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Introduction

Requirement §201.4(c)(2): *The State plan must include a risk assessment that provides the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.*

The risk assessment for the State of Florida Hazard Mitigation Plan (SHMP) provides the factual basis for developing a mitigation strategy for the state. This section profiles the natural, human-caused, and technological hazards that could possibly affect the state; determines which jurisdictions and populations are most vulnerable to each hazard; and estimates potential losses of state facilities for each hazard.

This risk assessment was originally developed as part of the first version of the State Hazard Mitigation Plan in 2004 and was subsequently reviewed and approved by the Federal Emergency Management Agency (FEMA) to meet the state's requirements under the Disaster Mitigation Act of 2000 (DMA2K). The Florida Division of Emergency Management (DEM) contracted for the revision of this section in 2007, 2010, and again in 2013.

The State Hazard Mitigation Plan Advisory Team (SHMPAT) has thoroughly reviewed all of the identified hazards and the respective profiles of each. Significant research has been conducted for each hazard and the following list provides information about the primary sources and methodologies used for this update:

- Declared Events: All federal and state declared events were researched and considered for this risk assessment. Any events occurring since the 2010 update have been added to the 2013 plan. Specifically, events from the last three years are discussed, as well as any significant historical events. Research includes geographic extent, number of occurrences, and the estimated damages and losses associated with the event. Hazus-MH 2.1 and geographic information systems (GIS) have also been used in the revision.
- National Climatic Data Center[1] (NCDC): This center maintains an ongoing database of all natural hazard events, with information about dates, locations, and estimated damages. This Web-based portal was used to further augment the hazard profiles in this assessment with additional data about events and their locations. This database records all events—not just the major weather incidents that are declared events; therefore, this source significantly helped to update the various profiles.

[1] http://www.ncdc.noaa.gov/oa/ncdc.html

- SHELDUS™: The Spatial Hazard Events and Losses Database for the United States (SHELDUS) provides county-level hazard data for 18 different natural hazard events. The data is derived from several existing national data sources, such as the National Climatic Data Center and the National Geophysical Data Center's (NGDC) Tsunami Event Database. The content and detail of the data provided is still evolving, but helps inform the historical data on some of the natural hazards.
- SHMPAT Feedback: The SHMPAT has been an integral part of this update process. Various members have provided feedback and data about the individual hazards. This personalized data has been used to further focus this overall risk assessment.
- Internet Research: The Internet and other online research tools have been used. The focus of this research centers on historical events, detailed event descriptions, and financial information.

Organizational Update

In an effort to organize the risk assessment by individual hazard (as opposed to including information about all hazards within each required section), the State of Florida has elected to combine the data previously organized within the following topical sections: Section 3.2: Profiling Hazard Events and Assessing Vulnerability by Jurisdiction, Section 3.3: Assessing Vulnerability of State Facilities, Section 3.4: Estimating Potential Losses by Jurisdictions, and Section 3.5: Estimating Potential Losses of State Facilities. This content is covered in the new Section 3.2. Also new to the 2013 plan update is the inclusion of data and analysis outcomes for former Sections 3.3–3.5 within each hazard profile—again organized by hazard as opposed to topical section.

The State of Florida believes this approach will allow each hazard to be evaluated with a single review of all data available in one central location and is preferable to the comparison of the previous four separate document sections, which contained information about each hazard.

All maps in this document have been updated as of August 2012 with the most recent data available, unless otherwise notated.

Local Mitigation Strategy Integration

Currently, all 67 counties within the State of Florida have an approved local mitigation strategy (LMS). Each LMS has been considered and, when appropriate, this local information has been included in the state risk assessment. The State of Florida has one of the most successful local mitigation planning efforts in the country.

Figure 3.1 provides a complete status report for all counties with respect to their LMS renewal dates up to the year 2017.[2]

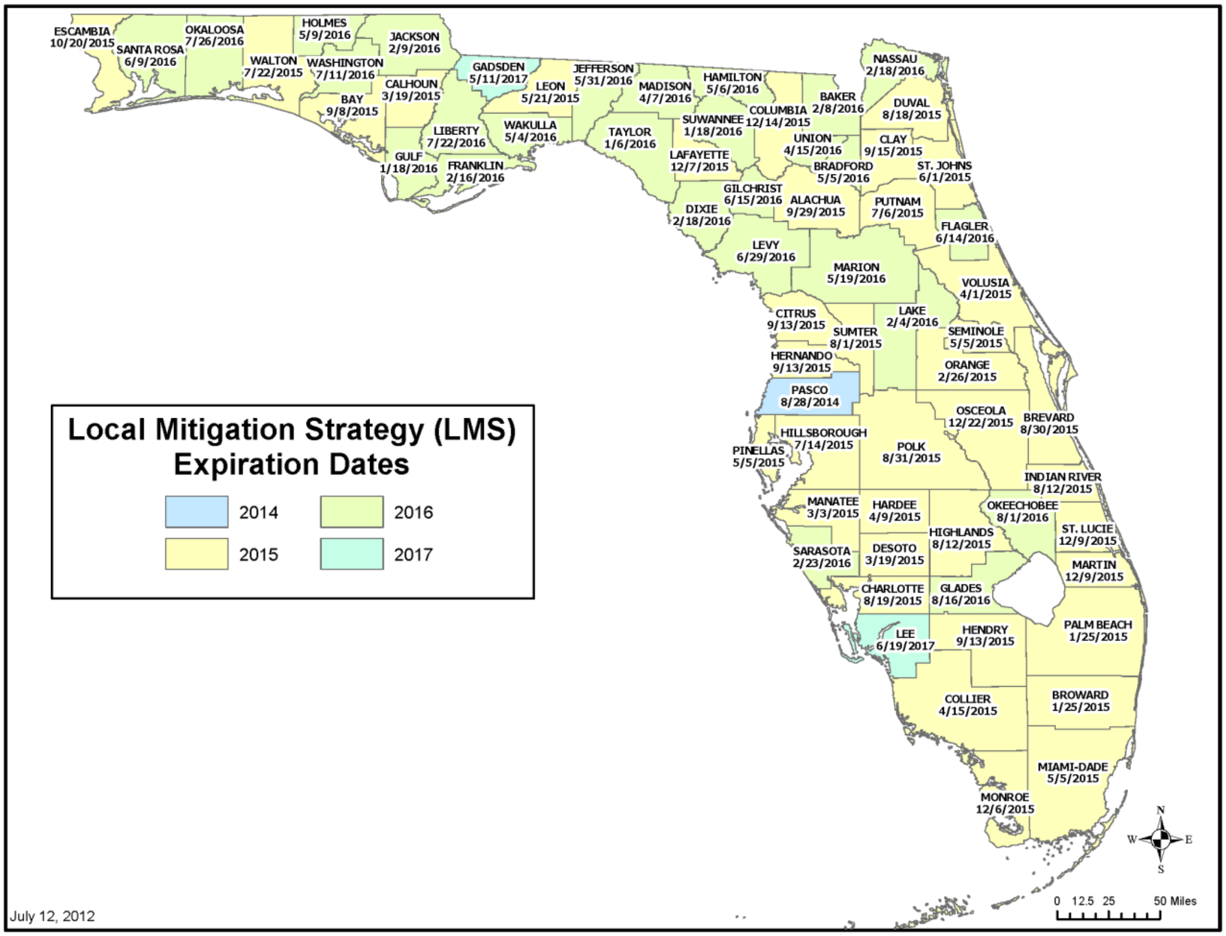

Figure 3.1 Local Mitigation Strategy Renewal Dates[3]

Current Status and Future Maintenance

As of 2013, this risk assessment was the most current and detailed hazard analysis for the State of Florida. The information has been analyzed using the most current data sets available at the time of revision and update. As this risk assessment is continually updated, this information will be used to further refine the current state mitigation strategies.

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[2] Information obtained through Florida Division of Emergency Management, Mitigation Section.

[3] All maps found within Section 3.0 of the SHMP were updated as part of the revision process for the 2013 plan. These maps are based on available data and were created in August 2012 unless otherwise notated.

3.1 Identifying Hazards

Requirement §201.4(c)(2)(i): *The State risk assessment shall include an overview of the location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate.*

Florida continues to be one of the fastest growing states in the nation; in 2010, it was the fourth largest state based on population. Table 3.1 displays resident population statistics from the 2010 U.S. Census and lists the five most populated states and a breakdown of population by selected age group. Note that Florida is second after California for individuals over the age of 65.

Table 3.1 Resident Population by Age Groups for Most Populous States[4]

Geographic Area	*California*	*Texas*	*New York*	*Florida*	*Illinois*
Total	37,253,956	25,145,561	19,378,102	18,801,310	12,830,632
Under 18 Years	9,295,040	6,865,824	4,324,929	4,002,091	3,129,179
18 Years and Over	27,958,916	18,279,737	15,053,173	14,799,219	9,701,453
20 to 24 Years	2,765,949	1,817,079	1,410,935	1,228,758	878,964
25 to 34 Years	5,317,877	3,613,473	2,659,337	2,289,545	1,775,957
35 to 49 Years	7,872,529	5,218,849	4,068,780	3,832,456	2,665,984
50 to 64 Years	6,599,045	4,272,560	3,723,596	3,677,959	2,403,992
65 Years and Over	4,246,514	2,601,886	2,617,943	3,259,602	1,609,213

This trend, coupled with the fact that a great majority of the population lives within 10 miles of the coastline,[5] makes Florida and its population extremely vulnerable to the impacts of natural and technological hazards. This plan is not intended to serve as a quantitative risk analysis and it is not intended to take the place of the in-depth hazard analyses that are being conducted at the local level as part of the LMS process, but data from these plans was used to further focus this risk assessment.

This section of the state plan profiles the potential hazards that pose the greatest threat to the State of Florida. As part of the 2013 revision, a comprehensive list of hazards was compiled from the review of the following sources:

- Review of the state's most recent Hazard Mitigation Plan (2010) and the Comprehensive Emergency Management Plan (2010)
- Review of historical data of events that occurred over the past 30 years, including input from subject matter experts and lessons learned from previous years
- Review of hazards identified in guidance materials provided by the FEMA Region IV Office on identifying hazards

[4] http://www.census.gov/popfinder/
[5] 2008 Municipality Population on Florida Geographic Data Library (FGDL)

- Assessment of National Climatic Data Center information about natural hazards
- Review of the vulnerability and risk analyses contained in the approved Local Mitigation Strategies for Florida counties
- Review of past state and federal disaster declarations
- Research of historical records and Web sites
- Research from the current Statewide Regional Evacuation Studies

Many of the identified hazards are related (e.g., flooding can occur and tornadoes can develop during tropical storms) in the sense that other hazards may result from a disaster event, such as sinkholes stemming from flooding; in such instances, these hazards are not listed separately but concurrently. The 2013 updated SHMP accounts for the following hazards according to the most up-to-date information available:

- Flooding, including related potential for dam/dike failure or breach and sea level rise
- Tropical cyclones, including hurricanes, tropical storms, and coastal storms
- Severe Storms, thunderstorms, and tornadoes
- Wildfire
- Drought
- Extreme heat
- Winter storms and freezes
- Erosion
- Sinkholes, landslides, and seismic events
- Solar Storms
- Tsunamis
- Technological and human-caused events

Table 3.2 Florida Natural Hazards lists all the natural hazards in Florida identified in the plan and provides details about the identification process.

Table 3.2 Florida Natural Hazards

Hazard	***How Identified***	***Why Identified***
Floods (including potential for dam failure and sea level rise)	• Review of past disaster declarations • Review of Federal Flood Insurance Rate Maps (FIRMs) • Input from state floodplain manager • Identification of National Flood Insurance Plan (NFIP) repetitive loss properties in the state • Research including new media and Internet resources	• Florida is affected by flooding nearly every year • Floods have caused extensive damage and loss of life in the state in the past • There are a number of dams in the state, the breach or failure of which could affect nearby populations • Sea level rise could affect coastal structures and lead to higher water levels
Tropical Cyclones	• Review of past disaster declarations • Review of National Climate Data Center Severe Storms Database • Review of National Oceanic and Atmospheric Administration climatology data • Research including new media and Internet resources • Research including National Hurricane Center	• Hurricanes and coastal storms affect Florida every year • Hurricanes have caused extensive damage and loss of life across the state over the last 50 years • 12 out of the last 15 federally declared disaster events in Florida were tropical storms or hurricanes[6] • The most recent federally declared disaster event in Florida (October 18, 2012) was Hurricane Isaac. • Potential risk to offshore oil and gas exploration and production infrastructure
Severe Storms & Tornadoes	• Review of past disaster declarations • Review of the National Climate Data Center Severe Storms Database • National Weather Service input and data • Research including new media and Internet resources	• Florida experiences a tornado nearly every year • Tornadoes have caused extensive damage and loss of life to state residents • Two recent federally declared disaster events in Florida (May 27, 2009 and April 21, 2009) were severe storms with flooding, tornadoes, and straight-line winds

[6] This statistic is current as of January 2, 2013. However, an earlier revision of this document from 2008 stated that eight out of the last 10 federally declared disaster events in Florida were hurricanes. Disaster #1539, which combines both Hurricane Charley and Tropical Storm Bonnie into one declaration, was apparently counted as two separate disaster events for the purposes of this document in 2008. For consistency, the 2009 statistic above also counts Disaster #1539 as two disaster events.

Hazard	*How Identified*	*Why Identified*
Wildfires	• Florida Forest Service statistics and input • U.S. Department of Agriculture, Florida Forest Service mapping of fire, fuel, and Wildland-Urban Interface (WUI) • Input from DEM about wildfires and the Emergency Operations Center (EOC) activations • Public input including newspapers and media	• Florida experiences wildfires every year • Development in much of the state is occurring at the WUI • Cyclical drought patterns result in increases of brush and other dry materials; this increases the overall risk for significant fires • As of May 29, 2012, there have been 2,032 wildfires affecting 93,338 acres on state and federal land during the 2012 calendar year[7]
Drought	• National Weather Service data • National Oceanic and Atmospheric Administration paleoclimatology data • The U.S. Drought Monitor • Keetch-Byram Drought Index (KBDI) • Agricultural community throughout the state	• Significant drought trends during the last 10 years, including the driest back-to-back calendar years in 2006–2007 • Drought has a severe economic impact on the state due to the large amounts of citrus, agriculture, and livestock
Extreme Heat	• National Weather Service data • Research including new media and Internet resources	• Significant impact to the population • From 1994–2003, on average more people died from excessive heat than hurricanes, flooding, tornadoes, and lightning combined[8]
Winter Storms and Freezes	• Review of past disaster declarations • Review of National Climate Data Center Severe Storms Database • National Weather Service input and data • Public input including newspapers and media	• Florida is affected by winter storms cyclically • There have been significant freezes, particularly during the 1980s that affected the citrus industry • There have been six federally declared disasters relating to winter storms and freezes since 1971 • The population is unprepared for cold weather, with many having inadequate heating capabilities

[7] http://www.floridaforestservice.com/wildfire/information.html
[8] http://www.crh.noaa.gov/lmk/?n=noaaexcessiveheat

Hazard	*How Identified*	*Why Identified*
Erosion	• Coordination with the Florida Department of Environmental Protection's Bureau of Beaches and Coastal Systems • SHMPAT interview and input • *Evaluation of Erosion Hazards*, the report from the Heinz Center that was presented to FEMA in April 2000 • Looking at shoreline change maps • Public input including newspapers and media	• Due to the gradual, long-term erosion, as many as 1 in 4 houses along the coast could fall into the ocean in the next 60 years[9] • Fifty-nine percent of Florida's beaches are currently experiencing erosion[10] • Significant economic impact for the state due to property damages, loss of actual beachfront real estate, and effects on tourism
Sinkholes, Landslides, and Seismic Events	• Coordination with the Florida Geological Survey • The Florida Subsidence Incident Report (SIR) Database • Coordination with the Florida Department of Transportation • Input from the Central United States Earthquake Consortium	• Sinkholes are a common feature of Florida's landscape • 3,378 sinkholes have been reported in the state since the 1940s[11], 175 of those developed as a result of Tropical Storm Debby • Issues arise as development continues in high-risk areas • Impact on the roads and physical infrastructure of the state • Localized lowering of groundwater table for agricultural pumping can trigger sinkholes • Historical earthquake events impacted Pensacola, FL previously

[9] www.fema.gov/pdf/library/erosion.pdf
[10] http://www.dep.state.fl.us/beaches/programs/bcherosn.htm
[11] http://www.dep.state.fl.us/geology/geologictopics/sinkhole/sink_dis_arc_zip.htm

Hazard	*How Identified*	*Why Identified*
Tsunamis	• Input from the National Oceanic and Atmospheric Administration Center for Tsunami Research • Coordination with Division of Emergency Management • Input from the U.S. Geological Survey	• Tsunamis commonly occur in large bodies of water • Almost all perimeters of Florida's boundaries are made up of large bodies of water • Recent tsunamis from around the world have caused widespread destruction • Residential and commercial development along Florida's coastlines is at risk to the effects of tsunamis • Tsunami and rogue wave occurrence in Florida is rare with approximately four documented events (1755, 1886, 1992, 1995)[12] • Potential tsunamis generation is possible by mass wasting events in the Canary and Cape Verde Islands based on geological evidence of their conjectured past impact on the east coast of the Bahamas
Solar Storms	• Coordination with Division of Emergency Management • Research including new media and Internet resources	• Emerging threat which could significantly interfere with the electrical grid and critical infrastructure functionality

[12] http://www.dep.state.fl.us/geology/geologictopics/hazards/earthquakes.htm

Table 3.3 outlines each major disaster declaration that Florida has received from Florida over the last decade. This establishes the vulnerability and historic occurrences of hazards that Florida regularly deals with.

Table 3.3 FEMA Major Disaster Declarations: Florida, 2002–2012[13]

Date	*Disaster Types*	*Disaster Number*
10/18/2012	Hurricane Isaac	4084
07/03/2012	Tropical Storm Debby	4068
05/27/2009	Severe Storms, Flooding, Tornadoes, and Straight-line Winds	1840
04/21/2009	Severe Storms, Flooding, Tornadoes, and Straight-line Winds	1831
10/27/2008	Hurricane Gustav	1806
08/24/2008	Tropical Storm Fay	1785
02/08/2007	Severe Storms, Tornadoes, and Flooding	1680
02/03/2007	Severe Storms and Tornadoes	1679
10/24/2005	Hurricane Wilma	1609
08/28/2005	Hurricane Katrina	1602
07/10/2005	Hurricane Dennis	1595
09/26/2004	Hurricane Jeanne	1561
09/16/2004	Hurricane Ivan	1551
09/04/2004	Hurricane Frances	1545
08/13/2004	Hurricane Charley and Tropical Storm Bonnie	1539
07/29/2003	Severe Storms and Flooding	1481
04/25/2003	Tornado	1460

The following financial statistics in Table 3.4 were provided by DEM and FEMA to show the magnitude of natural hazard events in the state based on the amount of Individual assistance (IA) funded.[14]

This table also includes IA statistics for Tropical Storm Debby, which are accurate as of August 20, 2012, however, they will change following completion of this plan as assistance continues to be provided. At the time of plan drafting, IA amounts were not yet available for Hurricane Isaac.

[13] http://www.fema.gov/disasters
[14] http://www.fema.gov/news/disasters_state.fema?id=12

Table 3.4 Amount of Individual Assistance Funded[15]

Declaration Date	*Declaration #*	*Name*	*Amount of I.A. Funded*
10/18/2012	4084	Hurricane Isaac	Not available yet
07/03/2012	4068	Tropical Storm Debby	$20,926,191.70
05/27/2009	1840	Tornado, Heavy Rains, and Flooding	$8,650,000
04/21/2009	1831	Tornado, Heavy Rains, and Flooding	$2,855,604
08/24/2008	1785	Tropical Storm Fay	$24,770,991
02/03/2007& 02/08/2007	1679 & 1680	Severe Storms, Tornadoes, Flooding	$28,518,175.81
10/24/2005	1609	Hurricane Wilma	$340,387,278.86
07/10/2005	1595	Hurricane Dennis	$21,550,393.51
09/26/2004	1561	Hurricane Jeanne	$398,624,417.44
09/16/2004	1551	Hurricane Ivan	$164,514,215.61
09/04/2004	1545	Hurricane Frances	$411,860,598.05
08/13/2004	1539	Hurricane Charley	$208,969,090.79
04/25/2003	1460	Tornado	$11,840,660.01
			$1,643,467,616.78

The following list in Table 3.5 details all of the Florida Governor's Executive Orders issued in relation to natural disasters in Florida from April 2006 to May 2012. In addition to the natural disasters referenced below, there have been several emergency management related executive orders issued, including those pertaining to the 2010 earthquake in Haiti and the 2010 Deepwater Horizon oil spill. However, only the executive orders pertaining to natural disasters within Florida are included below.

Table 3.5 Executive Orders[16]

Date	*Description*	*IA Awarded*	*EO #*
05/25/2012	Tropical Storm Debby	Yes	12-140
10/04/2011	Extension of 11-172	No	11-202
08/05/2011	Extension of 11-128	No	11-172
06/21/2011	Wildfires	No	11-128
01/07/2011	Freezing Temperatures	No	11-06
12/15/2010	Freezing Temperatures	No	10-275
12/10/2010	Freezing Temperatures	No	10-262
01/25/2010	Freezing Temperatures	No	10-21
01/10/2010	Freezing Temperatures	No	10-07
01/05/2010	Freezing Temperatures	No	10-01
04/01/2009	Severe Weather	Yes	09-81
11/09/2009	Hurricane Ida	No	09-243
02/04/2009	Freezing Temperatures	No	09-20

[15] http://www.fema.gov/disasters
[16] http://edocs.dlis.state.fl.us/fldocs/governor/orders/index.htm

Date	*Description*	*IA Awarded*	*EO #*
01/27/2009	Freezing Temperatures	No	09-19
06/02/2009	Wildfires	No	09-132
01/14/2009	Freezing Temperatures	No	09-04
11/03/2008	Extension of Hurricane Ike	No	08-225
09/05/2008	Hurricane Ike	No	08-187
09/02/2008	Hurricane Hanna	No	08-182
08/31/2008	Hurricane Gustav	No	08-181
08/17/2008	Suspend Early Voting due to 08-170	No	08-171
08/16/2008	Tropical Storm Fay	Yes	08-170
03/13/2008	Tornado	No	08-048
05/03/2007	Wildfires	No	07-86
04/03/2007	Extension of 07-21	No	07-63
02/02/2007	Hazardous Weather	No	07-21
08/27/2007	Extension of 07-117	No	07-173
06/28/2007	Extension of 07-86	No	07-117
02/20/2006	Extension of Freeze 06-32 for 7 days	No	06-35
02/13/2006	Freeze Suspended Restrictions	No	06-32
02/13/2006	Hurricane Wilma Extending 05-234	No	06-31
09/01/2006	Terminated 06-201 and 06-202	No	06-204
08/29/2006	Correction to 06-201	No	06-202
08/28/2006	Suspended Elections due to 06-200	No	06-201
08/27/2006	Tropical Storm Ernesto	No	06-200
08/10/2006	Roofing Repair Extension 06-131 for 60 days	No	06-180
06/27/2006	Wildfires Rescinding 06-108	No	06-151
06/16/2006	Tropical Storm Alberto Rescinding 06-130	No	06-140
06/12/2006	Roofing Repair Extension 06-83 for 60 days	No	06-131
06/12/2006	Tropical Storm Alberto	No	06-130
04/13/2006	Hurricane Wilma Ext 06-31 Trk #1075/ 1066	No	06-108

3.2 Profiling Florida's Hazards

The information included in the following sub-sections provides detailed information about the hazards that affect Florida as well as the changes that were made from the previous plan.

3.2.1 2013 Methodology for Analyzing Vulnerability

In conducting the 2010 profiling and vulnerability analysis of hazard events, the SHMPAT reviewed the official guidance and information from FEMA and the Emergency Management Accreditation Program (EMAP) regarding the specific elements of a complete hazard analysis. The SHMPAT risk assessment sub-group elected to join the Profiling Hazards Section and the Assessing Vulnerability by Jurisdiction Section into one section for a more consistent flow and easier referencing for those using this document; this approach was maintained for the 2013 update. Based on this research, SHMPAT considered the following elements for this vulnerability, impact, and consequence analysis:

- The overall vulnerability of each jurisdiction within the state, including the vulnerability of its residents, livestock, agriculture, property, facilities, and state infrastructure.
- Vulnerability of specific state-owned facilities within each jurisdiction.
- Potential losses of life and property within each jurisdiction, including the ongoing economic and financial impact to the State of Florida.
- The health and safety (including injury and death) of the population during an event.
- The state government's ability to continue essential government operations and to deliver essential services to the population.
- Potential impact to the state's Emergency Management Program operations.
- The overall environmental impact, including any long-term or residual effects.
- The state's regulatory and contractual obligation to the public and the public's confidence in the state's response and recovery abilities, including financial responsibility.

A number of factors were considered in assessing the risk of each hazard event including the frequency of occurrence, the severity of the event, and the areas vulnerable to the impact of each event.

These factors were assigned numerical values in the assessment as follows:

- Frequency of occurrence
    1. Annual event
    2. Approximately every 1-5 years
    3. Approximately every 5–10 years
    4. Approximately every 11–30 years
    5. Greater than 30 years

- Vulnerability impact areas
    a. Public
    b. Responder
    c. Continuity of Operations (COOP) and program operations
    d. Property, facilities, infrastructure
    e. Delivery of services
    f. The environment
    g. Economic condition
    h. Public confidence in jurisdiction's governance

The jurisdictional vulnerability assessment was conducted on a state level for the identified hazards with the integration of the local risk assessments. Since June 2009, local mitigation plans for all 67 of Florida's counties have been approved by FEMA under the requirements of the DMA2K. The local risk assessments are publicly available, and data from the plans was used for this assessment to examine vulnerability by local jurisdictions. The SHMPAT conducted an extensive search for information and data about the overall vulnerability of the state. The initiatives involved in this assessment include:

- Interviews with state agencies about best available data for their facilities and programs.
- Coordination with Florida Department of Financial Services (DFS) and DEM regarding state-owned and operated facilities, and other existing state databases.
- Research of public records including newspapers and the Internet.
- Communication with federal agencies for access to national data sets for weather, dams, highways, and other critical infrastructure.

Using this baseline data, the SHMPAT determined three distinct methodologies for analyzing the overall vulnerability of the state. The combination of the three methods gives a solid and complementary perspective of the "big picture" in Florida. The following list details the three methodologies:

- Local Plan Integration: Florida has 67 jurisdictions that have completed the rigorous FEMA approval process under the DMA2K. These county jurisdictions developed detailed risk assessments and mitigation strategies for their specific geographic areas, and these plans were incorporated into this state-level vulnerability analysis.
- Hazus-MH 2.1 (FEMA's loss estimation software): The Hazus-MH 2.1-driven methodology uses a statistical approach and mathematical modeling of risks to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus-MH 2.1 risk assessment methodology is parametric in that distinct hazard and inventory parameters (wind speed and building types) were modeled using the Hazus-MH 2.1 software to determine the impact (damages and losses) on the built environment. The Hazus-MH 2.1 software was used to estimate losses from wind (hurricane and tornado) and flood hazards.
- Statistical Risk Assessment Methodology: The statistical risk assessment methodology was applied to analyze hazards of concern that are outside the scope of the Hazus-MH 2.1 software.

Each approach provided estimates for the potential impact and consequences by using a common, systematic framework for evaluation. During the 2013 update, the SHMPAT collected the 67 approved LMS plans and used the local risk assessment data in the development of this section of the plan. Updated LMS plans that were received for review by the State Mitigation Planning Unit prior to May 1, 2012 were incorporated into the 2013 state risk assessment.

I. 2013 Statistical Risk Assessment Methodology

Risk associated with some natural hazards was analyzed using a statistical assessment methodology developed and used specifically for the 2013 plan update. Since automated software was not available to analyze all hazards, manual statistical assessments were performed by applying modeling principles used by FEMA's Hazus-MH 2.1 software. The general steps used in the statistical risk assessment methodology are summarized in the following list:

- Compile data from national and local sources
- Conduct statistical analysis of data to relate historical patterns within data to existing hazard models (i.e., minimum, maximum, average, and standard deviation)
- Categorize hazard parameters for each hazard to be modeled (e.g., hurricane)
- Develop model parameters based on analysis of data, existing hazard models, and risk engineering judgment
- Apply hazard model, including:
  - Analysis of frequency of hazard occurrence
  - Analysis of intensity and damage parameters of hazard occurrence
- Development of intensity and frequency tables and curves based on observed data
- Development of simple damage function to relate hazard intensity to a level of damage (e.g., one flood equals some dollar amount in estimated damages)
- Development of exceedance and frequency curves relating a level of damage for each hazard to an annual probability of occurrence
- Development of loss estimate

3.2.2 Hazard Profiling

The profiling process for hazard events considered historical records, geographic area, and probability for future occurrences. As part of the 2013 plan revision, each hazard was reconsidered and new information was added for the 2010–2013 period. The update focused on new information relating to the following subjects:

- General information and research
- Historical occurrences between 2010 and June 2012
- Geographic extent of the hazard, including detailed maps
- Analysis of the probability of an event occurring in the future
- Census and demographic information

In previous years, the risk assessment section contained a hazard consequence table based on requirements of EMAP. For the 2013 plan this table has been moved to **Appendix C: Risk Assessment Tables.** The information contained in the hazard consequence table is also available in **Appendix D: Hazard Summary Sheets** in an easier to read format. This table overviews the following areas:

- Frequency of occurrence: based on historical observation, how often the type or level of hazard will occur.
- Impact on Public: based on historical observation and demographic information and study, how the type or level of hazard would affect the general public and their daily lives.
- Impact on Responder: based on historical observation and study, how the type or level of hazard would affect responders' ability to save lives, protect property and carry out their mission.
- Impact on continuity of operations / program operations: based on historical observation and study, how the type or level of hazard would affect the operation of facilities and execution of services in support of disaster and daily operations.
- Impact on property, facilities, and infrastructure: based on historical observation, study and modeling, how the type or level of hazard would affect county facilities, critical infrastructure, and other structures.
- Impact on delivery of services: based on historical observation and study, how the type or level of hazard would affect the public or private delivery of essential services to the affected or neighboring population.
- Impact on the environment: based on historical observation, study and modeling, how the type or level of hazard would affect the environment, and associated affects that could cause (e.g., debris)
- Impact on the economic condition: based on historical observation, study and modeling, how the type or level of hazard would affect the economic success and viability of local, state and national enterprises, and longer-term impacts to supply chain, or commodity requirements.
- Impact on the public's confidence in jurisdiction's governance: based on historical observation and study, how the type or level of hazard would affect the view the public had on the elected leadership of the state.

3.2.3 2013 Population Vulnerability

For many years, the State of Florida has experienced population growth. Between 2000 and 2010, the state's population grew by 17.6 percent.[17] The 2013 update to the mitigation plan reflects updated population totals from the 2010 U.S. Census. This dataset is also used for the baseline population data in Hazus-MH 2.1.

[17] http://quickfacts.census.gov/qfd/states/12000.html

Table 3.6 provides 2010 population figures for each county as well as the percent change since 2000 and Figure 3.2 provides a graphical representation of the population figures, by county.

Table 3.6 Statewide County Population Summaries[18]

Jurisdiction	*2010 Census*	*Percent Change*	*Total Change*	*2000 Census*
Florida	18,801,310	17.6	2,818,486	15,982,824
Alachua	247,336	13.5	29,381	217,955
Baker	27,115	21.8	4,856	22,259
Bay	168,852	13.9	20,635	148,217
Bradford	28,520	9.3	2,432	26,088
Brevard	543,376	14.1	67,146	476,230
Broward	1,748,066	7.7	125,048	1,623,018
Calhoun	14,625	12.4	1,608	13,017
Charlotte	159,978	13.0	18,351	141,627
Citrus	141,236	19.6	23,151	118,085
Clay	190,865	35.5	50,051	140,814
Collier	321,520	27.9	70,143	251,377
Columbia	67,531	19.5	11,018	56,513
DeSoto	34,862	8.2	2,653	32,209
Dixie	16,422	18.8	2,595	13,827
Duval	864,263	11.0	85,384	778,879
Escambia	297,619	1.1	3,209	294,410
Flagler	95,696	92.0	45,864	49,832
Franklin	11,549	17.5	1,720	9,829
Gadsden	46,389	2.9	1,302	45,087
Gilchrist	16,939	17.3	2,502	14,437
Glades	12,884	21.8	2,308	10,576
Gulf	15,863	8.9	1,303	14,560
Hamilton	14,799	11.0	1,472	13,327
Hardee	27,731	2.9	793	26,938
Hendry	39,140	8.1	2,930	36,210
Hernando	172,778	32.1	41,976	130,802
Highlands	98,786	13.1	11,420	87,366
Hillsborough	1,229,226	23.1	230,278	998,948
Holmes	19,927	7.3	1,363	18,564
Indian River	138,028	22.2	25,081	112,947
Jackson	49,746	6.4	2,991	46,755
Jefferson	14,761	14.4	1,859	12,902
Lafayette	8,870	25.9	1,848	7,022

[18] Florida Office of Economic and Demographic Research, 2010 Census County Profiles. http://edr.state.fl.us/Content/area-profiles/2010-census-county/index.cfm

Jurisdiction	*2010 Census*	*Percent Change*	*Total Change*	*2000 Census*
Lake	297,052	41.1	86,525	210,527
Lee	618,754	40.3	177,866	440,888
Leon	275,487	15.0	36,035	239,452
Levy	40,801	18.4	6,351	34,450
Liberty	8,365	19.1	1,344	7,021
Madison	19,224	2.6	491	18,733
Manatee	322,833	22.3	58,831	264,002
Marion	331,298	28.0	72,382	258,916
Martin	146,318	15.5	19,587	126,731
Miami-Dade	2,496,435	10.8	242,656	2,253,779
Monroe	73,090	-8.2	-6,499	79,589
Nassau	73,314	27.1	15,651	57,663
Okaloosa	180,822	6.1	10,324	170,498
Okeechobee	39,996	11.4	4,086	35,910
Orange	1,145,956	27.8	249,612	896,344
Osceola	268,685	55.8	96,192	172,493
Palm Beach	1,320,134	16.7	188,943	1,131,191
Pasco	464,697	34.8	119,929	344,768
Pinellas	916,542	-0.5	-4,953	921,495
Polk	602,095	24.4	118,171	483,924
Putnam	74,364	5.6	3,941	70,423
St. Johns	190,039	54.3	66,904	123,135
St. Lucie	277,789	44.2	85,094	192,695
Santa Rosa	151,372	28.6	33,629	117,743
Sarasota	379,448	16.4	53,487	325,961
Seminole	422,718	15.8	57,519	365,199
Sumter	93,420	75.1	40,075	53,345
Suwannee	41,551	19.2	6,707	34,844
Taylor	22,570	17.2	3,314	19,256
Union	15,535	15.6	2,093	13,442
Volusia	494,593	11.6	51,250	443,343
Wakulla	30,776	34.6	7,913	22,863
Walton	55,043	35.6	14,442	40,601
Washington	24,896	18.7	3,923	20,973

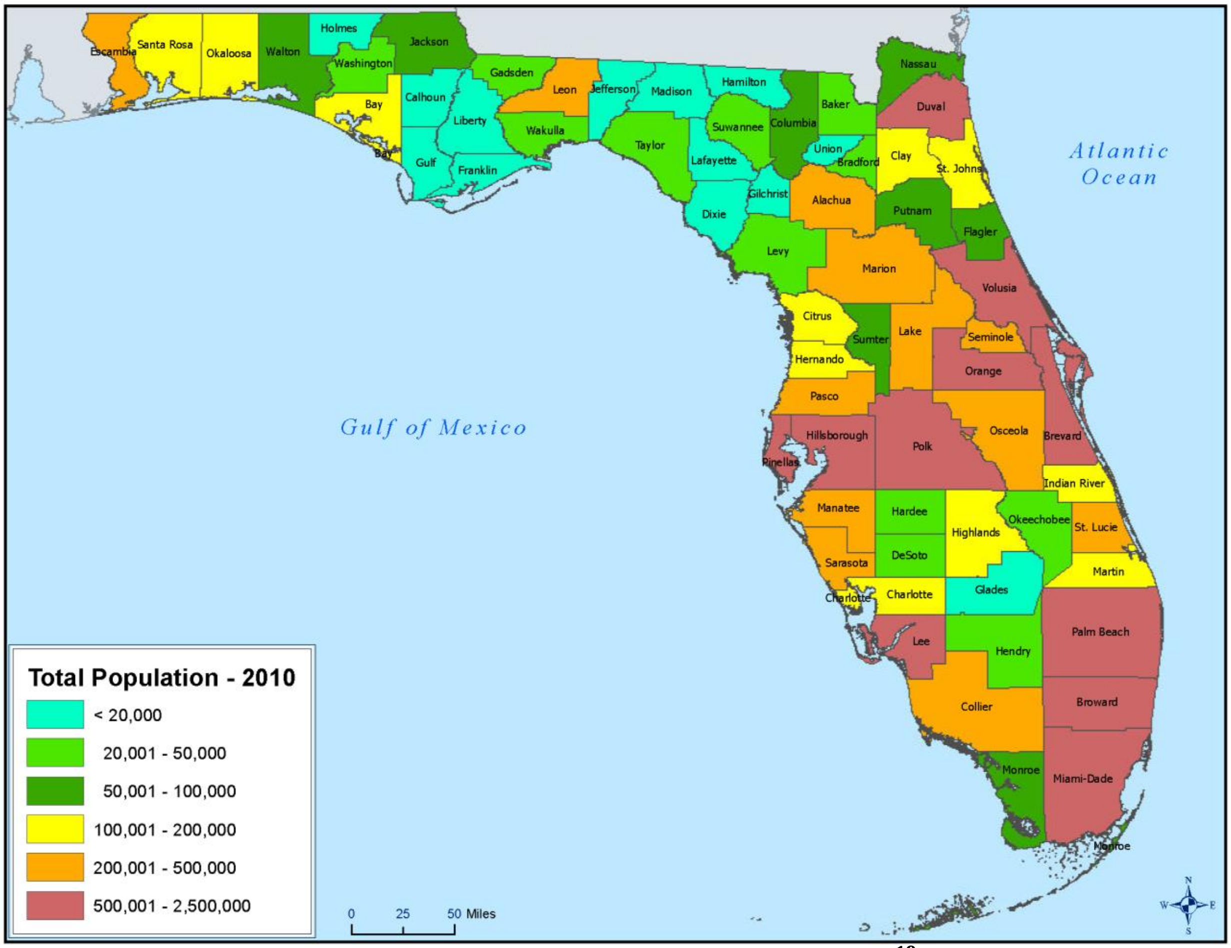

Figure 3.2 Statewide Population Summary[19]

A detailed listing by county of the total occupancy values for each type of key real estate: residential, medical, industrial, agricultural, educational, and government, has been included in **Appendix C: Risk Assessment Tables**.

3.2.4 Local Mitigation Strategies

I. Local Mitigation Strategy (LMS) Collection and Integration

During the 2013 revision and update process, the SHMPAT focused on producing a statewide vulnerability analysis, which included information provided by the 67 LMS risk assessments. All 67 counties within the State of Florida have a FEMA approved LMS. Copies of all county LMS plans are kept by DEM.

[19] http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

The risk assessment sections from the 67 LMS plans considered during the update process included the following:

- Hazard identification, including location
- Hazard probability, extent, and magnitude
- Hazard impacts
- Local vulnerabilities
- Locally estimated losses

II. Hazard Summary

Jurisdiction-level hazard data was reviewed individually, and a qualitative determination was made regarding the vulnerability of the jurisdiction to the specific hazard. Significant variation exists in the way hazards are described and quantified across Florida's counties, requiring some data and variables to be reclassified and/or re-categorized. Differences were equated to the state's ranking scale described below, and the table was sent out to each of the 67 counties for their concurrence or changes. The qualitative rankings for each hazard were based on a combination of factors discussed in the LMS plans:

- Probability of the hazard occurring in the jurisdiction
- Potential magnitude and severity of the hazard in the area
- Size of the population at risk in the jurisdiction
- Growth and development trends for the jurisdictions, especially in areas that are affected by the hazard
- Existence of large populations with special needs such as the elderly, the poor, and the non-English speaking communities
- Critical facilities and infrastructure that are vulnerable to the hazard

III. Statewide Matrix

The qualitative rankings for the hazards from each plan were collated to develop a statewide matrix for hazards and jurisdictions. Table 3.7 shows all of the hazard rankings from all local jurisdictions. The table also aided in the production of the county risk maps provided through the remainder of the plan.

Hazards were ranked for each county based on the following ranking scale:

- H – High Hazard Ranking (mapped in red)
- MH – Medium/High Hazard Ranking (mapped in pink)
- M – Medium Hazard Ranking (mapped in yellow)
- L – Low Hazard Ranking (mapped in green)
- Not Identified (mapped in base color of tan)

The two-letter codes at the top of the table correspond to the following hazards:

- DF – Dam Failure
- DR – Drought
- EH – Extreme Heat
- ER – Erosion
- FL – Flooding
- FR – Freezes
- HU – Hurricanes
- LS – Landslides
- MM – Mass Migration
- SH – Sinkholes
- SM – Seismic Events
- SS – Severe Storms
- TC – Technological Events
- TO – Tornadoes
- TR – Terrorism
- WF – Wildfires
- WS – Winter Storms

Tsunamis were not included as part of this table due to the fact that many coastal counties either discussed storm surge and tsunami risk simultaneously or it was determined that they were not at risk.

Table 3.7 Hazard Summary[20]

County	FL	DF	HU	TO	SS	WF	DR	EH	WS	FR	ER	SH	LS	SM	TR	TC	MM
Alachua	M		H	M	L	M	L	L			L	L			H		
Baker	MH	L	H	MH	M	H	M	L	M	M	L	L	L	L	L	L	L
Bay	H		H	H		M						L					
Bradford	H	L	MH	H	H	H	MH	MH	M	M	L	L	L	L			
Brevard	H	L	H	H	H	H	MH	L	L	L	M	L	L	L	H	H	L
Broward	H		H	H	H	M	M	L			M	L			M		L
Calhoun	L	L	H	H	H	H		M	M	M	M	L	L	L	L	L	L
Charlotte	H	M	H	MH	H	M	MH			L	MH	L		L			
Citrus	H	L	H	MH	H	M	M	L			MH	MH					
Clay	MH	M	H	MH	MH	MH	M	MH	M	M		M	L	L	M	L	
Collier	MH		H		MH	M		M	M	M		L	L		L		
Columbia	M		M	L	H	M	L		L		L	M					
DeSoto	H		H	M	M	H	L			M		L					
Dixie	H	L	H	M	M	M	M	M			L	L		L			
Duval	H		H	L	L	H	M	L		L					L	L	
Escambia	H	L	H	L	H	M	M			L	M	L	M	L	L		L
Flagler	M	L	H	MH	MH	H	H		L	L							
Franklin	H	L	H		MH	MH	M		M		MH		MH	L	L	MH	
Gadsden	MH	L	H	M	H	MH	MH	L	M	H	H	L	L	L			
Gilchrist	H		H	MH	MH	H	M	L	MH	MH	M	H			L		
Glades	H	MH	H	H	H	MH	MH			M	L	L		L			
Gulf	H	L	H	M	MH	MH	MH				H	L	H	L	M	MH	
Hamilton	H	L	H	MH	MH	H	H	H	MH	MH	M	H					
Hardee	H		H	L	M	L	M	M		M		L					
Hendry	M	L	H	M	H	H	H	H	M	M		L	L	L	L		
Hernando	H		H	MH	MH	MH	MH	L	M	M	MH	M		L			
Highlands	H	H	H	H	M	H	L		L	L		L	L		M		

[20] This table developed based on the 67 county Local Mitigation Strategies.

County	FL	DF	HU	TO	SS	WF	DR	EH	WS	FR	ER	SH	LS	SM	TR	TC	MM
Hillsborough	M	L	H	MH	H	M	M		L	L	L	L			M	L	
Holmes	H		H	H	MH	H	MH	MH	M	M	L	L					
Indian River	H		H	MH	MH	L	MH	MH		MH	MH	M	M	L	L	M	M
Jackson	MH		H	H	M	M	M				MH	L	MH		L	L	
Jefferson	H	L	MH	MH	M	H	MH		MH	MH	M	L	M	L	L	H	
Lafayette	H		H	H	MH	H	H	H	MH	MH	L	L	L	L	L		
Lake	H		H	L		H	M		M		M	L	M	L			
Lee	H	L	H	H	MH	H	M	M	M	M	H	L		L			
Leon	M	L	H	M	M	H	M		L			L		L	L	M	
Levy	H	L	MH	M		M	M	M	M	M	L	M					
Liberty	H		H	M	H	M	M				M	L		L			
Madison	H		H	H		H	M		M			M		L			
Manatee	H	L	H	H	H	H	M	M	M	M	M	L	L		L		
Marion	L		H	H		H	L	L	L		L	MH					
Martin	MH		H	L	MH	M	M	M			L	L			L	M	L
Miami-Dade	H		H	M	H	M	L	L		L					M	L	M
Monroe	H		H	M	MH	L	L	L			L				L	L	M
Nassau	MH	L	H	MH	M	MH	M	L	M	M	M	L	L	L	L	M	
Okaloosa	H	L	H	M	H	M	M	L	L	L	L	L	L	L			
Okeechobee	M		H	H	H	MH	L		L	L	L	L	L				
Orange	H		H	H		H	L					H	L	L	M	L	
Osceola	H		H	H	M	H	M	H	H			L	L				
Palm Beach	H	L	H	MH	MH	M	MH	M	L	L	L	L	L	L	M	M	L
Pasco	H	L	H	H	M	H	L		L	L	H	H	L	L	M	L	L
Pinellas	M		H	M	H	M	M	H	L	L	H	M		L	M	M	
Polk	M		H	H	H	H	M	M	M	M		M					
Putnam	H	M	M	M	H	H	M	M	M	M		M	M	L	L	M	
Santa Rosa	MH	L	M	H	H	L	M	M	M	M	H	L		L			
Sarasota	H	L	H	L	H	H	L				H	L		L			
Seminole	MH		MH	MH		MH	MH	MH	MH	MH	L	MH			MH	MH	L
St. Johns	MH		H	MH	MH	MH	L	L	M	M		L		L	L	M	L

County	FL	DF	HU	TO	SS	WF	DR	EH	WS	FR	ER	SH	LS	SM	TR	TC	MM
St. Lucie	H	L	H	L	M	M	L	M		M	M	L		L		L	
Sumter	M		H		H	H	H		M			M					
Suwannee	H		H	MH	H	H	M		H		M	H					
Taylor	MH		H		MH	MH	M		M		L	L		L			
Union	H		H	M	MH	H	M			M	M	L		L	M		
Volusia	H		H	H	M	H	H	M	L	L	M	L		L	M	L	
Wakulla	H	L	H	M		M	L		L		L	M		L			
Walton	H	L	H	H	H	L	L	L	L	L	H	L					
Washington	H	MH	H	M	M	M	M	M	M	L	MH	M		L			

IV. Hazard Mapping by Jurisdiction

The statewide matrix was imported into a GIS in order to map the areas at risk. A map was developed for each hazard, showing all jurisdictions together with their respective levels of risk to that specific hazard. The maps are included in the subsequent sections for each identified hazard.

The process of assessing local plans and mapping by jurisdiction was followed for all local plans, and the data was incorporated into the 2013 update of this plan. With the help of this information, the state's vulnerability was based on local data as well as the state-level data. As the local plans are updated, the information from such plans will be collected and added to subsequent versions of the State Hazard Mitigation Plan.

3.2.5 Assessing Vulnerability and Potential Losses

Requirement §201.4(c)(2)(ii): *The risk assessment shall include an overview and analysis of the state's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in the state risk assessment. The state shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State-owned or operated critical facilities located in the identified hazard areas shall also be addressed.*
Requirement §201.4(c)(2)(iii): *The state risk assessment shall include an overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the state risk assessment.*
Requirement §201.4(c)(2)(iii): *The state shall estimate the potential dollar losses to state owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.*

I. Assessing the Vulnerability of State Facilities

For the 2013 plan update, information assessing the vulnerability of state facilities follows information about hazard events and the vulnerability of jurisdictions instead of in completely different plan sections. As the State of Florida remains vulnerable to natural hazards, state-owned facilities are equally at risk to incur damages due to hazard occurrences. However, the state's resources, both monetary and fixed assets, depend heavily on these facilities and their functions. In developing this portion of the state plan, the SHMPAT coordinated with the Florida Department of Financial Services (DFS), which maintains a database of all state-owned facilities. This database, current as of August 2012, includes critical and non-critical facilities and state-owned infrastructure, as well as associated values for building structure and contents.

The state plan, however, does not include a detailed description of each facility. Due to the nature of information included in the list, detailed information of the facility may be classified and cannot be included in this plan. Information from that list is made available as needed and with limited access. 20,287 state facilities at an approximate aggregate insured value of $41.8 billion were analyzed for each hazard. The 2013 update analysis methodologies and results included the following:

- The detailed study of the state's most vulnerable facilities with regard to damages and losses associated with each hazard event.
- The detailed study of the state's most vulnerable facilities with regard to current and future development.

A summary of the total insured values, by county, is provided in Figure 3.3. A detailed listed of the number of facilities and insured value by county is provided in **Appendix C: Risk Assessment Tables.**

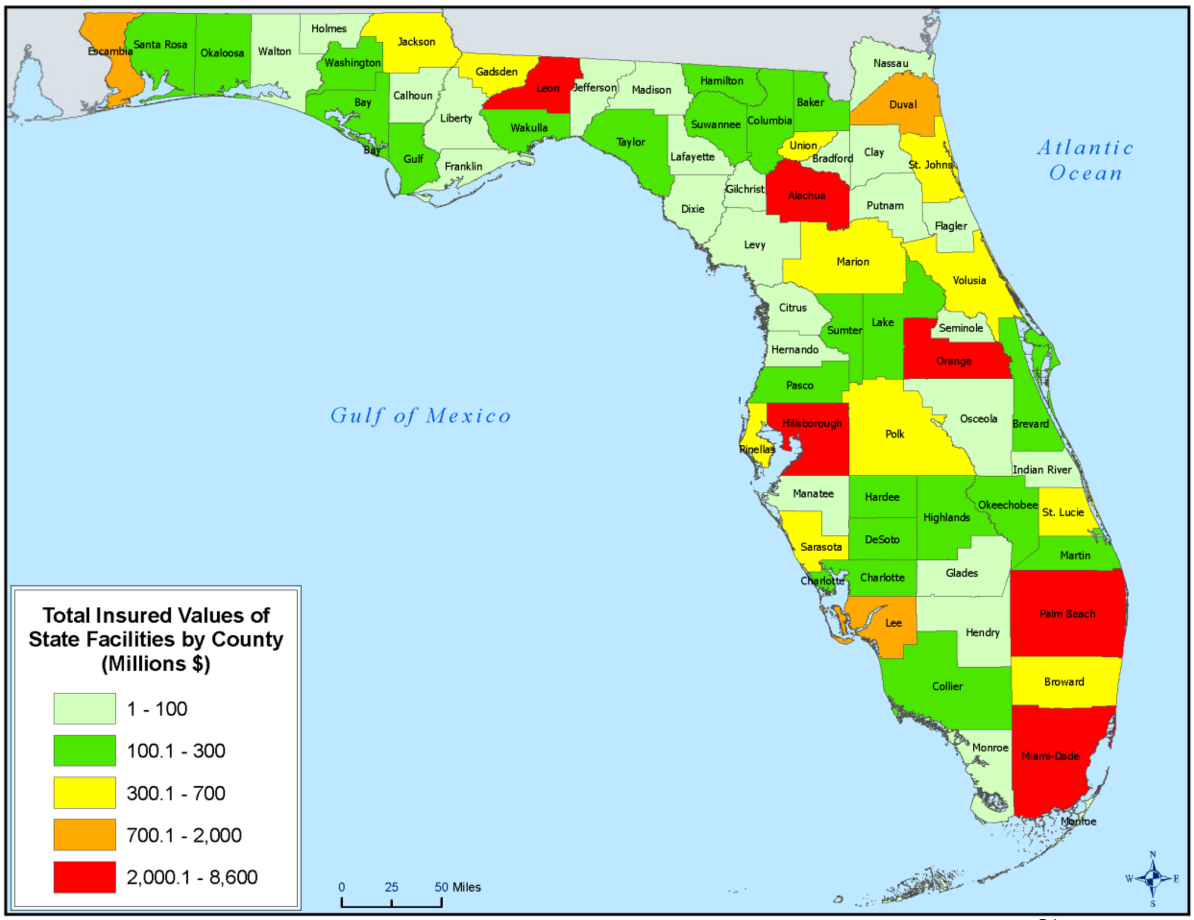

Figure 3.3 Total Insured State Facility Values by County[21]

[21] Data obtained from a Florida Department of Financial Services Database and integrated via GIS analysis.

II. Estimating Potential Losses by Jurisdictions

For the 2013 plan update, each hazard section includes a sub-section titled "Estimating Potential Losses by Jurisdiction." The State of Florida treats each county as one of its jurisdictions, whereas local plans use different determinations for considering what constitutes a jurisdiction. Information under this heading provides specific details about the potential losses in each county, or jurisdiction, associated with each hazard type.

The SHMPAT reviewed this section and has researched the state's potential for losses with regard to jurisdictions at risk. The planning team took into consideration recent development-related changes, as well as applicable new or revised building codes, land use, and future development trends statewide. Informed by multiple levels of review, a public comment process, and extensive research, the planning team made every effort to use the best available data for each hazard type in determining statewide loss estimates.

Methodology for Estimating Potential Losses by Jurisdiction

The 2010 U.S. Census data was used for determining losses by jurisdiction. This updated information was provided with associated demographics information for all analysis. Using this data allowed the estimation process to proceed without having to use the Department of Revenue's data like the 2010 plan did. When applicable, Hazus-MH 2.1 was used to simulate damages based on new census data and values of structures in the jurisdiction that would likely be affected by corresponding incidents. Specific sources and approaches are included in each applicable hazard section.

Loss Estimation

Data on damage loss amounts for hazard events was obtained from the NCDC searchable database. The database presents losses for events in terms of event records with loss amounts. Annualized losses for hazards were calculated by summarizing these loss amounts over the span of time for the loss records. The database does not include any loss data for sinkholes. Other data used for loss estimation was obtained from the National Hurricane Center preliminary reports.

The economic loss results are presented here using two interrelated risk indicators:

- The annualized loss (AL), which is the estimated long-term value of losses to the general building stock in any single year in a specified geographic area (i.e., county).
- The annualized loss ratio (ALR), which expresses estimated annualized loss as a fraction of the building inventory replacement value.

The estimated annualized loss addresses the two key components of risk—the probability of the hazard occurring in the study area and the consequences of the hazard—largely a function of building construction type and quality, and of the intensity of the hazard event. By annualizing estimated losses, the annualized loss calculation factors in historic patterns of frequent, smaller events and infrequent but larger events to provide a balanced presentation of the risk.

The ALR represents the annualized loss as a fraction of the replacement value of the local building inventory. This ratio is calculated throughout the risk assessment by using the following formula:

$$ALR = \frac{\text{Annualized Losses}}{\text{Total Exposure at Risk}}$$

The ALR gauges the relationship between average annualized loss and building replacement value. This ratio can be used as a measure of relative risk among areas since it is normalized by replacement value. It can be directly compared across different geographic units such as metropolitan areas or counties. In general, presenting results in the annualized form serves on three fronts:

- Contributing potential losses from all future disasters are accounted for with this approach.
- Different hazards are readily comparable and hence easier to rank.
- With respect to evaluating mitigation alternatives, the use of annualized losses is the most objective approach to serve for this purpose.

In conducting the 2013 estimation of potential losses from hazard events, official guidance and information from FEMA and EMAP regarding the specific elements for loss estimation were reviewed.

After the research phase, all available data was collated and used to estimate losses for each identified hazard. Using baseline data, the analysis primarily used information from the NCDC Storm Events Database. This database is maintained by the National Climatic Data Center (NCDC), an organization within the NOAA. The database contains historical records for local events, and it reports information about quantities, locations, deaths, injuries, property damage, and crop damage. Only the property and crop damage statistics are used as the basis for estimation of annualized losses.

The previously mentioned methodology produced an annualized loss estimate per hazard for the State of Florida. Since hazards and losses in this plan are summarized at the county level, a method was needed for dividing the state annualized loss estimate by county. The SHMPAT used a vulnerability weighting for each county to assign the annualized loss estimate for that county. Each weight was derived from the total value of the structures that reside within the overlying hazard zones of each county. Greater weights were assigned to higher structure values residing within high-hazard zones.

The SHMPAT considered the issues related to estimating losses on a statewide basis and noted that any scenario-based modeling would provide statistics and estimations only for the geographic area impacted by the scenario. Therefore, the team elected not to attempt this type of loss estimation. Instead, the focus was on the overall financial exposure for the high-risk areas and the average damage amounts from past events as the primary tools for estimating potential future losses on a statewide basis.

III. Estimating Potential Losses of State Facilities

As part of the 2013 plan update process, the SHMPAT reviewed the existing loss estimations from the original 2004 State Hazard Mitigation Plan. Using these original estimations as the starting point, the SHMPAT developed a more detailed analysis for all the profiled hazards.

This section provides specific details about the following items:

- The original 2004 estimation methodologies and results
- The 2013 update process used to enhance previous plan assessments
- The detailed study of the state's potential losses associated with each hazard event for state facilities

The SHMPAT has reviewed this entire section thoroughly and has fully researched the state's potential for losses in terms of facilities at risk. Through the public process and existing relationships with agencies that collect data, the team researched all relevant sources of data for use in the development of this analysis. The best available data for each category was used in this loss estimation.

2013 Methodology for Estimating Losses for State Facilities

In 2013, the SHMPAT provided the following explanation of the process used to estimate potential losses on a statewide basis for the profiled hazards.

Based upon the risk assessment methodology and the loss estimation methodology described herein, potential losses for facilities owned by the State of Florida were calculated and are presented within each hazard write up and in **Appendix C: Risk Assessment Tables**. To obtain facility loss estimates, an ALR is first computed for each county, using as its two components the loss estimate value and the total value of the structures in the county, as summarized from the Department of Financial Services state facility data. Applying this annualized loss ratio for the county against the total insured value of the state facilities in the county yields a loss estimate value for the facilities.

As discussed herein, the state plan does not include a detailed description of each facility, nor does it identify whether a facility or infrastructure is critical or non-critical. Due to its size and format, it was not possible to include the database in this plan. A list of state critical facilities and infrastructure was compiled as part of the state's Homeland Security initiative. However, due to the nature of information included in the list, detailed information about a facility may be classified and cannot be included in this plan.

3.3 Profiling Florida's Hazards

The following profiles will analyze each hazard, both natural, technological, and man-made, that have been determined that Florida is at risk of.

3.3.1 Flood Profile

I. Flood Description and Background Information

Flood or flooding refers to the general or temporary conditions of partial or complete inundation of normally dry land areas from the overflow of inland or tidal water and of surface water runoff from any source. Floodplains are defined as any land areas susceptible to being inundated by water from any flooding source.

Although storm surge presents the potential for loss of life, a study conducted from 1970 to 1999 by the National Hurricane Center found that freshwater flooding accounted for more than half (59%) of the tropical cyclone deaths in the United States.[22] FEMA estimates that about 41 percent of Florida is flood prone, which is the highest percentage of all 50 states.[23] Because of the potential for flood damage, Florida has the most flood insurance policies required by the National Flood Insurance Program than any other state.[24] More information about the number of policies in Florida by community can be found in **Appendix H: NFIP Policy Statistics** and more information about repetitive flood loss structures can be found in **Section 4: Goals and Capabilities** and **Section 7: Severe Repetitive Loss Outreach Strategy**.

In Florida, several variations of flooding occur due to the effects of severe thunderstorms, hurricanes, seasonal rain, and other weather-related conditions. The loss of life, personal property, crops, business facilities, utilities, and transportation are major impacts of flooding. Floodwaters present an additional hazard as a public health problem when they inundate drinking water facilities, chemical and waste storage facilities, wastewater treatment facilities, and solid waste disposal sites.

Coastal Flooding

Coastal flooding is usually the result of a severe weather system such as a severe thunderstorm, hurricane, or tropical storm with high winds. Water driven ashore by the wind, known as a storm surge, is the main cause of coastal flooding.

The damaging effects to structures in the beach areas are caused by a combination of higher levels of storm surge, winds, waves, rains, erosion, and battering by debris. Sea walls, jetties, and the beach areas are affected by coastal flooding, and the loss over a period of time

[22] http://www.nhc.noaa.gov/HAW2/english/inland_flood.shtml
[23] http://www.talgov.com/you/learn/water/floodplain.cfm
[24] http://www.sarasota.wateratlas.usf.edu/upload/documents/FloodplainFacts.pdf

becomes costly. Loss of life and property damage are often more severe because a storm surge involves velocity wave action and accompanying winds.

Inland or Riverine Flooding

Florida's low-lying topography combined with its subtropical climate makes it highly vulnerable to inland or riverine flooding. Riverine flooding occurs when the flow of runoff is greater than the carrying capacities of the natural drainage systems. Portions of major drainage basins in Alabama and Georgia drain into the rivers in north Florida, and excessive rainfall in these southern states often causes flood conditions in Florida.

The State of Florida has nearly 121,000 census blocks that are potentially threatened by riverine flooding. This exposure translates to nearly $880 billion in property. Estimated annual loss for the state associated with riverine flooding is $255 million.[25] However, different datasets make for numerous possible calculations.

Flash floods present more significant safety risks than other riverine floods because of the rapid onset, the high water velocity, the potential for channel scour, and the debris load. In addition, more than one flood crest may result from a series of fast moving storms. Sudden destruction of structures and the washout of access routes may result in the loss of life.

Flood damage is proportional to the volume and the velocity of the water. High volumes of water can move heavy objects and undermine roads and bridges. Flooding can occur as a result of precipitation upstream without any precipitation occurring near the flooded areas. Although rural flooding is dangerous to fewer people and may be less costly than urban flooding, it can cause great damage to agricultural operations. Flooding can also facilitate other hazards such as health concerns and hazardous material events.

Riverine Reach

The influence of river flooding on river stage gradually decreases with proximity to the Gulf, and the influence of tides and storm surges on river stage gradually increases the flood levels in bodies of water. Tides affect river stages at low and medium flows in the upper tidal reach and at all flows in the lower tidal reach. In the lower part of the lower tidal reach, stages during storm surges are higher than river flood stages. Soils are present in all riverine wetland forests, but the most nutrient-rich swamps are dry during low-flow periods. Most surface soils in the deepest riverine swamps, upper and lower tidal swamps and lower tidal mixed forests are continuously saturated mucks.

Upper Tidal Reach

Upper tidal mixed forests are found on low levees or in transitional areas between swamps and higher forest types. Upper tidal swamps are present at elevations below median

[25] http://www.floridadisaster.org/mitigation/State/documents/2010stateplan/Section%203.0%20(final)%20-%20State%20Risk%20Assessment.pdf

monthly high stage and usually have surface soils that are permanently saturated mucks. The lower Suwannee River is the best example of an upper tidal reach in Florida.

Lower Tidal Reach

Lower tidal hammocks in a floodplain are found on elevations that do not receive regular tidal inundation or frequent river flooding, but have a high water table and are briefly inundated by storm surges several times a decade. The lower Suwannee River is an example. Lower tidal mixed forests include swamps with numerous small hummocks and are found on deep muck soils that are below the elevation of the median daily or monthly high stage.

Floodplains

Mitigation measures are taken to reduce the flood risk in the floodplain; however, development is not prohibited. Management of floodplains can be handled through building codes, local ordinances, and zoning regulations to mitigate the damage from floodwaters. The floodway is the channel of a watercourse and those portions of the adjoining floodplain providing the passage of the 100-year flood stage waters. The floodway fringe is the portion of the floodplain where complete development will cause a significant rise (typically one foot) in the 100-year floodplain.

Flood stage is the water elevation at which damage to personal property is significant. Locally heavy precipitation may produce flooding in areas other than delineated floodplains or along recognized drainage channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems.

Floodplains cover a very large area in Florida, and it is unlikely that any undeveloped land will stay in its natural state. Pressure from developers to build, and the potential tax revenues from developments, make it difficult to keep floodplains open. This lack of control coupled with inadequate information available regarding the extent of floodplains and flood prone areas typically leads to unsound development on floodplain land.

Floodplains offer many benefits to communities by providing natural flood and erosion control, natural water filtration processes, habitats for plant and animal communities, as well as recreational areas and scientific field-study. Acting as natural flood storage areas, floodplains decrease the destructive force of floodwaters downstream by reducing the velocity of floodwaters. Though floodplain vegetation is partly responsible for slowing the rush of floodwaters, it also serves other valuable functions such as reducing soil erosion, trapping floodwater sediment that increases soil fertility by providing nutrients to estuarine environments, and reducing sediment load downstream.

The chemical filtration processes and biological activity that occur within a floodplain can also help reduce flood-generated pollution from agricultural and urban runoff and sewage overflow. Floodplains preserve and recharge groundwater supplies and provide opportunities for recreation, education, and scientific study. Urban expansion may encourage development in floodplains that would otherwise be reserved for these benefits.

The 10-year floodplain of the lower Suwannee River is a good example of the overall topography of the floodplain areas within the state. The lower Suwannee River runs across the entire north-central area of the state and starts from its confluence with the Santa Fe River to the tree line near the Gulf of Mexico. The Suwannee's floodplain is divided into three reaches based on changes in hydrology, vegetation, and soils with proximity to the coast: riverine (non-tidal), upper tidal and lower tidal.

Flash Flooding

As Florida's population has rapidly increased since 1960, so has the profile of the state's landscape. Rapid urbanization has manifested itself in the form of increased impervious surface areas such as asphalt roads, concrete areas, sidewalks, and structures. This increase has led to a much higher level of flash flooding during heavy rainstorms and also during flooding events. The design of urban drainage systems in the past has concentrated on disposing of storm water as rapidly and efficiently as possible in a concentrated area; however, stormwater is often collected and transported elsewhere without a comprehensive strategy for dealing with it as a system. As a result, drainage in many of Florida's urbanized areas is often "piecemeal" and lacking comprehensive design.

Dam/Dike Failure

The failure of a dam or dike may also result in a flood event. The amount of water impounded is measured in acre-feet; an acre-foot of water is the volume that covers an acre of land to a depth of one foot. Dam failures are not routine; two factors influence the potential severity of full or partial dam failure: (1) The amount of water impounded, and (2) the density, type, and value of development downstream.

In 2007, the U.S. Army Corps of Engineers declared that the Herbert Hoover Dike was on the top of the list of nationwide dams in need of repair. Since then, the Corps has funded more work on the Herbert Hoover Dike than for any other dam construction project in the nation.[26] The rehabilitation project received $56 million in 2008, $74 million in 2009, $124 million in 2010, and $107.8 million in 2011.[27]

The Herbert Hoover Dike is one of many dams in Florida, each of which are listed in the National Inventory of Dams and are assigned a high, significant, or low hazard classification based on potential for loss of life and damage to property if the dam fails.[28] Classifications are updated based on development and changing demographics upstream and downstream. The description for each of the different hazard classifications is provided below.

[26] http://www.saj.usace.army.mil/Documents/NewsReleases/archive/2009/NR0937.pdf

[27] http://www.saj.usace.army.mil/Divisions/ProgramProjectMgt/Branches/WtrRes/FloodCtrl/HHDProject/DOCS/FactSheets/HHD_FS_Rehab_Spring2012.pdf

[28] http://www.saj.usace.army.mil/Divisions/ProgramProjectMgt/Branches/WtrRes/FloodCtrl/HHDProject/DOCS/reports/HHD_ConsensusReport_10-30-07.pdf

Dam hazard is a term indicating the potential hazard to the downstream area resulting from failure or operational errors of the dam or facilities. The level of risk associated with dams is classified into three categories based on definitions from the US Army Corps of Engineers:

- Low: A dam where failure or operational error results in no probable loss of human life and low economic and/or environmental loss. Losses are principally limited to the owner's property.
- Significant: A dam where failure or operational error results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or affect other concerns. These dams are often located in predominantly rural or agricultural areas but could be located in areas with more dense populations and significant infrastructure.
- High: A dam where failure or operational error will probably cause loss of human life.

A number of outside forces can cause dam failure, including prolonged periods of rain or flooding, landslides into reservoirs, failure of dams upstream, high winds, and earthquakes. Failure due to natural events such as earthquakes or tornadoes is significant because there is little to no advance warning. It is important to note that dam failures can result from natural events, human-caused events, or a combination of the two. Improper design and maintenance, inadequate spillway capacity, or internal erosion or "piping" within a dam may also cause failure.

National statistics show that overtopping of dams due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for 34 percent of all dam failures.[29] Foundation defects, including settlement and slope instability, account for 30 percent of all failures. Piping and seepage cause 20 percent of national dam failures. This includes internal erosion caused by seepage, seepage and erosion along hydraulic structures, leakage through animal burrows, and cracks in the dam. The remaining 16 percent of failures are caused by other means, including the failure of conduits and valves.[30]

Though Florida has never independently executed an inventory of dams, a national database has been developed using numerous resources to provide dam statistics. The most recent statistics from the Florida Dam Safety Program identified 882 state-regulated dams.[31] Approximately 402, or 46 percent, of Florida dams officially counted are either high hazard (will cause at least one life lost if failure were to occur) or significant hazard (may cause loss of life if failure were to occur) dams. It was determined that the counties, river systems, and the immediate areas around these dams are the zones with the highest vulnerability to flooding resulting from dam failure. Overall dam failure is a low priority with respect to flooding since the risks of coastal and inland flooding are much higher. Polk County has the largest number of dams by far. Other high vulnerability jurisdictions include Palm Beach County, Osceola County, Glades County, and Okeechobee County.

[29] http://www.damsafety.org/news/?p=412f29c8-3fd8-4529-b5c9-8d47364c1f3e
[30] http://www.ecy.wa.gov/PROGRAMS/wr/dams/failure.html
[31] http://www.damsafety.org/map/state.aspx?s=9

Given the data classification for the dam data from U.S. Geological Survey (U.S. Army Corps of Engineers) database,[32] specific detail has been removed from this plan. In its place, Figure 3.4 indicates which counties have high or significant hazard dams. More detailed information can be requested from the State of Florida.

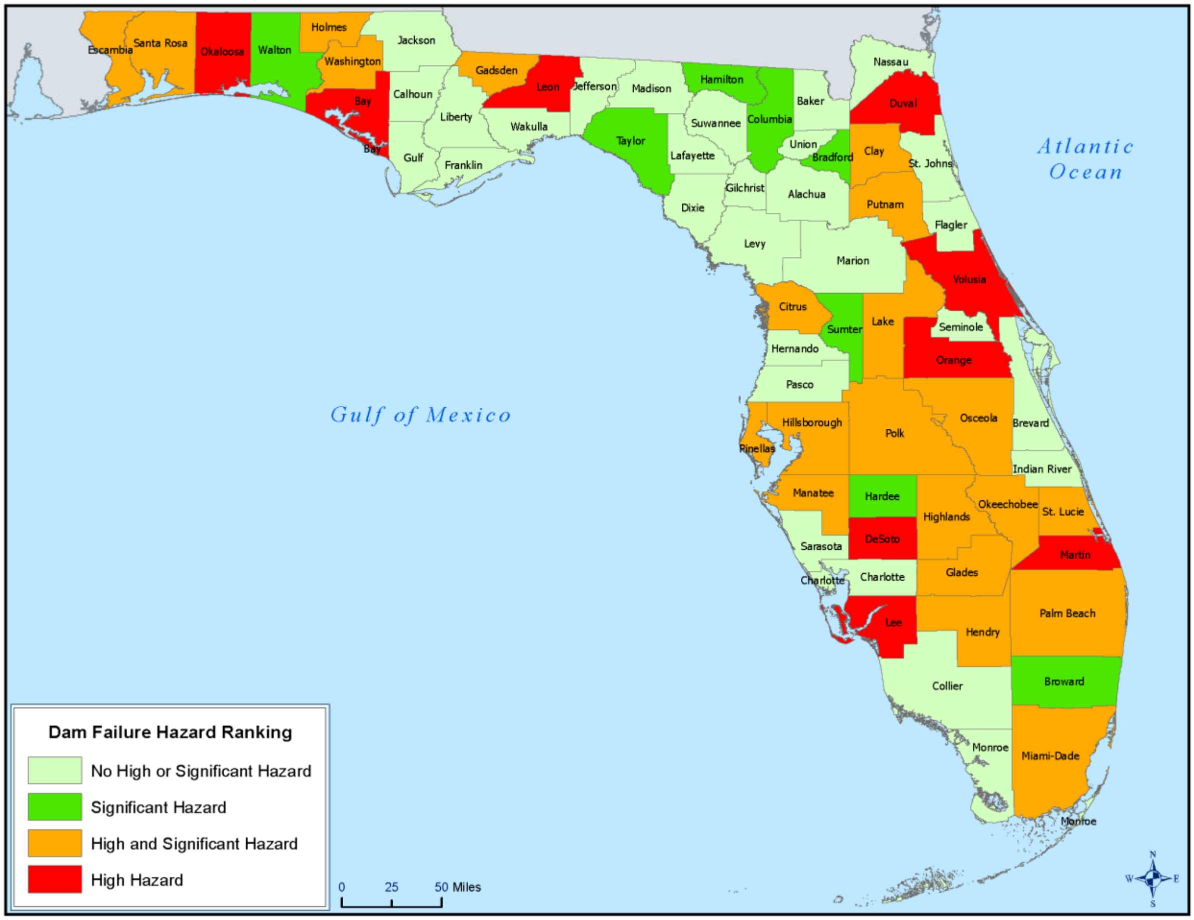

Figure 3.4 Counties with High or Significant Hazard Dams[33]

Sea Level Rise

Florida is vulnerable to sea level rise given its extensive shoreline and low elevation. Should sea levels rise, a number of consequences including the salination of fresh water sources, land loss, and increases in storms and flooding, could be observed.

Rising sea level affects the salinity of both surface water and ground water through salt water intrusion. Shallow coastal aquifers such as those in Florida are at risk via this salt water intrusion process. The freshwater Everglades currently recharges Florida's Biscayne aquifer, the primary water supply to the Florida Keys. As rising water levels submerge low-lying portions of the Everglades, portions of the aquifer would become saline.

[32] National Inventory of Dams, Florida dam inventory, 2012.
[33] National Inventory of Dams, Florida dam inventory, 2012.

As sea levels rise, water inundates and erodes coastal wetland ecosystems such as mangroves and salt marshes. Higher water levels wash away wetlands and flood previously dry land. These coastal wetland ecosystems are crucial to absorbing the impact of tropical storms and provide breeding ground for a significant proportion of sea life. The Intergovernmental Panel on Climate Change (IPCC) has reported that by 2080, “sea level rise could convert as much as 33 percent of the world’s coastal wetlands to open water.”

Sea level rise increases the vulnerability of coastal areas to flooding during storms. During a tropical storm or hurricane storm surge builds up on top of a higher base of water resulting in damages that are more significant. Given that storm surge from a hurricane or nor’easter builds on top of a higher base of water, a Report to Congress by FEMA (1991) estimated that existing development in the U.S. Coastal Zone would experience a 36–58 percent increase in annual damages for a 1-foot rise in sea level, and a 102–200 percent increase for a 3-foot rise.

Additionally, shore erosion increases storm vulnerability by removing the dunes and beaches that otherwise provide a buffer between coastal property and storm waves and surge. Lastly, sea level rise can result in an increase in coastal flooding from rainstorms because low areas drain more slowly as sea levels rise.

There exists interplay between vertical crustal motion and global seal level rise. However, no comprehensive analysis of vertical crustal motion has been done in Florida.

A 2009 Nature Conservancy evaluation of existing climate change data identified both a best- and worst-case scenario for the Florida Keys. In the best-case scenario, the study suggested that the sea would rise 7 inches by 2100 and subsume $11 billion worth of property value. The worst-case scenario predicted a 55-inch sea rise by 2100, which would include 5,950 acres of land lost on Big Pine Key alone and $35.1 billion in overall property value lost.

U.S. Geological Survey Flood Monitoring

The U.S. Geological Survey considers flooding in Florida to be a high probability, and has established a system of monitoring stations to retrieve data about stream flow conditions. This system works in real time for flood warnings and for short-term trends. The system is accessible at the following website: http://waterdata.usgs.gov/fl/nwis/rt.

FEMA Q3 Floodplain Data

A geographic assessment of the inland flooding hazard can be obtained using the FEMA Q3 digital floodplain data. This data is available for vulnerable counties in the state and it outlines the areas in the 100- year and the 500- year floodplains, with 1 percent annual probability and 0.2 percent probability of floods, respectively.

Floodplain data for the 2013 risk assessment includes updated Q3 data from April 2012. The data is reflected in Figure 3.5.

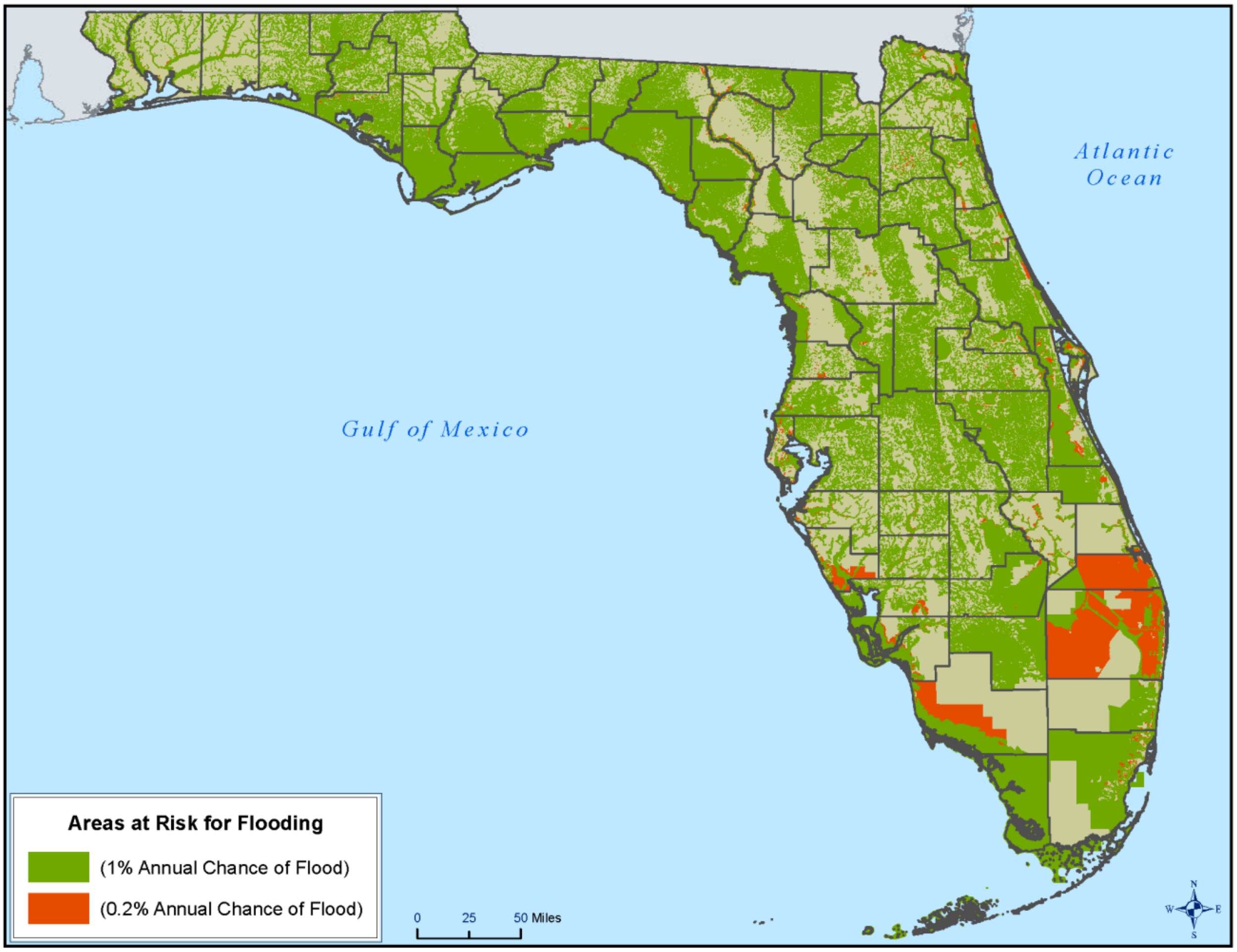

Figure 3.5 Areas at Risk for Flooding[34]

II. Geographic Areas Affected by Floods

The State of Florida is repeatedly impacted by flooding; 23 of 64 FEMA-declared disasters in Florida involved a flooding component.[35] Many of the remaining declarations were tropical storms and hurricanes that also included significant amounts of water, storm surge, and rain. The entire State of Florida is particularly susceptible to flooding due to the large amounts of coastline, significant drainage systems, and the relatively low elevations. Many other factors contribute to flooding in Florida and therefore help to define the geographic area impacted by flooding. Areas along waterways, including lakes, rivers, streams and wetlands, are particularly susceptible to flooding due to heavy storms and rain or storm surge.

[34] Map developed using FEMA Q3 digital floodplain data for 2013 plan update.
[35] http://www.fema.gov/disasters

III. Historical Occurrences of Floods

The worst flooding to date in Florida took place in 2000 as a result of Tropical Storm Leslie. On October 2 and 3, 2000, a broad area of low pressure in the Gulf of Mexico off the southwest Florida coast moved northeast across central Florida and eventually became subtropical depression number one, then Tropical Storm Leslie, as it moved off of the northeast Florida coast. Flood damage was particularly severe in the communities of Sweetwater, West Miami, Hialeah, Opa-Locka, and Pembroke Park. An estimated 93,000 houses and approximately 214,000 persons were isolated by floodwaters. Power was cut to 13,000 people. Some flood waters lingered for over a week. There were three indirect deaths, including two men who drove vehicles into canals and one man who fell from a roof while repairing a leak. Total property damage and crop damage estimates were $450 million and $500 million, respectively.

Other recent noteworthy flood-related events include Tropical Storm Fay in August 2008, which caused more than $150 million worth of property damage and more than $25 million worth of agricultural damage. In May 2009, five successive days of rain resulted in substantial flooding and standing water in Volusia County. Property damage totals were in excess of $68 million, and one fatality was indirectly related to the event.

Spring and summer 2012 have brought several significant flooding incidents to Florida. In May 2012, rain associated Tropical Storm Beryl caused extensive street flooding, stranding drivers across the Miami-metropolitan area. Miami International Airport recorded a one-day rainfall total of 9.7 inches.[36] More than 20 inches of rain fell in Escambia County and across the Florida Panhandle in early June 2012, causing extensive flooding. Consequences included the inundation of the Escambia County Jail with approximately 6 feet of water and flooding of many homes requiring emergency sheltering of 112 individuals.[37] Later in June 2012, Tropical Storm Debby produced significant flooding across large portions of Florida including 15–20 inches of rainfall in 24 hours across the Panhandle.[38] Preliminary damage from Debby was estimated to be at least $17 million and could be greater.[39]

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[36] http://usda01.library.cornell.edu/usda/waob/weather_weekly//2010s/2012/weather_weekly-05-31-2012.pdf

[37] http://www.cnn.com/2012/06/10/us/florida-flooding/index.html

[38] "NWS Tallahassee Local Storm Reports." National Weather Service in Tallahassee, Florida. National Oceanic and Atmospheric Administration. June 26, 2012. http://www.nws.noaa.gov/view/validProds.php?prod=LSR&node=KTAE

[39] Wells, C. "Disaster-relief Coming for Tropical Storm Debby Damage." July 9, 2012. Herald-Tribune. http://www.heraldtribune.com/article/20120709/ARTICLE/120709607/2416/NEWS

Table 3.8 describes other significant flooding occurrences and their impacts.

Table 3.8 Other Significant Flooding Occurrences[40]

Date	***Event***	***Property Damage***	***Agricultural Damage***	***Other Impacts or Damages of Note***
October 1999	Hurricane Irene	$205 million	$290 million	
October 2000	Tropical Storm Leslie	$450 million	$500 million	
September 2001	Tropical Storm Gabrielle	$26 million		Range of 6–9" rainfall
March 2003	Rain/Flooding	$1.0 million		Range of 3–16" rainfall
June 2003	Rain/Flooding	$11 million		100 homes destroyed
June 2003	Dam Failure			600 homes threatened
September 2004	Rain/Flooding	$5 million		Lake Gage crested at 10.1 feet
April 2005	Flash Floods	$5 million		150 homes damaged
February 2006	Flash Floods	$2 million		Range of 4–11" of rain in 5 hours
August 2008	Tropical Storm Fay	$150 million	$25 million	
May 2009	Rain/Flooding	$68 million		1 death
July 2009	Flood	$4 million		20 square blocks flooded
December 2009	Flood	$500,000		14" of rain recorded
May 2012	Tropical Storm Beryl			9.7" of rain at Miami International Airport
June 2012	Rain/Flooding	$20 million		23" of rain in Escambia County
June 2012	Tropical Storm Debby	+ $17 million		Range of 5–20" of rain

[40] http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2008&endDate_mm=12&endDate_dd=31&endDate_yyyy=2011&county=ALL&eventType=Coastal+Flood&statefips=12%2CFLORIDA

National Climatic Data Center

Based on data collected by the National Climatic Data Center (NCDC), there were 1,014 flooding events in Florida between January 1993 and April 2012. Total property damages were estimated at $1.5 billion with an additional $972 million in crop-related damages.[41]

Table 3.9 provides statistical data on flooding events that have occurred in Florida from 2008 through 2012. The statistics give an overview of how frequently each event occurs, as well as the dollar value of damages caused by each type of flood event..

Table 3.9 Flood Events in the State by Type (2008–2012) [42]

Type of Event	*Number of Events*	*Deaths*	*Injuries*	*Property Damage*	*Crop Damage*
Coastal Flood	10	0	0	$46,320,000	$0
Flash Flood	58	1	0	$116,962,000	$0
Flood	60	2	0	$152,737,000	$25,012,000
Total	128	3	0	$316,019,000	$25,012,000

Note: Multiple reports that occurred on the same day were counted as one event.

Many of Florida's coastal counties have large population concentrations that are vulnerable to the effects of coastal flooding. Miami-Dade County, for example, has 537,320 persons requiring evacuation in the event of a Category 3 hurricane. Other examples are Broward County with 155,705; Palm Beach with 271,993; Hillsborough with 295,636; Pinellas with 474,504; and Lee with 378,593. This information is current as of the 2010 plan update. There were not additional details available to update these numbers for the 2013 plan.

Using the 2010 census statistics for these counties, growth rates can be applied to the evacuation numbers above. Table 3.10 shows the comparisons of the 2000 census with the 2010 census and the related growth rates.

Table 3.10 2000 and 2010 Census Growth Rate Comparison

County	*2010*	*2000*	*Percent Growth*
Miami-Dade	2,496,435	2,253,779	10.8
Broward	1,748,066	1,623,018	7.7
Palm Beach	1,320,134	1,131,191	11.9
Hillsborough	1,229,226	998,948	18.2
Pinellas	916,542	921,495	-0.5
Duval	864,263	778,879	11

[41] Ibid.

[42] http://www.ncdc.noaa.gov/stormevents/listevents.jsp?beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2008&endDate_mm=12&endDate_dd=31&endDate_yyyy=2011&county=ALL&eventType=Coastal+Flood&statefips=12%2CFLORIDA

As the urban encroachment continues and the population grows, mitigation plans are an integral part of the overall emergency planning, especially as the sprawl stays on or near the coast. The following statistics show the importance of flooding to the state's mitigation planning effort:

- More than 45 percent of the state's population resides in 6 coastal counties: Miami-Dade, Broward, Palm Beach, Hillsborough, Pinellas, and Duval.
- About 3.95 million people reside in areas that are subject to coastal flooding.[43]
- As of January 2013, approximately 2.1 million of the 2.6 million National Flood Insurance Program policies in the nation are in Florida.[44]

IV. National Flood Insurance Program and Repetitive Loss Properties

One of the consequences of flooding is repetitive loss. A repetitive loss property is one for which two or more losses of at least $1,000 each have been paid by the National Flood Insurance Program (NFIP) over a rolling 10-year period. The facts below show the overall importance of the NFIP to the state and the level of flooding concern. These statistics are current as of January 16, 2013. Table 3.11 highlights the five states with the highest number of flood policies in force and

Table 3.12 goes into greater detail on Florida's polices.

Table 3.11 Flood Policies in Force Top 5 States[45]

Top Five States	***Flood Policies in Force***
1. Florida	2,059,797
2. Texas	656,335
3. Louisiana	493,416
4. California	263,492
5. New Jersey	234,717

Table 3.12 Florida Flood Policies[46]

The total amount of premium for policies in Florida	$1,021,351,301
The total coverage for all policies within the state	$476,463,660,400
The average coverage of a Florida policy	$219,180
The total number of claims reported within the state for all claims	238,547
The total amount paid on claims within the state since 1978	$3,693,593,921[47,48]

[43] http://www.floods.org/PDF/JCR_Est_US_Pop_100y_CFHA_2010.pdf
[44] http://stateofthecoast.noaa.gov/insurance/welcome.html
[45] http://bsa.nfipstat.com/reports/1011.htm%20 (Last updated January 16, 2013)
[46] http://bsa.nfipstat.com/reports/1011.htm%20 (Last updated January 16, 2013)
[47] http://bsa.nfipstat.com/reports/reports.html (July 31, 2009)
[48] http://stateofthecoast.noaa.gov/insurance/welcome.html

NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Ninety-seven percent of communities in Florida participate in the NFIP.[49] For more information about the NFIP, please see **Section 4: Goals and Capabilities**.

As a result of CRS, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS:

- Reduce flood losses
- Facilitate accurate insurance rating
- Promote the awareness of flood insurance

For the 2013 update, the state decided to highlight non-mitigated repetitive loss properties. Given the focus of the hazard mitigation plan on risks and vulnerabilities, this data was more pertinent to characterizing the state. The following data is based on the NFIP Repetitive Loss Master File.[50] As of January 16, 2013, Florida had 2,059,797 NFIP policies. Total premiums on that date equal an annual amount of $1,021,351,301. These policies cover more than $476 billion in property. Florida has 13,518 non-mitigated repetitive loss properties (RLPs). Table 3.13 details the non-mitigated repetitive loss properties and their losses.

Table 3.13 Non-Mitigated Repetitive Loss Properties by County[51]

County	*Non-Mitigated RLP's*	*Dollar Losses for Repetitive Loss*	*County*	*Non-Mitigated RLP's*	*Dollar Losses for Repetitive Loss*
Alachua	5	$165,493.05	Lee	612	$30,066,220.93
Baker	6	$251,409.23	Leon	68	$3,265,767.63
Bay	387	$48,985,642.87	Levy	74	$3,818,479.51
Bradford	4	$107,885.11	Liberty	0	$0
Brevard	138	$8,058,765.27	Madison	8	$451,078.59
Broward	707	$34,153,602.60	Manatee	338	$12,395,063.59
Calhoun	11	$628,086.23	Marion	7	$313,531.10
Charlotte	117	$4,572,684.25	Martin	177	$14,412,288.69
Citrus	335	$19,894,238.07	Miami-Dade	2,205	$130,358,079.08
Clay	63	$2,780,786.60	Monroe	912	$60,628,342.24
Collier	47	$2,313,410.92	Nassau	14	$787,316.84
Colombia	16	$641,841.71	Okaloosa	600	$121,550,418.85
DeSoto	28	$1,485,948.71	Okeechobee	12	$383,954.61
Dixie	75	$3,033,185.42	Orange	17	$790,124.10
Duval	260	$18,943,362.43	Osceola	8	$133,847.97

[49] http://www.floridadisaster.org/Mitigation/SFMP/Index.htm
[50] https://bsa.nfipstat.com/rlmf/index.html
[51] Individual data protected by the 1974 Privacy Act. Date in the table represents the compiled information from the NFIP Repetitive Loss Master File, https://bsa.nfipstat.com/rlmf/index.html.

County	*Non-Mitigated RLP's*	*Dollar Losses for Repetitive Loss*	*County*	*Non-Mitigated RLP's*	*Dollar Losses for Repetitive Loss*
Escambia	1,181	$222,689,291.68	Palm Beach	238	$13,889,121.02
Flagler	21	$908,609.24	Pasco	600	$28,333,300.55
Franklin	104	$4,934,817.56	Pinellas	1,264	$61,801,606.99
Gadsden	2	$42,836.36	Polk	31	$1,440,453.44
Gilchrist	33	$822,633.25	Putnam	20	$669,064.19
Glades	1	$10,732.28	Santa Rosa	690	$88,273,567.78
Gulf	55	$2,897,552.65	Sarasota	289	$13,802,985.02
Hamilton	16	$602,230.21	Seminole	31	$1,557,813.66
Hardee	6	$228,777.23	St. Johns	56	$2,226,465.73
Hendry	0	$0	St. Lucie	256	$27,846,392.56
Hernando	120	$5,546,940.12	Sumter	2	$55,010.58
Highlands	6	$200,455.95	Suwannee	26	$1,208,241.77
Hillsborough	371	$19,459,381.91	Taylor	25	$995,255.55
Holmes	22	$904,140.89	Union	1	$73,155.65
Indian River	179	$16,853,075.71	Volusia	188	$10,159,831.66
Jackson	2	$29,260.84	Wakulla	122	$7,302,860.31
Jefferson	0	$0	Walton	265	$26,958,985.02
Lafayette	30	$1,619,118.50	Washington	8	$221,087.48
Lake	6	$223,266.01			
Statewide Totals				**15,518**	**$1,090,159,175.55**

V. Probability of Future Flooding Events

The SHMPAT has considered the probability of flooding in previous revisions. Multiple factors have been considered for this analysis. Flooding will continue to occur throughout the state on an annual basis, although it is the goal of the SHMPAT and LMS working groups to reduce the effects of flooding through mitigation. Specific probability is difficult to gauge, however, 100-year and 500-year estimates help provide a baseline understanding. It is likely that Florida will continue to be impacted by flooding due to any number of causes annually.

VI. Flood Impact Analysis

Floods and flash flooding will negatively affect the State of Florida in a variety of ways:

- People, facilities, and infrastructure located within the floodplains in Florida are susceptible to flood impacts.
- Areas with poor drainage (e.g., fast growing municipalities that lack adequate storm drainage management) are more susceptible to the short-term effects of flash

flooding. Florida has experienced high levels of population growth; therefore, this will continue to be an issue until the infrastructure can handle rainfall and runoff.

- Injuries and deaths have resulted in the past from flooding events. Most cases involved automobile accidents during dangerous conditions.
- Florida is in the high-risk area for hurricanes and could expect to face a flooding event similar to the "worst case scenario" in Louisiana. The flooding situation created by Hurricane Katrina in 2005 showed the worst-case scenario resulting in long-term, significant flooding. The impacts included severe property damage, severe damage to cars and other equipment, water system contamination, wastewater treatment disruptions, civil unrest, and evacuation issues.
- Flooding, and particularly flash flooding, has caused traffic accidents and congestion that has resulted in short-term impacts on the transportation infrastructure.
- High dollar impact to uninsured property from floods. Most homeowner insurance policies do not cover floods and citizens do not always opt to purchase NFIP.
- Property damaged by a flooding event often results in a mold infestation that can require lengthy remediation and health issues.
- Responders are often put at risk during flood events as they respond to calls for assistance. Their risks can range from performing dangerous rescue missions for stranded citizens to sickness due to exposure to inclement weather. Most responders, however, are not at a great health and safety risk from flooding events.
- Flooding, as a localized event, does not pose a significant threat to the state's ability to maintain normal operations. However, during major flooding events, state resources directed by Florida Division of Emergency Management will be mobilized to assist in the response and recovery effort, and this can cause a re-prioritization of the short- and medium-term government agenda. This hazard could cause major disruptions to essential government services.
- Flooding is often the result of fast moving, severe storm systems and can include other hazards such as tornadoes, lightning, straight-line winds, and hail. The impact from these related hazards will compound the response and recovery issues related directly to flooding, as well as damages and injuries.

VII. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. The 67 multi-jurisdictional LMS plans provided a solid baseline for the overall state vulnerability analysis. Risk assessment information from the LMS plans is current as of May 1, 2012.

Based on the LMS plans in the State of Florida, Figure 3.6 displays the jurisdictional rankings for the flood hazard.

- High-risk Jurisdictions 44
- Medium-high–risk Jurisdictions 11
- Medium-risk Jurisdictions 10
- Low-risk Jurisdictions 02

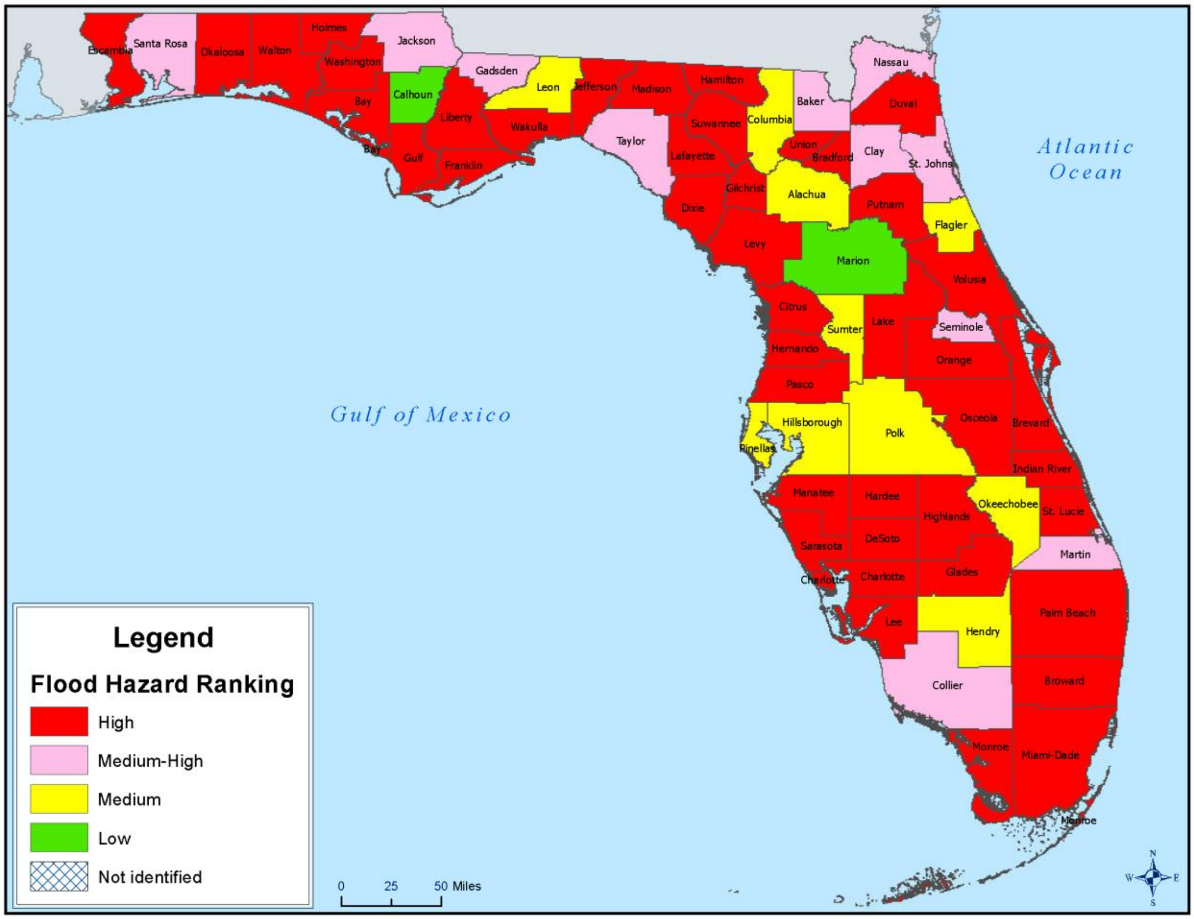

Figure 3.6 Flood Hazard Rankings by County

Based on the LMS plans in the State of Florida, Figure 3.7 displays the jurisdictional rankings for the Dam Failure hazard. Not all counties with dams have identified Dam Failure as one of their hazards.

- High-risk Jurisdictions 1
- Medium-high–risk Jurisdictions 2
- Medium-risk Jurisdictions 3
- Low-risk Jurisdictions 28

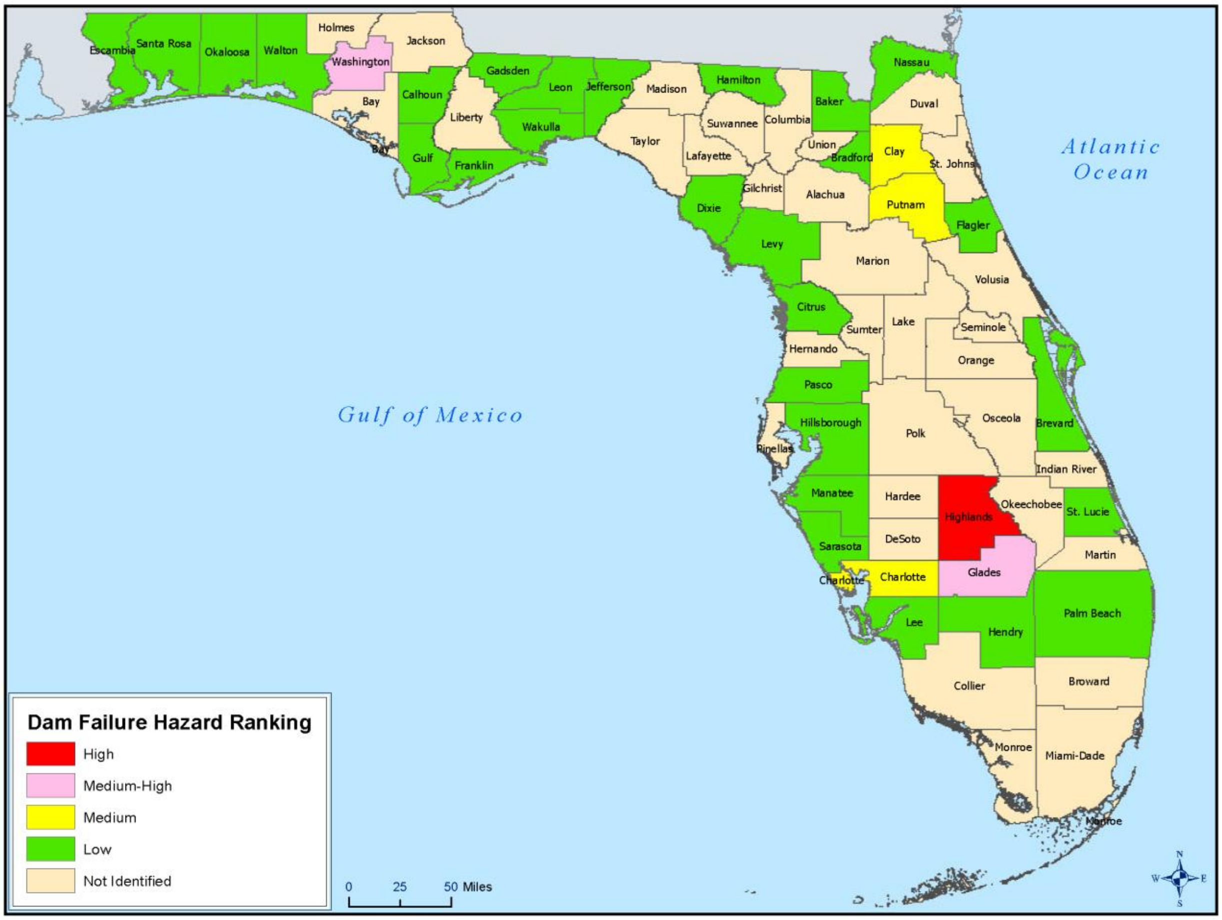

Figure 3.7 Dam Hazard Ranking by County

VIII. Flooding Hazard Vulnerability Analysis by Jurisdiction

Inland Flooding Vulnerability Analysis by Jurisdiction

The following analysis has been updated for the 2013 plan update. The information in Table 3.14 is based on the 2010 U.S. Census population data. The individual tract and block data was built based on updates to those as part of the 2010 data. Centroids for each block were then overlaid with the inland flood zones layer for 100-year and 500-year floodplains, and summarized to produce Table 3.14. The total exposure potentially at risk from riverine flooding is over $668 billion (or over one third of the total building exposure).

Table 3.14 Inland Flood Hazard, Population[52]

County	*100-Year*	*500-Year*	*County*	*100-Year*	*500-Year*
Alachua	126,934	19,218	Lee	311,566	166,360
Baker	14,810	9,566	Leon	139,853	44,439
Bay	103,780	19,410	Levy	16,742	1,135
Bradford	23,809	1,978	Liberty	5,578	835
Brevard	236,209	137,030	Madison	13,442	1,020
Broward	1,468,037	129,404	Manatee	136,691	109,330
Calhoun	7,178	521	Marion	131,725	27,466
Charlotte	106,510	15,567	Martin	52,270	124,254
Citrus	50,959	25,466	Miami-Dade	1,872,236	639,492
Clay	109,479	46,881	Monroe	68,543	16,208
Collier	119,227	183,797	Nassau	43,534	24,256
Columbia	50,100	10,660	Okaloosa	59,713	6,519
DeSoto	16,018	5,341	Okeechobee	18,353	15,626
Dixie	13,459	3,124	Orange	463,837	65,157
Duval	325,389	171,806	Osceola	146,428	90,778
Escambia	86,253	40,056	Palm Beach	389,406	1,061,429
Flagler	27,996	21,982	Pasco	277,934	147,077
Franklin	9,070	4,371	Pinellas	398,390	294,183
Gadsden	32,666	5,521	Polk	293,364	7,949
Gilchrist	9,397	2,615	Putnam	40,742	13,708
Glades	9,870	4,942	Santa Rosa	49,898	21,511
Gulf	12,947	4,199	Sarasota	149,490	163,816
Hamilton	11,212	2,971	Seminole	198,802	66,952
Hardee	13,672	6,654	St. Johns	132,006	101,292
Hendry	24,588	6,216	St. Lucie	44,970	32,519
Hernando	101,575	45,133	Sumter	44,982	3,141
Highlands	25,801	12,081	Suwannee	26,140	6,698
Hillsborough	690,351	22,580	Taylor	19,067	6,072
Holmes	17,051	1,467	Union	11,626	75
Indian River	67,702	25,592	Volusia	183,954	109,786
Jackson	33,092	1,989	Wakulla	22,343	2,333
Jefferson	10,777	1,780	Walton	41,406	2,358
Lafayette	4,048	2,081	Washington	18,479	796
Lake	154,239	10,552			

[52] Results obtained via GIS analysis of aggregated data sources.

Coastal Flooding Vulnerability Analysis by Jurisdiction

The following analysis was performed as a part of the update process for this revision. Figure 3.8 and Figure 3.9 were produced using coastal flood depth grids. Coastal flooding can be difficult to predict, and the following data reflects the FEMA Region IV Coastal Flood Atlas. Flooding may be worse from a direct hit by a lesser category hurricane, in comparison to a glancing hit by a larger category storm.

Coastal flooding is reflective of the potential impacts by a tropical storm or cyclone. Given the end effect of flooding, this section resides in the Flooding Section, rather than the Tropical Cycle Section. Category 2 and Category 5 hurricanes were used as they reflect both the low to medium impact, and a high impact. Using these two categories provides a range of potential damages based on intensity and projected impacts.

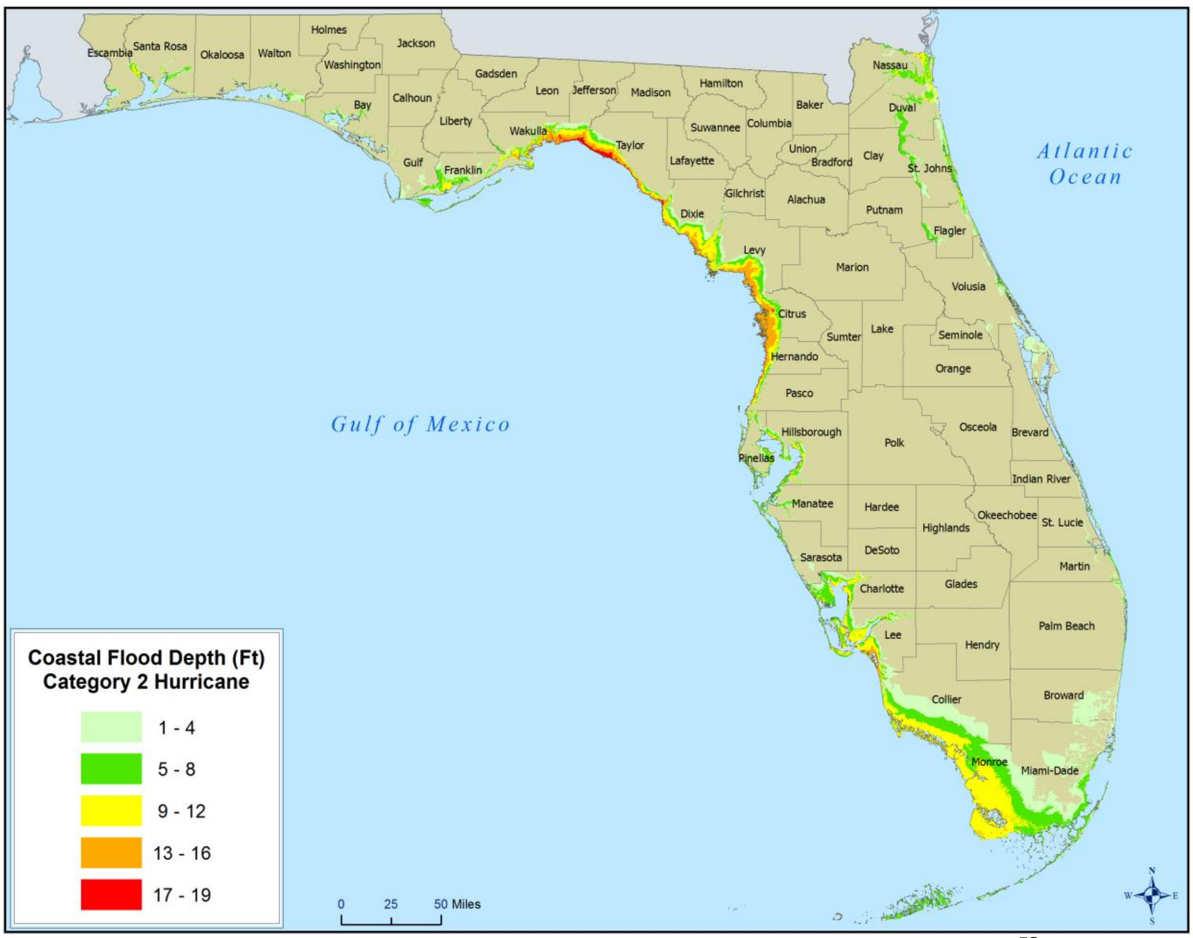

Figure 3.8 Coastal Flood Depth from a Category 2 Hurricane[53]

[53] Map was produced using 2010 census block populations with coastal flood depth grids.

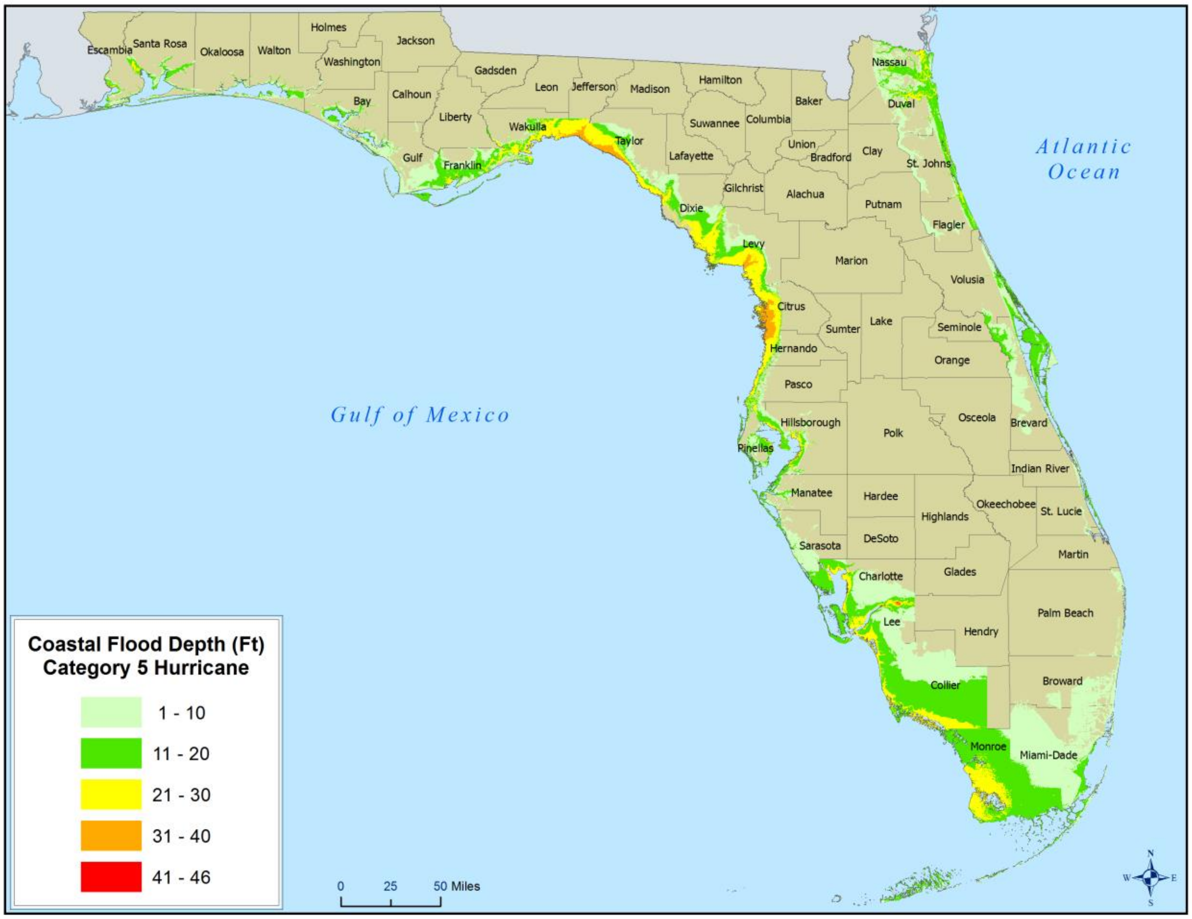

Figure 3.9 Coastal Flood Depth from a Category 5 Hurricane[54]

Tables showing the number and value of key community facilities vulnerable to flooding associated with Category 2 and 5 hurricanes by county and flooding depth can be found in **Appendix C: Risk Assessment Tables**.

Table 3.15 and Table 3.16 were produced by overlaying census block populations with the coastal flood depth grids. The information was then summarized according to the populations in each depth range. The flood depth grids came from the FEMA Coastal Flood Atlas and were combined with the recent 2010 Census information.

Table 3.15 Population in Coastal Flood Hazard, Category 2[55]

County	*1–3 ft.*	*4–6 ft.*	*7–10 ft.*	*11–13 ft.*	*14–16 ft.*	*17–19 ft.*
Bay	5,951	3,866	1,858			
Brevard	26,793	12,384	1,387			
Broward	623,004	57,162				
Charlotte	52,168	52,126	61,784	8,170		
Citrus	7,819	10,787	21,051	6,294	6,856	2,054

[54] Map was produced using 2010 census block populations with coastal flood depth grids.
[55] Results obtained via GIS analysis of aggregated data sources.

County	***1–3 ft.***	***4–6 ft.***	***7–10 ft.***	***11–13 ft.***	***14–16 ft.***	***17–19 ft.***
Collier	110,499	81,408	97,685	38,395	4,621	
Dixie	693	714	896	791	478	98
Duval	23,349	12,531	4,221	1,210		
Escambia	12,334	12,164	6,330			
Flagler	11,652	10,757	5,318			
Franklin	1,737	1,920	1,373	349	85	
Gulf	1,491	588	6			
Hernando	1,284	962	1,690	2,680	2,677	
Hillsborough	70,537	96,053	65,853	21,640		
Indian River	10,209	5,853				
Lee	116,252	119,317	220,756	98,507	9,449	
Levy	1,644	2,281	2,478	1,516	789	265
Manatee	25,422	29,413	22,160	25		
Martin	15,551	11,160	22			
Miami-Dade	779,416	275,249	26,350	21	21	
Monroe	34,492	50,502	29,123	1	-	
Nassau	9,367	9,565	9,004	915		
Okaloosa	6,408	6,994	3,689			
Palm Beach	64,181	45,309				
Pasco	15,184	32,423	25,922	19,561	5,508	
Pinellas	83,297	159,700	114,759	3,330		
Santa Rosa	6,956	8,342	5,299	370		
Sarasota	13,237	23,948	6,673	-		
St. Johns	35,686	28,175	24,523	2,051		
St. Lucie	10,448	9,145				
Taylor	376	437	591	774	562	484
Volusia	35,761	16,052	3,670			
Wakulla	4,453	3,879	4,194	2,160	1,056	213
Walton	6,781	3,507	2,455			

Table 3.16 Population in Coastal Flood Hazard, Category 5[56]

County	*1–3 ft.*	*4–6 ft.*	*7–10 ft.*	*11–13 ft.*	*14–16 ft.*	*17–20 ft.*	*21–23 ft.*	*24–26 ft.*	*27–30 ft.*	*31–33 ft.*	*34–36 ft.*	*37–40 ft.*	*41–43 ft.*	*44–46 ft.*
Bay	1,026	1,030	1,003	620	498	196								
Brevard	1,063	988	1,735	1,305	884	310								
Broward	8,248	3,412	555	3										
Charlotte	410	702	820	1,461	2,441	2,768	1,006	67						
Citrus	87	164	181	177	235	319	262	607	956	533	155			
Collier	179	302	773	1,300	1,548	2,143	1,125	134						
Dixie	184	236	263	259	250	188	207	172	63	21				
Duval	1,755	1,995	1,892	2,054	1,525	337	408	11						
Escambia	252	372	514	424	408	335	57	11						
Flagler	392	416	260	317	431	406	163	3						
Franklin	237	519	796	725	778	654	264	159	33					
Gilchrist						1								
Gulf	417	376	393	151	36	10								
Hernando	387	343	328	284	207	134	80	142	316	60				
Hillsborough	1,035	1,700	1,926	1,451	1,793	2,316	1,379	741	83					
Indian River	865	543	502	24										
Jefferson					1	4	11	12	13	15	13			
Lee	1,519	1,954	4,602	4,342	3,305	4,784	3,898	461	128	72	51	34	21	12
Levy	160	205	331	291	360	469	505	408	235	74	9			
Liberty								1						
Manatee	1,089	1,307	1,218	1,150	884	164								
Marion		1	1											
Martin			1											
Miami-Dade	16,388	8,689	5,987	2,045	388	87	3	1						
Monroe	290	733	1,834	1,376	145	216	176	24	2					

[56] Results obtained via GIS analysis of aggregated data sources.

County	*1–3 ft.*	*4–6 ft.*	*7–10 ft.*	*11–13 ft.*	*14–16 ft.*	*17–20 ft.*	*21–23 ft.*	*24–26 ft.*	*27–30 ft.*	*31–33 ft.*	*34–36 ft.*	*37–40 ft.*	*41–43 ft.*	*44–46 ft.*
Nassau	541	644	742	514	325	306	154							
Okaloosa	382	531	512	274	209	90	1							
Palm Beach	1,843	1,218	965	168										
Pasco	293	730	1,407	897	908	909	563	241	26					
Pinellas	1,229	2,880	4,034	2,977	3,179	3,153	675	1						
Putnam			1											
Santa Rosa	313	370	600	466	411	293	49							
Sarasota	2,486	2,385	1,923	907	613	86	1							
Seminole						1								
St. Johns	204	310	634	736	580	1,032	348	3						
St. Lucie	361	276	414	317	3									
Taylor	201	253	311	338	290	301	262	202	218	142	53			
Volusia	1,051	1,993	1,328	888	337	43								

IX. Assessing Vulnerability of State Facilities

The following section provides a detailed description of the vulnerability of state facilities to flooding. For this 2013 analysis, flooding was separated into two distinct categories and builds upon past plan updates:

- Inland Flooding
- Coastal Flooding

Inland Flooding Vulnerability Analysis for State Facilities

The State of Florida is extremely vulnerable to flooding—riverine and coastal—placing billions of dollars in property at risk. The Department of Environmental Protection owns more at-risk facilities vulnerable to flooding (riverine and coastal) than any other state agency. The SHMPAT reviewed the FEMA Flood Insurance Rate Maps and the existing Q3 data and, together with flood experts from the Division of Emergency Management, analyzed the vulnerabilities in 20-, 50-, 100-, and 200-year flood zones.

To complete this analysis the SHMPAT used the state facility database to calculate the total amounts of the state's vulnerability both in value and total facilities by county. The tables below show the values and facility number estimate totals for inland and coastal flooding. Some counties only have information for facilities in the 100-year floodplain. Counties in the table below that have only one row have no facilities in the 500-year floodplain.

After the analysis, the risk assessment SHMPAT sub-group found that the county with the most vulnerability in terms of total structures for 100-year floodplain is Miami-Dade County with 1,048 structures. Palm Beach County has the most structures in the 500-year floodplain with 612. For values, Broward County has $5.085 billion at risk within the 100-year floodplain and Miami-Dade has $5.710 billion within the 500-year floodplain. Figure 3.10 shows the range of facility values within 100-year and 500-year inland floodplains. A detailed breakdown of facilities and values, by county, can be found in **Appendix C: Risk Assessment Tables**.

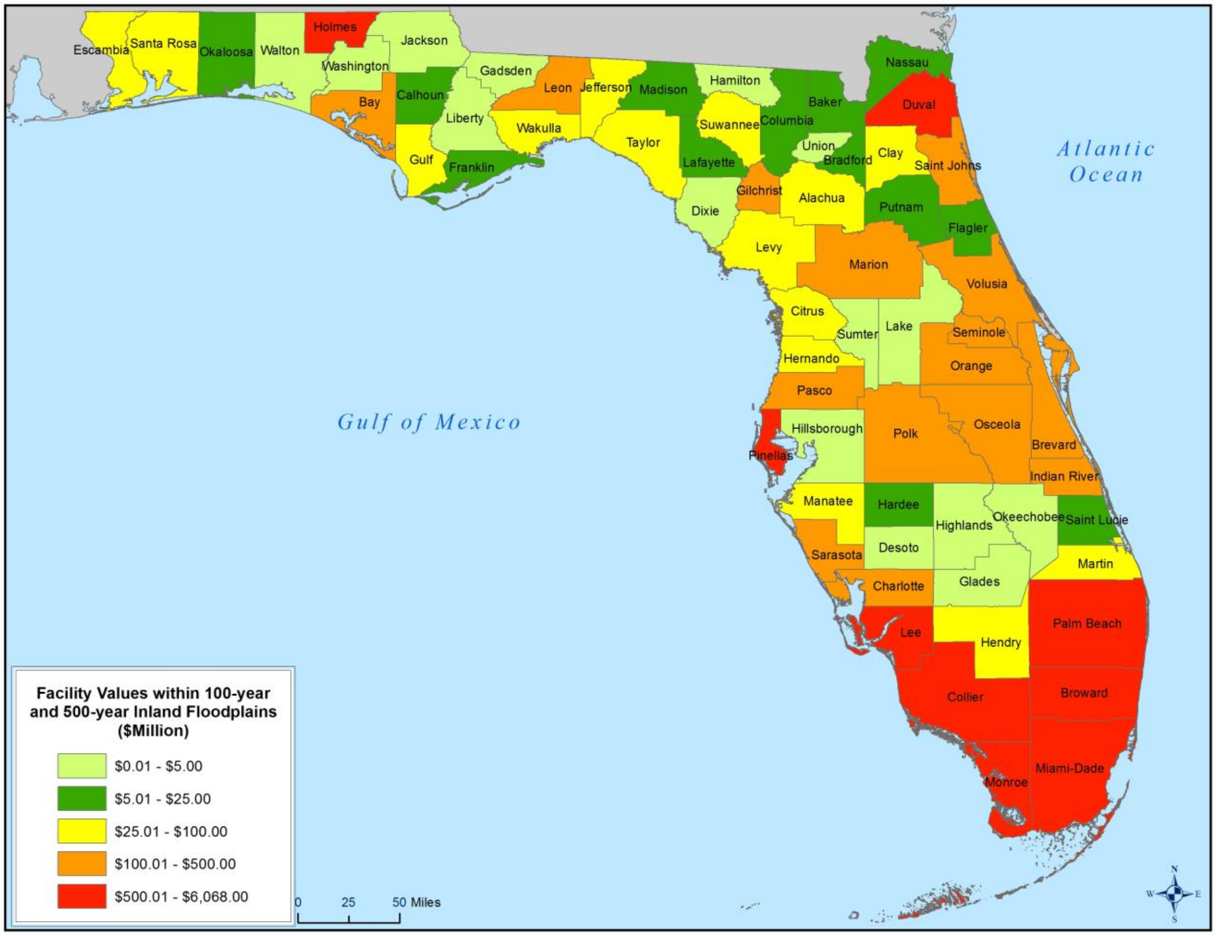

Figure 3.10 Facility Values within 100-Year and 500-Year Inland Floodplains[57]

Coastal Flooding Vulnerability Analysis for State Facilities

For this section, the SHMPAT had to identify the specific counties within the state that were perceived to be vulnerable to the effects of coastal flooding and their individual levels of vulnerability.

Using the state facility database provided by DFS, the SHMPAT identified which facilities lay within coastal flood depth zones. Summarizing the facilities by total counts and insured values within the zones provided estimates of dollar vulnerability by county. This approach allowed the SHMPAT to identify an overall view of the state's vulnerability to this hazard by county. Specific totals of the number of state facilities and their vulnerability within each county can be found in the tables below.

The risk assessment SHMPAT sub-group chose to evaluate two categories of hurricanes for potential state facilities at risk: Category 2 and 5. The vulnerability analysis and determining the exposure value for coastal flooding was based on the Sea, Lake and Overland Surge from

[57] Map based on data obtained from Hazus-MH 2.1 modeling and analysis.

Hurricanes (SLOSH) maps. Counties not at risk to storm surge have been omitted from the analysis. Table 3.17 and Table 3.18 summarize all facility types that could be affected by some level of surge, and their combined value for the different strength hurricanes. A detailed breakdown by county, facility type, value, and level of storm surge is available in **Appendix C: Risk Assessment Tables**.

Table 3.17 Summary of Facilities in Storm Surge Areas in a Category 2 Hurricane[58]

County	***Total Facilities***	***Total Value ($Millions)***	***County***	***Total Facilities***	***Total Value ($Millions)***
Bay	5	0.68	Manatee	29	34.66
Brevard	16	24.49	Martin	10	5.01
Broward	314	2092.78	Miami-Dade	561	3914.24
Charlotte	79	440.8	Monroe	196	201.01
Citrus	80	95.45	Nassau	7	11.7
Collier	183	619.16	Okaloosa	4	13.07
Dixie	1	0.03	Palm Beach	43	201.75
Duval	51	307.7	Pasco	19	83.88
Escambia	17	5.55	Pinellas	128	365.51
Flagler	30	13.59	Saint Johns	209	286.31
Franklin	91	15.5	Saint Lucie	24	1.23
Gulf	18	50.38	Santa Rosa	6	14.83
Hernando	4	3.64	Sarasota	37	14.84
Hillsborough	71	656.32	Taylor	6	2.35
Indian River	2	20.66	Volusia	24	75.89
Jefferson	1	0.01	Wakulla	20	1.76
Lee	266	881.88	Walton	5	0.42
Levy	36	19.09			

Table 3.18 Summary of Facilities in Storm Surge Areas in a Category 5 Hurricane[59]

County	***Total Facilities***	***Total Value ($Millions)***	***County***	***Total Facilities***	***Total Value ($Millions)***
Bay	123	141.24	Levy	47	23.72
Brevard	159	603.12	Manatee	89	345.22
Broward	518	3283.54	Miami-Dade	1235	7329.51
Charlotte	163	521.33	Monroe	226	248.26
Citrus	90	98.78	Nassau	43	130.25
Collier	212	822.55	Okaloosa	61	64.28
Dixie	6	8.2	Palm Beach	176	1096.06
Duval	236	952.51	Pasco	43	168.47
Escambia	59	45.51	Pinellas	332	1476.18

[58] Data obtained from Hazus-MH 2.1 modeling and analysis.
[59] Data obtained from Hazus-MH 2.1 modeling and analysis.

County	Total Facilities	Total Value ($Millions)	County	Total Facilities	Total Value ($Millions)
Flagler	56	116.87	Santa Rosa	26	56.92
Franklin	120	37.02	Sarasota	146	467.96
Gulf	55	75.01	St. Johns	248	328.63
Hernando	8	17.94	St. Lucie	38	26.44
Hillsborough	217	1231.75	Taylor	80	37.59
Indian River	36	102.88	Volusia	86	247.04
Jefferson	1	0.01	Wakulla	41	32.13
Lee	622	2222.77	Walton	42	20.01

Figure 3.11 presents an illustration of the values of facilities within each county that are vulnerable to storm surge from a Category 2 hurricane.

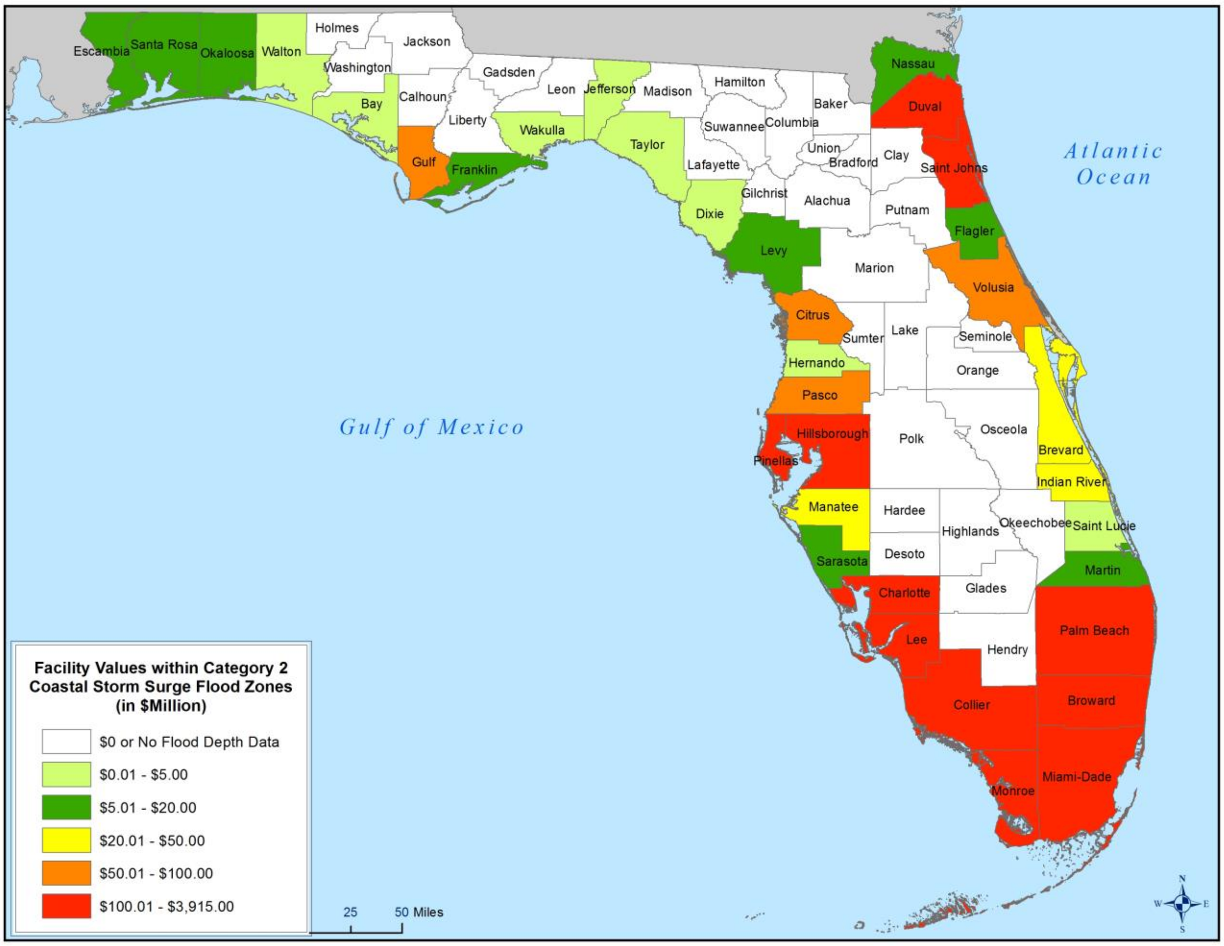

Figure 3.11 Values of Facilities Vulnerable to Storm Surge in a Category 2 Hurricane

Figure 3.12 presents an illustration of the values of facilities within the county that are vulnerable to storm surge from a Category 5 hurricane.

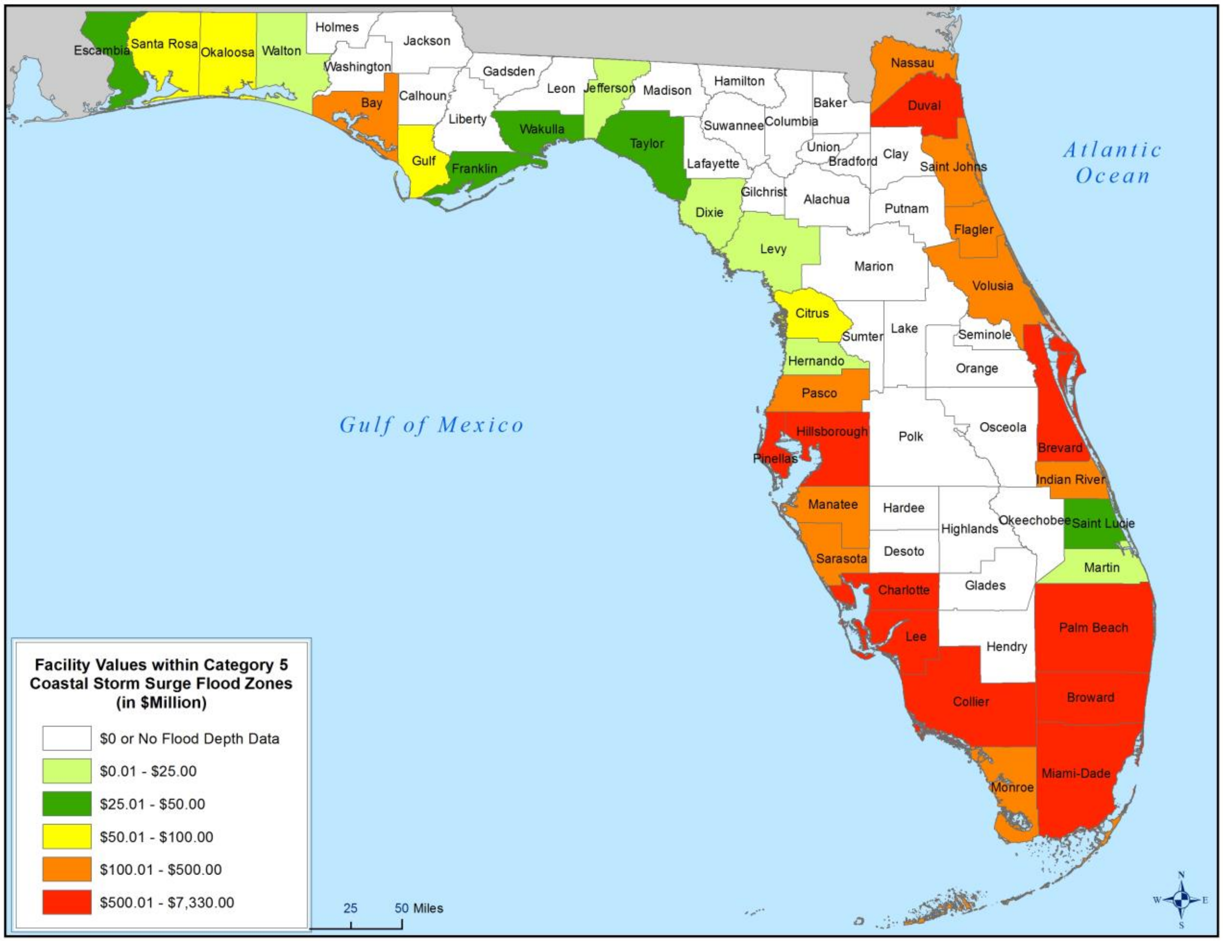

Figure 3.12 Values of Facilities Vulnerable to Storm Surge in a Category 5 Hurricane

X. Estimating Potential Losses by Jurisdiction

The SHMPAT conducted loss estimation on flooding during the 2013 plan update and revision process, the estimation was enhanced and expanded from the 2010 plan.

Flood Loss Estimation

Using DFIRM and updated flood data, along with the modeling approach as described herein, losses were estimated using return period events of 100 years and 500 years. With this approach, annualized losses were calculated by accounting for the losses from different return period events and their respective annual probabilities of occurrence (e.g., the annual probability of observing a 100-year flood is 1 percent).

Table 3.19 provides annualized loss estimates of residential buildings, commercial buildings, medical buildings, educational buildings, and governmental buildings per parcel data from coastal and riverine flooding.

Table 3.19 Estimated Flooding Structures Loss Summary[60]

County	***Total Value of Structures ($Millions)***	***Estimated Annualized Loss ($Thousands)***	***County***	***Total Value of Structures ($Millions)***	***Estimated Annualized Loss ($Thousands)***
Alachua	359,246	66	Lafayette	104,219	12
Baker	75,662	9	Lake	1,955,429	347
Bay	4,991,283	889	Lee	48,768,144	7,369
Bradford	305,306	48	Leon	1,735,991	255
Brevard	9,850,376	1,257	Levy	409,560	71
Broward	118,862,468	21,414	Liberty	39,541	3
Calhoun	129,412	21	Madison	151,489	17
Charlotte	7,714,062	1,444	Manatee	8,527,956	1,195
Citrus	3,543,443	612	Marion	1,945,702	274
Clay	2,118,391	349	Martin	9,508,097	366
Collier	26,125,980	2,484	Miami-Dade	126,721,149	20,460
Columbia	528,140	77	Monroe	7,382,879	1,328
Desoto	252,210	28	Nassau	2,018,218	239
Dixie	316,527	51	Okaloosa	3,011,188	538
Duval	8,979,606	1,359	Okeechobee	310,188	38
Escambia	3,447,723	624	Orange	4,663,496	745
Flagler	2,481,339	267	Osceola	8,534	1
Franklin	852,137	157	Palm Beach	105,096,212	4,607
Gadsden	129,904	18	Pasco	16,892,868	2,578
Gilchrist	169,518	23	Pinellas	36,327,523	5,807
Glades	218,760	29	Polk	4,123,540	758
Gulf	712,538	126	Putnam	948,042	162
Hamilton	122,499	14	Santa Rosa	2,090,992	345
Hardee	120,222	9	Sarasota	15,443,878	1,181
Hendry	984,148	134	Seminole	1,688,848	247
Hernando	1,589,419	248	St. Johns	33,892,040	5,294
Highlands	715	51	St. Lucie	5,510,329	957
Hillsborough	26,024,013	4,873	Sumter	2,109	0
Holmes	223,471	28	Suwannee	256,670	33
Indian River	5,879,063	979	Union	34,229	2
Jackson	476,667	70	Wakulla	584,850	100
Jefferson	124,367	13	Washington	357,667	42

[60] Results obtained via GIS analysis of aggregated data sources.

National Climatic Data Center Flooding Loss Estimation

Based on data collected by the NCDC, there were 1,014 flooding events in Florida between January 1993 and April 2012. Total property damages were estimated at $1.5 billion with an additional $972 million in crop-related damages.[61]

The table below provides statistical data on flooding events that have occurred in Florida from 1993 through April 2012. The statistics give an overview of how frequently each event occurs, as well as the dollar value of damages caused by each type of flood event. Property damage caused by flooding events costs an average of $168 million per year, and damage to crops average an additional $104 million per year.

Data from the National Climatic Data Center details the historical flooding in the state. Table 3.20 shows a breakdown of the types of floods and associated annualized losses that have occurred in Florida since 2008.

Table 3.20 Flood Events in the State by Type (2008-2012) [62]

Type of Flood	*NCDC Reports*	*Average per Year*	*Annualized Property Loss*	*Annualized Crop Loss*
Coastal Flood	10	2	$9,264,000	$0
Flash Flood	58	11.6	$23,392,400	$0
Flood	60	12	$30,547,400	$5,002,400
Total	128	25.6	$63,203,800	$5,002,400

Note: Multiple reports that occurred on the same day were counted as one event

XI. Estimating Potential Losses of State Facilities

The SHMPAT conducted loss estimations on flooding in 2004 during the original plan development process. During the 2013 plan update and revision process, this analysis was updated. The following section provides a detailed description of the estimates of potential losses to state facilities from flooding.

The State of Florida is extremely vulnerable to flooding—riverine and coastal—placing billions of dollars in property at risk. Over $25 billion in state-owned facilities are at risk for damage due to flooding.

[61] http://www.ncdc.noaa.gov/stormevents/
[62] National Climatic Data Center (NCDC) Storm Events database, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Inland Flooding Loss Estimation for State Facilities

Table 3.21 shows the total exposure and estimated losses from inland (riverine) flooding of state-owned facilities by agency, for all counties that have facilities within 100-year and 500-year inland floodplains.

Table 3.21 Inland Flooding Loss Estimation for State Facilities[63]

County	Facilities In Floodplains ($Millions)	Annualized Losses ($Thousands)	County	Facilities In Floodplains ($Millions)	Annualized Losses ($Thousands)
Alachua	39.69	8	Lee	570.85	87
Baker	5.2	1	Leon	295.15	46
Bay	106.78	19	Levy	91.81	18
Bradford	17.09	3	Liberty	0.08	0
Brevard	232.83	30	Madison	7.49	1
Broward	5,511.32	1,038	Manatee	93.67	14
Calhoun	7.43	1	Marion	181.92	29
Charlotte	196.3	38	Martin	88.33	4
Citrus	94.82	17	Miami-Dade	6,067.62	1,000
Clay	30.3	5	Monroe	1,300.17	236
Collier	739.24	70	Nassau	24.67	3
Columbia	5.37	1	Okaloosa	11.07	2
Desoto	3.19	1	Okeechobee	2.28	0
Dixie	0.19	0	Orange	268.43	45
Duval	562.43	87	Osceola	271.46	44
Escambia	41.97	8	Palm Beach	4,294.99	195
Flagler	12.9	1	Pasco	327.1	51
Franklin	8.5	2	Pinellas	844.94	137
Gadsden	2.12	0	Polk	158.92	31
Gilchrist	111.64	18	Putnam	5.29	1
Glades	2.17	0	Santa Rosa	78.67	13
Gulf	60.66	11	Sarasota	348.9	27
Hamilton	0.01	0	Seminole	129.43	20
Hardee	23.97	3	St. Johns	341.95	55
Hendry	59.97	10	St. Lucie	6.5	1
Hernando	42.69	8	Sumter	4.73	0
Highlands	1.26	0	Suwannee	31.05	5
Hillsborough	1.25	0	Taylor	69.23	10
Holmes	778.65	144	Union	1.53	0
Indian River	111.08	19	Volusia	270.5	46
Jackson	4.73	1	Wakulla	41.79	8

[63] Results obtained via GIS analysis of aggregated data sources.

County	Facilities In Floodplains ($Millions)	Annualized Losses ($Thousands)	County	Facilities In Floodplains ($Millions)	Annualized Losses ($Thousands)
Jefferson	43.77	8	Walton	2.45	0
Lafayette	10.32	2	Washington	2.96	1
Lake	0.29	0			

Coastal Flooding Loss Estimation for State Facilities

The State of Florida continues to be extremely vulnerable to coastal flooding. Over $22 billion in state-owned facilities are at risk for damage due to coastal flooding. Table 3.22 shows the total exposure and estimated losses from coastal flooding to state-owned facilities.

Table 3.22 Coastal Flooding Loss Estimation for State Facilities[64]

County	Total Value of Facilities ($Millions)	Annualized Losses ($Thousands)	County	Total Value of Facilities ($Millions)	Annualized Losses ($Thousands)
Bay	141.92	41.06	Manatee	379.88	0
Brevard	627.61	110.75	Martin	5.01	0
Broward	5,376.32	0	Miami-Dade	11,243.75	0
Charlotte	962.13	146.9	Monroe	449.27	152.1
Citrus	194.23	30.26	Nassau	141.95	18.4
Collier	1,441.71	363.13	Okaloosa	77.35	0
Dixie	8.23	2.08	Palm Beach	1,297.81	0
Duval	1,260.21	161.96	Pasco	252.35	0
Escambia	51.06	22.54	Pinellas	1,841.69	446.12
Flagler	130.46	29.53	Santa Rosa	71.75	0
Franklin	52.52	10.48	Sarasota	482.8	0
Gulf	125.39	20.1	St. Johns	614.94	45.23
Hernando	21.58	17.27	St. Lucie	27.67	14.87
Hillsborough	1,888.07	443.2	Taylor	39.94	0
Indian River	123.54	0	Volusia	322.93	0
Jefferson	0.02	0	Wakulla	33.89	0
Lee	3,104.65	0	Walton	20.43	0
Levy	42.81	14.61			

Note that values for losses in this table are extremely low. All annualized losses are under $1,000. The NCDC storm events database did not include event reports for coastal flooding for Hurricane Erin in 1995, and the NCDC storm events data for coastal flooding begins in 1993, which postdates the occurrence of Hurricane Andrew in 1992. The lack of comprehensive loss data for these major hurricanes, Category 2 and Category 5 storms respectively, skews the annualized loss amounts to low values.

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[64] Results obtained via GIS analysis of aggregated data sources.

XII. Public Facilities Flood Mitigation Initiative

As of October 1, 2014 new information regarding the vulnerability of state facilities has been added to Appendix R of this plan. The Public Facilities Flood Mitigation Initiative used data from the new Florida State Owned Lands and Records Information System (FL-SOLARIS) created by the Department of Environmental Protection and Department of Management Services. Moreover, information developed through this initiative will facilitate site-specific risk assessments for existing state facilities as well as assist in the process of choosing locations for future facilities. Information on this initiative can be found in Appendix R as well as online at http://www.floridadisaster.org/Mitigation/index.htm

3.3.2 Tropical Cyclones Profile

I. Tropical Cyclone Description and Background Information

In general terms, a hurricane is a cyclone. A cyclone is any closed circulation developing around a low-pressure center in which the wind rotates counterclockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. They act as a safety-value that limits the build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole ward latitudes.

As a developing center moves over warm water, pressure drops (measured in millibars or inches of Mercury) in the center of the storm. As the pressure drops, the system becomes better organized and the winds begin to rotate around the low pressure, pulling the warm and moist ocean air. It is this cycle that causes the wind (and rain) associated with a tropical cyclone. If all of the conditions are right (warm ocean water and favorable high altitude winds), the system could build to a point where it has winds in excess of 155 miles per hour and could become catastrophic if it makes landfall in populated areas. The following are descriptions of the three general levels of development for tropical cyclones:

- Tropical depression: The formative stages of a tropical cyclone in which the maximum sustained (1-min mean) surface wind is < 38 mph.
- Tropical storm: A warm core tropical cyclone in which the maximum sustained surface wind (1-min mean) ranges from 39–73 mph.
- Hurricane: A warm core tropical cyclone in which the maximum sustained surface wind (1-min mean) is at least 74 mph.

Table 3.23 displays the Saffir-Simpson scale that is used to define and describe the intensity of hurricanes.

Table 3.23 Saffir- Simpson Hurricane Wind Scale[65]

Category	*Millibars*	*Inches of Mercury*	*Winds (MPH)*
1	> 980	28.94	74–95
2	965–979	28.91–28.5	96–110
3	945–964	28.47–27.91	111–129
4	920–944	27.88–27.17	130–156
5	< 920	< 27.17	> 157

Storm Surge

Storm surge is perhaps the most dangerous aspect of a hurricane. It is a phenomenon that occurs when the winds and forward motion associated with a hurricane pile water up in front, as it moves toward shore. Storm surge heights, wind speed, fetch length, pressure and associated waves, are dependent upon the configuration of the continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). These as well as other factors can affect storm surge height and wave height. A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water in close proximity to the shoreline, tends to produce a lower surge but higher and more powerful storm waves.

This is the situation along most of the Atlantic Ocean side of the state. However, the Gulf Coast of Florida has a long, gently sloping shelf and shallow water depths, and can expect a higher surge but smaller waves (up to 38 feet in the Apalachee Bay area of Florida). South Miami-Dade County is somewhat of an exception to these general rules due to Biscayne Bay (wide shelf and shallow depth). In this instance, a hurricane has a larger area to “pile up” water in advance of its landfall. Nowhere is the threat of storm surge more prevalent than in the Apalachee Bay Region. The shallow depths of the Big Bend region of the state extend out into the Gulf of Mexico, creating a naturally enclosed pocket.

The National Hurricane Center forecasts storm surge using the SLOSH model, which stands for sea, lake, and overland surges from hurricanes. The model is accurate to within 20 percent. The inputs include the central pressure of a tropical cyclone, storm size, the forward motion, its track, and maximum sustained winds. Local topography, bay and river orientation, depth of the sea bottom, astronomical tides, as well as other physical features are taken into account in a predefined grid referred to as a “SLOSH basin.” Overlapping basins are defined for the southern and eastern coastlines of the continental U.S.

The final output from the SLOSH model run will display the maximum envelope of water, or MEOW, that occurred at each location. To allow for track or forecast uncertainties, usually several model runs with varying input parameters are generated to create a map of MOMs, or maximum of maximums. For hurricane evacuation studies, a family of storms with representative tracks for the region with varying intensity, eye diameter, and speed are modeled

[65] http://www.nhc.noaa.gov/aboutsshws.php

to produce worst-case water heights for any tropical cyclone occurrence. The results of these studies are typically generated from several thousand SLOSH runs. These studies have been completed by U.S. Army Corps of Engineers for several coastal states and are available on their Hurricane Evacuation Studies (HES) website.[66]

The studies include coastal county maps and frequently include analyses for riverine flooding for inland county areas. The State of Florida recently completed an enhanced Regional [Hurricane] Evacuation Study as part of a large-scale mitigation project involving light detection and ranging (LIDAR) data. LIDAR data was incorporated into the SLOSH basin data and was used to subtract the land elevation from the storm surge height to develop the storm tide limits. The resulting data was used to run new SLOSH models. The result of this storm surge hazard analysis is graphically portrayed in the Storm Tide Atlas, which illustrates the storm tide limits based on the maximum storm surge for land falling categories 1, 2, 3, 4 and 5. More information and potential impacts due to storm surge can be found in **Section 3.3.1: Flood Hazard Profile**.

Tornadoes

Tornadoes are a significant threat during severe storms and hurricanes and have been associated with the majority of tropical cyclones in Florida. Tornadoes tend to develop on the leading northwest edge (or the "dirty side") of hurricanes. The great majority of tornadoes that occur with hurricanes are of a weaker variety from those that occur in the Midwest. In recent years, much of the wind damage in hurricanes attributed to tornadoes has, in reality, been the result of "down bursts."

II. Geographic Areas Affected by Tropical Cyclones

The entire State of Florida is subject to the effects of a hurricane, but some areas are much more vulnerable than others. This is due to its large areas of coastal shorelines on the Atlantic and Gulf Coast. The average diameter of hurricane force winds is easily 100 miles, and tropical storm force winds extend out 300–400 miles;[67] while at the same time no point within Florida is more than 70 miles from the Atlantic Ocean/Gulf of Mexico. Maps throughout this section illustrate that all parts of Florida are and can be impacted by hurricanes at different levels over time. Hurricanes are random in distribution, so there is no specific region of Florida that is more at risk than another. However, the coastal areas are more vulnerable to the effects that a hurricane can produce due to their urban development, location, and the storm surge that can be created.

III. Historical Occurrences of Tropical Cyclones

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66 http://chps.sam.usace.army.mil/ushesdata/heshome.htm
67 http://www.wxresearch.org/family/pg5.html

Table 3.24 lists the hurricanes and tropical storms that have occurred in the state during the past 10 years.

Table 3.24 Previous Tropical Cyclone Occurrences in the Past 10 Years[68]

Name	***Date***	***Name***	***Date***
Bill	June 30, 2003	Rita	September 24, 2005
Charley	August 13, 2004	Wilma	October 23, 2005
Frances	September 5, 2004	Fay	August 18–23, 2008
Ivan	September 16, 2004	Ike	September 7, 2008
Jeanne	September 26, 2004	Gustav	October 27, 2008
Dennis	July 10, 2005	Beryl	May 28–30, 2012
Katrina	August 25, 2005	Debby	June 24–25, 2012

Table 3.25 details events of notable significance that fall outside the timeframe for inclusion in Table 3.24.

Table 3.25 Significant Events beyond 10 Years

Date	***Information***
September 16–17, 1928 Okeechobee Hurricane	At noon on September 16, 1928, Florida received word of a hurricane moving north through the Caribbean region. This Category 4 hurricane made landfall near Palm Beach with a central pressure of 929 millibars. The center passed near Lake Okeechobee. Many people in the Lake Okeechobee area gathered on large barges in the lake while 500 others sought shelter in nearby hotels. The storm hit at 6:00 p.m. with 160 mph winds, causing the lake waters to spill out into the low-lying fields. Dikes collapsed, nearby houses were swept away by severe flooding, and hundreds drowned in the onrushing waters. So many people died that rescue workers were forced to simply tow long lines of bodies along behind their boats. At least 700 victims were buried in a mass grave at West Palm Beach. Officials estimate as many as 2,500 people may have died around the lake, making it the second worst hurricane in U.S. history. An additional 312 people died in Puerto Rico, and 18 more were reported dead in the Bahamas. Damage throughout the region was estimated at between $25 million and $150 million and $50 million in Puerto Rico. After the storm, the government helped begin a $5 million flood control program for the Lake Okeechobee-Everglades region, building an 85-mile long levee, 34–38 feet high, along the southern lakeshore.
August 31–September 8, 1935 Labor Day Hurricane	The Labor Day hurricane was first given notice when it reached Turks Island in the southern Bahamas chain. Warnings were posted in Florida from Fort Pierce to Fort Myers on August 21. The full force of the storm, however, hit the Florida Keys. With winds in excess of 200 miles per hour, the storm passed over the Florida Keys on September 2 with a minimum barometric pressure of 26.35 inches. This hurricane is considered to be one of the most severe hurricanes ever recorded in Florida. The Keys, several small islands south of the Florida peninsula, were linked to the mainland by the Florida

[68] http://www.ncdc.noaa.gov/oa/ncdc.html

Date	Information
	East Coast Railway, which had tracks running across a stone causeway 30 feet above the water. On Labor Day, the last train started off for Key West with vacationers returning home from the mainland. As the train began to cross the Long Key viaduct over open water, a 20-foot wave swept over the path, overturned the ten-car train, and swept away both tracks and the bridge. One hundred and fifty people died from the train accident itself. Other destruction was caused by 200 mph winds, and the islands were cut off from the mainland for three days. Relief and supply boats as well as rescue workers finally reached the isolated islands. Damage was totaled at nearly $6 million. Three relief work camps, inhabited by veterans of World War I, were destroyed. The Red Cross estimated that 408 lives were lost. The original construction of the causeway had dammed natural sea channels through the islands into Florida Bay, piling waters up around piers and creating strong undertows that eroded shore supports for the causeway. It forced unusually high waves onto the southern key coast as well. A new roadway has since been constructed—a series of bridges instead of a solid causeway to remedy the problem.
August 24, 1992 Hurricane Andrew	Hurricane Andrew made a memorable landfall in South Miami-Dade County, causing an estimated $26.5 billion in damages. Andrew produced approximately 7 inches of rain, 165 mph sustained winds, a maximum storm tide of 16 feet, and a total of 96 deaths (including those in Louisiana). In all, Andrew destroyed 25,000 homes and significantly damaged more than 100,000 others in South Florida. Two weeks after the hurricane, the U.S. military deployed nearly 22,000 troops to aid in the recovery efforts, the largest military rescue operation in U.S. history. When Hurricane Andrew hit southeast Miami-Dade County, flying debris in the storm's winds knocked out most ground-based wind measuring instruments, and widespread power outages caused electric-based measuring equipment to fail. The winds were so strong that many wind-measuring tools were incapable of registering the maximum winds. Surviving wind observations and measurements from aircraft reconnaissance, surface pressure, satellite analysis, radar, and distribution of debris and structural failures were used to estimate the surface winds. Though originally classified as a Category 4 storm, extensive post-impact research led to the reclassification of Andrew to a Category 5 storm in 2002.
August 31–September 3, 1998	Hurricane Earl formed from a strong tropical wave that emerged from the west coast of Africa on August 17. Persistent convection accompanied the wave as it moved westward across the tropical Atlantic. The tropical depression became Tropical Storm Earl while centered about 500 nautical miles south-southwest of New Orleans, Louisiana on August 31. After briefly reaching Category 2 status, Earl made landfall near Panama City, Florida as a Category 1 hurricane on September 3. The strongest winds remained well to the east and southeast of the center, which resulted in the highest storm surge values in the Big Bend area of Florida, well away from the center. The tropical cyclone weakened to below hurricane strength soon after making

Date	*Information*
	landfall, and became extra-tropical on September 3 while moving northeastward through Georgia. The deepest convection became well removed from the center by this time and the strongest winds were located over the Atlantic waters off the U.S. southeast coast. The extra-tropical cyclone moved off the mid-Atlantic coast on September 4, crossed over Newfoundland September 6 and was tracked across the North Atlantic until being absorbed by a larger extra-tropical cyclone (formerly Hurricane Danielle) on September 8. This hurricane was responsible for two deaths in Panama City. The National Flood Insurance Program reported $21.5 million of insured losses in Florida.

IV. Probability of Future Tropical Cyclone Events

As the population grows, the number of those who have experienced the impact of a major hurricane declines. Approximately 33 percent of the total state population lives within 20 miles of the coast. The majority of the state's residents are not experienced with hurricanes. Based on a study covering the years 1980–2003 in an article published in *Planning*, a national magazine for professional planners, Florida's roads and infrastructure have not kept pace with its rapid growth over the last 30 years. This is a limiting factor for the state's overall evacuation strategy.[69]

Of the state's 67 counties, 35 have coastlines bordering either the Atlantic Ocean or the Gulf of Mexico. These counties comprise approximately 1,350 miles of general coastline and 8,436 miles of tidal inlets, bays, and waterways.

In addition, contributing to the state's vulnerability to tropical cyclones is the proximity of the Atlantic Ocean or the Gulf of Mexico, coupled with the generally low coastal elevations and the fact that 75 percent of the state's population resides in the 35 coastal counties.

Between 1906 and 2012, there have been 27 major (Category 3 or higher) hurricanes that have affected the state. Of all hurricanes that have threatened the state this century, 68 have made landfall within the state and the majority have been Category 1 hurricanes. Generally, the lower intensity hurricanes have made landfall in the northwest portion of the state.

The vulnerability of the state to hurricanes varies with the progression of the hurricane season. Early and late in the season (June and October), the region of maximum hurricane activity is in the Gulf of Mexico and the western Caribbean. Most of those systems that move into Florida approach the state from the south or southwest, entering the keys or along the west coast. Mid-season (August and most of September), tropical cyclones develop off the coast of Africa. These systems are known as Cape Verde Storms and approach the state from the east or southeast.

[69] http://www.intercom.net/~terrypl/evacuation-Planning.html

V. Tropical Cyclone Impact Analysis

Hurricanes will negatively affect the State of Florida with a variety of impacts:

- Severe coastal flooding
- Significant building damage from flooding and from high winds. Roofing is particularly susceptible to damage
- Human and animal deaths and injuries from flooding and from windblown debris
- Extreme disruptions to the transportation networks and to communications
- Requirements for sheltering, as well as humanitarian supplies (e.g., food, water, blankets, first aid)
- Termination of utility services, especially loss of electricity and contamination of the drinking water supplies
- Extraordinary financial impact for the immediate response and long-term recovery
- Damage to critical infrastructure that requires long-term recovery.

VI. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on information provided by county LMS plans. The local risk assessment data provided the SHMPAT with a solid baseline for the overall state vulnerability analysis. Based on the LMS plans in the State of Florida,

Figure **3.13** displays the jurisdictional rankings for the tropical cyclone hazard.

- High-risk Jurisdictions 60
- Medium-high–risk Jurisdictions 4
- Medium-risk Jurisdictions 3

- Low-risk Jurisdictions 0

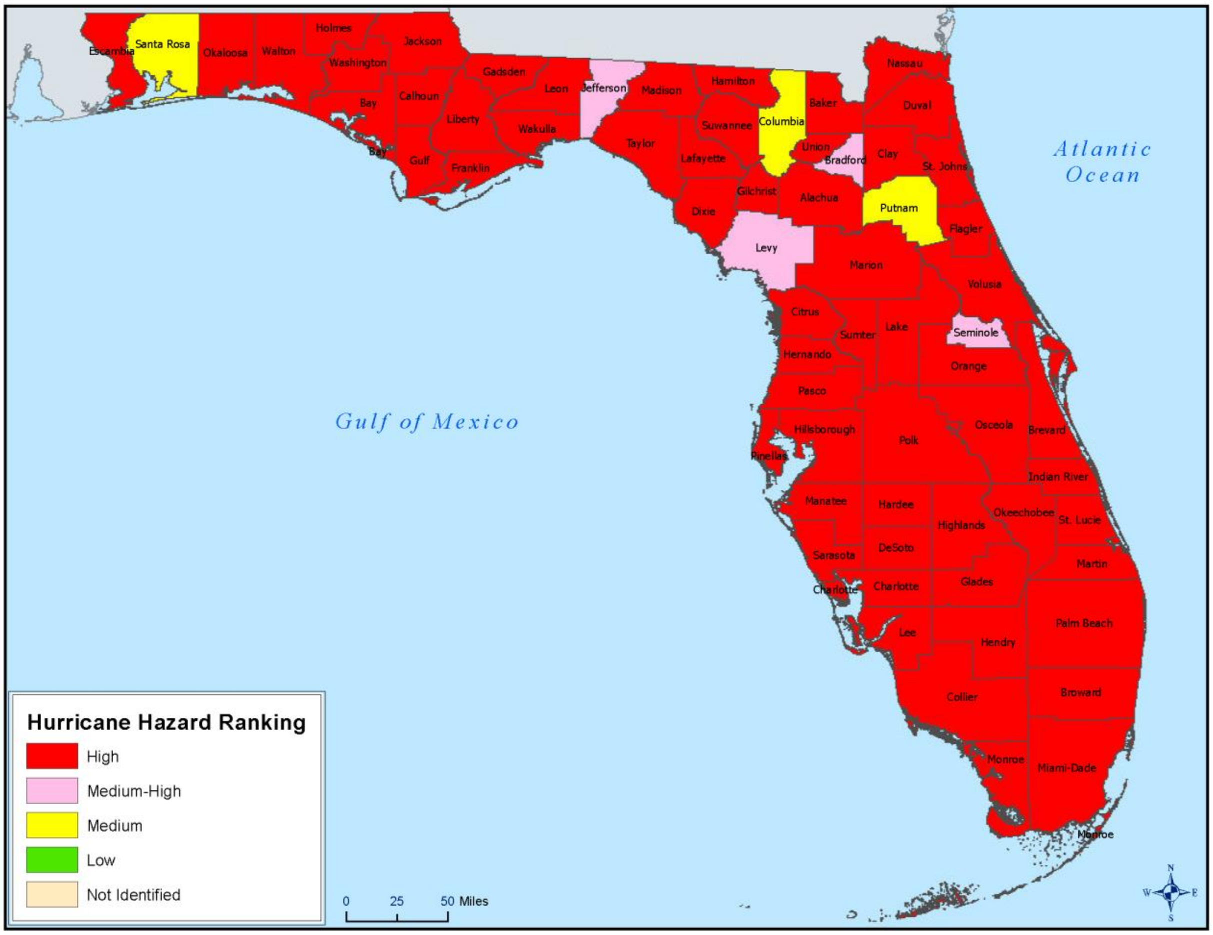


Figure 3.13 Tropical Cyclone Hazard Ranking by County

VII. Tropical Cyclone Hazard Vulnerability Analysis by Jurisdiction

Figure 3.14 contains a summary of the probability of occurrence that each county has based on geographic location for a return period of 20, 50, 100 or 200 years for Category 2 hurricane. Detailed impacts to structure types, based on the return period for Category 2 can also be found in **Appendix C: Risk Assessment Tables**. The classification of the winds into a Category 2 hurricane is based on wind speeds from the peak gusts wind layer for Florida from Hazus-MH 2.1.

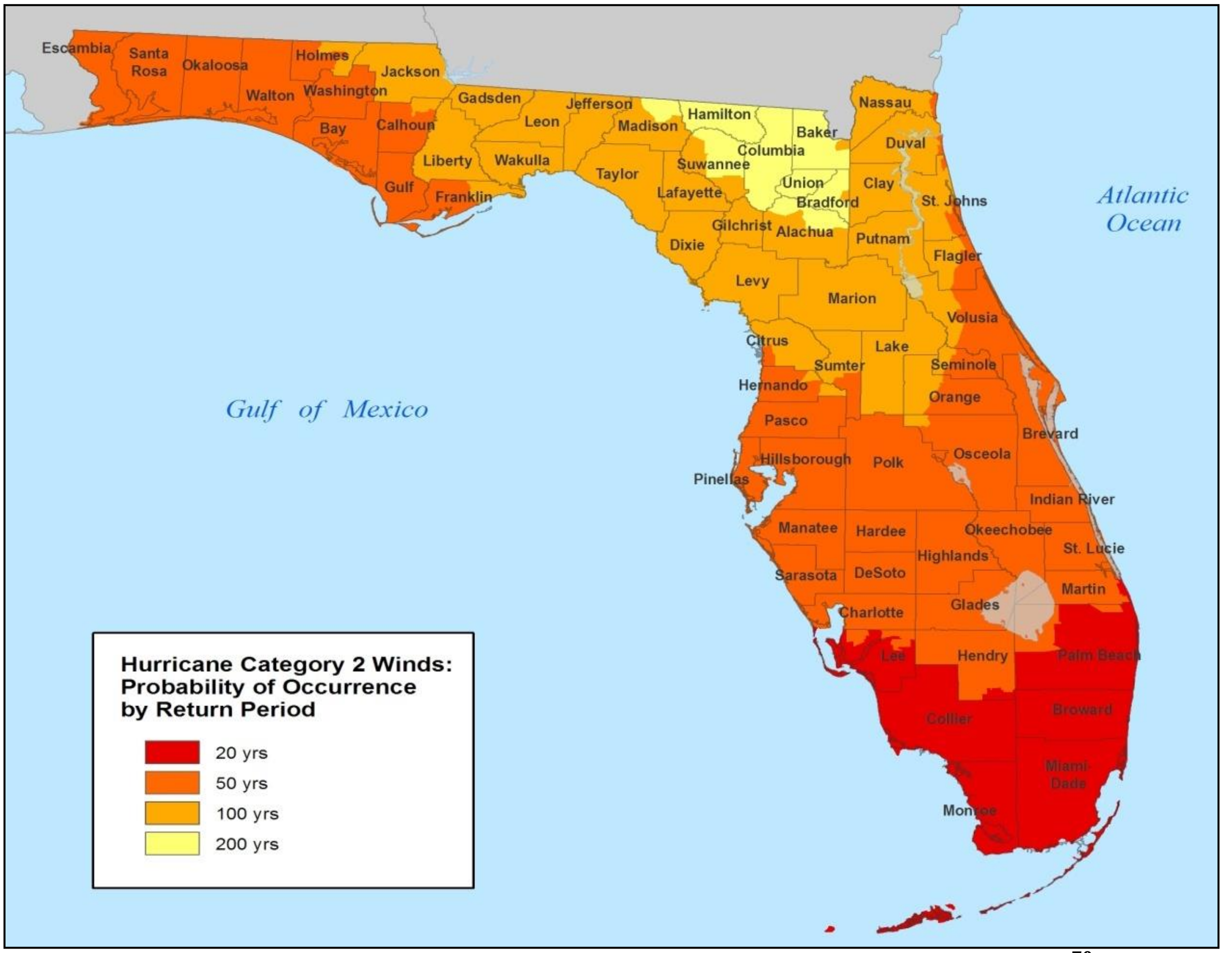


Figure 3.14 Category 2 Hurricane Winds Probability of Occurrence[70]

[70] This map has not changed since the 2010 update. No significant changes to data would affect the existing map outputs.

Figure 3.15 contains a summary of the probability of occurrence that each county has based on geographic location for a return period of 200, 500, 1,000 or greater than 1,000 years for a Category 5 hurricane. Detailed impacts to structure types, based on the return period for Category 5 can also be found in **Appendix C: Risk Assessment Tables**. The classification of the winds into a Category 2 hurricane is based on wind speeds from the peak gusts wind layer for Florida from Hazus-MH 2.1.

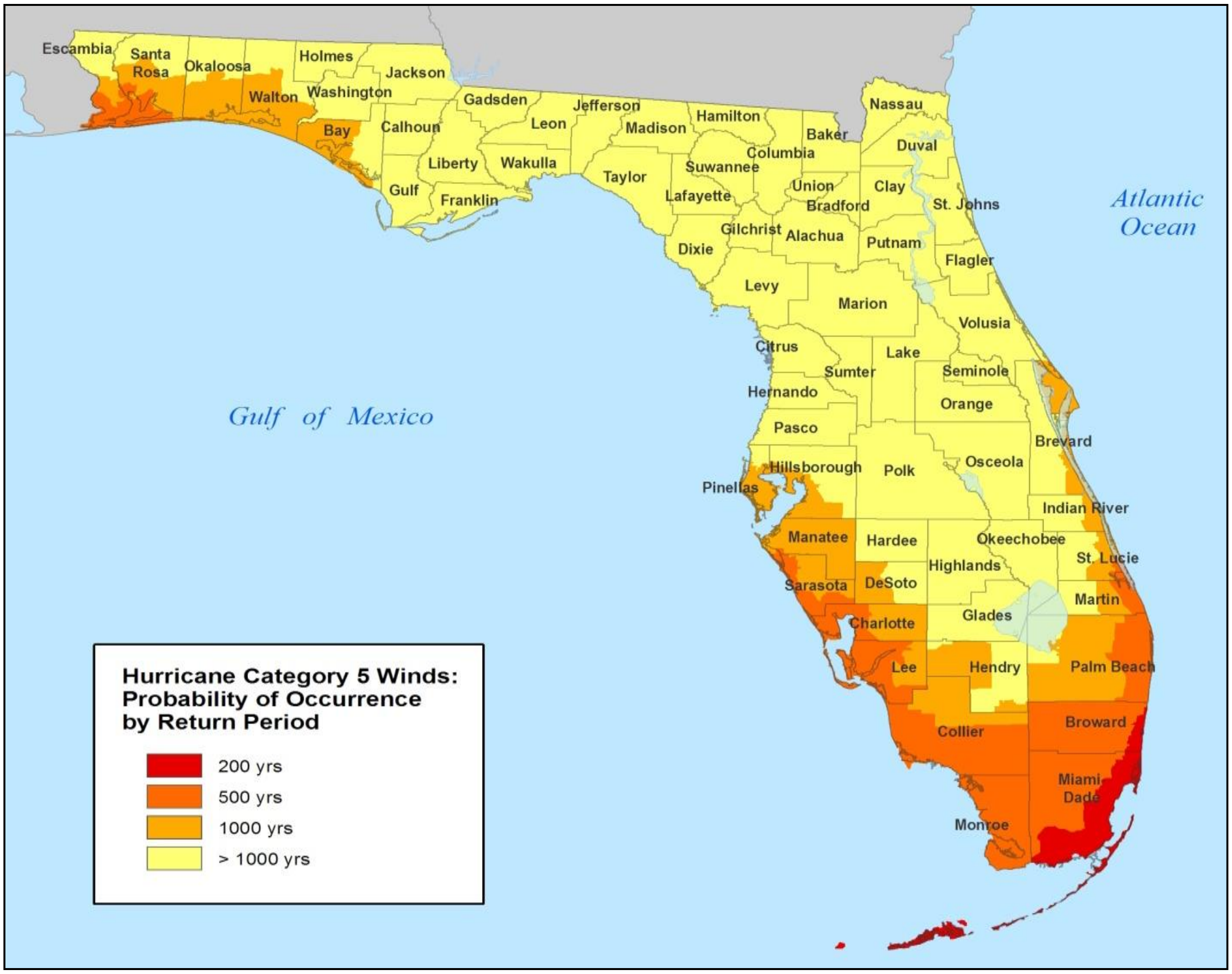


Figure 3.15 Category 5 Hurricane Winds Probability of Occurrence[71]

VIII. Assessing Vulnerability of State Facilities

In this section, the state's vulnerability to hurricanes is evaluated. The SHMP conducted a vulnerability analysis on hurricanes in 2004 during the original plan development process, which was updated in 2007, 2010 and now 2013.

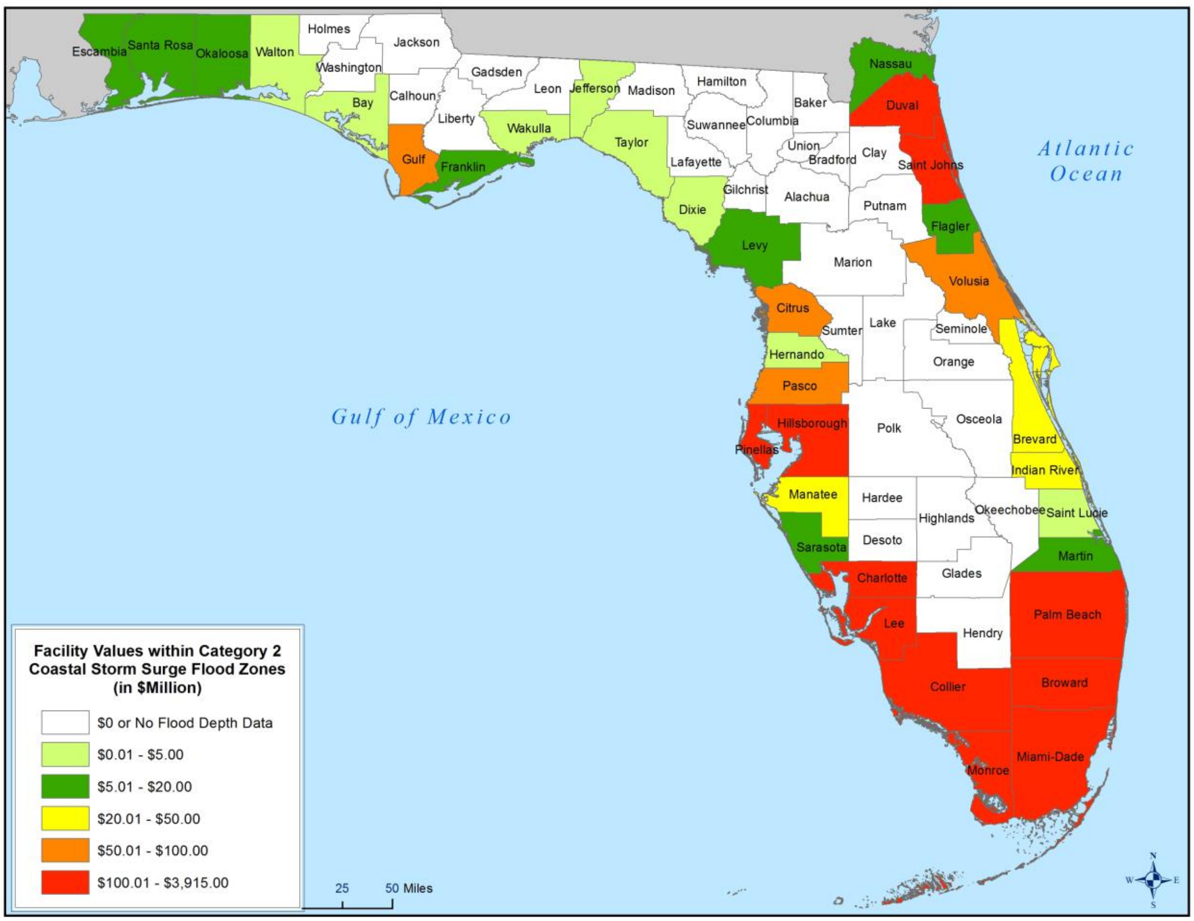
[71] This map has not changed since the 2010 update. No significant changes to data that would affect the existing map our outputs.

The risk assessment SHMPAT sub-group chose to evaluate two categories, 2 and 5, of hurricanes for potential state facilities at risk. The vulnerability analysis and determining the exposure value for coastal flooding was based on SLOSH maps. Not all counties are at risk to coastal flooding from storm surge. Using the state facility database provided by the DFS, the risk assessment SHMPAT sub- group identified which facilities lay within return period zones for hurricanes of categories 2 and 5 by overlaying them in a GIS. Summarizing the facilities by total counts and insured values within the zones provided estimates of dollar vulnerability by county.

The risk assessment SHMPAT sub-group determined that all counties within Florida are vulnerable to the effects of Category 2 and 5 hurricanes. Therefore, all of the 20,287 state-owned facilities and their insured values are currently exposed to potentially damaging winds from both Category 2 and 5 hurricanes.

Figure **3.16 Value of State Facilities Vulnerable to a Category 2 Hurricane**

and Figure 3.17 indicate the range of state-owned facilities in each county that are exposed to potentially damaging winds from hurricanes at the category 2 and 5 levels,



respectively, and the value of the facilities. A detailed breakdown of the types and values of facilities, by county and specified return period can be found in **Appendix C: Risk Assessment Tables**.

Figure 3.16 Value of State Facilities Vulnerable to a Category 2 Hurricane[72]

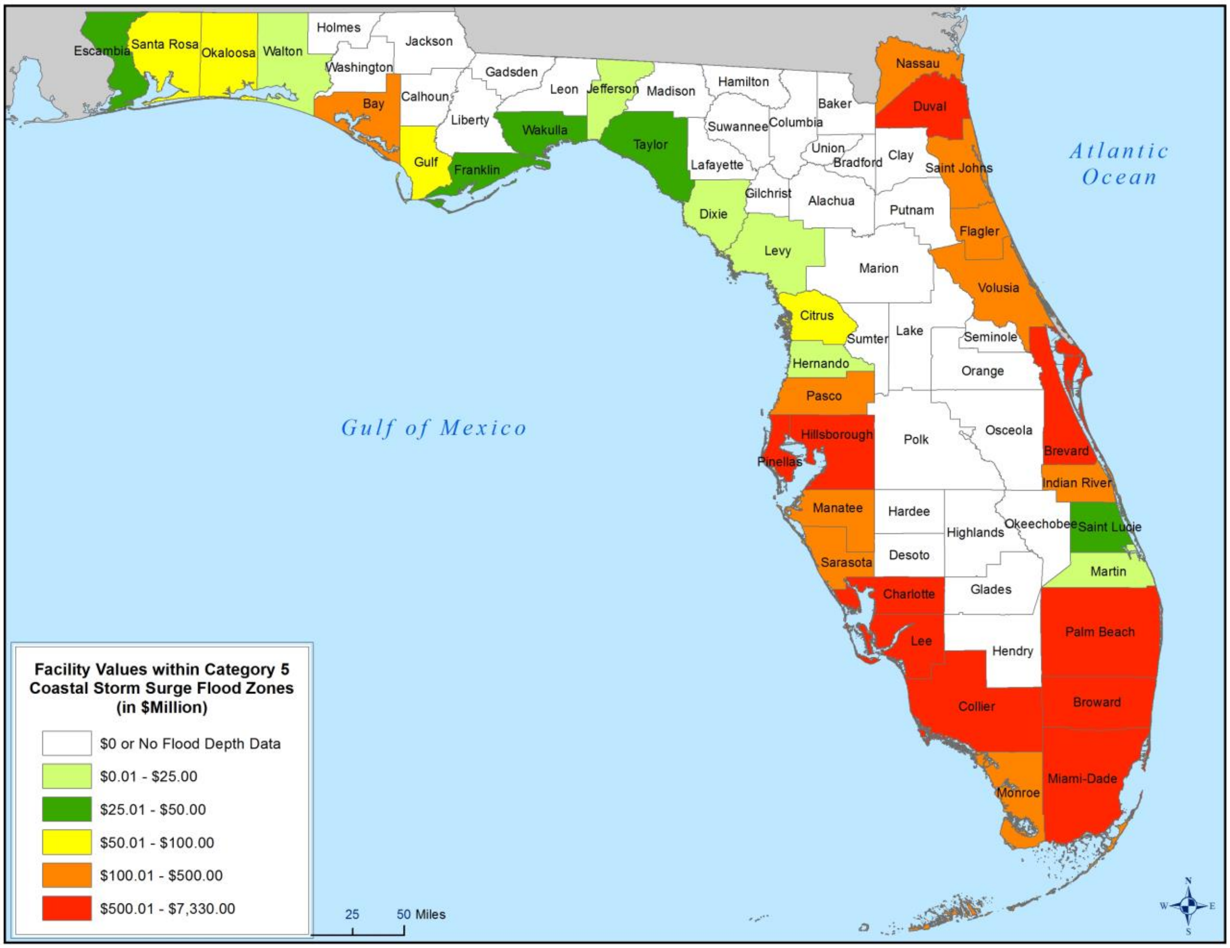


Figure 3.17 Value of State Facilities Vulnerable to Category 5 Hurricane[73]

IX. Estimating Potential Losses by Jurisdiction

The state conducted loss estimation on hurricanes during the original plan development process and updated it for the 2013 review and update. Due to Florida's geographic location, the entire state is vulnerable to damage from hurricane winds and impacts from coastal storms. The southern tip of the peninsula and the Florida Keys are especially vulnerable.

Table 3.26 provides annualized loss estimates of residential buildings, commercial buildings, medical buildings, educational buildings, and governmental buildings per parcel data from a Category 2 hurricane.

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[72] Results obtained via GIS analysis of aggregated data sources.
[73] Results obtained via GIS analysis of aggregated data sources.

Table 3.26 Estimated Structures Loss Summary from a Category 2[74]

County	*Total Value of Structures ($Millions)*	*Estimated Annualized Loss ($Thousands)*	*County*	*Total Value of Structures ($Millions)*	*Estimated Annualized Loss ($Thousands)*
Alachua	19,791	193	Lee	39,651	1,019
Baker	1,664	12	Leon	29,299	186
Bay	23,492	595	Levy	5,258	45
Bradford	3,928	34	Liberty	779	6
Brevard	48,078	1,242	Madison	2,602	10
Broward	148,288	9,303	Manatee	28,116	697
Calhoun	1,093	11	Marion	61,336	561
Charlotte	16,003	407	Martin	12,538	784
Citrus	21,344	251	Miami-Dade	160,059	10,297
Clay	24,667	272	Monroe	7,901	513
Collier	4,591	272	Nassau	9,305	110
Columbia	6,205	35	Okaloosa	17,521	438
Desoto	2,939	64	Okeechobee	3,356	122
Dixie	1,822	15	Orange	208,148	3,687
Duval	90,773	1,136	Osceola	21	0
Escambia	4,223	225	Palm Beach	126,662	8,041
Flagler	21,385	404	Pasco	65,283	1,057
Franklin	2,352	38	Pinellas	125,630	2,828
Gadsden	4,614	31	Polk	68,331	1,039
Gilchrist	2,545	18	Putnam	10,339	115
Glades	188	4	Santa Rosa	5,461	130
Gulf	3,205	62	Sarasota	25,305	644
Hamilton	2,675	9	Seminole	62,889	1,121
Hardee	2,015	40	St. Johns	93,109	1,302
Hendry	2,901	103	St. Lucie	23,357	1,497
Hernando	21,333	274	Sumter	2,507	28
Highlands	16,266	336	Suwannee	2,108	11
Hillsborough	255,252	4,939	Taylor	1,764	16
Holmes	2,121	24	Union	419	2
Indian River	3,175	120	Volusia	20,347	393
Jackson	9,492	87	Wakulla	4,351	32
Jefferson	2,645	9	Walton	1,358	36
Lafayette	764	5	Washington	3,961	62
Lake	29,711	349			

[74] Results obtained via GIS analysis of aggregated data sources.

Table 3.27 provides annualized loss estimates of residential buildings, commercial buildings, medical buildings, educational buildings, and governmental buildings per parcel data per county from a Category 5 hurricane.

Table 3.27 Estimated Structures Loss Summary from a Category 5 [75]

County	*Total Value of Structures ($Millions)*	*Annualized Loss ($Millions)*	*County*	*Total Value of Structures ($Millions)*	*Annualized Loss ($Millions)*
Broward	146,865	37.14	Monroe	16,872	7.30
Charlotte	16,003	4.09	Okaloosa	582	0.15
Collier	59,167	22.65	Palm Beach	105,579	27.11
Escambia	30,646	7.91	Santa Rosa	11,357	2.93
Lee	98,596	28.02	Sarasota	23,675	6.04
Miami-Dade	291,158	109.27			

National Climatic Data Center Hurricane/Coastal Storm Loss Estimation

Data from the NCDC accessed through the SHELDUS provides details about the historical hurricanes and tropical storms that have affected the state.[76] Table 3.28 shows a breakdown of the types of tropical cyclones and associated annualized losses that have occurred in Florida from 1993 to 2011.

Table 3.28 Historical Tropical Cyclones Summary

Type of Storm	*NCDC Reports*	*Average per Year*	*Annualized Property Loss ($Billions)*	*Annualized Crop Loss ($Millions)*
Hurricane	19	1.1	1.8	90.1
Tropical Storm	23	1.3	0.04	8.5
Total	107	6.7	1.94	96.8

Note: NCDC Reports is the count of reports that included property and/or crop damage from 1993–2011.

X. Estimating Potential Losses of State Facilities

The SHMPAT updated loss estimations on hurricanes in the 2013 plan review and update. The State of Florida continues to be extremely vulnerable to the effects of hurricanes, placing billions of dollars in property at risk. Table 3.29 and Table 3.30 show the total exposure and estimated losses of state-owned facilities from a Category 2 and Category 5 hurricane by county. The analysis contains coastal counties only as they would likely be hardest hit.

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[75] Results obtained via GIS analysis of aggregated data sources.
[76] http://webra.cas.sc.edu/hvriapps/sheldus_setup/sheldus_login.aspx

Table 3.29 Facilities Losses Summary in a Category 2[77]

County	*Total Facilities Value within return periods of 20-500 years ($Millions)*	*Estimated Annualized Facility Losses ($Thousands)*
Alachua	3,646.48	18.86
Baker	47.26	1.38
Bay	100.75	15.99
Bradford	82.36	1.42
Brevard	92.63	45.81
Broward	452.36	435.46
Calhoun	26.19	0.58
Charlotte	125.27	12.79
Citrus	14.04	5.5
Clay	55.99	10.39
Collier	182.15	7.96
Columbia	130.50	1.92
Desoto	114.41	4.62
Dixie	26.37	0.73
Duval	760.29	41.3
Escambia	404.29	5.37
Flagler	18.16	6.07
Franklin	47.76	0.94
Gadsden	569.18	4.62
Gilchrist	22.09	0.96
Glades	2.74	0
Gulf	54.97	3.39
Hamilton	61.37	0.41
Hardee	43.73	4.52
Hendry	9.38	5.67
Hernando	40.53	6.74
Highlands	20.24	10.49
Hillsborough	1,578.81	162.28
Holmes	33.51	1.13
Indian River	33.91	5.26
Jackson	140.53	2.71
Jefferson	25.53	0.23
Lafayette	27.76	0.36
Lake	50.67	10.89
Lee	464.75	31.84
Leon	3,350.85	6.02
Levy	24.44	2.08
Liberty	25.48	0.35

[77] Results obtained via GIS analysis of aggregated data sources.

County	*Total Facilities Value within return periods of 20-500 years ($Millions)*	*Estimated Annualized Facility Losses ($Thousands)*
Madison	38.97	0.51
Manatee	47.49	24.66
Marion	194.14	18.65
Martin	85.40	28.05
Miami-Dade	1,642.00	623.63
Monroe	78.84	13.58
Nassau	34.23	3.12
Okaloosa	63.11	14.23
Okeechobee	58.29	6.38
Orange	1,489.36	143.02
Osceola	66.73	0
Palm Beach	1,011.72	278.4
Pasco	49.64	30.71
Pinellas	253.22	93.96
Polk	287.70	39.3
Putnam	23.91	3.48
Santa Rosa	122.70	5.13
Sarasota	251.29	28.01
Seminole	74.68	51.14
St. Johns	181.25	9.21
St. Lucie	160.38	53.84
Sumter	81.88	2.83
Suwannee	121.50	0.77
Taylor	56.52	0.59
Union	98.81	0.48
Volusia	122.32	43.44
Wakulla	86.22	1.3
Walton	48.87	3.02
Washington	102.26	1.41

Table 3.30 Facilities Losses Summary in a Category 5[78]

County	*Total Facilities Value within return periods of 200-1,000 ($Millions)*	*Estimated Annualized Loss ($Millions)*

[78] Results obtained via GIS analysis of aggregated data sources.

County	*Total Facilities Value within return periods of 200-1,000 ($Millions)*	*Estimated Annualized Loss ($Millions)*
Broward	37.14	1.78
Charlotte	4.09	0.14
Collier	22.65	0.66
Escambia	7.91	0.36
Lee	28.02	0.65
Miami-Dade	109.27	7.57
Monroe	7.30	0.23
Okaloosa	0.15	0.00
Palm Beach	27.11	1.16
Santa Rosa	2.93	0.09
Sarasota	6.04	0.17

3.3.3 Severe Storms and Tornadoes Profile

I. Severe Storms and Tornadoes Descriptions and Background Information

Severe Storms

Florida is considered the thunderstorm capital of the United States. A thunderstorm forms when moist, unstable air is lifted vertically into the atmosphere. The lifting of this air results in condensation and the release of latent heat. The process to initiate vertical lifting can be caused by:

- Unequal warming of the surface of the Earth.
- Orographic lifting due to topographic obstruction of airflow.
- Dynamic lifting because of the presence of a frontal zone.[79]

Thunderstorms affect a relatively small area when compared to a hurricane. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Despite their small size, all thunderstorms are dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10 percent are classified as severe.

The National Weather Service (NWS) considers a thunderstorm severe if it produces hail at least one inch in diameter, winds of 58 mph or stronger, or a tornado.[80] The three key elements of a thunderstorm are wind, water, and lightning. In the United States, thousands of acres of crops are heavily damaged or destroyed by storm-borne hail each year. The Tampa region has

[79] http://www.eoearth.org/article/Thunderstorm
[80] http://www.nws.noaa.gov/os/severeweather/resources/ttl6-10.pdf

the highest incidences of thunderstorms in the United States, with Florida being first in the United States for lightning strikes per square mile.

Florida also leads the nation in lightning-related deaths, and is among the top ten states prone to devastation from tornadoes—the thunderstorm's most vicious offspring. Thunderstorms deliver most of the state's rainfall. Their winds also help invigorate sluggish environments in ponds, lakes, and estuaries, and break up oil spills.

Tornadoes

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. A tornado's wind speed normally ranges from 40 to more than 300 mph. Waterspouts are weak tornadoes that form over warm water and are most common along the Gulf Coast and the southeastern states. Waterspouts occasionally move inland, becoming tornadoes and causing damage and injuries.

Florida has two tornado seasons. The summer tornado season runs from June until September and has the highest frequencies of storm generation, with usual intensities of EF0 or EF1 on the Enhanced Fujita Scale. This includes those tornadoes associated with land-falling tropical cyclones.

The deadly spring season, from February through April, is characterized by more powerful tornadoes because of the presence of the jet stream. When the jet stream digs south into Florida and is accompanied by a strong cold front and a strong squall line of thunderstorms, the jet stream's high-level winds of 100 to 200 mph often strengthen a thunderstorm into what meteorologists call a "supercell" or "mesocyclone." These powerful storms can move at speeds of 30 to 50 mph, produce dangerous downburst winds, large hail, and usually the most deadly tornadoes.

Unlike hurricanes, which produce wind speeds of similar values over relatively widespread areas (when compared to tornadoes), the maximum winds in tornadoes are often confined to extremely small areas and vary tremendously over very short distances, even within the funnel itself.

The Enhanced Fujita Tornado Scale, (or the "EF Scale"), is the definitive scale for estimating wind speeds within tornadoes based upon the damage done to buildings and structures since 2007. The EF Scale is used extensively by the NWS in investigating tornadoes (all tornadoes are now assigned an EF Scale number), and by engineers in correlating damage to buildings and techniques with different wind speeds caused by tornadoes. Table 3.31 outlines the Fujita Scale, the derived EF Scale and the operational EF Scale. Though the Enhanced Fujita scale itself ranges up to EF28 for the damage indicators, the strongest tornadoes max out in the EF5 range (262 to 317 mph).

Table 3.31 Enhanced Fujita Tornado Scale[81]

Fujita Scale			*Derived EF Scale*		*Operational EF Scale*	
F Number	**Fastest 1/4-mile (mph)**	**3-Second Gust (mph)**	**EF Number**	**3-Second Gust (mph)**	**EF Number**	**3-Second Gust (mph)**
0	40–72	45–78	0	65–85	0	65–85
1	73–112	79–117	1	86–109	1	86–110
2	113–157	118–161	2	110–137	2	111–135
3	158–207	162–209	3	138–167	3	136–165
4	208–260	210–261	4	168–199	4	166–200
5	261–318	262–317	5	200–234	5	Over 200

Tornadoes develop under three scenarios: (1) along a squall line ahead of an advancing cold front moving from the north; (2) in connection with thunderstorm squall lines during hot, humid weather; and (3) in the outer portion of a tropical cyclone. Because the temperature contrast between air masses is generally less pronounced in the state, tornadoes are typically less severe in Florida than in other parts of the country.

The most common and usually the least destructive tornadoes in Florida are warm season ones. The cool season tornadoes are sometimes very destructive; they account for a disproportional large share of the tornado fatalities in Florida. They are typically caused by large-scale weather disturbances and sometimes occur in groups of six or more along fast-moving squall lines. This type of tornado usually occurs around the perimeter of the leading edge of the storm and sometimes results in the outbreak of several tornadoes. They generally move in an easterly direction.

II. Geographic Areas Affected by Severe Storms and Tornadoes

Tornadoes and severe thunderstorms can occur anywhere throughout the entire state. As the number of structures and the population increases, the probability that a tornado will cause property damage or human casualties also increases. When compared with other states, Florida ranks third in the average number of tornado events per year. These rankings are based upon data collected for all states and territories for tornado events between the years 1991 and 2010.[82]

The coastal portion of the state's Gulf Coast (between Tampa and Tallahassee), along with inland portions of the Panhandle region, have generally experienced more tornadoes than other areas of the state, primarily due to the high frequency of thunderstorms making their way east through the Gulf of Mexico.

81 http://www.spc.noaa.gov/faq/tornado/ef-scale.html
82 http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html

III. Historical Occurrences of Severe Storms and Tornadoes

Severe Storms

Severe storms occur frequently in Florida during the summer. According to the National Climatic Data Center, from 10/1/2006 to 12/31/2011, there have been 1,919 thunderstorm and high wind events and 910 events with hail greater than 0.75 inch. Considering the severe storm and tornado activity in the state, there are no specific “hazard zones”. Figure 3.18 shows the average number of severe thunderstorms per year by geographic area.

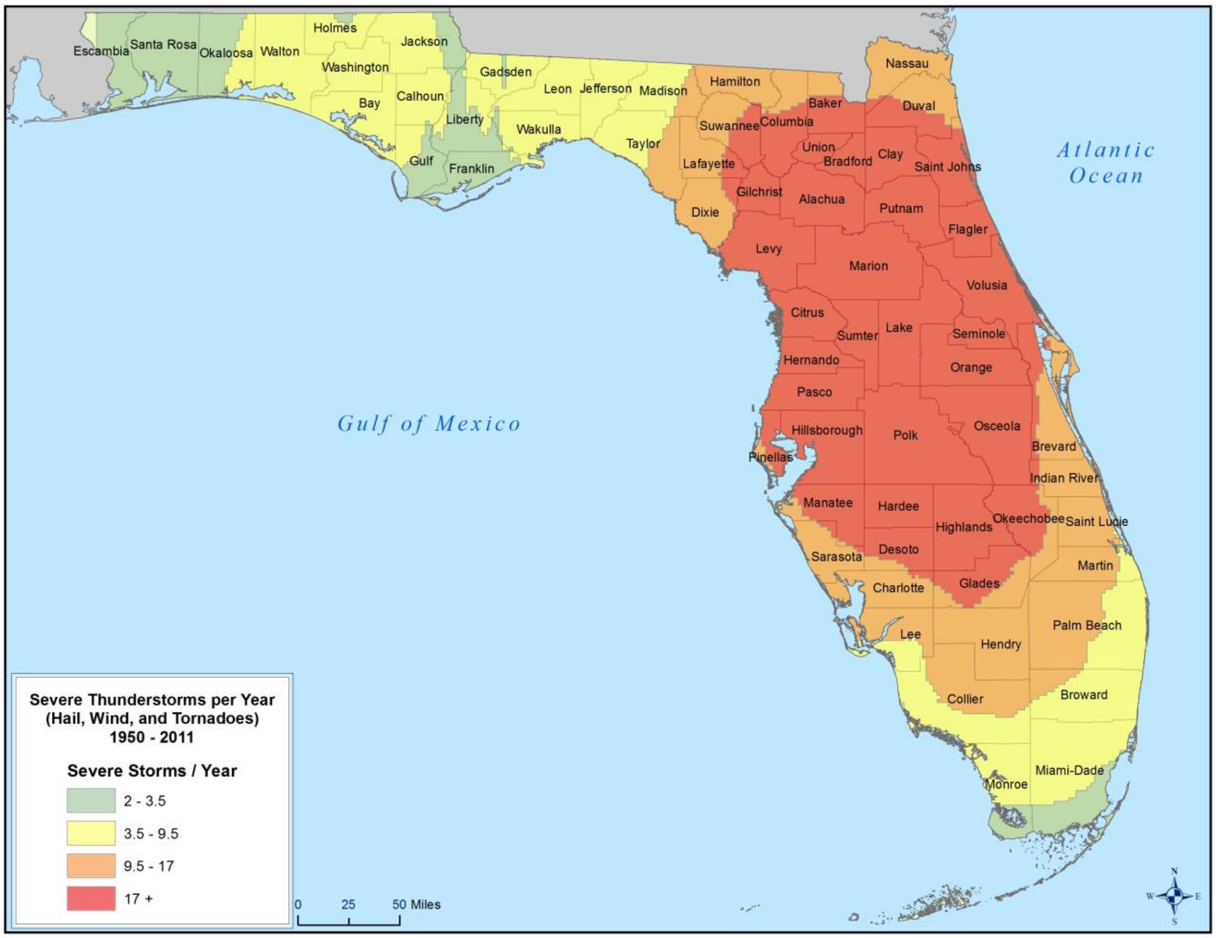

Figure 3.18 Severe Thunderstorms from 1950 to 2011

Tornadoes

Figure 3.19 shows all of the tornado occurrences in Florida from 1950 to 2012. For the populations at risk and building value tables, please see the tables at the beginning of **Section 3.1: Identifying Hazards** referring to statewide population and building values. For a comprehensive list of all tornado activity for Florida, please visit The Tornado History Project website.[85]

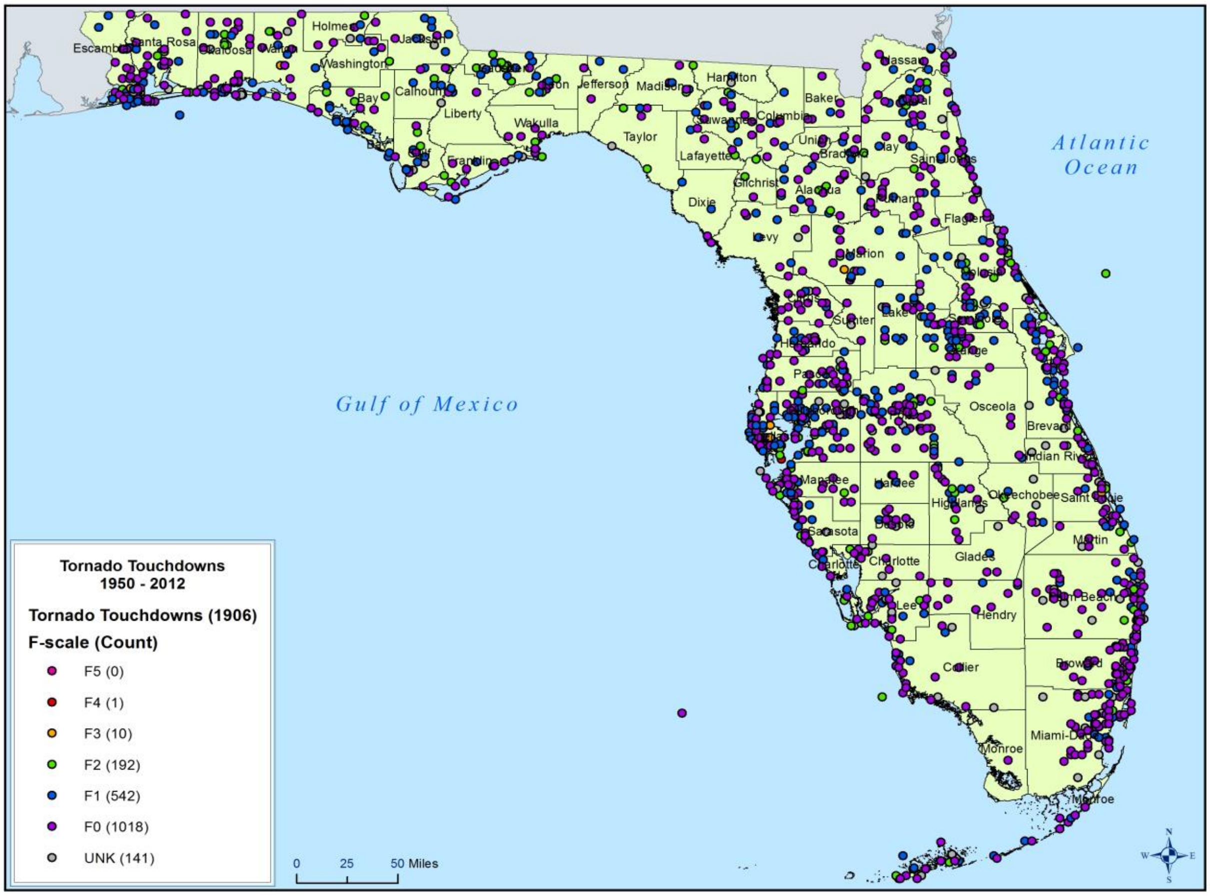

Figure 3.19 Tornado occurrences from 1950 to 2012

Table 3.32 outlines the severe tornado events in Florida since 1950.

Table 3.32 Florida Severe Tornado Events[83]

Date	*Information*
2/2/2007	F3 Tornado in Lake and Sumter counties, 8 fatalities, causing $114 million in damage.
2/22–23/1998	7 tornadoes in Brevard, Lake, Orange, Osceola, Seminole, and Volusia counties ranging from F1-F3. Deadliest tornado event in Florida history with 42 people killed and 260 injured.
2/2/1998	Costliest tornado with $205 million in damage.
4/15/1958	Tornado in Polk County, rated F4 on Fujita scale, causing up to $50 thousand in damages.

[83] http://www.tornadohistoryproject.com

SHELDUS™ Spatial Hazard Events and Losses Database for the United States[84]

SHELDUS is s a county-level hazard data set for the U.S. for 18 different natural hazard events types that includes the beginning date, location (county and state), property losses, crop losses, injuries, and fatalities that affected each county. The following maps (Figure 3.20, Figure 3.21, and Figure 3.22) reflect the number of tornadoes, severe storms, and lightning recorded from 1960 to 2010, respectively.

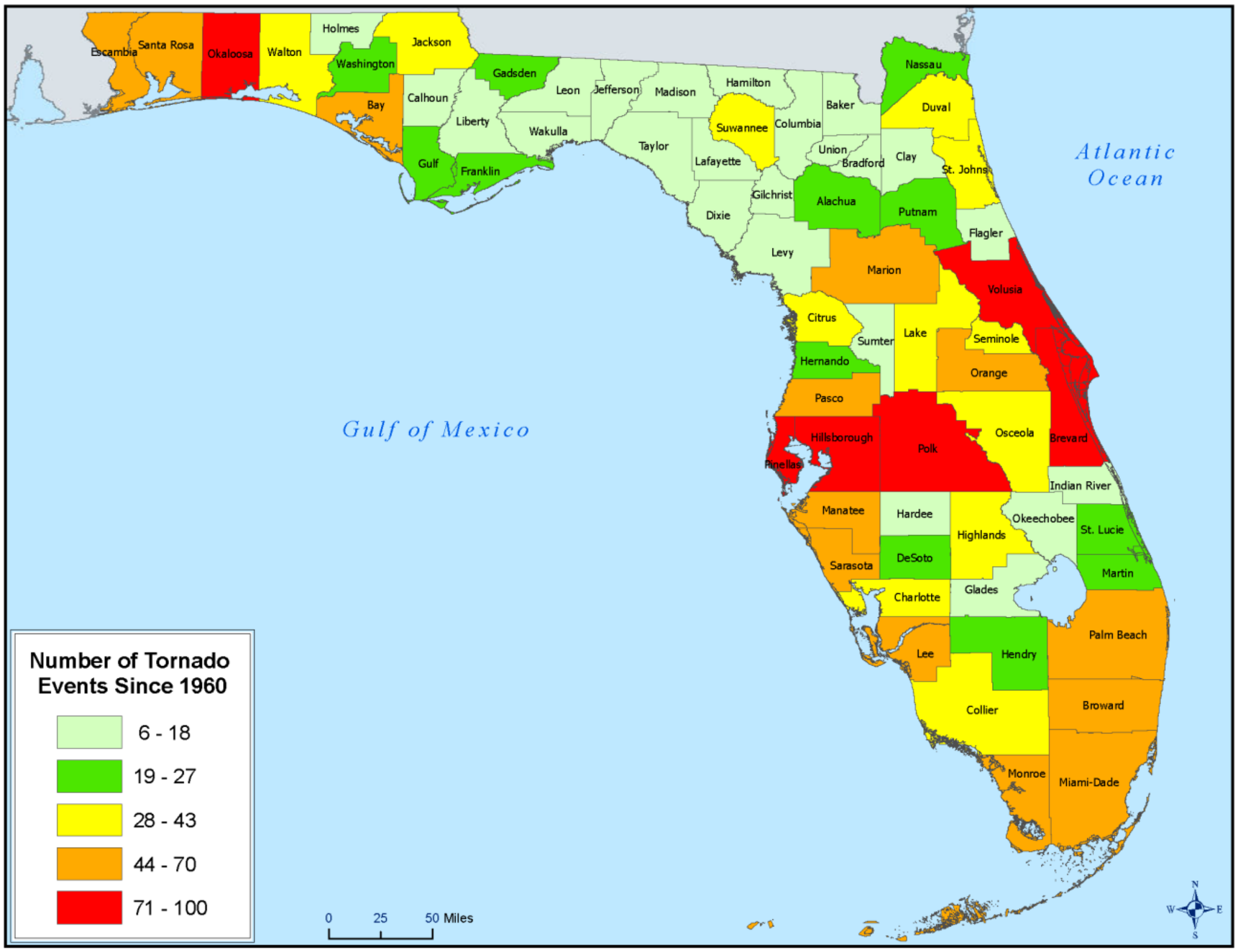

Figure 3.20 Number of Tornado Events since 1960

84 http://webra.cas.sc.edu/hvri/products/sheldus.aspx

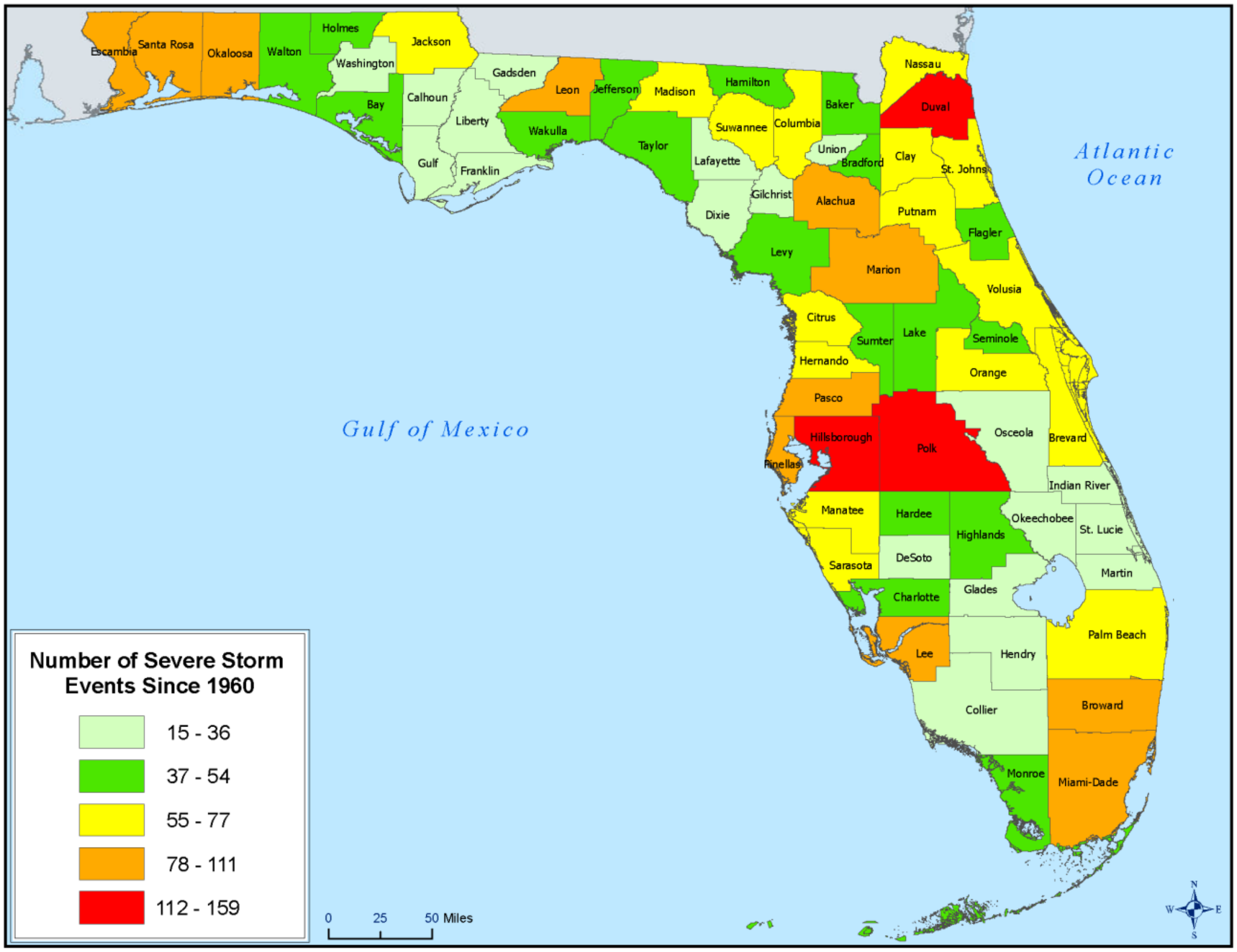

Figure 3.21 Number of Severe Storm Events since 1960

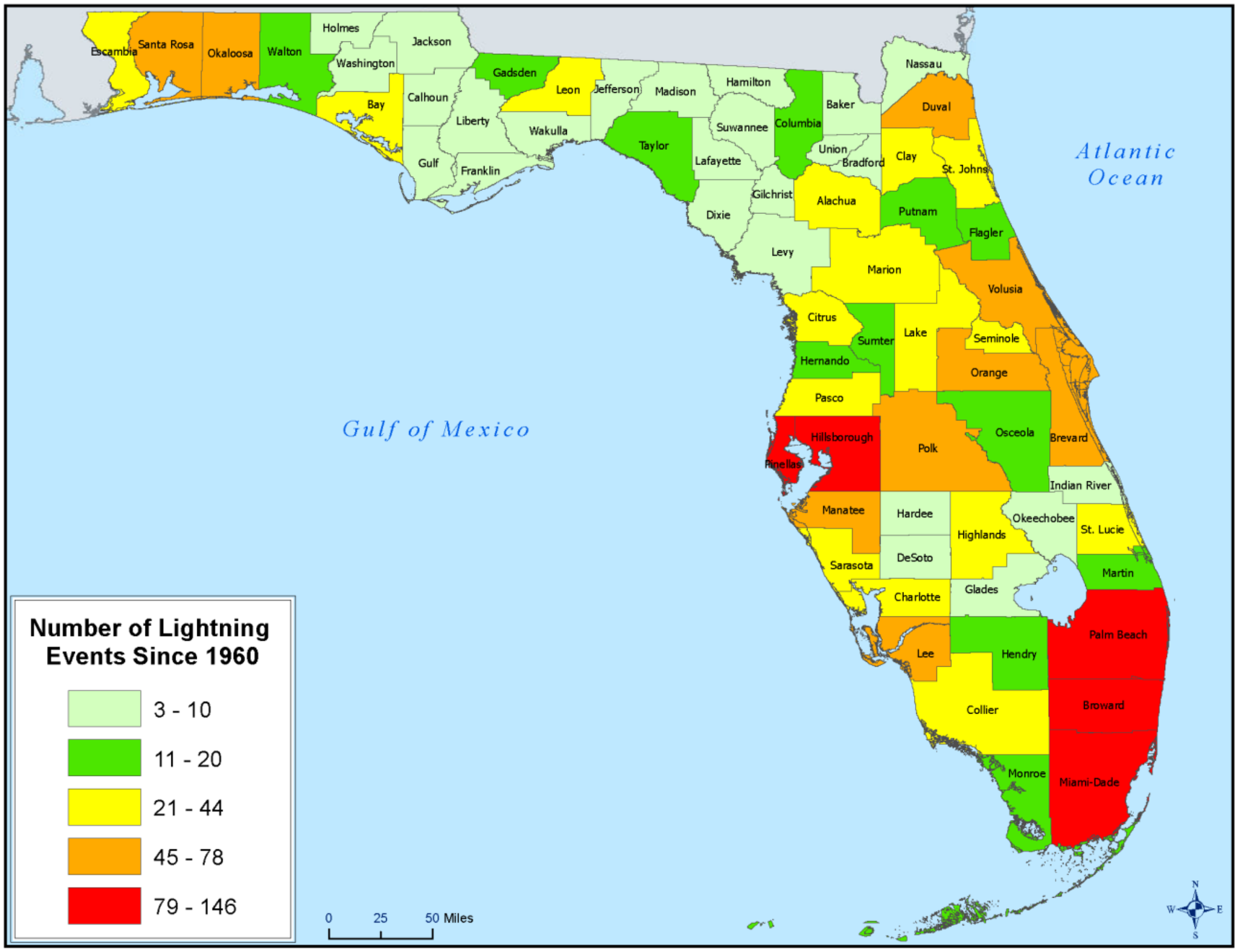

Figure 3.22 Number of Lightning Events since 1960

IV. Probability of Future Severe Storm and Tornado Events

Florida averages approximately 51 tornadoes, three deaths and 60 injuries per year since 1950. According to the NCDC, the state experienced 564 tornado events of an F1 magnitude or higher over the past 31 years from 1980 through October of 2011. These events caused 103 deaths, 1,376 injuries, and approximately $1,352,577,500 in property damage.[85] Although the Midwest has the reputation for the worst tornadoes, Florida is the state that experiences the most tornadoes per square mile of all states.

Florida's susceptibility to wind damage is further compounded by the fact that certain areas of the state contain a large concentration of mobile home residents. Mobile homes are extremely vulnerable to wind damage. There are more than 850,000 mobile homes within the state, with one in every five new homes being a manufactured home.[86]

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[85] National Climatic Data Center, 2011

[86] http://www.sfrpc.com/SRESP%20Web/Vol1-11_ChIV.pdf

V. Tornado Impact Analysis

Tornadoes can negatively affect the State of Florida with a variety of impacts and consequences:

- Tornadoes cause localized damage in the specific area of impact and are part of a larger storm system that affects communities with flooding, lightning, hail, and straight-line winds.
- Humans and animals are often injured or killed by severe tornado activity. Most cases involve a direct impact combined with minimal shelter or protection.
- Properties and facilities are often damaged by tornado activity. The severity of the damage depends on the type of construction, the age of the facility, and the strength of the storm, and results can vary from minor roof damage to the complete demolition of the structure.
- Buildings, facilities, and infrastructure are often impacted by the debris caused by a tornado. Common consequences of tornadoes are power outages and power line damage caused by fallen limbs and trees. This often occurs with large trees that have not been trimmed and are located near structures or power lines.
- It is not possible to identify the locations of at-risk facilities as tornadoes strike randomly throughout the State of Florida. All state facilities and critical locations were deemed vulnerable to this hazard.
- Losses due to tornadoes tend to be localized and do not tend to have many long-term effects on the economy of the affected area. After a tornado event, there is often an increase in economic activity as people rebuild their homes and repair additional damages. The monetary losses can be high in terms of actual damage to specific locations combined with injuries and the potential loss of life for humans and animals.
- Tornadoes usually do not have a long-term impact on the environment. Extreme damage may occur in a localized area, but long-term effects on the flora and fauna in the surrounding areas are not typical.
- Electricity and other essential services to local areas can be disrupted during storm events. In severe cases, power can be lost for several days or weeks. In most cases, however, disruptions in power are usually short-term and service is quickly restored by repair crews and responders.

VI. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. The 67 multi-jurisdictional LMS plans provided a solid baseline for the overall state vulnerability analysis. Risk assessment information from the LMS plans is current as of May 1, 2012.

Based on the LMS plans in the State of Florida, Figure 3.23 displays the jurisdictional rankings for the tornado hazard. Not all counties have identified tornadoes as one of their hazards.

- High-risk Jurisdictions 22
- Medium-high–risk Jurisdictions 16
- Medium-risk Jurisdictions 17
- Low-risk Jurisdictions 8

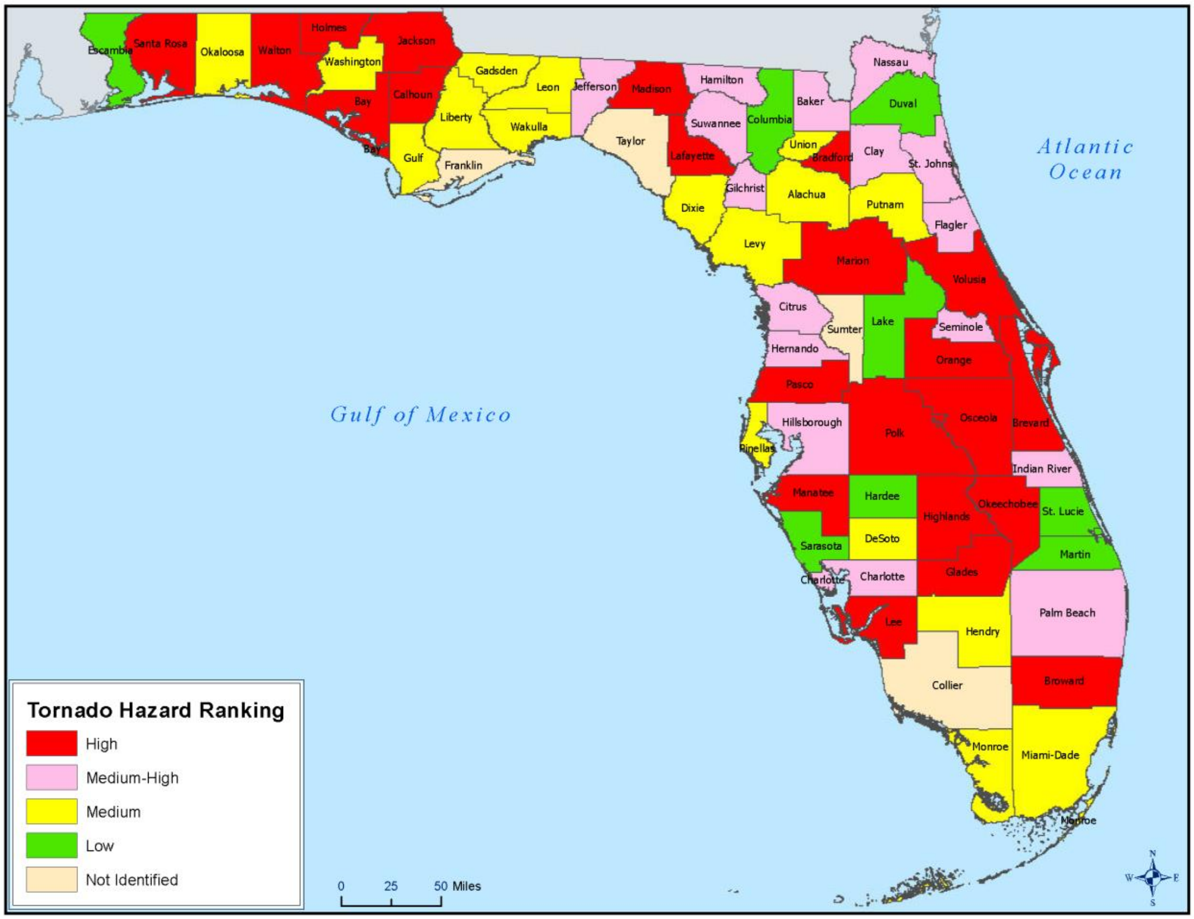

Figure 3.23 Tornado Hazard Rankings by County

Based on the LMS plans in the State of Florida, Figure 3.24 displays the jurisdictional rankings for the severe storm hazard. Not all counties have identified severe storms as one of their hazards.

- High-risk Jurisdictions 26
- Medium-high–risk Jurisdictions 18
- Medium-risk Jurisdictions 14
- Low-risk Jurisdictions 1

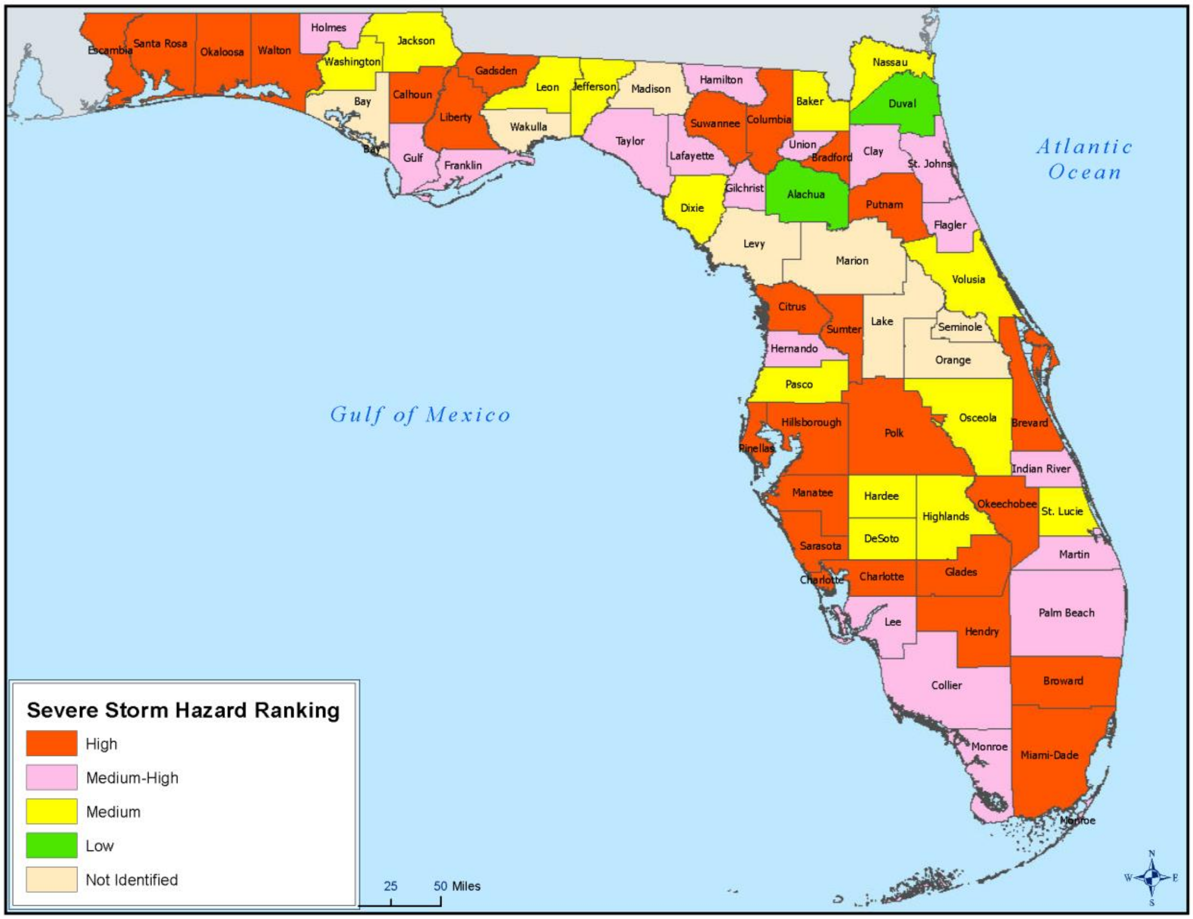

Figure 3.24 Severe Storm Hazard Rankings by County

VII. Severe Storms and Tornadoes Hazard Vulnerability Analysis by Jurisdiction[87]

The SHMPAT has conducted a vulnerability analysis on tornadoes and severe storms in all of its past plan updates and again in the 2013 plan update. Every county is at risk for tornadoes. Table 3.33 outlines, by county, the historical occurrences of tornadoes by severity. The following impact analysis provides a detailed description of the state's vulnerability based on exposure of population and buildings to tornadoes and frequency of tornadoes by county.

Table 3.33 Frequency of Tornadoes by County, 1950–2011[88]

County	*Counts by F/EF Number*					*Total Number*	*Frequency (Tornadoes per Year)*
	0	***1***	***2***	***3***	***4***		
Alachua	19	14	8	0	0	41	0.7
Baker	7	1	2	0	0	10	0.2
Bay	29	27	13	1	0	70	1.1
Bradford	6	10	1	0	0	17	0.3
Brevard	55	36	15	3	0	106	1.7
Broward	69	30	6	3	1	109	1.8
Calhoun	2	6	10	0	0	18	0.3
Charlotte	38	6	5	0	0	49	0.8
Citrus	33	13	3	1	0	50	0.8
Clay	6	14	6	0	0	26	0.4
Collier	39	12	3	0	0	54	0.9
Columbia	8	5	3	1	0	17	0.3
DeSoto	20	5	3	0	0	28	0.5
Dixie	2	1	0	0	0	3	0.0
Duval	38	16	7	0	0	61	1.0
Escambia	47	31	9	3	0	90	1.5
Flagler	17	2	2	0	0	21	0.3
Franklin	22	13	4	0	0	39	0.6
Gadsden	6	13	10	0	0	29	0.5
Gilchrist	2	0	2	0	0	4	0.1
Glades	14	3	0	0	0	17	0.3
Gulf	17	5	3	0	0	25	0.4
Hamilton	4	1	2	0	0	7	0.1
Hardee	15	5	0	0	0	20	0.3
Hendry	16	8	1	0	0	25	0.4
Hernando	26	7	0	0	0	33	0.5
Highlands	22	12	3	0	0	37	0.6

[87] Tornado History Project searchable database of tornadoes from years 1950-2011. (http://www.tornadohistoryproject.com)
[88] Ibid.

County	Counts by F/EF Number					Total Number	Frequency (Tornadoes per Year)
	0	***1***	***2***	***3***	***4***		
Hillsborough	76	45	13	0	0	134	2.2
Holmes	5	5	3	0	0	13	0.2
Indian River	15	6	2	0	0	23	0.4
Jackson	11	17	4	0	0	32	0.5
Jefferson	6	5	0	0	0	11	0.2
Lafayette	4	3	2	1	0	10	0.2
Lake	22	18	7	2	0	49	0.8
Lee	79	21	11	0	0	111	1.8
Leon	12	3	5	0	0	20	0.3
Levy	12	6	2	0	0	20	0.3
Liberty	4	5	0	0	0	9	0.1
Madison	5	9	2	1	0	17	0.3
Manatee	56	16	6	1	0	79	1.3
Marion	23	23	8	1	0	55	0.9
Martin	20	4	3	0	0	27	0.4
Miami-Dade	81	23	5	1	0	110	1.8
Monroe	48	15	6	0	0	69	1.1
Nassau	19	7	0	0	0	26	0.4
Okaloosa	56	19	13	1	0	89	1.4
Okeechobee	8	4	3	0	0	15	0.2
Orange	26	18	9	1	0	54	0.9
Osceola	16	12	3	1	0	32	0.5
Palm Beach	92	35	9	1	0	137	2.2
Pasco	54	18	6	0	0	78	1.3
Pinellas	70	40	12	2	1	125	2.0
Polk	102	43	12	0	1	158	2.5
Putnam	30	8	3	0	0	41	0.7
St. Johns	39	5	3	2	0	49	0.8
St. Lucie	27	7	2	2	0	38	0.6
Santa Rosa	37	18	5	1	0	61	1.0
Sarasota	42	24	8	1	0	75	1.2
Seminole	12	8	5	1	0	26	0.4
Sumter	9	2	2	1	0	14	0.2
Suwannee	19	15	5	0	0	39	0.6
Taylor	4	5	4	0	0	13	0.2
Union	3	3	0	0	0	6	0.1
Volusia	53	22	13	1	0	89	1.4
Wakulla	8	5	1	0	0	14	0.2
Walton	22	14	3	1	0	40	0.6
Washington	8	13	1	0	0	22	0.4

Note: Tornadoes reported after Feb. 1, 2007, use an EF number, in reference to the Enhanced Fujita Scale of wind speed estimates based on damage.

Population Vulnerability

The following analysis was performed as part of the 2010 plan development process. The NCDC has emerged as a more consistent source of data for exhibiting severe storms, as such the updated maps and data have used this source. Historical evidence shows that most of the state is vulnerable to severe storm/thunderstorm and tornado activity. Tornadoes will always occur in conjunction with a tropical cyclone or thunderstorm. Figure 3.25 breaks down the annual average number of historical occurrences of severe thunderstorms.

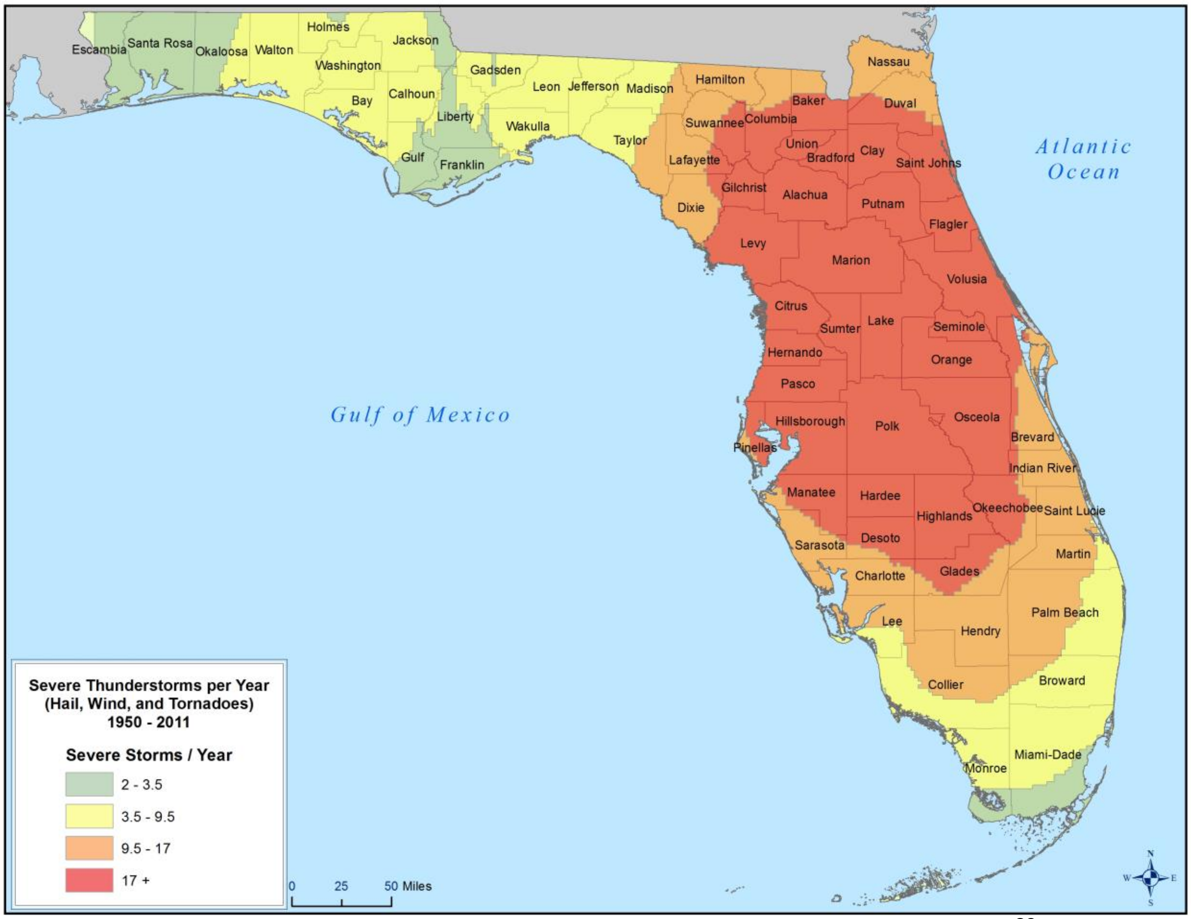

Figure 3.25 Historical Thunderstorm occurrences per year.[89]

VIII. Assessing Vulnerability of State Facilities

A vulnerability analysis for tornadoes and severe storms was conducted for the 2013 plan update. Tornado risk was determined by considering all of the land within the counties at risk for tornado activity. Tornadoes can strike anywhere in the state; therefore, all of the 20,287 state-owned facilities and their insured values are equally at risk.

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[89] Data obtained from NCDC database.

IX. Estimating Potential Losses by Jurisdiction

The SHMPAT conducted a loss estimation on tornadoes and severe storms during the original plan development process and updated it during the 2013 review and update process.

Severe Storm Loss Estimation

Historical evidence shows that most of the state is vulnerable to severe storms. This is a hazard during major tropical storms or hurricanes or during fronts that move through the state. Using the updated NCDC data, the vulnerability of facilities in each jurisdiction to thunderstorms were weighted according to the risk of being affected by a storm and comparative values to determine the annualized loss. Table 3.34 provides annualized loss estimates of residential buildings, commercial buildings, medical buildings, educational buildings, and governmental buildings per parcel data per county from severe storms.

Table 3.34 Severe Storm Structures Summary[90]

County	*Total Value of Structures ($Millions)*	*Estimated Annualized Loss ($Thousands)*	*County*	*Total Value of Structures ($Millions)*	*Estimated Annualized Loss ($Thousands)*
Alachua	0.98	0	Lake	25,177.53	580
Baker	1,054.07	24	Lee	88,625.27	1,335
Bay	22,277.12	196	Leon	26,699.68	235
Bradford	1,745.31	40	Levy	2,387.29	55
Brevard	48,146.96	904	Liberty	394.43	2
Broward	141,896.06	1,250	Madison	1,225.31	12
Calhoun	874.09	8	Manatee	26,572.96	526
Charlotte	15,531.97	279	Marion	28,624.65	660
Citrus	17,433.01	402	Martin	12,219.93	153
Clay	17,367.26	400	Miami-Dade	157,055.71	1,242
Collier	31,888.80	321	Monroe	7,820.22	15
Columbia	5,354.37	123	Nassau	8,036.71	145
Desoto	2,422.38	53	Okaloosa	19,984.75	120
Dixie	744.83	14	Okeechobee	2,904.39	65
Duval	85,275.32	1,760	Orange	120,238.90	2,771
Escambia	31,742.89	97	Osceola	10.49	0
Flagler	11,493.89	265	Palm Beach	122,910.89	1,101
Franklin	1,290.48	5	Pasco	47,697.06	1,099
Gadsden	3,127.67	26	Pinellas	91,568.49	1,979
Gilchrist	922.25	21	Polk	51,639.88	1,190
Glades	282.87	6	Putnam	7,636.04	176
Gulf	1,574.64	7	Santa Rosa	82,528.14	1,872

[90] Results obtained via GIS analysis of aggregated data sources.

County	Total Value of Structures ($Millions)	Estimated Annualized Loss ($Thousands)	County	Total Value of Structures ($Millions)	Estimated Annualized Loss ($Thousands)
Hamilton	1,009.18	18	Sarasota	27,754.53	463
Hardee	1,423.08	33	Seminole	14,690.55	45
Hendry	2,616.94	47	St. Johns	44,173.77	881
Hernando	20,861.62	481	St. Lucie	30,608.26	705
Highlands	10,114.96	233	Sumter	0.20	0
Hillsborough	139,804.20	3,222	Suwannee	1,678.41	33
Holmes	1,103.67	9	Taylor	0.55	0
Indian River	15,919.19	286	Union	266.23	6
Jackson	4,952.01	40	Volusia	4.27	0
Jefferson	1,074.51	9	Wakulla	2,003.57	18
Lafayette	279.06	5	Washington	3,172.02	28

Tornado Loss Estimation

The following estimation was performed in 2013 as part of the revision plan development process. Historical evidence shows that most of the state is vulnerable to tornado activity. This hazard can result from severe thunderstorm activity or may occur during a major tropical storm or hurricane. The following estimates are based on historic NCDC data combined with 2010 demographics parcel data and state facilities data. It is weighted according to the relative historical impacts and vulnerability, as seen through the comparative value of structures. Table 3.35 provides annualized loss estimates of residential buildings, commercial buildings, medical buildings, educational buildings, and governmental buildings per parcel data per county from tornado activity.

Table 3.35 Tornado Structures Summary[91]

County	Total Value of Structures ($Millions)	Estimated Annualized Loss ($Millions)	County	Total Value of Structures ($Millions)	Estimated Annualized Loss ($Millions)
Alachua	22,769,182	0.97	Lee	62,351,687	2.66
Baker	1,392,180	0.06	Leon	24,359,584	1.04
Bay	14,181,171	0.61	Levy	2,359,063	0.1
Bradford	1,555,244	0.07	Liberty	392,228	0.02
Brevard	52,019,167	2.22	Madison	1,095,019	0.05
Broward	158,558,280	6.77	Manatee	29,693,608	1.27
Calhoun	738,420	0.03	Marion	25,137,084	1.07
Charlotte	16,260,974	0.69	Martin	15,215,311	0.65
Citrus	10,868,053	0.46	Miami-Dade	200,767,099	8.58
Clay	14,114,091	0.6	Monroe	10,442,386	0.45

[91] Results obtained via GIS analysis of aggregated data sources.

County	Total Value of Structures ($Millions)	Estimated Annualized Loss ($Millions)	County	Total Value of Structures ($Millions)	Estimated Annualized Loss ($Millions)
Collier	33,076,953	1.41	Nassau	5,328,587	0.23
Columbia	3,989,162	0.17	Okaloosa	16,423,487	0.7
Desoto	2,071,518	0.09	Okeechobee	2,620,772	0.11
Dixie	867,115	0.04	Orange	104,657,193	4.47
Duval	73,915,566	3.16	Osceola	22,961,182	0.98
Escambia	25,849,486	1.1	Palm Beach	131,609,520	5.62
Flagler	8,301,145	0.35	Pasco	37,249,367	1.59
Franklin	1,104,806	0.05	Pinellas	86,745,231	3.71
Gadsden	2,939,769	0.13	Polk	47,212,655	2.02
Gilchrist	832,017	0.04	Putnam	4,950,120	0.21
Glades	673,043	0.03	Santa Rosa	10,625,719	0.45
Gulf	1,108,271	0.05	Sarasota	13,595,791	0.58
Hamilton	702,903	0.03	Seminole	7,900,794	0.34
Hardee	1,661,286	0.07	St. Johns	41,340,218	1.77
Hendry	2,076,880	0.09	St. Lucie	40,204,558	1.72
Hernando	13,595,791	0.58	Sumter	17,307,155	0.74
Highlands	7,900,794	0.34	Suwannee	24,568,559	1.05
Hillsborough	110,893,082	4.74	Taylor	7,026,843	0.3
Holmes	1,011,611	0.04	Union	2,154,086	0.09
Indian River	14,603,512	0.62	Volusia	1,344,905	0.06
Jackson	3,095,835	0.13	Wakulla	680,725	0.03
Jefferson	802,196	0.03	Walton	48,755,507	2.08
Lafayette	445,093	0.02	Washington	1,797,836	0.08
Lake	23,973,192	1.02			

X. Estimating Potential Losses of State Facilities

The SHMPAT conducted loss estimations on tornadoes in 2004 during the original plan development process as part of the hurricane wind section above. During the 2010 plan update and revision process, this tornado-specific estimation has been enhanced and expanded. The 2013 plan updates the 2010 revision process.

The State of Florida continues to be vulnerable to the effects of tornadoes, placing billions of dollars in property at risk. Table 3.36 shows the total exposure and estimated losses of state-owned facilities to tornadoes by county.

Table 3.36 Tornado Facilities Summary[92]

County	***Value of Facilities ($Millions)***	***Estimated Annualized Facility Losses ($Thousands)***	***County***	***Value of Facilities ($Millions)***	***Estimated Annualized Facility Losses ($Thousands)***
Alachua	5,758	250	Lee	2,246	100
Baker	200	10	Leon	3,703	160
Bay	689	30	Levy	136	10
Bradford	224	10	Liberty	59	0
Brevard	1,814	80	Madison	96	0
Broward	6,983	300	Manatee	988	40
Calhoun	78	0	Marion	1,213	50
Charlotte	550	20	Martin	535	20
Citrus	404	20	Miami-Dade	11,137	480
Clay	710	30	Monroe	254	10
Collier	992	40	Nassau	223	10
Columbia	434	20	Okaloosa	723	30
Desoto	296	10	Okeechobee	216	10
Dixie	67	0	Orange	5,643	240
Duval	3,767	160	Osceola	1,079	50
Escambia	1,410	60	Palm Beach	5,307	230
Flagler	232	10	Pasco	1,437	60
Franklin	47	0	Pinellas	3,416	150
Gadsden	987	40	Polk	2,243	100
Gilchrist	80	0	Putnam	273	10
Glades	19	0	Santa Rosa	775	30
Gulf	140	10	Sarasota	988	40
Hamilton	137	10	Seminole	606	30
Hardee	228	10	St Johns	1,293	60
Hendry	151	10	St Lucie	1,506	60
Hernando	549	20	Sumter	231	10
Highlands	306	10	Suwannee	140	10
Hillsborough	6,902	300	Taylor	139	10
Holmes	92	0	Union	204	131.1
Indian River	467	20	Volusia	1,593	9.28
Jackson	322	10	Wakulla	90.53	24.75
Jefferson	49	0	Walton	46.36	5.71
Lafayette	37	0	Washington	102.75	109.6
Lake	903	40			

[92] Results obtained via GIS analysis of aggregated data sources.

3.3.4 Wildfire Profile

I. Wildfire Description and Background Information

Wildfire is defined by the Florida Forest Service (FFS) as any fire that does not meet management objectives or is out of control. Wildfires occur in Florida every year and are part of the natural cycle of Florida's fire-adapted ecosystems. Many of these fires are quickly suppressed before they can damage or destroy property, homes and lives.

There are four types of wildfires:

- Surface Fires: Burn along the forest floor consuming the litter layer and small branches on or near the ground.
- Ground Fires: Smolder or creep slowly underground. These fires usually occur during periods of prolonged drought and may burn for weeks or months until sufficient rainfall extinguishes the fire, or it runs out of fuel.
- Crown Fires: Spread rapidly by the wind, moving through the tops of the trees.
- Wildland/Urban Interface Fires: Fires occurring within the WUI in areas where structures and other human developments meet or intermingle with wildlands or vegetative fuels. Homes and other flammable structures can become fuel for WUI fires.

Prescribed or controlled fires have been used on both public and private lands across the state to replace the natural benefits that wildfires can provide. Prescribed burns help to reduce the amount of flammable vegetation in an area which in turn lessens the intensity of a wildfire that may occur in that same area. Firefighters then have an opportunity to suppress the fire while it is small and easier to control. Approximately 70 percent to 80 percent of all wildfires in Florida are caused by humans. Wildfire prevention and public awareness campaigns have helped to greatly reduce the number of human-caused wildfires in Florida. Other measures used to help reduce the number and severity of wildfires includes red flag warnings issued by the NWS and county burn bans.

Environmental short-term loss caused by a wildland fire can include the destruction of wildlife habitat and watersheds. Long-term effects include reduced access to affected recreational areas, destruction of cultural and economic resources and community infrastructure, and vulnerability to flooding due to the destruction of watersheds.

The type and amount of fuel, as well as its burning qualities and level of moisture, affect wildfire potential and behavior. The continuity of fuels, expressed in both horizontal and vertical components, is also a factor because it expresses the pattern of vegetative growth and open areas. Topography is important because it affects the movement of air (and thus the fire) over the ground surface. The slope and shape of terrain can change the rate of speed at which the fire travels. Temperature, humidity, and wind (both short- and long-term) affect the severity and duration of wildfires.

II. Geographic Areas Affected by Wildfires

Of Florida's approximately 37,478,400 acres (including water), about 30 percent is urban, industrial, or wetland and another 31 percent is agricultural, including crops, pasture, and range.[93] Approximately 39 percent, or 16.2 million, of Florida's acreage is covered by forests. 91 percent of this forestland is considered to be timberland (i.e., commercially productive land). Six percent is classified as woodland (i.e., unproductive forestland).[94] State and national forests make up 19 percent of Florida's forestlands, with 33 state forests and three national forests.[95] Protected acreage is any wildland or forest that is not in a city or municipality whether incorporated or unincorporated. The protected forest acreage does not include acreage under federal jurisdiction.

In 2005, Florida timberlands totaled 15.6 million acres and supported more harvestable wood volume than any time in the previous 18 years.[96] However, Florida's total acreage of commercial forestland is slowly declining due to other more profitable land uses, primarily residential and commercial development. Currently, there are approximately 16 million acres of commercial forest in Florida.[97]

The wildland-urban interface (WUI) is largely the result of development in areas once considered wildlands where people desire to live in a more natural setting. Natural landscaping, which allows natural vegetation to grow and accumulate near homes, is a hazardous trend and does not mitigate the risk of fire reaching into a homeowners' land. Many subdivision layouts are designed with numerous dead-end streets and cul-de-sacs, creating access issues for firefighting services and equipment. In addition, many of these areas do not have wet hydrants or other sources of water for firefighting.

WUI areas can be classified into the following types:

- The mixed interface contains structures that are scattered throughout rural areas. Usually, there are isolated homes surrounded by larger or smaller areas of land.
- An occluded interface is characterized by isolated (either large or small) areas within an urban area. An example may be a city park surrounded by urban homes trying to preserve some contact with a natural setting.
- A class interface is where homes, especially those crowded onto smaller lots in new subdivisions, press along the wildland vegetation along a broad front. Vast adjacent wildland areas can propagate a massive flame front during a wildfire, and numerous homes are put at risk by a single fire.

A national compilation from the U.S. Geological Survey shows all fires from 1980 through 2003 that burned over 250 acres total. Based on this information, the larger fires in Florida tend to occur in the southwest portion of the state or in a few areas across the northern

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93 http://www.swfwmd.state.fl.us/education/splash/wetland_foryour_thoughts.html
94 http://edis.ifas.ufl.edu/FR143
95 http://www.yourforestmanaged.com/forests/
96 http://www.floridaforest.org/facts_resources.php
97 http://www.freshfromflorida.com/newsroom/press/2011/09272011.html

region. The NCDC shows that 83 wild and forest fires have burned in Florida from October 2006 through December 2011, resulting in three injuries and approximately $14 million in property damages.[98]

The northwest, northeast, and central regions of the state are the major forested areas. South Florida's protected land has more of a potential threat for wildfire due to the humus material in the soil and the type of vegetation. However, damages in this area are not expected to be as costly as the threat to forestland. With more commercial forestland located in the northern portions of the state, the chances of a forest fire causing financial damage are greater in this part of the state.

Grasslands, marshes, and muck lands in and near the Everglades (approximately 4.3 million acres) have their own unique conditions that lead to increased threat from fire damage. The Everglades itself has approximately 1.4 million gross area acres, including federal and non-federal land. These lands are exceptionally vulnerable during drought conditions, leading to increased threat from fire damage. When drought conditions prevail, the soil, as well as the vegetation, is prone to combustion.

The increasing popularity of outdoor recreation means greater numbers of people visiting wildland areas. Additionally, urban sprawl in various parts of the state has increased due to rapid growth in population. This, coupled with extensive drainage problems from storm water runoff, improper site development, and old water systems, has severely altered the characteristics of the water table and increased the potential for disastrous fires in this area. Drought conditions increase the probability of wildfires.

Wildland-Urban Interface (WUI)

Population movement trends in the U.S. have resulted in rapid development in the outlying fringes of metropolitan areas and in the rural areas with attractive recreational and aesthetic amenities, such as forests. This demographic change is increasing the size of the WUI, defined as the area where structures and other human development meet or intermingle with undeveloped wildland. The WUI creates an environment for fire to move readily between vegetation fuels, such as brush or forests; and structural fuels, such as houses and buildings.

The U.S. Department of Agriculture Forest Service and the University of Wisconsin (Madison) released new scientific maps depicting United States' communities and lands within the WUI. This is the first consistent nationwide representation of the WUI as defined in the Federal Register (Volume 66:751, 2001) and makes mapping and analysis a reality at the national, state, and local levels. Two types of WUI were mapped-- intermix and interface. Intermix WUI are areas where housing and vegetation intermingle; interface WUI are areas with housing in close proximity to contiguous wildland vegetation.

[98] http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=12%2CFLORIDA

III. Historical Occurrences of Wildfires

The most naturally caused fires typically occur in July due to lightning and coincide with the height of the thunderstorm season. Other causes are human-caused, including arson, carelessness, debris/trash burning, and operation of equipment that may emit sparks. Table 3.37 includes a brief narrative for significant fire seasons in the state.

Table 3.37 Significant Wildfires by Year[99]

Date	*Information*
1998	After the late winter rain stopped, severe drought conditions developed and lasted from April through June of 1998. As a result of the extreme drought conditions, high temperatures, and buildup of flammable wildland fuels, the 1998 wildfires began. The first fire broke out on May 25, 1998, in the Apalachicola National Forest. In a two-month period, almost 500,000 acres of the state had burned in approximately 2,300 separate wildfires. An entire county was evacuated as a protective measure for a series of fires, and the total cost of the fire season reached over $160 million. The wildfires of 1998 damaged or destroyed over 300 homes, and the value of lost timber exceeded $300 million.
1999	Florida's drought continued and, as a result, the state was again stricken with a severe wildfire outbreak. The year 1999 saw nearly 4,500 wildfires burn more than 365,000 acres statewide.
May 2001	A smoldering lightning fire flared up into the Mallory Swamp Fire. It became one of the largest wildfires in Florida's history at that time, burning more than 60,000 acres and causing over $10 million in timber losses, but it did not burn any houses because of its remote location in Dixie and Lafayette Counties.
2007	The wildfires that put much of Florida in a several weeks-long smoky haze were started May 5 by a lightning strike on Bugaboo Island in Georgia's Okefenokee National Wildlife Refuge. Thick smoke from area wildfires forced officials to close stretches of I-75 and I-10 in northern Florida. A section of I-95 in Duval County, from Pecan Park to State Road A1A, was also closed due to smoke, as was a section of I-75 in Broward County near fire-ravaged Collier County in southern Florida. The fires scorched at least 212,000 acres, according to the joint information center, a coalition of state and federal agencies. Of those acres, 101,000 were in Florida and about 111,000 were in Georgia. Interstate 75 was closed from Valdosta, Georgia; south to Lake City, Florida, and Interstate 10 was closed from Sanderson, Florida, eastward to Live Oak.
June 2007	There were 17 wildfires burning within approximately 300 acres and a much larger number of smaller fires.
2009	According to the Florida Department of Agriculture, in 2009 there were 2,863 wildfires, which burned 136,623 acres.[100] Much of the wildfire activity

[99] Florida Department of Fire. Wildfire Hazard Mitigation Annex.
[100] http://www.floridaforestservice.com/wildfire/information.html

Date	*Information*
	occurred unusually early in the year with 1,024 wildfires occurring January 1–March 5.
2012	As of July 15, 2012, Florida was experiencing a heavy wildfire season with 2,369 fires to date. In January, smoke from wildfires significantly reduced visibility resulting in a multicar accident on I-75, which killed 11 people.

IV. Probability of Future Wildfire Events

Approximately 80 percent of all wildfires in Florida occur within one mile of the WUI. Florida has a year round fire season with the most active part taking place from April to July. The majority of wildfires in Florida (70-80 percent) are caused by humans with arson and escaped debris burning being the top two causes. The largest number of lightning-caused fires occurs in July. The drier months tend to be January, February and March but this is not always the case depending on drought conditions and frequency of frontal passages. Dry months, combined with low humidity and high wind have the highest number of fires reported.

The Florida Forest Service has developed a web-based Geographic Information System (GIS) mapping application called Fire Risk Assessment System (FRAS). This system provides statewide risk data that assists in determining high-risk areas and can be accessed at: http://www.floridaforestservice.com/wildfire/wf_fras.html. FRAS uses wildfire fuel types and densities, environmental conditions, and fire history to produce a Level of Concern (LOC), which is a number on a scale that runs from 1 (low concern) to 9 (high concern), for a given geographic area.

The computation of LOC incorporates two other indices: the Wildland Fire Susceptibility Index (WFSI) and the Fire Effects Index.

The WFSI calculates the probability of a given acre burning, given a probability of ignition based on historical data, and expected fire size based on a rate of spread. The rate of spread depends on fuel types, topography, shading from the sun, wind conditions, and potential weather conditions in the given geographic area. Based on necessary assumptions, this index is not the probability of an acre burning but a relative comparison of index values between areas in the state.

The wildland fire susceptibility analysis integrates the probability of an acre igniting and wildland fire behavior. It combines the data from the fire occurrence areas with fire behavior data developed by FlamMap. An index was computed for each 30x30 meter cell of burnable vegetation within the state. Figure 3.26 shows the graphic representation of this analysis.

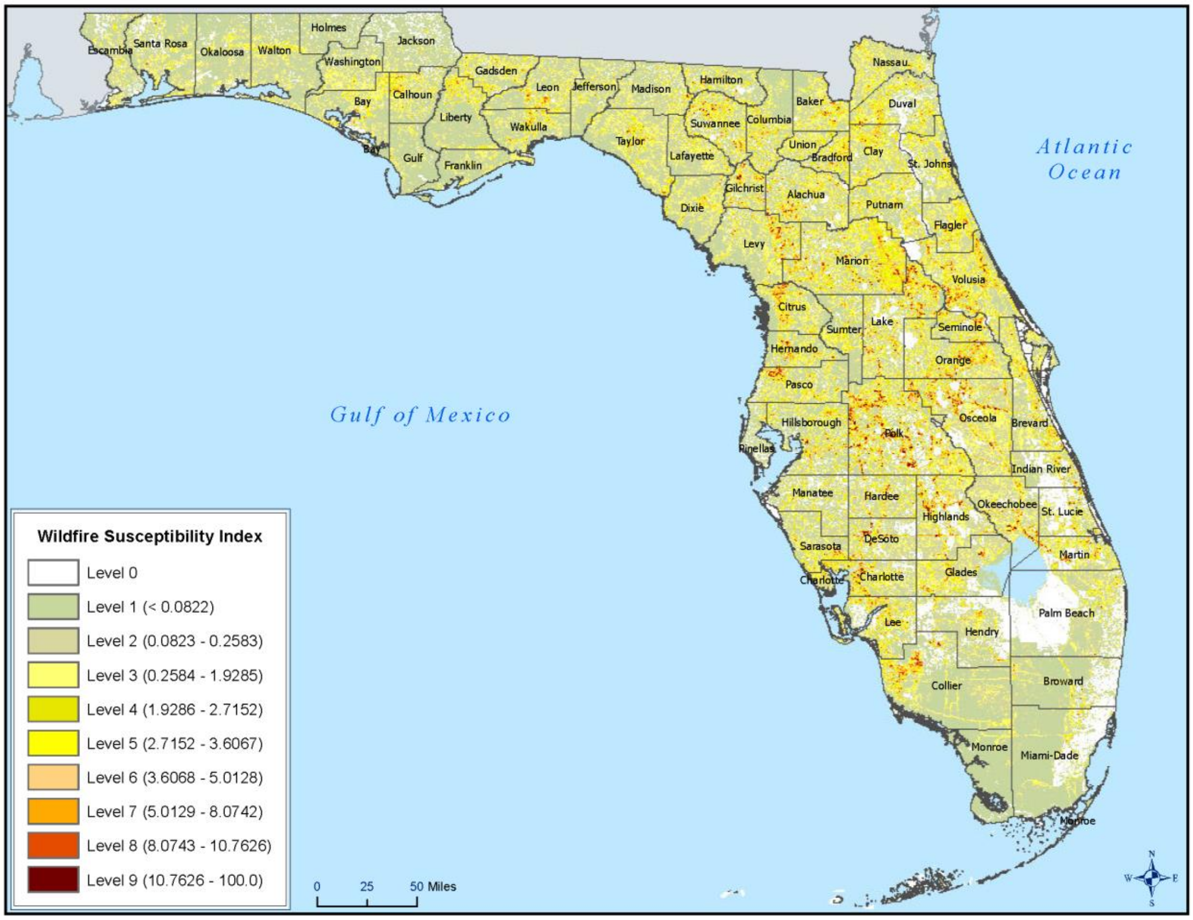

Figure 3.26 Florida's Wildfire Susceptibility

The Fire Effects Index accounts for "environmental effects" such as critical facilities, utility corridors, farmland, and the WUI in the given geographic area. Also included in the Fire Effects Index is the estimated suppression monetary cost, based on historic suppression costs for particular fuel types.

Based on the National Interagency Fire Center (NIFC) assessments, the State of Florida has remained in the "above normal" range for previous years and is forecast to continue into May 2012; therefore, the probability of fire events in the foreseeable future continues to be relatively high for the entire state.[101]

Appendix C: Risk Assessment Tables contains a detailed listing by county of the type and number of facilities for each LOC. In addition, the FFS has completed a detailed state-wide wildfire hazard mitigation plan which provides additional information on wildfires in Florida. Please see **Appendix E: Wildfire Mitigation Annex** for a copy of the plan.

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[101] http://www.nifc.gov/nicc/predictive/outlooks/monthly_seasonal_outlook.pdf. Retrieved May 2012.

V. Wildfire Impact Analysis

Wildfires will negatively affect the State of Florida with a variety of impacts:

- Forested lands and any surrounding urban areas, WUI, are most at risk to wildfires. Potential risks include destruction of land, property, and structures, as well as injuries and loss of life.
- Although rare, deaths and injuries usually occur at the beginning stages of wildfires when sudden flare-ups result from high wind conditions. In most situations, however, people have the opportunity to evacuate the area and avoid bodily harm.
- Responders are most at risk during the process of fire suppression. Responders put themselves in harm's way to contain the fire and save lives and property. Firefighters are often trapped by fires that either grow or suddenly change directions.
- Wildfires are usually small and quickly contained in Florida, and therefore the state government does not expect any events to result in the loss of the ability to deliver essential services or continue day-to-day government functions.
- Major fires have the ability to disrupt transportation in large areas of the state. The recent events in 2012 resulted in closures to the interstate system that affects local residents as well as seasonal tourists.

VI. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. The 67 multi-jurisdictional LMS plans provided a solid baseline for the overall state vulnerability analysis. Risk assessment information from the LMS plans is current as of May 1, 2012.

Based on the LMS plans in the State of Florida, Figure 3.27 displays the jurisdictional rankings for the wildfire hazard.

- High-risk Jurisdictions 30
- Medium-high–risk Jurisdictions 11
- Medium-risk Jurisdictions 21
- Low-risk Jurisdictions 5

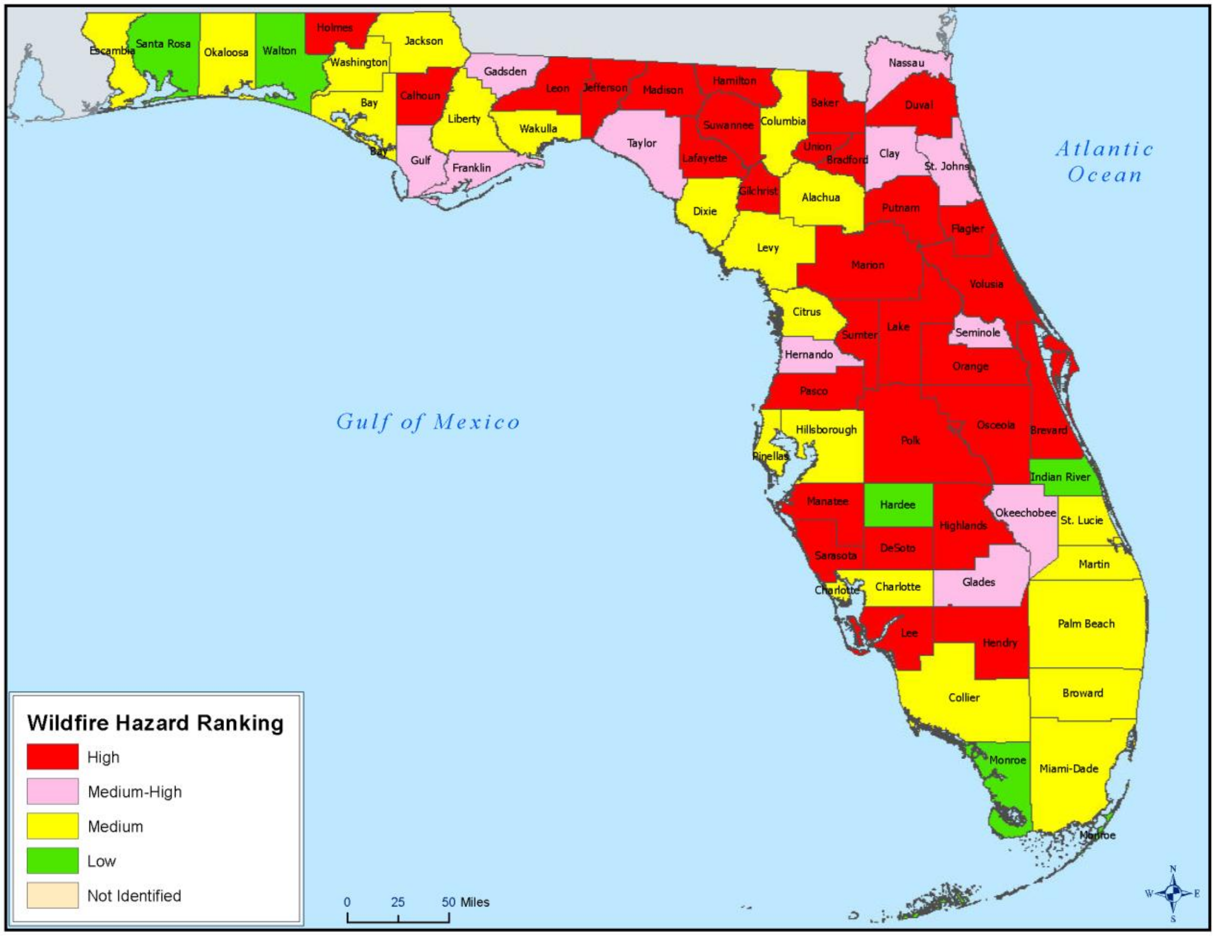

Figure 3.27 Wildfire Hazard Rankings by County

VII. Wildfire Hazard Vulnerability and Impact Analysis by Jurisdiction

Population at Risk

Approximately 9.9 percent of the population of Florida (1,848,394 people) reside in an area of high wildfire risk (LOC 7-9). Another 11.3 percent of the state's population (2,112,245 people) live in medium-risk wildfire areas denoted by LOC 4-6. The five counties with the highest number of persons within LOC 7-9 are Orange, Polk, Duval, Volusia, and Osceola counties, which account for 36.6 percent of the statewide population at high risk from wildfire. The counties with the highest percent of their countywide population at high risk from wildfire are: Desoto (40.6 percent), Flagler (39.7 percent), Charlotte (31.5 percent), Osceola (30.9 percent), and Hardee (29.9 percent). Table 3.38 shows the population by county and wildfire level of concern.

Table 3.38 Wildfire Population by Level of Concern Category[102]

County	*LOC 1*	*LOC 2*	*LOC 3*	*LOC 4*	*LOC 5*	*LOC 6*	*LOC 7*	*LOC 8*	*LOC 9*
Alachua	4,886	7,374	50,742	15,994	12,691	13,481	19,272	8,637	10,054
Baker	631	608	2,614	1,338	1,530	1,814	2,948	1,569	2,586
Bay	2,063	2,363	15,890	4,671	4,746	5,831	7,884	3,166	6,255
Bradford	240	302	3,144	1,678	2,028	2,702	4,115	1,810	1,504
Brevard	3,620	6,795	44,360	24,565	24,368	26,350	32,533	12,233	14,829
Broward	4,422	6,476	41,481	20,449	20,582	19,812	19,985	7,384	1,848
Calhoun	602	672	3,196	945	771	743	742	193	102
Charlotte	4,951	5,419	8,438	3,697	4,015	8,700	23,299	14,337	21,463
Citrus	6,253	8,178	42,668	15,864	12,246	13,499	13,804	6,261	6,165
Clay	1,579	5,787	22,352	10,699	11,061	14,001	20,621	11,954	16,487
Collier	3,091	5,181	16,396	7,638	10,341	15,167	29,209	16,353	30,139
Columbia	1,757	2,772	11,890	4,439	4,391	5,493	6,176	2,845	2,934
DeSoto	261	1,135	1,969	716	1,121	2,214	5,041	3,213	4,667
Dixie	853	1,225	4,160	927	824	883	1,197	538	354
Duval	8,829	19,035	111,315	39,167	31,546	40,216	54,781	26,052	42,105
Escambia	7,123	20,608	79,751	8,729	3,980	2,611	864	103	37
Flagler	612	1,206	4,665	4,192	4,411	6,687	13,505	9,692	15,997
Franklin	338	333	2,742	465	321	308	381	143	25
Gadsden	1,810	2,245	10,833	2,590	1,910	2,045	2,356	860	1,159
Gilchrist	784	1,457	3,109	1,036	970	1,214	2,025	1,186	1,410
Glades	493	1,150	1,902	714	663	1,012	1,096	290	531
Gulf	712	1,008	4,611	795	491	232	88	29	0
Hamilton	842	664	2,904	897	931	882	788	195	172
Hardee	459	1,756	1,720	897	1,239	2,130	3,907	2,041	2,011
Hendry	663	1,311	5,840	2,015	818	785	1,238	585	918
Hernando	4,260	7,687	30,168	8,429	7,027	8,004	10,880	5,108	5,309
Highlands	1,587	4,121	8,972	2,736	3,264	5,716	9,120	6,141	14,039
Hillsborough	44,745	42,229	357,986	68,377	46,886	41,347	34,994	11,424	11,598
Holmes	2,278	1,752	3,283	73	37	41	38	4	0
Indian River	905	1,288	8,511	3,020	2,908	4,757	10,042	5,079	9,263
Jackson	6,156	5,811	9,304	366	140	40	29	0	0
Jefferson	1,350	1,196	5,263	1,094	728	620	443	68	25
Lafayette	876	524	1,839	472	390	397	479	208	353
Lake	6,406	29,128	44,444	20,759	23,408	27,890	34,190	14,220	18,258
Lee	6,937	12,083	41,531	13,208	15,366	21,980	31,469	18,129	28,202
Leon	17,515	13,921	64,768	13,949	9,523	8,410	9,128	2,793	1,877
Levy	2,595	2,946	11,886	3,787	2,947	3,167	5,293	3,447	4,325
Liberty	330	328	1,485	523	465	464	355	103	42
Madison	1,629	1,419	5,316	1,185	756	600	549	104	84
Manatee	21,138	22,500	86,677	24,644	10,392	5,654	2,817	470	163

[102] Data obtained from the Florida Department of Fire Wildfire Hazard Mitigation Annex, 2011.

County	LOC 1	LOC 2	LOC 3	LOC 4	LOC 5	LOC 6	LOC 7	LOC 8	LOC 9
Marion	16,134	31,736	66,302	21,151	19,763	22,329	26,331	9,893	12,417
Martin	628	1,299	5,596	2,413	3,350	4,832	6,298	3,113	3,904
Miami-Dade	4,629	10,554	28,182	10,454	12,961	19,201	28,652	9,857	10,589
Monroe	9,779	6,527	1,943	90	20	8	0	0	0
Nassau	1,701	2,966	24,753	6,294	4,761	4,604	4,379	1,424	1,958
Okaloosa	7,186	8,483	29,965	4,987	3,211	2,701	1,362	202	22
Okeechobee	862	3,608	9,814	1,215	1,167	2,059	3,079	2,912	4,755
Orange	17761	38045	122648	92614	93202	110172	116560	43225	47772
Osceola	1,448	7,888	18,634	12,514	14,120	22,244	42,186	20,308	24,486
Palm Beach	6,755	9,765	43,266	29,892	26,287	25,624	26,085	9,048	11,439
Pasco	17,820	12,835	87,994	27,130	17,897	17,739	18,329	7,089	5,907
Pinellas	21,408	9,671	130,103	20,346	8,235	3,591	2,366	753	353
Polk	11,184	21,917	76,638	35,063	32,824	37,620	63,737	38,010	58,067
Putnam	1,956	2,454	14,059	5,437	5,399	6,776	10,028	5,228	7,006
Santa Rosa	3,248	5,684	48,017	12,177	8,168	6,724	3,392	748	168
Sarasota	14,772	21,942	76,604	15,405	9,260	6,676	7,896	10,027	9,413
Seminole	9,819	13,288	75,561	45,868	36,030	34,509	31,185	10,665	6,633
St. Johns	3,345	5,108	28,502	9,312	8,319	9,118	11,193	4,258	7,398
St. Lucie	1,167	5,585	16,469	5,997	9,645	17,011	20,712	8,347	7,817
Sumter	14,011	11,599	16,623	13,221	2,895	3,326	1,014	174	59
Suwannee	1,669	2,073	7,378	2,786	2,407	2,872	4,113	1,786	2,126
Taylor	715	661	3,027	1,117	1,151	1,560	1,876	617	847
Union	195	216	1,762	618	561	738	843	176	99
Volusia	5,970	12,093	70,962	35,398	30,173	34,176	46,681	24,201	32,738
Wakulla	784	1,015	7,862	2,493	2,212	2,619	3,034	1,197	1,823
Walton	5,152	6,296	21,165	2,725	1,964	1,708	1,049	371	580
Washington	3277	2638	7633	691	270	178	62	8	1

Property at Risk

In Florida, there are almost 1.4 million structures within medium to high wildfire risk areas (LOC 4-9). County-level data shows that a majority of the structures located within medium to high-risk areas are single-family homes.

In a county comparison of wildfire risk, the five counties with the highest number of structures within LOC 7-9 are Polk, Orange, Duval, Volusia, and Osceola Counties. These counties have the highest number of persons as well as structures at high risk from wildfire due to residential properties being disproportionally represented in high-risk wildfire areas compared to other structure types. These five counties have 214,575 structures within LOC 7-9. The counties with the highest percent of their countywide building stock at high risk from wildfire are: Desoto (39.0 percent), Flagler (37.6 percent), Osceola (31.0 percent), Charlotte (29.6 percent), and Baker (29.2 percent).

There is over $298 billion in property value with a medium to high risk from wildfire. The estimates of property value include structure value as assessed by each county, but do not include the value of agriculture or silviculture that may be present on the property.

In a county comparison of wildfire risk, the five counties with the highest property values within LOC 7-9 are Orange, Duval, Collier, Polk, and Osceola Counties. Together these counties have over $45 billion in property at high risk from wildfire. The counties with the highest percent of their countywide property value at high risk from wildfire are: Flagler (30.6 percent), Osceola (28.0 percent), Highlands (25.6 percent), Charlotte (25.6 percent), and Baker (25.3 percent).

Appendix C: Risk Assessment Tables contains detailed information organized by level of concern and for the type and number of structures by county that are at risk.

VIII. Assessing Vulnerability of State Facilities

A vulnerability analysis for wildfires was conducted for the 2010 plan update. In this section, the state's vulnerability to wildfires was analyzed, identifying the specific counties within the state that were perceived to be vulnerable to the effects of wildfires and assessing their individual levels of vulnerability. The following outlines the 2010 process, however, the state facility portion was not updated for 2013 because the levels of concern overlay for the state facility data was not available.

Using the state facility database provided by the DFS, the SHMPAT identified which facilities lay within the wildfire LOC (LOC zones 1–9). Summarizing the facilities by total counts and insured values within the zones provided estimates of dollar vulnerability by county.

The wildfire maps illustrate the counties that were identified as vulnerable to the effects of wildfires and their overall levels of vulnerability. Specific totals of the number of state facilities and their vulnerability within each county can be found in the following tables. Detailed financial information pertaining to the estimated losses of state facilities by county can also be found in **Appendix C: Risk Assessment Tables**.

All regions of Florida are vulnerable to the effects of wildfires; however, there are specific areas of Florida that are perceived to have more vulnerability than others. It is acknowledged that this range of risk to wildfires can change dramatically over time based on the occurrence of long-term climatic events such as droughts. All parts of Florida are understood to be vulnerable to the effects of wildfires, and the central and southern parts of Florida are the most vulnerable. These findings are based primarily on the facts of Florida's current multi-year long drought.

The drought has affected all areas differently depending on their ecological surroundings, but what is consistent is the fact that the drought has caused a dramatic reduction in water levels and has dried out forests and timberland to dangerous levels, which makes them highly vulnerable to a wildfire event.

IX. Estimating Potential Losses by Jurisdiction

During the 2013 plan update process, the SHMPAT researched the potential losses related to wildfires and collected data to assist with this estimation. The updated Florida Forest Service Wildfire Mitigation Annex provides county level data by levels of concern that helped to outline the number of structures potentially affected.

Wildfire Loss Estimation

Historical evidence shows that most of the state is vulnerable to wildfires. Table 3.39 provides annualized loss estimates of residential buildings, commercial buildings, medical buildings, educational buildings, and governmental buildings per county from wildfires.

Table 3.39 Wildfire Structures Summary[103]

County	*Total Value of Structures ($Millions)*	*Estimated Annualized Loss ($Thousands)*	*County*	*Total Value of Structures ($Millions)*	*Estimated Annualized Loss ($Thousands)*
Alachua	9,747	225	Lee	19,330	526
Baker	1,108	22	Leon	11,103	211
Bay	6,222	142	Levy	3,056	45
Bradford	1,250	22	Liberty	562	5
Brevard	14,518	402	Madison	893	7
Broward	19,955	481	Manatee	13,344	208
Calhoun	625	5	Marion	18,355	364
Charlotte	8,003	244	Martin	7,337	167
Citrus	8,093	175	Miami-Dade	17,556	428
Clay	7,635	222	Monroe	5,870	49
Collier	21,515	649	Nassau	4,976	100
Columbia	2,683	53	Okaloosa	5,778	83
DeSoto	1,939	30	Okeechobee	1,989	34
Dixie	1,347	11	Orange	53,301	1,405
Duval	31,679	811	Osceola	17,197	419
Escambia	6,995	109	Palm Beach	26,018	637
Flagler	5,997	194	Pasco	15,753	320
Franklin	1,114	17	Pinellas	17,117	281
Gadsden	1,739	23	Polk	18,288	513
Gilchrist	1,090	15	Putnam	3,671	82
Glades	2,527	15	Santa Rosa	6,286	111
Gulf	1,210	16	Sarasota	20,698	382
Hamilton	873	7	Seminole	19,713	514

[103] Data obtained from the Florida Department of Fire Wildfire Hazard Mitigation Annex, 2011

County	Total Value of Structures ($Millions)	Estimated Annualized Loss ($Thousands)	County	Total Value of Structures ($Millions)	Estimated Annualized Loss ($Thousands)
Hardee	1,633	18	St. Johns	11,954	282
Hendry	2,742	28	St. Lucie	6,916	181
Hernando	6,351	145	Sumter	5,525	74
Highlands	3,633	114	Suwannee	1,552	26
Hillsborough	41,554	790	Taylor	971	14
Holmes	675	3	Union	659	5
Indian River	6,085	155	Volusia	18,441	517
Jackson	1,386	11	Wakulla	1,596	32
Jefferson	1,095	8	Walton	6,524	111
Lafayette	566	4	Washington	1,044	9
Lake	13,869	371			

National Climatic Data Center Wildfire Loss Estimation

Data from the NCDC provides details about the historical wildfires in the state. For future revisions, it is the intent of the risk assessment sub-group to use loss information from the Florida Forest Service. Table 3.40 shows the quantity of wildfires and the associated annualized losses that have occurred in Florida from October 2006 to July 2012. Previous years' data is not currently available from the database.

Table 3.40 Historical Wildfire Summary[104]

NCDC Reports	Average per Year	Annualized Property Loss ($Millions)	Annualized Crop Loss ($Millions)
97	16	4.67	0

Based on this historical data, the average estimated loss per wildfire is approximately $289,247. The following statistics were noted by the SHMPAT to qualify this estimated loss:

- The event with the highest damage was May 2008, in Brevard County with $16 million in damages.
- Columbia County, in May 2007, also had an event worth $10.6 million in damages.

The SHMPAT determined that worst-case loss estimates for wildfires could reach into the hundreds of millions of dollars. In addition, the sample size, given the number of wildfires without damages would not yield a valid estimate.

[104] http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=12%2CFLORIDA

X. Estimating Potential Losses of State Facilities

The SHMPAT did not conduct loss estimations on wildfires in the original plan development process. This wildfire-specific estimation was added and updated for the 2010 plan update. Data was not available for the updated levels of concern to overlay with the new state facility data for 2013. Table 3.41 shows the range of values for facilities within areas of concern. **Appendix C: Risk Assessment Tables** contains a detailed breakdown for each type of facility per LOC by county and the associated value.

Table 3.41 Wildfire Facilities Summary[105]

County	*Value of Facilities ($Millions)*	*Estimated Annualized Facility Losses ($Thousands)*	*County*	*Value of Facilities ($Millions)*	*Estimated Annualized Facility Losses ($Thousands)*
Alachua	3,652.66	67.81	Liberty	26.84	0.49
Bay	97.38	0.94	Manatee	29.29	0.52
Brevard	87.93	1.42	Marion	140.29	2.17
Broward	433.74	2.91	Martin	78.28	1.04
Charlotte	79.22	2.17	Miami-Dade	1,600.45	9.2
Citrus	22.4	0.7	Monroe	57.47	0.46
Clay	20.7	0.13	Nassau	24.89	0.13
Collier	177.64	5.31	Okaloosa	62.59	0.46
Desoto	114.83	1.55	Orange	1,454.5	32.61
Dixie	25.36	0.64	Osceola	61.27	1.84
Duval	666.14	3.96	Palm Beach	945.69	7.52
Escambia	412.5	4.35	Pasco	47.69	0.66
Flagler	9.96	0.24	Pinellas	286.59	2.5
Franklin	50.35	0.64	Putnam	25.48	0.14
Gilchrist	21.14	0.22	Santa Rosa	120.56	1.69
Glades	2.44	0.06	Sarasota	278.79	5.07
Gulf	56.8	0.73	Seminole	27.58	0.84
Hendry	31.89	0.67	St Johns	177.31	2.99
Hernando	31.02	0.56	St Lucie	176.02	3.05
Hillsborough	1570	28.18	Taylor	56.59	1.17
Indian River	23.9	0.2	Volusia	145.87	3.53
Lafayette	27.37	0.33	Wakulla	90.53	1.28
Lee	477.88	10.7	Walton	46.36	0.87
Leon	681.2	15.56	Washington	102.75	1.56
Levy	21.33	0.36			

[105] Data obtained from the Florida Forest Service Wildfire Hazard Mitigation Annex, 2011

3.3.5 Drought Profile

I. Drought Description and Background Information

In the most general sense, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector.

Drought should be considered relative to some long-term average condition of balance between precipitation and "evapotranspiration" (i.e., evaporation + transpiration) in a particular area, a condition often perceived as "normal." It is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness (i.e., rainfall intensity, number of rainfall events) of the rains. Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with it in many regions of the world and can significantly intensify its severity.

When drought begins, the agricultural sector is usually the first to be impacted because of its heavy dependence on stored soil water. Those who rely on surface water (i.e., reservoirs and lakes) and subsurface water (i.e., ground water), for example, are usually the last to be affected. A short-term drought that persists for three to six months may have little impact on these sectors, depending on the characteristics of the hydrologic system and water use requirements.

Drought Indexes and Measurements

In 1965, W.C. Palmer developed an index to measure the departure of the moisture supply.[106] Palmer based his index on the supply-and-demand concept of the water balance equation, taking into account more than just the precipitation deficit at specific locations. The objective of the Palmer Drought Severity Index (PDSI), shown in Table 3.42, was to provide measurements of moisture conditions that were standardized so that comparisons using the index could be made between locations and between months.

Table 3.42 Palmer Drought Severity Index[107]

Palmer Classifications			
4.0 or more	Extremely wet	-0.5 to -0.99	Incipient dry spell
3.0 to 3.99	Very wet	-1.0 to -1.99	Mild drought
2.0 to 2.99	Moderately wet	-2.0 to -2.99	Moderate drought
1.0 to 1.99	Slightly wet	-3.0 to -3.99	Severe drought
0.5 to 0.99	Incipient wet spell	-4.0 or less	Extreme drought
0.49 to -0.49	Near normal		

[106] W.C. Palmer, 1965. Palmer Drought Severity Index (PDSI).
[107] W.C. Palmer, 1965. Palmer Drought Severity Index (PDSI).

The PDSI is most effective in determining long-term drought, a matter of several months, and is not as reliable with short-term forecasts, a matter of weeks. It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, minus 2 is moderate drought, minus 3 is severe drought, and minus 4 is extreme drought. The advantage of the PDSI is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions.

The Keetch-Byram Drought Index (KBDI) is a continuous reference scale for estimating the dryness of the soil and duff layers. The index increases for each day without rain (the amount of increase depends on the daily high temperature) and decreases when it rains. The scale ranges from 0 (no moisture deficit) to 800. The range of the index is determined by assuming that there are 8 inches of moisture in saturated soil that is readily available to the vegetation.

For different soil types, the depth of soil required to hold 8 inches of moisture varies (loam 30 inches, clay 25 inches, and sand 80 inches). A prolonged drought (high KBDI) influences fire intensity largely because more fuel is available for combustion (i.e., fuels have a lower moisture content). In addition, the drying of organic material in the soil can lead to increased difficulty in fire suppression.

Figure 3.28 shows the most recent KDBI levels for Florida.[108]

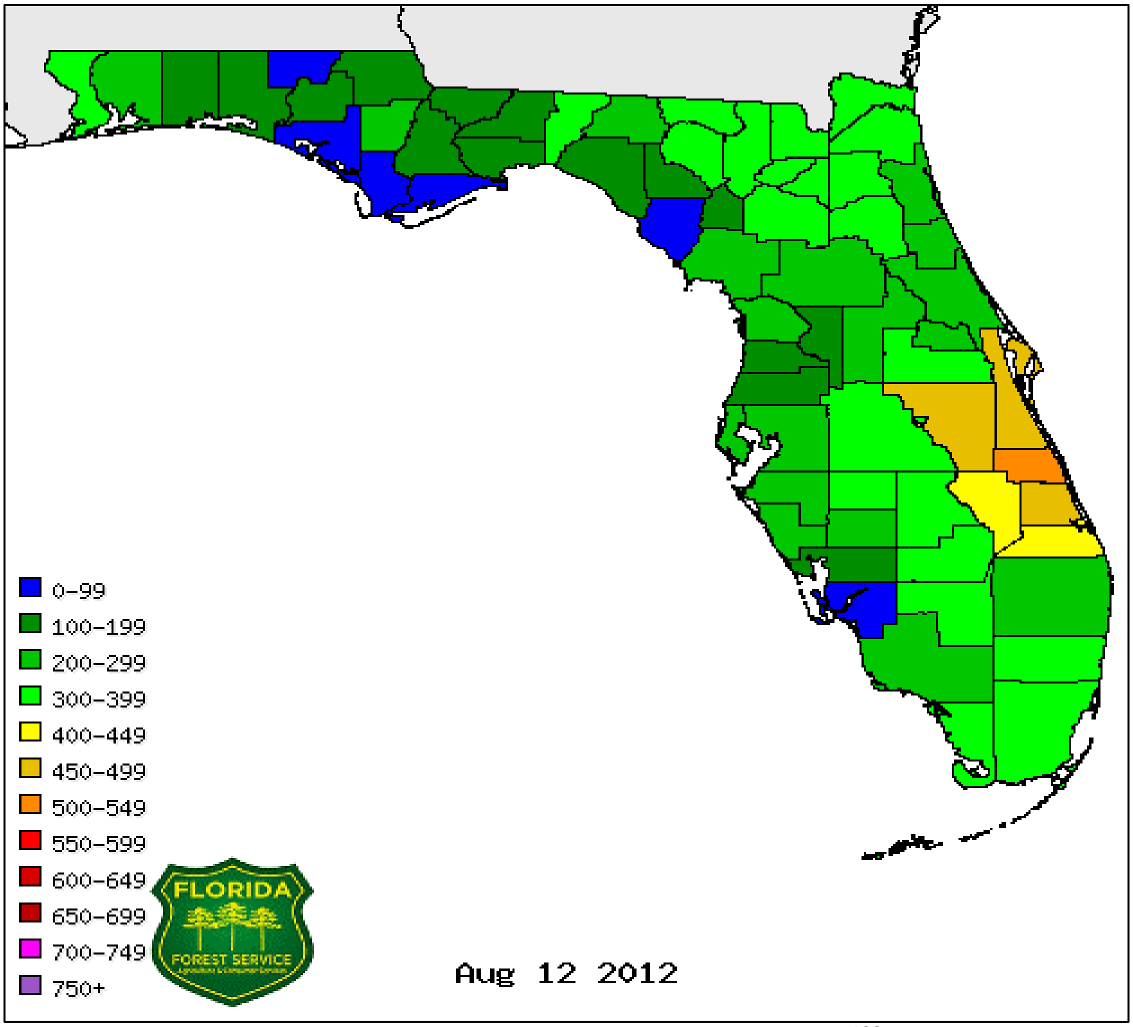

Figure 3.28 Keetch-Byram Drought Index[109]

II. Geographic Areas Affected by Drought

The State of Florida experiences cyclical drought on a regular basis. Currently, there are visible long-term trends toward a drier climate and warmer weather. Analyzing past events as well as the current drought conditions has proven that the drought conditions and the severity of drought conditions has been variable over the years, affecting the east, north, south, and central regions randomly and somewhat equally.

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[108] http://flame.fl-dof.com/fire_weather/KBDI/index.html
[109] http://flame.fl-dof.com/fire_weather/KBDI/index.html

III. Historical Occurrences for Drought

Bordered by two large bodies of water, Florida has the longest coastline in the continental United States, the second largest lake in the nation that lies entirely within the United States[110]—Lake Okeechobee—and 50,000 miles of rivers, streams, and waterways. Even as recently as from 1998–2001, Florida experienced a destructive drought where farm crops were ruined, forest fires burned, and lake levels reached an all-time low. Additionally, in 2006–2007 rainfall deficits were the largest observed since the mid-1950s. The following summation in Table 3.43 illustrates the droughts that have affected the State of Florida, as well as its neighboring regions.

From 1950 to May 2009, there were 33 recorded instances of drought in Florida. Four major hydrologic droughts have affected Florida. Areas of the state most severely affected by these droughts were the Panhandle and South-Central peninsula from 1932–1935; the entire state from 1949–1957 and again from 1980–1982; and the peninsula from 1970–1977.

Table 3.43 Historical Occurrences of Drought[111]

Date	*Information*
1954–1956	The most extreme drought on record occurred during 1954–1956 when runoff was 8 inches below normal, causing extensive loss of crops and timber.
1980–1982	The drought of 1980–1982 was the result of rainfall deficiencies ranging from 22.1–31.3 inches, causing water levels at Lake Okeechobee to reach the lowest levels ever recorded.
May 2001	A 13-month period of below normal rainfall ended on May 20, 2001, with the beginning of the rainy season. Rainfall amounts since May 2000 over interior and southwest portions of south Florida and over all of Palm Beach County averaged about 30 percent below normal. Lake Okeechobee fell to a historic low level of 9.1 feet. Sugar cane and other crops were adversely impacted, as well as marine life around Lake Okeechobee.
Long Term Drought 1998–2002	Lower than normal precipitation caused a severe long-term statewide drought in Florida lasting from 1998–2002. Based on precipitation and stream flow records dating to the early 1900s, the drought was one of the worst ever to affect the state. In terms of severity, this drought was comparable to the drought of 1949–1957 in duration and had record-setting low flows in several basins. The drought was particularly severe over the 5-year period in the northwest, northeast, and southwest regions of Florida, where rainfall deficits ranged from 9–10 inches below normal (southwest Florida) to 38–40 inches below normal (northwest Florida). Within these regions, the drought caused record-low stream flows in several river basins, increased freshwater withdrawals, and created hazardous conditions ripe for wildfires, sinkhole development, and even the draining of lakes. South Florida was affected primarily in 2001, when the region experienced below-average stream flow conditions; however, cumulative rainfall in south Florida never fell below the 30-year normal. Among the drought measures taken in 2001:

[110] U.S. Corps of Engineers publication, “Lake Okeechobee & the Herbert Hoover Dike”, 2009.
[111] Various sources including http://www.ncdc.noaa.gov/sotc/drought/

Date	*Information*
	• Three of Florida's five water management districts imposed mandatory cutbacks, strictly limiting water use. • Several municipalities hiked water-sewer rates, meaning even customers who cut back were paying more. • Restaurants in South Florida were ordered to stop serving water, except to diners who asked.
2007–2008	Most portions of South Florida were in the grips of a one in 25-year drought as they approached the "typical" 3–4 month dry season. The Lake Okeechobee water level dropped at a rate of about 0.5 feet per month and is currently at 11.5 feet, which is three feet below its historical average for this time of year and 2.5 feet from the record low of 8.97 feet on May 24, 2001. Mandatory phase one restrictions (15 percent cutback) were in force for the Lake Okeechobee Service Area, as well as the Northern Indian Prairie Basin. These areas include the Everglades Agricultural Area and portions of Hendry, Glades, Lee, Okeechobee, Palm Beach, and Martin counties. Also included are agricultural areas south of Lake Istopoka in Highlands County. A formal water shortage warning (voluntary reductions) is also in place for the Lower East Coast Service Area.
2009	A drought began in the late winter months and continued into early and mid-May over South Florida. Severe drought (D2) conditions in southeast Florida were triggered by the driest winter on record in many locations. Winter season rainfall at the Miami International Airport was .74 inches, making it the driest winter on record. Also, rainfall at Fort Lauderdale was .39 inches, which was the driest on record. Additionally, winter season rainfall at West Palm Beach was 2.01 inches, which was the second driest on record. The level of Lake Okeechobee fell from 12.83 feet to 12.20 feet by the end of March. The KDBI reached extreme levels across most of South Florida indicating high fire danger values. This resulted in several small brush fires.
2010	Severe drought conditions (D2) developed across Jackson and Holmes counties on September 14 and continued into October. Severe drought conditions (D3) developed on October 19 and continued into November. Severe drought conditions (D2) developed in Washington and Northern Walton counties on October 5. Extreme drought conditions (D3) developed in Washington and northern Walton counties on October 19 and continued into November. Severe drought conditions (D2) persisted through all of December across portions of northern Florida and the Big Bend.
2011	Severe drought conditions (D2) persisted through all of January and into February across portions of northern Florida and the Big Bend. Continued dry weather in January, coupled with long-term dryness going back to the previous summer, led to the expansion of severe drought conditions over South Florida. Rainfall deficits in October were in the 3–6 inch range with the level of Lake Okeechobee remaining steady at about 12.5 feet, which is 2.2 feet below normal.

IV. Probability of Future Drought Events

As of April 2012, drought conditions have improved over South Florida with a low-pressure system moving through that brought rainfall amounts between 1–3 inches.[112] Based on the previous occurrences of drought conditions in the state, the probability of future drought events occurring over the long term with some frequency remains high. As the state continues to develop with higher populations, higher water demands, and more demands related to agriculture and livestock, these drought conditions and drier trends may begin to have a profound impact on the state and its residents.

V. Drought Impact Analysis

Drought will negatively affect the State of Florida with a variety of impacts:

- Drought is often associated with periods of long and intense heat. Drought usually does not affect humans directly, but extreme heat can cause injury and even death, particularly with children, elderly citizens, and other special needs populations. Injuries and potential deaths are most likely to impact rural, poor areas that lack air conditioning and immediate medical care.
- The largest impact of prolonged drought is the financial impact to farmers with crops and livestock. Florida has a significant agriculture industry, and a serious drought would damage or possibly destroy annual crops and limit the number of livestock that could be properly cared for.
- Drought and extreme heat have no real effect on houses, facilities, or state infrastructure. Rationing water supplies would most likely be the worst-case scenario impact for drought.
- Prolonged drought over a number of years could have long-term environmental impacts on the area, including species endangerment and necessary changes to the local agricultural makeup.
- There is an increased sinkhole formation risk under drought conditions

Agricultural Vulnerability to Drought

The primary vulnerability to drought is the robust agricultural sector of the state. Both short-term drought during critical times in the growth cycle and long-term drought over many years affect the farmers. The following statistics provide an idea of the magnitude of this industry and the profound economic impact that this hazard could have on the state. [113]

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[112] Drought Information Station. National Weather Service. http://www.srh.noaa.gov/productview.php?pil=DGTMFL

[113] Overview of Florida Agriculture. Florida Department of Agriculture and Consumer Services http://www.florida-agriculture.com/

As of June 2012, Florida ranked:

- First in the U.S. in the cash receipts for oranges, grapefruit, fresh snap peas, sweet corn, watermelons, fresh cucumbers, squash, and sugar cane.
- Second in the production of greenhouse and nursery products.
- Eleventh in beef cows.
- Seventh in overall agricultural exports, at $3.1 billion.

According to the latest information available from the Florida Department of Agriculture and Consumer Services in 2010, in terms of total value of production, Florida accounted for:[114]

- 62 percent of the total U.S. value for oranges ($1.2 billion)
- 72 percent of the total U.S. value for grapefruit ($207 million)
- 44 percent of the total U.S. value for snap beans ($135 million)
- 22 percent of the total U.S. value for tangerines ($61 million)
- 52 percent of the total U.S. value for sugarcane for sugar and seed ($551 million)
- 45 percent of the total U.S. value for fresh market tomatoes ($631 million)
- 46 percent of the total U.S. value for bell peppers ($296 million)
- 25 percent of the total U.S. value for fresh market cucumbers ($48 million)
- 23 percent of the total U.S. value for watermelons ($113 million)

Florida had 47,500 commercial farms in 2010,[115] using a total of 9.25 million acres. There were 5,950 farms with sales exceeding $100,000. The average farm size was less than 250 acres. The number of farms in Florida has remained stable over the past 10 years.[116]

VI. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. Risk assessment information from the LMS plans is current as of May 1, 2012. Based on the LMS plans, Figure 3.29 displays the jurisdictional rankings for the drought hazard. Not all counties have identified drought as one of their hazards.

- High-risk Jurisdictions 4
- Medium-high–risk Jurisdictions 12
- Medium-risk Jurisdictions 33
- Low-risk Jurisdictions 15

[114] http://florida-agriculture.com/consumers/crops/agoverview/
[115] This is the most recent update from the Florida Department of Agriculture and Consumer Services.
[116] http://www.fl-ag.com/agfacts.htm

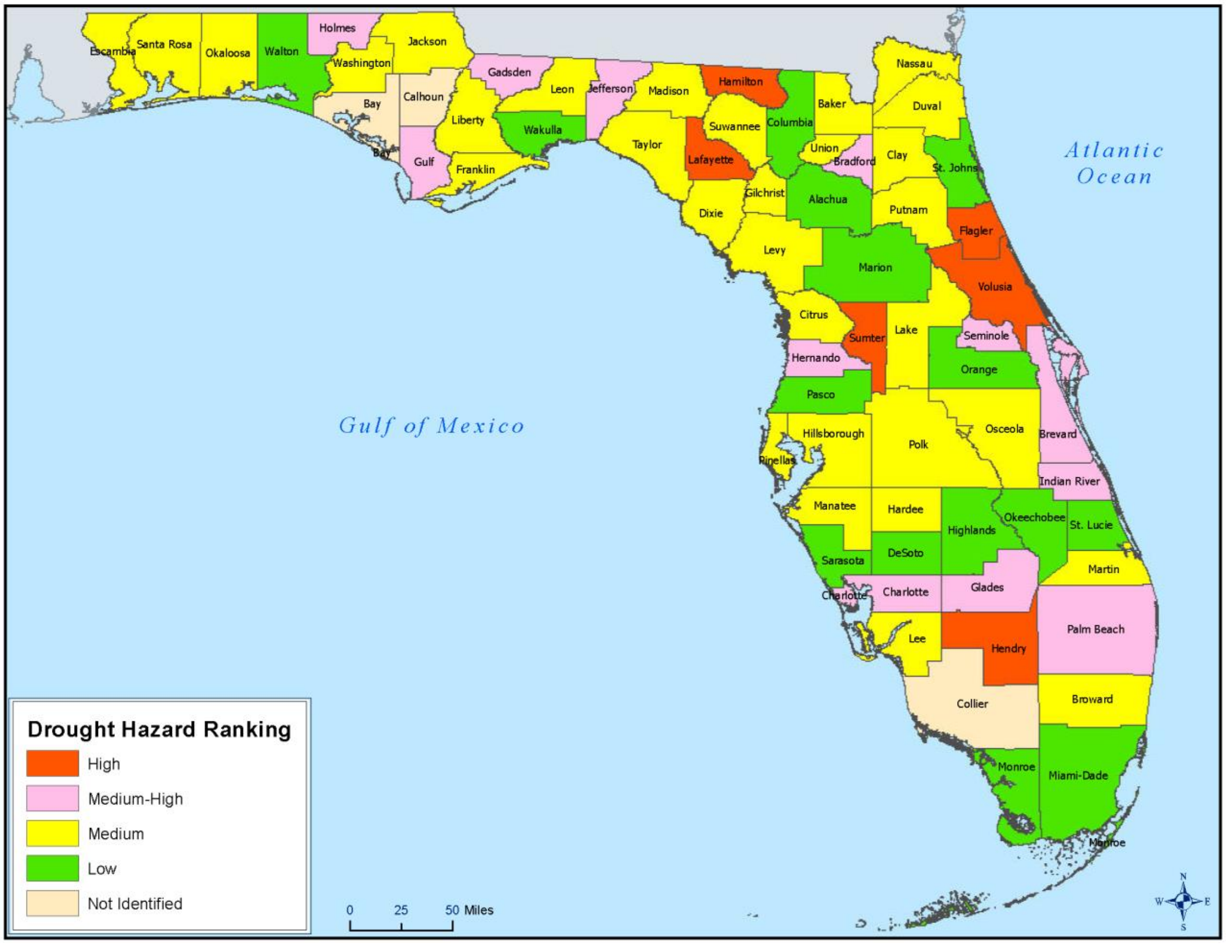

Figure 3.29 Drought Hazard Rankings by County

VII. Drought Hazard Vulnerability Analysis by Jurisdiction

During the 2013 plan update process, the SHMPAT researched the overall vulnerability to drought and collected data to assist with the estimation of potential losses. The following section provides details for this hazard.

Availability of water during drought conditions is controlled largely by the topography, geology, hydrogeology, and hydrology of an area. Because these factors vary considerably by physiographic region in Florida, drought vulnerability can be generally assessed by physiographic region. Local conditions, such as the availability of a large impoundment for water storage, may affect drought vulnerability on a local scale. Florida has been involved in a cyclical drought, and early in 2007, very dry conditions led to large fires across the northern part of the state. As of this revision, based on the wet climatology of Florida, drought improvement is likely.[117]

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[117] http://www.cpc.ncep.noaa.gov/products/expert_assessment/DOD.html

The drought vulnerability was reviewed as a part of the 2013 plan revision. The entire state continues to be vulnerable to cyclical drought, with the northern portion having a higher overall risk factor. The vulnerability to drought is different from the other vulnerabilities considered in this plan since the majority of the built environment is not vulnerable to this hazard.

VIII. Assessing Vulnerability of State Facilities

A vulnerability analysis on drought was not conducted in 2004; however, one was completed during the 2007, 2010, and 2013 plan update and revision process. Although facilities themselves are not vulnerable to drought, the areas or regions that the facilities are located in may be susceptible to drought. The efficiency at which a building operates may be affected (i.e., low water pressure) if the building is in a drought-stricken area.

To complete the analysis, the specific counties within the state that were perceived to be vulnerable to the effects of drought and their individual levels of vulnerability were first identified. Droughts are common in the State of Florida and can occur in virtually any region and last for any length of time. Therefore, all counties are perceived to be vulnerable to the effects of drought, a drought event at one time, or another over the long-term. Because of this fact, the current drought events within Florida were reviewed and their effects modeled on the "Long-Term Indicators" currently provided by the National Oceanic and Atmospheric Association. The current existing long-term forecast for drought conditions within the State of Florida was used to model the state's vulnerability to droughts.

The analysis researched the current two-year long drought conditions within Florida as well as the long-term indicator to determine the state's overall vulnerability. However, droughts, like winter storms and other similar hazards that do not cause direct structural damage to facilities, do not pose a severe risk to state facilities.

Currently, the "most extreme" vulnerable risk areas of Florida to drought are the northern portion of the state and the Panhandle. The "extreme" risk vulnerable areas are the southern counties from Orlando south.

IX. Estimating Potential Losses by Jurisdiction

The 2004 original plan did not perform a loss estimate on a statewide level for drought. During the 2013 plan update process, the SHMPAT researched the potential losses related to drought and extreme heat and collected data to assist with this estimation. There were no significant changes since the 2010 plan update.

National Climatic Data Center Drought Loss Estimation

Data from the NCDC provides details about the historical droughts in the state. While 572 events are listed between October 2006 and April 2012, only two events have reported damages through the NCDC. One of these events pre-dates the currently available information from the NCDC. Of these two events, there is a large disparity in the crop damage statistics as seen here:

- May 1, 2001: Event reported $100 million in crop damages
- December 18, 2006: Event reported $32,000 in crop damages

Based on this historical data, the average estimated loss for each drought is approximately $174,576. The SHMPAT determined that worst-case loss estimates for drought could easily reach into the hundreds of millions of dollars. However, many drought events are much less severe.

SHMPAT Drought Research

Due to the lack of data from the NCDC, the SHMPAT conducted some additional research during the 2010 and 2013 plan update process in order to further enhance the ability to estimate losses from drought. It recognized the following items as potential impacts from drought that would involve losses:

- The agricultural sector is the most at risk from this hazard, with potential significant economic loss due to farming, nurseries, and other water-dependent businesses. Lack of water is likely to result in crop losses, particularly during the time of year when “evapotranspiration” losses are highest and crop needs are the most intense.
- Livestock suffer in drought, and their related pasturelands are affected.
- The risks of water shortage in Florida include increased potential of saltwater intrusion into coastal well fields.
- Drought increases the likelihood of wildland fires and a related lack of water for fire protection. Lowered water levels in canals and surface waters could hamper the ability to fight fires in rural areas.
- Potential losses also are due to tourism impacts and the related economic factor.

The SHMPAT developed exposure amounts as an indicator of the potential losses that would occur if a drought damaged agricultural commodities. Table 3.44 lists these commodities.

Table 3.44 Drought Commodities Summary[118]

Type of Commodity	*Value of Receipts ($Thousands)*	*Percent of U.S. value*
Greenhouse/nursery	1,931,750	12.0
Oranges	1,340,655	68.1
Tomatoes	622,251	26.2
Dairy products	464,204	1.3
Cane for sugar	442,166	52.0
Total	7,978,081	2.5

[118] http://www.ers.usda.gov/Statefacts/FL.htm

During the 2010 and 2013 update process, the SHMPAT noted the lack of sufficient data to fully estimate losses for drought. It recognized that some droughts are temporary and localized, with minimal or no subsequent losses, and that some have been statewide and prolonged, with extreme financial impact to the state. To collect better data for improved loss estimations during the next plan revision cycle, the team has agreed to work closely with these agencies involved in the state's Drought Action Plan:

- Department of Environmental Protection
- Division of Emergency Management
- Department of Agriculture and Consumer Services
- State Water Management Districts

X. Estimating Potential Losses of State Facilities

The SHMPAT did not conduct loss estimations on drought because the facilities themselves are not vulnerable to drought.

3.3.6 Extreme Heat Profile

I. Extreme Heat Description and Background Information

Extreme heat is defined as extended period of time where the temperature and relative humidity combine for a dangerous heat index.[119] Extreme heat can occur throughout the state but typically occurs in the summer between the months of June and September.This hazard is focused on the affects to the human population, while drought focuses more in agricultural interests.

Extreme heat can ultimately cause death. Most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. Older adults, young children, and those who are sick or overweight are more likely to succumb to extreme heat.

II. Historical Occurrences of Extreme Heat

Florida has always been known for its high humidity and heat, which combine to affect its population. According to the NCDC, there have been 34 reported extreme heat occurrences in Florida since 2007.

[119] http://www.nws.noaa.gov/os/heat/index.shtml

On average, 175 people die per year from heat-related illnesses throughout the United States. From 1993-2004, extreme heat killed, on average, more people than flooding, hurricanes, tornadoes, and lightning combined.[120] Table 3.45 highlights the major historical occurrences.

Table 3.45 Historical Occurrences of Extreme Heat

Date	*Information*
June 1998	In June 1998, a deep high-pressure ridge persisted across the Gulf of Mexico and Florida throughout most of June and into early July, resulting in several long stretches of record-breaking high temperatures and claiming one life. Melbourne had 22 days, Orlando had 12 days, and Daytona Beach had 13 days where high temperature records were either tied or broken. Melbourne had four 100 degree or greater days, Orlando had three, and Daytona Beach had nine.
July 2000	July 2000 was the hottest month ever recorded in northwest Florida. The average temperature in Pensacola for the month was 85.6 degrees, breaking the old record of 85.4 degrees. The temperature also reached 100 degrees or higher seven days during the month. The highest temperature during the month at the Pensacola airport was 103 degrees. Milton had five days of 100 degrees or higher, with the highest being 102 degrees. Niceville had six days of 100 degrees or higher during the month, with the highest temperature of 103 degrees.

III. Probability of Future Extreme Heat Events

The NCDC compares each state's temperature over the month, 3 months, 6 months, and year.[121] The June 2012 report showed that Florida is experiencing a continuing trend toward temperatures that are milder to near normal. This is a drastic change from the longer averages that put the state in above to "much above" normal ranges. Tropical Storm Debby provided some affect to the climate data. The outlook for the short-term remainder of 2012 includes average temperatures driven by the seasonal change and a maturing El Niño.

IV. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. The 67 multi-jurisdictional LMS plans provided a solid baseline for the overall state vulnerability analysis. Risk assessment information from the LMS plans is current as of May 1, 2012.

[120] http://www.crh.noaa.gov/lmk/?n=noaaexcessiveheat
[121] http://www.ncdc.noaa.gov/sotc/drought/2012/6

Based on the LMS plans in the State of Florida, Figure 3.30 displays the jurisdictional rankings for the extreme heat hazard. Not all counties have identified extreme heat as one of their hazards.

- High-risk Jurisdictions 5
- Medium-high–risk Jurisdictions 5
- Medium-risk Jurisdictions 15
- Low-risk Jurisdictions 16

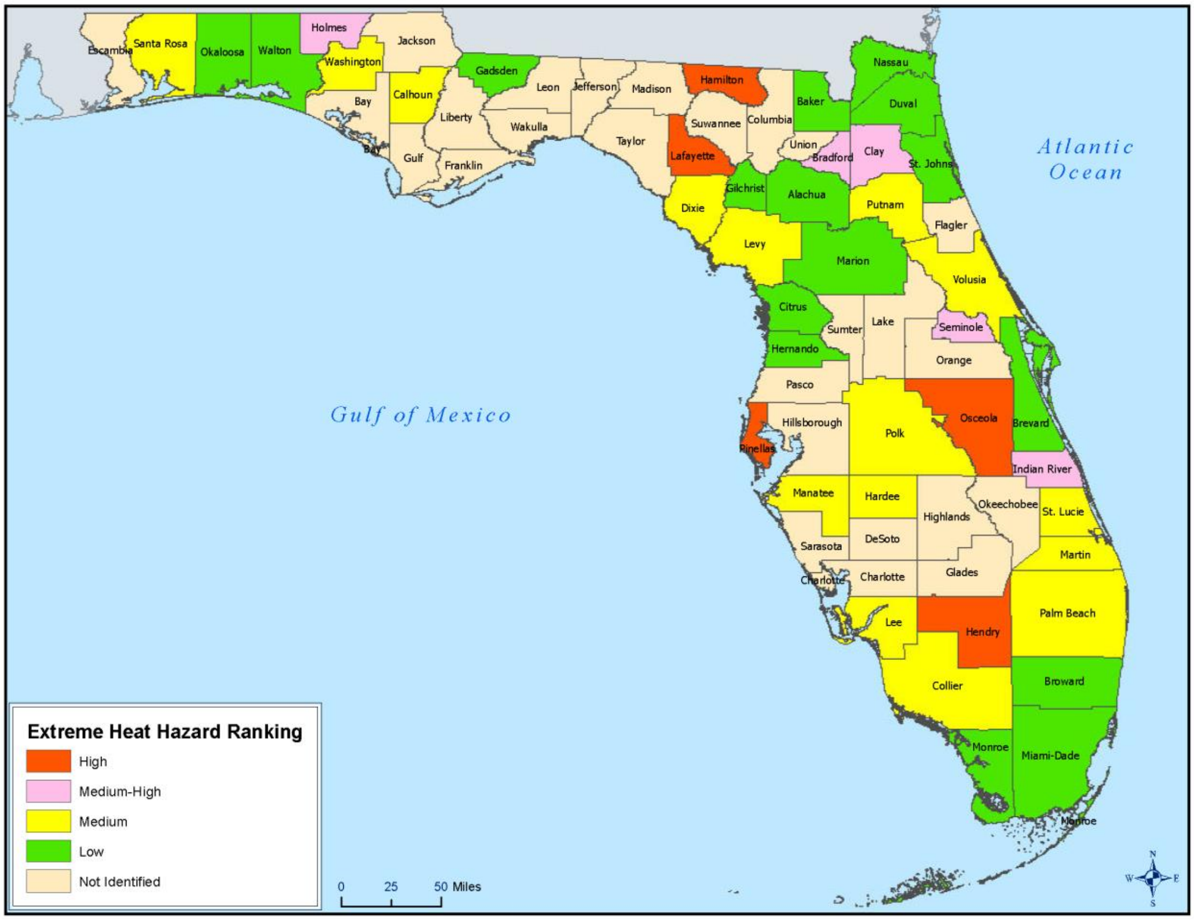

Figure 3.30 Extreme Heat Hazard Rankings by County

V. Extreme Heat Hazard Vulnerability Analysis by Jurisdiction

The State of Florida experiences extreme heat in all regions. Currently, there are visible long-term trends toward a drier climate and warmer weather. Analyzing past events as well as the current conditions has proven that the extreme heat conditions have been somewhat variable over the years; however, the southern counties of the state do tend to exhibit more tendencies to extreme heat.

VI. Assessing Vulnerability of State Facilities

A vulnerability analysis on extreme heat was not conducted in 2004; however, in conjunction with drought, one was completed during the 2007 and 2010 plan update and revision process. In the 2013 update, extreme heat was separated from drought. Although facilities themselves are not vulnerable to extreme heat, the areas or regions that the facilities are located in may be susceptible to extreme heat. The efficiency at which a building operates may be affected (i.e. added load to building cooling systems) if the building is in an area vulnerable to extreme heat.

To complete the analysis, the specific counties within the state that were perceived to be vulnerable to the effects of drought and their individual levels of vulnerability were first identified. Extreme heat is common in the State of Florida and can occur in virtually any region of the state and last for any length of time. Therefore, all counties are perceived to be vulnerable to the effects of extreme heat at one time or another over the long-term. The long-term temperature outlook from the NWS Climate Prediction Center indicates that El Niño conditions will increase in the coming months leading to lower than average temperatures. However, trends of higher than average temperatures counter the emerging El Niño for equal changes of above, near, or below normal temperatures.[122]

VII. Estimating Potential Losses by Jurisdiction

The previous version of the plan grouped extreme heat and drought together. The SHMPAT did not conduct loss estimations by jurisdiction on extreme heat and drought in 2004 during the original plan development process. For extreme heat, the 2013 plan update does not include extreme heat-specific estimation by jurisdiction because structures are not vulnerable to extreme heat.

VIII. Estimating Potential Losses of State Facilities

The SHMPAT did not conduct loss estimations on extreme heat for the 2013 plan because the facilities themselves are not vulnerable to extreme heat.

[122] http://www.cpc.ncep.noaa.gov/products/predictions/long_range/fxus05.html

3.3.7 Winter Storms and Freezes Profile

I. Winter Storms and Freezes Description and Background Information

Severe winter weather includes extreme cold, snowfall, ice storms, winter storms, and/or strong winds, and affects every state in the continental United States. Areas where such weather is uncommon, such as Florida, are typically affected more by severe winter weather than regions that experience this weather more frequently.

As a hazardous winter weather phenomena, the NWS defines snowfall as a steady fall of snow for several hours or more. Heavy snow is defined as either a snowfall accumulating to 4 inches in depth in 12 hours or less, or snowfall accumulation to 6 inches or more in depth in 24 hours or less. In states such as Florida, where lesser accumulations can cause significant impacts, lower thresholds are typically used to define significant snows. However, due to the overall levels of preparedness, a relatively small event in Florida can have a much more significant impact than a blizzard in the northeast where they are fully prepared for these conditions.

Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes. Heavy sleet is a relatively rare event defined as the accumulation of ice pellets covering the ground to a depth of 0.5 inch or more. Ice accumulations are usually accumulations of 0.25 inches or greater across the country; however, amounts as little as 0.1 inch in Florida have significant impact on transportation, special needs populations, and agriculture and livestock throughout the state.

Winter storm formation requires below-freezing temperatures, moisture, and lift to raise the moist air to form the clouds and cause precipitation. Lift is commonly provided by warm air colliding with cold air along a weather front. These storms move easterly or northeasterly and use both the southward plunge of cold air from Canada and the northward flow of moisture from the Gulf of Mexico to produce ice, snow, and sometimes blizzard conditions. These fronts may push deep into the interior regions, sometimes as far south as Florida.

Between 1992 and 2011, an average of 23 deaths per year were attributed to severe winter storms nationally, with 17 occurring during the winter of 2011.[123] The storm of 1993, considered to be among the worst non-tropical weather events in the United States, killed at least 79 people, injured more than 600, and caused more than $2 billion in property damage across parts of 20 states. Florida was affected by this winter storm, and it was a FEMA-declared event for tornadoes, flooding, high winds, tides, and freezing.

Accumulations of ice from ice storms or heavy snow can damage trees, electrical wires, telephone poles and lines, and communication towers. Communications and power are often disrupted while utility companies work to repair the damage.

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[123] http://www.nws.noaa.gov/om/hazstats.shtml

Prolonged exposure to the cold can cause frostbite or hypothermia and become life threatening. Infants and elderly people are most at risk. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." During unexpected cold periods in Florida, there are often issues with propane gas supplies, and electrical and natural gas systems are pushed to their limits to meet the record demands. Also, many residents of Florida have inadequate heating systems and turn to alternatives such as space heaters and wood fires that increase the likelihood of accidental house fires.

II. Geographic Areas Affected by Winter Storms and Freezes

The significant economic impact of freezing on the citrus industry drives much of the planning and analysis related to winter weather in the state. Given its southern location and tropical weather, Florida experiences a lower overall rate of winter storms and freezes. The NCDC maintains freeze and frost data based on 86 stations located throughout the State of Florida. Of those 86 stations, only 18 of them maintain a 5 percent probability, or better, of a freeze or frost in the yearly period. Those stations all fall in the upper half of the state, starting in Chiefland, cutting through Gainesville, and ending just south of Jacksonville.[124]

III. Historical Occurrences of Winter Storms and Freezes

The following information updates the previous plan section. Of the 63 FEMA-declared events in Florida, there have been seven events that involved severe winter weather. These events all related to freezing and to a large degree focused on the overall impact to the Florida economy. These are the major disaster declarations as designated by the FEMA:

- March 15, 1971
- January 31, 1977
- March 29, 1984
- March 18, 1985
- January 15, 1990
- March 13, 1993
- February 6, 2001

The NCDC database for storm events only reports seven combined snow and ice events in Florida since 1950, with four of the entries from the same storm. The SHMPAT recognized the data limitations from this source; however, the available events are listed in Table 3.46.

[124] http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl?directive=prod_select2&prodtype=CLIM2001&subrnum

Table 3.46 Historical Severe Winter Storms

Date	*Information*
January 6, 1999	Temperatures fell below freezing for up to 12 hours in the winter crop–producing counties of Polk, Highlands, Hardee, DeSoto, Hillsborough, and Manatee, causing $200,000 in property damage and $475,000 in crop damage to tomato, squash, and strawberry crops. Also, minimum temperatures in the farming areas of Collier County reached 27 to 32 degrees for about four hours, causing approximately $100,000 in widely scattered damage to vegetable crops.
December 20, 2000	Freezing temperatures were observed over a large portion of West Central Florida during the predawn through late morning hours, causing an estimated $1 million in crop damage. Freezing temperatures in Citrus County damaged an estimated one hundred acres of the local citrus crop. In Polk, Hillsborough, Hardee, and Highlands Counties, low temperatures dropped into the upper 20s and lower 30s and remained below freezing for durations of two to four hours.
December 30, 2000	Widespread freezing temperatures were observed across most of West Central and Southwest Florida during the late evening of December 30 through the mid-morning hours of December 31st, 2000, causing $4.5 million in crop damage. In Manatee and Hillsborough Counties, freezing temperatures may have caused an estimated $2 million worth of damage to the tropical fish industry. In eastern Charlotte, eastern Lee, and northern Pinellas Counties, temperatures dropped into the lower 30s and remained below freezing for periods of two to five hours. The freeze caused an estimated 25 to 50 percent damage to tomato, pepper, and squash crops in Lee and Charlotte Counties. Temperatures fell into the mid-20s over Glades, Hendry, eastern Collier, and western portions of Palm Beach and Broward Counties and fell to 32 degrees in the farming areas of Southern Miami-Dade County. Approximately $2 million in damage to vegetable crops occurred in Hendry and Glades Counties.
January 1, 2001	The second and coldest night of a two-night freeze in south Florida saw minimum air temperatures ranging from 25 to 30 degrees over interior sections of the peninsula. In the metropolitan areas of Miami-Dade, Broward, and Palm Beach Counties, temperatures were in the middle 30s over the western suburbs. An estimated $6 million in crop damage included losses to corn and newly planted sugar cane in Palm Beach County, and to certain vegetables in Hendry and Eastern Collier Counties. An additional $5.1 million in crop damage was caused by widespread freezing temperatures across most of West Central and Southwest Florida. In Lee County, the freeze caused nearly $3 million in damage to the squash and cucumber crop. In Charlotte County, the freeze caused at least $100,000 in damage to the pepper crop.

Date	*Information*
January 5, 2001	A freeze occurred throughout the interior sections of South Florida, causing an estimated $78 million in damage to certain crops. Hardest hit were certain vegetable crops, with 75 percent losses in Hendry and eastern Collier Counties and 30 percent losses in the farming areas of Miami-Dade County. Other crops that were damaged included newly planted sugar cane, ornamentals, and tropical fruits. Widespread freezing temperatures were also observed across most of West Central and Southwest Florida during the pre-dawn and mid-morning hours, causing $6.9 million in crop damage. In Levy, Sumter, Citrus, Hernando, and Pasco Counties, low temperatures dropped into the upper teens and lower 20s with durations below freezing for up to nine hours. In Hillsborough, Polk, Hardee, DeSoto, and Highlands Counties, low temperatures ranged from the low to middle 20s with durations below freezing for up to eight hours. The freeze caused nearly $4 million worth of damage to the tropical fish crop in Hillsborough County. In Lee County, the freeze caused nearly $2.6 million worth of damage to the squash and cucumber crops. In Charlotte County, the freeze caused nearly $250,000 in damage to the pepper crop.
January 10, 2001	Freezing temperatures were observed over most of West Central and parts of Southwest Florida during the pre-dawn through mid-morning hours. In Levy, Sumter, and Citrus Counties, low temperatures dropped into the middle teens to the lower 20s with durations below freezing for up to nine hours. In mainly inland Hernando, Pasco, Hillsborough, Manatee, and western Polk Counties, low temperatures dropped into lower to middle 20s with durations below freezing for up to seven hours. In Hillsborough County, the freeze caused nearly $4 million worth of damage to the tropical fish industry.
February 6, 2001	FEMA declaration for unemployment compensation or Disaster Unemployment Assistance (DUA) benefits was issued due to the significant winter weather from December 2000 through January 2001.
December 2001–January 2002	Freezing temperatures occurred in portions of West Central Florida on several occasions between December and early March. However, hard freezes occurred only across the Nature Coast, an area more accustomed to colder winter nights. The freezes, which occurred both early and late, produced only minor damage to tender vegetation. This winter weather was long lasting and geographically distributed; however, it did not cause significant damages.

Date	*Information*
January 23–25, 2003	A strong cold front ushered in cold temperatures and gusty northwest winds into the Florida peninsula. Wind chill temperatures ranged from 10 to 15 degrees in Bronson, around 20 degrees in Tampa and Lakeland, to 20 to 25 degrees in Fort Myers. Overnight low temperatures ranged from near 20 degrees in the inland counties north to the upper 20s in the inland counties south, to the lower 30s along the coast near Fort Myers. A hard freeze (temperatures of 27 degrees or less for three or more hours) reached south into northeast Hillsborough and northern Polk Counties. Citrus crops fared well because the freeze did not last long enough, but strawberries took a $4.5 million loss and tropical fish a $4 million loss. Early morning low temperatures on January 24 dropped well below freezing across east central Florida. Temperatures ranged from 24 degrees in Leesburg and 25 degrees in Daytona Beach to 29 degrees in Melbourne and 27 degrees in Orlando. To the south, Ft. Pierce and Vero Beach reported lows near 30 degrees. Later that morning, winds shifted off the ocean, producing a few snowflakes in the coastal communities from Daytona Beach to Fort Pierce. On January 25, an arctic high-pressure system settled over the southeastern US that maintained the clear and cold weather across the Florida peninsula. Overnight lows of 19 to 24 degrees occurred from Bronson to Brooksville, with temperatures in the 30s farther south. Northeast winds of 10 to 15 mph produced wind chills down to 25 degrees from Tampa to Lakeland to Fort Myers.
February 2010	An area of low pressure moved across the North Central Gulf region. Heavy rain changed over to snow across portions of the Central Gulf Coast as the low moved to the east. Snowfall accumulations ranged from a dusting to as much as 2 inches across the interior Western Florida Panhandle. Two inches of snow were reported in Munson and Berrydale.

IV. Probability of Future Winter Storm and Freeze Events

During the 2013 revision process, data indicated that the likelihood and probability of future occurrences of severe winter storms in Florida tended to result more in flooding and tornadoes than in snow and ice. Based on all the historical evidence, it is anticipated that a moderate freeze may be expected in Florida every one to two years. Severe freezes, where the greatest numbers of winter crops are lost, may be expected on average once every five years based on historic FEMA-declared disasters.

V. Winter Storm and Freeze Impact Analysis

Winter storms will negatively affect the State of Florida with a variety of impacts:

- Winter storms affect the northern portion of the state more often and more severely than the southern areas; however, the entire state is susceptible to some level of winter weather and the related storms.
- Severe winter events including snow and ice are considered hazards; however, the impacts resulting from these events are historically more severe in regards to human and economic losses as opposed to damages to buildings and infrastructure.
- Deaths and injuries have occurred in the past from winter storm events. Deaths and injuries have resulted from various accidents including automobile collisions due to poor driving conditions or hypothermia resulting from insufficient heat. Emergency medical response can be severely hindered from the effects of a winter storm event.
- Roads and highways are most vulnerable to the effects of winter storms. Roads frequently become iced over, resulting in accidents, injuries, deaths, and traffic congestion. Roads can be heavily damaged due to winter weather events. Potholes and cracks can be found on roadways after a winter weather event, resulting in the need for repairs and causing further economic losses to the local area.
- Electrical transmission lines are highly vulnerable to severe winter weather. Trees frequently fall due to the extra weight of ice accumulating on branches. Trees falling on nearby power lines cause disruption of power service, which results in additional costs for repairs and maintenance.
- Other impacts resulting from winter storms include damage to plumbing, sewers, and waterlines, as well as minor roof damage and house fires resulting from portable heaters.
- First responders are increasingly at risk as they respond to traffic incidents and calls for medical attention. They are vulnerable to the same transportation dangers as other citizens, but often have to go out in hazardous conditions when ordinary citizens would not.
- During a winter storm and the days that follow, many people do not travel due to the road conditions. The absenteeism of workers affects the overall continuity of operations of the state government.

Agricultural Vulnerability Analysis

The State of Florida is vulnerable to winter storms, especially in the north; however, the state does not get the significant snow and ice that is typical in the northern United States. The state's primary vulnerability to this hazard is freezing temperatures that affect agriculture and specifically the citrus industry. The state has significant agriculture and livestock (details are included within in the drought hazard profile); however, the citrus industry is very important to the overall state economy. The citrus industry is particularly vulnerable to freezing temperatures since the primary growing season is throughout the winter months. Figure 3.31 shows the various types and the time periods of the greatest vulnerability.

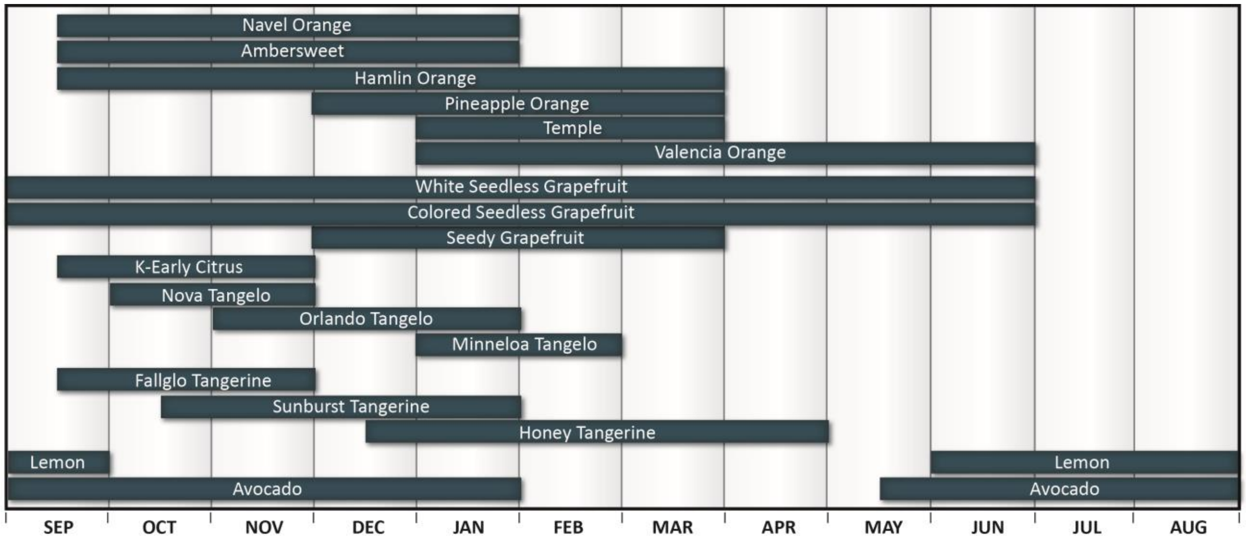

Figure 3.31 Crop Vulnerability by Month

Florida agriculture generates farm cash receipts of about $7 billion annually and has an estimated overall economic impact of $100 billion. The Florida citrus industry creates a $9.3 billion annual economic impact, employing nearly 76,000 people and covering more than 576,000 acres. Production of Florida citrus in 2008–2009 totaled 10.9 million tons of oranges, down eight percent from the previous season. In the 2009–2010 seasons, Florida accounted for 63.6 percent of the total U.S. citrus production.

The top five agricultural commodities in 2010, with percent of U.S. value, were:[125]

- Greenhouse/nurseries (11.2 percent)
- Oranges (63.6 percent)
- Tomatoes (27.2 percent)
- Cane for sugar (54.4 percent)
- Cattle and calves (1 percent)

The top five agricultural exports in 2010, with ranks among other states, include:[126]

- Fruits and preparations (3rd)
- Other (2nd)
- Vegetables and preparations (6th)
- Live animals and meat (24th)
- Seeds (6th)

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[125] http://www.ers.usda.gov/Statefacts/FL.htm. These statistics reflect the most recent updates to data available from the USDA Economic Research Service.
[126] Ibid.

Table 3.47 lists the top five counties in Florida for agriculture sales and what percentage they are of the entire state's sales.

Table 3.47 Top 5 Counties in Agricultural Sales in 2007[127]

County	*Percent of State Total Receipts*	*Sales ($Thousands)*
1. Palm Beach County	12.0	931,731
2. Miami-Dade County	8.5	661,100
3. Hendry County	7.3	567,429
4. Hillsborough County	6.3	488,220
5. Polk County	5.1	398,956
State Total		**7,785,228**

Table 3.48 shows the sales of citrus in the state up from 1999-2007.

Table 3.48 Florida Citrus Value of Sales On-tree from 1999–2007[128]

Crop Year[129]	*Values ($Thousands)*
1999–2000	1,108,523
2000–2001	862,031
2001–2002	879,142
2002–2003	787,378
2003–2004	745,963
2004–2005	754,169
2005–2006	1,043,293
2006–2007	1,362,427

There were no existing updates for Table 3.47 and Table 3.48 above since the 2007 information.

VI. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. Risk assessment information from the LMS plans is current as of May 1, 2012.

127 Ibid.
128 http://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Citrus/cspre/cit92007.pdf
129 Excludes lemons beginning in the 2003-04 season.

Based on the LMS plans in the State of Florida, Figure 3.32 displays the jurisdictional rankings for the winter storm hazard. Not all counties have identified winter storm as one of their hazards.

- High-risk Jurisdictions 2
- Medium-high–risk Jurisdictions 5
- Medium-risk Jurisdictions 23
- Low-risk Jurisdictions 15

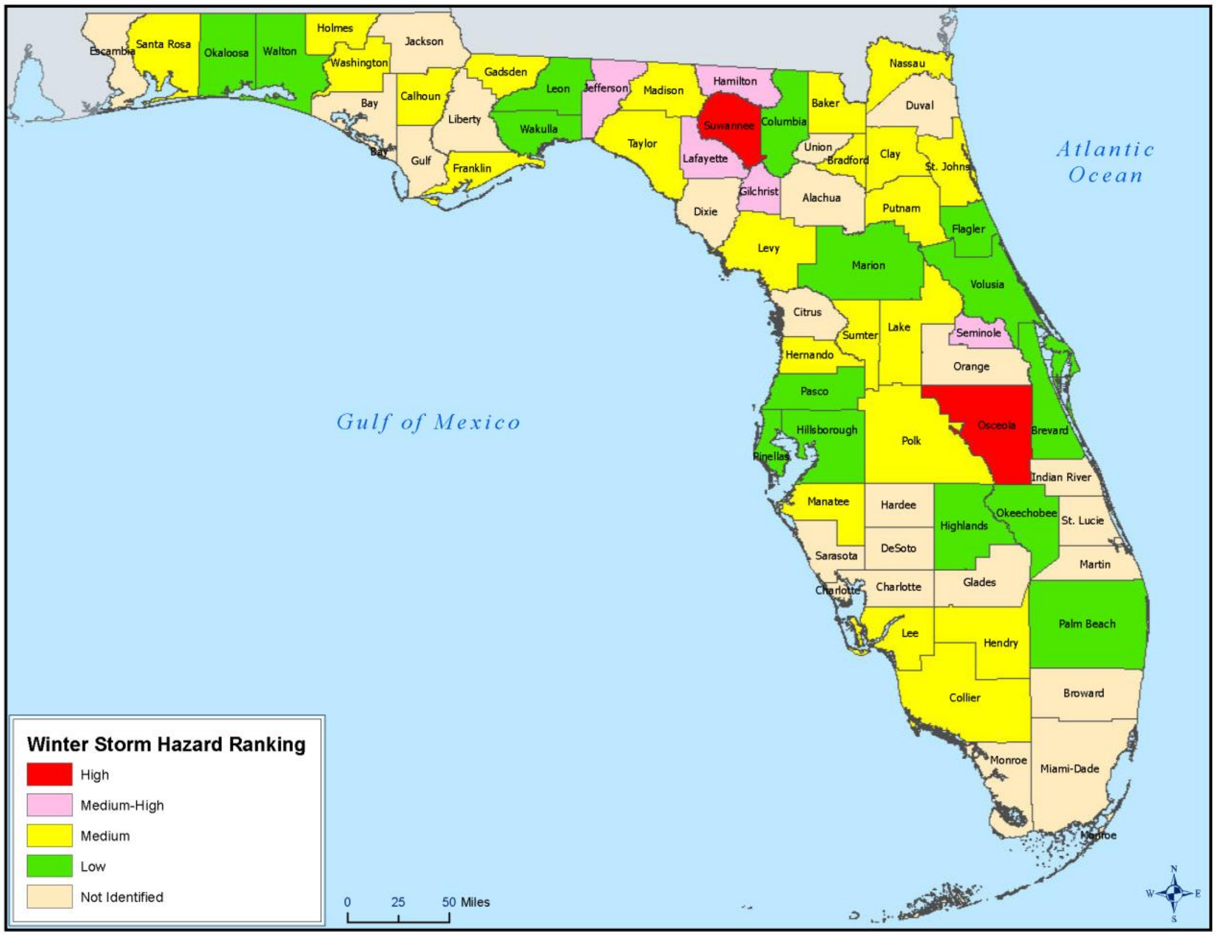

Figure 3.32 Winter Storm Hazard Rankings by County

Based on the LMS plans in the State of Florida, Figure 3.33 displays the jurisdictional rankings for the freeze hazard. Not all counties have identified freezes as one of their hazards.

- High-risk Jurisdictions 1
- Medium-high–risk Jurisdictions 6
- Medium-risk Jurisdictions 21
- Low-risk Jurisdictions 16

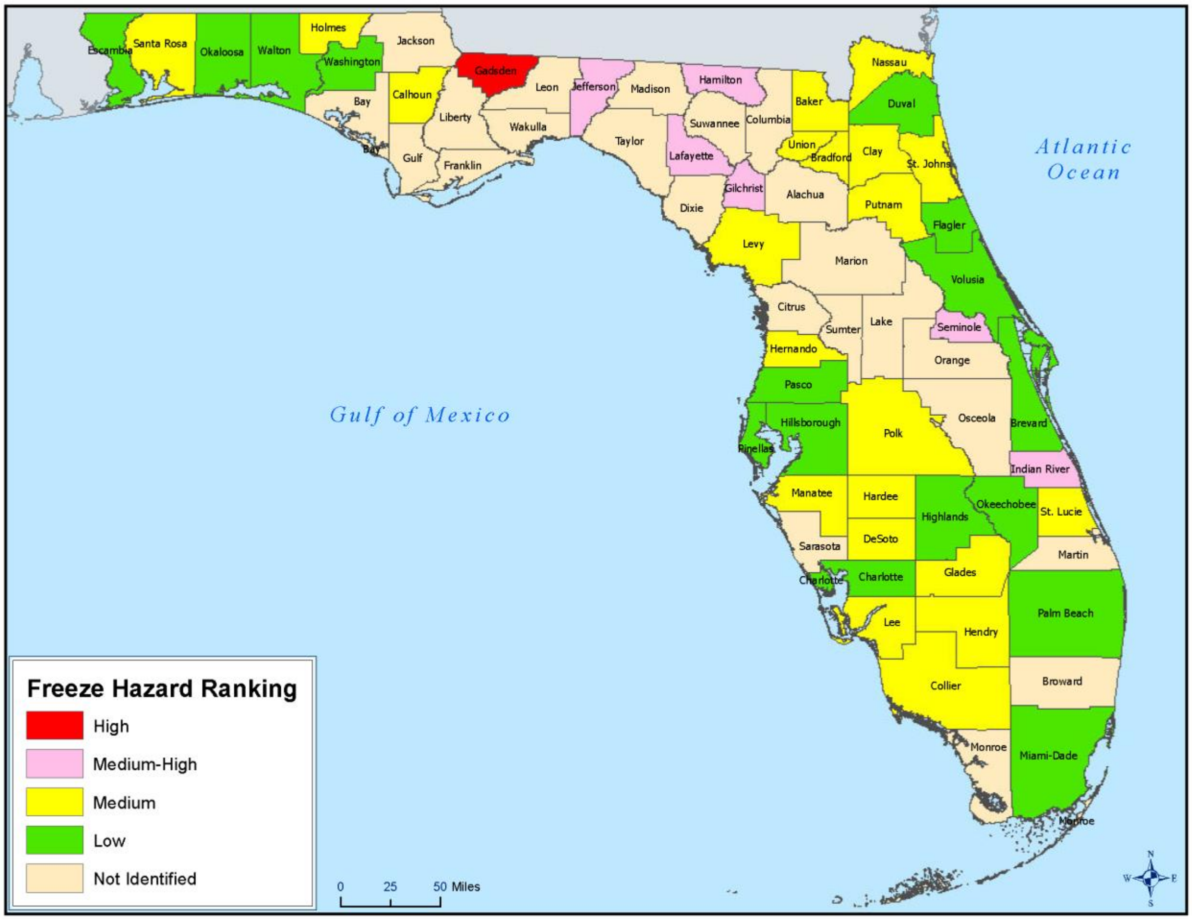

Figure 3.33 Freeze Hazard Rankings by County

VII. Winter Storm and Freeze Hazard Vulnerability Analysis by Jurisdiction

This update researched the overall vulnerability to winter weather and collected data to assist with the estimation of potential losses. Severe winter weather events do not occur with the same frequency within all parts of Florida. Counties found in northern Florida have experienced more winter weather than central and southern counties.

VIII. Assessing Vulnerability of State Facilities

During the initial analysis, a vulnerability analysis on winter storms and freezes was not conducted. During the 2007 plan update and revision process, a winter storm and freeze specific analysis was added. The 2013 plan does not change the perspective that state facilities are not themselves vulnerable to winter storms and freezes; the operating capacity of a building may be affected by this particular hazard but not to a significant degree.

The past and future vulnerabilities to winter storm events within Florida were reviewed in an effort to determine the state's overall vulnerability. However, winter storms—similar to droughts—usually do not cause direct structural damage to facilities. Currently, the "low" risk vulnerable areas of the state to winter storms are the northern portion of the state and the Panhandle. The "very low" risk vulnerable areas of the state are the north-central counties, and the "extremely low" risk areas are found from the central part of the state southward.

IX. Estimating Potential Losses by Jurisdiction

The 2004 original plan did not perform a loss estimate on a statewide level for winter storms and freezes. During the 2010 and 2013 plan update process, the SHMPAT researched the potential losses related to winter storms and freezes and collected data to assist with this estimation.

National Climatic Data Center Winter Storm and Freeze Loss Estimation

Data from the NCDC provides details about the historical winter storms and freezes in the state. Table 3.49 shows a breakdown of the types of winter weather events that have occurred in Florida between October 2006 and April 2012.

Table 3.49 Historical Winter Storm and Freeze Summary[130]

Type of Weather Event	*NCDC Reports*	*Average per Year*	*Annualized Property Loss ($Millions)*	*Annualized Crop Loss ($Millions)*
Extreme Cold	14	2.8	0	0
Freeze	350	70	.604	174.4
Winter Storm/Weather	18	3.6	0	0
Total	**382**	**76.4**	**0.604**	**174.4**

[130] http://www.ncdc.noaa.gov/stormevents/

In Table 3.50, according to the NCDC, the following losses resulted from the 79 winter weather events in the state from 1996 to April 2012.

Table 3.50 Winter Weather Event Impacts on Florida

	Deaths	*Injuries*	*Property Damage*	*Crop Damage*	*Total Damages*
Total (1996–2012)	2	1	$4,415,000	$1,271,705,000	$1,276,120,000
Annual Average	0.125	0.0625	$275,937	$79,481,563	$79,757,500
Average per Event	0	0	$9,577	$2,758,579	$2,768,156

Based on this historical data, the average estimated loss per winter weather event is approximately $2,768,156, with the majority of this related to crop damage and not property damage. The following statistics were noted by the SHMPAT to qualify this estimated loss:

- There were seven listed extreme cold events with damages greater than $50 million.
- The event with the highest crop damage occurred December 14, 2010, with more than $300 million in damages in Indian River County.

The SHMPAT determined that worst-case loss estimates for winter freezes could easily reach into the hundreds of millions of dollars in damages. However, as part of the loss estimation, the team discarded the events with no damage and the seven "high-dollar" events (more than $50 million) and calculated a more typical loss. Based on this revised estimation, a more typical loss from a winter storm or freeze is approximately $2,547,500.

X. Estimating Potential Losses of State Facilities

During the 2013 plan update and revision process, the winter weather-specific estimation of losses has not been calculated, as the impacts to state facilities from severe winter weather are negligible. Over long-term analysis, the State of Florida is impacted regularly with winter storm events, placing billions of dollars in property at risk. The southern part of the state is the least vulnerable, while the northern part of the state and the Panhandle are the most vulnerable.

3.3.8 Erosion Profile

I. Erosion Description and Background Information

Coastal erosion is the wearing away of land or the removal of beach or dune sediments by wave action, tidal currents, wave currents, or drainage; the wearing away of land by the action of natural forces; on a beach, the carrying away of beach material by wave action, tidal currents, littoral currents or by deflation.[131] Waves generated by storms cause coastal erosion, which may take the form of long-term losses of sediment and rocks, or merely in the temporary redistribution of coastal sediments. The study of erosion and sediment redistribution is called "coastal morphodynamics," which can be described also as the dynamic interaction between shoreline, seabed, and water. The floodplains data used in this revision does not contain coastal flood zones (high velocity zones vulnerable to erosion).

The ability of waves to cause erosion depends on a number of factors, which include:

- The hardness or "erodibility" of the beach, cliff, or rocks, including the presence of fissures, fractures, and beds of non-cohesive materials such as silt and fine sand.
- The rate at which sediment is eroded from the foreshore is dependent on the power of the waves crossing the beach, and this energy must reach a critical level or material will not be removed from the debris lobe.
- Beaches actually help dissipate wave energy on the foreshore and can provide a measure of protection to cliffs, rocks, and other harder formations, as well as any area upland.
- The lowering of the beach or shore platform through wave action is a key factor controlling the rate of erosion. A beach is generally lowered when its profile changes shape in response to a change in the wave climate. If the beach is not lowered, the foreshore should widen and become more effective at dissipating the wave energy, so that fewer and less powerful waves affect the area.
- The near shore bathymetry controls the wave energy arriving at the coast, and can have an important influence on the rate of erosion.

Table 3.51 outlines the major factors that control the overall rate of erosion in an area.

Table 3.51 Erosion Contribution Factors

First Order	*Second Order*	*Third Order*
Geological structure and lithology a) Hardness b) Height, etc. c) Fractures/faults d) Wave climate e) Prevailing wave direction f) Sub-aerial climate g) Weathering (frost, etc.) h) Stress relief swelling/ shrinkage i) Water-level change j) Groundwater fluctuations k) Tidal range l) Geomorphology	• Weathering and transport slope processes • Slope hydrology • Vegetation • Cliff foot erosion • Cliff foot sediment accumulation • Resistance of cliff foot sediment to attrition and transport	• Coastal land use • Resource extraction • Coastal management

[131] Coastal Engineering Manual, glossary, http://chl.erdc.usace.army.mil/cemoverview

As beaches are constantly moving, building up here and eroding there, in response to waves, winds, storms, and relative sea level rise, this issue requires long-term analysis and planning. The current beach-erosion problem has many causes, including the following items:

- The desire by many to live near the sea.
- A historically rapid rise in average ocean levels, now estimated to be rising at about 25–30 centimeters per century in much of the United States.
- The gradual sinking of coastal land (since the height of the land and the sea are both changing, the "relative sea level rise" is used to describe the rise of the ocean compared to the height of land in a particular location).
- Efforts to reduce erosion that have proved to be ineffective and instead increased it.
- Global warming, which is expected to accelerate the rise in sea level.

Some erosion changes are slow, inexorable, and usually gradual. However, the changes on a beach, in contrast, can happen overnight, especially during a storm. Even without storms, sediment may be lost to long shore drift (the currents that parallel coastlines), or sediment may be pulled to deeper water and lost to the coastal system. Fortunately, even though beach erosion is a major problem, it has many solutions; however, they do not address the cause of erosion:

- Beach nourishment : This is a process in which the sand is deposited onto the beaches by humans; however, there is a very high cost associated with the solution.
- Rebuilding rivers : This is a process of guiding rivers back into places with a lack of sediment with the hope that they will push the sediment back into place.
- Breakwaters, sea walls, and groins: There are a number of structural remedies that have some success with erosion. Each location has different requirements that drive the specific development and construction of breakwaters, groins, and sea walls. There are some flaws and issues with these types of remedies as they sometimes trap as much sediment as they deposit with down-drift effects.
- Limits on beach development: Limiting, restricting, or prohibiting development on the impacted beaches.

The primary vehicle for implementing the beach management planning recommendations is the Florida Beach Erosion Control Program (BECP) within the Florida Department of Environmental Protection (DEP), a program established for the purpose of working in concert with local, state, and federal governmental entities to achieve the protection, preservation, and restoration of the coastal sandy beach resources of the state. Under the program, financial assistance in an amount of up to 50 percent of project costs is available to Florida's county and municipal governments, community development districts, or special taxing districts for shore protection and preservation activities. Eligible activities include beach restoration and nourishment activities, project design and engineering studies, environmental studies and monitoring, inlet management planning, inlet sediment transfer, dune restoration and protection activities, and other beach erosion prevention-related activities consistent with the adopted Strategic Beach Management Plan. [132]

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[132] http://www.dep.state.fl.us/beaches/publications/pdf/CritEroRpt7-11.pdf

As part of the 2013 revision process, it is noted that the following items provide some detail about this program and the general erosion hazard in the state, as of June 2011:

- Nearly 495 miles, or approximately 60 percent of the state's beaches, are experiencing erosion.
- About 40 feet of shoreline erodes every year according to DEP.[133]
- About 410 miles of the state's 825 miles of sandy beaches have experienced "critical erosion," a level of erosion that threatens substantial development, recreational, cultural, or environmental interests.
- While some of this erosion is due to natural forces and imprudent coastal development, a significant amount of coastal erosion in Florida is directly attributable to the construction and maintenance of navigation inlets. Florida has over 60 inlets around the state, many of which have been artificially deepened to accommodate commercial and recreational vessels and employ jetties to prevent sediment from filling in the channels. A by-product of this practice is that the jetties and the inlet channels have interrupted the natural flow of sediment along the beach, causing an accumulation of sediment in the inlet channel and at the jetty on one side of the inlet, and a loss of sediment to the beaches on the other side of the inlet.
- Local, state, and federal entities are now managing more than 200 miles of restored beaches in Florida.[134]

Beach Erosion and Control Program

The following items in Table 3.52 show the general progression of the erosion program managed by the Florida Department of Environmental Protection and detail some of the major initiatives.

Table 3.52 Erosion Control Milestones[135]

Date	*Information*
1999	A post-Hurricane Earl and Georges Recovery Plan was prepared in January 1999. The March 1999 critical erosion list included changes resulting from the impacts of Hurricanes Opal, Earl, and Georges, as well as other less impacting storms.
2000	The 2000 critical erosion list was the result of continued investigations in 1999, including the significant effects from Hurricanes Floyd, Irene and Tropical Storm Harvey.
2001	Only a couple of additions were made in Palm Beach County in 2001; however, Tropical Storm Gabrielle caused erosion in the fall of 2001, prompting the addition of critical areas in Flagler and Charlotte Counties in 2002. Due to recovery in the Panhandle since the hurricanes of 1995 and 1998, a few areas in Okaloosa, Bay, and Gulf Counties were removed from the critical list.

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[133] Florida Battles Over Beach Erosion, Costs of Replenishment. Tamara Rush. Insurance Journal. March 19, 2012. http://www.insurancejournal.com/news/southeast/2012/03/19/239838.htm
[134] http://www.dep.state.fl.us/beaches/programs/bcherosn.htm
[135] Florida Department of Environmental Protection. Critically Eroded Beaches in Florida, 2011 update.

Date	*Information*
2002	The current 2002 list includes 329.9 miles of critical beach erosion, 9.1 miles of critical inlet shoreline erosion, 107.7 miles of non-critical beach erosion, and 3.7 miles of non-critical inlet shoreline erosion statewide.
2006	The 2006 annual report on critically eroded beaches in Florida lists the following statistics: 385.2 miles of critical beach erosion, 96.8 miles of non-critical beach erosion, 8.6 miles of critical inlet erosion, and 3.2 miles of non-critical inlet erosion.
2008	The Beach and Shore Preservation Act and the Ecosystem Management and Restoration Trust Fund charge the DEP with developing and implementing a comprehensive, long-range, statewide beach management plan. This budget plan projects the 10-year funding needs from federal, state, and local governments necessary to implement the strategic plan. The first year of this budget plan was FY 2009-10. The 2008 list included 396.4 miles of critically eroded beach, 8.9 miles of critically eroded inlet shoreline, 95.5 miles of non-critically eroded beach, and 3.2 miles of non-critically eroded inlet shoreline statewide.
2010	The “Critical Eroded Beaches in Florida” report updated June 2010, listed 398.6 miles of critically eroded beach, 8.6 miles of critically eroded inlet shoreline, 95.9 miles of non-critically eroded beach, and 3.2 miles of non-critically eroded inlet shoreline statewide. There were no updates to these totals in 2011.
2012	The “Critical Eroded Beaches in Florida” report updated June 2012, listed 397.9 miles of critically eroded beach, 8.7 miles of critically eroded inlet shoreline, 96.2 miles of non-critically eroded beach, and 3.2 miles of non-critically eroded inlet shoreline statewide.

II. Geographic Areas Affected by Erosion

The Bureau of Beaches and Coastal Systems develops and publishes annually the *Critically Eroded Beaches Report*. The data from this report is gathered from a set of monitoring locations along the coast throughout the state. Data is collected from each of these stations, and then compiled into a GIS database for modeling and analysis. The continual reporting and analysis is combined with the historical data for detailed records about the status of the state’s beaches. Erosion is a constantly changing issue as development continues on the beaches and in the inlets. It can also be instantly changed by a large storm or a hurricane.

III. Historical Occurrences of Erosion

DEP maintains a database of all the occurrences of erosion in the state with high quality reporting since the inception of BECP. There are constantly cases of beach erosion throughout the state, and the 2013 revision reflects agreement that these previous occurrences would not be listed in this section. BECP develops databases about these previous occurrences and can be accessed at the following website: http://www.dep.state.fl.us/beaches/programs/becp/index.htm. The disastrous hurricane seasons of 2004–2005 had a severe impact on the state in terms of erosion, and DEP has published a number of reports about the specific details of these events. A number of these events are profiled below in Table 3.53.

Table 3.53 Significant Erosion Contribution Events[136]

Date	*Information*
2004 Hurricane Season	During the 2004 hurricane season, one tropical storm and four major hurricanes made landfall along Florida's coastline. Nearly all of the state's sandy beach shorelines were affected. DEP, in concert with local and federal agencies, conducted impact assessments of the state's Gulf and Atlantic fronting sandy beaches. Over 825 miles of beach were impacted. Many of the impact areas required varying levels of recovery activities ranging from natural recovery to dune restoration or full-scale beach re-nourishment. Many structures were damaged or destroyed and continue to be threatened due to the condition of the beach and dune systems.
July 10, 2005 Hurricane Dennis	Hurricane Dennis made landfall on the northwest coast of Florida with the eye crossing Santa Rosa Island near Big Sabine Point. Dog Island in Franklin County, Florida, lies between 184 and 190 miles east of the point of landfall of the eye of Hurricane Dennis. Dennis made landfall as a Category 3 hurricane with winds of 115 to 120 mph near its eye. On Dog Island, winds were below hurricane strength and likely in the 40 to 65 mph range. However, storm tides of around 10 feet were observed in this area and contained damaging storm waves. The NOAA weather buoy offshore from Panama City measured wave heights to 34.8 feet. Major beach and dune erosion (condition IV) was sustained along most of the island. The western "Narrows" (R156-R160) and eastern "Narrows" (R163-R168) were inundated by the storm tide, and all dunes in these areas were leveled with over-wash into St. George Sound.
2005 Hurricane Season	The south Florida counties of Dade and Monroe sustained significant beach erosion conditions from the 2005 hurricane season. Four hurricanes, Dennis (July 10), Katrina (August 25), Rita (September 20), and Wilma (October 24), caused erosion and flooding along the coastal barrier beaches of Dade County and the Florida Keys and mainland beaches of Monroe County. Hurricanes Dennis, Katrina, and Rita affected south Florida as Category 1 or 2 hurricanes before crossing the Gulf of Mexico, becoming major hurricanes and making landfall on the northern Gulf Coast outside of Florida. Hurricane Wilma crossed the southeast Gulf of Mexico from the west and made landfall to the north of Monroe and Miami-Dade counties as a Category 3 hurricane before exiting southeast Florida into the Atlantic Ocean.
2006-2008 Hurricane Seasons	A mild tropical storm season in 2006 led to few additions for the 2007 updated listing. Notably, a recently eroded segment of South Ponte Vedra (2.0 miles) was added in St. Johns County, as well as small beach and inlet segments in Lee County at Boca Grande. Another segment was added to Escambia County on Perdido Key (0.9 miles) for the continuity of management of the coastal system. Although there was another relatively mild tropical storm season in 2007, with only Tropical Storms Andrea, Barry, and Noel affecting Florida beaches, persistent northeasters cumulatively stressed erosion conditions at a few hotspots along the Atlantic coast. Due to these storm effects, three small

[136] http://www.dep.state.fl.us/beaches/programs/becp/index.htm

Date	*Information*
	shoreline segments at Painters Hill in Flagler County (0.3 miles) and Lantana Municipal Beach in Palm Beach County (0.1 miles) have been added to the 2008 updated listing. At the north end of Manatee County, the shoreline of Passage Key (0.3 mile) has also been added to the 2008 updated listing. Segments on Perdido Key in Escambia County (4.0 miles), St. Joseph Peninsula in Gulf County (1.7 miles), and Alligator Point in Franklin County (0.8 miles) have been added for the design integrity of adjacent beach management projects. An updated study of Manasota Key resulted in the addition of a 1.5-mile segment in Sarasota County and Lee County included a non-critically eroded segment on North Captiva Island with a 0.8-mile critically eroded segment on Big Hickory Island.[137] 2008 brought a relatively mild tropical storm season for Florida's beaches with Tropical Storm Fay affecting predominately the Atlantic shoreline, and the Gulf Coast receiving fringe impacts of Hurricanes Gustav and Ike. Minor additions to critical erosion areas were seen in Nassau and Palm Beach counties. Small segments of Walton County were designated critical for the design integrity of adjacent beach management projects. The critically eroded north end of Anna Maria Island had its identity changed from inlet shoreline to gulf beach.[138]
2011 Hurricane Season	Statewide, 398.6 miles of critically eroded beach, 8.6 miles of critically eroded inlet shoreline, 95.9 miles of noncritical eroded beach, and 3.2 miles of noncritical eroded inlet shoreline, were recorded.[138]

IV. Probability of Future Erosion Events

The beaches of Florida will continue to shift and change over time, especially when faced with the current levels of development. During the 2013 plan revision process, it was agreed that this hazard will continue to affect the state, and there is considerable work being done regularly to mitigate potential damages. DEP maintains an active and on-going program to study this issue and mitigate damages as much as possible. The SHMPAT considers this a high probability hazard, especially in conjunction with hurricanes, winter storms, and coastal flooding. There is a very high probability that this hazard will continue to affect the state in the future based on these factors:

- Locations: Erosion will continue to affect practically all the beaches of the state.
- Timing: This hazard will occur throughout the year during all seasons.
- Historical precedence: This hazard has occurred continually since recorded statistics have been kept.
- Episodic: This hazard is storm-induced and short-term.

[137] http://www.dep.state.fl.us/beaches/publications/pdf/CritEroRpt7-11.pdf
[138] http://www.dep.state.fl.us/beaches/publications/pdf/CritEroRpt7-11.pdf

V. Erosion Impact Analysis

Erosion will negatively affect the State of Florida with a variety of impacts:

- The state's beaches are eroded away at varying levels at all times, especially by strong storms and hurricanes.
- Erosion can cause property damage to houses and structures on or near the beach.
- Beach erosion can affect transportation waterways such as inlets and can interfere with boat traffic.
- Eroded beaches affect the level of tourism, and this lowers the overall economy of the coastal areas and the state.

VI. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. The 67 multi-jurisdictional LMS plans provided a solid baseline for the overall state vulnerability analysis. Risk assessment information from the LMS plans is current as of May 1, 2012. Based on the LMS plans in the State of Florida, Figure 3.34 displays the jurisdictional rankings for the Erosion hazard. Not all counties have identified erosion as one of their hazards.

- High-risk Jurisdictions 8
- Medium-high–risk Jurisdictions 7
- Medium-risk Jurisdictions 15
- Low-risk Jurisdictions 19

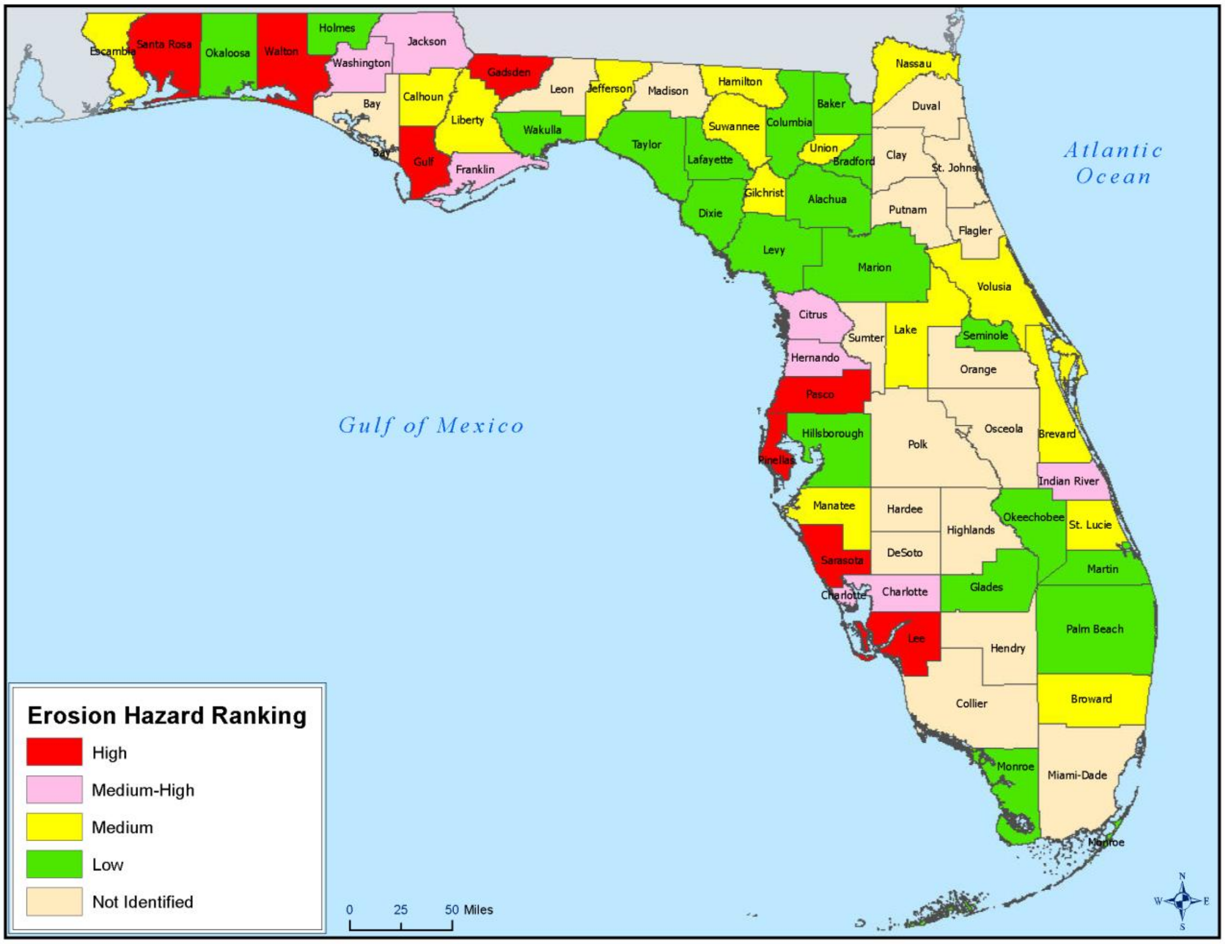

Figure 3.34 Erosion Hazard Rankings by County

VII. Erosion Hazard Vulnerability Analysis by Jurisdiction

During the 2010 plan update process, the SHMPAT coordinated with DEP regarding beach erosion. DEP provided data about the current areas considered at a high risk to erosion according to the GIS formatting that was used in this vulnerability analysis. There have not been updates to the data since the 2010 update. In the May 2008 Strategic Beach Management Plan, the critically eroded shorelines were listed by region along with the levels of management. Table 3.54 lists those values.

Table 3.54 Critically Eroded Managed Shoreline by Region[139]

Region	*Critically Eroded Shoreline (miles)*	*Critically Eroded Managed Shoreline (miles)*	*Percent Managed*
Northeast Atlantic Coast	27.7	17.0	61
Central Atlantic Coast	106.5	34.8	33
Southeast Atlantic Coast	69.3	43.4	66
Florida Keys	10.2	1.5	15
Panhandle Gulf	77.6	38.0	49
Big Bend Gulf	3.7	0.2	18
Southwest Gulf	96.5	62.9	65
Total	**391.5**	**197.8**	**58.1**

Early statewide inventories of critical erosion areas included only those erosion problem areas where a threat existed to upland development or recreational interests. The most current inventory of critical erosion areas (March 1999/April 2002) was formulated based upon an updated and modified definition of critical erosion. The following definition has been adopted by the DEP's Bureau of Beaches and Coastal Systems to identify areas of critical erosion:

Critical erosion area is a segment of the shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost. Critical erosion areas may also include peripheral segments or gaps between identified critical erosion areas, which, although they may be stable or slightly erosional now, their inclusion is necessary for continuity of management of the coastal system or for the design integrity of adjacent beach management projects.

For an erosion problem area to be critical, a threat to or loss of one of four specific interests must exist: upland development, recreation, wildlife habitat, or important cultural resources. Of all the erosion problem areas around Florida, many have significant erosion conditions, yet the erosion processes do not currently threaten public or private interests. These areas are therefore designated as non-critical erosion areas and require close monitoring in case conditions become critical.

By contrast, in some areas erosion processes are not particularly significant except to the extent that adjacent public or private interests may be threatened. Regardless of whether erosion is critical, the existence of a threat to public or private interests results in the need for protection. Lacking any threat, an erosion condition is not a critical problem. Figure 3.35 graphically shows the critical and noncritical shoreline erosion areas.

[139] http://www.dep.state.fl.us/beaches/publications/pdf/SBMP/Cover%20and%20Introduction.pdf

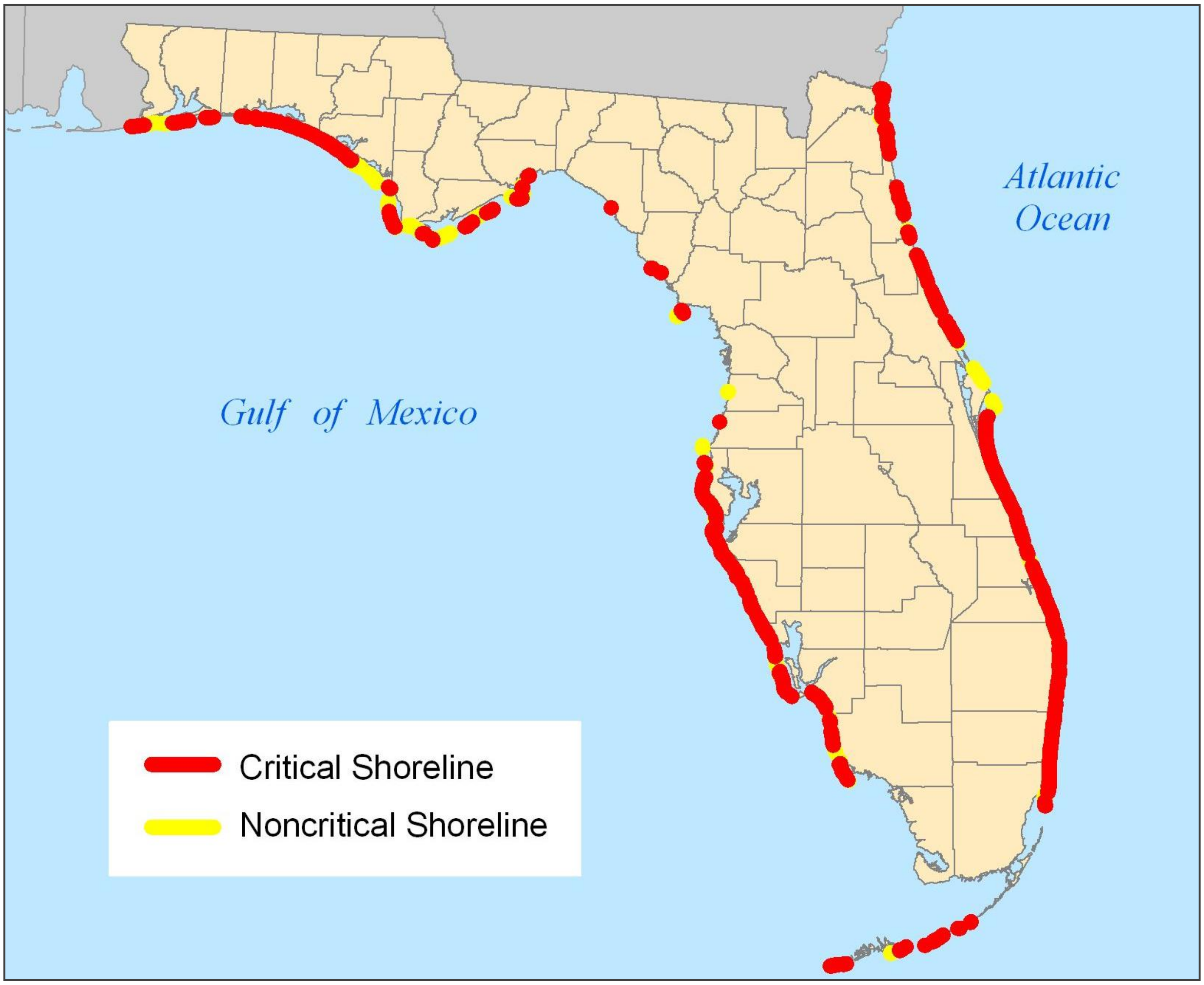

Figure 3.35 Identified Critical and Noncritical Shoreline Erosion Areas[140]

Table 3.55 and Table 3.56 summarize the number of critical and non-critical erosion areas by county and coast (coastal counties only).

Table 3.55 Number of Critical and Non-Critical Erosion Areas by County[141]

County	*Critical Areas (in Miles)*	*Non-Critical Areas (in Miles)*	*County*	*Critical Areas (in Miles)*	*Non-Critical Areas (in Miles)*
Bay	20.1	10.4	Martin	17.8	0.0
Brevard	36.6	12.4	Miami-Dade	16.9	2.0
Broward	21.1	0.0	Monroe	12.7	2.6
Charlotte	5.8	0.4	Nassau	10.6	0.0
Collier	14.3	5.5	Okaloosa	7.8	1.7
Dixie	0.6	0.0	Palm Beach	31.6	0.9

140 http://www.dep.state.fl.us/beaches/data/gis-data.htm#GIS_Data
141 http://www.dep.state.fl.us/beaches/data/gis-data.htm#GIS_Data

County	*Critical Areas (in Miles)*	*Non-Critical Areas (in Miles)*	*County*	*Critical Areas (in Miles)*	*Non-Critical Areas (in Miles)*
Duval	11.1	2.0	Pasco	0.2	1.1
Escambia	14.7	11.3	Pinellas	21.8	4.1
Flagler	5.7	0.0	Santa Rosa	4.0	0.0
Franklin	11.4	20.7	Sarasota	24.0	0.4
Gulf	8.4	8.2	St. Johns	9.9	0.5
Hernando	0.0	0.5	St. Lucie	9.2	7.8
Hillsborough	1.8	0.0	Taylor	0.2	0.0
Indian River	15.7	0.0	Volusia	22.6	1.2
Lee	21.9	5.9	Wakulla	1.6	0.6
Levy	1.0	1.3	Walton	15.3	0.0
Manatee	13.1	0.0			

Table 3.56 Summary of Florida Coastal Erosion Areas[142]

	Beach		*Inlet*	
	Critical	***Non-Critical***	***Critical***	***Non-Critical***
Total Gulf Coast	182.3	70.3	4	0.9
Total Atlantic Coast	204.9	24.1	4.6	2.3
Total Florida Keys	10.2	1.6	---	---
Statewide	397.4	96	8.6	3.2

Appendix C: Risk Assessment Tables contains detailed information of critical erosion areas by county and length of the critical area.

Additional information on the erosion areas for each coastal county fronting on the Atlantic Ocean, Gulf of Mexico, and Straits of Florida is available from FDEP, Bureau of Beaches and Coastal Systems. The listing of critical and non-critical erosion areas are identified by the Bureau's reference movement system (R numbers) or by virtual stations (V numbers). A few areas are not identified by either the R or V numbers because they are not included in the coastal construction control line program, nor have virtual stations been designated. These areas without R or V numbers are usually inlet shoreline areas, Florida Keys erosion areas, coastal bend erosion areas, and a few barrier islands in Pinellas, Hillsborough, and Collier counties.

VIII. Assessing Vulnerability of State Facilities

During the 2013 plan update and revision process, a specific hazard vulnerability analysis has been addressed and updated.

142 http://www.dep.state.fl.us/beaches/data/gis-data.htm#GIS_Data

For this hazard, an accurate vulnerability to state facilities could not be adequately conducted due to the following elements:

- Coastal erosion takes place only in specific areas along the coastline.
- Few to none of the state's facilities are located on the beach or coastline.
- Implying that a county has a coastal erosion problem and therefore all of its state facilities located within the county are thereby vulnerable would be an inaccurate and misleading statement.

IX. Estimating Potential Losses by Jurisdiction

SHMPAT Erosion Research

As part of the loss estimation, the SHMPAT coordinated with the Bureau of Beaches and Coastal Systems for current data on beach erosion. There were no significant updates to the beach erosion information for the 2010 or 2013 plan update. The information below is a continuation of the 2007 plan update. The SHMPAT and DEP recognized the difficulty in estimating losses related directly to erosion because of these factors:

- Some erosion is long term and must be monitored constantly over years.
- Significant beach erosion is related to hurricanes and severe storms that suddenly reshape a beach. Damage from these events is typically caused by winds and water, and the erosion is not specifically related to the losses.
- Many erosion-related damages are small, on private property, and are never reported.

The SHMPAT and DEP determined that a better way to estimate potential losses from erosion was to analyze the various projects and initiatives that DEP manages in order to protect and revitalize the state's beaches. The DEP program is authorized by Section 161.101, Florida Statutes. Since its inception in 1964, BECP has been a primary source of funding to local governments for beach erosion control and preservation activities. Through the fiscal year 2006, the most current information, over $582 million has been appropriated by the legislature for beach erosion control activities and hurricane recovery. Eligible activities include:

- Beach restoration and nourishment activities
- Project design and engineering studies
- Environmental studies and monitoring
- Inlet management planning
- Inlet sand transfer
- Dune restoration and protection activities
- Other beach erosion prevention-related activities consistent with the adopted Strategic Beach Management Plan

Practically all coastal jurisdictions are experiencing losses from beach erosion. DEP studies predict this trend to continue; therefore, the SHMPAT estimates that more than 50 percent of the state's beaches will continue to experience losses to these beautiful and critical natural resources.

X. Estimating Potential Losses of State Facilities

The SHMPAT did not conduct loss estimations on erosion for state facilities in 2004 during the original plan development process. During the 2013 plan update and revision process, the team concluded that an accurate loss estimate to state facilities could not be adequately conducted due to the geographic data limitations of the state facility database. Coastal erosion takes place only in specific areas along the coastline, and to accurately model the estimated losses to state facilities, more precise geographic state facility data is needed against which to model. Modeling the coastal erosion on a county-by-county basis and implying that a county has a coastal erosion problem and therefore all of its state facilities could suffer potential losses would be an inaccurate statement.

The SHMPAT has concluded that the requirements to effectively model the estimated losses of state facilities to coastal erosion require that more accurate geographic data be collected for each of the state facility locations. When more accurate data becomes available, loss estimation information will be included.

3.3.9 Sinkholes, Earthquakes, and Landslides Profile

I. Sinkholes, Earthquakes, and Landslides Description and Background Information

Sinkholes

Sinkholes are common where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that can naturally be dissolved by ground water circulating through them. As the rock dissolves, spaces and caverns develop underground. Sinkholes are dramatic because the land usually stays intact on the surface until the underground spaces get too big. If there is not enough support for the land above the spaces, then a sudden collapse of the land surface can occur. These collapses can be small or they can be large, and they can occur under a house or road.

A significant number of sinkholes tend to occur in the years that follow a drought. When an area has a long-term lack of rain and water levels decrease, there is usually a correlated link to an increase in incidences of sinkholes being reported. Historically, years where dry weather has been followed by wet weather have resulted in some of the greatest increases in sinkhole occurrences.

Ground water pumping in specific areas when water levels are already low and are forced lower can trigger a more sudden collapse of overburdened sediments and create sinkholes that might not have otherwise happened. Increases in ground water pumping, loading at land surface, retention pond building, and altering a landscape where the depth of the ground is being significantly changed are all activities that can induce sinkholes.

Earthquakes

An earthquake (also known as a quake, tremor, or temblor) is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface that creates seismic waves. This shaking can cause buildings and bridges to collapse; disrupt gas, electric, and phone service; and sometimes trigger landslides, flash floods, fires, and tsunamis.

The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally - total destruction. Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. It was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at that place. The lower numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above. The following list is the description of the Modified Mercalli Intensity Scale:

- I. Not felt except by a very few under especially favorable conditions.
- II. Felt only by a few persons at rest, especially on upper floors of buildings.
- III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
- IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
- V. Felt by nearly everyone, many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
- VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
- VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.

VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.

XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Landslides

Landslides are rock, earth, or debris flows down slopes due to gravity. They can occur on any terrain given the right conditions of soil, moisture, and the angle of slope. Integral to the natural process of the Earth's surface geology, landslides serve to redistribute soil and sediments in a process that can be in abrupt collapses or in slow gradual slides. Also known as mud flows, debris flows, earth failures, and slope failures, landslides can be triggered by rains, floods, earthquakes, and other natural causes as well as human-made causes including grading, terrain cutting and filling, and excessive development.

Because the factors affecting landslides can be geophysical or human-made, they can occur in developed areas, undeveloped areas, or any area where the terrain was altered for roads, houses, utilities, buildings, and even for lawns in one's backyard. They occur in all fifty states with varying frequency and more than half the states have rates sufficient to be classified as a significant natural hazard.[143] The State of Florida has very little relief compared to other states, and landslides are not a significant natural hazard. Any risk or vulnerability to people, property, the environment, or operations would be seen as uniformly low, and for this reason, there will not be a full hazard profile of landslides covered in this section.

II. Geographic Areas Affected by Sinkholes and Earthquakes

Sinkholes

The most damage from sinkholes tends to occur in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania; however, Florida has more sinkholes than any other state in the nation. Florida's average sinkhole size is 3-4 feet across and 4-5 feet deep.[144] For this reason, and because they are one of the predominant landform features of the state, sinkholes are of particular interest to Florida. Their development may be sudden and has the potential to result

[143] http://www.ussartf.org/landslides.htm
[144] http://www.fldisasterkit.com/hazards_analysis/sinkholes.shtml

in property damage or loss of life. There are as many as 150 sinkholes reported each year in Florida. This is because the Florida landmass is generally formed by limestone with a thin layer of sediment covering it, usually consisting of very loose sediment. However, the covering on the porous limestone below is often only temporary. Limestone is very soluble, and as water moves through it, small holes develop and grow into larger holes. The overburdened sediments can cover the hole for a certain amount of time, but once the holes get larger than their ability to bridge across it, the sediments collapse into it.

Figure 3.36 notes the locations of sinkhole occurrences throughout the state that have been reported to the Florida Subsidence Incident Report (SIR) Database at Florida Geological Survey. These land subsidences have not been verified by a geologist, but are rather reports from citizens when land subsidences occurred that they were aware of. Although these are not the best source of information, due to the lack of an official database for the state, this is the most relevant and useful source that the SHMP can utilize for the purposes of this plan.

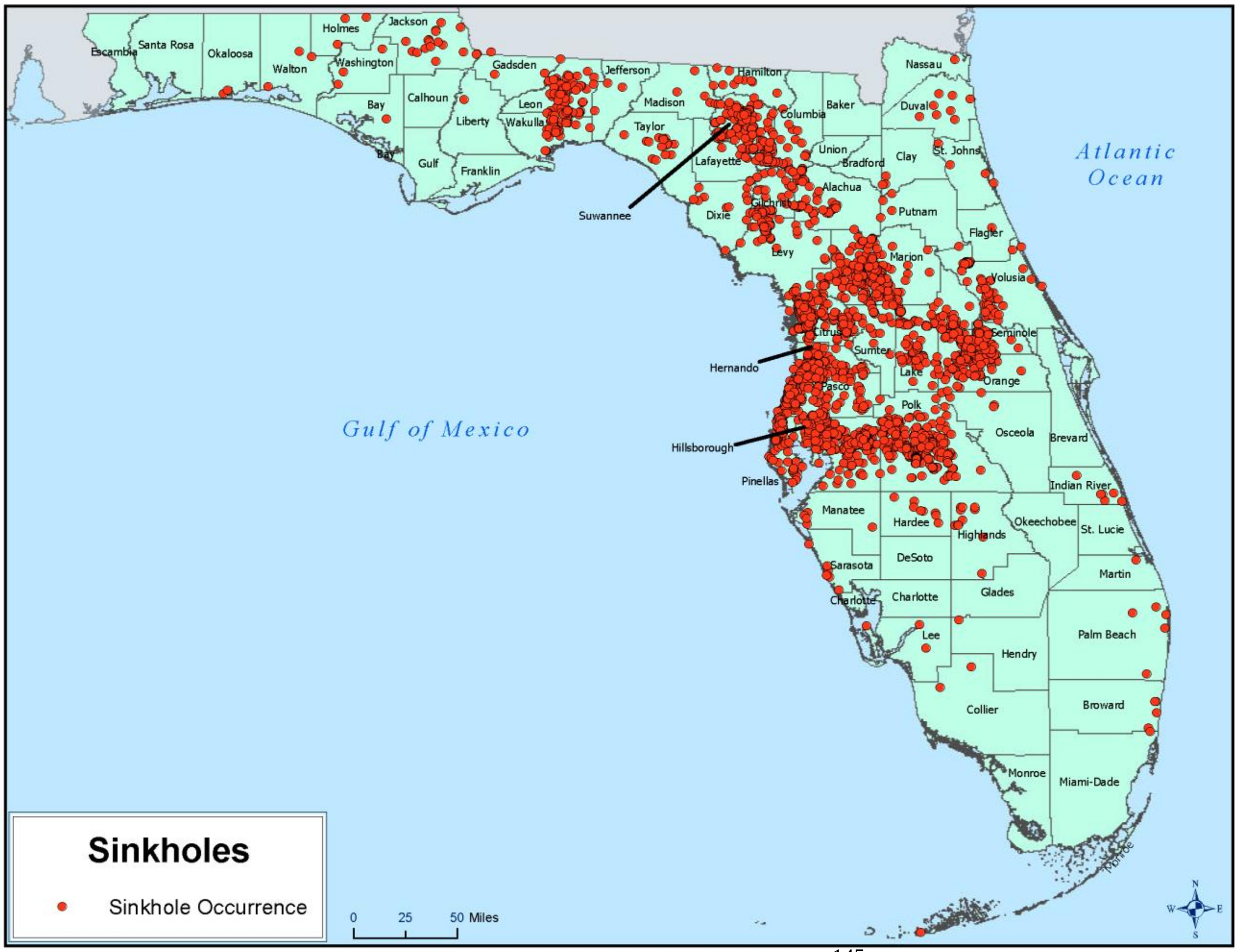

Figure 3.36 Sinkhole Occurrences[145]

[145]FL Department of Environmental Protection (DEP) sinkhole inventory at: http://www.dep.state.fl.us/geology/geologictopics/sinkhole/sink_dis_arc_zip.htm.

Sinkholes are common wherever there is limestone terrain, but are rare in the southern part of the state. Central Florida and the Big Bend region have the largest incidence of sinkholes. Table 3.57 identifies the number of sinkholes 50 feet or deeper, by county in Florida reported through the SIR Database. These land subsidences have not been verified by a geologist, but are rather reports from citizens when land subsidences occurred that they were aware of. Although these are not the best source of information, due to the lack of an official database for the state, this is the most relevant and useful source that the SHMP can utilize for the purposes of this plan.

Table 3.57 Sinkholes per County that were 50 Feet or Deeper

County	*Number of Sinkholes 50 feet or Deeper*	*County*	*Number of Sinkholes 50 feet or Deeper*
Alachua	1	Levy	2
Citrus	1	Marion	1
Columbia	1	Orange	11
Gadsden	1	Pasco	3
Hernando	4	Polk	23
Hillsborough	5	Seminole	3
Jackson	1	Suwannee	2
Jefferson	1	Taylor	1
Lake	4	Volusia	1
Lee	1		
Total Recorded			**67**

III. Historical Occurrences of Sinkholes and Earthquakes

Sinkholes

Perhaps the most famous sinkhole in recent U.S. history is the one formed in May 1981 in Winter Park, Florida. The sinkhole was roughly circular but elongated, (approximately 300 feet by 300 feet in size) and swallowed one house, a shed, half of a swimming pool, a sports car, several large oak trees, a section of the crossing street, and an estimated four million cubic feet of soil. An overview of other occurrences is found in Table 3.58.

Table 3.58 Significant Sinkhole Occurrences

Date	*Information*
September 16, 1999	Lake Jackson in Tallahassee, a nationally known bass fishing lake, experienced a sinkhole on September 16, 1999, that suddenly drained more than half the lake, including water, fish, and alligators.
July 12, 2001	Emergency officials for Hernando County investigated 18 confirmed sinkholes that hit in one day across the area, affecting a 15–16 block residential area and causing extensive damage to one house. One of the largest holes measured between 50 and 100 feet deep.

Date	*Information*
June 2002	A 150-foot-wide sinkhole forced the evacuation of part of a 450-unit apartment building in Orlando, and a Spring Hill woman saw a 40-foot wide hole open in a retention area behind her uninsured home.
June 8, 2009	A sinkhole occurred at about 8:45 a.m. and forced the FDOT to close the northbound outside lane of Route 29 near Hollymead, leaving drivers to pack into one lane, backing up traffic most of the day.
September 15, 2009	Less than 10 feet in width but more than 50 feet deep, this sinkhole was the first of many discovered in High Spring after a Thursday, Sept. 15, torrential downpour. The largest sinkhole measured 75 feet deep and more than a hundred feet across. About a half dozen more are clustered in the same area, with some ranging from just a few feet across and a few feet deep to others that are much larger and deeper.
June 2012	Tropical Storm Debby resulted in a number of new sinkholes opening across Florida including in Suwannee, Hernando, and Pasco counties. Comprehensive sinkhole data from Tropical Storm Debby has not been compiled or published as of July 15, 2012.

Earthquakes

Earthquakes are very rare in Florida and there are no significant recorded incidents. Of the earthquakes felt in Florida, only six are thought to have had epicenters within Florida. The following list in Table 3.59 has been compiled from numerous sources that cite Campbell (1943), the U.S. Geological Survey, and accounts from local newspapers as sources.

Table 3.59 Seismic Activity Reports

Date of Occurrence	*Mercalli Intensity*	*Description*
October 1727	VI	A severe quake was reported in St. Augustine (unofficial).
February 1780		A mild tremor was felt in Pensacola.
January 1879	VI	Earthquake felt through North and Central Florida from Fort Myers to Daytona on the south, to a line drawn from Tallahassee to Savannah, Georgia, on the north (25,000 square miles).
January 1880	VII	Earthquake in Cuba; felt in Florida, about 120 miles east of Havana.
January 1880	VII–VIII	Several shocks were felt in Key West resulting from a disastrous earthquake at Vuelta Abajo, about 80 miles west of Havana, Cuba.
August 1886	V–VI	The great earthquake in Charleston, South Carolina (MMX) was felt all over Florida, ringing bells in St. Augustine. Also, felt in Tampa.
September 1886	IV	Jacksonville felt more aftershocks from the Charleston quake.
November 1886		Jacksonville felt another aftershock from the Charleston quake.
June 1893	IV	Jacksonville felt a tremor.
October 1900	V	Shock at Jacksonville, recorded by U.S. Coast and Geodetic

Date of Occurrence	*Mercalli Intensity*	*Description*
		Survey.
June 1912	V	Strong shock felt in Savannah, probably associated with 6/12 quake, felt in north Florida.
June 1930	V	(Exact date unknown) A tremor was felt over a wide area in central Florida near LaBelle, Fort Myers, and Marco Island.
November 1935	IV or V	Two short tremors were felt at Palatka and another shock was felt at St. Augustine and on nearby Anastasia Island.
January 1942	IV	Several shocks felt on the south coast of Florida, with some shocks felt near Lake Okeechobee and in the Fort Myers area.
January1945		Windows shook violently in the DeLand courthouse, Volusia County.
December 1945	I–III	Shock felt in the Miami Beach – Hollywood area.
November 1948		A sudden jar, accompanied by sounds like distant explosions, rattled doors and windows on Captiva Island, west of Fort Myers.
November 1952		A slight tremor rattled windows and doors at Quincy, about 20 miles northwest of Tallahassee.
March 1953	IV	Two shocks were felt in the Orlando area.
October 1973	V	Shock felt in central east coastal area of Seminole, Volusia, Orange, and Brevard Counties.
December 1975	IV	Shock felt in Daytona and Orlando areas.
January 1978		Two shocks reported by residents in eastern Polk County south of Haines were about one minute apart and each lasted 15 seconds, shaking doors and rattling windows.
November 1978		Tremors felt in parts of Northwest Florida near Lake City, origination believed to be in the Atlantic Ocean.
September 2006		The magnitude 6.0 temblor, centered about 330 miles (530 kilometers) southeast of New Orleans, Louisiana, occurred at 8:56 a.m. local time. It was felt in parts of Florida, Georgia, Alabama, Louisiana, and Mississippi.[146]

IV. Probability of Future Sinkhole and Earthquake Events

Sinkholes

The SHMPAT has determined that the probability of future sinkhole events within the State of Florida is considered to be high due to their review of past historical events and the continuation of ongoing reports of sinkhole activity from across the state.

[146] http://news.nationalgeographic.com/news/2006/09/060911-earthquake.html

Earthquakes

The probability is extremely low that a major earthquake will affect the State of Florida and cause significant damage. The state is considered to be in the low-risk category for seismic activity. Figure 3.37 shows a model for the region in the state at risk for earthquakes. The map below shows zones of peak ground acceleration as a percentage of gravitational acceleration. There is a two percent probability that the given acceleration range will be exceeded in a 50-year period.

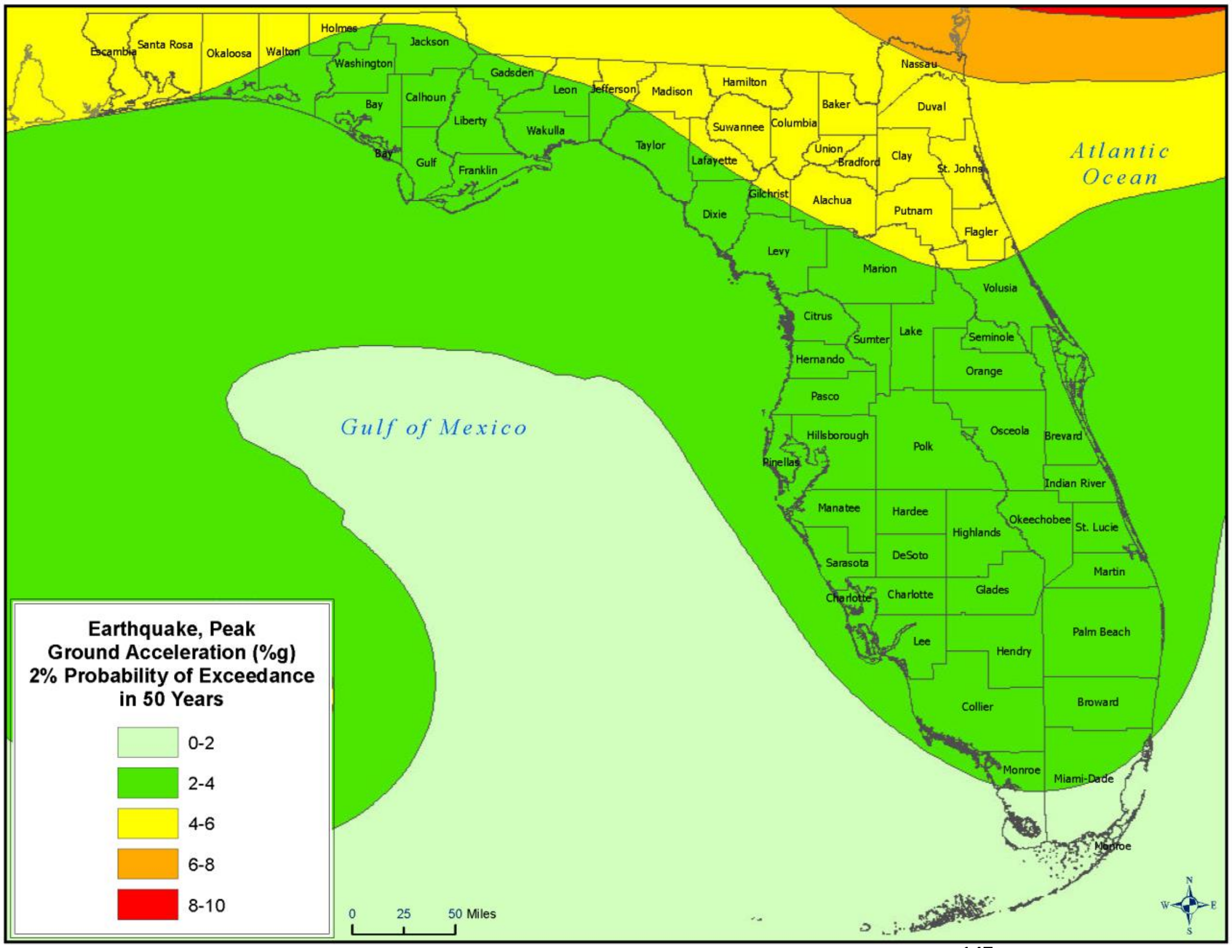

Figure 3.37 Earthquake, Peak Ground Acceleration[147]

V. Sinkhole and Earthquake Impact Analysis

This section has been updated for the 2013 plan revision, since its addition for the 2010 plan update. Sinkholes and seismic events will negatively affect the State of Florida with a variety of impacts. The following section discusses these hazards.

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[147] Results obtained via GIS analysis of aggregated data sources.

Sinkholes

- Sinkholes can be very sudden and relatively large.
- Depending on the location of the sinkhole, severe damage can be done to individual properties or to roads and other infrastructure.
- Sinkholes occur because the entire state is underlain by limestone, a type of rock that is slowly dissolved by weak natural acids found in rain and in the pore spaces in soil.
- Solution sinkholes: where limestone bedrock is thinly covered, depending on the area, there are relatively few to a moderate number of sinkholes. They are usually shallow and broad and develop gradually.
- Cover-subsidence sinkholes: areas of limestone covered by sediment, that are easily permeable to water and incohesive because they contain little clay, are susceptible to these types of sinkholes. Sinkholes in these areas tend to be few, small, and develop gradually, even though the sediment may range in thickness from 30 to 200 feet.
- Cover-collapse sinkholes: sinkholes are a problem in areas where sediments that lie above the limestone are mainly clays mixed with sediment. Clay causes these sediments, which also range in thickness from 30 to 200 feet, to be cohesive. They are not very permeable to water. Sinkholes are most numerous in these areas. They vary in size and may form suddenly. In a few areas of Florida, over 200 feet of sediments cover the underlying limestone. Although there are not many sinkholes in these areas, the ones that occur are deep and wide.
- The abrupt formation of sinkholes may follow extreme rain producing events such as tropical storms or hurricanes. This is because the weight of a large amount of rainwater at the earth’s surface may bring about the collapse of an underground cavity if its limestone “ceiling” has become thin. This tendency for sinkholes to form following events that produce large amounts of rainfall is made worse in times of drought. During periods of drought, underground cavities that might normally be filled with water may be only partially filled. These cavities are less likely to bear the weight of floodwaters without collapsing.
- Sinkhole activity can be triggered by localized extreme lowering of the groundwater table (generally caused by agricultural pumping).

Earthquakes

- Earthquakes are very rare in Florida.
- Florida is situated on the trailing (or passive) margin of the North American Plate, while California is located on its active margin. The active margin is bounded by faults that generate earthquakes when there is movement along them. This is the fundamental reason that Florida has an extremely low incidence of earthquakes, while California experiences many (mostly small) earthquakes.
- A number of seismic faults have been proposed for Florida over the years based on various criteria. Because of the difficulties in defining faults in the state, there is little agreement concerning the validity of those that have been proposed. None of the proposed features in Florida is known to have any seismicity associated with them, with the possible exception of Escambia County.

VI. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. The 67 multi-jurisdictional LMS plans provided a solid baseline for the overall state vulnerability analysis. Risk assessment information from the LMS plans is current as of May 1, 2012. The following pages having the risk assessment information for sinkholes and earthquakes in the State of Florida.

Sinkholes

Based on the LMS plans, Figure 3.38 displays the jurisdictional rankings for the sinkhole hazard. Not all counties have identified sinkholes as one of their hazards.

- High-risk Jurisdictions 5
- Medium-High-risk Jurisdictions 3
- Medium-risk Jurisdictions 12
- Low-risk Jurisdictions 41

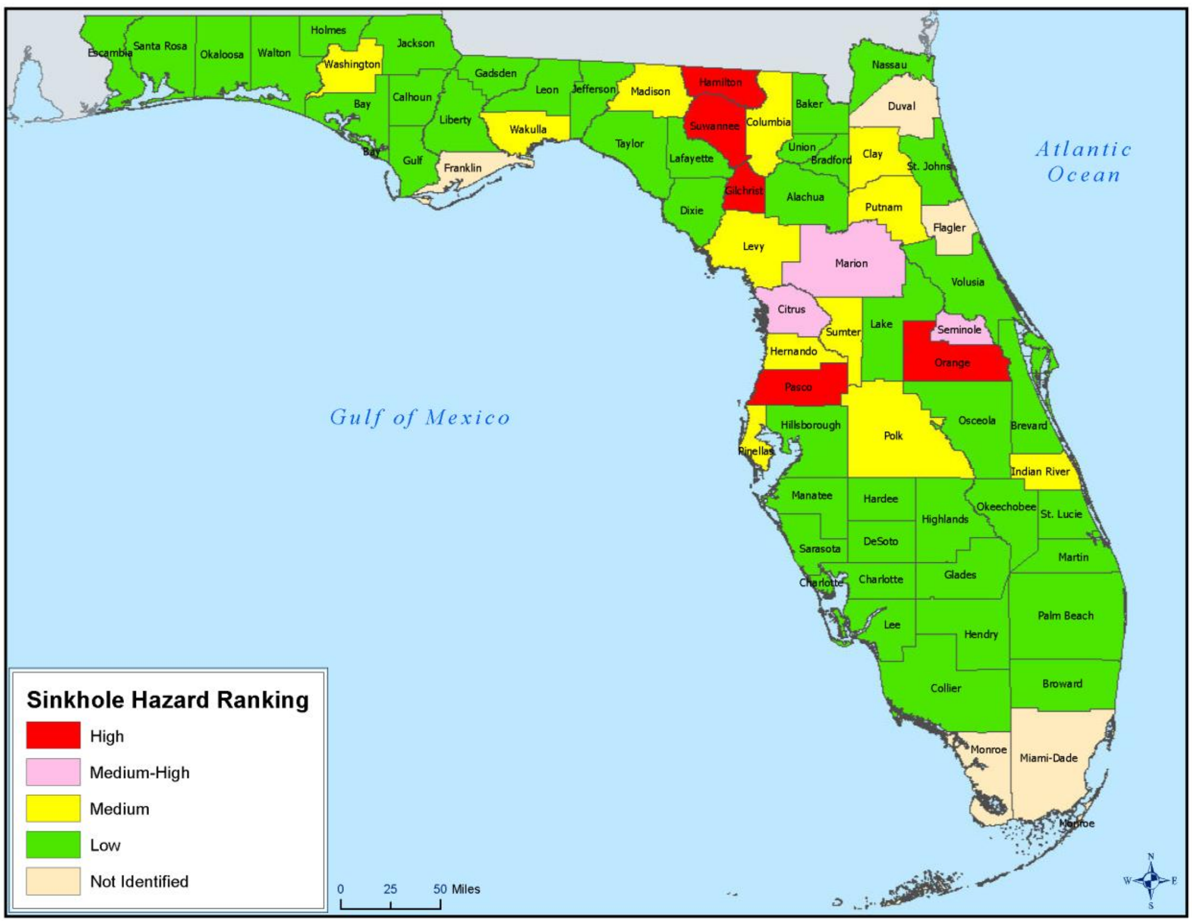

Figure 3.38 Sinkhole Hazard Rankings by County

Earthquakes

Based on the LMS plans in the State of Florida, Figure 3.39 displays the jurisdictional rankings for the earthquake hazard. Not all counties have identified seismic activity as one of their hazards.

- High-risk Jurisdictions 0
- Medium-High-risk Jurisdictions 0
- Medium-risk Jurisdictions 0
- Low-risk Jurisdictions 38

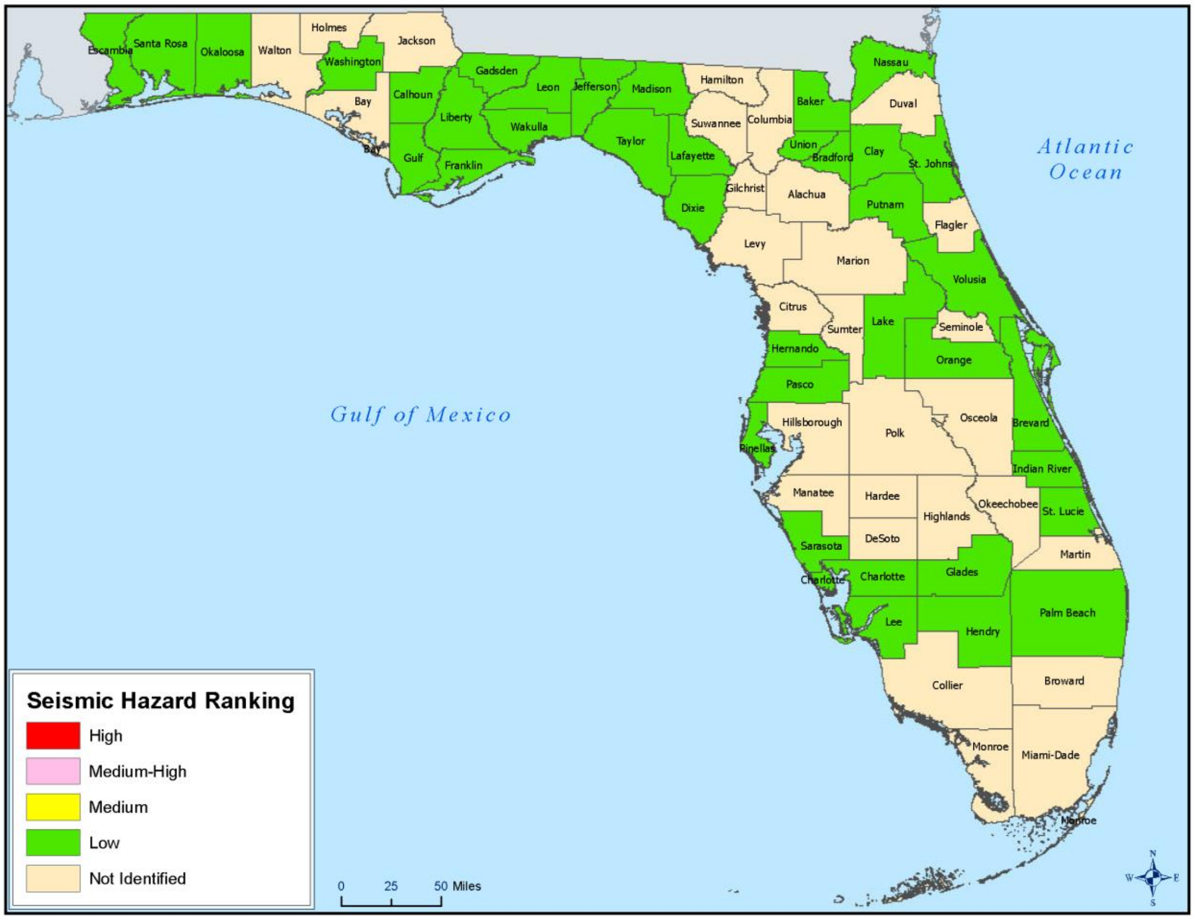

Figure 3.39 Earthquake Hazard Rankings by County

VII. Sinkhole and Earthquake Hazard Vulnerability Analysis by Jurisdiction

Sinkholes

As of August 2012, the FGS SIR database has 3,378 entries of land subsidences with the first entry recorded April 1, 1948. Table 3.60 shows their distribution by county.

These land subsidences haven't been verified by a geologist, but are rather reports from citizens when land subsidences occurred that they were aware of. Although these are not the best source of information, this is the most relevant and useful source that the SHMP can utilize.

Table 3.60 Reported Sinkholes in Florida[148]

County Name	*Number of Sinkholes*	*County Name*	*Number of Sinkholes*
Alachua	55	Levy	69
Bay	1	Liberty	1
Broward	4	Madison	6
Charlotte	1	Manatee	5
Citrus	355	Marion	339
Clay	3	Martin	1
Collier	2	Monroe	1
Columbia	30	Nassau	2
Dade	1	Okaloosa	2
Dixie	13	Orange	194
Duval	8	Osceola	11
Gadsden	2	Palm Beach	5
Gilchrist	46	Pasco	255
Hamilton	13	Pinellas	74
Hardee	22	Polk	267
Hendry	1	Putnam	3
Hernando	263	Sarasota	6
Highlands	11	Seminole	130
Hillsborough	516	St. Johns	4
Holmes	3	Sumter	24
Indian River	6	Suwannee	190
Jackson	20	Taylor	20
Jefferson	3	Volusia	87
Lafayette	6	Wakulla	55
Lake	115	Walton	3
Lee	3	Washington	3
Leon	118		
Total	3,378		

[148] http://www.dep.state.fl.us/geology/geologictopics/sinkhole/sink_dis_arc_zip.htm.

Based on historical evidence, the most vulnerable counties to sinkholes are located mostly in the center portion of the peninsula in Hillsborough, Citrus, Marion, Polk, Hernando, Pasco, and Orange counties.

Earthquakes

The population vulnerable to earthquakes using this model is showing in Table 3.61. Detailed tables about vulnerability to facilities and structures, and the economic value by county, can be found in **Appendix C: Risk Assessment Tables**.

Table 3.61 Earthquake Hazard, Population[149]

County	*0–2% g*	*2–4% g*	*4–6% g*	*6–8% g*
Alachua		4,502	242,834	
Baker			27,115	
Bay		168,852		
Bradford			28,520	
Brevard		543,376		
Broward		1,748,066		
Calhoun		14,625		
Charlotte		159,978		
Citrus		141,236		
Clay			190,865	
Collier		321,520		
Columbia			67,531	
DeSoto		34,862		
Dixie		16,284	138	
Duval			864,263	
Escambia		1,422	296,197	
Flagler			95,696	
Franklin		11,549		
Gadsden		35,210	11,179	
Gilchrist		10,514	6,425	
Glades		12,884		
Gulf		15,863		
Hamilton			14,799	
Hardee		27,731		
Hendry		39,140		
Hernando		172,778		
Highlands		98,786		
Hillsborough		1,229,226		
Holmes		11,661	8,266	
Indian River		138,028		

149 http://gldims.cr.usgs.gov/nshmp2008/viewer.htm

County	*0–2% g*	*2–4% g*	*4–6% g*	*6–8% g*
Jackson		38,098	11,648	
Jefferson		2,570	12,191	
Lafayette		84	8,786	
Lake		297,028	24	
Lee		618,754		
Leon		238,376	37,111	
Levy		40,801		
Liberty		8,365		
Madison		322	18,902	
Manatee		322,833		
Marion		320,691	10,607	
Martin		146,318		
Miami-Dade	862,971	1,633,464		
Monroe	73,084	6		
Nassau			38,436	34,878
Okaloosa		126,699	54,123	
Okeechobee		39,996		
Orange		1,145,956		
Osceola		268,685		
Palm Beach		1,320,134		
Pasco		464,697		
Pinellas		916,542		
Polk		602,095		
Putnam			74,364	
Santa Rosa		10,440	140,932	
Sarasota		379,448		
Seminole		422,718		
St. Johns			190,039	
St. Lucie		277,789		
Sumter		93,420		
Suwannee			41,551	
Taylor		22,430	140	
Union			15,535	
Volusia		466,152	28,441	
Wakulla		30,776		
Walton		37,781	17,262	
Washington		24,896		

VIII. Assessing Vulnerability of State Facilities

A vulnerability analysis on sinkholes and seismic events was conducted in the 2013 plan update. To accomplish this task, the first step was to identify the specific counties within the state that were perceived to be vulnerable to the effects of sinkholes and seismic events, and determine their individual levels of vulnerability.

Sinkholes

For sinkholes, the SHMPAT determined vulnerability for each county in proportion to the total area of sinkholes that have occurred in the county. If no sinkholes were reported for a county in the FGS's SIR database[150] used for the sinkhole analysis, then the SHMPAT determined that the county was not vulnerable. The entire land area of a county containing a historical occurrence of a sinkhole was assumed to be vulnerable. Therefore, a summary of all the insured values within each vulnerable county gave an overview of the relative vulnerabilities for all counties.

The analysis researched past sinkhole events and concluded that there are specific areas of the state that have more active occurrences to sinkholes than others do. Due to the infrequency of when a sinkhole event will occur and the inability to accurately forecast a sinkhole event, it was decided to address each county individually based on past historical occurrences. The most active and vulnerable part of Florida to sinkholes was found to be in the central region near the Gulf of Mexico. Additionally, there were significant numbers found along the Suwannee River basin in North Florida and on the eastern edges of Leon and Wakulla Counties.

Earthquakes

In addition, the SHMPAT used the state facility database to identify which facilities lay within seismic event vulnerability zones. Summarizing the facilities by total counts and insured values within the zones provided estimates of dollar vulnerability by county. Facility counts were summarized by overlaying the geo-coded state facility layer with a layer for earthquake zones (peak ground acceleration as a percent of gravity, with two percent probability of exceedance in 50 years). This approach provided an overall view of the state's vulnerability to these hazards by county.

The analysis researched past seismic events and concluded that there are specific areas of the state that have more active occurrences to seismic events than others do. Due to the infrequency of when an seismic event will occur and the inability to accurately forecast an seismic event, the decision was made to address each county individually based on past historical occurrences. Historically, there has been little, if any damage, due to seismic activity in Florida. As Florida facilities are built to strict codes, there would be minimal impact on the facilities if a minor seismic event were to occur, with the possible exception of Escambia County's facilities.

[150] FGS SIR Database. http://www.dep.state.fl.us/geology/geologictopics/sinkhole/sink_dis_arc_zip.htm.

Below are maps representing the number of state facilities in each county vulnerable to peak ground acceleration, and their cumulative values, in Figure 3.40 and Figure 3.41. Detailed information on facility type by county can be found in **Appendix C: Risk Assessment Tables**.

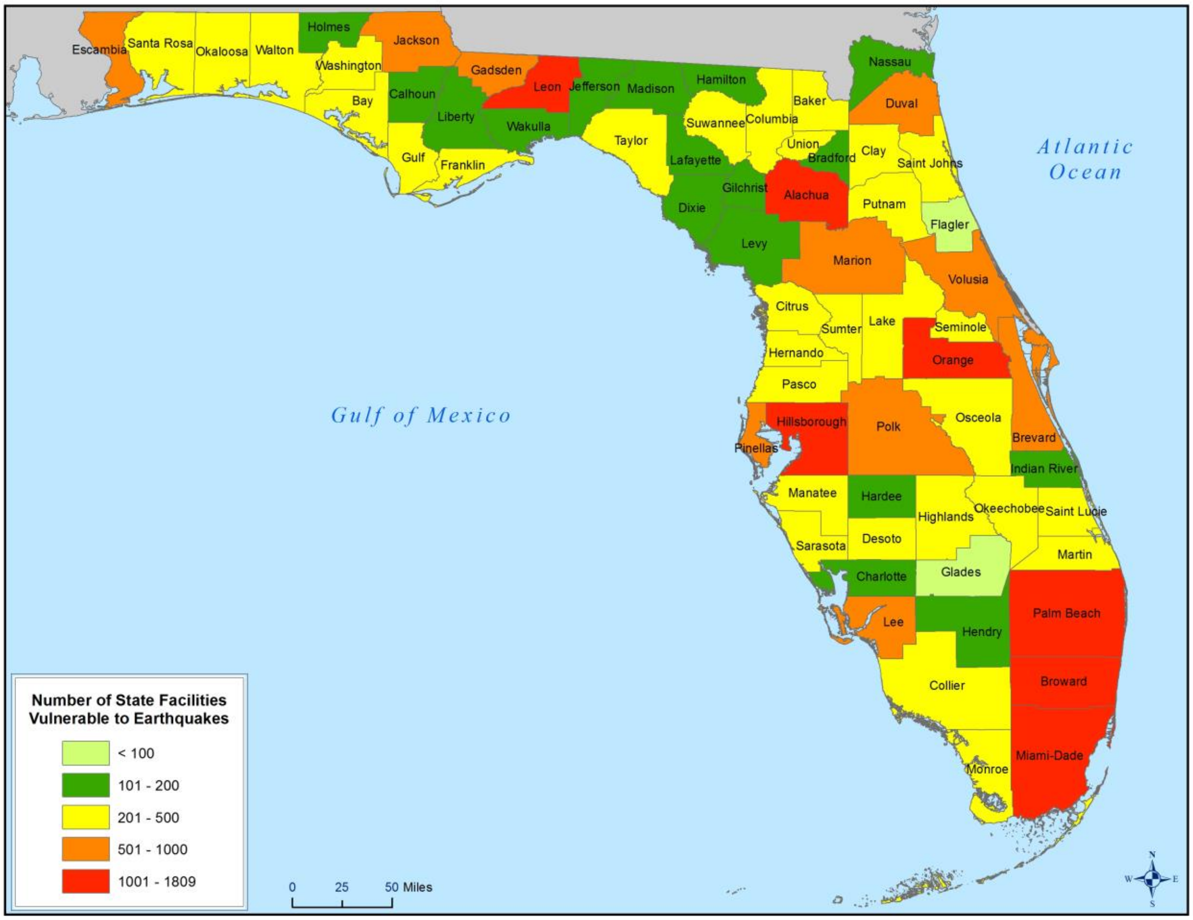

Figure 3.40 Number of State Facilities Vulnerable to Peak Ground Acceleration[151]

[151] Results obtained via GIS analysis of aggregated data sources.

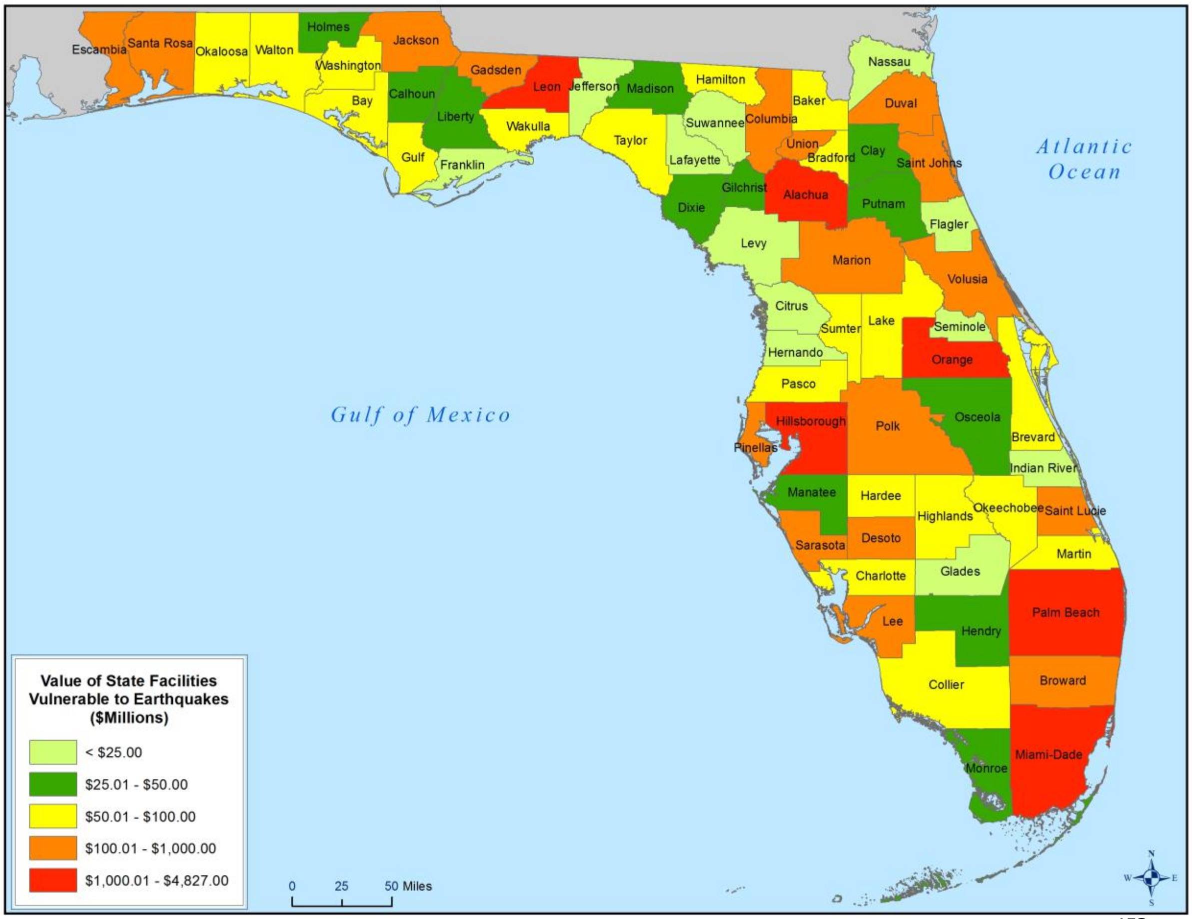

Figure 3.41 Value of State Facilities Vulnerable to Peak Ground Acceleration[152]

IX. Estimating Potential Losses by Jurisdiction

The 2004 original plan did not perform a loss estimate on a statewide level for sinkholes and seismic events. During the 2010 plan update process, the SHMPAT researched the potential losses related to these geological hazards and collected data to assist with this estimation. These have been updated for the 2013 plan.

Sinkholes

Table 3.62 shows the vulnerabilities for sinkholes, as originally modeled by Kinetic Analysis Corporation (KAC), along with the overall damage estimates. The data in the table below is several years old, but it is the most current data available for sinkholes.

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[152] Results obtained via GIS analysis of aggregated data sources.

Table 3.62 Value of Structures KAC Sinkhole Risk (Sinkhole Structures Summary)[153]

Zone	Total	SF Res	Mob Home	MF Res	Commercial	Agriculture	Govnt/ Institution
Low	$1122 BI	$511.4 BI	$12.1 BI	$274.4 BI	$156.7 BI	$92.7 BI	$74.8 BI
Medium	$753.3 BI	$367.3 BI	$13.6 BI	$117.2 BI	$118.8 BI	$93.0 BI	$43.1 BI
High	$147.5 BI	$80.0 BI	$2.3 BI	$18.0 BI	$23.8 BI	$19.2 BI	$3.9 BI
Very High	$66.9 BI	$37.9 BI	$1.3 BI	$6.8 BI	$8.2 BI	$10.4 BI	$2.0 BI
Extreme	$31.5 BI	$17.6 BI	$606.4 MI	$3.0 BI	$4.7 BI	$4.8 BI	$747.3 MI
Adjacent	$1.2 BI	$832 MI	$29.4 MI	$142.4 MI	$161.5 MI	$57.4 MI	$40.5 MI

SHMPAT Sinkhole Research

As part of the loss estimation, the SHMPAT coordinated with FGS for current data on sinkholes. Using the state-maintained SIR database as the baseline, the team determined that there were 3,378 reported sinkholes in Florida as of August 2012. In order to estimate losses, the team researched the sinkholes that were relatively large. Using a 50-foot depth as a dividing line, the team found 67 sinkholes throughout the state that met that depth parameter.

As of January 2013, DEM and the FGS have begun talking about completing a new sinkhole study for the State of Florida. As information from the study becomes available it will be integrated into the risk assessment and distributed to county partners.

Earthquakes

For earthquake values by structure, the 2013 plan will use Hazus-MH 2.1 with 2010 demographics information to replace the previous table showing structures, by occupancy type based on the 50-year earthquake. **Appendix C: Risk Assessment Tables** contains this detailed breakdown of values, by county, peak ground acceleration percentage and occupancy type.

X. Estimating Potential Losses of State Facilities

Sinkholes

Sinkhole events are prevalent across all parts of the State of Florida and there is no way of knowing where future sinkholes might appear. Because of this, the state and its facilities continue to be vulnerable to potential losses caused by sinkholes, placing billions of dollars in property at risk.

Earthquakes

Earthquake events are rare in the State of Florida, and state facilities continue to be minimally vulnerable to future potential losses caused by earthquakes. **Appendix C: Risk Assessment Tables** contains the detailed analysis, based on Hazus-MH 2.1 of the potential value

[153] http://lmsmaps.kinanco.com/

of impacts to state facilities, by county, facility type, and peak ground acceleration percentage. Table 3.63 is the total value, by county, of those facilities.

Table 3.63 Value of Facilities at Risk to Earthquake Hazard[154]

County Name	*Total Value of Facilities (Millions $)*	*County Name*	*Total Value of Facilities (Millions $)*
Alachua	4826.32	Lee	510.32
Baker	86.3	Leon	3274.87
Bay	79.98	Levy	21.3
Bradford	51.72	Liberty	34.36
Brevard	68.78	Madison	39.22
Broward	348.4	Manatee	32.36
Calhoun	32.58	Marion	267.62
Charlotte	63.1	Martin	68.14
Citrus	19.48	Miami-Dade	1934.62
Clay	26.95	Monroe	47.42
Collier	68.85	Nassau	19.16
Columbia	100.71	Okaloosa	70.02
Desoto	121.99	Okeechobee	84.06
Dixie	31.03	Orange	1307.19
Duval	644.79	Osceola	40.04
Escambia	237.93	Palm Beach	1055.99
Flagler	10.59	Pasco	59.42
Franklin	17.45	Pinellas	317.63
Gadsden	200.07	Polk	199.75
Gilchrist	30.29	Putnam	28.86
Glades	1	Santa Rosa	116.06
Gulf	55.05	Sarasota	247.83
Hamilton	99.56	Seminole	18.22
Hardee	55.58	St. Johns	219.31
Hendry	33.03	St. Lucie	164.49
Hernando	21.63	Sumter	65.42
Highlands	66.17	Suwannee	11.78
Hillsborough	2409.56	Taylor	75.79
Holmes	34.36	Union	244.71
Indian River	19.39	Volusia	146.09
Jackson	173.53	Wakulla	70.91
Jefferson	23.78	Walton	52.07
Lafayette	17.89	Washington	83.7
Lake	64.99		

[154] Results obtained via GIS analysis of aggregated data sources.

3.3.10 Tsunami Profile

I. Tsunami Description and Background Information

A tsunami is a series of waves created when a body of water, such as in an ocean, is rapidly displaced. A tsunami has a much smaller amplitude (wave height) offshore, and a very long wavelength (often hundreds of kilometers long), which is why they generally pass unnoticed at sea, forming only a passing "hump" in the ocean. Tsunamis have been historically referred to as tidal waves because as they approach land, they take on the characteristics of a violent onrushing tide rather than the sort of cresting waves that are formed by wind action upon the ocean. Since they are not actually related to tides, the term is considered misleading and its usage is discouraged by oceanographers.

There is another phenomenon often confused with tsunamis called rogue waves. There remains debate as to whether these waves are related to tsunamis. They are included in this section as the mitigation plans address the threat in the same relative manner. The characteristics are:

- Unpredictable nature
- Little is known about the formation
- May be caused by regularly-spaced ocean swells that are magnified by currents or the atmosphere

Tsunamis are formed as the displaced water mass moves under the influence of gravity and radiates across the ocean like ripples on a pond. These phenomena rapidly displace large volumes of water, as energy from falling debris or energy expansion is transferred to the water into which the debris falls. Tsunamis caused by these mechanisms, unlike the ocean-wide tsunami caused by some earthquakes, generally dissipate quickly and rarely affect coastlines distant from the source due to the small area of sea affected. However, an extremely large landslide could generate a “mega-tsunami” that might have ocean-wide impacts. The geological record tells us that there have been massive tsunamis in the earth’s past.

There is often no advance warning of an approaching tsunami. However, since earthquakes are often a cause of tsunamis, an earthquake felt near a body of water may be considered an indication that a tsunami will shortly follow. The first part of a tsunami to reach land is a trough rather than a crest of the wave. The water along the shoreline may recede dramatically, exposing areas that are normally submerged. This can serve as an advance warning of the approaching crest of the tsunami, although, the warning only gives a very short time before the crest, which typically arrives seconds to minutes later.

National Geophysical Data Center (NGDC)

NOAA’s National Geophysical Data Center (NGDC) is building high-resolution digital elevation models (DEMs) for select U.S. coastal regions. These combined bathymetric-topographic DEMs are used to support tsunami forecasting and modeling efforts at the NOAA

Center for Tsunami Research, Pacific Marine Environmental Laboratory (PMEL). The DEMs are part of the Short-term Inundation Forecasting for Tsunamis (SIFT) system currently being developed by the PMEL for the NOAA tsunami warning centers, and are used in the Method of Splitting Tsunami (MOST) model developed by the PMEL to simulate tsunami generation, propagation, and inundation.

The NWS has two tsunami warning centers:

- The West Coast and Alaska Tsunami Warning Center in Palmer, Alaska, which covers Alaska south to California and the U.S. Gulf of Mexico and Atlantic Coast.
- The Pacific Tsunami Warning Center in Ewa Beach, Hawaii, serves as a national/international warning center for tsunamis that pose a Pacific-wide threat and they also are responsible for the Caribbean.

Interim Method of Warning:

- The Alaska Tsunami Warning Center (ATWC) issues a Tsunami Warning if there is an earthquake 7+ on the Richter Scale on/near a coast.
- The NWS office in Melbourne, Florida, receives the warning via fax and phone call from the ATWC.
- The NWS in Melbourne disseminates the warning to coastal NWS offices via the dedicated Hurricane Hotline.
- Affected coastal NWS offices issue a coastal flood warning via the following:
  - All Hazards NOAA weather radios
  - Emergency Alert System
  - Statement transmitted over "weather wire" to EM officials and the media[155]

II. Geographic Areas Affected by Tsunamis

Tsunami events occur most often in the Pacific Ocean, but they are a global phenomenon and all are potentially dangerous, though they may not damage every coastline they strike. Analyzing the past 150 years of tsunami records shows that the most frequent and destructive tsunamis to affect the U.S. have occurred along the coasts of California, Oregon, Washington, Alaska, and Hawaii.

However, the State of Florida is located within the Caribbean area, and over the past 156 years, the Caribbean has experienced more total tsunami events, which have ultimately resulted in over 2,500 deaths.[156] Overall, Florida has experienced few destructive tsunami or rogue wave events, but there were several small events.

[155] http://www.tsunami.noaa.gov/warnings_forecasts.html

[156] http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CGIQFjAA&url=http%3A%2F%2Fwww.srh.noaa.gov%2Fmedia%2Fmlb%2Fpresentations%2FFloridaTsunamis.ppt&ei=R78yUPPcH4Tg8wTx84Fo&usg=AFQjCNHLP-P9hWKFx9-nlK81iXc51dHzkQ

The SHMPAT found that there are two ways of identifying geographic locations that could be affected by a tsunami event. The first way is to consider the fact that there is scientific evidence that shows that there is the potential for a geological event to take place with Cumbre Vieja in the Canary Islands. If this event were to occur, a large-scale tsunami could affect the United States' eastern coastline. If this event were to take place, it is expected that the eastern coastline of the State of Florida would suffer extensive damage and loss of life.

Earthquakes are frequently the cause for tsunami events, and because there is no way of knowing exactly when and where future earthquake events might take place, the SHMPAT has concluded that all geographic areas of Florida that border the Atlantic Ocean or Gulf of Mexico are at risk. The following vulnerabilities are organized by threat to the Atlantic Coast, or Gulf Coast and Keys and list the potential causes of a tsunami that would put the state at risk:

- Florida's Atlantic Coast
- Puerto Rico Trench
- Cumbre Vieja Volcano in Canary Islands
- Azores-Gibraltar Fracture Zone
- Florida's Gulf Coast and Keys
- Puerto Rico Trench (minor effect as wave wraps around islands)
- Large Meteorite into Gulf of Mexico

III. Historical Occurrences of Tsunamis

Table 3.64 summarizes previous tsunami or rogue wave occurrences that have been in Florida and even notable occurrences nationally and internationally.

Table 3.64 Previous Tsunami and Rogue Wave Occurrences

Date	*Information*
July 7, 1992	Daytona Beach experienced a rogue wave at about 11 p.m. EST. "Strollers along the beach and the boardwalk were horrified to see a white wall of water 3–6 meters high come rolling in from the ocean."[157] Between 1,500 and 2,000 vehicles were parked on the beach when the waves struck and all were jammed against the seawall or under the pier. Only 100 damage reports were filed. 20 people were injured. This rogue wave is believed to have been meteorologically induced.
March 25, 1995	A rogue wave caused a strong outgoing tide at the mouth of Tampa Bay before an 11 foot rise around 9 a.m. EST. The tide was 1-4 feet above normal south of Tampa Bay to Naples (124 miles) and carried stingrays and jellyfish on the beach. The wave broke about one mile offshore.
September 10, 2006	A strong earthquake occurred about 250 miles southwest of Apalachicola, Florida at 8:56 a.m. MST. No reports or sightings of tsunami events were recorded within the state; however, the SHMPAT

[157] http://www.ngdc.noaa.gov/nndc/struts/results?EQ_0=2462&t=101650&s=9&d=99,91,95,93&nd=display

Date	Information
	felt that this type of event should be mentioned as it could have created a tsunami under these conditions, which could have affected the West Coast and Panhandle of Florida.
December 26, 2004	The deadliest event was not a Florida event, but rather happened in Phuket, Thailand. The 2004 Indian Ocean earthquake, which had a magnitude of 9.0 to 9.3, triggered a series of lethal tsunamis that killed approximately 300,000 people (168,000 in Indonesia alone), making it the deadliest tsunami, as well as one of the deadliest natural disasters in recorded history. It also was the second-largest earthquake in recorded history. The initial surge was measured at a height of approximately 33 meters, making it the largest earthquake-generated tsunami in recorded history. The tsunami killed people over an area ranging from the immediate vicinity of the quake in Indonesia, Thailand, and the north-western coast of Malaysia, to thousands of kilometers away in Bangladesh, India, Sri Lanka, the Maldives, and even as far away as Somalia, Kenya, and Tanzania in eastern Africa. This is an example of a tele-tsunami, which can travel vast distances across the open ocean; in this case, it was an inter-continental tsunami. Tsunami waves at 2.6 meters tall were reported even in places such as Mexico, nearly 13,000 km away from the epicenter. The energies for these waves travel along fault lines and become concentrated, therefore traveling further. Unlike the Pacific Ocean, there was no organized alert service covering the Indian Ocean. This was in part due to the absence of major tsunami events since 1883. In light of the 2004 tsunami, UNESCO and other world bodies have called for an international tsunami monitoring system.
March 11, 2011	A magnitude 9.03 earthquake occurred off the coast of Japan, which was the most powerful one in that area to occur since modern record keeping began. The earthquake triggered a series of powerful tsunami waves that devastated large portions of the Pacific coastline of Japan's northern islands. Tsunami waves were estimated to be in excess of 30 meters in certain locations. Japan's National Police Agency lists 15,870 confirmed dead and 92 percent are believed to have died by drowning.

IV. Probability of Future Tsunami Events

Using data provided by the NGDC tsunami database, it was found that there were at least one or more tsunami or rogue wave events that have occurred along the coast of Florida since 1900, specifically an event that occurred in Daytona Beach on July 7, 1992. During that event, there were over 20 people injured, one death, and damage to many cars parked in the area close to the coastline. Because of this and the frequency of prior tsunami events from around the world, it is the SHMPAT's conclusion that the probability of future tsunami events affecting the State of Florida is low.

V. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the Local Mitigation Strategies (LMS). With 67 multi-jurisdictional Local Mitigation Strategy plans, the local risk assessment data provided a solid baseline for the overall state vulnerability analysis. For counties that analyzed tsunamis, all reported low vulnerability and many included the analysis within the "Storm Surge" or "Coastal Flooding" portion of their plan. Due to this fact, it was not possible to acquire a vulnerability score for each county.

VI. Tsunami Hazard Vulnerability Analysis by Jurisdiction

Historically, large-scale tsunami events have not been a major threat to the State of Florida; however, that exposure has increased as more people move into the state in areas of close proximity to the coast. Only one Atlantic-wide tsunami was documented (the 1755 Lisbon earthquake); however, the eastern U.S. has had 40 tsunamis/ rogue waves in the last 400 years, or an average of one event every 10 years.

Approximately 33 percent of the total state population lives within 20 miles of the coast, and that number is increasing. The majority of the state's residents are not educated on the warning signs or effects of a tsunami and would be put at a higher risk of exposure should a large-scale event occur.

VII. Assessing Vulnerability of State Facilities

The state's vulnerability to a tsunami is addressed in this section. After further analysis, the SHMPAT elected to use the coastal flooding analysis as the tsunami analysis due to the limited information available on impacts of tsunamis.

The state facility database provided by DFS was used to correlate the number of vulnerable state facilities within each county to the county's specific level of vulnerability, as given in their local mitigation strategies. This information is equivalent to the coastal flooding vulnerability information provided herein. Using this approach allows for the identification and overall view of the state's vulnerability to this hazard by county.

VIII. Estimating Potential Losses by Jurisdiction

The original plan did not perform a loss estimate on a statewide level for tsunamis. During the 2013 plan update process, no new data or numbers were found by the SHMPAT.

IX. Estimating Potential Losses of State Facilities

The SHMPAT did not conduct loss estimations on a tsunami event in 2004 during the original plan development process. During the 2010 and 2013 plan update and revision process, this analysis was included. The following section provides a detailed description of the estimates of potential losses to state facilities from a tsunami.

Tsunami events are rare in the State of Florida, and there is no way of knowing when and where future tsunami events might occur. Because of this, the state and its future potential losses to state facilities are assumed to be minimally vulnerable to the effects of a tsunami. The tables within this section show the total exposure and estimated losses of state-owned facilities to a tsunami by county.

To estimate potential losses to state facilities, the SHMPAT had to first identify the specific counties within the state that are perceived to be vulnerable to the effects of a tsunami, as well as each county's individual level of vulnerability. For tsunamis, the levels of vulnerability identified by the SHMPAT, using the local mitigation strategy, if available was within this estimated loss analysis.

Using the state facility database provided by the Florida DFS, the team overlaid the state facility information into a geographic information system (GIS) to correlate the number of vulnerable state facilities within each county with the county's specific level of vulnerability. These are showing in Table 3.65. Vulnerability was measured using the impacts of a Category 5 hurricane, given tsunamis impact to coastal counties. This approach allowed the SHMPAT to identify an overall view of the state's estimated losses to this hazard by county. This approach was used for coastal counties only.

Table 3.65 State Facility Estimated Losses to Tsunami[158]

County	Number of Facilities	Replacement Value	County	Number of Facilities	Replacement Value
Bay	123	$141,240,000	Levy	47	$23,720,000
Brevard	159	$603,120,000	Manatee	89	$345,220,000
Broward	518	$3,283,540,000	Miami-Dade	1235	$7,329,510,000
Charlotte	163	$521,330,000	Monroe	226	$248,260,000
Citrus	90	$98,780,000	Nassau	43	$130,250,000
Collier	212	$822,550,000	Okaloosa	61	$64,280,000
Dixie	6	$8,200,000	Palm Beach	176	$1,096,060,000
Duval	236	$952,510,000	Pasco	43	$168,470,000
Escambia	59	$45,510,000	Pinellas	332	$1,476,180,000
Flagler	56	$116,870,000	Saint Johns	248	$328,630,000
Franklin	120	$37,020,000	Saint Lucie	38	$26,440,000
Gulf	55	$75,010,000	Santa Rosa	26	$56,920,000

[158] Results obtained via GIS analysis of aggregated data sources.

County	Number of Facilities	Replacement Value	County	Number of Facilities	Replacement Value
Hernando	8	$17,940,000	Sarasota	146	$467,960,000
Hillsborough	217	$1,231,750,000	Taylor	80	$37,590,000
Indian River	36	$102,880,000	Volusia	86	$247,040,000
Jefferson	1	$10,000	Wakulla	41	$32,130,000
Lee	622	$2,222,770,000	Walton	42	$20,010,000
			Total	**5,640**	**$22,379,700,000**

3.3.11 Solar Storm Profile

I. Solar Storm Description and Background

Solar storm is a broad term used to describe a number of atmospheric events that have the potential to adversely affect conditions on earth. These events can include: solar flares, large explosions in the Sun's atmosphere, which can cause radio wave interference, and coronal mass ejections, which occur when a burst of solar wind and magnetic fields are released from the Sun's atmosphere. If the charged particles reach Earth's atmosphere they can cause a wide range of effects including atmospheric aural lights, and consequences ranging from requiring the diversion of air traffic, to the disruption of global positioning systems and other satellite systems, to potentially interfering with the electrical power grid.

A 1989 solar storm significantly disrupted the power system in Quebec, Canada, affecting power for approximately 6 million people and costing an estimated $2 billion in total economic impacts. The most recent solar storm on March 8, 2012 caused some air traffic to be re-routed away from polar regions, and dumped a huge amount of energy into the Earth's atmosphere but did not otherwise affect the Earth. In 1859, the most powerful solar storm in recorded history, known as the Carrington Super Flare, occurred causing telegraph systems across Europe and North America to fail. In a 2012 study, researchers concluded that the probability of a Carrington-like event occurring over the next decade is approximately 12 percent.

The entire State of Florida and its population and infrastructure is susceptible to solar storms, however, the effect that minor solar events could have on the public, property, environment, and operations would be minimal. If a rare, major solar storm were to occur, there could be a much larger impact on the population, property, and operations. However, the environment would still not be affected.

The SHMPAT identified solar storms as a potential emerging threat. Specific details and vulnerabilities are not clearly available at this time, therefore, there is a not a full hazard profile for this plan update. Subsequent updates to the plan will evaluate new data and analysis on the hazard.

3.3.12 Technological Hazards Profile

I. Technological Hazards Description and Background Information

Technological hazards are those that are caused by tools, machines, and substances that are used every day. The major technological hazards that will be discussed in this section are hazardous materials and radiological accidents.

Hazardous Materials

Hazardous Materials (HazMat) refers generally to hazardous substances, petroleum, natural gas, synthetic gas, and acutely toxic chemicals. The term Extremely Hazardous Substance (EHS) is used in Title III of the Superfund Amendments and Reauthorization Act of 1986 to refer to those chemicals that could cause serious health effects following short-term exposure from accidental releases.

With the passage of the Federal Emergency Planning and Community Right-To-Know Act (EPCRA) in 1986, the division began implementation of a statewide Hazardous Materials Emergency Planning Program. For the first time, passage of the EPCRA allowed emergency planners, responders, and the public access to facility-specific information regarding the identification, location, and quantity of particular hazardous materials at fixed sites.

The law requires facilities with threshold quantities of federally mandated substances to report annually to state and local emergency officials. In addition, facilities must immediately notify officials of any releases of harmful chemicals that have the potential to result in offsite consequences. This information is utilized to prepare emergency plans for hazardous materials incidents, to allow responders to receive training based on specific known threats, and to inform and educate the public regarding the chemicals present in their communities. Florida has more than 4,500 fixed facility locations that report the presence of an EHS in federally mandated threshold amounts.

There are a total of 30,638 miles of pipeline within Florida. The vast majority (91 percent) of pipelines in the state carry natural gas. Energy pipelines are a fundamentally safe and efficient means of transporting material key to the U.S. energy supply but, given that they often carry toxic, volatile, or flammable material, energy pipelines have the potential to cause injury and environmental damage.

Between 2002 and 2011, there were 36 "serious or significant pipeline incidents" in Florida, resulting in one fatality, eight injuries, and a total of $8,126,666 in property damage. Table 3.66 and Table 3.67 summarize the information and commodities of pipelines while Figure 3.42 illustrates the pipelines in Florida.

Table 3.66 Total Pipeline Mileage in Florida

Pipeline System	*Mileage*
Hazardous liquid line mileage	475
Gas transmission line mileage	4,871
Gas distribution mileage (851,042 total services)[159]	25,291
Total pipeline mileage	**30,638**

Table 3.67 Total Pipeline Mileage by Commodity

Commodity	*Pipeline Miles*	*Percent*
Anhydrous Ammonia HVL	88	1.6
Crude Oil	45	0.8
Natural Gas	4,871	91.1
Refined Products	342	6.4
Total	**5,345**	**100**

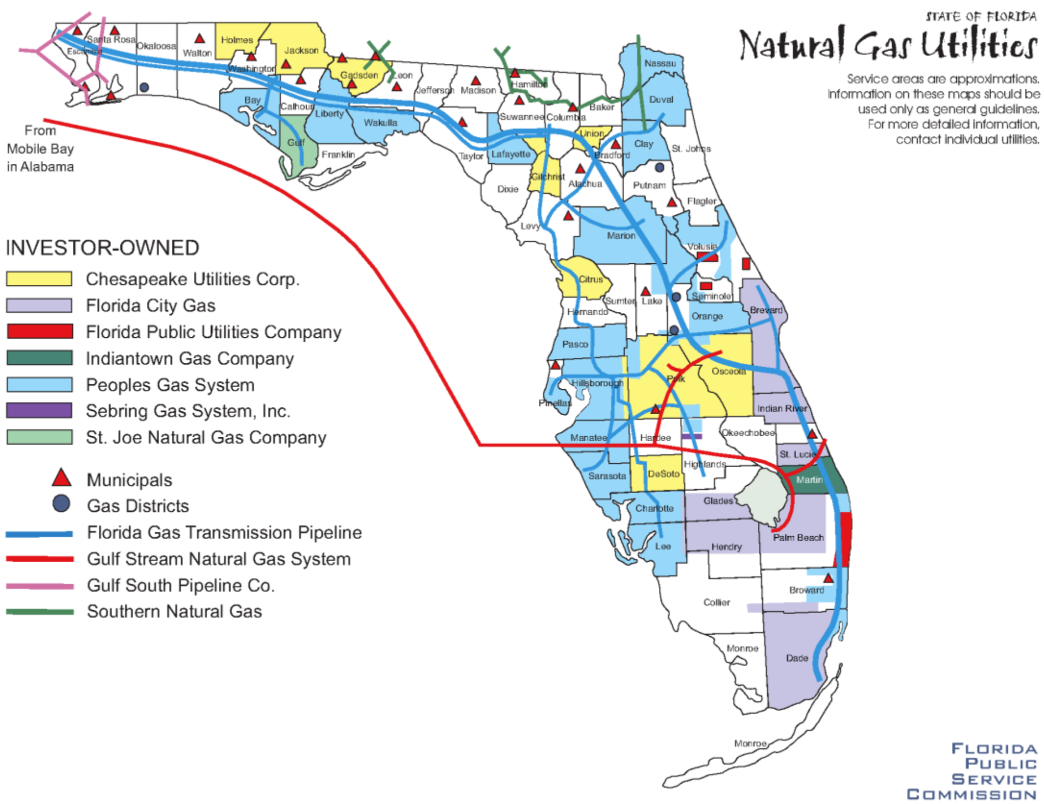

Figure 3.42 Natural Gas Infrastructure in Florida

159 The miles of gas distribution service lines (the connection between the distribution line and the end user) are not included in the Gas distribution mileage. The total number of such services is provided.

Historically, the most common threats to energy pipelines have been accidents and seismic activity; however, more recently, DHS has warned that U.S. natural gas pipelines are the target of cyber-attack. DHS spokesperson Peter Boogaard said that DHS "has been working with critical infrastructure owners and operators in the oil and natural gas sector to address a series of cyber intrusions targeting natural gas pipeline companies." Publically available information does not indicate the extent to which systems have been infiltrated but cyber security officials warn that, with sufficient access, a hacker could potentially "manipulate pressure and other control system settings, potentially reaping explosions or other dangerous conditions." Additionally, sufficient access could shut down energy transit, significantly disrupting U.S. energy supply.

Oil Spill

Given Florida's dependence on tourism and the related sales tax revenue, an oil spill which is classified as a type of Hazardous Material event, could affect any of Florida's many natural treasures which could be catastrophic. The Florida impacts of the 2010 BP Deepwater Horizon blowout were mostly limited and contained, but the predictions at the time of potential impacts were severe. Moody's Analytics released a report which stated, should a significant amount of oil wash onto Florida's shores, the economic impact from tourism-related tax revenue and job losses could rival that of the ongoing recession and "simulate a double dip recession". In addition to economic impacts, an oil spill in Florida or off its shores could have severe consequences for wildlife, ecosystems, and the ecology.

Radiological Accidents

Nuclear power-generating facilities have the greatest concentration of radioactive materials of any private source. Florida has three nuclear power plants: Crystal River in Citrus County, Turkey Point in Miami-Dade County, and St. Lucie on Hutchison Island in St. Lucie County. Florida is also in the Ingestion Pathway Zone (i.e., a 50-mile zone around each site) for the Farley Plant in Dothan, Alabama. In order to be in compliance with federal regulations, there must be a demonstrated ability to respond to any event that could occur at a site.

The State of Florida has had a proactive Radiological Emergency Preparedness Program for many years. There have been many training courses and instruction given both to those counties within the immediate area of the plants (within 10 miles) and those who are in the ingestion pathway of the plant (within 50 miles). DEM is involved in either a practice or evaluated exercise of each plant every year.

Although extensive safeguards are required, accidents can occur. These could affect large populations through the accidental release of radiation. Other sources of radiological accidents can occur through transportation of radioactive materials and the launching of spacecraft from Kennedy Space Center. In addition, the King's Bay Nuclear Submarine Base is located in St. Mary's, Georgia, just across the state boundary of Northeast Florida. Although the facility has the potential to use and store nuclear materials, as a military facility it is not required to conduct the same radiological emergency preparedness programs as nuclear power plants, nor do they identify evacuation zones or ingestion pathways. Release of radiological materials due to a facility or transportation-related accident has the potential for affecting a number of Northeast Florida counties.

II. Historical Occurrences of Technological Hazards

Table 3.68 records previous technological hazard incidents of note in the state.

Table 3.68 Previous Technological Hazard Occurrences[160]

Date	*Information*
November 29, 2005	Raw material was combined at the Moss Soap and Chemical Facility and re-packaged for sale. Throughout its years of operation, product lines were no longer carried, resulting in the accumulation of various chemicals. These chemicals were stored throughout the building in drums and other containers. The facility first came to the attention of EPA after a safety audit conducted by MDFR. MDFR found deteriorating drums and containers and leaking chemicals at the facility. The building was found to be in poor condition, with large holes in the roof and corroded support beams. MDFR requested EPA and Dade County Buildings Department assistance.
July 19, 2005	An area business owner contacted the city of Tampa regarding the dumping of an unknown material in a drainage ditch along Channelside Drive. The dumping was estimated to have occurred on July 16, 2005. On July 25, 2005, additional material was found to have been dumped in the ditch. The City of Tampa requested the assistance of the Hillsborough County Environmental Protection Commission (HCEPC).
August 2, 2005-August 12, 2005	DEP found approximately 100 yards of a drainage ditch was covered with a black sludge- like material. HCEPC contacted DEP about this material, who sampled the material. Analytical results indicate the material has high levels of lead. Based on the size and scope of this, DEP requested EPA assistance.
June 1, 2006	The EPA Region 4 Phone Duty Officer received a NRC report (#775738) indicating the release of mercury within a residence. The EPA Duty Officer contacted the DEP and was informed that the mercury levels in the mobile home were approximately 35,000 ng/m3. The DEP also stated that they do not have the resources to conduct a residential mercury cleanup. EPA Duty Officer dispatched On-Scene Commander (OSC) Jardine, along with START contractor, TN&A, to conduct the emergency cleanup. Emergency response personnel and contractors were dispatched to perform cleanup actions.
June 7, 2006	The local fire department identified a 10-inch pipeline that was spraying diesel fuel into the air. The fuel landed on two private residences and several yards of other residents in Plant City, Florida. The fire department evacuated the nearby residents and notified the responsible party. The responsible party secured a couple of environmental contractors to conduct the response.
July 10, 2006	A petroleum transport tanker overturned and spilled approximately 5,000 gallons of unleaded fuel onto the ground and into a tributary of the Peace River. DEP State OSC's responded. The PRP hired a contractor to contain and mitigate the release. OSC Bass was dispatched to the site to oversee cleanup actions.

[160] http://www.epaosc.org/site/region_list.aspx?region=4. The search was filtered by “Florida”, “emergency”, and “removal action”.

Date	*Information*
September 2007	The Deland Leasing Drum site houses approximately 220 55-gallon drums, as well as hundreds of other smaller containers. DEP personnel conducted sampling activities at this facility the first week of September 2007. The results of this sampling event revealed that many of the drums at this site contain hazardous substances. Furthermore, the DEP noted that several of the drums were leaking. Once the sampling results were received by the DEP and they confirmed that hazardous substances were leaking at this facility, they contacted EPA Region 4 and requested EPA's assistance in addressing this facility.
March 5, 2009	After receiving a 911 call on March 5th, 2009, the Pasco County Fire Department responded to the site of Regency Artistic Metal Refinishing and found the owner unconscious. Firefighters entered the building and rescued the owner. The firefighters themselves were overcome by unknown fumes inside the facility. The Pasco County HazMat team responded to the site and entered the facility in proper personal protective equipment and discovered open plating vats, open 5-gallon pails of unknown liquids, and numerous 55-gallon drums. The HazMat team suspected acids and cyanide salts were present on site. They in turn requested assistance from the DEP's Bureau of Emergency Response.
December 15, 2009	Approximately 1,000 gallons of sodium hydroxide was released from a faulty gasket on a pipeline connected to an above ground storage tank at the liquid transfer facility in St. Marks, Florida. The product flowed to an adjacent tidal creek before ultimately releasing some of the product into the St. Marks River. A Unified Command was established between EPA, USCG, DEP, County EMA, DOI and the RP. Response efforts included stabilizing the leaking gasket, sampling the impacted water bodies, conducting water patrols to ensure endangered/threatened species did not enter the area (e.g., manatees, birds, and alligators), damming up the tidal creek and pumping out the majority of the contaminated water (ph12+) from the tidal creek. The contaminated water was transferred to a containment area and was properly treated and disposed of.
May 9, 2009	A east coast railway train consisting of 22 rail cars and 2 locomotives derailed in Palm Coast, Florida. One rail car containing hydrochloric acid (HCL) was breached, resulting in HCL being released into the environment. Response operations concentrated on providing air-monitoring support for worker safety, as well as ensuring the off-loading procedures were conducted in a safe manner.
February 4, 2010	An assessment was conducted at 740 Lexington Ave, Pensacola, Florida and confirmed that five 10-pound containers of mercury were improperly stored in a shed at a private residence within a heavily populated neighborhood. One of the containers was found to be leaking and free mercury was on the ground. The OSC determined that immediate removal activities were necessary to prevent further migration ahead of inclement weather, and response contractors were needed on-scene immediately. A notice-to-proceed was issued to Southern Waste Services (SWS) of Pensacola who will begin removal operations.

Date	*Information*
February 4-11, 2010	A three-foot long mercury barometer ruptured in the science classroom. The class instructor quickly contained the spill, evacuated the classroom, and contacted authorities to respond to the incident. The West Port High School Principal shutdown the ventilation to the building after closing off the classroom. The Ocala Fire Department's HazMat Team responded and utilized their mercury spill kit to collect the remaining free standing mercury on the floor and applied an indicator absorbent to stabilize the residue.
January 3, 2009	A Seaboard Coastline Railroad (CSX) train derailment in Pace, Florida resulted in the release of approximately 15,000 gallons of Raffene 750K (a non-hazardous petroleum lubricating oil) from a tanker car. The Raffene Oil was discharged onto the ballast and soil surrounding the car. CSX’s emergency response cleanup contractor, Southern Waste Services, EPA, DEP and the city of Milton Fire Department personnel responded. During the derailment, the fuel tank of one of the locomotives breached, releasing approximately 2,100 gallons of off-road diesel fuel onto the track bed and south right-of-way.
August 28-30, 2010	A resident of Margate, Florida, provided bottles of elemental mercury to several neighborhood children to play with. The children reportedly “squirted” each other with the mercury and dropped much of it on the ground outside of the residence; at least one partially filled bottle was reportedly dropped into the nearby canal. Weekend rains washed much of the outdoor mercury off the source location property, but several beads remain visible across the driveway and lawn. Later, the parents of the children discovered what had happened and one or more were taken to the hospital for screening.
November 23, 2010	The Florida Department of Health (DOH) reported a private residence was found with high levels of mercury due to unknown causes. A child was taken to the hospital and was found to have elevated levels of mercury. DEP screened the residence with a Lumex mercury vapor analyzer on 11/23/10. Mercury concentrations within the house ranged from over 50,000 ng/m3 within the affected child's bedroom to 2,000-15,000 ng/m3 throughout the remainder of the house. Based on the levels of mercury vapors within the house the EPA mobilized resources to site for remediation activities.
March 10, 2011	Local resident notified NRC, elected official, DEP, and DOH regarding suspect mercury contamination within his home. EPA collaborated with DEP to conduct an evaluation.
May 31, 2011	The DEP's Bureau of Emergency Response reported a mercury spill in a residential house in Tampa, Florida. DEP personnel observed at least two ounces of visible mercury within the residence. Mercury vapor readings with windows open in two rooms were 43,000 ng/m3 and 47,000 ng/m3 respectively (Lumex readings). Based on the readings, DEP advised the owners and their children to relocate until the hazards could be mitigated. The source of mercury is unknown and was discovered during home renovation activities.
August 31, 2011	A broken sphygmomanometer released mercury to a medical facility pediatrics examining room. Ambient mercury vapor readings were measured in the 55 to 70 ug/m3 range throughout the facility.

Date	*Information*
January 11, 2012	Exposure to an unknown substance on a forest service road overcame two nearby community members. The Lake County HazMat Team conducted field screening of material and identified formaldehyde as a constituent.
August 10, 2010	DEP requested the EPA respond to an inactive chromated copper arsenate wood treatment facility located within an economically challenged neighborhood in Jacksonville, Florida. The facility operators have reportedly explored bankruptcy options and have ceased all operations at the facility. R4 Legal has gained access through negotiations with the trustee.
March 29, 2012	A student at Heron Creek Middle School broke a sling psychrometer in a science classroom. The teacher isolated the spill and evacuated the room. The Sarasota County School Board contracted a cleanup contractor to perform removal operations.
July 22, 2012	Kinder Morgan (Central Florida Pipeline) had an ongoing release of refined petroleum product from a 10 inch pipeline. Kinder Morgan shut off the pipeline and responded with state and local response agencies to locate the source and evaluate extent of impact. It was determined that the pipeline failed in a drainage ditch full of water. The ditch flows into a nearby creek which discharges into Tampa Bypass Canal and then into McKay Bay. Kinder Morgan estimated 750 barrels of refined product were released. About two miles of the creek, which includes ditches, creek, ponds, and wetlands were impacted. Kinder Morgan's resources were able to set up recovery at the source.

III. Probability of Future Technological Hazard Events

Hazardous Materials

Major disasters like that in Bhopal, India, in December 1984, which resulted in 2,000 deaths and over 200,000 injuries, are rare. Reports of hazardous material spills and releases, however, are increasingly commonplace. Thousands of new chemicals are developed each year.

Major chemicals spills can occur at any facility that produces, uses, or stores chemicals. These include chemical manifesting plants, laboratories, shipyards, railroad yards, warehouses, or chemical disposal areas. Illegal dumpsites can appear anywhere. Recent evidence shows that hazardous materials incidents may be the most significant threat facing local jurisdictions.

Radiological Accidents

Areas at risk are normally designated as (1) within the plume emergency planning zone (EPZ) of such facilities (i.e., jurisdiction located within a 10-mile radius of a nuclear power plant) or (2) within the ingestion emergency planning zone (IPZ) (i.e., jurisdictions within a 50-mile radius of a nuclear power plant).

The transportation and disposal of radioactive materials and waste creates problems because of the long life of radioactive materials. The launch of spacecraft from the Kennedy Space Center also represents a significant threat to the state for launch vehicles carrying Radioisotope Thermoelectric Generators (RTG). The primary threat is an in-flight explosion within the first two minutes of vehicle lift-off.

Following the Tōhoku earthquake and tsunami on March 11, 2011 a series of equipment failures, nuclear meltdowns, and releases of radioactive materials occurred at the Fukushima Daiichi Nuclear Power Plant in Fukushima, Japan. In total 3 reactors experienced full meltdown and the event eventually scored a 7 on the International Nuclear Event Scale, the maximum score possible, and is considered the largest nuclear disaster since the Chernobyl disaster of 1986.[161] There have been no deaths directly attributable to the nuclear disaster, though a number of plant workers were injured and killed as a result of the earthquake and tsunami. A Japanese government roadmap for cleaning up the plant and surrounding areas estimates it will take 40 years and more than 3 trillion yen ($13 billion US).[162]

IV. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. The 67 multi-jurisdictional LMS plans provided a solid baseline for the overall state vulnerability analysis. Risk assessment information from the LMS plans is current as of May 1, 2012. Based on the LMS plans in the State of Florida, Figure 3.43 displays the jurisdictional rankings for the technological event hazard. Not all counties have identified technological events as one of their hazards.

- High-risk Jurisdictions 2
- Medium-high–risk Jurisdictions 3
- Medium-risk Jurisdictions 8
- Low-risk Jurisdictions 12

[161] http://spectrum.ieee.org/tech-talk/energy/nuclear/explainer-what-went-wrong-in-japans-nuclear-reactors
[162] http://fukushima.ans.org/report/cleanup

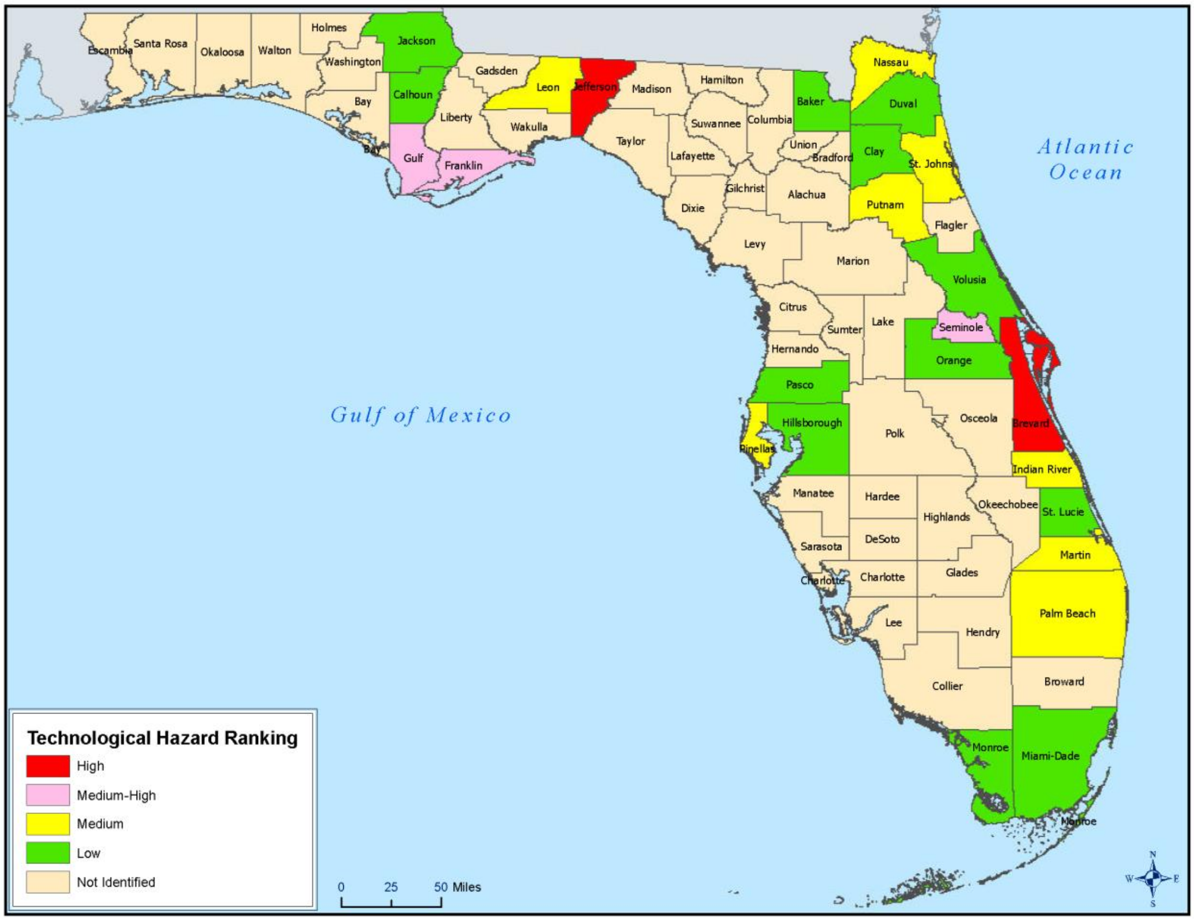

Figure 3.43 Technological Hazard Rankings by County

V. Assessing Vulnerability of Jurisdictions and State Facilities

Technological hazards can and do occur anywhere and at any time. In most cases, they do not result in serious impacts to people, property, infrastructure, or the environment. However, in larger incidents, whether it be hazardous materials or radiological events, the risk and vulnerability can be high concerning people and property. Operations may be hindered in large scale situations and the environment is extremely susceptible, especially concerning hazardous materials.

3.3.13 Human-Caused Hazards Profile

I. Human-Caused Hazards Description and Background Information

Other human-caused hazards are those hazards caused by direct human intervention and that create a potential threat to the health, safety, and welfare of citizens. Property, the environment, and operations in Florida can be impacted by these incidents depending on the nature and magnitude. The major human-caused hazards that will be discussed in this section are civil disturbances, mass immigration, and mass casualty.

Civil Disturbances

Civil disturbances are public crises that occur with or without warning and that may adversely affect significant portions of the population. These disturbances may be the actions of any number of persons causing disruption of the populace.

Mass Immigration

Florida's proximity to the Caribbean basin makes it a vulnerable point of entry for a massive influx of refugees entering the United States illegally. Even though all of Florida's counties are subject to receiving illegal arrivals, the most vulnerable counties are Monroe, Miami-Dade, Broward, Palm Beach, Martin, St. Lucie, Indian River, Lee, and Collier. The consequences of a mass arrival of illegal entrants include the threat of health, safety, and welfare if entrants are detained en masse for an extended length of time. The state has participated with the federal government in the development of a federal Mass Immigration Annex that bridges components of the federal Mass Immigration Plan with the National Response Framework. Several full-scale exercises for mass migration have been held.

Mass Casualty Incidents

Mass casualty incidents occur as the result of injuries or death to numerous individuals at the same time. Examples include massive building structural failure, airplane crashes, bus crashes, train derailments, and multiple collisions on interstate highways.

II. Historical Occurrences of Human-Caused Hazards

Civil Disturbances

One example of civil disturbances was during the 'Free Trade Area of the Americas' negotiations in Miami in November 2003. Due to the controversial nature of some of the provisions of these negotiations, somewhere between 10,000 and 25,000 protestors demonstrated outside the conference center. Police used rubber bullets to control the crowd and more than 100 people were arrested.

Mass Immigration

In 1994, the state responded to two major mass migration incidents. In August 1994, there was an influx of 700 Cuban refugees, and in May 1994, there was an influx of 100 Haitian refugees. The state and the U.S. Department of Justice worked together to minimize the impact of these immigration emergencies.

While not an incident of mass migration, the 2010 Haiti Earthquake resulted in a number of unique immigration situations and challenges. Florida supported the transport of more than 26,000 U.S. citizens, as well as helping Haitian and other foreign nationals with passports or visas into the U.S.[163] A large number of earthquake victims were brought to the United States, and in particular Florida, for treatment. Some Haitians visiting or residing in Florida at the time of the earthquake were unable or unwilling to return to their newly devastated homeland and were given special immigration status in order to remain in the United States.

Mass Casualty Incidents

The ValuJet crash in the Everglades in May 1996 is a good example of how a mass casualty incident can overtax the resources of even the largest and most urbanized local government within the state.

Another incident occurred on January 25, 2002 when dense fog contributed to a massive motor vehicle collision along I-75 in the rural area of Collier County, Florida. The incident occurred between mile markers #85 and #86 on I-75 in an area known as Alligator Alley. A total of 27 vehicles, including 17 tractor-trailer trucks, were involved in eight separate collisions, which spread over a distance of one-half mile. I-75 was shut down in both directions for approximately 8.5 hours and traffic was backed up across the state. Three adult males were killed and 13 people were injured.[164]

III. Probability of Future Human-Caused Events

Human-caused hazards can and do occur anywhere and at any time. In most cases, they result in injuries, possible loss of life, damage to infrastructure, property, and the environment as well as the threat of further violence or consequences. Due to the importance of international tourism and trade to the state's economy and cultural diversification of the state's population, the threats of human-caused hazards will continue to exist. Local, state, and federal law enforcement officials monitor threats of civil disturbances, mass immigration, and mass casualty events.

IV. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. The 67 multi-jurisdictional LMS plans provided a solid baseline for the overall state vulnerability analysis. Risk assessment information from the LMS plans is current as of May 1, 2012. While civil disturbances, mass immigration, and mass casualty

[163] http://www.floridadisaster.org/documents/Haiti%20AAR%20Final.pdf

[164] I-75 Multiple Vehicle Collision/Mass Casualty Incident. U.S. Fire Administration/Technical Report Series. Department of Homeland Security. USFA-TR-155/January 2002. http://www.usfa.fema.gov/downloads/pdf/publications/tr-155.pdf

hazards have been discussed, only mass immigration was incorporated into LMS plans. There is no LMS integration information currently available for civil disturbances or mass casualty events.

Mass Immigration

Based on the LMS plans in the State of Florida, Figure 3.44 displays the jurisdictional rankings for the mass migration hazard. Not all counties have identified mass immigration as one of their hazards.

- High-risk Jurisdictions 0
- Medium-high–risk Jurisdictions 0
- Medium-risk Jurisdictions 3
- Low-risk Jurisdictions 10

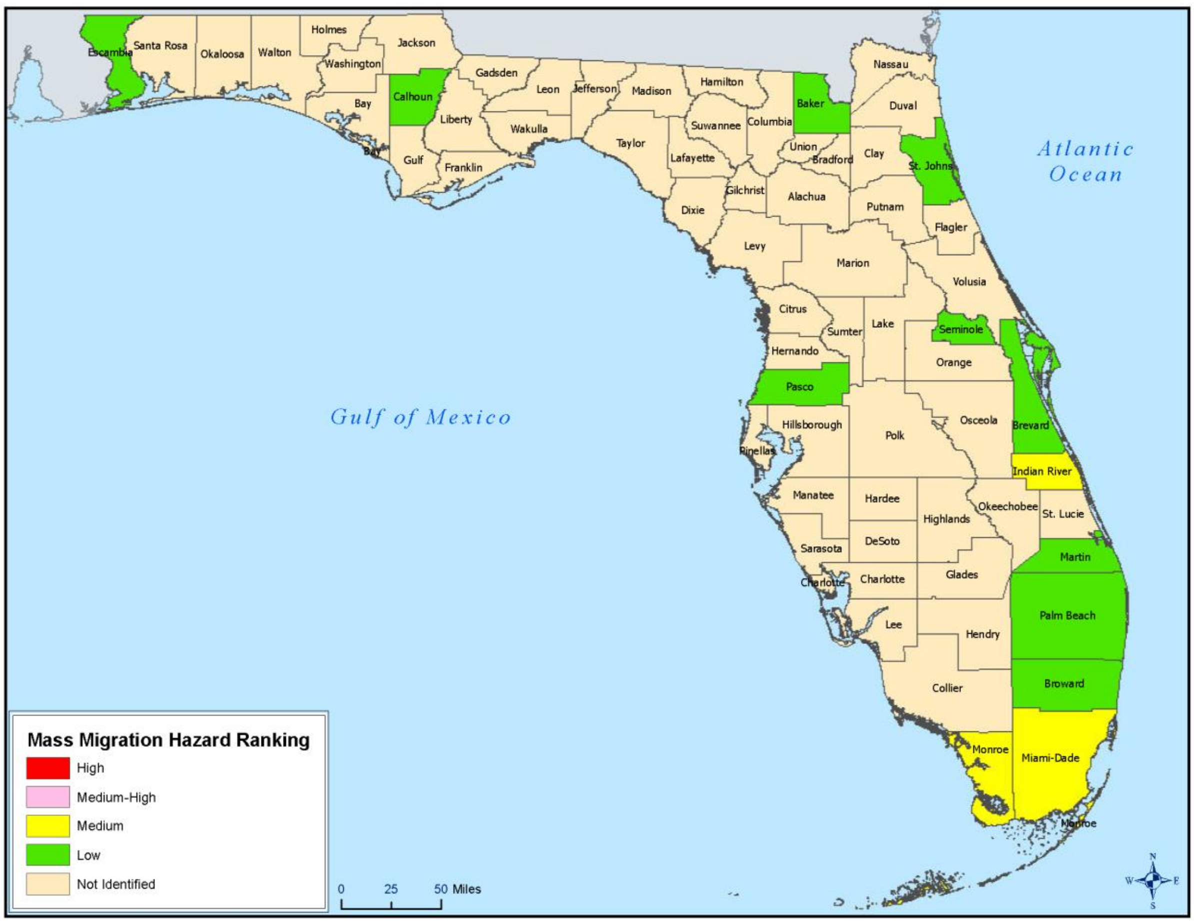

Figure 3.44 Mass Immigration Hazard Rankings by County

V. Assessing Vulnerability of Jurisdictions and State Facilities

Due to the nature and unpredictability of human-caused hazards, all property and infrastructure in the State of Florida is at risk to these events.

Though Florida recognizes that state facilities are vulnerable to human caused hazards, there is a lack of data to quantify the vulnerability of facilities to these hazards compared to natural hazards.

VI. Estimating Losses by Jurisdiction and of State Facilities

Florida recognizes that jurisdictions are vulnerable to human caused hazards, but there is a lack of data to quantify the economic vulnerability from these hazards compared to others.

Though Florida recognizes that state facilities are vulnerable to human caused hazards, there is a lack of data to quantify the estimated losses of facilities to these hazards compared to natural hazards.

VII. THIRA

Fiscal year 2012 Homeland Security Grant Program and Emergency Management Performance Grant guidance requires all State Administrative Agencies (SAAs) and Urban Areas (UASIs) receiving 2012 funding from these grants to complete and submit a Threat and Hazard Identification and Risk Assessment (THIRA). The THIRA is the initial stage of the State Preparedness Report (SPR), a requirement of the Post-Katrina Emergency Management Reform Act of 2006. The required elements, developed in alignment with *Comprehensive Preparedness Guide (CPG) 201*, consist of the following:

- A list of threats and hazards, natural, technological, and human-caused, which are of concern to a jurisdiction
- Context statements which describe when and where a threat or hazard may occur
- Desired outcome statements , what the jurisdiction wants to achieve, for all 31 core capabilities as described in the National Preparedness Goal
- Estimations of how the threats and hazards described in context statements impact the core capabilities
- Capability targets for all core capabilities

The capability targets generated through the THIRA process are used as the basis for the SPR assessment. Florida's THIRA was developed through a combination of existing plans and studies, past events/incidents, and regional interdisciplinary meetings. These meetings, held primarily to ascertain the human-caused threats, included local and state emergency management, fire, and law enforcement personnel as well as other stakeholders. The Division of Emergency Management was responsible for information regarding natural and technological threats and hazards while the Florida Department of Law Enforcement was responsible for the human-caused threats and hazards.

The final THIRA document is considered to be For Official Use Only (FOUO) and should be handled in a manner consistent with this classification. FEMA requires that each state and UASI submit its respective THIRA by December 31 to the FEMA regional Federal Preparedness Coordinator through the on-line SPR Assessment Tool on the Preparedness Comprehensive Assessment System Tool (PrepCAST) portal. The State of Florida submitted its 2012 THIRA as requested.

3.3.14 Terrorism Profile

I. Terrorism Description and Background Information

Terrorism is defined in the Code of Federal Regulations as “the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.” It is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom.

If a terrorist incident occurs in a city or county, communities may receive assistance from both state and federal agencies under the existing Integrated Emergency Management System. The Department of Homeland Security is the lead federal agency for supporting state and local response to the consequences of terrorist attacks. Terrorism is often categorized as “domestic” or “international.” The following descriptions explain the difference:

- Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of the U.S. government or population without foreign direction.
- International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States or whose activities transcend national boundaries.

This distinction refers not to where the terrorist act takes place but rather to the origin of the individuals or groups responsible for it. For example, the 1995 bombing of the Murrah Federal Building in Oklahoma City was an act of domestic terrorism, but the attacks of September 11, 2001 were international in nature. For the purposes of consequence management, the origin of the perpetrator(s) is of less importance than the impacts of the attack on life and property; thus, the distinction between domestic and international terrorism is less relevant for the purposes of mitigation, preparedness, response, and recovery than for understanding the capabilities of terrorist groups and how to respond to the impacts they can generate.

Before the September 11, 2001, attacks in New York, the Pentagon, and Pennsylvania, most terrorist incidents in the US had consisted of bombing attacks, tear gas, and pipe and fire bombs. The effects of terrorism can vary significantly—from loss of life and injuries to property damage and disruptions in services such as electricity, water supply, public transportation, and communications. One way that governments attempt to reduce vulnerability to terrorist incidents is by increasing security at airports and other public facilities that could be considered as targets.

While we can never predict what target a terrorist will choose, we do know some of the factors they use when selecting a target. Terrorists want to achieve one or more of the following:

- Produce a large number of victims and mass panic
- Attack places that have a symbolic value
- Get the greatest possible media attention

Terrorists also select targets best suited for the type of material being used. For example, some biological agents are not effective in sunlight. Most chemical agents are more effective indoors with limited airflow. A radioactive material will be most effective where large numbers of people will pass by without detecting it. Terrorists are likely to target heavily populated, enclosed areas like stadiums, government buildings, sporting events, airport terminals, subways, shopping malls, and industrial manufacturing facilities.

A terrorist attack can take several forms, depending on the technological means available to the terrorist, the nature of the political issue motivating the attack, and the points of weakness of the terrorist's target. Other possibilities include an attack at transportation facilities, an attack against utilities or other public services, or an incident involving chemical or biological agents.

Terrorism in Florida

Florida is considered to be vulnerable because the chief objective of a terrorist is to spread fear and create economic damage, and Florida is a major tourist attraction with big theme parks, beaches, cruises, and military bases.

The open availability of basic shelf-type chemicals and mail-order biological research materials, coupled with access to even the crudest laboratory facilities, could enable the individual extremist or an organized terrorist faction to manufacture proven highly lethal substances or to fashion less sophisticated weapons of mass destruction (WMD). The use of such weapons could result in mass casualties and long-term contamination and could wreak havoc to both the state and national economies.

Unlike natural disasters, there are relatively few methods to predict the time or place of a WMD/terrorist event. This fact negates the "watch" and "warning" time phases. The action phases for a WMD/terrorist event will be Prevention, Protection, Mitigation, Response, and Recovery. Activities associated with each action are detailed below:

Prevention Phase

- The actions during this phase are those taken by local, state, and federal agencies to monitor and coordinate intelligence and other potential indicators to prevent, defend against, prepare for, and mitigate the impacts of terrorist attacks against our nation.
- The state uses intelligence provided by Fusion Centers, Joint Terrorism Taskforces, and Regional Domestic Security Taskforces.

Protection Phase

- The actions during this phase are those taken by local, state, and federal agencies to limit the impacts of a potential event on a specific area.
- These actions could occur during the threat of a natural event such as a hurricane, or during a terrorist threat.

Mitigation Phase

- The actions during this phase are those that require time to carry out. They include mitigation, training, planning, public awareness, and any activities that require long-term programs to accomplish their objectives.
- These pre-disaster activities take place in the normal living and working environments of the participants.

Response Phase

- The actions during this phase are those emergency response activities taken during the first 72 hours to a few weeks after the incident.
- These actions are those taken immediately after an incident with the major goal of saving lives, alleviating suffering, and preventing further disaster.
- When responding to disaster events, the National Incident Management System (NIMS) will be used by trained/qualified staff to manage the response actions.

Recovery Phase

- The actions during this phase are those taken during the first one to two months after the incident.
- These actions, which begin immediately after the emergency response operations, have the goal of returning the state and citizens to normal conditions.
- The emphasis will transition from saving lives to cleanup of the affected areas and returning people to normal activities.

The SHMPAT realizes that there is appropriate concern that a terrorist event is possible due to the state's highly visible and popular tourist destinations including Disney World, Sea World, and other family attractions. The state also has nuclear power plant locations, numerous international shipping ports, cruise ship destinations, and large-capacity arenas across the state.

DEM maintains a list of state critical infrastructure and key resource (CI/KR) locations within the state that are determined to be credible targets of a terrorist event. The data and details of these structures cannot be provided within the mitigation plan due to the sensitivity of the data. Structures selected for inclusion in the CI/KR list are eligible for additional government grant funding to increase their security against a terrorist event. One example of funding for which CI/KR sites qualify is the Buffer Zone Protection Program (BZPP).

Buffer Zone Protection Program

The Protective Security Division (PSD) is responsible for supporting the efforts of the U.S. Department of Homeland Security (DHS) to reduce the nation's vulnerability to terrorism and deny the use of U.S. critical infrastructure and key resources (CI/KR) as a weapon. In support of this objective, the PSD is developing, coordinating, integrating, and implementing plans and programs that identify, catalog, prioritize, and protect critical infrastructure in cooperation with all levels of government and partners in the private sector. The purpose of the BZPP is to make it more difficult for terrorists to conduct planning activities or successfully launch attacks from the immediate vicinity of likely targets.

The program is based on the premise that local law enforcement agencies and first responders are on the front lines preventing, defending against, preparing for, and mitigating the impacts of terrorist attacks against our nation.

Weapons of Mass Destruction (WMD)

Weapons of mass destruction are defined as (1) any destructive device as defined in 18 U.S.C., Section 2332a, which includes any explosive, incendiary, or poison gas, bomb, grenade, rocket having a propellant charge of more than four ounces, missile having an explosive or incendiary charge of more than one quarter ounce, mine or device similar to the above; (2) poison gas; (3) any weapon involving a disease organism; or (4) any weapon that is designed to release radiation or radioactivity at a level dangerous to human life.

Although bombs are still the weapon of choice for most terrorists, many are beginning to use nuclear, biological, and chemical weapons for their terrorist acts. The ways they spread these contaminants vary by the type used. For an attack on a wider area, terrorists may use crop dusting techniques or introduce the agent into the heat and air conditioning system of a building. They may use an explosive device, breaking device, or fan. The terrorist’s goal is to reach the maximum number of people with the minimum amount of nuclear, biological, or chemical material.

Chemical

Chemical warfare agents are substances specifically designed to kill, seriously injure, or disable people. They can be similar to many household chemicals such as insect killers, but are hundreds of times more hazardous. In general, terrorists use chemical agents because they are relatively easy and cheap to make. They work very fast—within minutes—and will cause mass injury, panic, and death using very small amounts. These agents were originally designed for military use as weapons of war. Their use in World War I and other combat situations proved their effectiveness. This effectiveness is what attracts terrorists.

Most chemical agents, depending on their type, concentration, and length of exposure, can be deadly. Some attack the central nervous system like nerve gas and incapacitating agents. Some, such as blood and choking agents, attack the respiratory system. Blistering agents and riot control agents affect the skin, eyes, and mucous membranes by direct contact. Blister and riot control agents such as tear gas, mace, and pepper sprays can also affect the respiratory system.

Some of these chemical agents, with slight modifications, have industrial or commercial applications. For example, the same chlorine used to disinfect swimming pools was the first chemical warfare agent used in World War I as a choking agent.

How chemical agents enter the body:

- Breathing it in
- Direct contact with skin and eyes
- By eating or drinking

Each chemical agent has different effects on people depending on the amount and duration of exposure, how it gets into the body, and its concentration. However, in general, people exposed to these chemical agents will share common physical signs and symptoms:

- Red or irritated eyes and skin
- Choking and coughing
- Shortness of breath or tightening of the chest
- Vomiting and nausea
- Runny nose
- Dizziness or loss of consciousness
- Convulsions or seizures
- Pinpointed pupils and dimness of vision

Unlike nuclear and biological materials, some chemical agents tend to cause symptoms in people in seconds to minutes. Some of these symptoms are similar to a heart attack or other illness. However, if you see several people in an area with the same signs and symptoms, it is highly unlikely that they are all having a heart attack. It is possible they have been exposed to a chemical agent.

Biological

Biological agents are actually living organisms or the products of living organisms and they can be deadly. Biological agents can go undetected for hours to days. Signs and symptoms might initially look like a bad cold, flu, or other common illness. Some agents can be extremely lethal in very small quantities. Biological weapons fall into three categories: bacteria, viruses, and toxins with bacteria. All three types can potentially be deadly to people and animals.

Bacteria and viruses can cause diseases such as anthrax, smallpox, and cholera. Toxins are poisonous products of living organisms. Examples include snake and scorpion venom and food poisoning, which are caused by a bacteria-produced toxin.

How biological agents enter the body:

- Breathing it in
- Breaks in the skin
- Injection
- Eating or drinking

Signs and symptoms are different for each agent, and each agent will affect people differently. Young children, elderly, and chronically ill victims are more likely to be severely affected by these agents. Some common general symptoms may include coughing and flu-like symptoms, shortness of breath, weakness or fatigue, vomiting, and diarrhea.

Biological agents can take hours or days to produce an effect and make people sick. If the agent is contagious and the victims are experiencing flu symptoms, those people could infect others without even knowing they had been exposed. Victims can survive in most cases as long as they are identified in time and medically treated. Small-scale attacks of limited lethality can elicit a disproportionate amount of terror and real or perceived psychological and social disruption, as evidenced by the 2001 anthrax letter attacks.

Nuclear

Human-caused radiation comes from medical devices, like x-ray machines, and also from nuclear power plants. There are low levels of radiation exposure present in the everyday environment, but the danger in a nuclear terrorist attack comes with the amount and type of radiation given off.

The effects of a nuclear attack depend on how much radiation is received, how long someone is exposed to the radiation, and how the radiation entered the body. For example, there would be a difference in the effects if someone drank radiation-contaminated water or if they were in the path of a nuclear explosion.

How radiation enters the body:

- Breathing it in
- Swallowing contaminated food or water
- Absorbed through the skin
- Penetrating radiation that affects organs and blood

Signs and symptoms of radiation exposure depend on the amount of radiation received and the length of exposure. Victims exposed to deadly or extremely high doses of radiation in a short period of time – seconds to minutes – will display symptoms you can recognize:

- Burned, reddened skin
- Nausea, vomiting, diarrhea
- Hair loss
- Convulsions and unconsciousness

Exposure to non-deadly doses may produce similar symptoms but may take longer to show up. Exposure to low doses of radiation will take 15–20 years for the medical effects, such as vision loss and cancer, to appear. Radiation also affects people differently depending on their age, gender, and overall health. Other health effects include brain swelling, blood chemistry changes, and internal organ and tissue damage.

Nuclear attacks are very dangerous because radiation is invisible and odorless and requires special devices for detection. Unless a sign that reads "Radioactive" is present or a nuclear explosion is witnessed, it is almost impossible to know that radiation is present or that people may have been exposed. Victims of this type of attack can often survive provided they are quickly decontaminated (washed or cleaned off) and medically treated as soon as possible.

II. Historic Occurrences of Terrorism Events

Table 3.69 summarizes the major terrorism events in Florida since the attacks in New York City on September 11, 2001.

Table 3.69 Major Terrorism Events in Florida since September 11, 2001

Date	*Information*
December 2001	Richard Reid unsuccessfully attempted to blow up an American Airlines Paris-to-Miami flight by placing explosives in his shoes.
November 2006	In Sanibel, Florida, a small bomb was found in a parking lot located among three restaurants. Authorities said the eight inch-by two inch-by three inch bomb was connected to a cell phone. It was rigged so that if the phone was called, the device would explode. The Lee County bomb squad responded to the scene and dismantled the device. Two other restaurants and a nearby road were closed for about four hours.
April 2007	Six schools in six different Central Florida counties received bomb threats over a seven-day period. One threat forced authorities to evacuate East Ridge High School in Lake County and another anonymous note threatened to detonate a bomb at West Port Middle and High School in Marion County. A similar bomb threat occurred that same day at Jones High School in Orlando. Two similar bomb threats occurred at Merritt Island High in Brevard County, followed by the arrests of two teenagers in connection with the bomb threats.
May 2010	The Federal Bureau of Investigation (FBI) investigated a pipe bomb found at the scene of the May 10, 2010 attack at the Islamic Center of Northeast Florida (ICNEF) in Jacksonville, Florida. There were 60 people in the building at the time of the attack.[165]
May 2011	The FBI arrested three Pakistani-Americans, including father and son imams from South Florida mosques, charging them with providing financing and other material support to the Pakistani Taliban.[166]
January 2012	Sami Osmakac, an American citizen born in the former Yugoslavia who is a Florida resident, was charged with plotting a terrorist spree around Tampa, including bombing nightclubs, destroying bridges, and shooting police officers in the name of radical Islam.[167]

[165] http://www.realcourage.org/2010/05/florida-fbi-investigation/
[166] http://www.nytimes.com/2011/05/15/world/15taliban.html
[167] http://www.nytimes.com/2012/01/10/us/florida-man-charged-with-plotting-strikes-in-name-of-islam.html?_r=1

III. Probability of Future Terrorism Events

There is no sure way to predict future terrorism events. The probability of a major terrorist event in the State of Florida is perceived to be high, and planning must be done as part of the larger national DHS initiatives. The Regional Domestic Security Taskforces play a large role in providing the state with critical intelligence and serve as a prevention measure to the state.

IV. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. Risk assessment information from the LMS plans is current as of May 1, 2012. Based on the LMS plans in the State of Florida, Figure 3.45 displays the jurisdictional rankings for terrorism. Not all counties have identified terrorism as one of their hazards.

- High-risk Jurisdictions 2
- Medium-high–risk Jurisdictions 1
- Medium-risk Jurisdictions 12
- Low-risk Jurisdictions 19

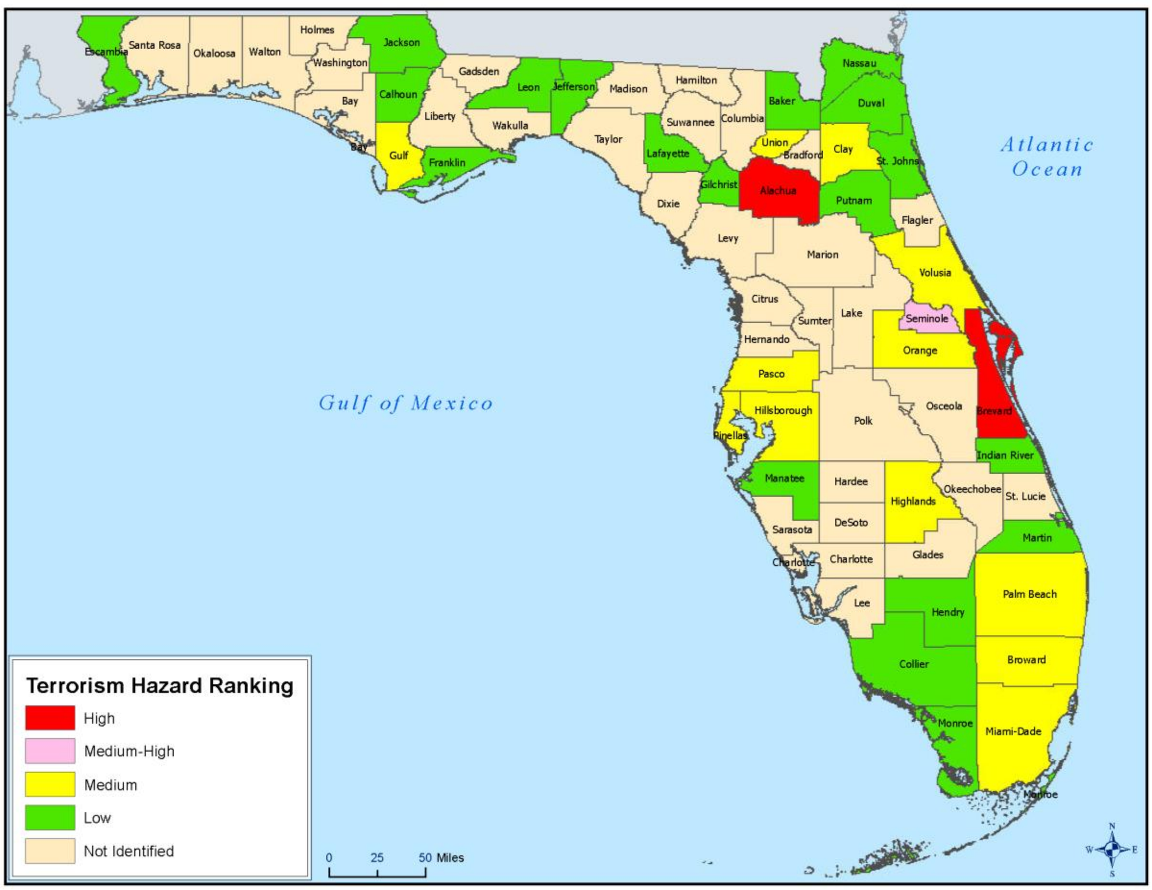

Figure 3.45 Terrorism Hazard Rankings by County

V. Estimating Losses by Jurisdiction

Though Florida recognizes that state facilities are vulnerable to terrorism, the abstract way in which terrorism occurs creates a vacuum of high-level detailed vulnerability and risk assessment. As such, while it is prudent to recognize the threat there is not a viable manner in which to quantitatively communicate the vulnerability of facilities compared to other hazards.

3.3.15 Biological Incidents Profile

I. Biological Incidents Description and Background Information

Biological agents are actually living organisms or the products of living organisms and they can be deadly. Biological agents can go undetected for hours to days. Signs and symptoms might initially look like a bad cold, flu, or other common illness. Some agents can be extremely lethal in very small quantities. Biological incidents can fall into three categories: bacteria, viruses, and toxins with bacteria. All three types can potentially be deadly to people and animals.[168]

Disease transmission can occur via direct contact with contaminated environment, infected people, animals or arthropods, ingestion of contaminated food or liquids, and natural or artificial infectious aerosols or droplets. Recognition of an outbreak can occur in multiple ways. Public health agencies assess an outbreak's potential for becoming a serious epidemic requiring an emergency response. A network of local and state epidemiology and laboratory staff, receiving technical assistance from the Center for Disease Control (CDC), interact with healthcare providers to review available data in order to identify those outbreaks which require special attention at the local, county, regional, state, national, or international level.

The severity of incidents will range from mild to severe forms of a disease with attendant high mortality. Even with mild virulence, losses of even a few days of personnel time in critical functions can cause widespread difficulties in a critical response. Florida Department of Health (DOH), in collaboration with its public health partners, determines the threshold for a comprehensive state government public health and medical response. This threshold is based on event specific information rather than pre-determined risk levels, and will depend on the assessment of epidemic potential as described in the Biological Incident Operations Guide Hazard Vulnerability Assessment of human, animal, and environmental impacts from select biological agents. Regardless of whether or not biological agents occur naturally or are introduced with terroristic intentions, the identification and treatment protocols remain the same. If the spread of a biological agent is suspected to be the result of terroristic activities, law enforcement will become involved in attempts to find the source.

[168] Biological Incident Annex, November 2011, http://www.floridadisaster.org/cemp.htm

The entire state of Florida is vulnerable to biological incidents. By definition, a biological agent will probably affect multiple states due to the nature of both air travel and international business structures.[169]

II. Historical Occurrences of Biological Incidents

The Florida DOH collects information on communicable diseases. A frequency report pulled from the communicable disease database (January 1900-November 2013) includes more than 500,000 incident reports ranging from monkey bites, rabies, and food poisoning cases to various rare and common bacterial infections and viruses.[170] Outbreaks are very common and range from the occasional waterborne outbreak to hundreds of food borne outbreaks statewide, including over 250 person-to-person norovirus gastroenteritis outbreaks each year.[171]

III. Probability of Future Biological Incidents

Biological incidents, including annual occurrences of the flu, will continue to occur. Due to the variability and unpredictability of biological incidents, it is difficult to determine a standardized probability of incident occurrences. Incidents of national concern occur on a less frequent basis.

VI. 2013 LMS Integration

The SHMPAT focused on producing a statewide vulnerability analysis based on estimates provided by the LMS plans. Due to the limited number of mitigation plans in Florida that identify biological agents, it was not possible to acquire vulnerability information for each county. It is likely that this information is contained in plans developed and maintained by the county health departments.

IV. Assessing Vulnerability and Losses

The Florida DOH conducts assessments on a regular basis to identify vulnerable population. In addition, many resources are available from DOH on the topics of public health risk and vulnerability assessments for emergency preparedness and response planning.[172]

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[169] Biological Incident Annex, November 2011, http://www.floridadisaster.org/cemp.htm
[170] http://www.floridacharts.com/charts/EnvironmentalHealth/
[171] Biological Incident Annex, November 2011, http://www.floridadisaster.org/cemp.htm
[172] http://www.floridahealth.gov/preparedness-and-response/preparedness-planning/hazard-vulnerability-risk.html.

Commonly, the people most at risk to sickness and sometimes loss of life from biological agents are the elderly and young children; however, all people are vulnerable. Buildings and infrastructure are not impacted by biological incident occurrences but impacts to the workforce, agriculture and animals may cause economic problems. Response efforts may also be affected if first responders become infected.