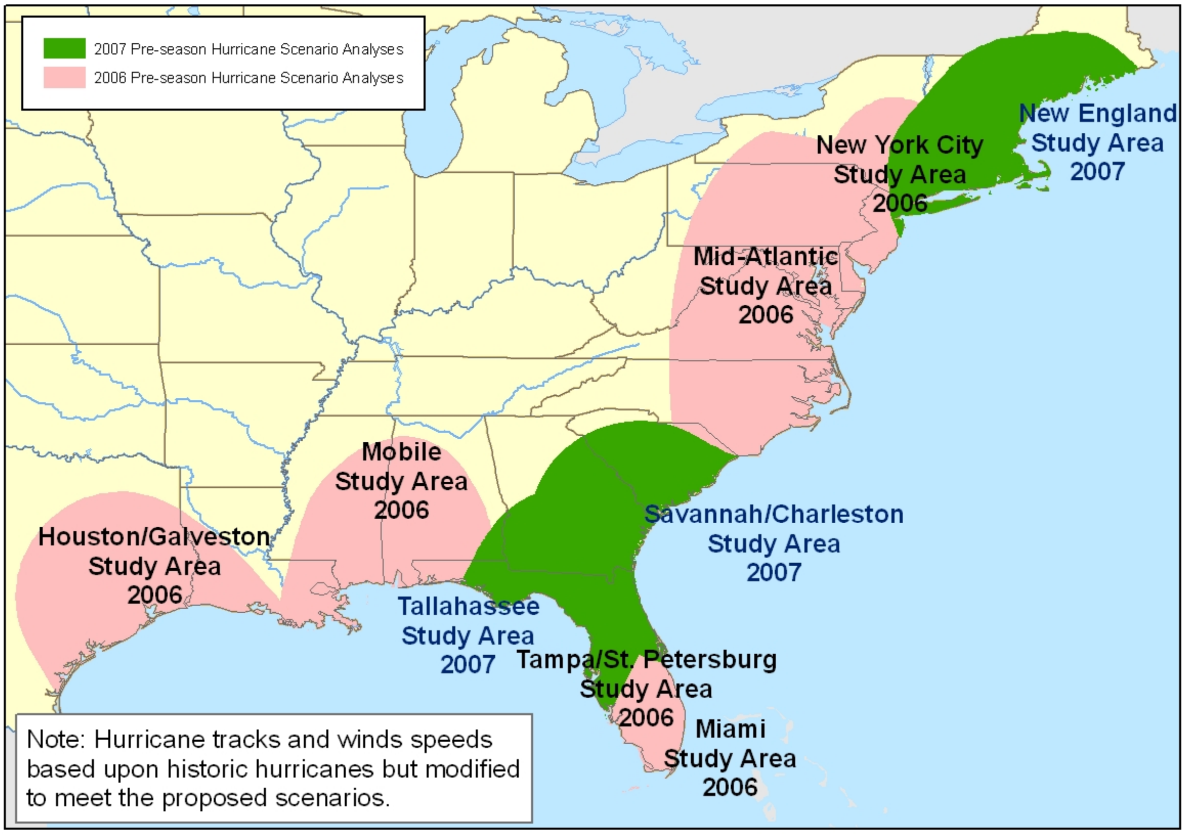

Figure 1-2: Map highlighting areas covered by Hurricane Swath Analyses.

Combined, these 9 areas represent many of the major metropolitan areas that could be significantly impacted by a hurricane.

2 Hurricane Swath Scenarios

2.1 New York City Metropolitan Area, Category 3 Storm, August 2006 final database update

Although the historic probability of a hurricane strike on this area is lower than that for the Gulf Coast and Southeastern Coast, the impacts to population and infrastructure could be significant. The New York City area is a very important world financial center and contains port facilities essential for the flow of commerce. The hurricane used as a basis for this scenario was the hurricane of 1938 that came ashore on Long Island. The NISAC team shifted the storm trajectory to the west to maximize the effects on Manhattan, and the intensity was increased to a Category 3 storm at landfall. Storm surge was calculated based on a stronger storm (Category 5) in the Atlantic that weakens before making landfall.

2.2 New England, Category 3 Storm, May 2007 final database update

The New England area was chosen because of the political and economic importance of the area. A major hurricane striking this area could temporarily close airports and seaports in Rhode Island, Massachusetts, and Connecticut. A major hurricane making landfall in this area would also affect local military facilities and the defense industrial base. The characteristics used for this storm were based upon the May 2007 Hurricane Yvette exercise scenario.

2.3 Mid-Atlantic States, Category 4 Storm, August 2006 final database update

The Mid-Atlantic area was chosen because of the political and economic importance of the area. A major hurricane striking this area could impact some operations of the federal government, temporarily close seaport ports in Baltimore and Norfolk, and affect nearby military facilities. The characteristics used for this storm were based upon Hurricane Isabel that made landfall in the Mid-Atlantic States in September 2003. NISAC moved the storm track slightly north and strengthened the storm to a strong Category 4 hurricane at landfall to maximize the effect.

2.4 Savannah Area, Category 4 Storm, May 2007 final database update

The Savannah area has a lower historic frequency for severe hurricane impacts, as compared with other hurricane-prone regions. Major issues could include evacuation of population in response to projected surge and power outages. The wind characteristics used for this storm are based upon Hurricane Katrina's landfall in August 2005 in Buras, Louisiana. The storm track is based upon a hurricane that made landfall in 1898 near Savannah, Georgia.

2.5 Miami Area, Category 5 Storm, August 2006 final database update

The Miami, Florida area was chosen because of the high risk of hurricanes impacting this area. There are over 2.2 million people residing in Miami-Dade County. Miami-Dade also ranks fifth in the world among telecommunications centers. A major hurricane striking this area could temporarily close the region's seaports and several airports. The storm characteristics used for this study were based upon Hurricane Andrew, which made landfall in August 2002 south of the Miami area. This Category 5 storm track was moved slightly north to maximize the effects on Miami.

2.6 Tampa Bay Area, Category 4 Storm, August 2006 final database update

The Tampa/St. Petersburg, Florida area was chosen because of the high risk of hurricanes impacting this area and its importance to the area for providing petroleum products to Florida. A major hurricane striking this area could temporarily close seaport facilities in Tampa area, the entry point for many of the refined products for Central and Southern

Florida. This port was designed to withstand the storm surge of a Category 3 hurricane. The characteristics used for this storm were based upon a 1921 hurricane which made landfall just south of the Tampa area. NISAC moved the storm track for this study slightly north to maximize the effects on the Tampa Bay area.

2.7 Tallahassee Area, Category 4 Storm,[2] May 2007 final database update

The Tallahassee area has a lower historic frequency for severe hurricane impacts, as compared with other hurricane-prone regions. Major issues could include evacuation of population in response to projected surge and power outages. Storm characteristics used for this scenario are based upon Hurricane Katrina and Hurricane Dennis. The trajectory is based on a hurricane that made landfall in 1896 north of Tampa.

2.8 Mobile Area, Category 5 Storm,[3] August 2006 final database update

The Mobile, Alabama area was chosen because of the high risk of hurricanes impacting this area and Mobile's economic importance. There are over 500,000 people living in the area, and its economy is expanding very quickly at present. The storm characteristics used for this study were based upon Hurricane Ivan. For this scenario, NISAC moved the storm track slightly west and increased the storm to a Category 5 hurricane at landfall to maximize the effects on Mobile.

2.9 Houston/Galveston Area, Category 4 Storm,[4] August 2006 final database update

The Houston/Galveston area was chosen because of the high risk of hurricanes impacting this area and the area's importance to the U.S. petroleum and gas industry. A major hurricane striking this area could temporarily close seaports in the Houston area and affect several oil production and refinery facilities. The characteristics used for this scenario were based upon the hurricane of 1932 that came ashore on Galveston. The intensity used was a strong Category 4 storm at landfall.

[2] Post-Katrina infrastructure changes are currently being evaluated. For future updates, NISAC will use the revised critical infrastructure/key resources database, once it becomes available.

[3] Post-Katrina infrastructure changes are currently being evaluated. For future updates, NISAC will use the revised critical infrastructure/key resources database, once it becomes available.

[4] Post-Katrina infrastructure changes are currently being evaluated. For future updates, NISAC will use the revised critical infrastructure/key resources database, once it becomes available.

Table 2–1: Summary of populations living in impacted area and business disruption costs for each scenario (ordered by population within power outage zone)

Study Area	**Hurricane category** (Saffir-Simpson Scale)	**Residing in power outage zones** (millions of people)	**Expected to lose power** (millions of people)	**Residing in surge zone** (millions of people)	**Business disruption costs** ($ billion)
Mid-Atlantic	4	50.0	16.0	1.00	26–50
New York	3	35.5	14.0	3.00	29–42
New England	3	31.2	12.0	0.72	18–34
Houston	4	12.0	5.0	0.30	14–22
Miami	5	12.0	5.0	1.70	9–15
Tallahassee	4	10.1	4.2	0.09	7–13
Savannah/ Charleston	4	9.5	4.0	0.08	6–11
Mobile	5	7.8	3.2	0.34	4–7
Tampa	4	5.3	2.2	0.75	3–4

3 Intended Use of Documents

This document is not intended to serve as a substitute for real-time analyses of hurricane impacts. Generally, these pre-hurricane season analyses offer the following benefits:

- Expansion of situational awareness
- Expedition of real-time analyses
- Enhancement of NISAC's ability to provide timely, actionable information

When this compiled information is used, an important factor to evaluate is the degree to which the hypothetical storms resemble actual hurricanes. These study results can serve as a baseline to pre-position emergency management resources and inform early consequence management decisions before actual weather systems develop. As numerical weather predictions become available prior to an actual event, the simulations reported in this document should be customized and extended through event-specific modeling. Meaningful consideration must be given to the manner in which pre-analyzed information in the hypothetical scenario varies from the expected track and intensity.

In the week before projected landfall, the NISAC team will have available current forecasts of surface wind, precipitation, and uncertainty in tracks, as well as early inundation predictions. If these conditions vary significantly from those used in the applicable scenario (e.g., landfall location varies more than 60 nautical miles per day before landfall or official inundation numbers vary more than 3 feet at critical evacuation nodes) then the analyses should be used with caution, and event specific calculations will be performed based on the forecasted weather conditions.

For new analyses, the NISAC Analysis and Response Plan presents a timeline and criteria for initiation of event-specific analyses. NISAC works closely with key partners, such as the

Homeland Infrastructure Threat and Risk Analysis Center (HITRAC) and others as illustrated in Figure 3–1.

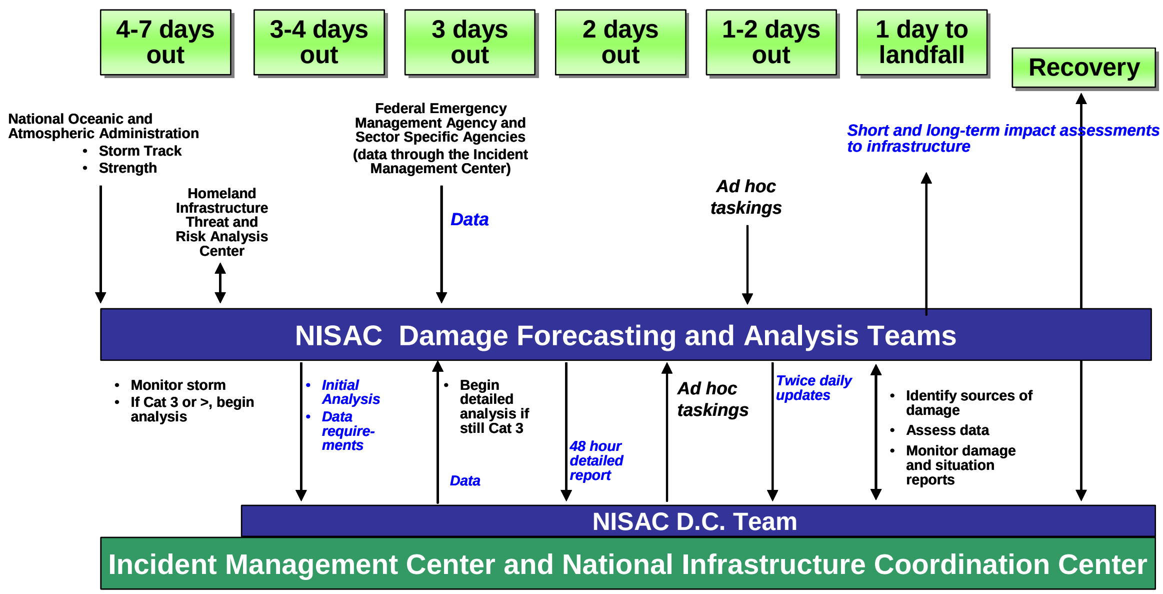

Figure 3-1: Diagram of NISAC hurricane analysis support process