# 3.5 Tropical Cyclone Risk Assessment

## Hazard Description

Tropical Cyclones are naturally occurring events that produce damaging high winds, storm surge flooding, tornadoes, and torrential rainfall capable of causing inland flooding. The Atlantic hurricane season begins on June 1 and ends on November 30, but hurricanes have developed outside of the designated season. Mississippi has been subject to winter and spring extra-tropical storms driving higher than normal tides from southerly and southeasterly winds. The Mississippi Coast has also experienced tropical depressions and tropical storms which have caused higher-than-normal tides, storm surges, and gusting winds.

FEMA defines coastal storms as causing "increases in tidal elevations (called storm surge), wind speed and erosion, caused by both extra-tropical events and tropical cyclones." FEMA defines hurricanes as "tropical cyclones characterized by thunderstorms and defined wind circulation." These winds "blow in a large spiral around a calm center called the eye."

The following terms are used to describe tropical storms and hurricanes:

Tropical Wave: A trough or cyclonic curvature maximum in the trade-wind easterlies. The wave may reach maximum amplitude in the lower middle troposphere.

Tropical Depression: A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) is 33 kt (38 mph or 62 km/hr.) or less.

Tropical Storm: A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 kt (39 mph or 63 km/hr.) to 63 kt (73 mph or 118 km/hr.).

Hurricane: A tropical cyclone in which the maximum sustained surface wind (using the U.S. 1-minute average) is 64 kt (74 mph or 119 km/hr.) or more.

Hurricane wind intensity is measured by the Saffir-Simpson Scale based on a 1-5 rating of a hurricane's sustained wind speed at the time of measurement. This is used to give an estimate of the potential property damage expected along the coast from a hurricane's landfall. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventative measures. Wind speed is the determining factor in the scale. All winds are described using the U.S. 1-minute average. Previously, storm surge was described by the Saffir-Simpson Scale, but is no longer included.

The following excerpt from the National Hurricane Center explains the revised definition of the Saffir-Simpson Hurricane Scale and the separation of storm surge from storm category followed by an explanation of the need to revise the new range of wind speeds:

> Earlier versions of the Saffir-Simpson Hurricane Scale incorporated central pressure and storm surge as components of the categories. The central pressure was used during the 1970s and 1980s as a proxy for the winds as accurate wind speed intensity measurements from aircraft reconnaissance were not routinely available for hurricanes until 1990. Storm surge was also quantified by category in the earliest published versions of the scale dating back to 1972. However, hurricane size (extent of hurricane-force winds), local bathymetry (depth of near-shore waters), topography, the hurricane's forward speed, and angle to the coast also affect the surge that is produced. For example, Hurricane Ike (with hurricane-force winds extending as much as 125 miles from the center) in 2008 made landfall in Texas as a Category 2 hurricane and had peak storm surge values of about 20 ft. In contrast, Hurricane Charley

(with hurricane-force winds extending at most 25 miles from the center) struck Florida in 2004 as a Category 4 hurricane and produced a peak storm surge of only about 7 ft. These storm surge values were substantially outside of the ranges suggested in the original scale. Thus, to help reduce public confusion about the impacts associated with the various hurricane categories as well as to provide a more scientifically defensible scale, the storm surge ranges, flooding impact, and central pressure statements were removed from the Saffir-Simpson Hurricane Scale, and only peak winds are employed in the revised version.

The Saffir-Simpson Hurricane Wind Scale (SSHWS) underwent a minor modification in 2012 to resolve the awkwardness associated with conversions among the various units used for wind speed in advisory products. The change broadens the Category 4 wind speed range by one mile per hour (mph) at each end of the range, yielding a new range of 130-156 mph. This change does not alter the category assignments of any storms in the historical record, nor will it change the category assignments for future storms.

**Table 3.5.1** depicts the revised Saffir-Simpson Scale by category, associated wind speeds, and expected damages from a particular event.

**Table 3.5.1**
**Saffir-Simpson Hurricane Wind Scale**

| Category | Previous Range | New Range | Effects on Land |
|---|---|---|---|
| One | 74-95 mph | No change | **Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roofs, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallow-rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days. |
| Two | 96-110 mph | No Change | **Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallow-rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks. |
| Three | 111-130 mph | 111-129 mph | **Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes. |
| Four | 131-155 mph | 130-156 mph | **Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with the loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks or months. |

| Category | Previous Range | New Range | Effects on Land |
|---|---|---|---|
| Five | Greater than 155 mph | Greater than 157 mph | **Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months. |

Source: National Hurricane Center. Revised 2012

## Storm Surge

### Hazard Description

The National Hurricane Center defines a storm surge as an abnormal rise of water generated by a storm over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide. This rise in water level can cause extreme flooding in coastal areas particularly when storm surge coincides with normal high tide, resulting in storm tides reaching up to 20 feet or more in some cases (Figure 3.5.1).

Storm surge is produced by water being pushed toward the shore by the force of the winds moving cyclonically around the storm. The impact of storm surge on the low pressure associated with intense storms is minimal in comparison to the water being forced toward the shore by the wind.

The maximum potential storm surge for a particular location depends on many different factors. Storm surge is a very complex phenomenon because it is sensitive to the slightest changes in storm intensity, forward speed, size (radius of maximum winds-RMW), angle of approach to the coast, central pressure (minimal contribution in comparison to the wind), and the shape and characteristics of coastal features, such as bays and estuaries (Figure 3.5.2).

Other factors impacting storm surge are the width and slope of the continental shelf. A shallow slope will potentially produce a greater storm surge than a steep shelf. For example, a Category 4 storm hitting the Louisiana coastline, which has a very wide and shallow continental shelf, may produce a 20-foot storm surge; while, the same hurricane in a place like Miami Beach, Florida, with the continental shelf dropping off very quickly, might see an 8 or 9-foot surge.

**Figure 3.5.1**
**Storm Surge vs. Storm Tide**
(Source: NHC)

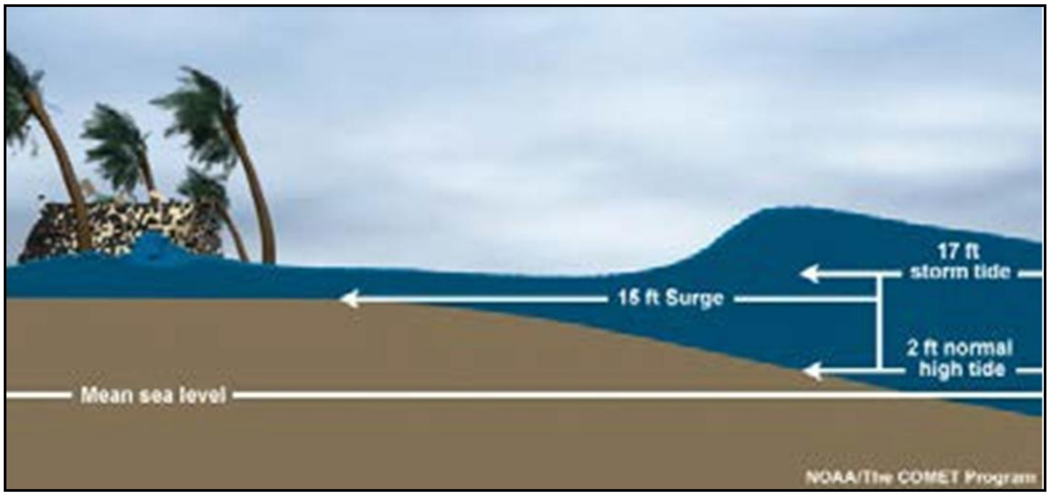



**Figure 3.5.2**
**Wind and Pressure Components of Hurricane Storm Surge**
(Source: NHC)


## Hazard Profile

### Location

The Gulf Coast of Mississippi is located in a high-hazard area for hurricanes and storm surges and is one of the more densely populated areas of the state. According to the 2020 U.S. Census, approximately 397,926 residents reside in the coastal counties of Hancock, Harrison, and Jackson. The second tier of counties is comprised of George, Pearl River, and Stone. These counties, located immediately upland from the coastal counties, had a combined population of 98,828 in 2020. The combined total population of all six counties was 496,754 or approximately 17% of the State's population. The effects of Hurricane Katrina, which made landfall in August 2005, caused drastic population shifts as people sought shelter in non-coastal areas. As housing was built and employment centers and schools were rebuilt many residents returned to their homes. In 2010, the population of these six counties was 466,900, reflecting a population increase of 29,854 (6.4%) residents. This population increase reflects significant redevelopment in the years following Hurricane Katrina.

The three coastal counties are at very high risk from the direct impact of a hurricane or tropical storm. Residents of the three upland counties are at high risk from strong winds, rain damage, flooding, severe storms, and tornadoes generated by hurricanes and tropical storms.

Storm surge is potentially the most devastating factor associated with hurricanes. Within the boundaries of the first-tier counties, properties adjacent to areas affected by tides, particularly areas south of U.S. Highway 90, are the most susceptible to damage from storm surges with heavy flooding as the most common result. In extreme cases, such as Hurricanes Camille and Katrina, the incoming wall of water and wind destroyed well-built buildings along the immediate coastline.

Hurricanes also significantly impact the medium-risk, and more inland counties of Clarke, Covington, Forrest, Greene, Jasper, Jefferson Davis, Jones, Lamar, Lauderdale, Marion, Perry, Pike, Rankin, Simpson, Smith, Walthall, and Wayne. All of these counties have the potential to experience the effects of high winds, rain damage, severe storms, and flooding. Hurricane effects have also impacted lower-risk counties as far north as Hinds and Lauderdale in central Mississippi. As an example, disaster declarations from Hurricane Katrina providing Individual Assistance were issued for 49 of Mississippi's 82 counties. Disaster declarations providing for public assistance were issued for all 82 counties.

Hurricanes that move northeast across the Louisiana Delta or move inland between Mobile, Alabama, and Panama City, Florida, usually are less damaging because these storms are located on the "weak side" of the storm. Even if a hurricane/tropical storm does not make landfall, the Mississippi Gulf Coast can suffer the damaging effects of high tide, rain, and wind from hurricanes and tropical storms that move in from the Gulf of Mexico.

## Shelter Requirements

The State of Mississippi has implemented a statewide sheltering program to build FEMA 361 community safe rooms to house displaced households or those seeking shelter from impending storms. Below is a summary of the progress made to date on the construction and capacity of these saferooms. This information will assist in evaluating the expected shelter requirements outlined in the scenarios presented in this plan update. The number of facilities and capacity for the FEMA 361 safe rooms includes 32 facilities that are currently under construction with the capacity to house approximately 21,245 persons.

**Mississippi Safe Room Program**

| Safe Room Type | County | No. of Facilities | Est. Capacity |
|---|---|---|---|
| Individual | Statewide | 10,918 | 28,824 |
| FEMA 361 | Adams, Copiah, Desoto, Forrest, George, Hancock, Harrison, Jackson, Jones, Lafayette, Lamar, Lauderdale, Lincoln, Monroe, Neshoba, Pearl River, Pike, Rankin, Stone, Tate, Tunica, and Wayne | 72 | 52,337 |
| Community | Attala, Calhoun, Chickasaw, Holmes, Itawamba, Lafayette, Lamar, Lauderdale, Lee, Leflore, Lowndes, Madison, Monroe, Panola, Pontotoc, Prentiss, Smith, Tallahatchie, Tippah, Union, Wayne, Winston, and Yalobusha | 183 | Undetermined |

## Education and Outreach

Hurricane Preparedness Week occurs each year during the last week in May. For more information on hurricane awareness call the MEMA Public Information number (866-519-6362) between 8 a.m. and 5 p.m. on weekdays.

The state also participates in state, regional, and national hurricane and all-preparedness conferences. During these conferences, public and private agencies have an opportunity to receive education and training to further their efforts in preparing for and responding to future events.

## Past Occurrences

Since 1965 Mississippi has been struck by 17 hurricanes and 18 tropical storms/depressions. **Tables 3.5.2 and 3.5.3** reflect the history of hurricanes and tropical storms/depressions from 1965 to 2022 in Mississippi followed by storm surge events in **Table 3.5.4**. **Figures 3.5.3 to 3.5.5** are also provided by category to show the tracks of these storms as they entered the Gulf of Mexico.

**Table 3.5.2**
**Hurricane/Tropical Storm Events**
**Presidential Disaster Declarations- Mississippi**

| Event/Declaration Number | Incident Period | Number of Counties Affected | Major Declaration Declared |
|---|---|---|---|
| Hurricane Ida DR-4626 | August 28, 2021-September 1, 2021 | 82 | October 22, 2021 |
| Hurricane Zeta DR-4576 | October 28, 2020-October 29, 2020 | 8 | December 31, 2020 |
| Hurricane Nate DR-4350 | October 6-10, 2017 | 5 | November 22, 2017 |
| Hurricane Isaac DR-4081 | August 26 – September 11, 2012 | 49 | August 20, 2012 |
| Hurricane Gustav DR-1794 | August 28 – September 8, 2008 | 22 | September 22, 2008 |
| Hurricane Katrina DR-1604 | August 29 – October 14, 2005 | 82 | August 29, 2005 |
| Hurricane Dennis DR-1594 | July 10-15, 2005 | 41 | July 10, 2005 |
| Hurricane Ivan DR-1550 | September 13-20, 2004 | 44 | September 15, 2004 |
| Tropical Storm Isidore DR-1436 | September 23 – October 6, 202 | 10 | October 1, 2002 |
| Tropical Storm Allison DR-1382 | June 6-13, 2001 | 8 | June 21, 2001 |
| Hurricane Georges DR-1251 | September 25-October 5, 1998 | 13 | October 1, 1998 |
| Hurricane Elena DR-741 | August 29 – September 4, 1985 | 4 | September 4, 1985 |
| Hurricane Frederic DR-599 | September 13, 1979 | 13 | September 13, 1979 |
| Hurricane Camille DR-271 | August 18, 1969 | 20 | August 18, 1969 |
| Hurricane Betsy DR-210 | September 25, 1965 | No County Information | September 25, 1965 |

**Table 3.5.3**
**Mississippi Hurricane & Tropical Storm History**
**Non-Declared Events**

| Incident Name | Event Date | County(s) Affected | Deaths | Injuries | Property Damage |
|---|---|---|---|---|---|
| Tropical Storm (unnamed) | 6/19/2021 | Hancock, Harrison, Jackson, Pearl River | 0 | 0 | $120,000 |
| Tropical Storm/Hurricane Delta | 10/9/2020 | Harrison, Walthall, Amite, Hancock, Wilkinson, Pike | 0 | 2 | $5,050,000 |
| Hurricane Sally | 9/16/2020 | Hancock, Harrison, Jackson | 0 | 0 | $0 |
| Hurricane Laura | 8/27/2020 | Adams, Jefferson, Washington, Warren, Bolivar, Covington, Jones, Smith | 0 | 0 | $121,000 |

| Incident Name | Event Date | County(s) Affected | Deaths | Injuries | Property Damage |
|---|---|---|---|---|---|
| Hurricane Barry | 7/13/2019 | Hancock, Harrison, Jackson, Amite, Wilkinson | 0 | 0 | $0 |
| Hurricane Michael | 10/8/2018 | Hancock, Harrison, Jackson | 0 | 0 | $0 |
| Tropical Storm Gordon | 9/4/2018 | Forrest, Jones, Clarke, Jasper, Carrol, Smith, Scott, Covington, Grenada, Winston, Noxubee, Montgomery, Carroll, Grenada, Holmes, Leflore | 0 | 0 | $396,100 |
| Tropical Storm Nate | 10/8/2017 | George, Wayne | 0 | 0 | $150,000 |
| Hurricane Nate | 10/7/2017 | Hancock, Harrison, Jackson | 0 | 0 | $0 |
| Tropical Storm Cindy | 6/21/2017 | Hancock, Harrison, Jackson | 0 | 0 | $0 |
| Tropical Storm Isaac | 8/28/2012 | Adams, Amite, Claiborne, Copiah, Covington, Forrest, Franklin, Hancock, Harrison, Hinds, Issaquena, Jackson, Jefferson, Jefferson Davis, Jones, Lamar, Lawrence, Lincoln, Marion, Pearl River, Pike, Rankin, Simpson, Smith, Walthall, Wilkinson, and Warren | 1 | 2 | $7,375,000 |
| Tropical Storm Lee | 9/2/2011 | Amite, Hancock, Harrison, Jackson, Pearl River, Pike, and Wilkinson | 0 | 0 | $55,000 |
| Tropical Storm Ida | 11/9/2009 | Forrest, Hancock, Harrison, and Pearl River | 0 | 0 | $0 |
| Tropical Storm Ike | 9/11/2008 | Hancock, Harrison, and Jackson | 0 | 0 | $0 |
| Tropical Storm Gustav | 9/2/2008 | Adams, Claiborne, Copiah, Forrest, Franklin, Jefferson, Jefferson Davis, Lamar, Lawrence, Lincoln, and Marion | 0 | 0 | $5,850,000 |
| Tropical Depression Rita | 9/25/2005 | Coahoma and Tunica | 0 | 0 | $10,000 |
| Hurricane Rita | 9/24/2005 | Adams, Bolivar, Carroll, Claiborne, Copiah, Franklin, Hinds, Holmes, Humphreys, Issaquena, Jefferson, Jefferson Davis, Lawrence, Leflore, Lincoln, Madison, Marion, Rankin, Sharkey, Simpson, Sunflower, Warren, Washington, and Yazoo | 0 | 0 | $485,000 |
| Tropical Depression Dennis | 7/11/2005 | Calhoun, Chickasaw, Itawamba, Lee, and Union | 0 | 0 | $35,000 |
| Hurricane Cindy | 7/5/2005 | Hancock, Harrison, Jackson, and Pearl River | 0 | 0 | $9,000,000 |

| Incident Name | Event Date | County(s) Affected | Deaths | Injuries | Property Damage |
|---|---|---|---|---|---|
| Tropical Storm Cindy | 7/5/2005 | Forrest, George, Greene, Lamar, and Stone | 0 | 0 | $200,000 |
| Tropical Storm Arlene | 6/10/2005 | Clarke, Clay, Hancock, Harrison, Jackson, Kemper, Lauderdale, Lowndes, Noxubee, and Oktibbeha | 0 | 0 | $445,000 |
| Tropical Storm Matthew | 10/9/2004 | Hancock, Harrison, and Jackson | 0 | 0 | $20,000 |
| Tropical Storm Ivan | 9/16/2004 | Chickasaw, Itawamba, Lee, and Monroe | 1 | 0 | $30,000 |
| Tropical Storm Bill | 6/30/2003 | Clarke, Covington, Forrest, Hancock, Harrison, Jackson, Jasper, Jefferson Davis, Jones, Kemper, Lamar, Lauderdale, Marion, Newton, Pearl River, and Smith | 0 | 0 | $1,200,000 |
| Hurricane Lili | 10/3/2002 | Adams, Amite, Attala, Carroll, Covington, Hancock, Harrison, Hinds, Jackson, Jasper, Leake, Leflore, Madison, Pearl River, Pike, Scott, Smith, Walthall, Warren, Washington, Wilkinson, and Yazoo | 0 | 0 | $13,900,000 |
| Tropical Storm Hanna | 9/14/2002 | Hancock, Harrison, and Jackson | 0 | 0 | $0 |
| Tropical Storm Bertha | 8/4/2002 | Hancock, Harrison, and Jackson | 0 | 0 | $50,000 |
| Tropical Storm Hermine | 9/19/1998 | Hancock, Harrison, Jackson, and Pearl River | 0 | 0 | $85,000 |
| Tropical Storm Earl | 9/2/1998 | Hancock, Harrison, and Jackson | 0 | 0 | $0 |
| Hurricane Danny | 7/17/1997 | Hancock, Harrison, and Jackson | 0 | 0 | $0 |
| Hurricane Opal | 10/4/1995 | Hancock, Harrison, and Jackson | 0 | 1 | $75,000 |
| Hurricane Erin | 8/20/1995 | Greene, Perry, and Wayne | 0 | 0 | $100,000 |

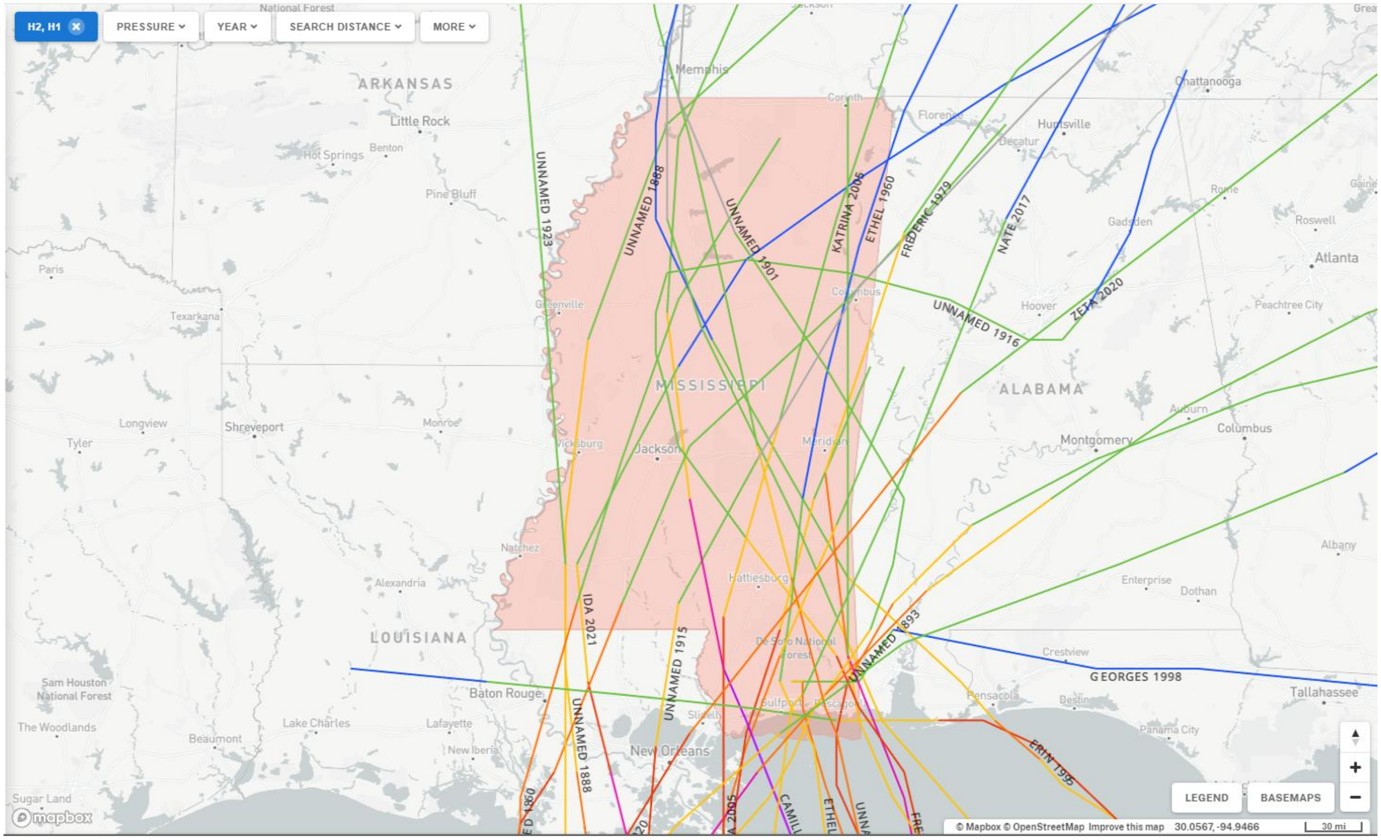
Source: NCEI

## Table 3.5.4
## Storm Surge History

| Date | County | Property Damage ($) | | Date | County | Property Damage ($) |
|---|---|---|---|---|---|---|
| 8/28/2021 | Hancock | $0 | | 8/28/2012 | Jackson | $600,000 |
| | Harrison | $0 | | | Harrison | $2,100,000 |
| | Jackson | $0 | | | Hancock | $2,100,000 |
| 6/19/2021 | Hancock | $0 | | 9/2/2011 | Jackson | $10,000 |
| | Harrison | $0 | | | Hancock | $10,000 |
| | Jackson | $0 | | | Harrison | $10,000 |
| 10/28/2020 | Hancock | $10,000,000 | | 9/11/2008 | Harrison | $0 |
| | Harrison | $10,000,000 | | | Jackson | $0 |
| | Jackson | $0 | | | Hancock | $0 |
| 10/10/2020 | Hancock | $0 | | 9/1/2008 | Hancock | $1,250,000 |
| | Harrison | $200,000 | | | Harrison | $750,000 |
| 9/22/2020 | Hancock | $0 | | | Jackson | $500,000 |
| | Jackson | $0 | | 8/29/2005 | Hancock | $3,380,000,000 |
| 9/15/2020 | Hancock | $0 | | | Harrison | $5,630,000,000 |
| | Harrison | $0 | | | Jackson | $2,250,000,000 |
| | Jackson | $0 | | 7/5/2005 | Hancock | $500,000 |
| 7/11/2018 | Hancock | $0 | | | Harrison | $300,000 |
| | Harrison | $0 | | | Jackson | $200,000 |
| | Jackson | $0 | | 10/9/2004 | Hancock | $15,000 |
| 10/8/2018 | Hancock | $0 | | | Harrison | $15,000 |
| | Jackson | $0 | | 9/15/2004 | Harrison | $400,000 |
| 6/20/2017 | Jackson | $0 | | | Jackson | $1,200,000 |
| | Harrison | $0 | | | Hancock | $400,000 |
| | Hancock | $0 | | 6/30/2003 | Jackson | $250,000 |
| 10/7/2017 | Jackson | $0 | | | Hancock | $500,000 |
| | Harrison | $0 | | | Harrison | $250,000 |
| | Hancock | $0 | | 10/13/2001 | Hancock | $0 |
| | | | | 2/15/1998 | Harrison | $250,000 |
| | | | | | Hancock | $500,000 |
| | | | | | Jackson | $250,000 |
| | | **Total Estimated Property Damage** | | **$11,292,560,000** | | |

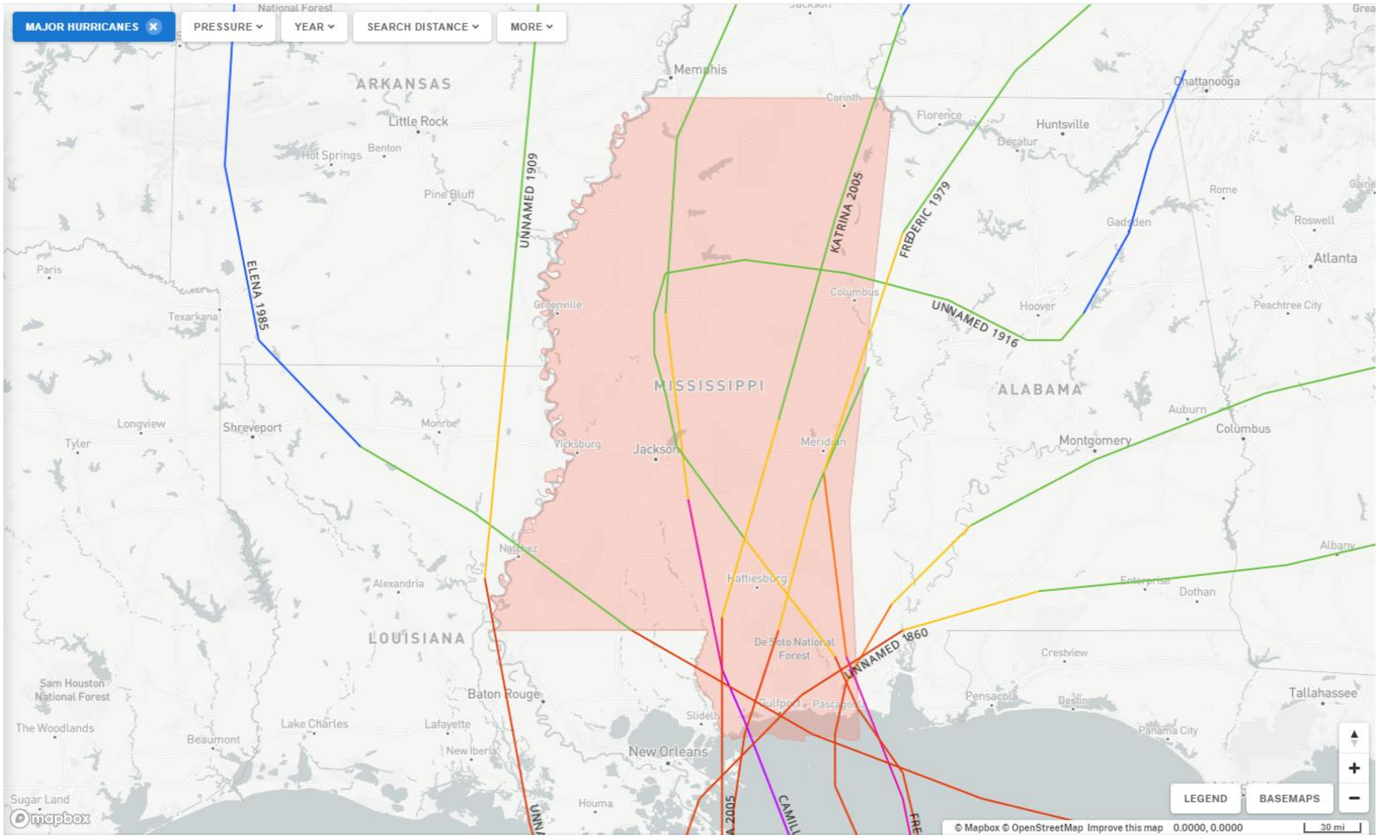
Source NCEI

# Figure 3.5.3
# Category 1 and 2 Historical Hurricanes
# 1852-2023



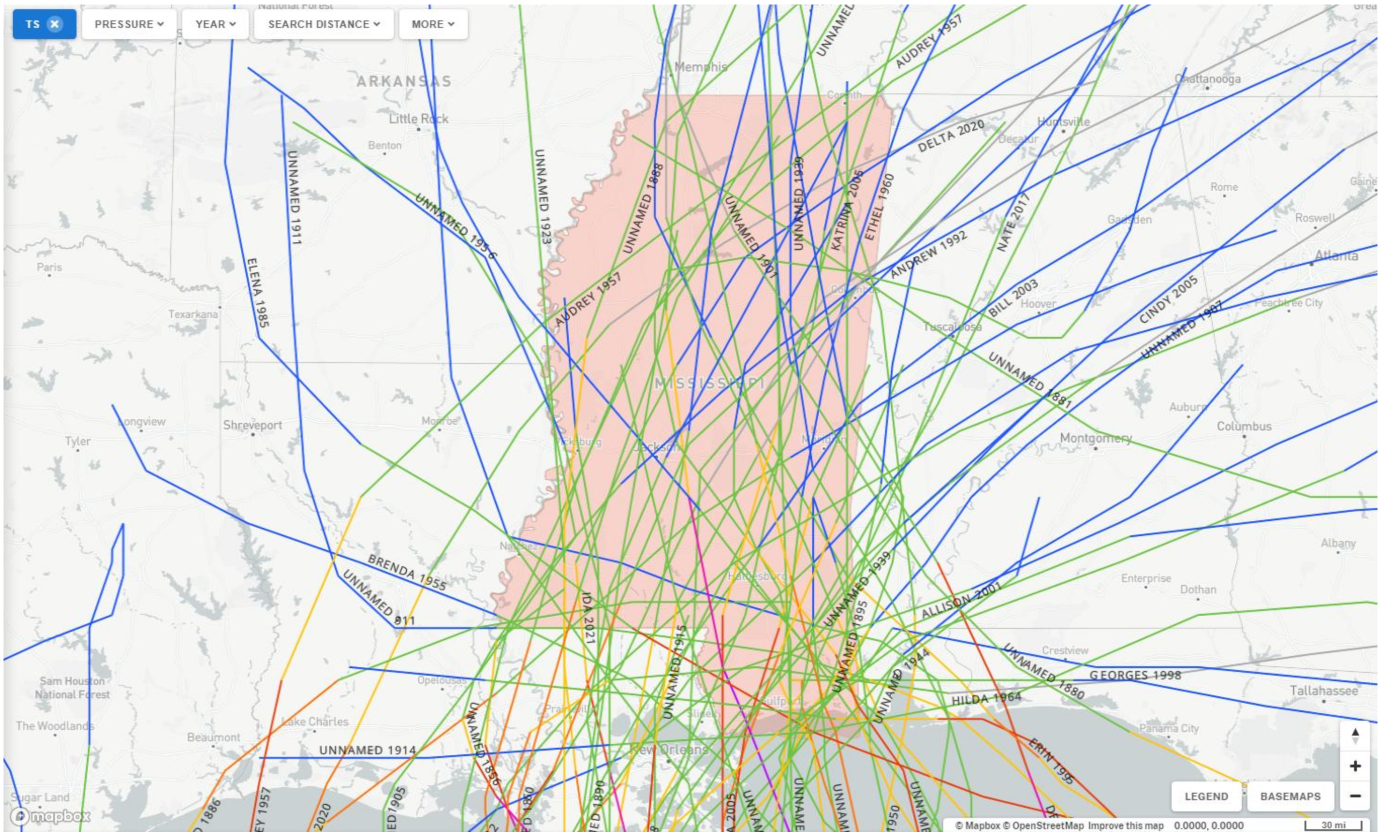

Source: www.csc.noaa.gov/hurricanes

**Figure 3.5.4**
**Category 3, 4, and 5 Historical Hurricanes**
**1852-2023**




Source: www.csc.noaa.gov/hurricanes

**Figure 3.5.5**
**Historical Tropical Storms**
**1852-2023**




Source: www.csc.noaa.gov/hurricanes

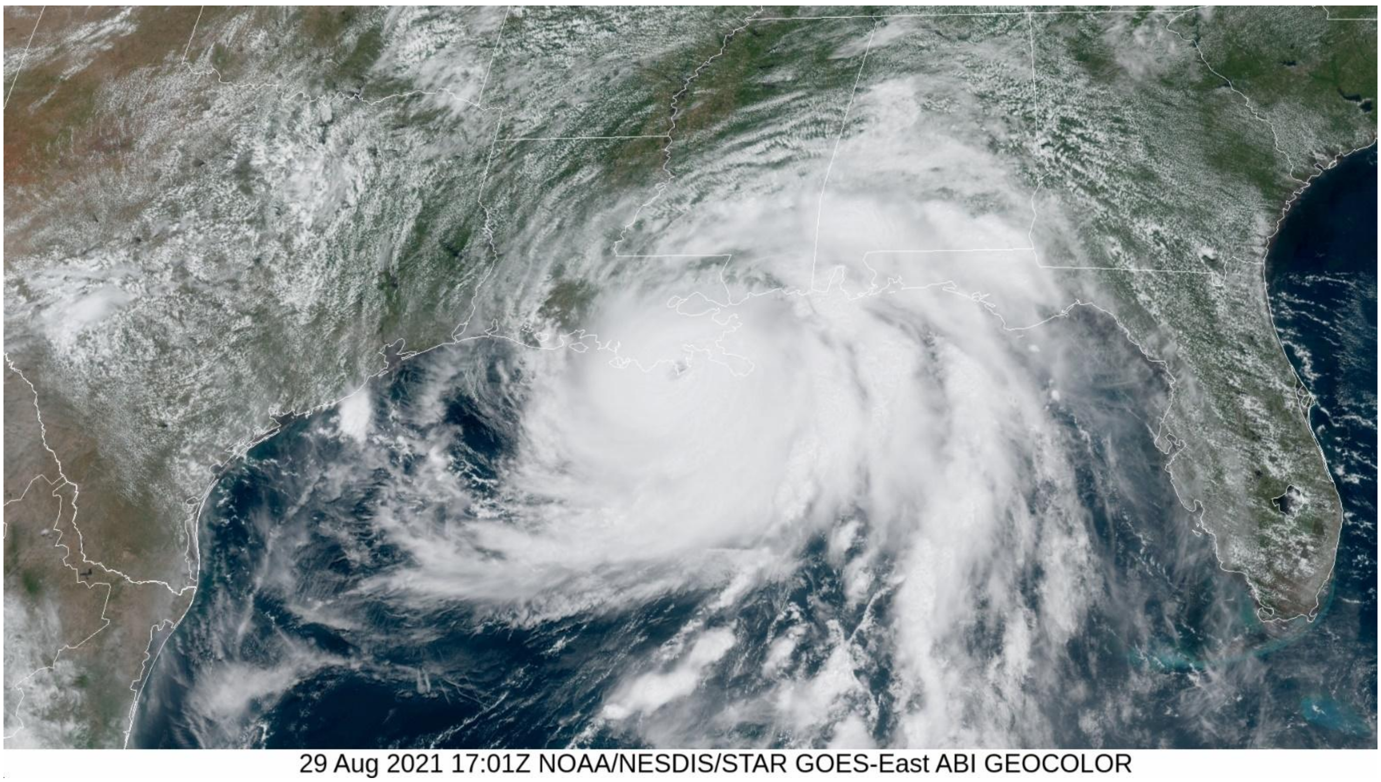
Summaries of the Presidentially declared disaster events that have occurred over the past ten years are provided below. The summaries also include data from the NCEI and FEMA on the impacts on people and property and the public assistance dollars obligated.

## August 28, 2021 – Hurricane Ida

The ninth named storm, fourth hurricane, and second major hurricane of the 2021 Atlantic hurricane season, Ida originated from a tropical wave in the Caribbean Sea on August 23rd. On August 26th, the wave developed into a tropical depression, which organized further and became Tropical Storm Ida later that day, near Grand Cayman. On a northwestward track, Ida intensified into a hurricane on August 27, just before moving over western Cuba. A day later, the hurricane underwent rapid intensification over the Gulf of Mexico as it passed over a warm core eddy and reached major hurricane strength. It was just under 72 hours from tropical depression formation to category 4 strength with 150 mph winds. Ida remained at its peak intensity of 150 mph winds and a minimum central pressure of 929 millibars as it made landfall near Port Fourchon midday on August 29th. It didn't weaken to a tropical storm until it reached the Louisiana/Mississippi border. Ida produced over a dozen tornadoes and light to moderate wind damage across southwestern and coastal Mississippi. Around 100,000 residents were without power. Around 100 homes were damaged, and 6 were destroyed. Storm surge inundation ranged from a few feet in Jackson County to 7 feet in Harrison County. Hurricane Ida caused approximately $10 million worth of damage.

| | |
|---|---|
| Counties Affected | 82 |
| Deaths | 0 |
| Injuries | 0 |
| Estimated Property Damage | $11,280,000 |
| Total Public Assistance Grants | $28,226,619 |
| Emergency Work (Categories A-B) | $6,564,339 |
| Permanent Work | $20,036,952 |

**Satellite image of Hurricane Ida**

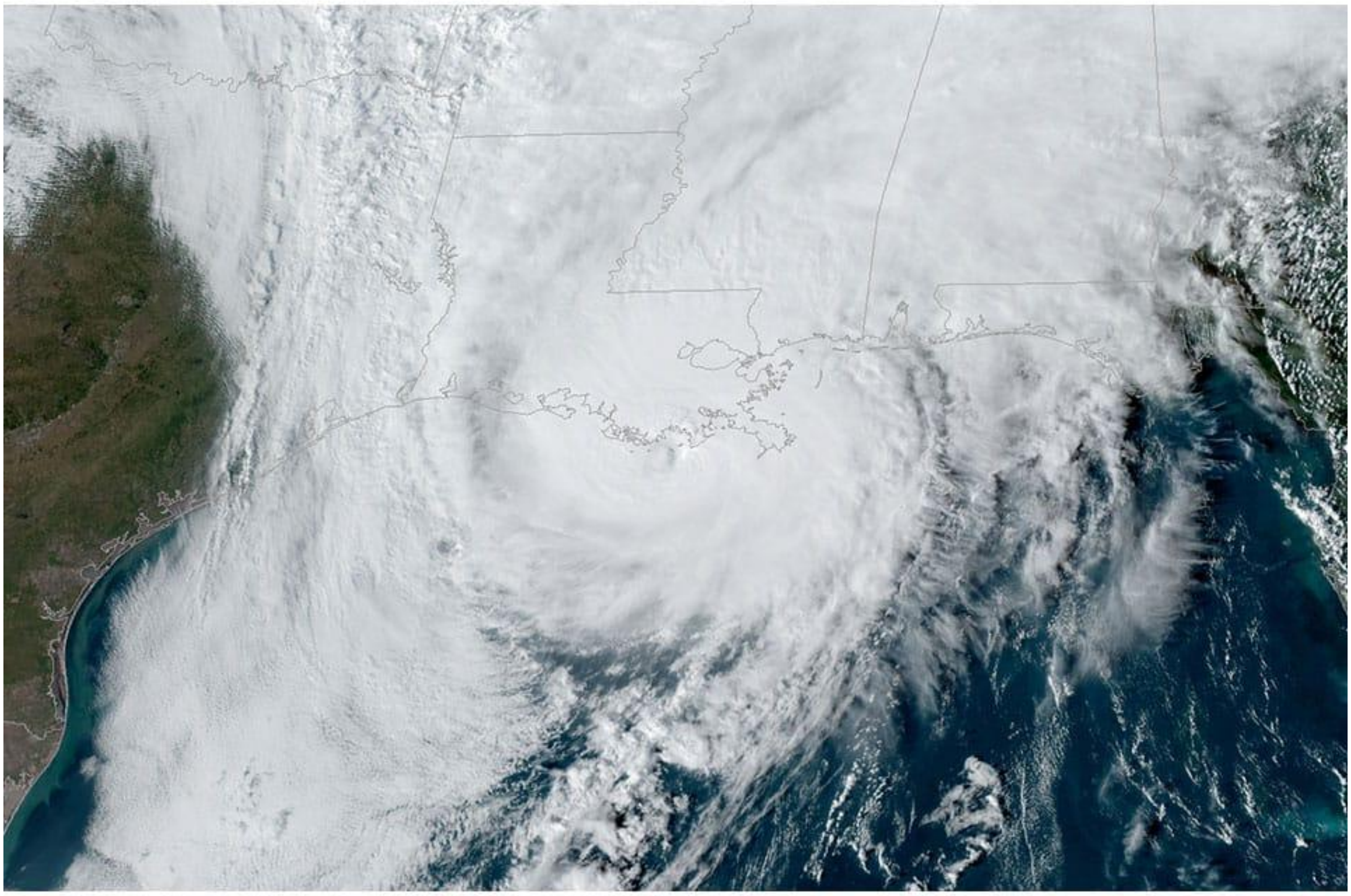



## October 28, 2020 – Hurricane Zeta

Hurricane Zeta formed in the northwestern Caribbean on the afternoon of October 24th and became the twenty-seventh named storm and eleventh hurricane of the 2020 Atlantic hurricane season. Before landfall, Zeta reached sustained wind speeds of 110 mph and became a Category 2 hurricane. Zeta produced extensive wind damage across coastal Mississippi with measured sustained winds up to 81 mph and gusts up to 104 mph. Thousands of power poles were downed and thousands of homes experienced minor damage. Storm surge ranged from a few feet to several feet. There were 2 fatalities and 75 injuries. Hurricane Zeta caused approximately $90 million worth of damage. Zeta was the record-tying sixth hurricane to make landfall in the United States and the record-fifth named storm to strike Louisiana in 2020.

| | |
|---|---|
| Counties Affected | 8 |
| Deaths | 1 |
| Injuries | 0 |
| Estimated Property Damage | $125,150,000 |
| Total Public Assistance Grants | $115,522,249 |
| Emergency Work (Categories A-B) | $55,348,969 |
| Permanent Work | $55,202,714 |

***Satellite image of Hurricane Zeta***



## November 22, 2017- Hurricane Nate

Hurricane Nate originated in the Western Caribbean and was an unusually fast-moving storm, which caused widespread destruction and casualties in Central America. Hurricane Nate moved through the Yucatan Channel and into the Gulf of Mexico on October 7, 2017. The next day, Hurricane Nate made landfall near the mouth of the Mississippi River in Louisiana. After crossing the marshland of the delta, Hurricane Nate made its second U.S. landfall in Biloxi, Mississippi. Hurricane Nate caused a storm surge along the coastline, as well as rip currents, hurricane-force winds, and beach erosion.[i]

| | |
|---|---|
| Counties Affected | 6 |
| Deaths | 0 |
| Injuries | 0 |
| Estimated Property Damage | $125,000 |
| Total Public Assistance Grants | $986,297 |
| Emergency Work (Categories A-B) | Not Available |
| Permanent Work | Not Available |

Source: NCEI and FEMA

***Satellite image of Hurricane Nate***

## August 28, 2012–Hurricane Isaac

Hurricane Isaac entered the Gulf of Mexico as a tropical storm on August 26, 2012, moving northwest after crossing Haiti, Cuba, and the Florida Straits. Isaac moved slowly north-northwest over the eastern Gulf. Isaac strengthened into a hurricane on the morning of the 28th when it was 75 miles south-southeast of the mouth of the Mississippi River. Isaac made landfall in Plaquemines Parish as a Category 1 Hurricane near the Southwest Pass of the Mississippi River on the evening of the 28th. A second landfall occurred near Port Fourchon the following morning. The storm weakened to a tropical storm on the afternoon of the 29th about 50 miles west southwest of New Orleans and weakened further to a tropical depression on the afternoon of the 30th near Monroe, Louisiana.

Even though Isaac was of hurricane status from near the mouth of the Mississippi River into southeast Louisiana, only tropical storm force winds were recorded on land areas of Mississippi. The maximum sustained wind in south Mississippi was 46 knots or 53 mph measured at the Gulfport- Biloxi-Airport during the early afternoon of August 29th. A portable weather station (Weatherflow Inc) near Gulfport measured a 48-knot gust, or 55 mph, late on the morning of August 29. A maximum wind gust of 58 knots or 67 mph was recorded at the NOAA NOS Bay Waveland station and Gulfport (Weatherflow Inc) late on the morning of Aug 29. The long duration of tropical-storm-force winds downed some trees and power lines across the region.

The minimum sea level pressure measured from a land station was 995.9 mb at the NOAA-NOS station at Bay-Waveland station during the early morning of Aug 29th. A storm tide ranged from approximately 5 feet in Jackson County to nearly 10 feet in Hancock County closer to Isaac’s center. These values are approximately 3 to 8 feet above normal astronomical values. Storm surge flooding impacts were the greatest in Hancock County. Persistent rain bands affected south Mississippi, especially the coastal sections, and produced heavy rainfall over three days. 10 to 20 inches of rainfall was common across the region. A cooperative observer near Pascagoula recorded the maximum reading of 22.20 inches of rain. Heavy rainfall produced both flash flooding and later moderate-to-major river flooding. Record crests were observed on the Wolf River near Landon (August 31) and Gulfport (September 1), and the East Hobolochitto River near Caesar (Aug 31). Storm surge and high tides restricted the outflow of the rivers near the coast and lakes exacerbating flooding of low-lying areas along rivers and bayous near the coast as they emptied into the Gulf. There were two weak tornadoes documented that occurred along the Mississippi coast, resulting in minor property damage

Overall, impacts from Isaac resulted in millions of dollars in damages in south Mississippi and one direct fatality. Much of the damage in the coastal counties of Hancock, Harrison, and Jackson was related to storm surge on the coast, flash flooding, or river flooding. The chart below provides a summary of the reported impacts on people and property damage from NCEI and the dollars obligated to date for public assistance through FEMA.

| | |
|---|---|
| Counties Affected | 49 |
| Deaths | 1 |
| Injuries | 2 |
| Estimated Property Damage | $7,375,000 |
| Total Public Assistance Grants | $37,002,798 |
| Emergency Work (Categories A-B) | $23,061,498 |
| Permanent Work | $13,941,300 |

Source: NCEI and FEMA

*Satellite image of Hurricane Isaac*

## September 1, 2008- Hurricane Gustav

Hurricane Gustav made landfall as a Category 2 hurricane near Cocodrie, LA on the morning of September 1, 2008. Gustav continued to move northwest and weakened to a Category 1 storm over south-central Louisiana later that day. The highest wind gust recorded in south Mississippi was 74 mph at the Gulfport-Biloxi International Airport while the highest sustained wind of 54 mph was recorded at the Waveland Yacht Club. No official wind observations were available in far southwest Mississippi; however, hurricane-force wind gusts may have occurred. Rainfall varied considerably, ranging from around 4 to 10 inches. Gustav produced mainly light wind damage across coastal Mississippi, although more significant and concentrated damage occurred in southwest Mississippi closer to the track of the center of the storm. Widespread power outages occurred in southern Mississippi.

| | |
|---|---|
| Counties Affected | 22 |
| Deaths | 0 |
| Injuries | 0 |
| Estimated Property Damage | $19,370,000 |
| Total Public Assistance Grants | $33,702,564 |
| Emergency Work (Categories A-B) | $19,932,178 |
| Permanent Work | $12,657,491 |

Source: NCEI and FEMA

**Satellite image of Hurricane Gustav**

## August 28, 2005 - Hurricane Katrina

Hurricane Katrina was one of the most destructive hurricanes on record to impact the coast of the United States. It was one of the worst natural disasters in the history of the U.S., resulting in catastrophic damage and numerous casualties along the Mississippi coast. Damage and casualties resulting from Hurricane Katrina extended as far east as Alabama and the panhandle of Florida. Post-event analysis by the National Hurricane Center indicates that Katrina weakened slightly before making landfall as a strong Category 3 storm during its initial landfall in lower Plaquemines Parish. The storm continued a north-northeast track with the center passing about 40 miles southeast of New Orleans with a second landfall occurring near the Louisiana and Mississippi border as a Category 3 storm with maximum sustained winds estimated at 121 mph. Katrina continued to weaken as it moved north-northeast across Mississippi during the day but remained at hurricane strength 100 miles inland.

Damage across coastal Mississippi was catastrophic. The storm surge associated with Hurricane Katrina approached or exceeded the surge associated with Hurricane Camille (1969) and impacted a wider area. Almost total destruction was observed along the immediate coast in Hancock and Harrison Counties with storm surge damage extending north along bays and bayous to Interstate 10. Thousands of homes and businesses were destroyed by the storm surge. Hurricane-force winds caused damage to roofs, power lines, signage, downed trees, and some windows were broken by wind and wind-driven debris in areas away from storm surge flooding. Wind damage was widespread with fallen trees causing damage to houses and power lines. Excluding losses covered by the National Flood Insurance Program (NFIP), insured property losses in Mississippi were estimated at $9.8 billion. Uninsured and insured losses combined were estimated to exceed $100 billion across the Gulf Coast.

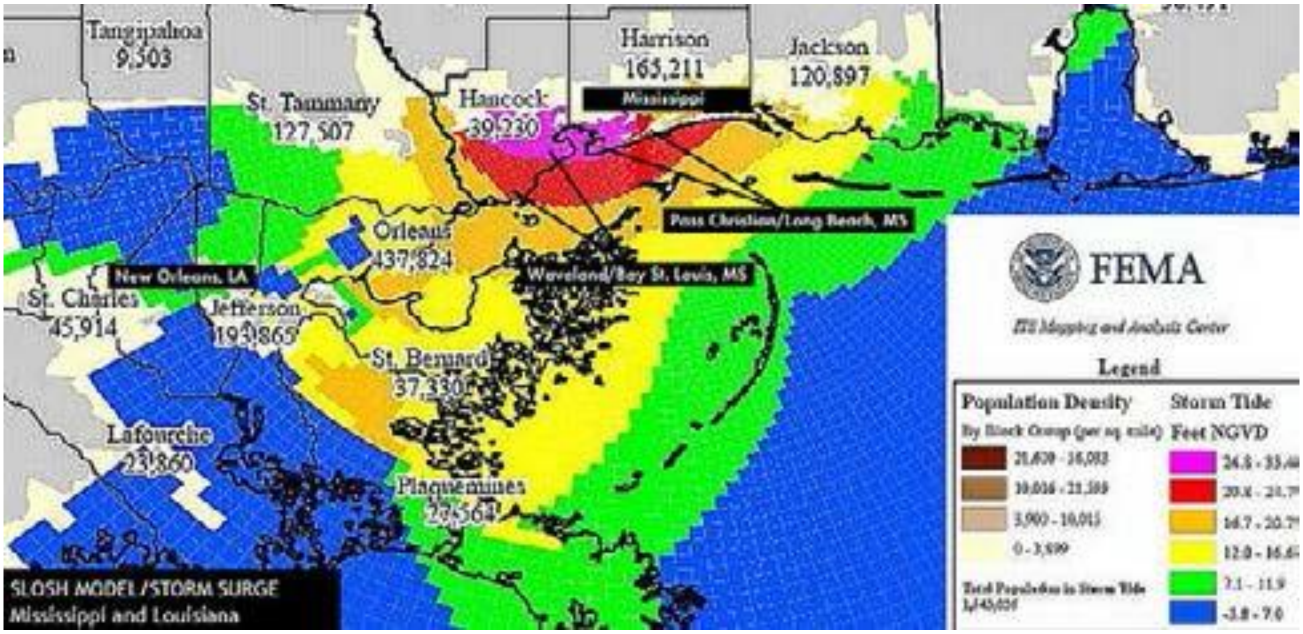
**Satellite image of Hurricane Katrina**

The NCEI reports that tide gauges were destroyed by Hurricane Katrina; therefore, storm surge was determined by post-storm high water marks. It was estimated that the storm surge along Harrison County was between 19 and 25 feet. 23 feet was recorded at the Hancock County EOC operations area in Waveland, and the high-water mark measured on the Jackson County EOC building in Pascagoula was 16.1 feet. Total rainfall amounts generally ranged from 10 to 16 inches across coastal and south Mississippi with much lower amounts observed over southwest Mississippi. The highest observed rainfall was 11 inches at Stennis Space Center and near Picayune. To help understand the total effects of this catastrophic event, a storm surge, and HAZUS final wind field figures are presented as **Figures 3.5.6 and 3.5.7**.

| | |
|---|---|
| Counties Affected | 82 |
| Deaths | 238 |
| Injuries | Undetermined |
| Estimated Property Damage | $80,000,000,000 |
| Total Public Assistance Grants | $3,237,615,391 |
| Emergency Work (Categories A-B) | $1,170,007,750 |
| Permanent Work | $1,885,105,865 |

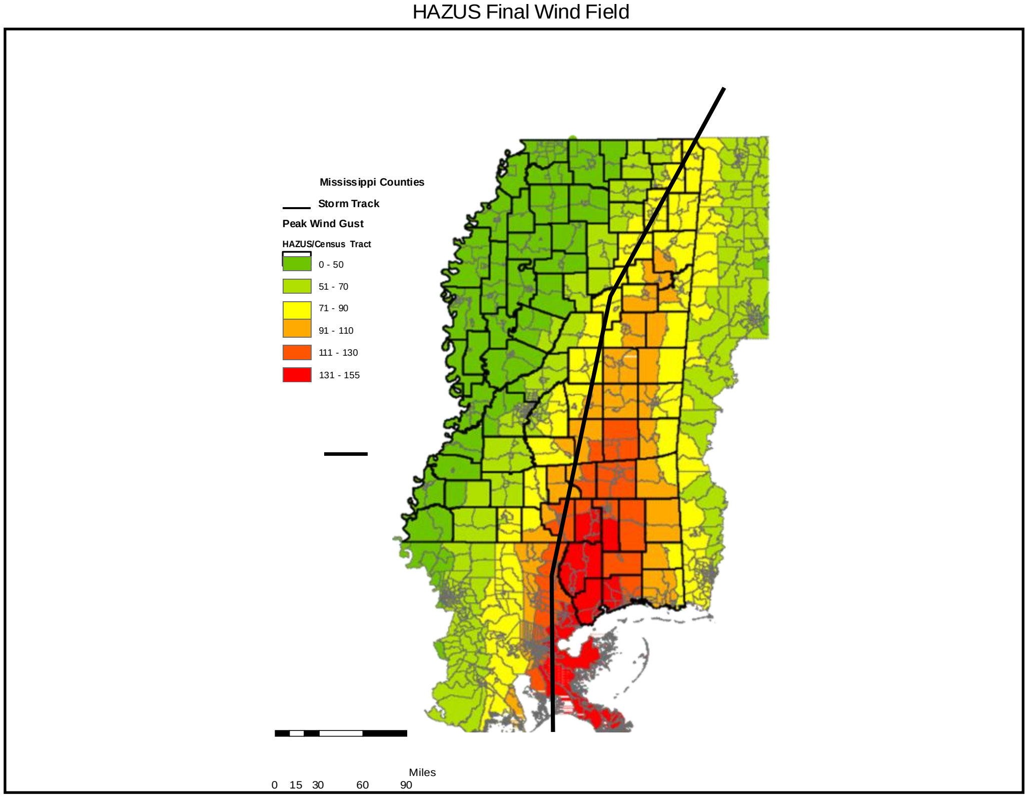
Source: NCEI and FEMA

## Figure 3.5.6
## Hurricane Katrina Storm Surge Map




## Figure 3.5.7
## Hurricane Katrina Peak Gust by Census Track
## HAZUS and Wind Field

Peak Gust by Census Track
HAZUS Final Wind Field



## July 10, 2005 – Hurricane Dennis

Hurricane Dennis entered the Gulf of Mexico as a hurricane. After crossing over Cuba, Dennis moved into the central Gulf of Mexico and strengthened to a Category 4 hurricane on July 10th. Hurricane Dennis weakened to a Category 3 hurricane before making landfall along the western Florida panhandle. The Mississippi Gulf Coast experienced some tropical weather from Hurricane Dennis. The highest wind gusts over land in Mississippi were reported at Keesler Air Force Base at 46 mph. The highest wind gusts over water adjacent to Mississippi was 52 mph from a buoy located 22 miles south-southeast of Biloxi. Rainfall on the Mississippi Gulf Coast was reported to be less than 2 inches. The lowest reported pressure on the Mississippi Gulf Coast was 994.2 mb, and the highest reported tide was 4 feet MMSL at Waveland (NCEI: Event Details). Harrison County received public assistance under a Presidential Disaster Declaration.

| | |
|---|---|
| Counties Affected | 41 |
| Deaths | 0 |
| Injuries | 0 |
| Estimated Property Damage | $2,550,000 |
| Total Public Assistance Grants | $1,707,563 |
| Emergency Work (Categories A-B) | $1,735,639 |
| Permanent Work | $0 |

Source: NCEI and FEMA

**Satellite image of Hurricane Dennis**

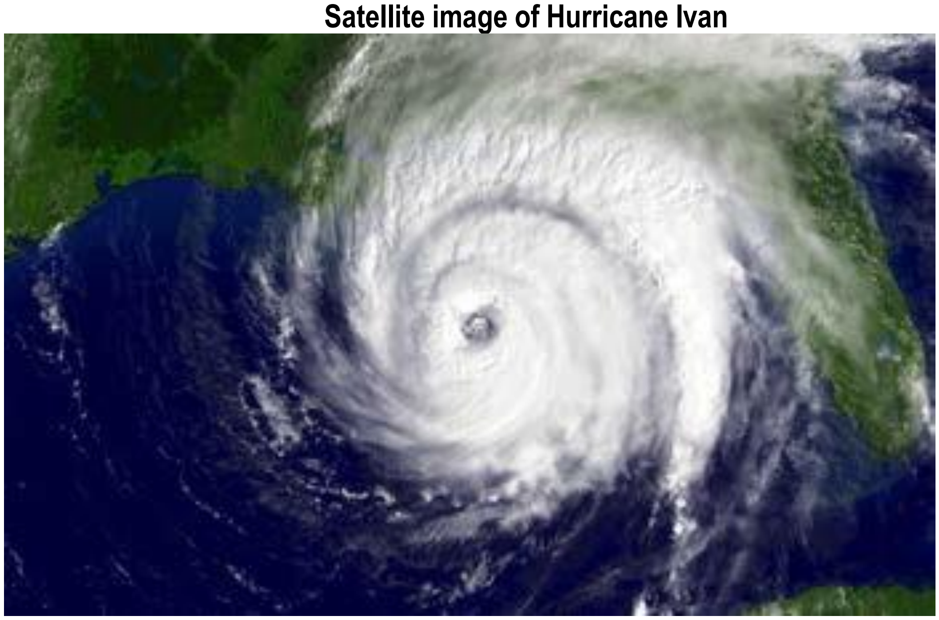
## September 16, 2004, Hurricane Ivan

Hurricane Ivan made landfall near Gulf Shores, Alabama as a Category 3 hurricane on the morning of September 16, 2004. The storm caused extensive damage in Coastal Alabama and Florida. Harrison and Hancock Counties experienced tropical storm force winds. A wind gust of 78 mph was captured at Point Cadet in Biloxi. The lowest pressure reported on the Mississippi Gulf Coast was 975.6 mb at the Jackson County Emergency Operations Center. Keesler Air Force Base captured a low pressure of 982.9 mb about two hours later. The highest storm surge on the Mississippi Gulf Coast was at the mouth of the Pascagoula River and was 3.72 ft NGVD. A Presidential Disaster Declaration was made, providing individual assistance to residents of Harrison County and public assistance to local governments in Harrison County.

| | |
|---|---|
| Counties Affected | 44 |
| Deaths | 1 |
| Injuries | 0 |
| Estimated Property Damage | $9,720,000 |
| Total Public Assistance Grants | $14,403,026 |
| Emergency Work (Categories A-B) | $10,113,755 |
| Permanent Work | $4,289,274 |

Source: NCEI and FEMA

**Satellite image of Hurricane Ivan**



## September 26, 2002-Tropical Storm Isidore

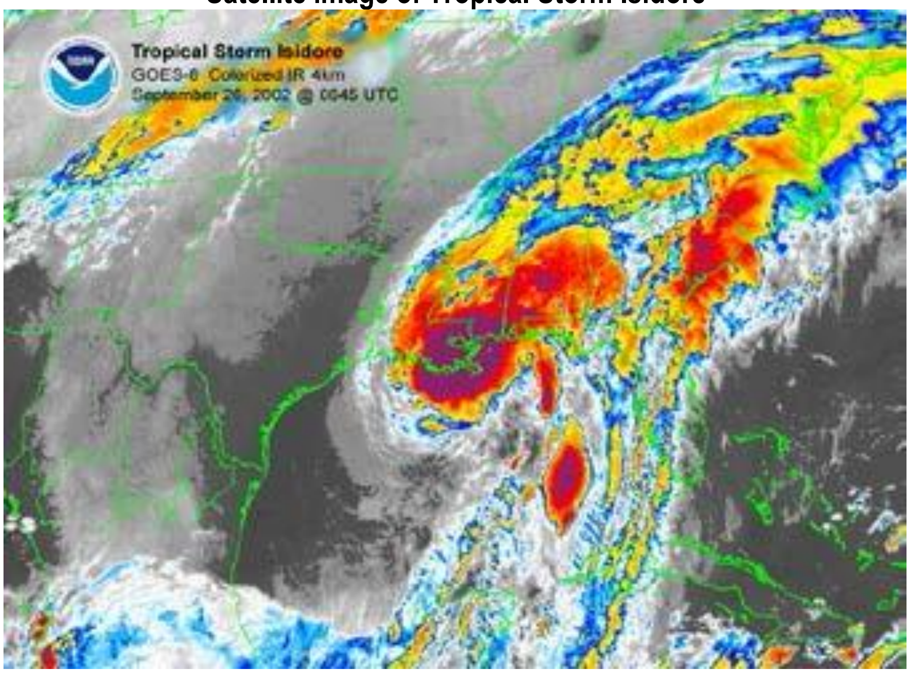
Tropical Storm Isidore made landfall near Grand Isle, LA during the early morning of September 26, 2002. The tropical storm moved north across southeast Louisiana and by the evening was located in central Mississippi, where it was downgraded to a tropical depression. Tropical Storm Isidore had a large circulation with tropical-storm-force winds extending several hundred miles from its center. Tide levels were generally 4 to 7 feet above normal, with locally higher levels across much of coastal Mississippi. Significant beach erosion occurred along the coast and on the barrier islands. The maximum storm surge reading on the

Mississippi Coast was 7.61 feet NGVD at the Corps of Engineers tide gage at Gulfport Harbor, and 6.86 feet NGVD in Biloxi Bay at Point Cadet. There were two fatalities on the Mississippi Coast related to the tropical storm; one direct and another indirect. Rainfall amounts associated with Isidore were generally 5 to 8 inches and resulted in some river flooding and flash flooding. Approximately 2,500 homes in Hancock County and 1,400 homes in Harrison County were flooded as a result of the storm surge, with river flooding and flash flooding causing some of the flood damage.

| | |
|---|---|
| Counties Affected | 10 |
| Deaths | 1 |
| Injuries | 0 |
| Estimated Property Damage | $25,500,000 |
| Total Public Assistance Grants | $6,784,617 |
| Emergency Work (Categories A-B) | $999,661 |
| Permanent Work | $5,784,956 |

Source: NCEI and FEMA

**Satellite image of Tropical Storm Isidore**



## Probability of Hurricane Future Events

Researchers have studied the probability of a tropical cyclone landfall and guest calculations for 17 regions from Brownsville, Texas to Eastport, Maine. A web page that displays this information has been created as a joint project between the Tropical Meteorology Project at Colorado State University, Fort Collins, Colorado, and the GeoGraphics Laboratory at Bridgewater State College, Bridgewater, MA. (http://hurricanepredictor.com/County.aspx)

**Tables 3.5.5 and 3.5.6** break down the probability by coastal county for 2023 and the next 50-year period.

**Table 3.5.5**
**2023 Hurricane Landfall Probability**

| Probability | George | Hancock | Harrison | Jackson | Pearl River | Stone |
|---|---|---|---|---|---|---|
| Probability of 1 or more named storms making landfall | 7.4% | 6.1% | 8.0% | 8.9% | 7.5% | 7.2% |
| Probability of 1 or more hurricanes making landfall | 3.7% | 3.1% | 4.0% | 4.4% | 3.8% | 3.6% |
| Probability of 1 or more intense hurricanes making landfall | 1.7% | 1.4% | 1.8% | 2.0% | 1.7% | 1.6% |
| Probability of tropical storm force (>= 40 mph) wind gusts | 50.7% | 50.7% | 50.7% | 50.7% | 50.7% | 50.7% |
| Probability of hurricane force (>=75 mph) wind gusts | 17.3% | 17.3% | 17.3% | 17.3% | 17.3% | 17.3% |
| Probability of intense hurricane force (>= 115 mph) wind gusts | 6.1% | 6.1% | 6.1% | 6.1% | 6.1% | 6.1% |

Source: http://hurricanepredictor.com/County.aspx

**Table 3.5.6**
**50-Year Hurricane Landfall Probability**

| Probability | George | Hancock | Harrison | Jackson | Pearl River | Stone |
|---|---|---|---|---|---|---|
| Probability of 1 or more named storms making landfall | 88% | 82.7% | 90.3% | 92.5% | 88.6% | 87.4% |
| Probability of 1 or more named hurricanes making landfall | 64.2% | 57.3% | 67.6% | 71.4% | 65% | 63.4% |
| Probability of 1 or more intense hurricanes making landfall | 36.9% | 31.8% | 39.7% | 42.9% | 37.6% | 36.3% |
| Probability of tropical storm force (>= 40 mph) wind gusts | 99.9% | 99.9% | 99.9% | 99.9% | 99.9% | 99.9% |
| Probability of hurricane force (>=75 mph) wind gusts | 99.6% | 99.6% | 99.6% | 99.6% | 99.6% | 99.6% |

| Probability | George | Hancock | Harrison | Jackson | Pearl River | Stone |
|---|---|---|---|---|---|---|
| Probability of intense hurricane force (>= 115 mph) wind gusts | 82.3% | 82.3% | 82.3% | 82.3% | 82.3% | 82.3% |

Source: http://hurricanepredictor.com/County.aspx

## Assessing Vulnerability

In assessing Mississippi's vulnerability to damage and loss of life from hurricanes and tropical storms, at the top of the list is the loss of life and property due to flooding. Mississippi's citizens are vulnerable to hurricanes. The very young, the elderly, and the handicapped are especially vulnerable to harm from hurricanes. Not only are residents' homes vulnerable to hurricanes, but also public buildings, infrastructure, and natural resources are all subject to damage. In some cases, the damage to natural resources cannot be restored to pre-incident levels.

### Damages from Flooding Due to Hurricanes

Torrential rains from hurricanes and tropical storms can produce extensive urban and riverine flooding. Winds from these storms located offshore can drive ocean water up the mouth of a river, compounding the severity of inland overbank flooding.

In addition to the combined destructive forces of wind, rain, and lightning, hurricanes can cause a "surge" in the ocean, which can raise the sea level as high as 25 feet or more in the strongest hurricanes. This "storm surge" also can have the opposite effect, in that the sea level can be lowered to below mean sea level at the backside of a hurricane. This phenomenon causes more destruction as storm surge waters are sucked back out to sea.  For more information on flood-related losses from hurricanes see the flood section of the risk assessment.

### Vulnerability of People to Hurricanes

For those who are unable to evacuate for medical reasons, there should be provision to take care of special-needs patients and those in hospitals and nursing homes. Many of these patients have specific pharmaceutical needs or require intensive medical care. There is a need to provide ongoing treatment for these vulnerable citizens, either on the coast or by air evacuation to upland hospitals. The stress from disasters such as a hurricane can result in immediate and long-term physical and emotional health problems among victims.

According to U.S. Census Bureau 2020 American Community Survey, there were 6,969 non-institutionalized persons residing in Hancock County with various disabilities.  There were 35,003 in Harrison County and 24,816 in Jackson County. The types of disabilities include  hearing, vision, cognitive, ambulatory, self-care, and/or independent living difficulties.  Together these counties accounted for a total of 66,788 persons with disabilities who may need assistance in evacuating from a major hurricane.

Total population vulnerability in the high-risk counties has increased for Jackson and Harrison Counties and decreased for Hancock County. **Table 3.5.7** compares the 2012 and 2020 populations.

## Table 3.5.7
## Vulnerable Populations in High-Risk Counties Updated

| County | City | 2012 Population | 2020 Population |
|---|---|---|---|
| Jackson | Pascagoula | 3,524 | 3,202 |
| | Moss Point | 3,370 | 2,449 |
| | Gautier | 2,955 | 2,673 |
| | Ocean Springs | 3,066 | 3,141 |
| | Jackson County (unincorporated area) | 10,136 | 13,351 |
| **Jackson County Totals** | | **23,051** | **24,816** |
| Harrison | Biloxi | 5,605 | 5,986 |
| | Gulfport | 10,417 | 11,372 |
| | Pass Christian | 680 | 996 |
| | D'Iberville | 1,232 | 2,239 |
| | Long Beach | 2,017 | 2,383 |
| | Harrison County | 6,470 | 12,027 |
| **Harrison County Totals** | | **26,421** | **35,003** |
| Hancock | Bay St. Louis | 1,655 | 1,929 |
| | Waveland | 1,446 | 970 |
| | Diamondhead | 1,055 | 1,189 |
| | Hancock County (unincorporated areas) | 2,933 | 2,881 |
| **Hancock County Totals** | | **7,089** | **6,969** |

Source: Based on 2012 and 2020 U.S. Census American Community Survey 5-Year Estimates. Total population includes cities and unincorporated areas

The need for efficient evacuation by Gulf Coast residents in their personally-owned vehicles has been expedited, utilizing the National Weather Service's storm surge model Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Model. Modelers examined the population density of each coastal county, the capability of evacuation roads to handle evacuees, and the topography (which areas would flood first in the event of a hurricane) to establish evacuation zones. These zones identify who should leave and in what order based on which areas are most vulnerable to storm surge. This assignment of evacuation zones enables residents to assess their vulnerability to a hurricane, given their location. Local officials can then call for an evacuation of the particular zone when the need exists.

The model, developed in 2000, has been effectively implemented in the evacuation of people in their vehicles. If used on a timely basis, and given sufficient warning, this SLOSH model is effective in saving lives in the Gulf Coast counties of Hancock, Harrison, and Jackson.

The Mississippi Department of Transportation's (MDOT) Statewide Traffic Management Center (TMC) provides coordinated and timely management of all traffic conditions. In addition to keeping citizens safer and more informed during routine travel, the TMC provides improved emergency event coordination and incident management compared to previous years.

The TMC has enhanced MDOT's ability to respond to traffic-flow impediments resulting from adverse weather, debris in the roadway, and the presence of hazardous materials. MDOT utilizes 260 traffic cameras located throughout the state to accomplish this. Once an incident is detected, the operations staff initiates an appropriate response by coordinating closely with other state and local agencies and disseminating real-time information to emergency responders and the public. In addition, the TMC has helped staff establish close working relationships with similar TMC's in border states to more efficiently coordinate regional responses.

When the Traffic Engineering Desk at the Mississippi Emergency Management Agency (MEMA) is operational, the TMC is capable of relaying incident information to contribute to MEMA's situational awareness. A similar working relationship exists with state and local law enforcement agencies to address any impediments to the flow of traffic during emergencies, especially during evacuation events.

Contraflow is the practice of turning traffic flow in one direction on controlled-access routes during times of emergency evacuation. It was first implemented in Mississippi during Hurricane Katrina. The purpose of contraflow is to quickly and efficiently assist the state of Louisiana in evacuating the greater New Orleans area by reversing southbound lanes of I-55 and I-59 to northbound flow. Contraflow is only implemented when requested by Louisiana and approved by the Governor of Mississippi. After Hurricane Katrina, MDOT's post-disaster evaluation indicated that changes should be made to contraflow to improve operations. The primary improvement included extending the termination point of the I-59 contraflow to just south of Hattiesburg. During Hurricane Katrina, I-59 contraflow in Mississippi extended from the Mississippi/Louisiana state line to just south of Poplarville. Contraflow for I-55 begins in Louisiana and extends into Mississippi to just south of Brookhaven. An evacuation and contraflow map with primary and alternate evacuation routes is provided in Appendix 7.3.5-A.

## Loss of Life from Hurricanes

In general, loss of life and property due to high winds is confined to the coastal area. This loss of life is due to wind-borne glass, building materials, and limbs and shrubs. Upland losses can be attributed to rain damage and flooding as well as tornadoes. Flooded road crossings in upland and coastal areas frequently pose significant risks to the motoring public.

Most deaths due to hurricanes are flood-related. Both coastal and inland flooding are common occurrences with hurricanes and tropical storms. The death toll from Mississippi hurricanes amounts to 391 persons. This includes 238 persons who died in Hurricane Katrina, 152 who died in Hurricane Camille, and two who died in Hurricane Georges. Ninety percent of the deaths in hurricanes involve water-related or flooding deaths. The remaining deaths are due to the impacts of wind and wind-borne projectiles.

Effective warnings and timely evacuation from coastal areas inundated by storm surge have shown a dramatic reduction in deaths. Evacuation ensures that nobody remains present in the hazard area.

## Vulnerability of Natural Resources to Hurricanes

Natural resources are particularly vulnerable to hurricanes. The erosion of the coastline is considerable due to the impact of wind, waves, and debris in a hurricane event. Beaches need to be replenished with appropriate materials to reduce erosion. Storm surge and subsequent erosion of the shoreline lead to the loss of property. The Barrier Islands - Cat, Horn, Petit Bois, and Ship protect the Mississippi Gulf Coast but have experienced damage from earlier events and are at risk of being permanently lost. Inland rivers and lakes can become clogged with wind-blown debris and trees, thus slowing recovery from a hurricane. Obstructions, if not removed, can create conditions favorable for flooding.

Trees that are blown down to the forest floor quickly become a target for infestation from insects that may spread to healthy trees. Water quality may suffer due to unwanted debris and vegetation blown in from a hurricane. Potential debris from fallen trees affected by hurricanes and tornadoes that often accompany them can create wildfires when the area dries sufficiently to allow for burning through lightning or human.

According to research conducted by the U.S.G.S - Historical Changes in the Mississippi-Alabama Barrier-Island Chain and the Roles of Extreme Storms, Sea Level and Human Activities (Robert A. Morton), the islands off the coast of Mississippi are seeing a decline in land mass. These islands provide not only storm protection but also have a high social value for their recreational offerings.

**Figures 3.5.8 to 3.5.11** are provided to show the location of the barrier islands and the changes in their land mass between 1847 to 2007.

**Figure 3.5.8**
**Mississippi Barrier Islands**

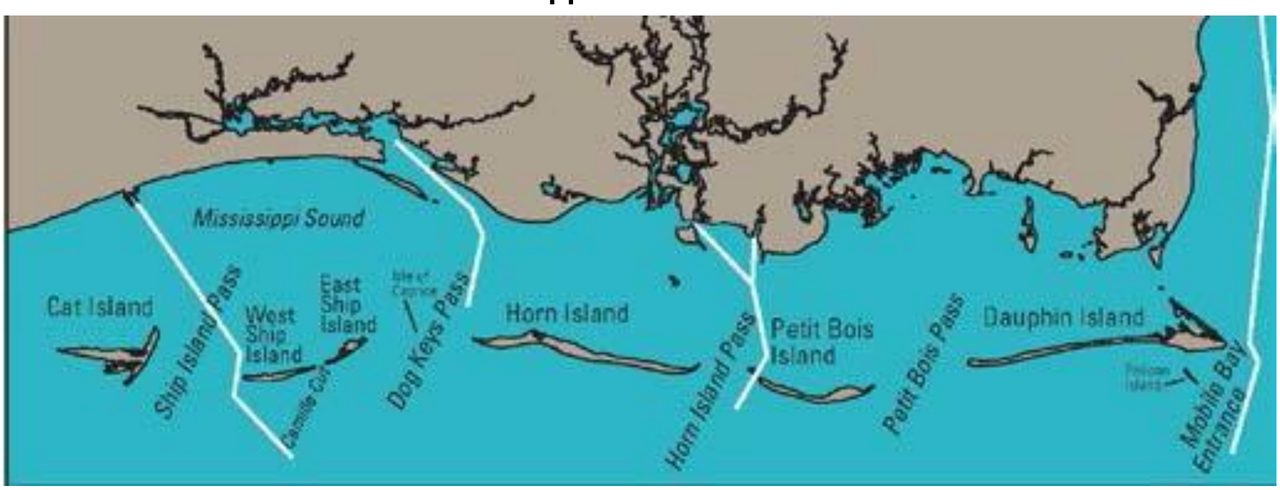
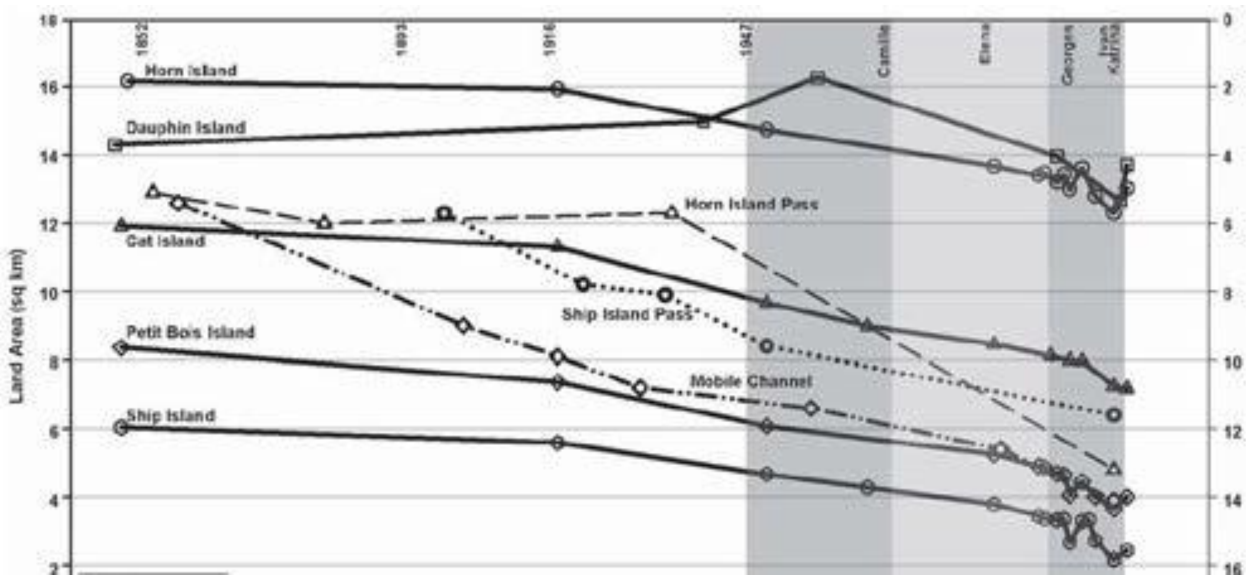
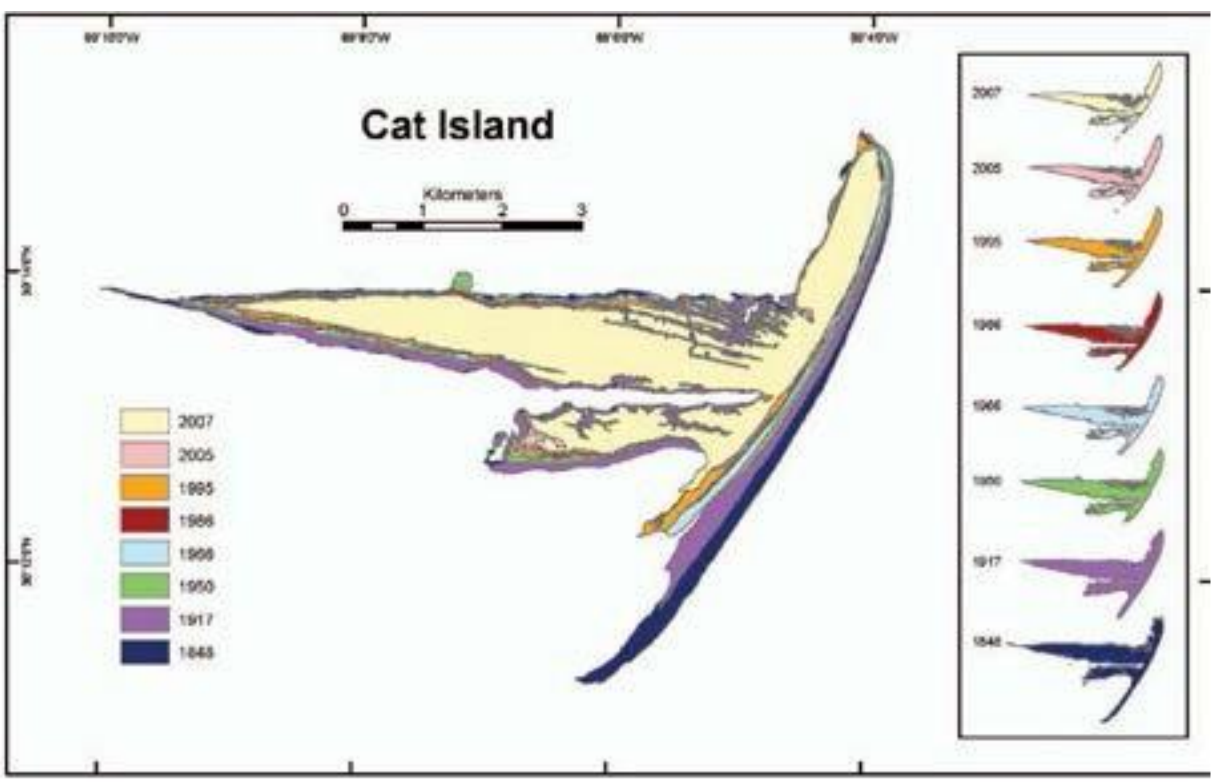
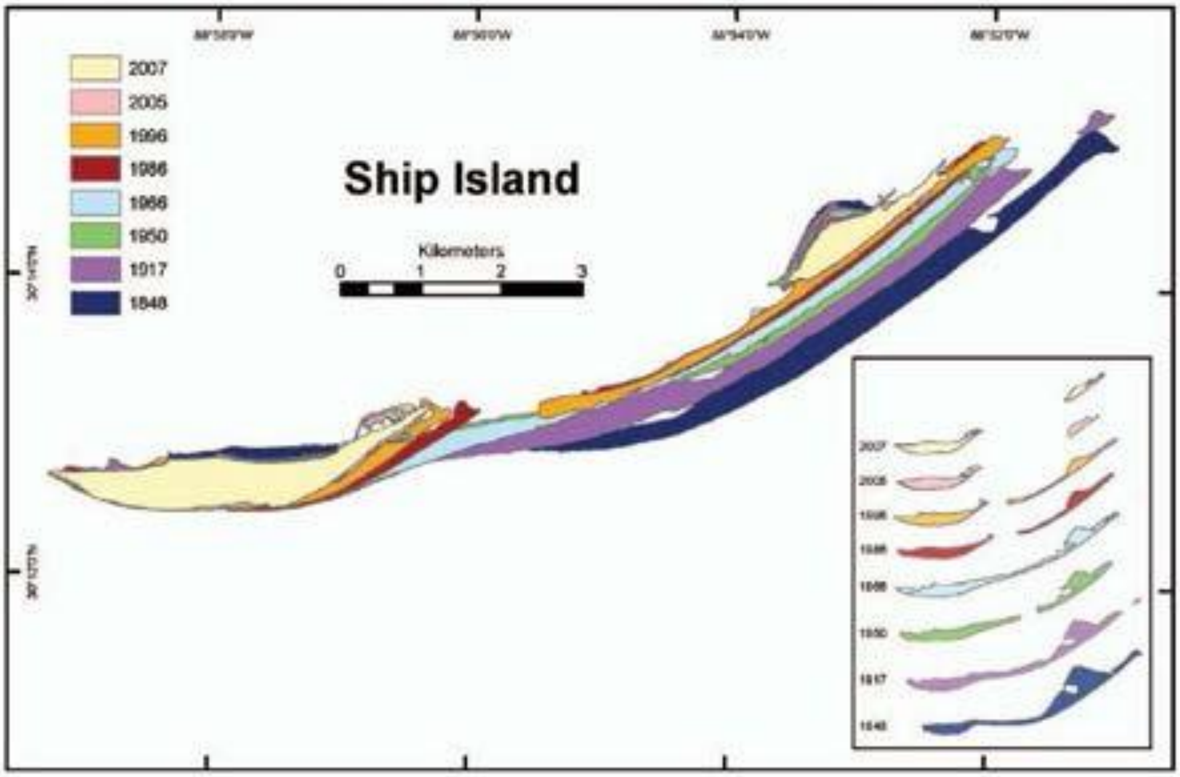


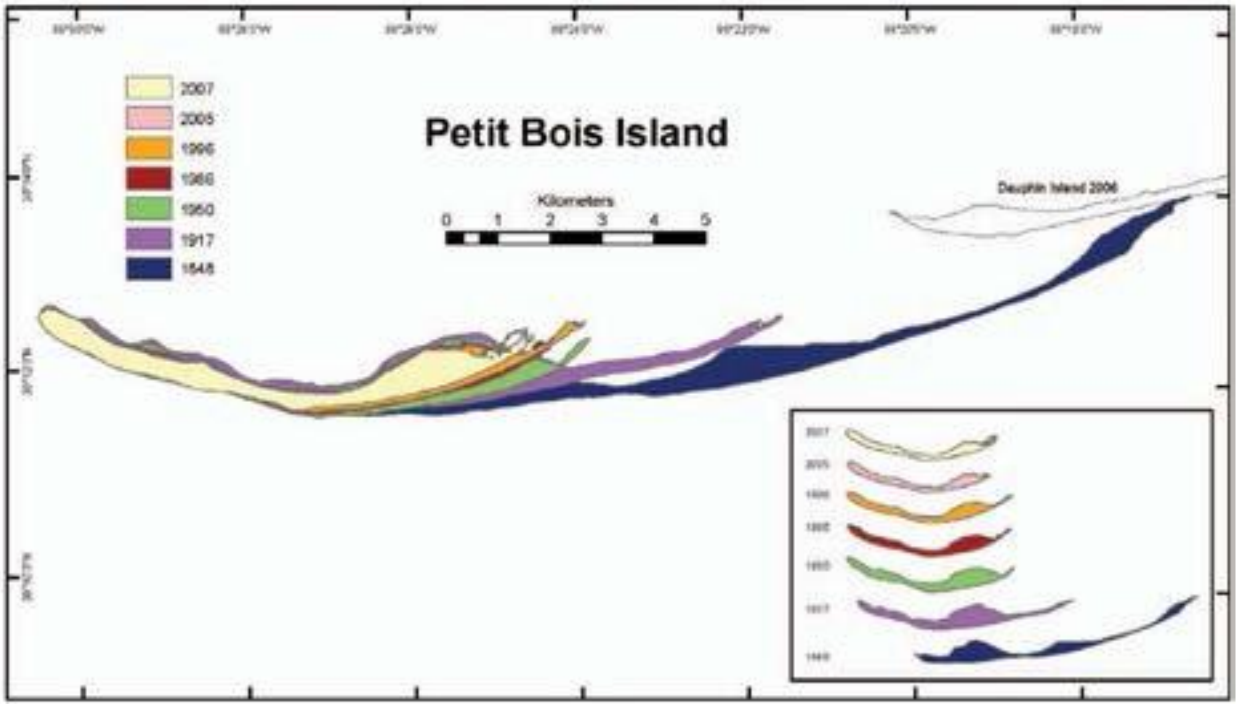
**Figure 3.5.9**
**Historical Land-Loss Trends**

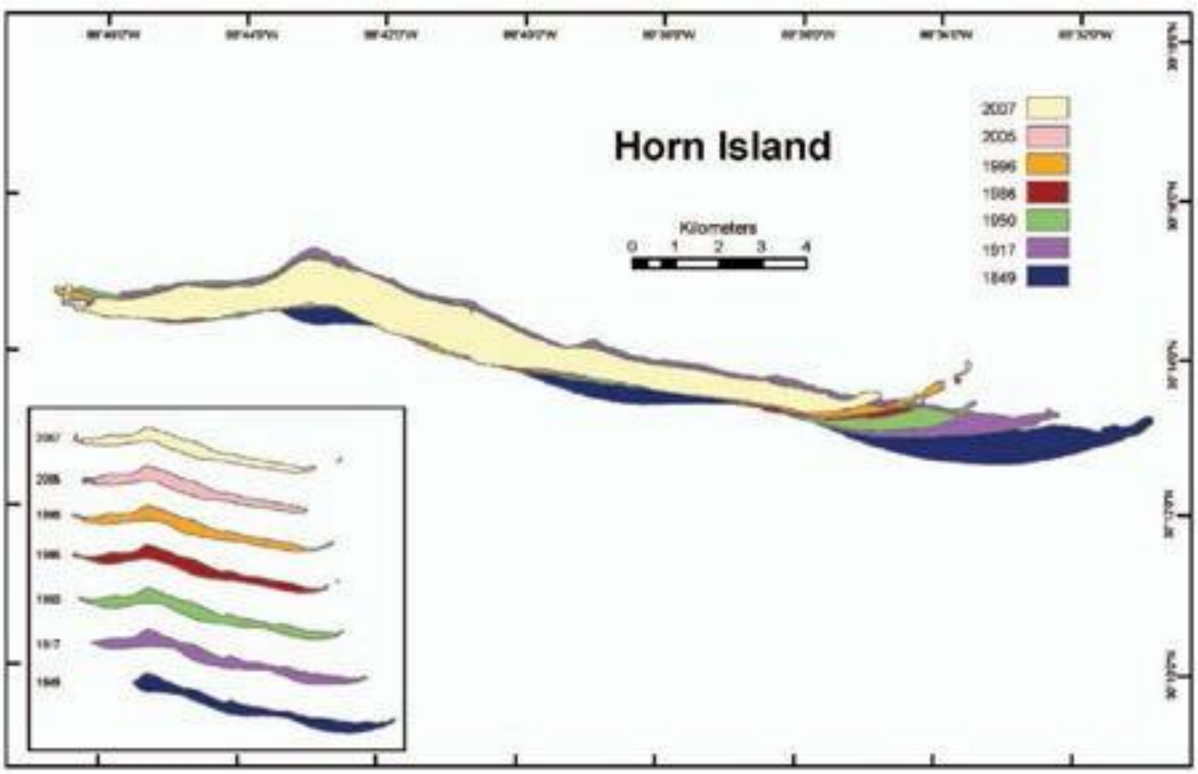



Ship Island
2007
2005
1996
1986
1966
1950
1917
1848
Kilometers
0
1
2
3

**Figures 3.5.11**
**Petit Bois and Horn Islands**



## Vulnerability of Private Improvements to Hurricanes

Homes, businesses, and manufactured homes are especially vulnerable to the effects of a hurricane and the winds, rain, and tornadoes generated by a hurricane. The effects of storm surge can flatten a house.

Although hurricane winds can exert tremendous pressure against homes, a large fraction of hurricane damage is not from the wind itself, but from airborne missiles such as tree limbs and branches, signs and signposts, roof tiles, metal siding, and other pieces of buildings, including entire roofs in major storms. This wind-borne debris penetrates doors and windows and allows the force of the wind to act against interior walls and ceilings not designed to withstand such forces, thus blowing the building apart.

# Local Plan Risk Assessment Summary

Below is a summary of the risk classification identified in the individual local mitigation plans by MEMA Region.

| MEMA Region | Low | Medium | High |
|---|---|---|---|
| 1 | 1 | -- | -- |
| 2 | 1 | -- | - |
| 3 | 1 | -- | -- |
| 4 | -- | 1 | -- |
| 5 | -- | 19 | -- |

| MEMA Region | Low | Medium | High |
|---|---|---|---|
| 6 | - | - | 1 |
| 7 | - | - | 1 |
| 8 | - | 2 | 1 |
| 9 | - | -- | 1 |

## Assessing Vulnerability by Jurisdiction

**Table 3.5.8** provides information on the coastal and inland counties that have been declared in previous hurricanes/tropical storm events to establish frequency and vulnerability to hurricane/tropical storm damage. In Camille and Katrina, for example, central Mississippi counties, as well as coastal counties, received damage. These incidents cover the period from 1969 to 2022. The counties are sorted with those with the greatest number of declarations listed first to the least.

**Table 3.5.8**
**Counties Declared in Hurricane/Tropical Storm Events**

| County | Camille DR-271 | Frederic DR-599 | Elena DR-741 | Georges DR-1251 | T.S. Allison DR-1382 | T.S. Isidore DR-1436 | Ivan DR-1550 | Dennis DR-1594 | Katrina DR-1604 | Gustav DR-11794 | Isaac DR-4081 | Nate DR-4350 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hancock | X | X | X | X | X | X | X | X | X | X | X | X |
| Harrison | X | X | X | X | X | X | X | X | X | X | X | X |
| Jackson | X | X | X | X | X | X | X | X | X | X | X | X |
| Pearl River | X | X | X | X | X | X | X | X | X | X | X | |
| George | X | X | | X | X | X | X | X | X | X | X | X |
| Forrest | X | X | | X | | | X | X | X | X | X | |
| Greene | X | X | | X | | X | X | X | X | | X | X |
| Jones | X | X | | X | X | | X | X | X | | X | |
| Stone | X | X | | | | X | X | X | X | X | X | X |
| Lamar | X | | | X | X | | X | X | X | | X | |
| Perry | X | X | | X | | | X | X | X | | X | |
| Wayne | X | X | | X | | | X | X | X | | X | |
| Covington | X | X | | | | | X | X | X | | X | |
| Jefferson Davis | | | | X | | | X | X | X | X | X | |
| Marion | X | | | X | | | X | | X | X | X | |
| Pike | | | | | X | X | X | | X | X | X | |
| Amite | | | | | | X | X | | X | X | X | |
| Clarke | | X | | | | | X | X | X | | X | |
| Copiah | | | | | | X | X | | X | X | X | |
| Jasper | X | | | | | | X | X | X | | X | |
| Lauderdale | X | | | | | | X | X | X | | X | |
| Rankin | X | | | | | | X | X | X | | X | |
| Simpson | X | | | | | | X | X | X | | X | |
| Smith | X | | | | | | X | X | X | | X | |
| Walthall | X | | | | | | X | | X | X | X | |
| Adams | X | | | | | | X | | X | X | X | |
| Claiborne | | | | | | | X | | X | X | X | |
| Franklin | | | | | | | X | | X | X | X | |
| Hinds | | | | | | | X | X | X | | X | |
| Jefferson | | | | | | | X | | X | X | X | |
| Kemper | | | | | | | X | X | X | | X | |
| Lawrence | | | | | | | X | | X | X | X | |
| Lincoln | | | | | | | X | | X | X | X | |
| Neshoba | | | | | | | X | X | X | | X | |
| Newton | | | | | | | X | X | X | | X | |
| Noxubee | | | | | | | X | X | X | | X | |
| Scott | | | | | | | X | X | X | | X | |
| Wilkinson | | | | | | | X | | X | X | X | |
| Winston | | | | | | | X | X | X | | X | |

| County | Camille DR-271 | Frederic DR-599 | Elena DR-741 | Georges DR-1251 | T.S. Allison DR-1382 | T.S. Isidore DR-1436 | Ivan DR-1550 | Dennis DR-1594 | Katrina DR-1604 | Gustav DR-11794 | Isaac DR-4081 | Nate DR-4350 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Attala | | | | | | | | X | X | | X | |
| Clay | | | | | | | X | X | X | | | |
| Lowndes | | | | | | | X | X | X | | | |
| Leake | | | | | | | | X | X | | X | |
| Madison | | | | | | | | X | X | | X | |
| Monroe | | | | | | | X | X | X | | | |
| Oktibbeha | | | | | | | X | X | X | | | |
| Warren | | | | | | | X | | X | | X | |
| Calhoun | | | | | | | | X | X | | | |
| Carroll | | | | | | | | X | X | | X | |
| Chickasaw | | | | | | | | | X | | X | |
| Choctaw | | | | | | | | | X | | X | |
| Grenada | | | | | | | | | X | | X | |
| Holmes | | | | | | | | | X | | X | |
| Issaquena | | | | | | | | | X | X | | |
| Itawamba | | | | | | | | X | X | | | |
| Lee | | | | | | | | X | X | | | |
| Montgomery | | | | | | | | | X | | X | |
| Pontotoc | | | | | | | | X | X | | | |
| Washington | | | | | | | | | X | X | | |
| Webster | | | | | | | | X | X | | | |
| Yazoo | | | | | | | | | X | | X | |
| Alcorn | | | | | | | | | X | | | |
| Benton | | | | | | | | | X | | | |
| Bolivar | | | | | | | | | X | | | |
| Coahoma | | | | | | | | | X | | | |
| Desoto | | | | | | | | | X | | | |
| Humphreys | | | | | | | | | X | | | |
| Lafayette | | | | | | | | | X | | | |
| Leflore | | | | | | | | | X | | | |
| Marshall | | | | | | | | | X | | | |
| MS Choctaw Indian Reservation | | | | | | | | | | | X | |
| Panola | | | | | | | | | X | | | |
| Prentiss | | | | | | | | | X | | | |
| Quitman | | | | | | | | | X | | | |
| Sharkey | | | | | | | | | X | | | |
| Sunflower | | | | | | | | | X | | | |
| Tallahatchie | | | | | | | | | X | | | |
| Tate | | | | | | | | | X | | | |
| Tippah | | | | | | | | | X | | | |
| Tishomingo | | | | | | | | | X | | | |
| Tunica | | | | | | | | | X | | | |
| Union | | | | | | | | | X | | | |
| Yalobusha | | | | | | | | | X | | | |
| Hurricane Betsy, 1965, is not included as historical data is not available. | | | | | | | | | | | | |

## Assessing Vulnerability by Jurisdiction Methodology/HAZUS-MH Modeling

HAZUS-MH hurricane loss modeling capabilities were used to quantify expected losses to the state and differentiate vulnerability by region. HAZUS-MH can model specific hypothetical or historical scenarios and probabilistic scenarios. Scenario results represent the expected damage from a single hurricane event, while probabilistic scenario results represent the range of probable losses estimated from a 1,000-year simulation of expected hurricane activity. The direct economic loss results for a probabilistic analysis include annualized loss estimates. Annualized losses are the total losses summed over the entire simulation period divided by 1,000 years.

As noted in the previous information on the location of past hurricanes and tropical storms, Mississippi's highest risk of impact is in the coastal counties of Jackson, Hancock, and Harrison. As demonstrated by past events, the impact diminishes as storms move inland, but as witnessed with Katrina, even inland counties can experience damage from hurricanes. Katrina's storm track served as the pattern for the 2018 deterministic scenario.

## State Probabilistic Scenario

To identify potential losses from a hurricane event, a probabilistic scenario was developed from HAZUS-MH.  This analysis evaluates the statistical likelihood that a specific event will occur and what losses and consequences will result. Provided in the tables below are the estimated average yearly losses annualized losses) and the expected distribution of losses (return period). **Appendix 7.3.5-B** contains the detailed HAZUS reports.

**Table 3.5.9**
**Summary Impacts by Building Occupancy Type- 100-year Return**

| Occupancy | Exposure | Percentage of Total |
|---|---|---|
| Residential | $210,772,463 | 75.14% |
| Commercial | $43,001,230 | 15.33% |
| Industrial | $11,641,553 | 4.15% |
| Agriculture | $1,383,000 | 0.49% |
| Religious | $7,032,841 | 2.51% |
| Government | $2,358,594 | 0.84% |
| Education | $4,328,839 | 1.54% |
| **Totals** | **$280,518,520** | **100%** |

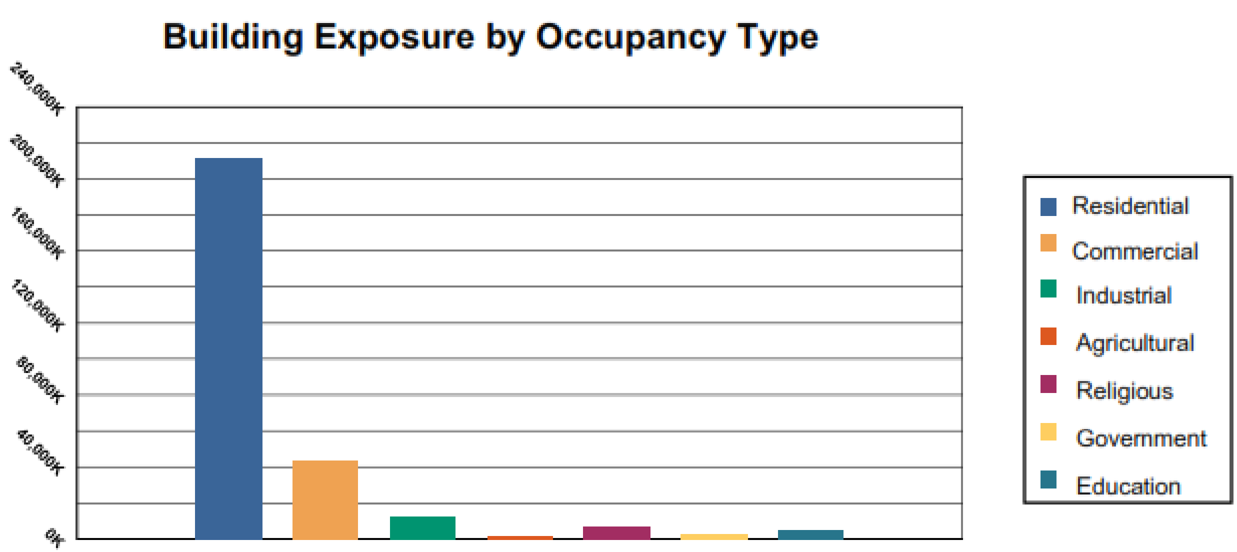
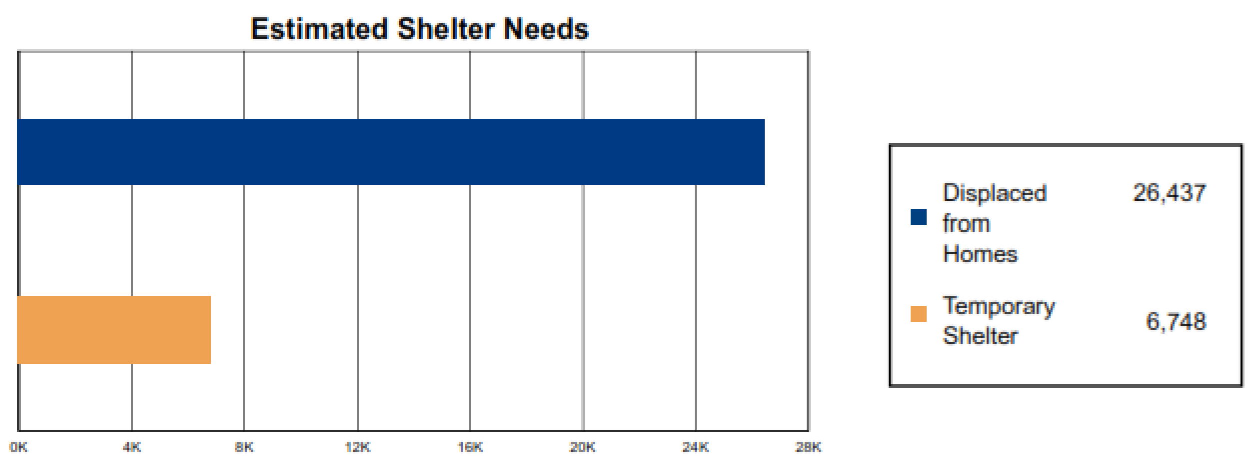


**Table 3.5.10**
**Expected Number of Buildings Damaged by Occupancy: 100-Year Event**

| Occupancy | None | Minor | Moderate | Severe | Destruction |
|---|---|---|---|---|---|
| Residential | 5,139 | 41 | 47 | 80 | 32 |
| Commercial | 61,225 | 1,072 | 1,176 | 1,459 | 96 |
| Industrial | 2,463 | 37 | 41 | 67 | 1 |
| Agriculture | 2,929 | 40 | 45 | 78 | 1 |
| Religious | 15,390 | 230 | 237 | 407 | 15 |
| Government | 8,670 | 117 | 128 | 201 | 7 |
| Education | 1,071,652 | 23,678 | 18,646 | 13,512 | 12,854 |
| **Totals** | 1,167,468 | 25,214 | 20,320 | 15,803 | 13,006 |

HAZUS estimates the number of households that are expected to be displaced from their homes due to the hurricane and the estimated amount of people that may require temporary shelter. The model estimates 26,437 households to be displaced due to the hurricane. Of these, 6,748 people will seek temporary shelter in public shelters.

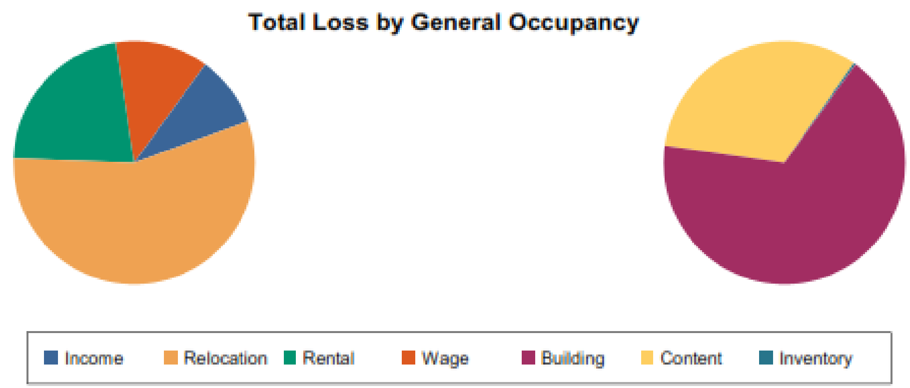


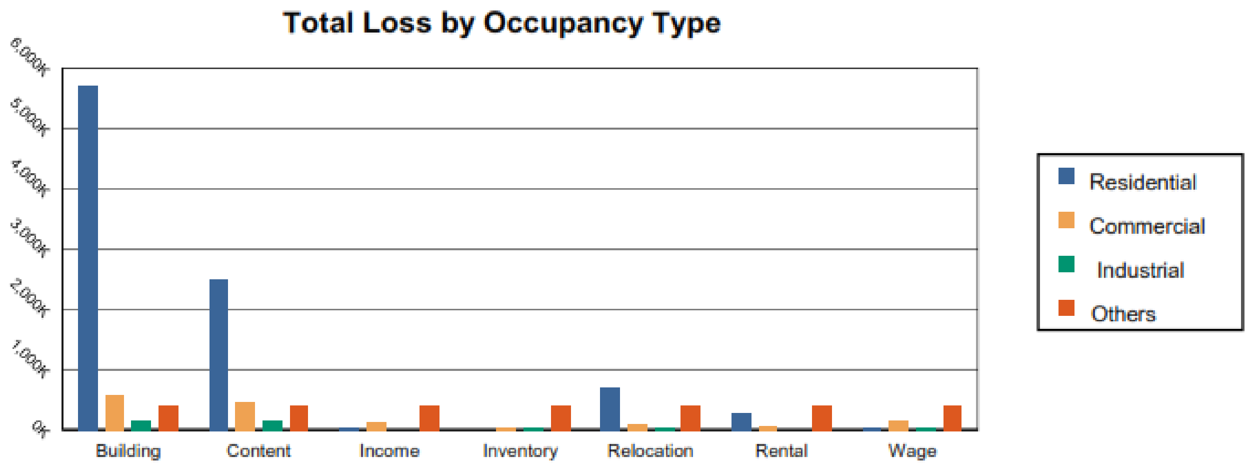

Building-related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. Business interruption losses are the losses associated with the inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include temporary living expenses for those people displaced from their homes because of a hurricane.

HAZUS estimates the total property damage losses at $11,318,000. Three percent of the estimated losses were related to business interruption. The largest loss was sustained by residential occupancies which made up over 81% of the total loss.

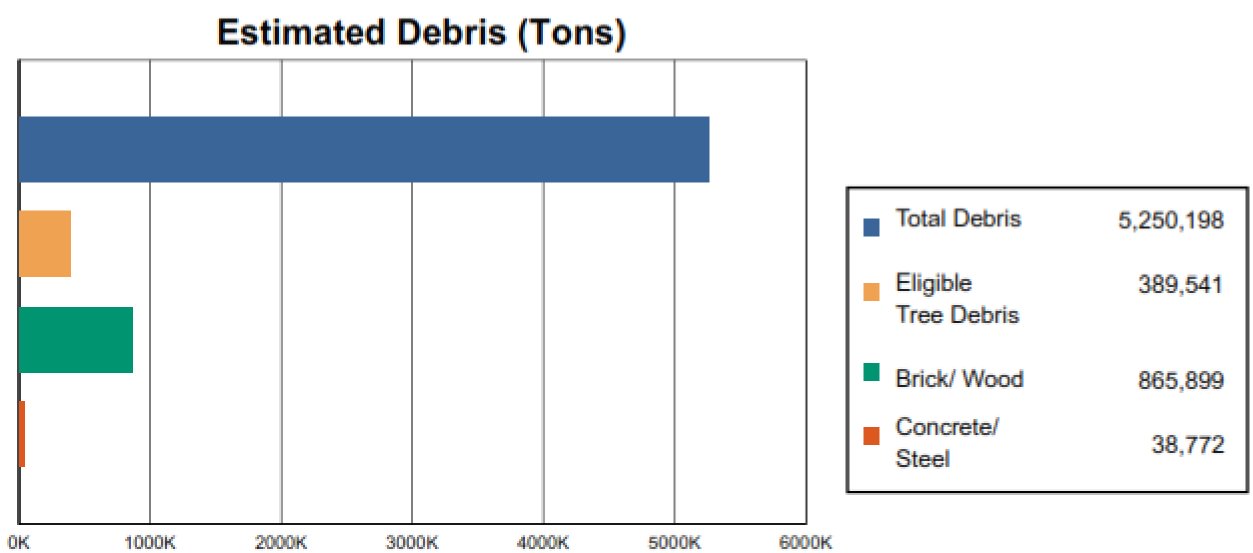
**Table 3.5.11**
**Building Related Economic Loss Estimates: 100-Year Event**

| Occupancy | Property Damage | Business Interruption Loss | Total |
|---|---|---|---|
| Residential | $8,173,663 | $993,814 | $9,167,477 |
| Commercial | $1,023,023 | $397,982 | $1,421,005 |
| Industrial | $329,989 | $20,048 | $350,038 |
| Others | $321,839 | $57,799 | $379,639 |
| **Totals** | $9,848,515 | $1,469,644 | $11,318,160 |





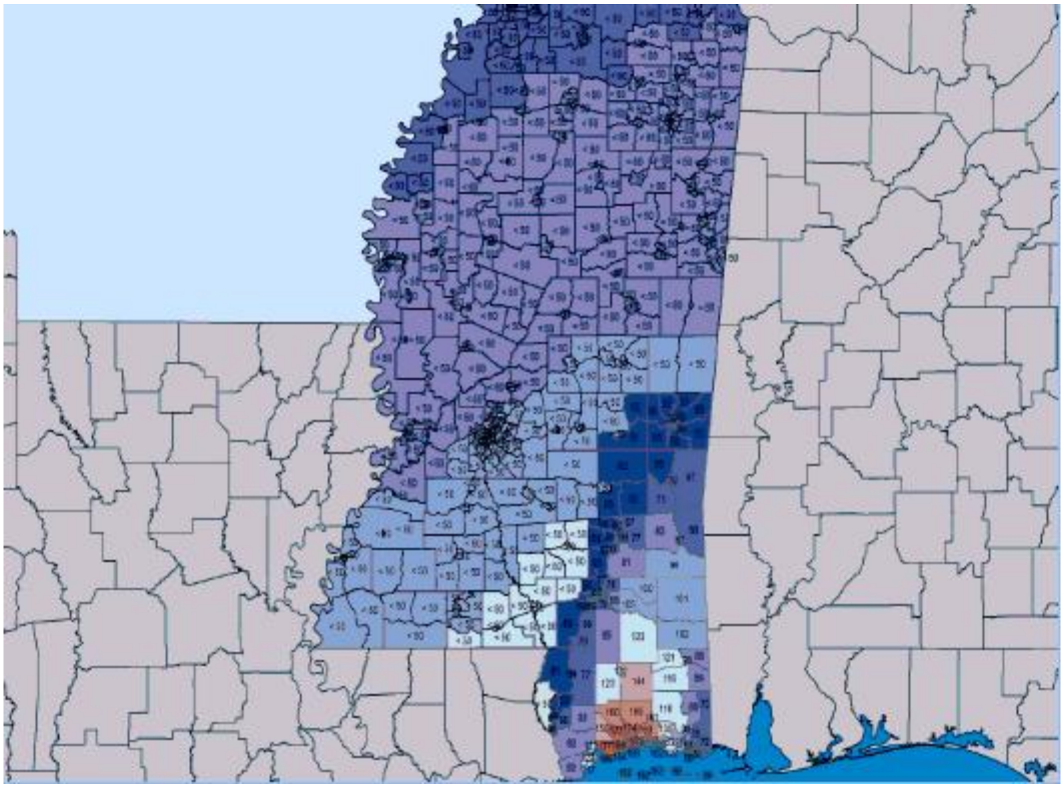

HAZUS estimated the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: brick/wood, reinforced concrete/steel, eligible tree debris, and other tree debris. The model estimates that a total of 5,250,918 tons of debris will be generated. Of the total amount, 3,957,811 tons (75%) is other tree debris. Of the remaining, brick/wood comprises 67% of the total, reinforced concrete/steel comprises 3%, and the remainder is comprised of eligible tree debris.



### Peak Windspeed Forecast

Figure 3.5.12 illustrates the frequency of anticipated peak sustained wind speeds associated with tropical cyclones making landfall in Mississippi. These data were derived us HAZUS-MH probability estimates.

**Figure 3.5.12**
**Peak Windspeed Forecast**
**100-Year Event**



## Hurricane Katrina Scenario (500-Year Event)

### HAZUS General Description

This scenario is based on 47,705.34 square miles and contains 605 census tracts. There are over 1,046,000 households with a total population of 2,844,658 people (2000 Census Bureau data). An estimated 1,282,000 buildings are included in this scenario with a total replacement value (excluding contents) of $159,417,000 (2006 dollars). Approximately 92% of the buildings (and 72% of the building value) are associated with residential housing. Appendix 7.3.5-C contains the detailed HAZUS reports for all 82 counties.

### General Building Stock

HAZUS estimates that there are 1,282,365 buildings included in this scenario which have an aggregate total replacement value of $159,417,000 (2006 dollars). Table 3.5.12 presents the relative distribution of the value concerning the general occupancies for all 82 counties followed by the expected damages by occupancy in **Table 3.5.13.**

**Table 3.5.12**
**Building Exposure by Occupancy Type**

| Occupancy | Exposure ($1000) | Percent of Total |
|---|---|---|
| Residential | $114,980,081 | 72.1% |
| Commercial | 427,348,654 | 17.2% |
| Industrial | $7,456,047 | 4.7% |
| Agricultural | $898,946 | .06% |
| Religious | $4,652,775 | 2.9% |
| Government | $1,527,107 | 1.0% |
| Education | $2,553,782 | 1.6% |
| **Total** | **$159,417,392** | **100.0%** |

HAZUS estimates that about 34,770 buildings will be at least moderately damaged. This is over 3% of the total number of buildings in the state. There are an estimated 1,792 buildings that will be destroyed.

**Table 3.5.13**
**Expected Building Damage by Occupancy**

| | None | | Minor | | Moderate | | Severe | | Destruction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Occupancy | Count | % | Count | % | Count | % | Count | % | Count | % |
| Agriculture | 5,232 | 91.83 | 225 | 3.94 | 136 | 2.39 | 89 | 1.56 | 15 | .27 |
| Commercial | 55,971 | 89.68 | 3,720 | 5.96 | 2,169 | 3.47 | 545 | 0.87 | 9 | 0.01 |
| Education | 2,030 | 91.58 | 111 | 4.99 | 59 | 2.64 | 17 | 0.79 | 0 | 0.00 |
| Government | 2,629 | 92.71 | 126 | 4.45 | 62 | 2.19 | 18 | 0.64 | 0 | 0.00 |
| Industrial | 14,647 | 90.22 | 947 | 5.83 | 488 | 3.01 | 150 | 0.92 | 3 | 0.02 |
| Residential | 1,069,831 | 90.28 | 84,384 | 7.12 | 25,535 | 2.15 | 3,491 | 0.29 | 1,764 | 0.15 |
| **Total** | **1,157,666** | | **89,929** | | **28,621** | | **4,356** | | **1,792** | |

### Essential Facility Damage

In this scenario, the state had 111 hospitals with 17,989 hospital beds available for use. On the day of the hurricane, the number of beds was reduced to 3,064 beds (73%). After one week, 80% of the beds will be in service with 89% operational after 30 days. Table 3.5.15 presents the expected damage to essential facilities statewide.

**Table 3.5.14**
**Expected Damage to Essential Facilities**

| | | Number of Facilities | | |
|---|---|---|---|---|
| Classification | Total | Probability of at least Moderate Damage >50% | Probability of Complete Damage >50% | Expected Loss of Use < 1 Day |
| EOCs | 37 | 0 | 0 | 37 |
| Fire Stations | 399 | 0 | 0 | 399 |
| Hospitals | 111 | 38 | 8 | 85 |
| Police Stations | 368 | 0 | 0 | 368 |
| Schools | 1,288 | 38 | 0 | 1,014 |

## Shelter Requirements

It is estimated that 5,486 households could be displaced due to the scenario of a Katrina-like event. Of these, 1,520 people (out of a total population of 2,844,658) will seek temporary shelter in public safe rooms. Table 3.5.15 provides an individual county detail for MEMA Regions 9, and 8; county totals are given for Regions 7, 6, and 5 with no shelter requirements indicated for Regions 1-4.

**Table 3.5.15**
**Shelter Requirements by MEMA Region**

| MEMA Region/County | | No. of Displaced Households | No. of People Needing Shelter |
|---|---|---|---|
| 9 | George | 22 | 6 |
| | Hancock | 510 | 135 |
| | Harrison | 3,339 | 918 |
| | Jackson | 292 | 72 |
| | Pearl River | 263 | 71 |
| | Stone | 108 | 30 |
| **Total Region 9** | | **4,534** | **1,232** |
| 8 | Covington | 17 | 6 |
| | Forrest | 500 | 163 |
| | Greene | 6 | 2 |
| | Jefferson Davis | 8 | 3 |
| | Jones | 76 | 23 |
| | Lamar | 228 | 58 |
| | Marion | 44 | 13 |
| | Perry | 34 | 10 |
| | Wayne | 3 | 0 |
| **Total Region 8** | | 916 | 278 |
| **County Total Region 7** | | 8 | 3 |
| **County Total Region 6** | | 27 | 7 |
| **County Total Region 5** | | 1 | 0 |

## Building-Related Losses

The following building-related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. Business interruption losses are the losses associated with the inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were $3,139,000 with 3% of the estimated losses related to business interruption. By far, the largest loss was sustained by the residential occupancies which made up over 81% of the total loss. A summary of the statewide impact of the losses associated with the building damage is provided below followed by Table 3.5.17 which provides detailed county data for MEMA Regions 6-9.

## Table 3.5.16
## Statewide Building-Related Economic Loss Estimates

(thousands of dollars)

| Property Damage | | | | | |
|---|---|---|---|---|---|
| **Area** | **Residential** | **Commercial** | **Industrial** | **Others** | **Total** |
| Building | $1,646,525 | $205,475 | $25,778 | $40,066 | $1,917,844 |
| Content | $573,726 | $109,495 | $15,960 | $18,897 | $718,077 |
| Inventory | 0 | $2,416 | $3,655 | $558 | $6,630 |
| **Subtotal** | **$2,220,250** | **$317,387** | **$45,393** | **$59,521** | **$2,641,552** |
| **Business Interruption Loss** | | | | | |
| Income | $3,955 | $26,365 | $453 | $2,724 | $33,497 |
| Relocation | $212,726 | $55,033 | $2,955 | $11,588 | $282,303 |
| Rental | $99,385 | $25,054 | $429 | $1,171 | $126,039 |
| Wage | $9,322 | $30,528 | $745 | $13,861 | $54,457 |
| **Subtotal** | **$325,388** | **$136,980** | **$4,583** | **$29,344** | **$496,295** |
| **Total Losses** | **$2,545,639** | **$454,367** | **$49,976** | **$88,865** | **$3,138,847** |

**Table 3.5.17**
**MEMA Region/County Building-Related Economic Loss Estimates**

| MEMA Region/ County | | Total Property Damage | Total Business Interruption | Total Losses |
|---|---|---|---|---|
| 9 | George | 21,167 | 2,592 | 23,759 |
| | Hancock | 237,561 | 47,245 | 284,807 |
| | Harrison | 1,339,646 | 287,667 | 1,627,312 |
| | Jackson | 211,836 | 29,376 | 1,627,312 |
| | Pearl River | 140,822 | 25,456 | 166,277 |
| | Stone | 47,659 | 9,552 | 57,212 |
| 8 | Covington | 15,365 | 1,996 | 17,361 |
| | Forrest | 205,234 | 42,356 | 247,589 |
| | Greene | 6,751 | 611 | 7,363 |
| | Jefferson Davis | 6,597 | 544 | 7,143 |
| | Jones | 61,853 | 9,519 | 71,371 |
| | Lamar | 111,468 | 21,618 | 133,08 |
| | Marion | 29,969 | 5,262 | 20,061 |
| | Perry | 17,498 | 2,562 | 20,061 |
| | Wayne | 7,661 | 569 | 8,230 |
| 7 | Adams | 87 | 0 | 87 |
| | Amite | 1,048 | 0 | 1,048 |
| | Franklin | 361 | 0 | 361 |
| | Jefferson | 67 | 0 | 67 |
| | Lawrence | 5,233 | 250 | 5,482 |
| | Lincoln | 4,475 | 86 | 4,561 |
| | Pike | 10,220 | 913 | 11,132 |
| | Walthall | 7,448 | 1,000 | 8,448 |
| | Wilkinson | 91 | 0 | 91 |
| 6 | Clarke | 6,280 | 351 | 6,631 |
| | Jasper | 7,188 | 549 | 7,737 |
| | Kemper | 2,674 | 125 | 2,799 |
| | Lauderdale | 33,733 | 2,914 | 36,647 |
| | Leake | 1,869 | 1 | 1,870 |
| | Neshoba | 5,177 | 330 | 5,507 |
| | Newton | 6,008 | 343 | 6,350 |
| | Scott | 4,231 | 247 | 4,479 |
| | Smith | 7,890 | 339 | 8,230 |
| 5 | Simpson | 8,297 | 505 | 8,802 |
| | Claiborne | 47 | 0 | 47 |
| | Copiah | 2,280 | 12 | 2,293 |
| | Hinds | 11,774 | 9 | 11,784 |
| | Issaquena | 0 | 0 | 0 |
| | Madison | 3,752 | 2 | 3,754 |
| | Rankin | 12,307 | 118 | 12,425 |

| MEMA Region/ County | | Total Property Damage | Total Business Interruption | Total Losses |
|---|---|---|---|---|
| | Sharkey | 0 | 0 | 0 |
| | Warren | 24 | 0 | 24 |
| | Yazoo | 19 | 9 | 19 |
| 4 | County Totals | 30,924 | 1,259 | 32,193 |
| 3 | County Totals | 726 | 0 | 726 |
| 2 | County Totals | 8,199 | 3 | 8,201 |
| 1 | County Totals | 33 | 0 | 33 |

### Debris Generation

HAZUS estimates that 12,098,123 tons of debris will be generated from this Katrina scenario. Of the total amount, 10,979,123 tons (91%) is other tree debris. The remaining 1,119,000 tons include 33% of brick/ wood and the remainder is eligible tree debris. A summary of the statewide impact of debris being generated by this scenario is provided below followed by Table 3.5.18 with county-specific data for MEMA Regions 6-9 with county totals for Regions 2-5 (Region 1 did not report any debris generation).

| Statewide Summary of Debris Generation (in tons) | | | | |
|---|---|---|---|---|
| Brick, Wood and Other | Reinf. Concrete and Steel | Eligible Tree Debris | Other Tree Debris | Total |
| 369,224 | 1,963 | 747,813 | 10,979,123 | 12,098,123 |

**Table 3.5.18**
**MEMA Region/County Debris Generation**

| MEMA Region/ County | | Brick, Wood , and Other | Reinf. Concrete and Steel | Eligible Tree Debris | Other Tree Debris | Total |
|---|---|---|---|---|---|---|
| 9 | George | 3,022 | 3 | 14,894 | 340,564 | 358,483 |
| | Hancock | 34,941 | 268 | 57,758 | 584,794 | 677,761 |
| | Harrison | 177,734 | 1,236 | 146,861 | 800,204 | 1,126,035 |
| | Jackson | 30,5711 | 84 | 58,891 | 494,667 | 583,707 |
| | Pearl River | 20,936 | 127 | 56,891 | 889,281 | 967,235 |
| | Stone | 7,337 | 52 | 31,254 | 685,186 | 723,829 |
| **County Region 9 Totals** | | **274,541** | **1,770** | **366,043** | **3,794,696** | **4,437,050** |
| 8 | Covington | 2,589 | 2 | 14,311 | 257,730 | 274,632 |
| | Forrest | 34,778 | 100 | 54,230 | 569,558 | 658,666 |
| | Greene | 1,046 | 0 | 12,453 | 350,928 | 364,427 |
| | Jefferson Davis | 1,102 | 0 | 8,408 | 201,782 | 211,292 |
| | Jones | 10,191 | 5 | 32,042 | 451,469 | 493,708 |
| | Lamar | 17,378 | 77 | 44,388 | 608,394 | 670,237 |
| | Marion | 5,210 | 5 | 21,052 | 430,211 | 456,478 |

| MEMA Region/ County | | Brick, Wood , and Other | Reinf. Concrete and Steel | Eligible Tree Debris | Other Tree Debris | Total |
|---|---|---|---|---|---|---|
| | Perry | 2,872 | 3 | 25,330 | 727,625 | 755,830 |
| | Wayne | 945 | 0 | 11,637 | 340,081 | 352,663 |
| **County Region 8 Totals** | | **76,111** | **192** | **223,851** | **3,937,778** | **4,237,933** |
| 7 | Adams | 0 | 0 | 0 | 0 | 0 |
| | Amite | 37 | 0 | 1,450 | 46,894 | 48,381 |
| | Franklin | 5 | 0 | 544 | 17,599 | 18,148 |
| | Jefferson | 0 | 0 | 0 | 0 | 0 |
| | Lawrence | 535 | 0 | 5,795 | 155,733 | 162,063 |
| | Lincoln | 400 | 0 | 3,566 | 72,680 | 76,646 |
| | Pike | 1,354 | 0 | 7,534 | 111,876 | 120,764 |
| | Walthall | 1,415 | 1 | 8,590 | 192,624 | 202,630 |
| | Wilkinson | 0 | 0 | 285 | 9,219 | 9,504 |
| **County Region 7 Totals** | | **3,746** | **1** | **27,764** | **606,625** | **638,136** |
| 6 | Clarke | 694 | 0 | 10,009 | 255,369 | 266,072 |
| | Jasper | 950 | 0 | 11,260 | 292,087 | 304,297 |
| | Kemper | 251 | 0 | 6,707 | 216,857 | 223,815 |
| | Lauderdale | 4,476 | 0 | 20,645 | 268,414 | 293,535 |
| | Leake | 92 | 0 | 1,478 | 38,999 | 40,569 |
| | Neshoba | 455 | 0 | 4,330 | 91,059 | 95,844 |
| | Newton | 687 | 0 | 5,888 | 144,566 | 151,141 |
| | Scott | 379 | 0 | 3,765 | 94,916 | 99,060 |
| | Smith | 825 | 0 | 9,490 | 255,305 | 265,620 |
| **County Region 6 Totals** | | **8,809** | **0** | **73,572** | **1,657,572** | **1,739,953** |
| 5 | **County Totals** | **2,479** | **0** | **21,802** | **311,702** | **335,983** |
| 4 | **County Totals** | **3,135** | **0** | **25,385** | **524,149** | **552,669** |
| 3 | **County Totals** | **19** | **0** | **978** | **28,025** | **29,022** |
| 2 | **County Totals** | **384** | **0** | **8,415** | **118,578** | **127,377** |

## Assessing the Vulnerability of State Facilities/Estimating Potential Losses

### Methodology for Assessing Vulnerability of State Facilities

The methodology and HAZUS runs for assessing the vulnerability of state facilities were updated for the 2018 plan. State plan developers used the HAZUS-MH Level 1 scenario to assess the vulnerability of State-owned critical or operated facilities located in hurricane-hazard areas.

The HAZUS-MH scenario provided damage states and loss estimates for government buildings. As stated in the section on Critical Facilities and Infrastructure at the beginning of the risk assessment, Critical Facilities are addressed under the category of Essential Facilities.

The HAZUS-MH scenarios returned a probability of expected damages to essential facilities. In the absence of damage and loss information for the HAZUS-MH categories as noted above, plan developers decided to total the value of the overall State asset inventory for each region to show the vulnerability.

With the limitations noted below, the table provides a clear picture of the losses that could be sustained from a 100-year event. Apparent in the data is the very high vulnerability of state-owned or operated facilities in the three coastal counties and the diminishing vulnerability of such as the storms moved northward.

### Data Limitations:

For the category of government buildings, HAZUS-MH does not distinguish between federal, state, or local ownership or building operation. Nor does it distinguish between federal, state, local, or private ownership in the three other categories of facilities addressed in the assessment. Therefore, all facilities regardless of ownership are included in the assessment.

The state of Mississippi does not have a comprehensive list of state-owned or operated buildings, critical facilities, and infrastructure sorted by county that could be input into HAZUS-MH to conduct a Level 2 analysis. During the 2018 update state facilities data was available in tabular form from MEMA, but did not include XY coordinates, and thus could not be incorporated into HAZUS-MH.

### 100-Year Event:

Before the hurricane, the region had 17,989 hospital beds available for use. On the day of the hurricane, the model estimates that 15,513 hospital beds (only 86%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 90% of the beds will be in service. By 30 days, 96% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

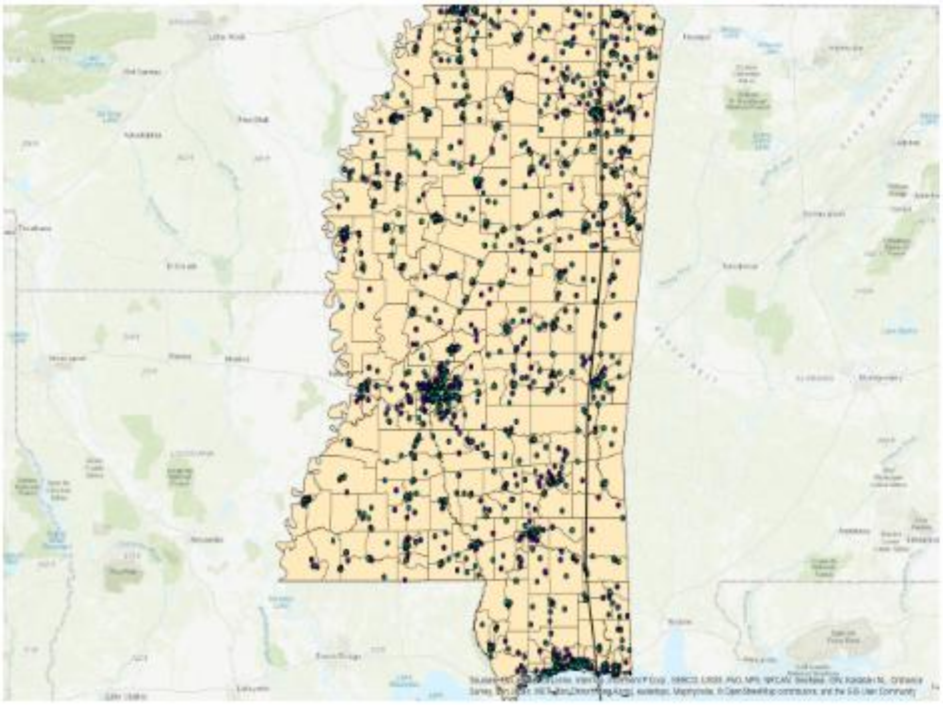


**Table 3.5.19**
**Expected Damages to Essential Facilities**

| Classification | Facilities | | | |
|---|---|---|---|---|
| | Total | Probability of at Least Moderate Damage <50% | Probability of at Least Complete Damage >50% | Expected Loss of Use < 1-Day |
| EOCs | 37 | 0 | 0 | 37 |
| Fire Stations | 399 | 15 | 0 | 390 |
| Hospitals | 111 | 12 | 4 | 100 |
| Police Stations | 368 | 8 | 0 | 362 |
| Schools | 1,288 | 73 | 0 | 1,184 |

**Table 3.5.20**
**Summary of Potential Losses to Essential Facilities**

| Region | Number of Buildings with Available Replacement Values | Total Replacement Value (as available) |
| --- | --- | --- |
| MEMA Region 1 | 171 | $57,356,843 |
| MEMA Region 2 | 331 | $156,546,716 |
| MEMA Region 3 | 552 | $256,299,605 |
| MEMA Region 4 | 134 | $27,175,900 |
| MEMA Region 5 | 1,335 | $2,648,653,307 |
| MEMA Region 6 | 918 | $813,681,823 |
| MEMA Region 7 | 247 | $79,618,031 |
| MEMA Region 8 | 455 | $286,676,990 |
| MEMA Region 9 | 268 | $215,287,139 |