2

Hazard Identification and Statewide Risk Assessment

State Hazard Mitigation Requirements

The FEMA State Mitigation Plan Review Guide asks the following:

Does the risk assessment provide an overview of the probabilities of future hazard events? [44CFR §201.4(c)(2)(i)]

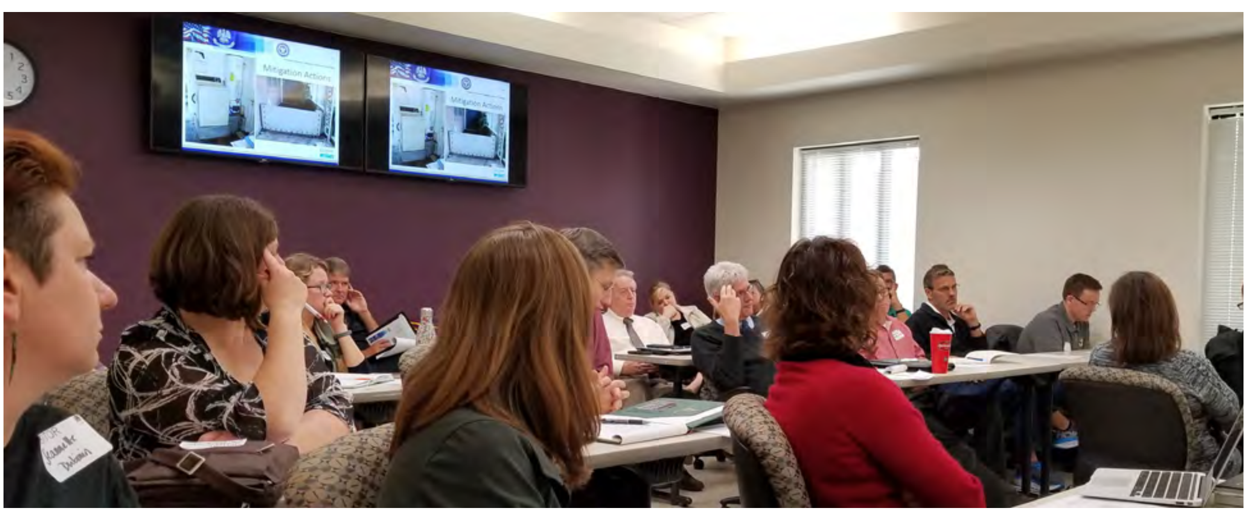
Does the risk assessment address the vulnerability of state assets located in hazard areas and estimate the potential dollar losses to these assets? [44 CFR §§201.4(c)(2)(ii) and 201.4(c)(2)(iii)]

Does the risk assessment include an overview and analysis of the vulnerability of jurisdictions to the identified hazards and the potential losses to vulnerable structures? [44 CFR §§201.4(c)(2)(ii) and 201.4(c)(2)(iii)]

Was the risk assessment revised to reflect changes in development? [44 CFR §201.4(d)]

To answer these questions,
the FEMA State Mitigation Plan Review Guide requires that:

- The risk assessment must provide a summary of the probability of future hazard events that includes projected changes in occurrences for each natural hazard in terms of location, extent, intensity, frequency, and/or duration.
- Probability must include considerations of changing future conditions, including the effects of long-term changes in weather patterns and climate on the identified hazards.
- The risk assessment must include an analysis of the potential impacts of hazard events to state assets and a summary of the assets most vulnerable to the identified hazards. These assets may be located in the identified hazard areas or affected by the probability of future hazard events.
- The risk assessment must estimate potential dollar losses to state assets located in identified hazard areas.
- The risk assessment must provide a current summary of the most vulnerable jurisdictions based on the state, local, and tribal, as applicable, risk assessments. Vulnerability must be analyzed in terms of:
    - Jurisdictions most threatened by the identified hazards (based on hazard location, extent, and probability).
    - Jurisdictions most susceptible to damage and loss from hazard events related to populations and assets (such as, structures, infrastructure, critical facilities, and systems). These populations and assets may be located in the identified hazard areas or affected by the probability of future hazard events.
    - The risk assessment must include a summary of the potential losses to the identified vulnerable structures based on estimates in the local risk assessments as well as the state risk assessment.
    - The risk assessment must address repetitive loss (RL) and severe repetitive loss (SRL) properties.
    - The plan must provide a summary of the changes in development that have occurred or are projected to occur in hazard prone areas based on the state, local, and tribal, as applicable, risk assessments, specifically:
    - Changes in land use and the built environment;
    - Changes in population demographics that may affect vulnerability to hazard events.
    - Changes to the vulnerability of state-owned or operated buildings, infrastructure, and critical facilities.



Hazards Summary

The information in this chapter describes the natural hazards that Louisiana faces and is expected to face in the future. A planning time horizon of 25 years was selected, projecting the potential impacts of natural hazards in the year 2043.

The following table summarizes the information presented in this section across Louisiana. Greater detail is found in this chapter and the Technical Appendix, including maps showing historic and future hazard probabilities and locations of projected losses.

State Asset Risk Assessment

Data from the Louisiana Office of Risk Management show 8,593 state buildings with a total building and contents replacement value of approximately $13 billion. In addition to state-owned assets, a number of historic properties of particular importance are identified. The potential average annual dollar losses for state assets are shown by hazard. A complete loss estimate table for each hazard by parish is provided in the Technical Appendix.

HAZARDS

- Extreme Heat
- Drought
- Wildfire
- Winter Storms
- High Wind
- Hailstorms
- Lightning
- Tornadoes
- FLooding
- Dam Failure
- Earthquake
- Sinkholes
- Expansive Soil

Extreme Heat

Past HIstory: 1 to 45 days per year (on average) with temperatures exceeding 95 degrees F

Projected Change by 2043: +20% days over 95 degees F

2043 Probability: Up to 55 days per year (on average) with temperatures exceeding 95 degrees F

Projected 2043 Average Annual Statewide Loss: $744,345

Estimated State Asset Annual Average Loss: $N/A

Drought

Past HIstory: 8 to 16 weeks of drought conditiions per year (16% to 31% weekly probability)

Projected Change by 2043: +25% probability of occurence

2043 Probability: 17% to 39% weekly probability of drought

Projected 2043 Average Annual Statewide Loss: $52,795,132

Estimated State Asset Annual Average Loss: $N/A

Wildfire

Past HIstory: More than 15,000 wildfires in past 11 years, 0% to 9.6% annual probability

Projected Change by 2043: +25% probability of occurence

2043 Probability: 0 to 12% annual probability

Projected 2043 Average Annual Statewide Loss: $5,876,211

Estimated State Asset Annual Average Loss: $157,889

Winter Storms

Past HIstory: 1 to 56 days per year (on average) with temperatures less than 32 degrees F

Projected Change by 2043: -20% days under 32 degrees F

2043 Probability: 1 to 45 days per year (on average) with temperatures less than 32 degrees F

Projected 2043 Average Annual Statewide Loss: $38,134,715

Estimated State Asset Annual Average Loss: $1,189,351

High Wind

Past HIstory: 700-year return period (0.14% annual probability) wind speeds ranging from 105mph to 170 mph

Projected Change by 2043: No projected change

2043 Probability: 700-year return period (0.14% annual probability) wind speeds ranging from 105mph to 170 mph

Projected 2043 Average Annual Statewide Loss: $N/A

Estimated State Asset Annual Average Loss: $N/A

Hail Storm

Past HIstory: 1 to 7 days per year (on average) experiencing hail >.75 inches in diameter

Projected Change by 2043: +10% days with hail

2043 Probability: 1 to 6 days per year (on average) experiencing hail >.75 inches in diameter

Projected 2043 Average Annual Statewide Loss: $2,086,269

Estimated State Asset Annual Average Loss: $64,803

Lightning

Past HIstory: 0 to 27 lightning flashes per square mile per year

Projected Change by 2043: +10% increase in flash intensity

2043 Probability: 0 to 30 lightning flashes per square mile per year

Projected 2043 Average Annual Statewide Loss: $2,920,890

Estimated State Asset Annual Average Loss: $94,702

Tornadoes

Past HIstory: 0 to 1.6 tornado touchdown days within 25 miles per year

Projected Change by 2043: +10% probability of occurrence

2043 Probability: 0 to 1.9 tornado touchdown days within 25 miles per year

Projected 2043 Average Annual Statewide Loss: $34,917,236

Estimated State Asset Annual Average Loss: $1,089,364

Flooding

Past HIstory: 100-year return period (1% annual probability) flood depths ranging from 0 ft to XX ft

Projected Change by 2043: No projected change

2043 Probability: 100-year return period (1% annual probability) flood depths ranging from 0 ft to XX ft

Projected 2043 Average Annual Statewide Loss: $Not yet complete

Estimated State Asset Annual Average Loss: $Not yet complete

Dam Failure

Past HIstory: One threatened out-of-state dam failure

Projected Change by 2043: No projected change

2043 Probability: .01% annual probability of failure

Projected 2043 Average Annual Statewide Loss: $Not Yet Complete

Estimated State Asset Annual Average Loss: $Not yet complete

Levee Failure

Past HIstory: Failures during 2005 Hurricane Katrina in New Orleans (0.006% annual probability)

Projected Change by 2043: No projected change

2043 Probability: .006% annual probability

Projected 2043 Average Annual Statewide Loss: $Due to the small probability of levee failure in Louisiana, losses were not estimated

Estimated State Asset Annual Average Loss: $N/A

Earthquake

Past HIstory: 5 minor earthquakes in past 25 years (20% annual probability statewide)

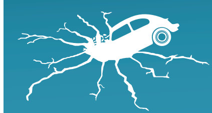
Projected Change by 2043: +10% probability of occurence

2043 Probability: .22% annual probability statewide

Projected 2043 Average Annual Statewide Loss: Due to the minor nature of earthquakes in Louisiana, losses were not estimated

Estimated State Asset Annual Average Loss: $N/A

Sinkholes



Past HIstory: 2 sinkholes in 70 years from 174 salt domes (0.01% annual probability)

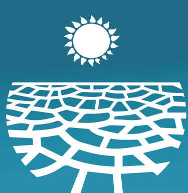
Projected Change by 2043: +10% probability of occurence

2043 Probability: 0.02% annual probability

Projected 2043 Average Annual Statewide Loss: $219,914

Estimated State Asset Annual Average Loss: $955,295

Expansive Soil



Past HIstory: N/A

Projected Change by 2043: No projected change

2043 Probability:

Projected 2043 Average Annual Statewide Loss: $316,603,969

Estimated State Asset Annual Average Loss: $8,506,998

TOTAL State Property Average Annual Loss:

$12,058,403

Risk Assessment Summary

The statewide annual average loss for each hazard is shown below and summed for the state, excluding flood hazard losses, which represent the 1% annual chance event rather than average annual loss. Parish level loss estimates are provided in the Technical Appendix.

The most vulnerable jurisdictions for each of the hazards are shown visually on maps included in each of the hazard sections. The top 5 jurisdictions most susceptible to damage and loss from each of the identified hazards are listed in the following table, with 1 being the most susceptible. A complete loss estimate table for each hazard by parish is provided in the Technical Appendix.

Projected Average Annual Loss in 2043	**Building Average Annual Loss**	**Crop Average Annual Loss**	**Total Average Annual Loss**
Extreme Heat	-	$744,345	$744,345
Drought	-	$52,795,132	$52.795,132
Wildfire	$5,876,211	-	$5,876,211
Extreme Cold	$36,978,826	$1,155,889	$38,134,715
Wind	$642,927,351	-	$642,927,351
Hail	$1,976,212	$110,057	$2,086,269
Lightning	$2,917,407	$3,483	$2,920,890
Tornado	$31,725,662	$281,804	$32,007,466
Flood	$451,389,758	-	$451,389,758 - 1% annual chance event
Dam Failure	$1,011,414	-	$1,011,414
Sinkhole	$342,071	-	$342,071
Expansive Soil	$92,869,675	-	$92,869,675
Total Average Annual Projected Loss	**$816,624,830**	**$55,090,711**	**$818,176,063** (excludes flood loss)

	1.	2.	3.	4.	5.
Extreme Heat	Franklin	Richland	St.Landry	Tensas	Caddo
Drought	Vermilion	St.Landry	Franklin	Acadia	Richland
Wildfire	St Tammany	Tangipahoa	Orleans	Livingston	East Baton Rouge
Extrme Cold	Ouachita	Caddo	St.Tammany	East Baton Rouge	Bossier
Wind	Orleans	Jefferson	St.Tammany	Lafayette	Terrebonne
Hail	Orleans	East Baton Rouge	Caddo	Bossier	St.Tammany
Lightning	Orleans	East Baton Rouge	Jefferson	St.Tammany	Lafayette
Tornado	Orleans	Lafayette	Jefferson	East Baton Rouge	Caddo
Flood	St.Tammany	Jefferson	Terrebonne	Orleans	East Baton Rouge
Dam Failure	Bossier	Rapides	Caddo	Natchitoches	Grant
Sinkhole	Calcasieu	St.Martin	Acadia	St.Mary	Plaquemines
Expansive Soil	Orleans	Jefferson	St.Tammany	East Baton Rouge	Lafayette
Total Losses	Orleans	Jefferson	St.Tammany	Terrebonne	East Baton Rouge

Critical Facilities and State Asset Risk Assessment Summary

Critical Facilities. Data from FEMA Hazus-MH were used to identify critical facilities throughout the state, defined as fire stations, hospitals, police stations, and emergency response centers. Considering the projected damage from all hazards, critical facilities were assigned as low vulnerability (total annual probability of damage <0.5%), moderate vulnerability (total annual probability of damage 0.5% to 1.0%), or high vulnerability (total annual probability of damage >1%).

State Assets. Data from the Louisiana Office of Risk Management show 8,593 state-owned properties with a total building and contents replacement value of approximately $13 billion. The expected number of state-owned properties for the given annual loss ranges and the potential average annual dollar losses are shown by hazard. A complete loss estimate table for state assets for each hazard by parish is provided in the Technical Appendix. In addition to state-owned assets, a number of historic properties of particular importance are identified. Hazard exposure data are provided for the historic structures in the Technical Appendix.

Expected number of state assets for given annual loss						**Projected 2043 Average Annual State Asset Losses**
Hazard	>$100,000	$25,000-$100,000	$5,000-$25,000	$500-$5,000	<$500	
Wildfire	0	0	0	22	8,571	$157,889
Extreme Cold	0	0	6	213	8,374	$1,189,351
Wind	11	42	170	760	7,610	$20,544,070
Hail	0	0	1	2	8,590	$64,803
Lightning	0	0	2	4	8,587	$94,702
Tornado	1	1	5	157	8,429	$973,424
100-Year Flood	4	28	128	508	7,925	$9,138,278 (1% annual chance loss)
Dam Failure	0	0	0	10	8,583	$12,955
Sinkhole	0	0	0	0	8,593	$2,624
Expansive Soil	2	1	21	120	8,449	$3.211,214

2043 Vulnerability of Critical Facilities

2017

State Building Locations in Louisiana

2017 State Historic Preservation Office (SHPO) Properties Location in Louisiana

Changes in Development

PARISH-LEVEL POPULATION

Based on land cover data for the state and major urban areas, urban growth in previously rural locations was limited in the last 12 years, with the majority of urban areas established in Louisiana by 2001. Recent development primarily occurred in outlying metro areas of Shreveport, Monroe, Alexandria, Lake Charles, Lafayette, Houma, Baton Rouge, and New Orleans. The population of Louisiana was 4,533,372 in the 2010 census, and is projected to grow to 5,518,889 by 2043. Due to data limitations, loss projections are based on densification of currently populated areas. Additional analysis of development patterns and areas is recommended prior to the next plan update in order to more accurately forecast future populations and development.

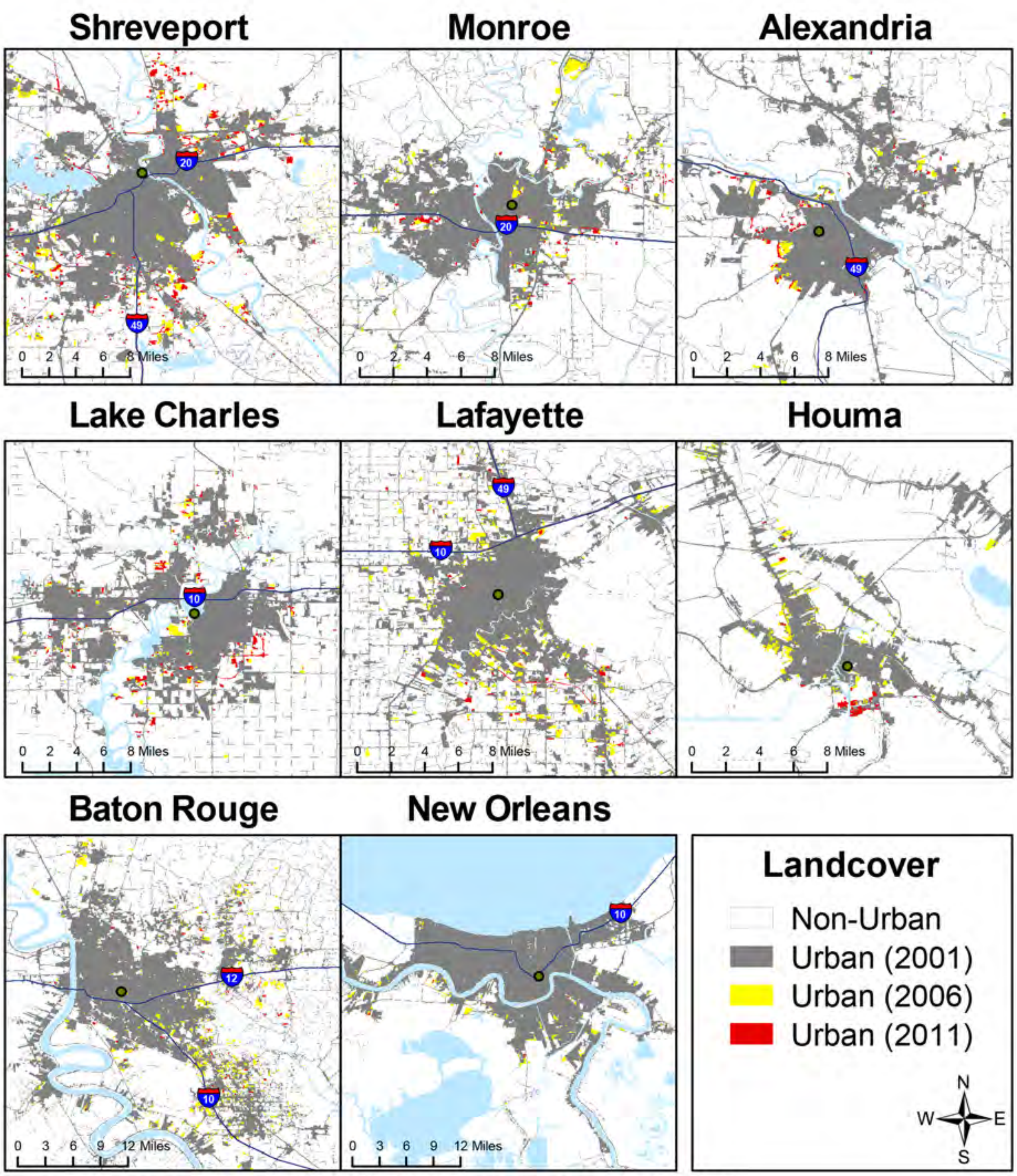
VULNERABLE POPULATIONS

The rates of growth of vulnerable populations were determined based on American Community Survey (ACS) 5-year estimates for population age, disability, poverty status, and manufactured homes from 2010 to 2016. The parishes with the highest sum of vulnerable population growth rates, indicating a greater likelihood of future increase in demographic vulnerability, are Beauregard, Vernon, Tangipahoa, Ascension, Plaquemines, and Terrebonne Parishes. A full listing of changes in vulnerable populations is provided in the Technical Appendix.

2001-
-2011

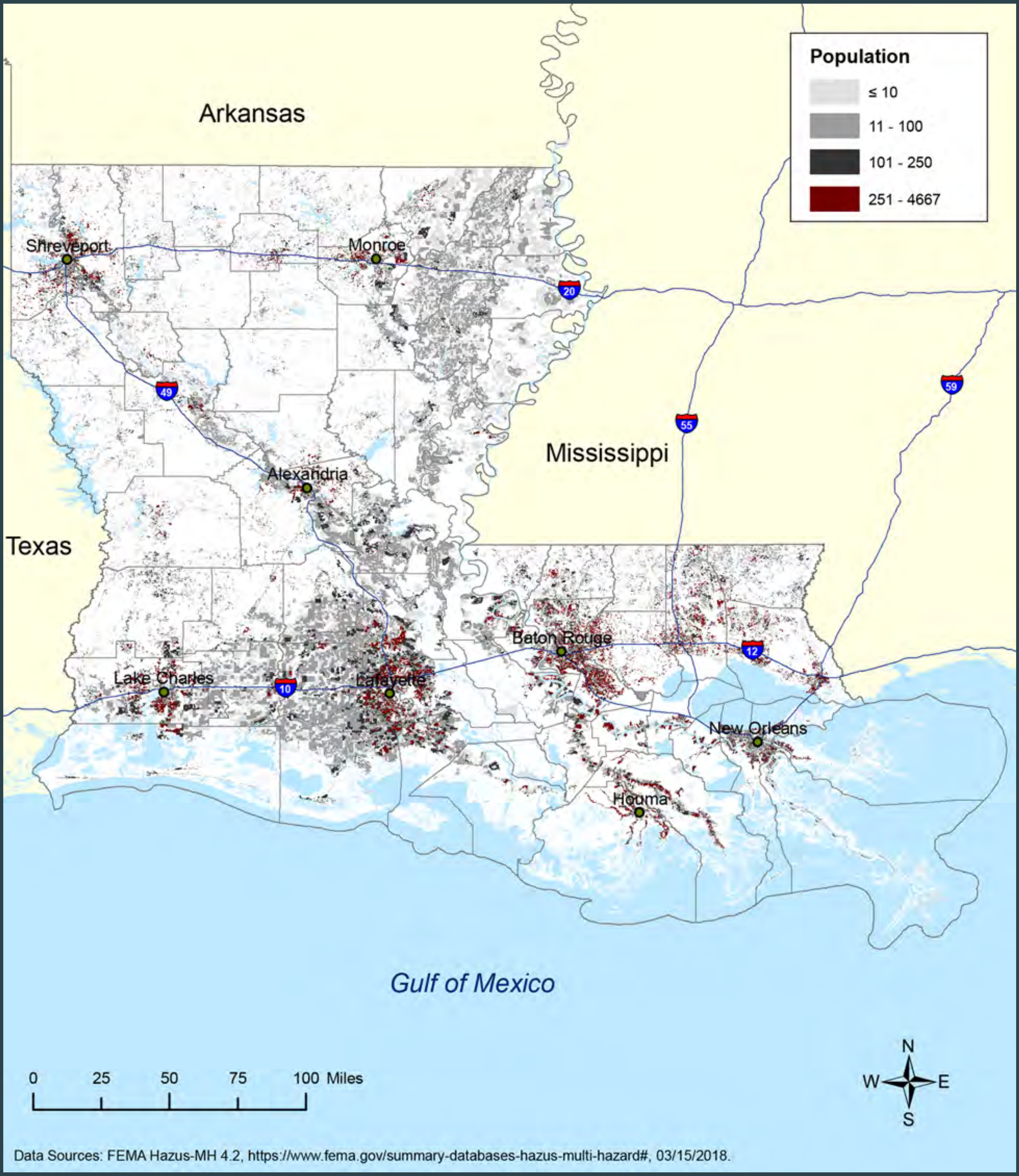
Urban Landcover Change

2001--2011 Major Urban Centers Landcover Change



Data Source: National Land Cover Database (NLCD) 2001; 2006; 2011, https://www.mrlc.gov/index.php, 3/22/2018.

2043 Projected Population Distribution at Census Block



Risk Assessment Organization

The following sections depict the locations of historical hazards using maps created through analysis of previous occurrences. These data and maps were analyzed to determine annual probability of occurrence or number of days per year for each hazard where appropriate. Anticipated hazard maps, reflecting hazard conditions in the year 2043, were developed using the historical data and evaluation of future conditions, which are described in the Technical Appendix for each hazard. The 2043 hazard maps are used in the risk assessment for each hazard to estimate the annual losses expected to occur in Louisiana 25 years from now.

Temperature Hazards

Hazards in Louisiana related to temperature include extreme heat, drought, wildfire, and extreme cold. The following sections contain a discussion of each of these hazards as well as a risk assessment.

Extreme heat

OVERVIEW

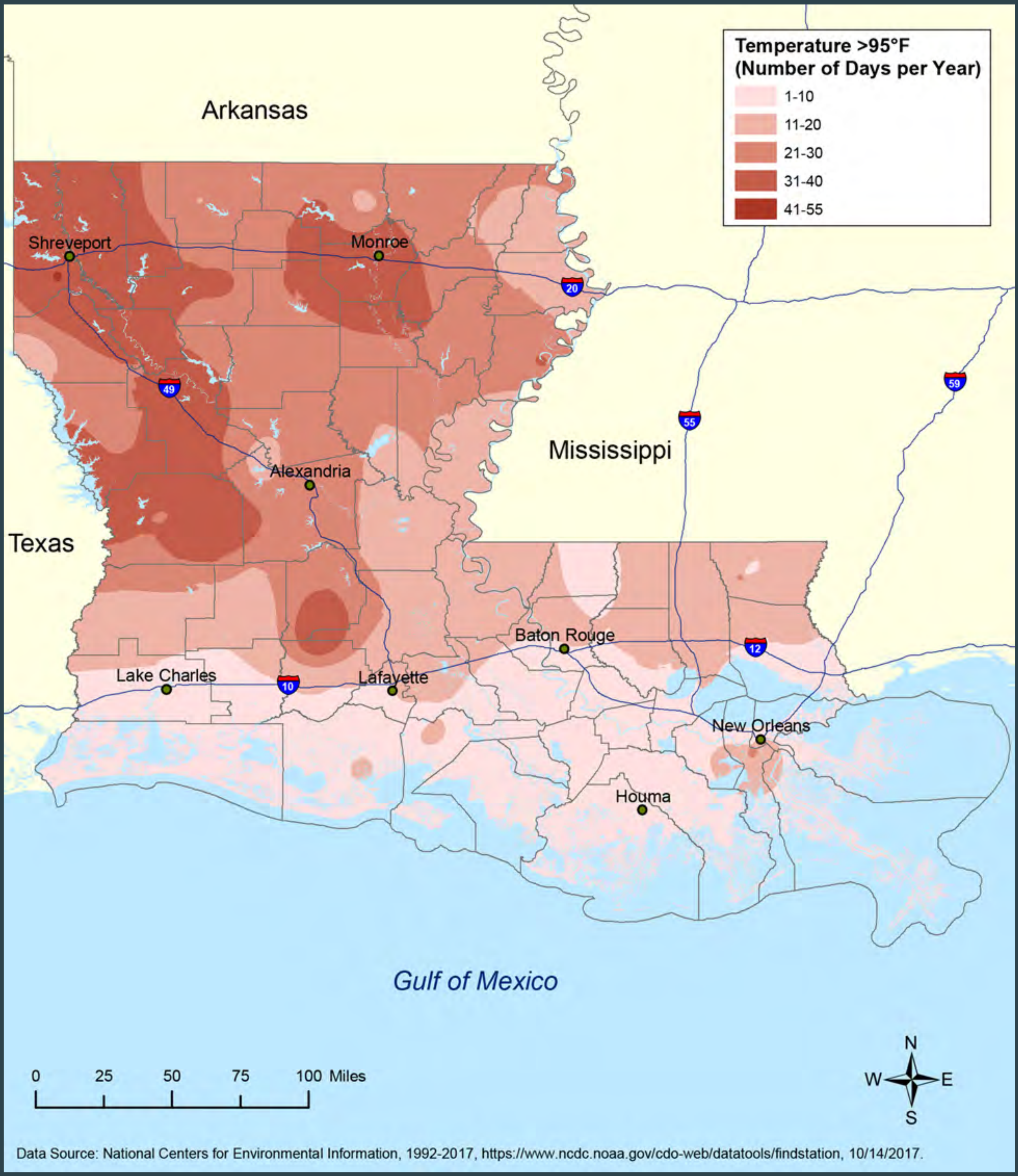
Although all of Louisiana is vulnerable to extreme heat, summer temperatures can often exceed 100° F in the northern parishes, particularly during dry spells when clear skies allow increased solar radiation to reach the surface. Afternoon highs in the north have occasionally reached 110° F, with an all-time extreme of 114° F recorded in Plain Dealing (Bossier Parish) on August 10, 1936, during the 1936 North American Heat Wave. A more recent occurrence of extreme heat hazards is the August 2007 Heatwave, affecting Lake Charles, Lafayette, New Iberia, and Alexandria, setting new record high temperatures of between 101°F and 103°F.

The following map shows the historic number of days with temperatures exceeding 95°F. Most studies on the topic focus on the number of days with temperatures exceeding 95°F. The 2043 temperature map showing number of days with temperatures exceeding 95°F considers the projected increases in the intensity of extreme heat hazards we could expect to see in the year 2043. This probability map is used in the risk assessment.

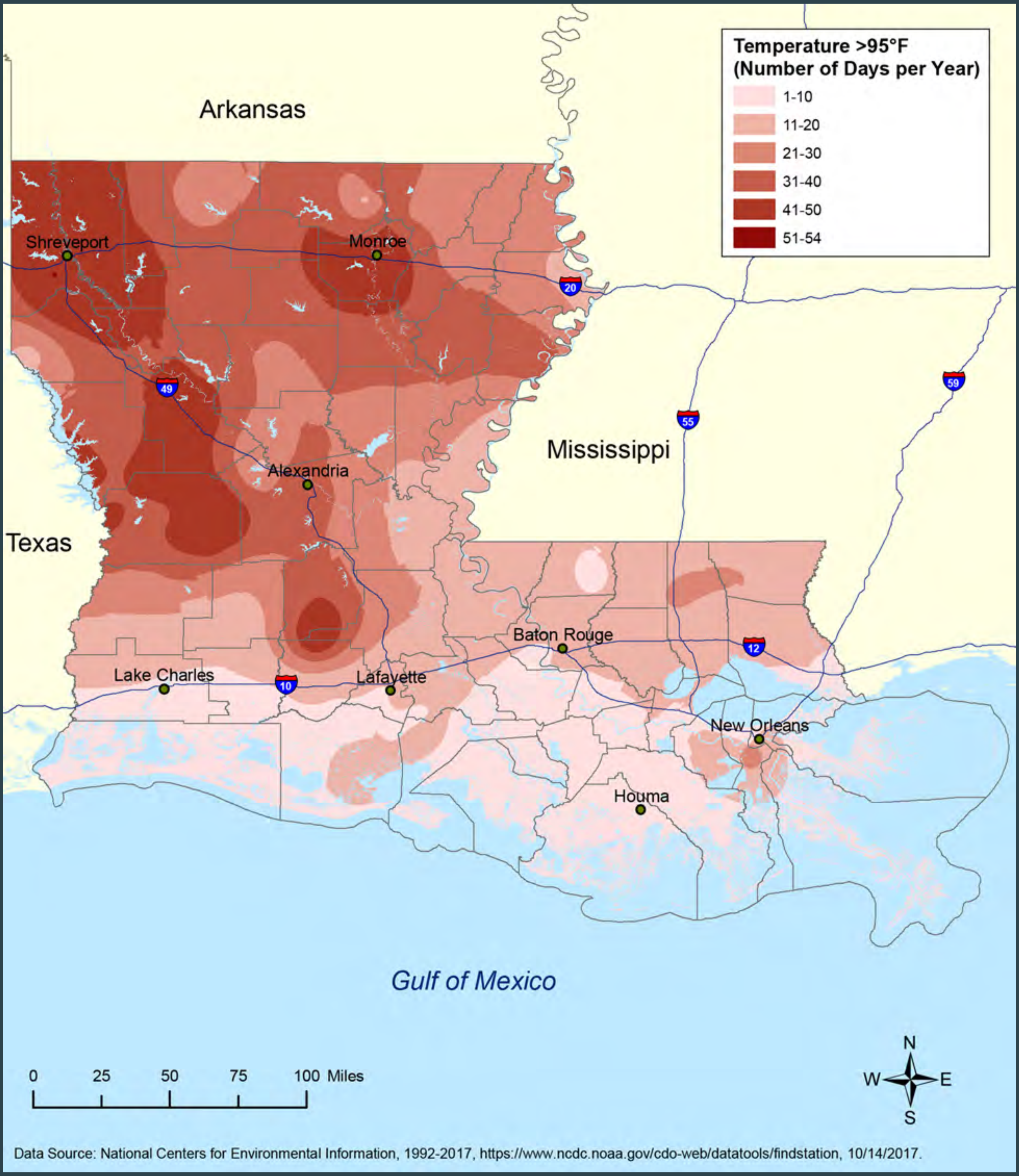
RISK ASSESSMENT

The projected crop loss map shows anticipated annual average losses due to extreme heat hazards by census block. Extreme heat has not historically caused property losses.

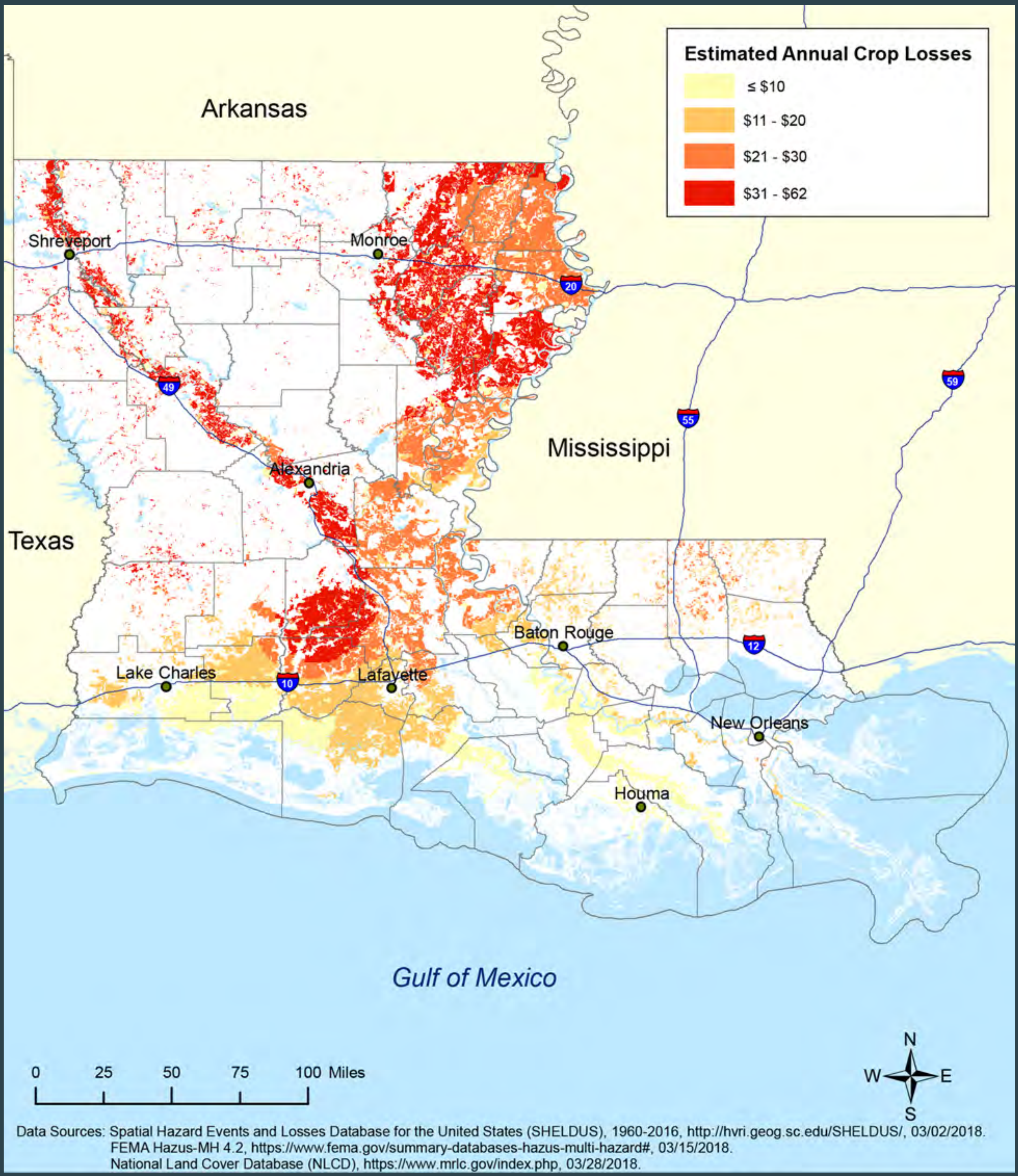
1992- -2017 Number of Days per Year with Temperature Above 95°F



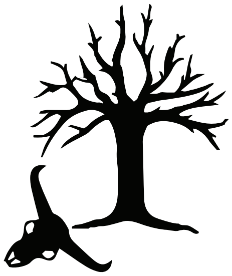
2043 Predicted Number of Days per Year with Temperature Above 95°F



2043 Predicted Annual Crop Losses from Extreme Heat by Census Block



Drought



OVERVIEW

A drought is a deficiency in water availability over an extended period of time, caused by precipitation totals and soil water storages that do not satisfy the environmental demand for water, either by evaporation or transpiration through plant leaves. It is important to note that the lack of precipitation alone does not constitute drought; the season during which the precipitation is lacking has a major impact on whether drought occurs. For example, a week of no precipitation in July, when the solar energy to evaporate water and vegetation's need for water to carry on photosynthesis are both high, may trigger a drought, while a week of no precipitation in January may not initiate a drought. The dryest year on record in Louisiana occurred in 1963. The second dryest year on record occurred in 2011, with parts of southeast Louisiana in extreme drought status.

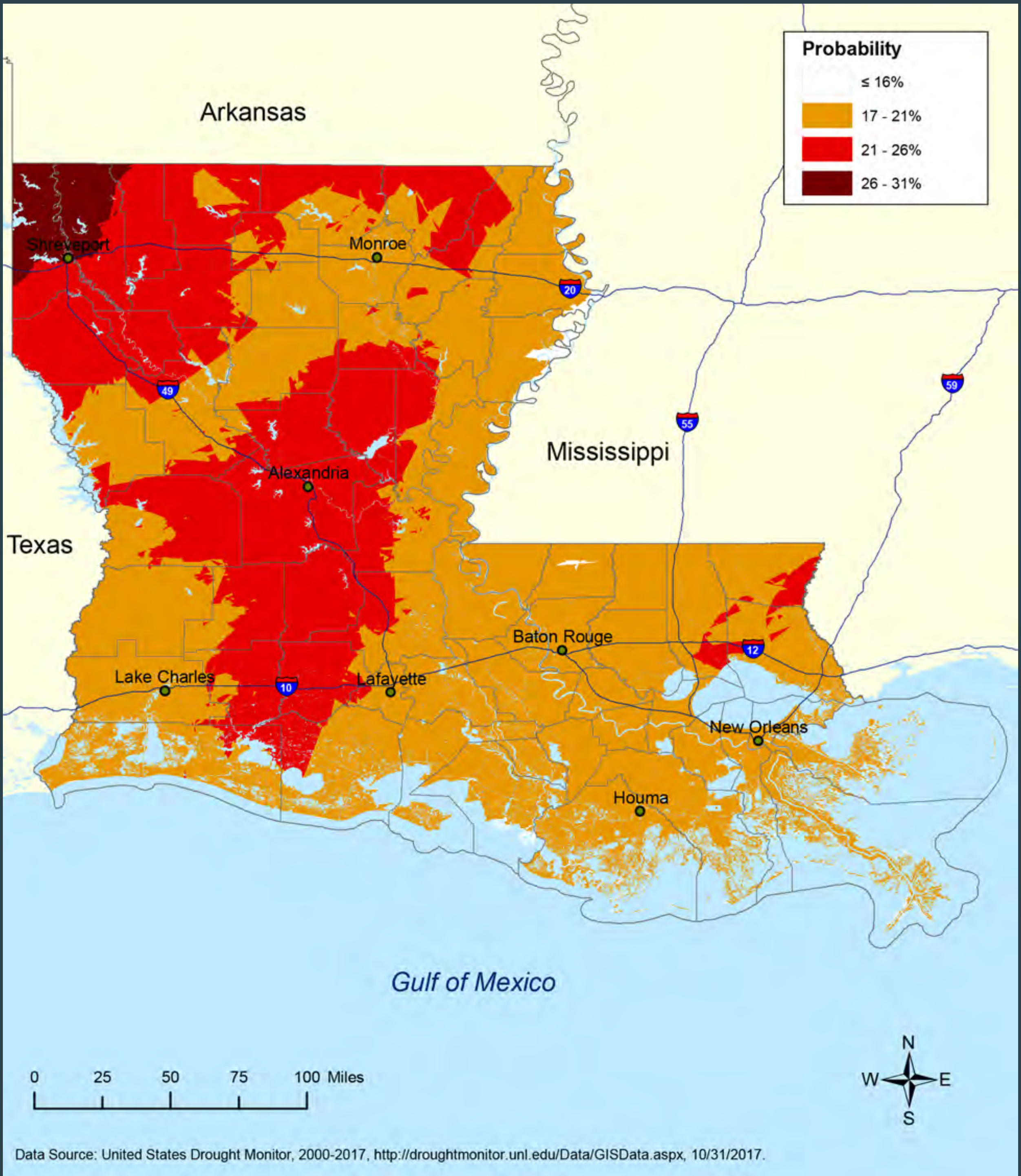
Drought is a unique and insidious hazard. Unlike other natural hazards, no specific, standard threshold of "dryness" exists for declaring a drought. In addition, the definition of drought depends on stakeholder needs. For instance, the onset (and demise) of agricultural drought is quick, as crops need water every few days; once they get rainfall, they improve. But hydrologic drought sets in (and is alleviated) only over longer time periods. A few dry days will not drain a reservoir, but a few rain showers cannot replenish it, either. Moreover, different geographical regions define drought differently based on the deviation from local, normal precipitation. And drought can occur anywhere, triggered by changes in the local-to-regional-scale atmospheric circulation over an area or by broader-scale circulation variations such as the expansion of semi-permanent oceanic high-pressure systems or the stalling of an upper-level atmospheric ridge in place over a region. The severity of a drought depends upon the degree and duration of moisture deficiency, as well as the size of the affected area. Periods of drought tend to be associated with other hazards such as wildfires and/or heat waves as well. Lastly, drought is a slow onset event, causing less direct—but tremendous indirect—damage. Depletion of aquifers, crop loss, and livestock and wildlife mortality rates are examples of direct impacts.

The 2000-2017 weekly drought probability map shows areas that have historically been affected by drought, while the 2043 probability map considers projected increases in the probability of drought hazards we could expect to see in the year 2043. This probability map is used in the risk assessment.

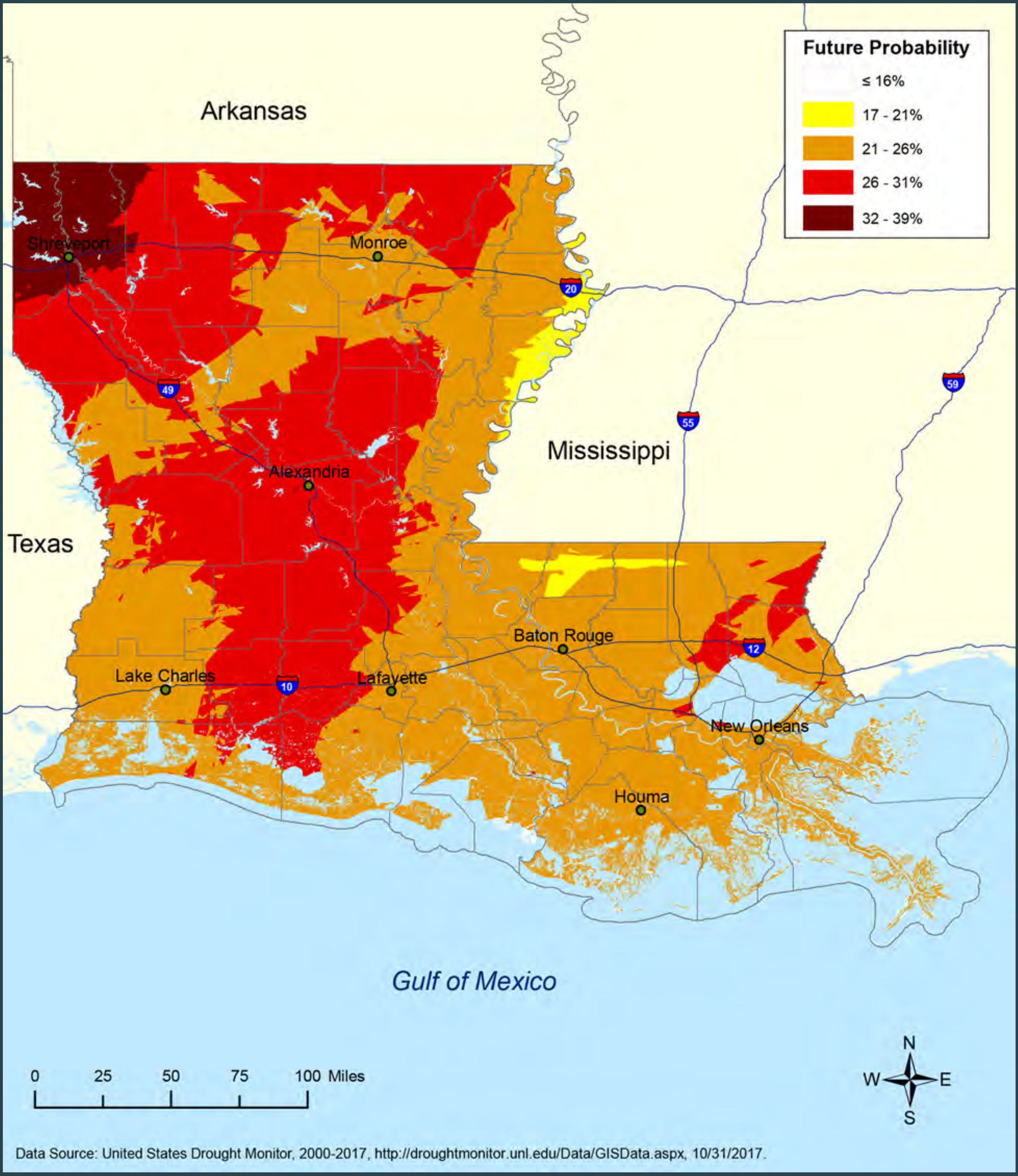
RISK ASSESSMENT

The projected crop loss map shows anticipated annual average loss due to drought hazards by census block.

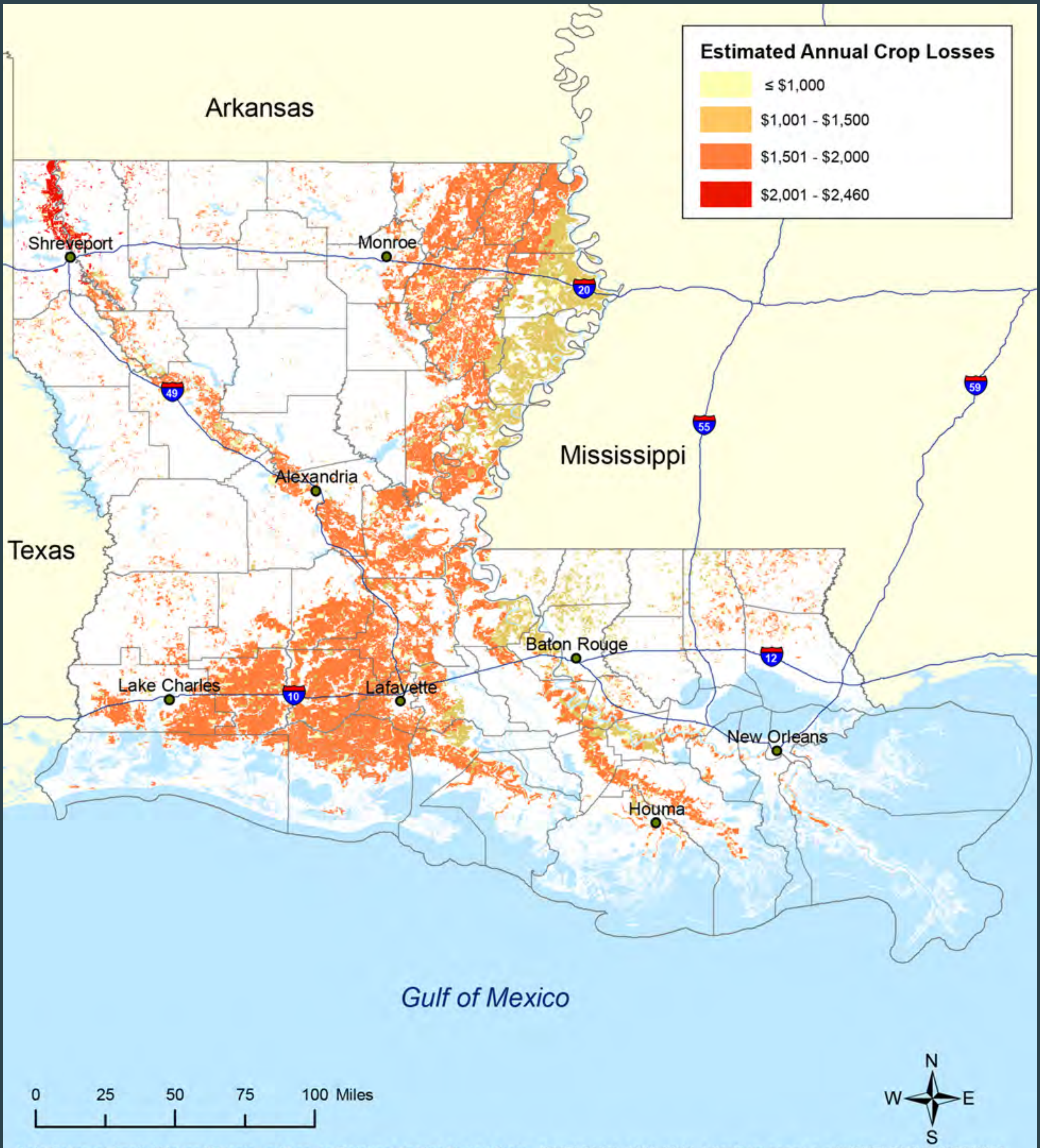
2000--2017 Weekly Probability of Drought in Louisiana



2043 Predicted Weekly Probability of Drought in Louisiana



2043 Predicted Annual Crop Losses from Extreme Cold by Census Block



Data Sources: Spatial Hazard Events and Losses Database for the United States (SHELDUS), 1996-2016, http://hvri.geog.sc.edu/SHELDUS/, 03/02/2018.
FEMA Hazus-MH 4.2, https://www.fema.gov/summary-databases-hazus-multi-hazard#, 03/15/2018.
National Land Cover Database (NLCD), https://www.mrlc.gov/index.php, 03/28/2018.

Wildfire

OVERVIEW

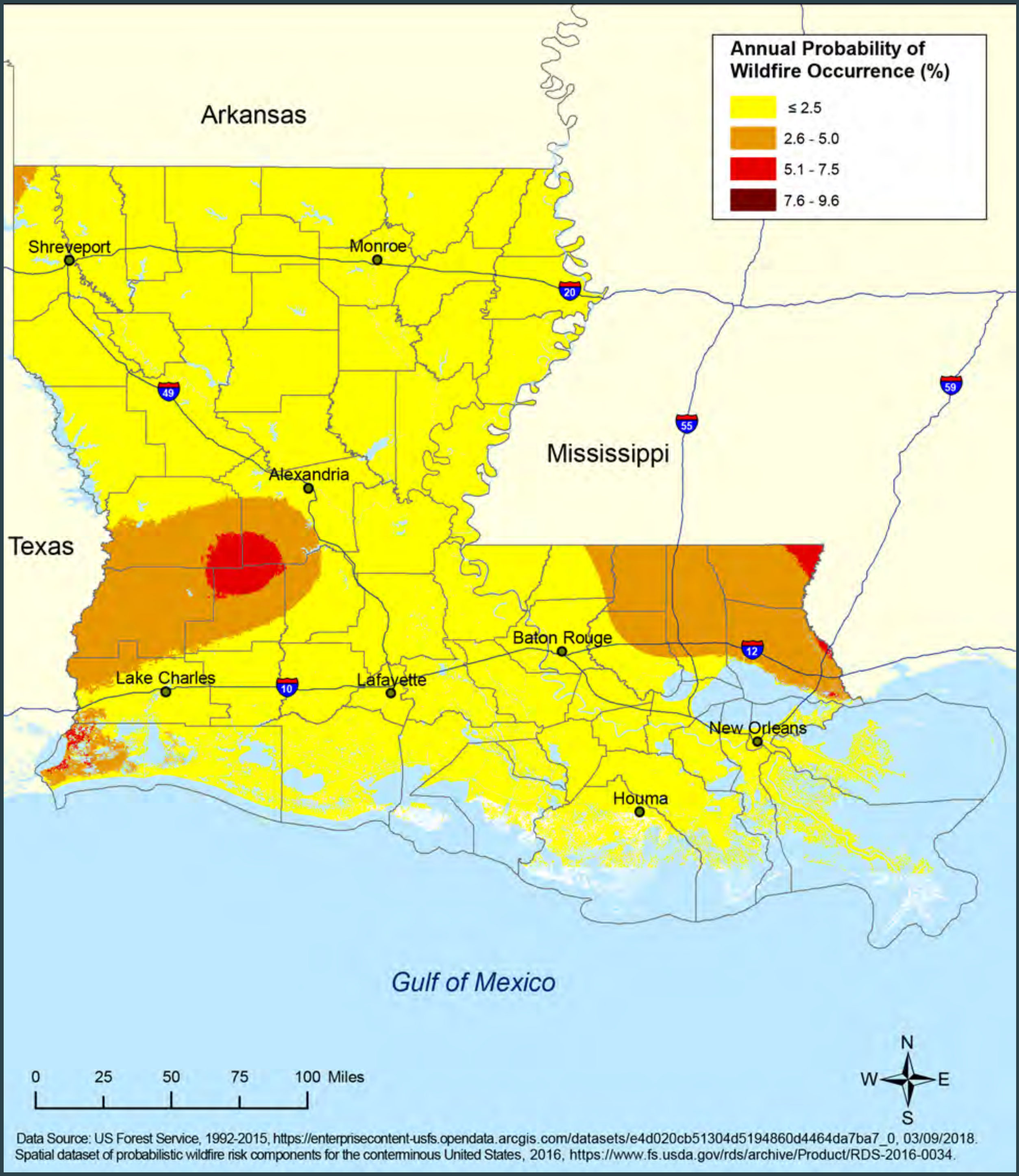
A wildfire is combustion in a natural setting, marked by flames or intense heat. According to the State of Louisiana Forestry Division, most forest fires in Louisiana are caused by intentional acts (arson) or carelessness and negligence committed by people, exacerbated by human confrontation with nature. The wildland–urban interface (WUI) is the area in which development meets wildland vegetation, where both vegetation and the built environment provide fuel for fires. As development near wildland settings continues, more people and property are exposed to wildfire danger.

Wildfires are common in Louisiana. In contrast with much of the U.S., Louisiana wildfires tend to be small, averaging 10 acres in size. Data from the Louisiana Department of Agriculture and Forestry show that in the past 11 years, there have been more that 15,000 wildfires, burning nearly 160,000 acres. On average, 3% of residences threatened by fires are damaged while 97% are protected. The year 2011 was the most active fire year in the past 11 years, with 2,888 fire events and 76 damaged structures. This same year, 2,764 residences were threatened by fire but protected from damage. Without the effort and dedication of Office of Forestry personnel, the loss from wildfire could be catastrophic. The 1992-2015 annual wildfire probability map was derived from previous wildfire occurrences, while the 2043 probability map considers projected increases in the probability of wildfire hazards we could expect to see in the year 2043. This probability map is used in the risk assessment.

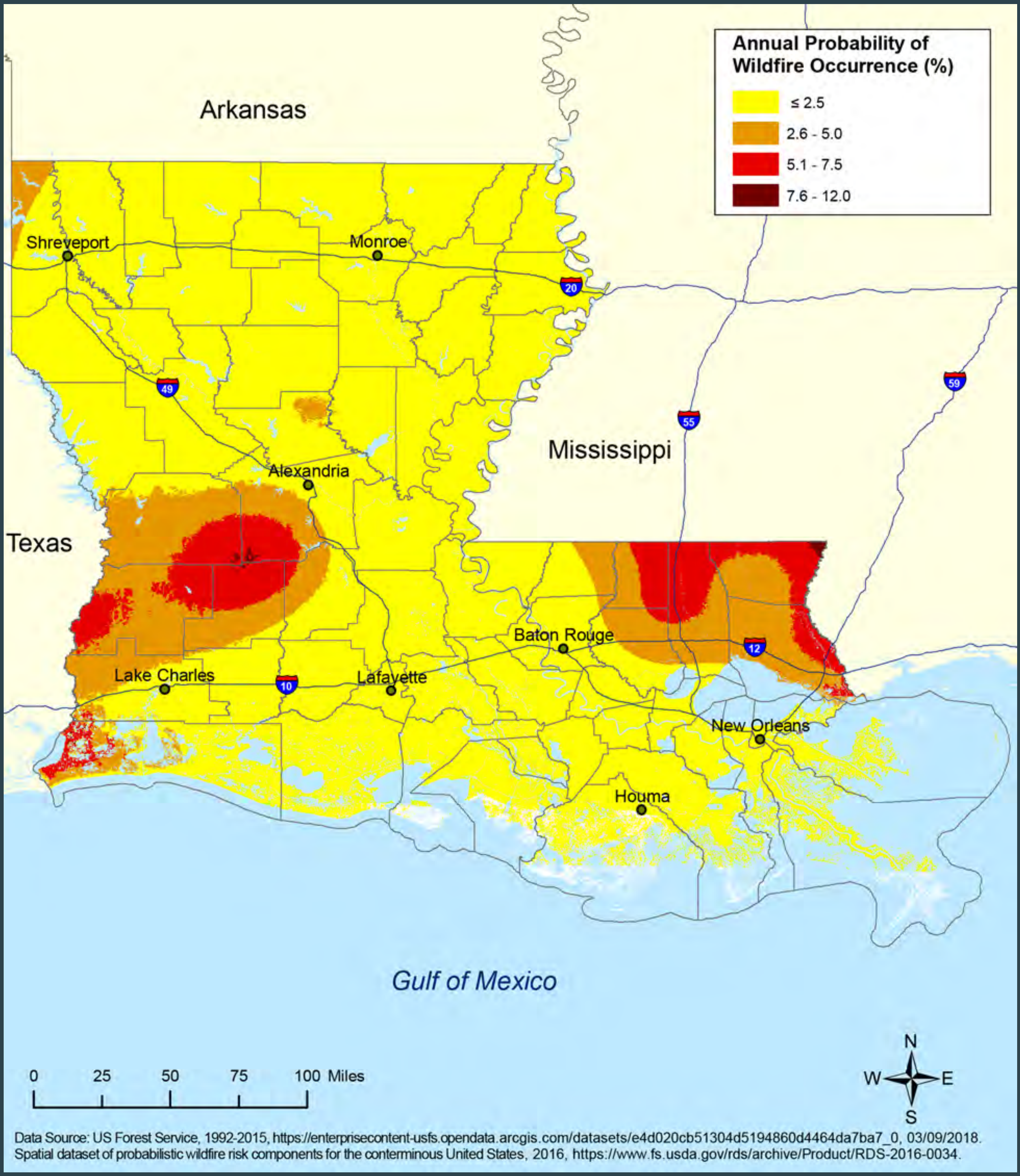
RISK ASSESSMENT

Projected property and crop loss maps show anticipated annual average losses due to wildfire hazards by census block.

1992-2015 Annual Probability of Wildfire in Louisiana

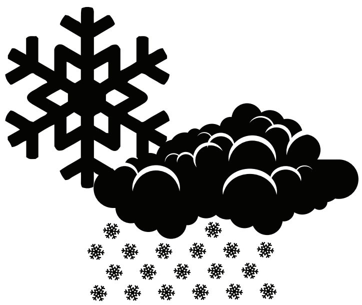


2043 Predicted Annual Probability of Wildfire in Louisiana



2043 Predicted Annual Property Losses from Wildfire by Census Block

Extreme Cold



OVERVIEW

Extreme cold temperatures occur in Louisiana when the normal quasi-west-to-east upper-level steering circulation patterns undulate with an unusually strong north-to-south component of motion directed toward Louisiana. A cold front generally forms on the southwestern flank of the southward-moving air mass, trailing from a surface cyclone (i.e., low-pressure center). An anticyclone (high-pressure, clear-sky area) northwest of the cold front's associated low-pressure center then follows. Once the cold front passes, temperatures fall suddenly. After the cloudiness associated with the cold front and low-pressure areas passes through the area and higher pressure approaches, the clearing skies allow for rapid loss of radiant energy from the surface, especially at night, resulting in an even more abrupt drop in temperature. If air of Arctic origin traverses over snow-covered land on its trek southward, it can become even more bitterly cold by the time it reaches Louisiana. This scenario of cold temperatures, or "Arctic outbreaks," represents a formidable hazard in subtropical climates like Louisiana, where natural and human systems are ill-equipped to adapt, but yet are exposed to the hazard occasionally. Property and crops are particularly vulnerable, as extreme cold can cause freezing pipes, snow, freezing rain, etc.

Recent extreme cold events include January 18, 2018, when temperatures at the New Orleans International Airport and Baton Rouge Metro Airport (20°F and 14° F, respectively) broke the previous record lows at those locations, which had been set in 1977.

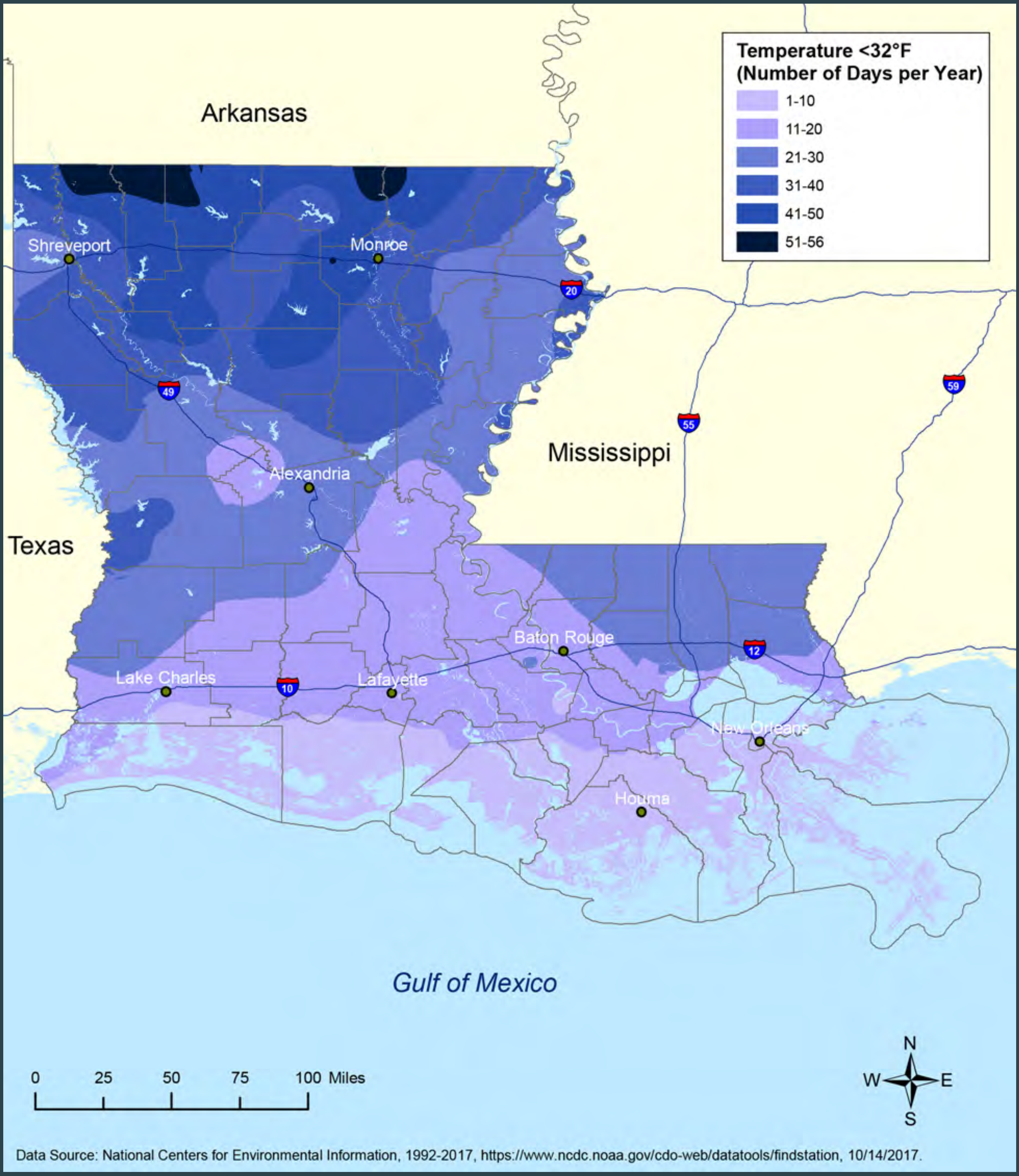
The following map shows the historic number of days with temperatures below 32°F. Most studies on the topic focus on the number of days with temperatures below 32°F. The 2043 temperature map showing number of days with temperatures below 32°F we could expect to see in the year 2043 considering projected decreases in the intensity of extreme cold hazards, and is used in the risk assessment.

RISK ASSESSMENT

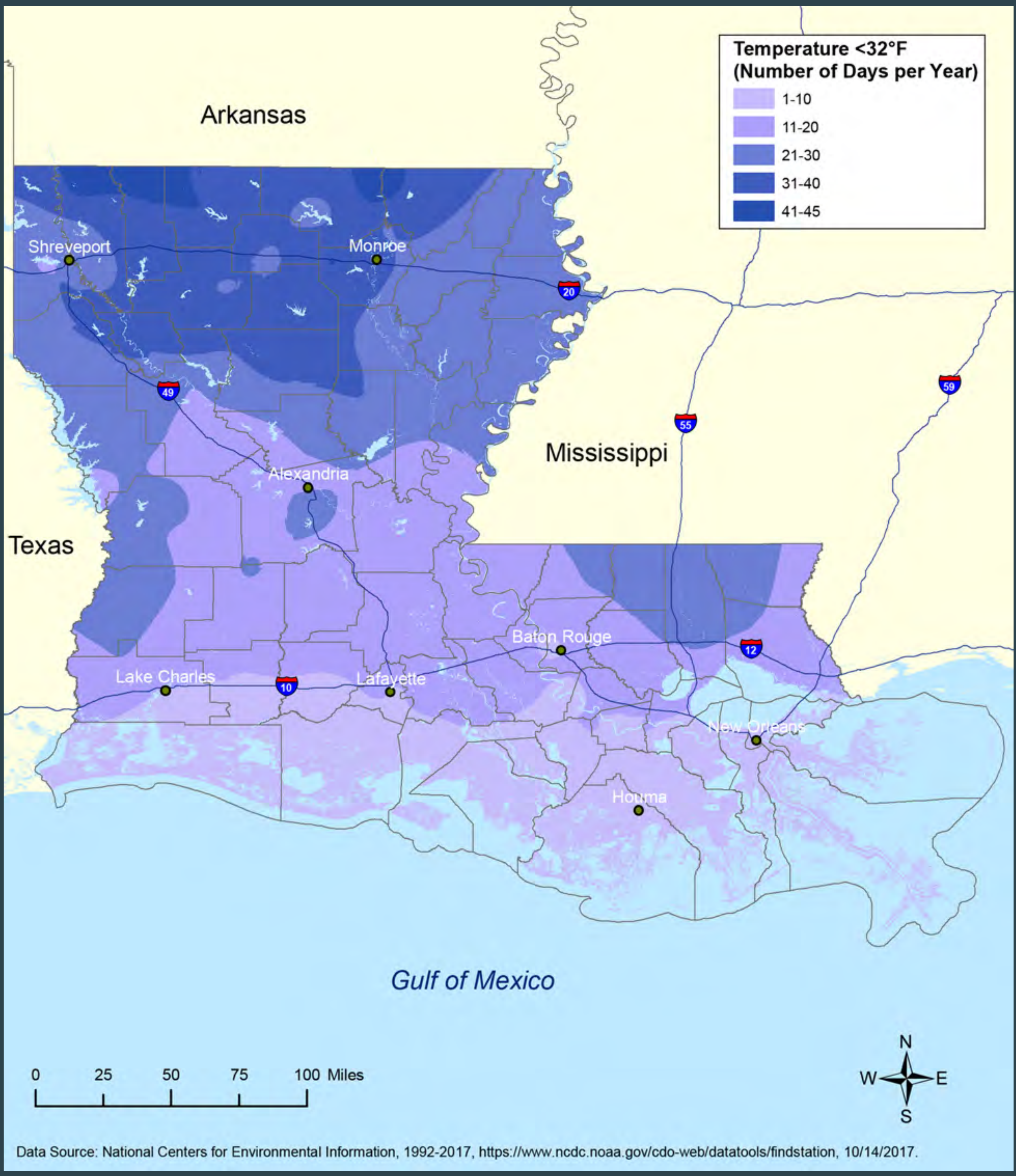
Projected property and crop loss maps show anticipated annual average losses due to extreme cold hazards by census block.

1992-
-2017

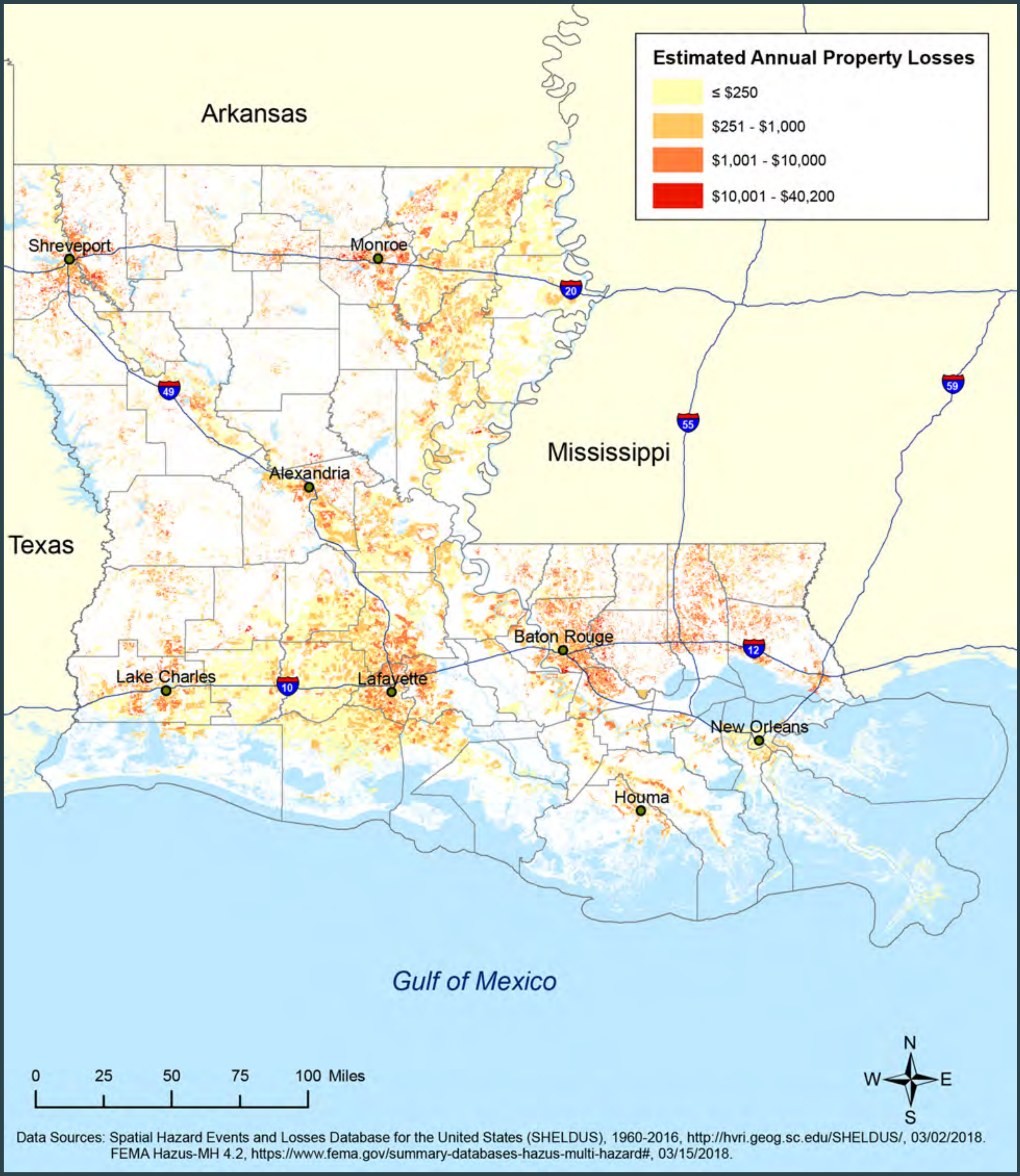
Number of Days per Year with Temperature Below 32°F



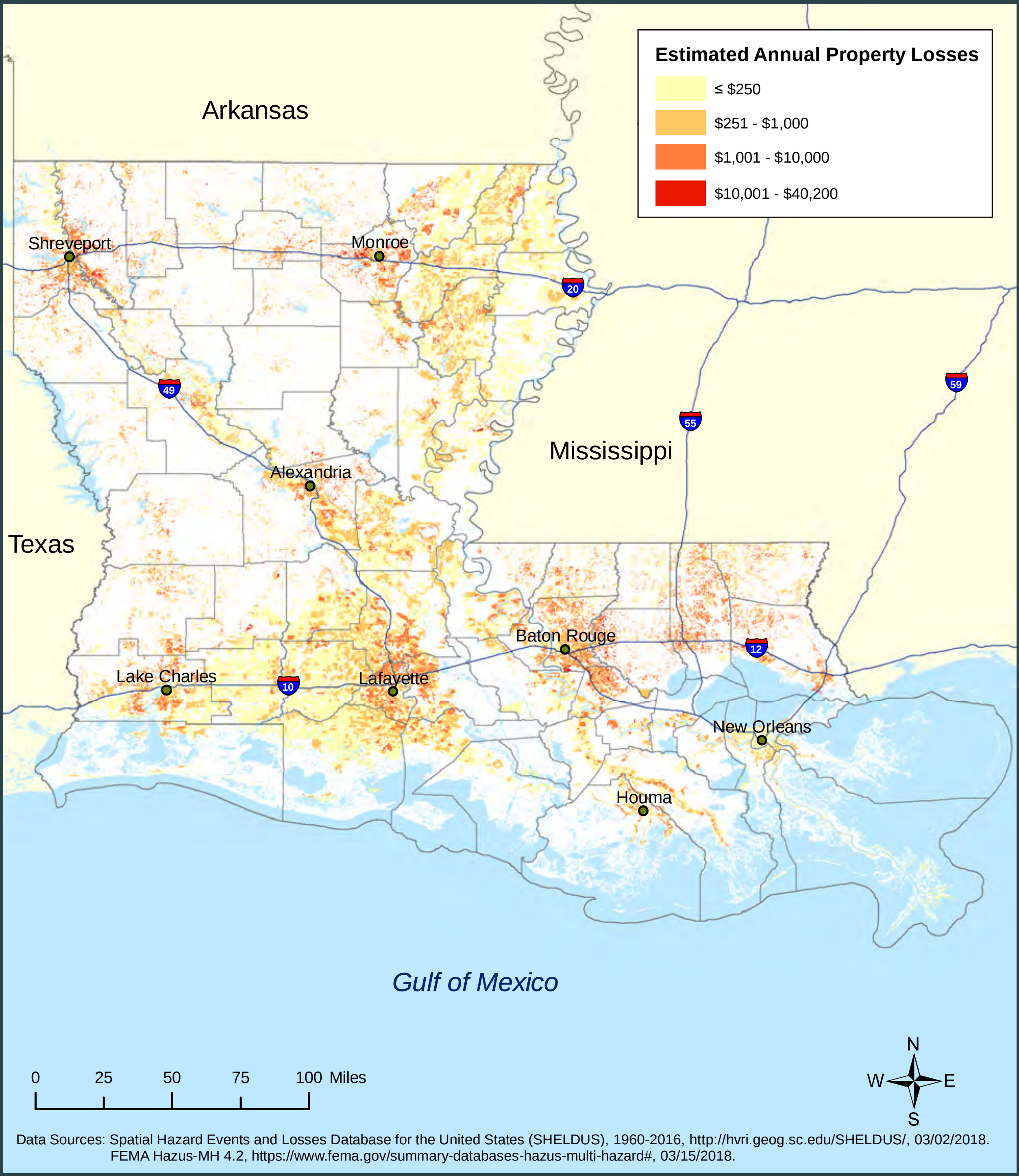
2043 Predicted Number of Days per Year with Temperature Below 32°F



2043 Predicted Annual Property Losses from Winter Storms by Census Block



2043 Predicted Annual Crop Losses from Winter Storms by Census Block



Wind and Flood Hazards

Hazards in Louisiana related to wind and flood include tropical cyclones, high wind, hailstorms, lightning, tornadoes, flooding (coastal and riverine), dam failure, and levee failure. There have been five major disaster declarations since the 2014 State Hazard Mitigation Plan Update – all for wind and flood hazards.

Declaration Number	Description	Incident Period
DR-4345	Louisiana Tropical Storm Harvey	Aug. 28, 2017 / Sept. 10, 2017
DR-4300	Louisiana Severe Storms, Tornadoes and Straight-line Winds	February 7, 2017
DR-4277	Louisiana Severe Storms and Flooding	Aug. 11, 2016 / Aug. 31, 2016
DR-4263	Louisiana Severe Storms and Flooding	Mar. 8 2016 / April 8, 2016
DR-4228	Louisiana Severe Storms and Flooding	May 18, 2015 / June 20, 2015

An overview of tropical cyclones (which includes all storms of tropical origin, from weak easterly waves to the most intense hurricanes) is provided in the following section. However, many associated hazards can occur during a hurricane, including flooding, high winds, and tornadoes. Because these hazards are discussed individually in this chapter, a risk assessment is not performed for hurricane hazards themselves. The probabilities of occurrence and annualized losses for flooding, winds, and tornadoes are inclusive of hurricane-related incidents. The wind and flood hazards are discussed in the following sections, and a risk assessment is provided, except in the case of levee failure. Due to the low probability of levee failure, the losses have not been estimated.

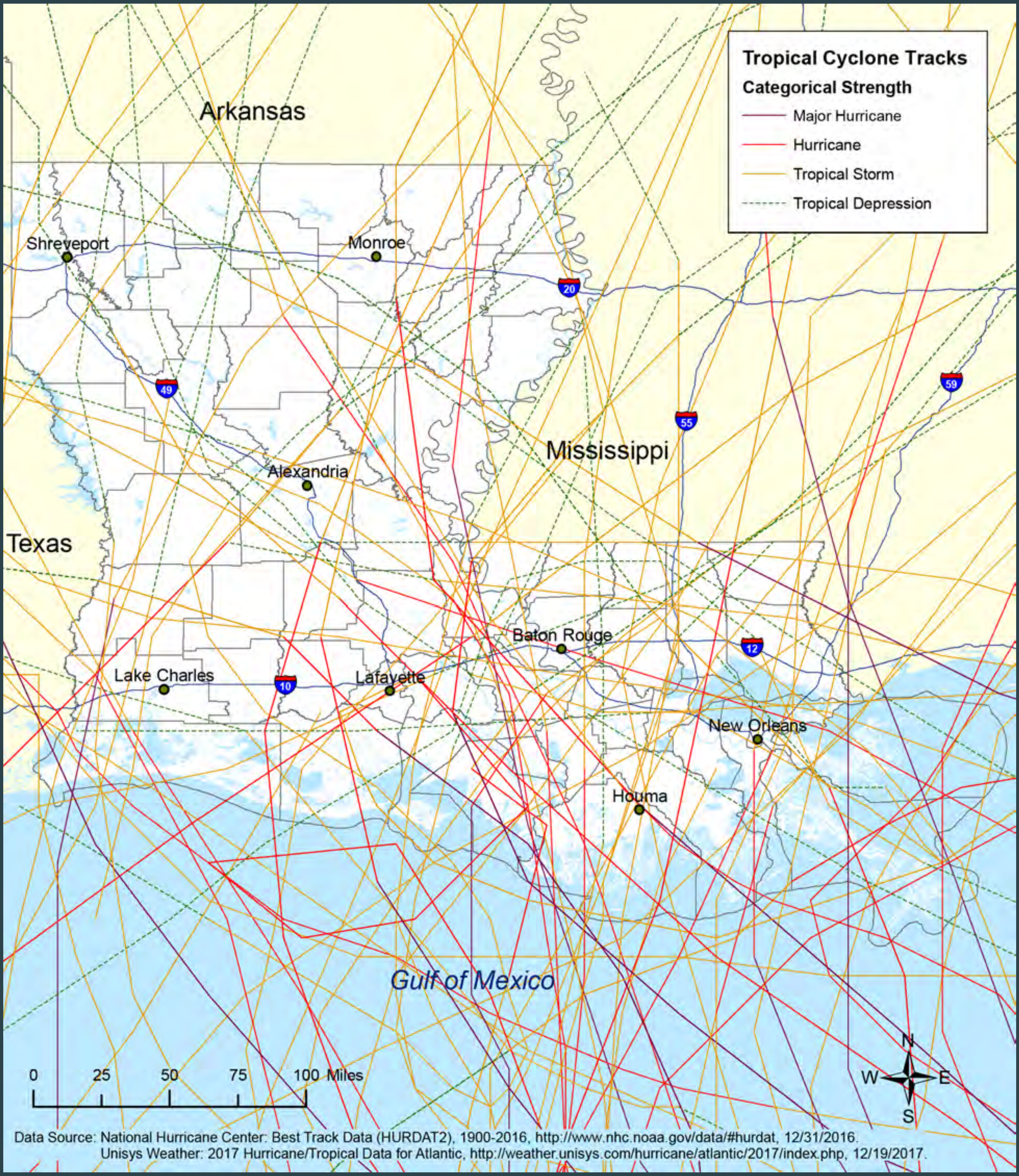
Tropical Cyclones

OVERVIEW

Tropical cyclones are spinning, low-pressure storms that draw surface low-latitude air into their centers and attain strength, ranging from weak tropical waves to the most intense hurricanes. Often, these storms begin as clusters of oceanic thunderstorms off the western coast of Africa, moving westward in the trade wind flow. These thunderstorms acquire a rotational component when a small "buckle" forms in the east-to-west trade wind, caused by the Earth's spin. This west-moving, counterclockwise-spinning collection of storms—now called a tropical disturbance—may then gather strength as it draws humid air toward its low-pressure center, forming a tropical depression (defined when the circulation is completely developed but maximum sustained surface wind speed is 38 mph or less), then a tropical storm (when the maximum sustained surface wind speed ranges from 39 mph to 73 mph), and finally a hurricane (when the maximum sustained surface wind speeds exceed 73 mph). Major hurricanes are those classified as Category 3 to 5 based on the Saffir-Simpson Hurricane Wind Scale.

Data from 1900 to 2017 show that the entire state has been impacted by tropical cyclones, often significantly. As an example, Hurricane Katrina in 2005 remains the costliest tropical cyclone in U.S. history. However, the probabilities of occurrence and historical losses for high winds, tornadoes, lightning, and flooding that constitute the tropical cyclone hazard are best represented within each hazard. Therefore, a risk assessment is not provided for tropical cyclones as a standalone hazard.

1900--2017 Tropical Cyclone Tracks Across Louisiana



High wind

OVERVIEW

High winds considered in this section are caused by thunderstorms, downbursts, straight-line winds, and tropical cyclones, with their scope defined in the table below.

Source, frequency, and duration of high winds (source: Making Critical Facilities Safe from High Wind, FEMA).

High Wind Type	Description	Relative Maximum Duration in Louisiana
Thunderstorm Winds	Wind blowing due to thunderstorms, and thus associated with temperature and pressure gradients	~Few minutes-several hours
Downbursts	Sudden wind blowing down due to downdraft in a thunderstorm; spreads out horizontally at the ground, possibly forming horizontal forming horizontal vortex rings around the downdraft	~15-20 minutes
Straight-line Winds	Wind blowing in straight line; usually associated with intense low-pressure area	Few minutes 1 day
Hurricane Winds	Wind blowing in spirals, converging with increasing speed toward eye; associated with temperature and pressure gradients between the Atlantic and Gulf and land	Several days

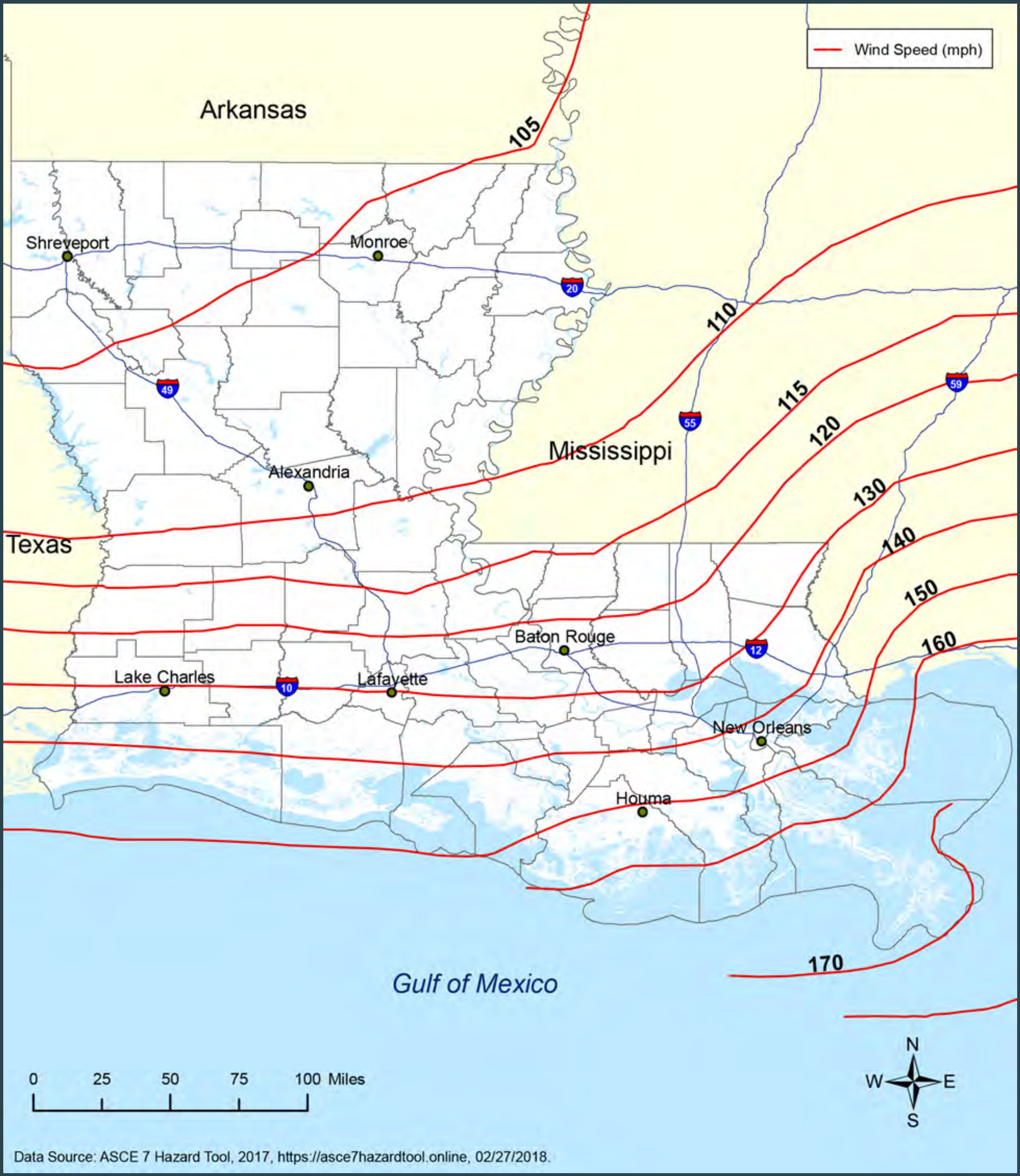
Recent high wind events (excluding tornadoes, which are discussed separately) include the severe storms and straight-line winds on February 7, 2017 impacting Livingston and Orleans Parishes (DR-4300), and the winds associated with Tropical Storm Harvey in 2017 (DR-4345).

The wind contour map depicts historic wind speeds by location, representing the 700-year return period wind speeds for Louisiana, corresponding to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.14%). Wind speeds for other return periods (e.g., 300-year, 1700-year return period) defined by the American Society of Civil Engineers are used to more fully describe the probability of hazard occurrence used in the risk assessment. Higher wind speeds near the coast reflect the intensity of tropical cyclone winds. These wind speeds are the basis for design of smaller buildings, including homes. No increase in wind speed is projected in 2043, therefore only one hazard map is provided, which is used in the risk assessment.

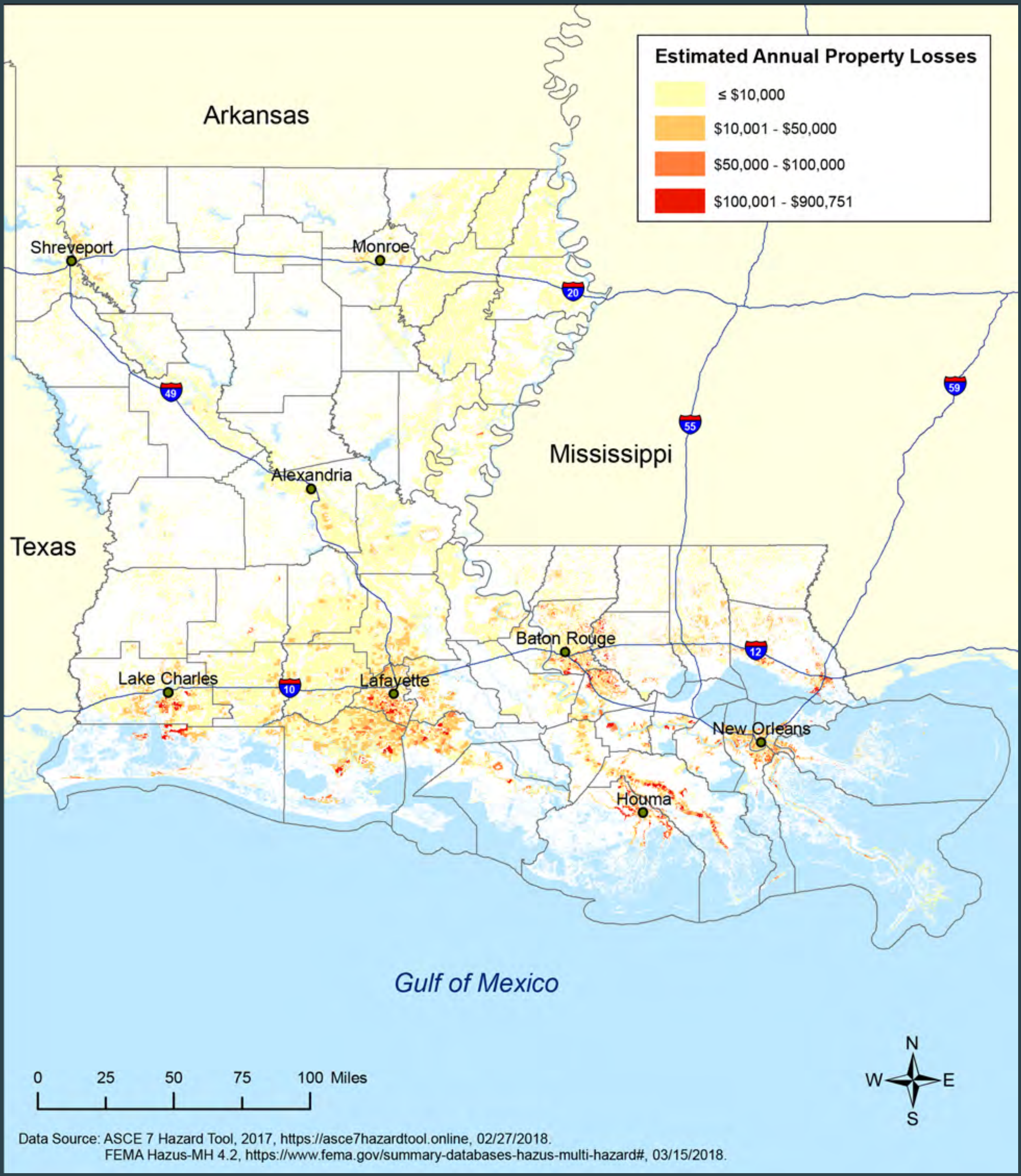
RISK ASSESSMENT

The projected property loss map shows anticipated annual average losses due to wind hazards by census block.

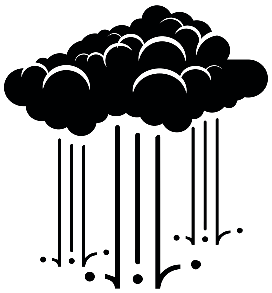
2017 700-Year 3-Second Peak Gust Wind Speeds in Louisiana



2043 Predicted Annual Property Losses from Wind by Census Block



Hailstorms



OVERVIEW

Hailstorms are severe thunderstorms in which balls or chunks of ice fall along with rain. Hail develops in the upper atmosphere as ice crystals that are bounced about by high-velocity updraft winds. The ice crystals grow through deposition of water vapor onto their surface, fall partially to a level in the cloud where the temperature exceeds the freezing point, melt partially, get caught in another updraft whereupon re-freezing and deposition grows another concentric layer of ice, and fall after developing enough weight, sometimes after several trips up and down the cloud. The size of hailstones varies depending on the severity and size of the thunderstorm.

Because of this cycle, hailstorms generally occur more frequently during the late spring and early summer—a period of extreme variation between ground surface temperatures and upper atmospheric temperatures, which contributes to vigorous updrafts of air. Hailstorms can cause widespread damage to homes and other structures, automobiles, and crops. While the damage to individual structures or vehicles is often minor, the cumulative cost to communities, especially across large metropolitan areas, can be quite significant. Hailstorms can also be devastating to crops. Thus, the severity of hailstorms depends on the size of the hailstones, the length of time the storm lasts, and where it occurs. An example of a recent significant hail event is the January 21, 2017 severe weather event, where several reports of large hail, up to 2 inches in diameter, were documented in Northwest Louisiana.

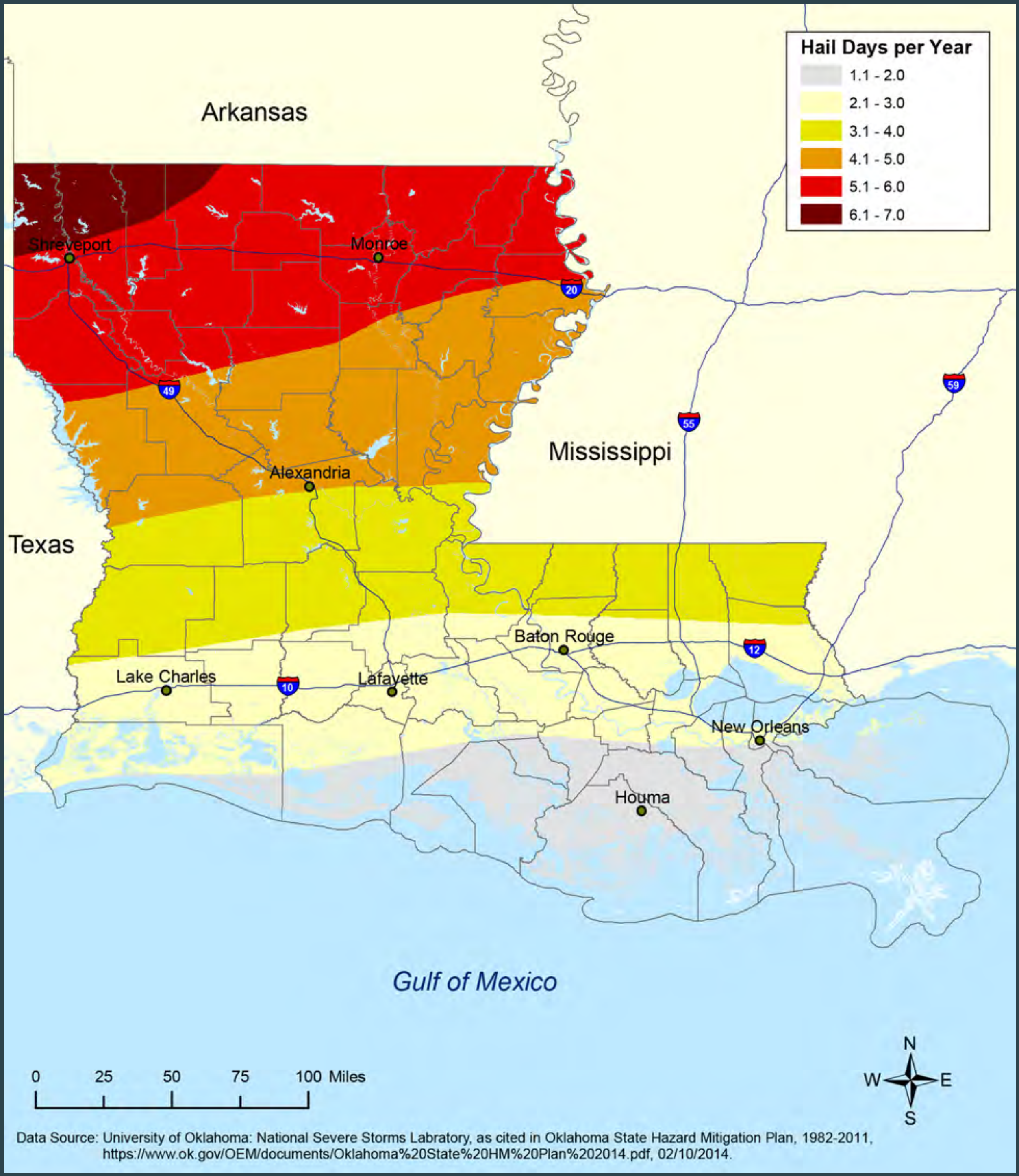
Historic hail occurrences are represented through the 1982-2011 annualized map showing the number of days per year experiencing events with hailstones 3/4" diameter or larger within 25 miles. The 2043 annual projected occurrence map considers projected increases in the probability of tornado hazards we could expect to see in the year 2043. This projected occurrence is used in the risk assessment.

RISK ASSESSMENT

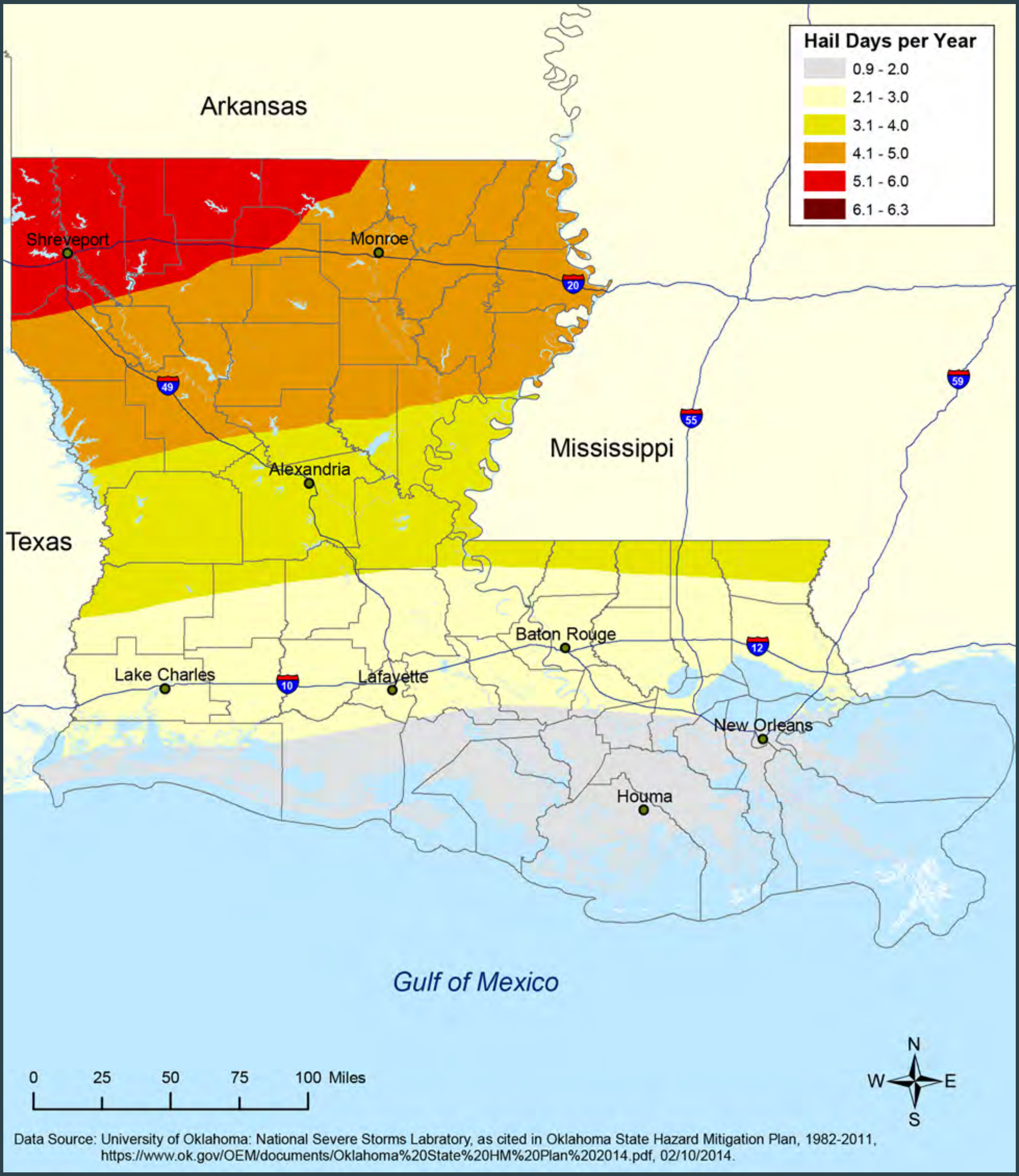
The projected property and crop loss maps show the anticipated annual average losses due to hail hazards by census block.

1982-
-2011

Number of Days per Year Experiencing Hail ≥ 0.75" within 25 Miles



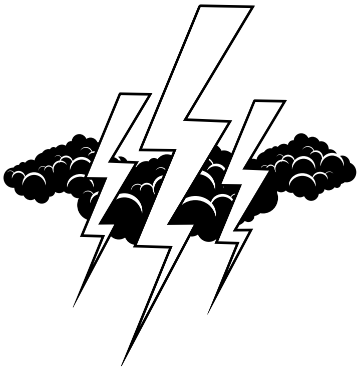
2043 Predicted Number of Days per Year Experiencing Hail ≥ 0.75" within 25 Miles



2043 Predicted Annual Property Losses from Hail by Census Block

2043 Predicted Annual Crop Losses from Hail by Census Block

Lightning



OVERVIEW

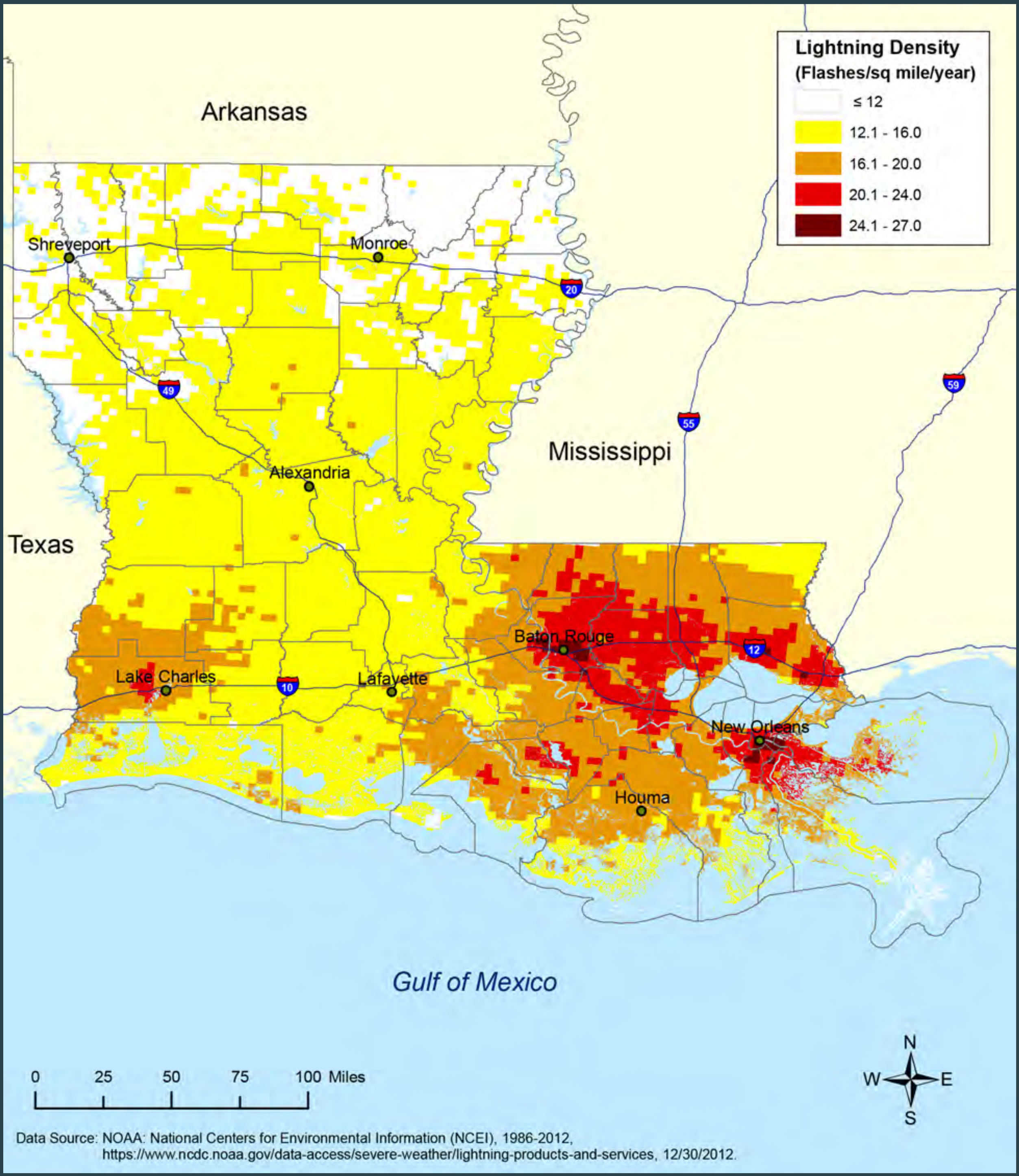
The warning signs for possible cloud-to-ground lightning strikes are high winds, rainfall, and darkening cloud cover. While many lightning casualties happen at the beginning of an approaching storm, more than half of lightning deaths occur after a thunderstorm has passed. The lightning threat diminishes after the last sound of thunder, but still may persist for more than 30 minutes. When thunderstorms are in the area, but not overhead, the lightning threat can exist even when overhead skies are clear. Lightning can even strike more than ten miles from the storm in an area with clear skies. According to NOAA, Louisiana is the second-most lightning-prone state, with around 825,000 lightning strikes per year, following Florida. The year 2016 was one of the worst years nationally for lightning deaths, with 38 fatalities around the country. Louisiana recorded 4 lightning-related deaths that year.

The 1986 to 2012 average annual lightning density is based on historic lightning observations, while the 2043 lightning density map considers projected increases in the probability of lightning hazards we could expect to see in the year 2043. The probability of lightning hazards in 2043 is used in the risk assessment.

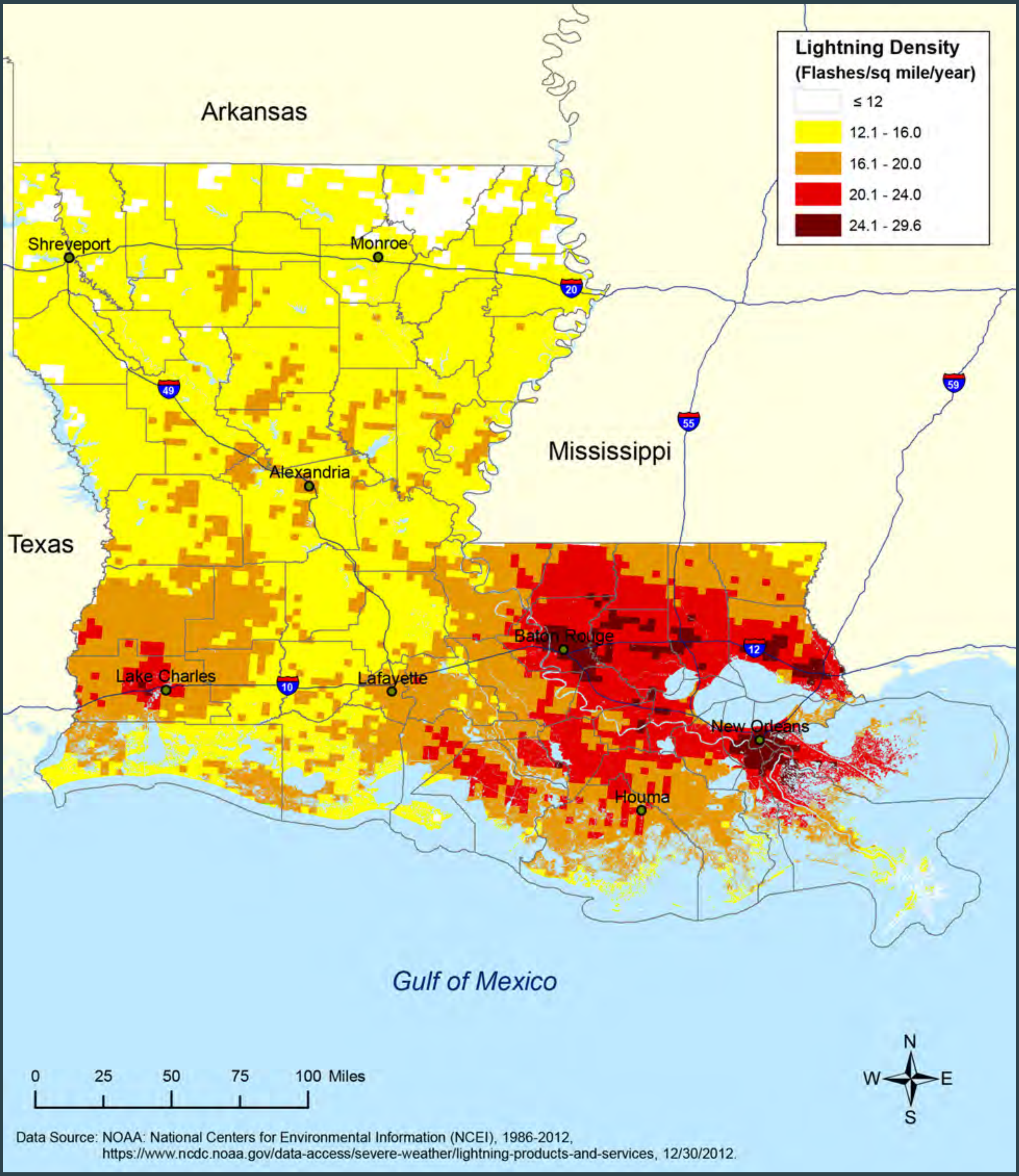
RISK ASSESSMENT

The projected property and crop loss maps show the anticipated annual average losses due to lightning hazards by census block.

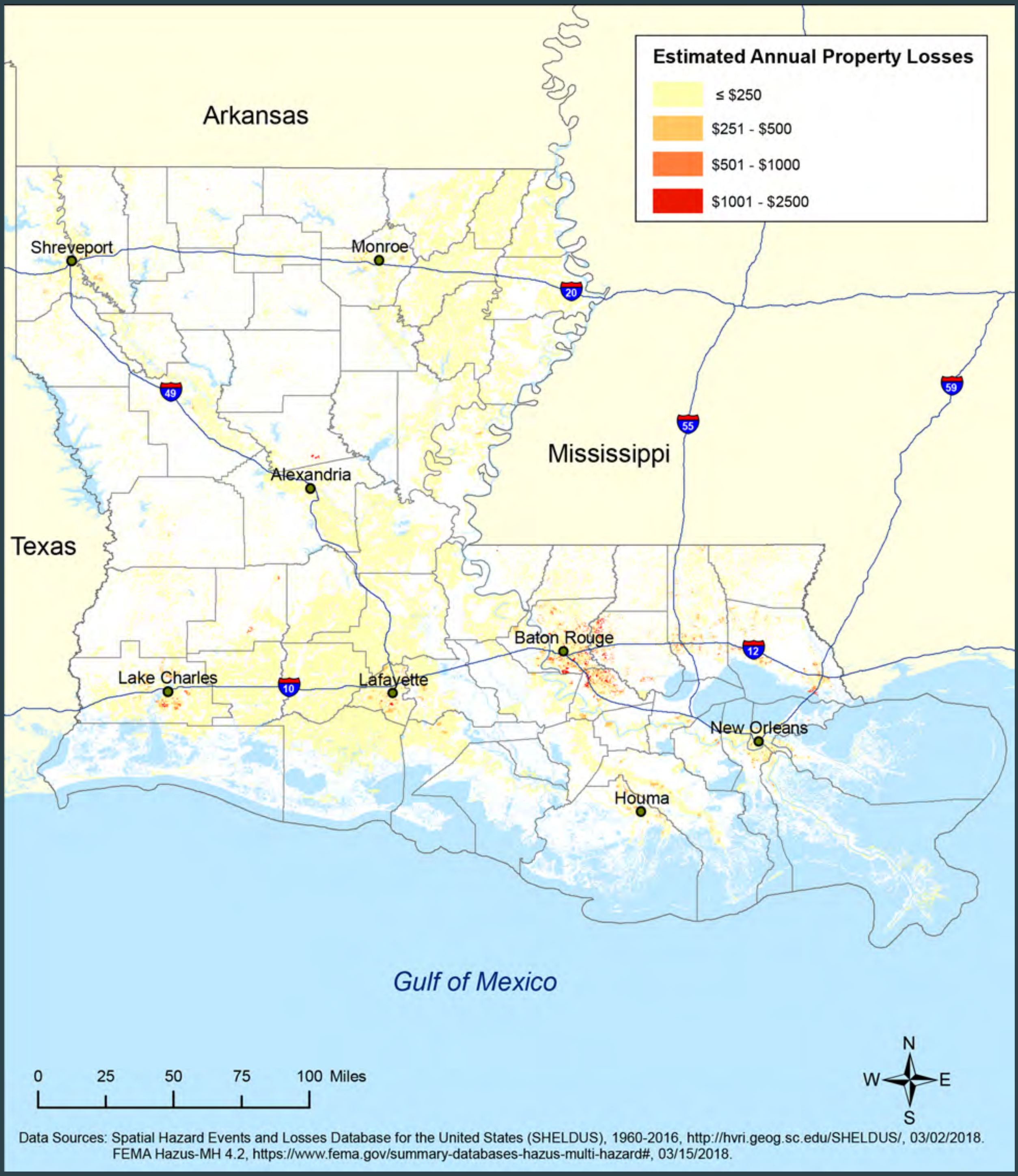
1986--2012 Average Lightning Density per Year in Louisiana



2043 Predicted Lightning Density per Year in Louisiana

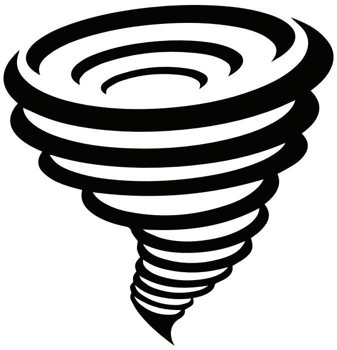


2043 Predicted Annual Property Losses from Lightning by Census Block



2043 Predicted Annual Crop Losses from Lightning by Census Block

Tornadoes



OVERVIEW

Tornadoes are rapidly rotating funnels of wind extending between storm clouds and the ground. For their size, tornadoes are the most severe storms. Approximately 70 percent of the world's reported tornadoes occur within the continental United States, making them one of the most significant hazards Americans face. When tornadoes exist over water, they are considered waterspouts. Tornadoes and waterspouts form during severe weather events, such as thunderstorms, when cold air overrides a layer of warm air, causing the warm air to rise rapidly, which usually occurs in a counterclockwise direction in the northern hemisphere. Tornadoes can also occur in association with hurricanes, but are more likely to be weaker in intensity than land-based tornadoes that occur shortly before a cold frontal passage.

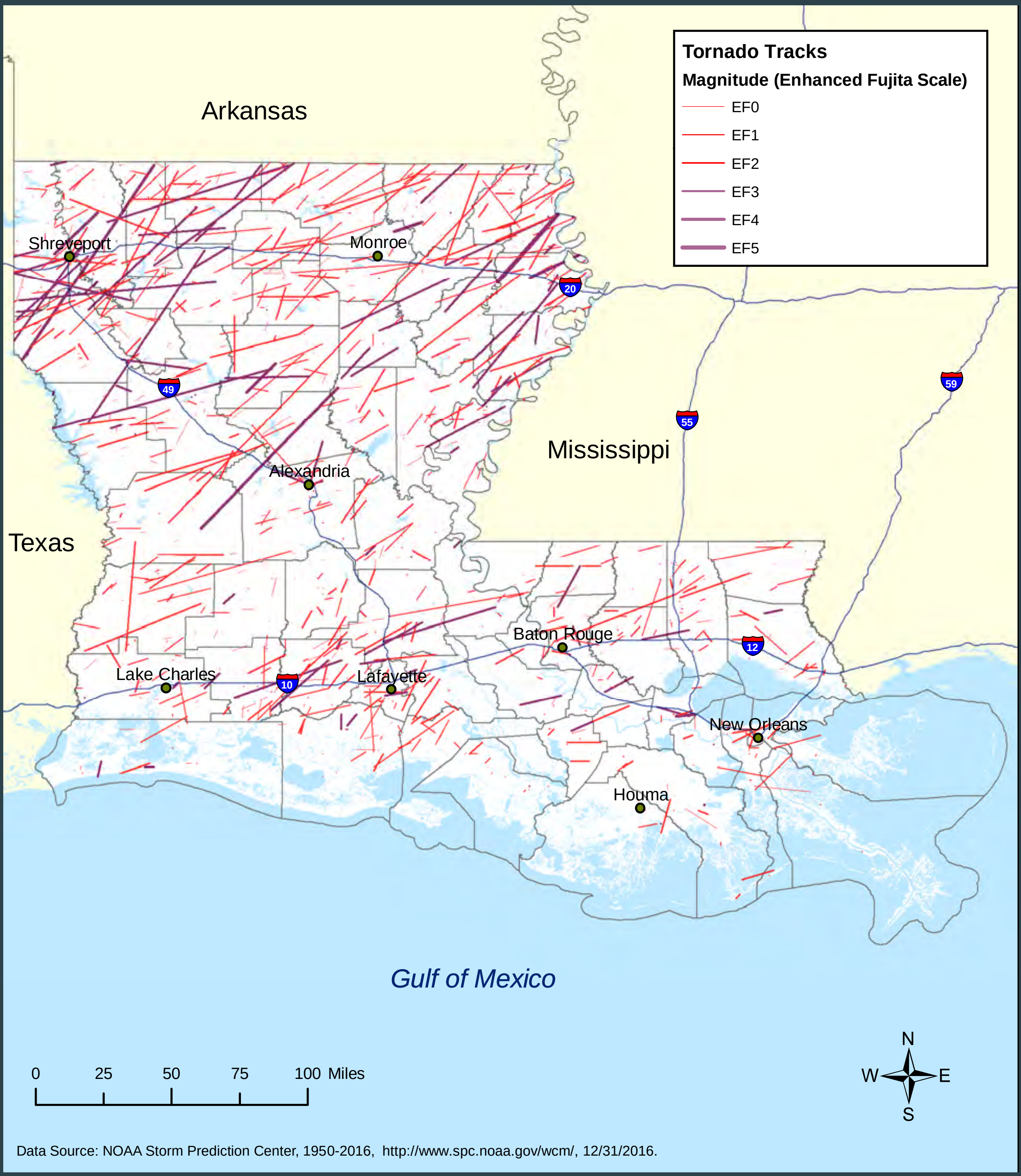
Peak tornado activity in Louisiana occurs during the spring, as it does in the rest of the United States. Nearly one-third of observed tornadoes in the U.S. occur during April and May. About half of the tornadoes in Louisiana, including many of the strongest, occur between March and June. Fall and winter tornadoes are less frequent, but the distribution of tornadoes throughout the year is more uniform in Louisiana than in locations farther north. Recent tornado outbreaks in Louisiana include at least 20 tornadoes on April 12-13, 2018, in northwest Louisiana, as well as the Eastern New Orleans Tornado on February 7, 2017 (DR-4300).

Historic tornado occurrence is shown by EF classification (from the weakest tornadoes starting at EF0 to the most powerful category of EF5) of tornado tracks, as well as through an annualized map depicting the number of days per year with a tornado touchdown within 25 miles. The 2043 annual projected occurrence map considers projected increases in the probability of tornado hazards we could expect to see in the year 2043. These projected increases are used in the risk assessment.

RISK ASSESSMENT

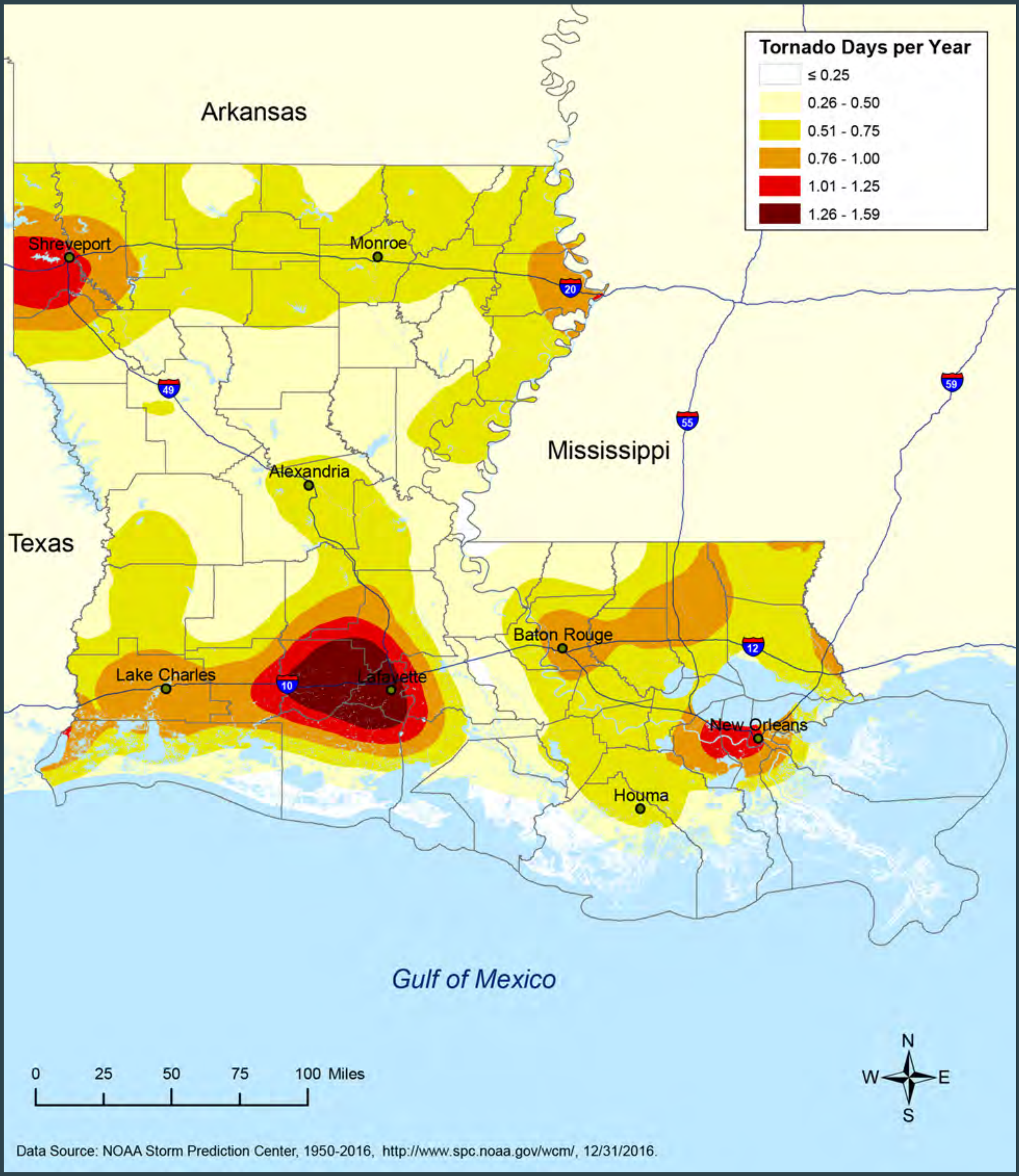
The projected property and crop loss maps show the anticipated annual average losses due to tornado hazards by census block.

1950- -2016 Tornado Tracks in Louisiana

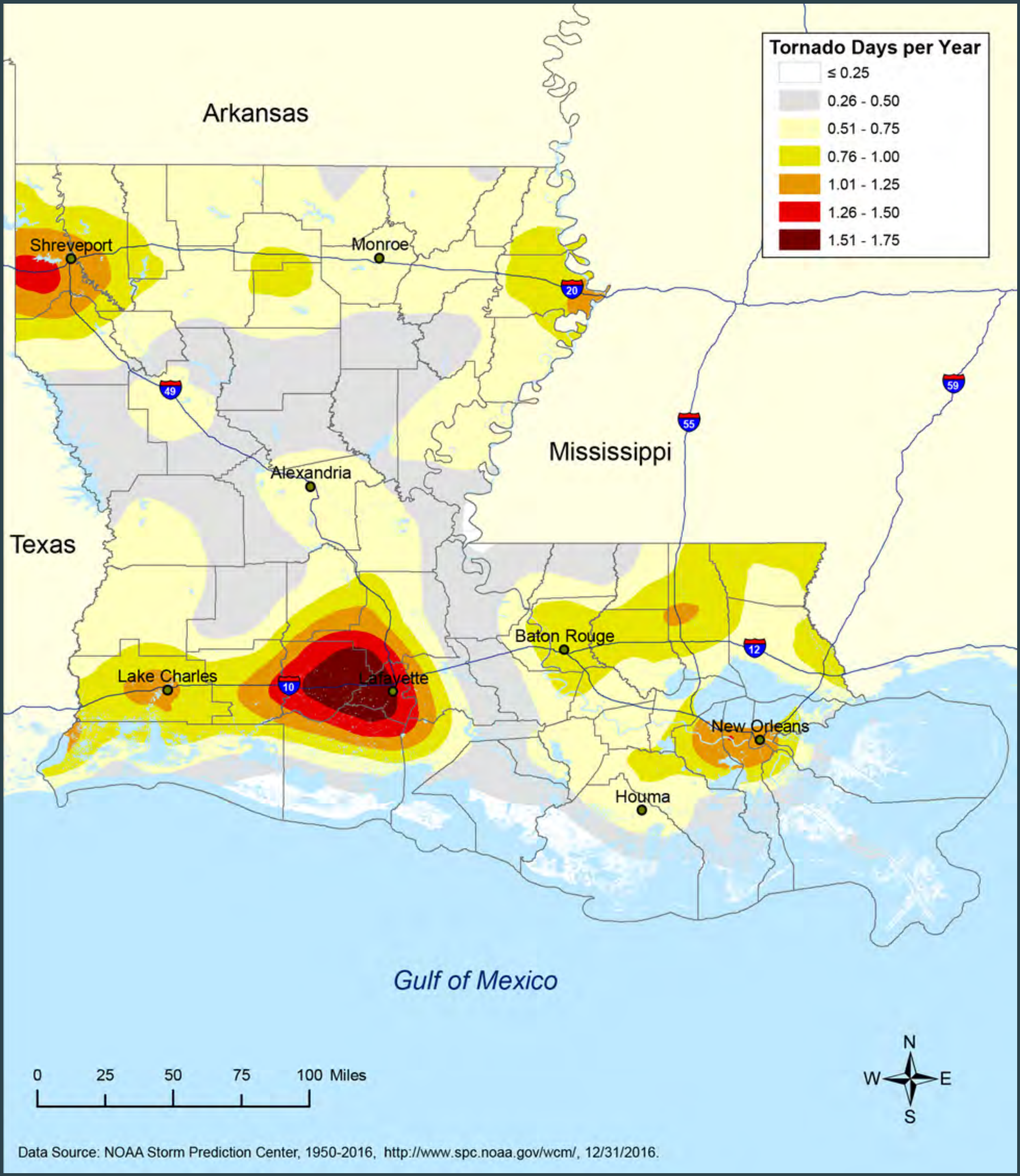


1950-
-2016

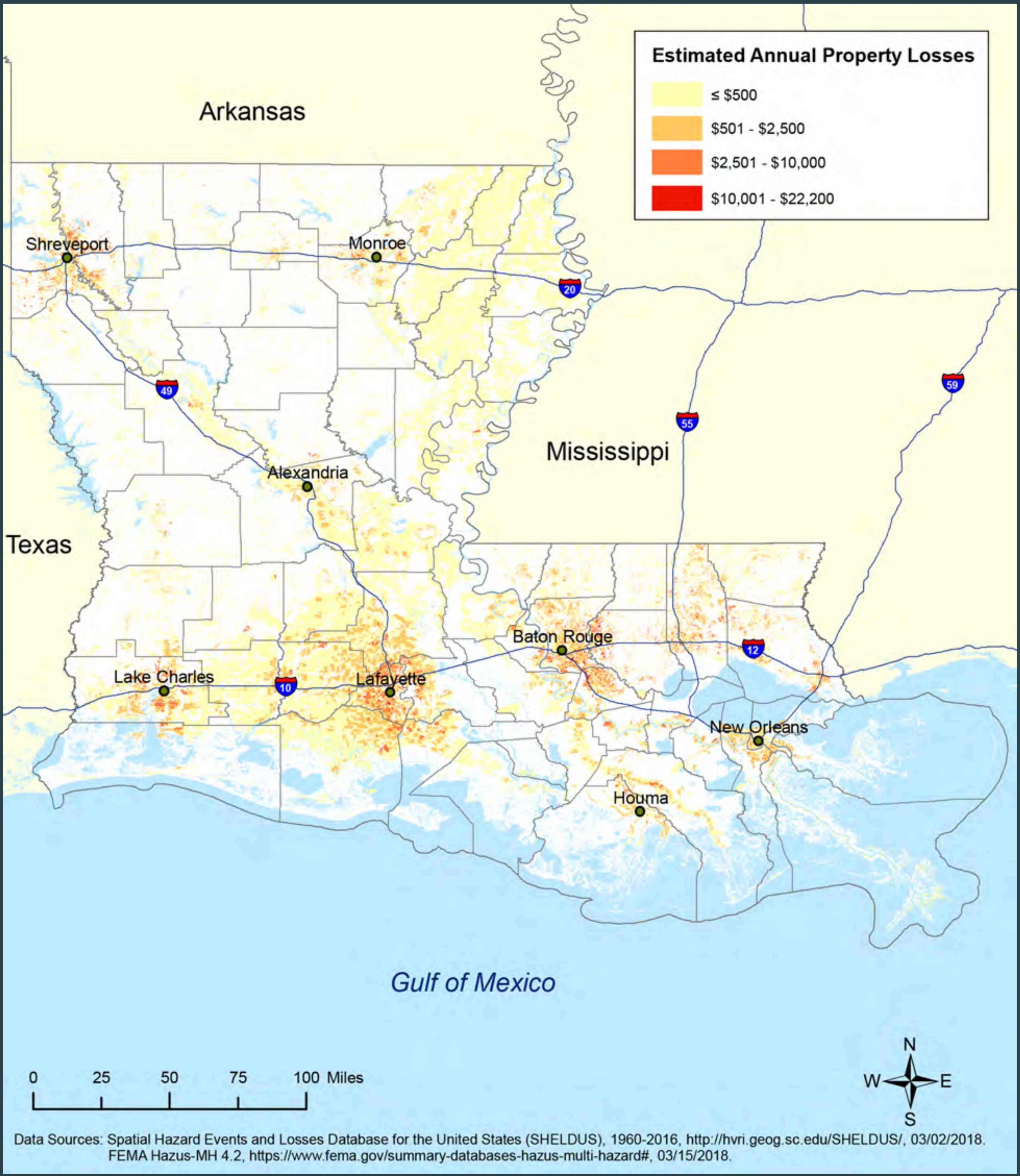
Number of Days per Year Having a Tornado Touchdown within 25 Miles



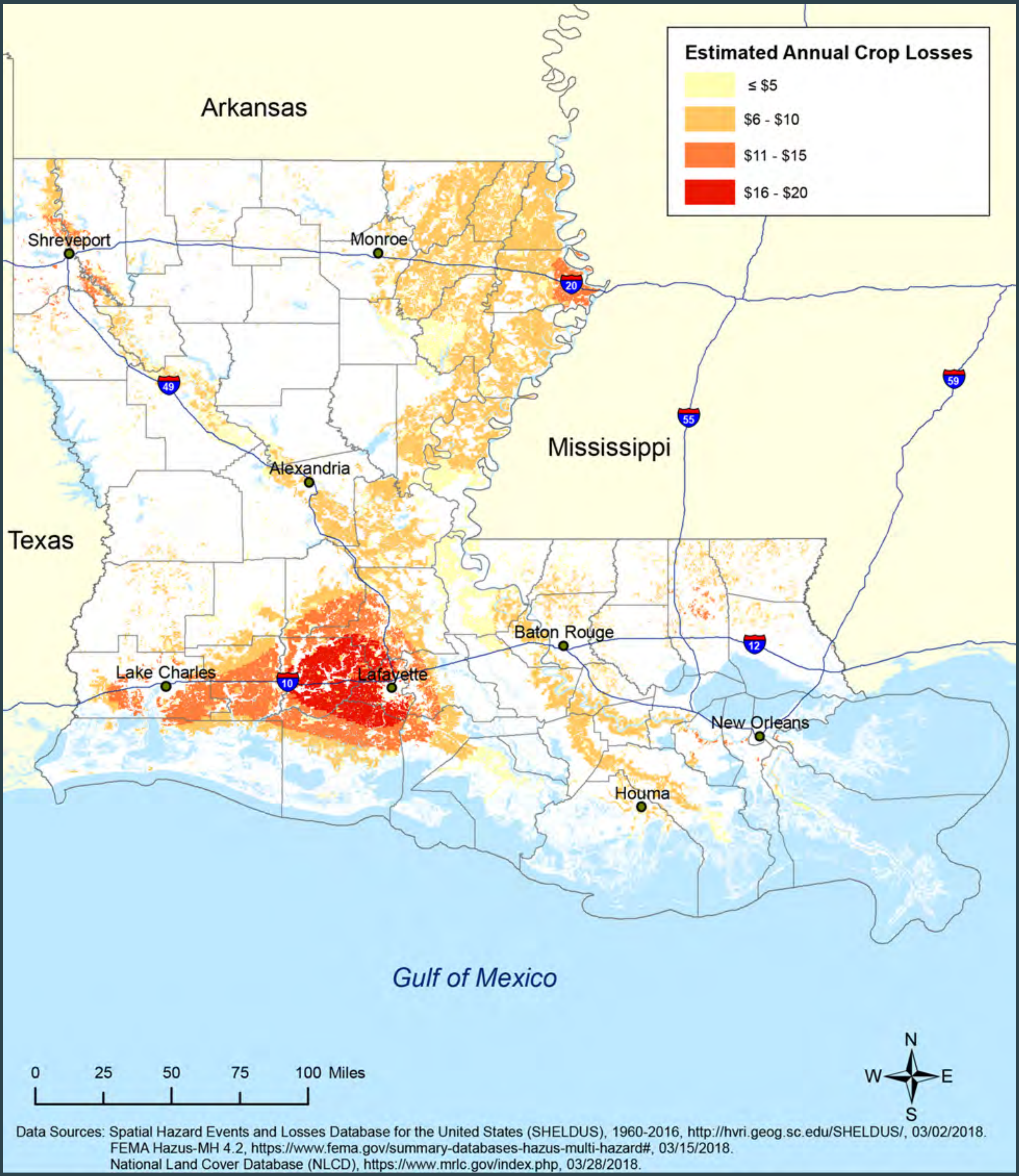
2043 Predicted Number of Days per Year Having a Tornado Touchdown within 25 Miles



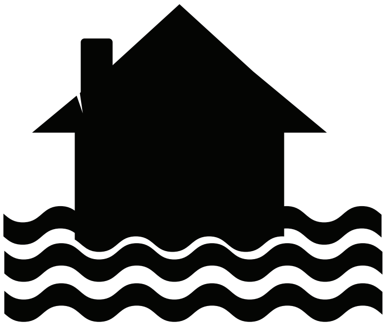
2043 Predicted Annual Property Losses from Tornado by Census Block



2043 Predicted Annual Crop Losses from Tornado by Census Block



Flooding



OVERVIEW

A flood is the overflow of water onto land that is typically not inundated. Excess precipitation, produced from thunderstorms or hurricanes, is often the major initiating condition for flooding, and Louisiana can have high rainfall totals at any time of the day or year. In Louisiana, five specific types of floods are of main concern: riverine, flash, ponding, backwater, and urban. The 1% annual exceedance probability flood (often called the 100-year flood, corresponding to a mean recurrence interval of 100 years) is of particular significance, because it is used as the basis for regulatory standards, such as building codes and flood insurance requirements.

Over the period 1959 to 2005, Louisiana ranked 18th among the states in flood fatalities (excluding those related to Katrina), but third in flood-related injuries and in total flood casualties. Recent significant floods include the August 11-31, 2016 flood affecting southeast Louisiana (DR-4277), the March 8-April 8, 2016 flood affecting northern Louisiana (DR-4263), and the May 18-June 20, 2015 flood along the Red River in northwest Louisiana (DR-4228).

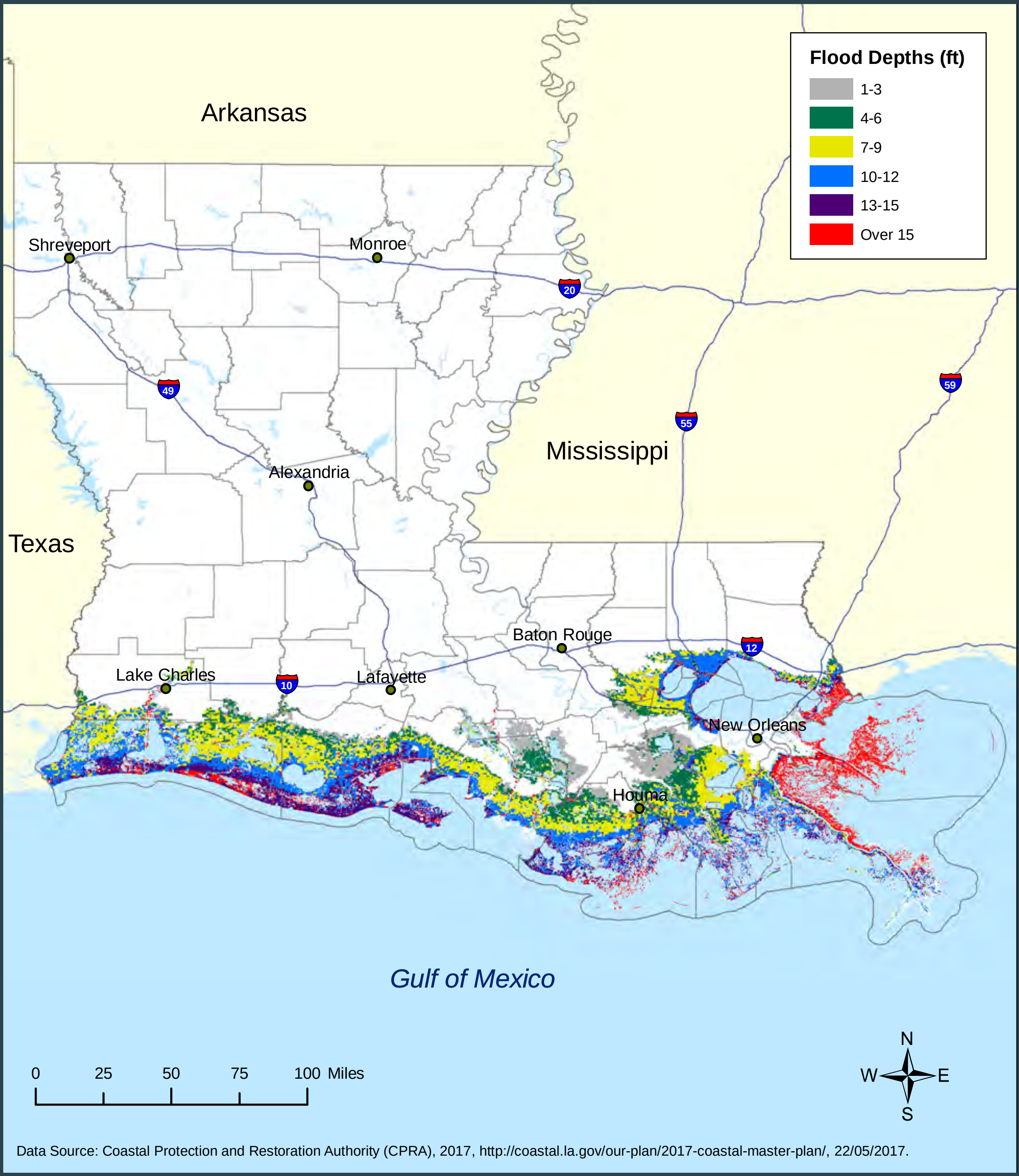
The flood hazard area is defined as the land area that has a 1% chance of flooding per year; however, this is not a complete picture of flood risk, as the flood inundation boundaries corresponding with other likelihoods have not yet been systematically defined. While no changes are projected for riverine flooding due to lack of data, the Louisiana Coastal Protection and Restoration Agency (CPRA) has predicted increases in coastal flooding. The map on the following page merges predicted (increased) 100-year coastal inundation under a medium environmental scenario with no mitigation action in 2042 with the current 100-year flood depths. This map represents the flood hazard we could expect to see in the year 2043. This 2043 representation was used in the risk assessment.

RISK ASSESSMENT

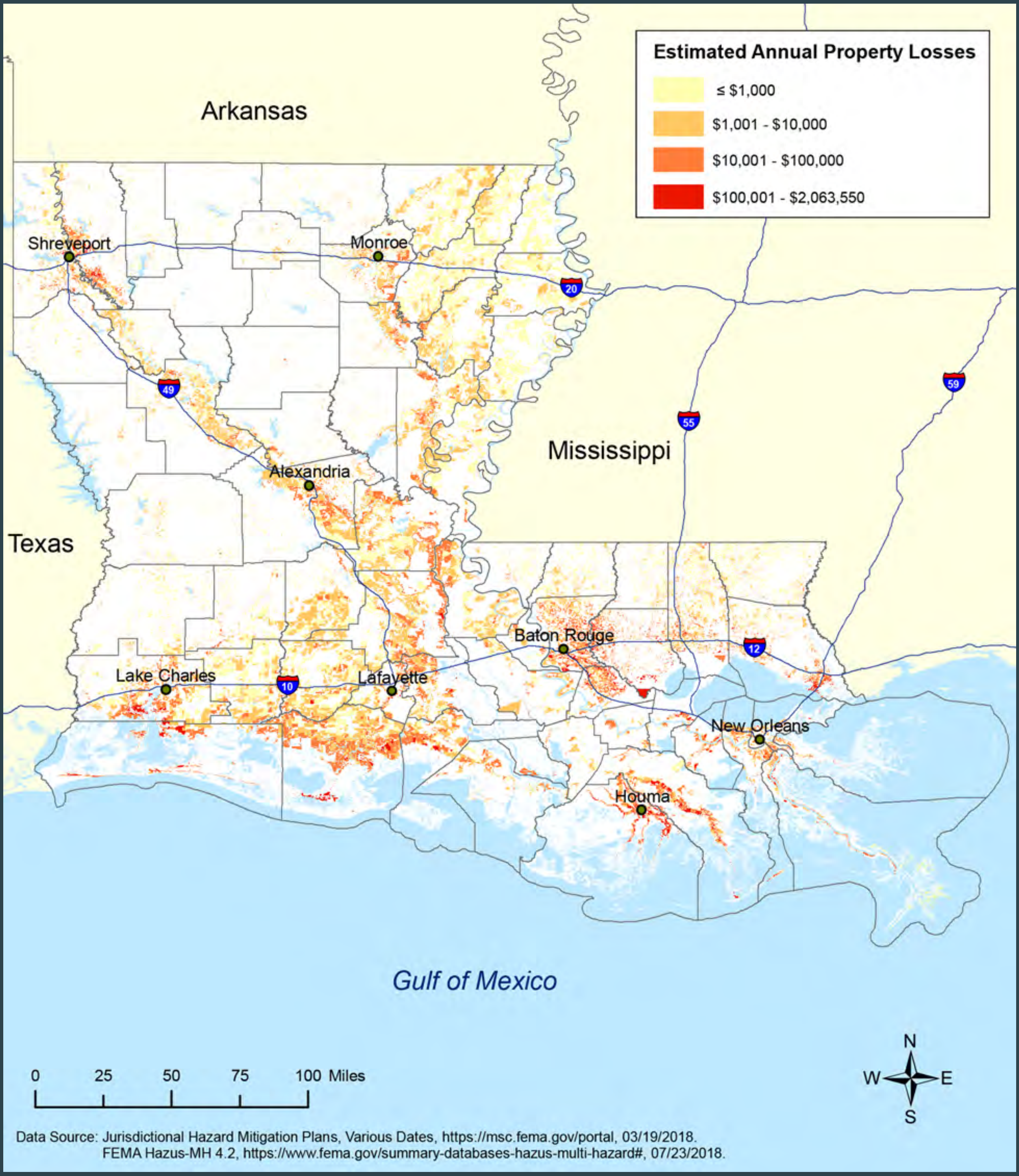
The projected property loss map shows losses associated with the 100-year flood event by census block. Due to insufficient data, annualized losses for parishes are not available for this plan update. Additional study is recommended prior to the next plan update to be able to forecast annualized flood losses.

2017 100-Year Flood Inundation Area in Louisiana

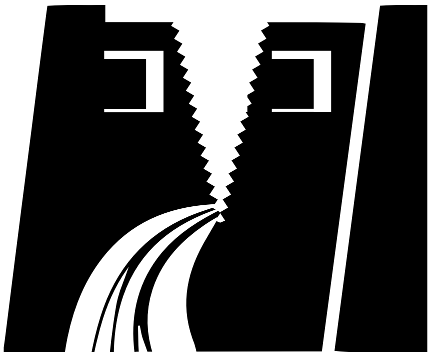
2042 Predicted 100-Year Flood Coastal Inundation Medium Environmental Scenario with No Additional Action



2043 Predicted Annual Property Losses from 100-Year Flood by Census Block



Dam failure



OVERVIEW

Dams are water storage, control, or diversion barriers that impound water upstream in reservoirs. Dams are a vital part of our nation's infrastructure, providing drinking water, flood protection, renewable hydroelectric power, navigation, irrigation, and recreation. These critical daily benefits are also inextricably linked to the potential harmful consequences of a dam failure.

Dam failure is a collapse or breach in the structure. A dam failure can result in severe loss of life, economic disaster, and extensive environmental damage. While most dams have storage volumes small enough that failures have few repercussions, dams with large storage volumes can cause significant flooding downstream. Dam failures often have a rapid rate of onset, leaving little time for evacuation. The first signs of the failure may go unnoticed upon visual inspection of the dam structure. However, appropriate design and continual maintenance and inspection of dams often provide the opportunity to identify possible deficiencies in their early stages, and can prevent a possible catastrophic failure event. High hazard potential dams are dams where failure or improper operation will most likely cause loss of human life. Louisiana has 41 high hazard potential dams. There have been zero high hazard dam failures in the state of Louisiana, although a threatened failure of the Percy Quin Dam in Mississippi following 2012 Hurricane Isaac resulted in a mandatory evacuation for Tangipahoa Parish.

Because Louisiana does not have a history of high hazard dam failures, this section assumes a future probability of 0.0001 (0.01% annual probability) for dam failure in 2043 in consultation with the Louisiana Dam Safety Program. We assume no increases in the number of high hazard dams; therefore, the current data are used to represent conditions in 2043 for the risk assessment.

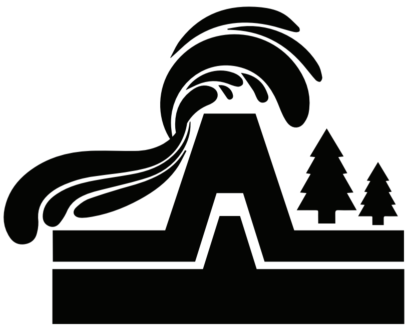
RISK ASSESSMENT

The map depicting dam inundation areas was developed using dam failure simulation data provided by the Louisiana Dam Safety Program. The projected property loss map shows anticipated annual average losses due to failure of high hazard dams by census block.

2017 High Hazard Potential Dams and Innundation Area

2043 Predicted Annual Property Losses from Dam Failure by Census Block

Levee failure



OVERVIEW

Levees and floodwalls are flood control barriers constructed of earth, concrete, or other materials. For the purposes of this plan, levees are distinguished from smaller flood barriers (such as berms) by their size and extent. Berms are barriers that only protect a small number of structures, or at times, only a single structure. Levees and floodwalls are barriers that protect significant areas of residential, commercial, or industrial development; at a minimum, they protect a neighborhood or small community.

Levees are commonplace throughout Louisiana. Northern Louisiana is protected by levees on the Ouachita River, under the authority of the Vicksburg District of the United States Army Corps of Engineers (USACE). The Vicksburg District encompasses 68,000 mi2 in the states of Arkansas, Mississippi, and Louisiana. They manage seven drainage basins, including the Yazoo, Pearl, Big Black, Red, Ouachita, and Mississippi Rivers; 12 locks and dams on the Pearl, Red, and Ouachita Rivers; 1,808 miles of levees, including 468 along the Mississippi River; and multiple lakes with 1,709 mi. of shoreline. The following map illustrates the leveed areas in the Vicksburg and New Orleans Districts.

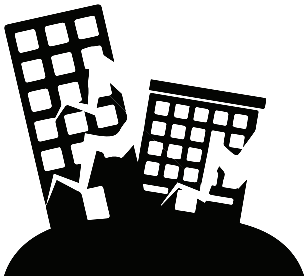
Levee failure involves the overtopping, breach, or collapse of the levee. Levee failure can be especially destructive to nearby development during flood and hurricane events. The most well-known levee breaches in Louisiana occurred in association with Hurricane Katrina in 2005, when several sections along Lake Pontchartrain and along both navigation and drainage canals failed in New Orleans. The extent and depth of these levee failures resulting from Hurricane Katrina caused extreme flooding in New Orleans. However, given the quantity of levees in Louisiana, the annual probability of levee failure is 0.3%.

RISK ASSESSMENT

Due to the low probability of occurrence and insufficient failure model data, the annualized losses for parishes are not available.

2017 Levee Protected Areas in Louisiana

Earthquake



OVERVIEW

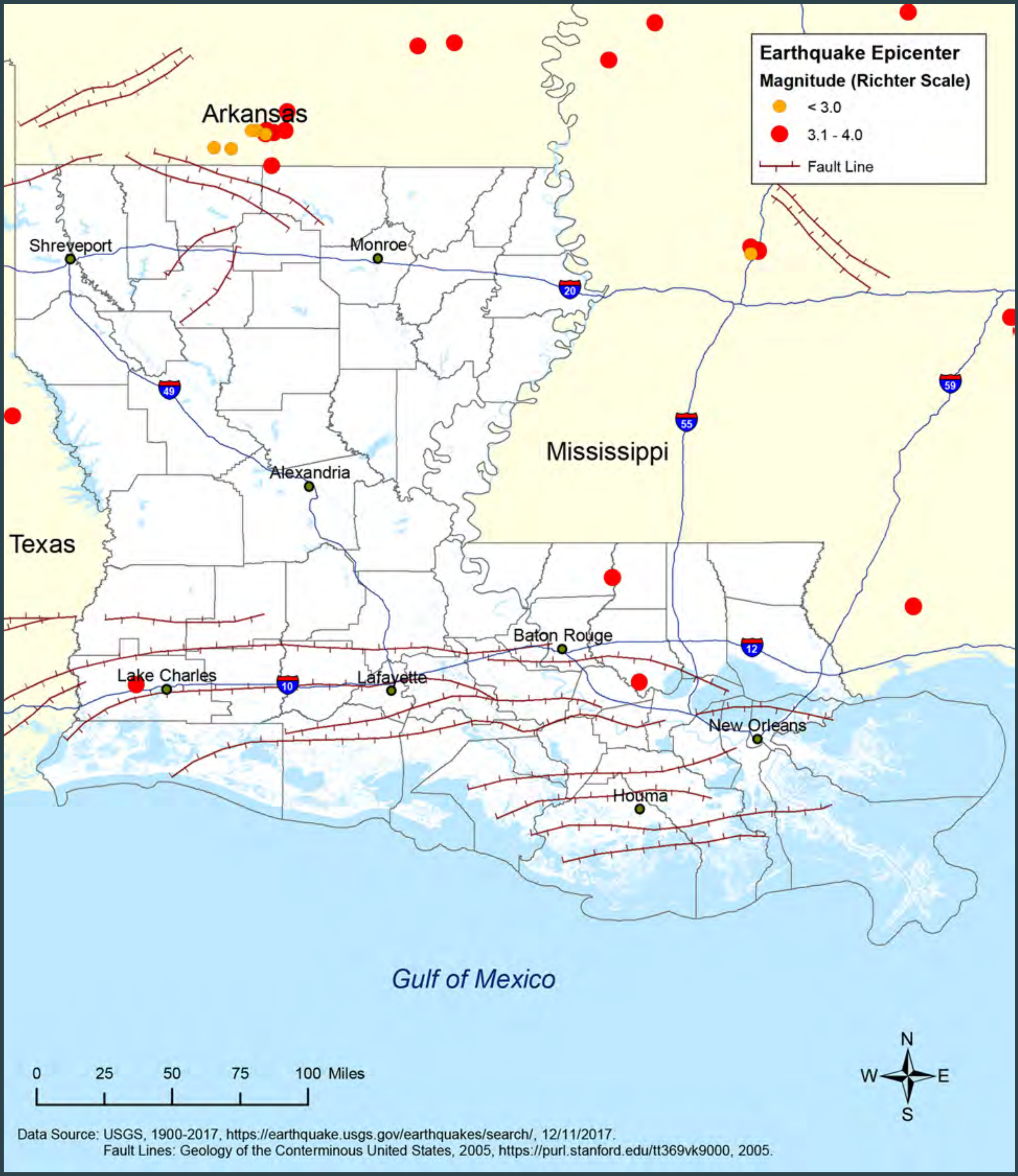
An earthquake is a sudden motion or trembling of the Earth caused by an abrupt release of stored energy in the rocks beneath the Earth's surface. The energy released results in vibrations known as seismic waves. Ground motion from seismic waves is expressed as peak ground acceleration (PGA), the fastest measured change in speed for a particle at ground level that is moving because of an earthquake. PGA is commonly measured as a percentage of acceleration due to Earth's gravity (%g). This measurement is considered in seismic load engineering design and construction requirements.

Based on historic events, the most severe earthquakes in the state are likely to occur to the very north (near the Arkansas–Mississippi border), originating from the New Madrid seismic zone, and to the south (near the coast) from the subsidence fault system. Nevertheless, the USGS has recorded only five minor earthquakes in Louisiana in the past 25 years. Historically, earthquakes have caused minimal damage in Louisiana.

RISK ASSESSMENT

Based on the results of the hazard profiling for this Plan Update, earthquakes are not considered significant by the SHMPC in comparison to the other profiled hazards. Therefore, a technical risk assessment is not included.

1900- -2017 Earthquake Events and Fault Lines in and near Louisiana



Sinkholes

OVERVIEW

Sinkholes are areas of ground with no natural external surface drainage where the Earth's surface has collapsed. They vary in size from a few square feet to hundreds of acres, and reach in depth from 1 to more than 100 feet. In Louisiana, sinkholes are typically formed when a natural salt dome is perforated, fills with water, and the salt dissolves, leading to failure of the surface. Two recent sinkhole events are the Lake Peigneur sinkhole, which began to form in 1980, and the Bayou Corne sinkhole, which formed in 2012.

Both of these sinkholes were caused by the human-influenced collapse of salt dome caverns. Thus, the future sinkholes are more likely to occur in locations that contained salt domes. Based on historic sinkhole formation, the future annual probability of sinkholes in 2043 is 0.01%.

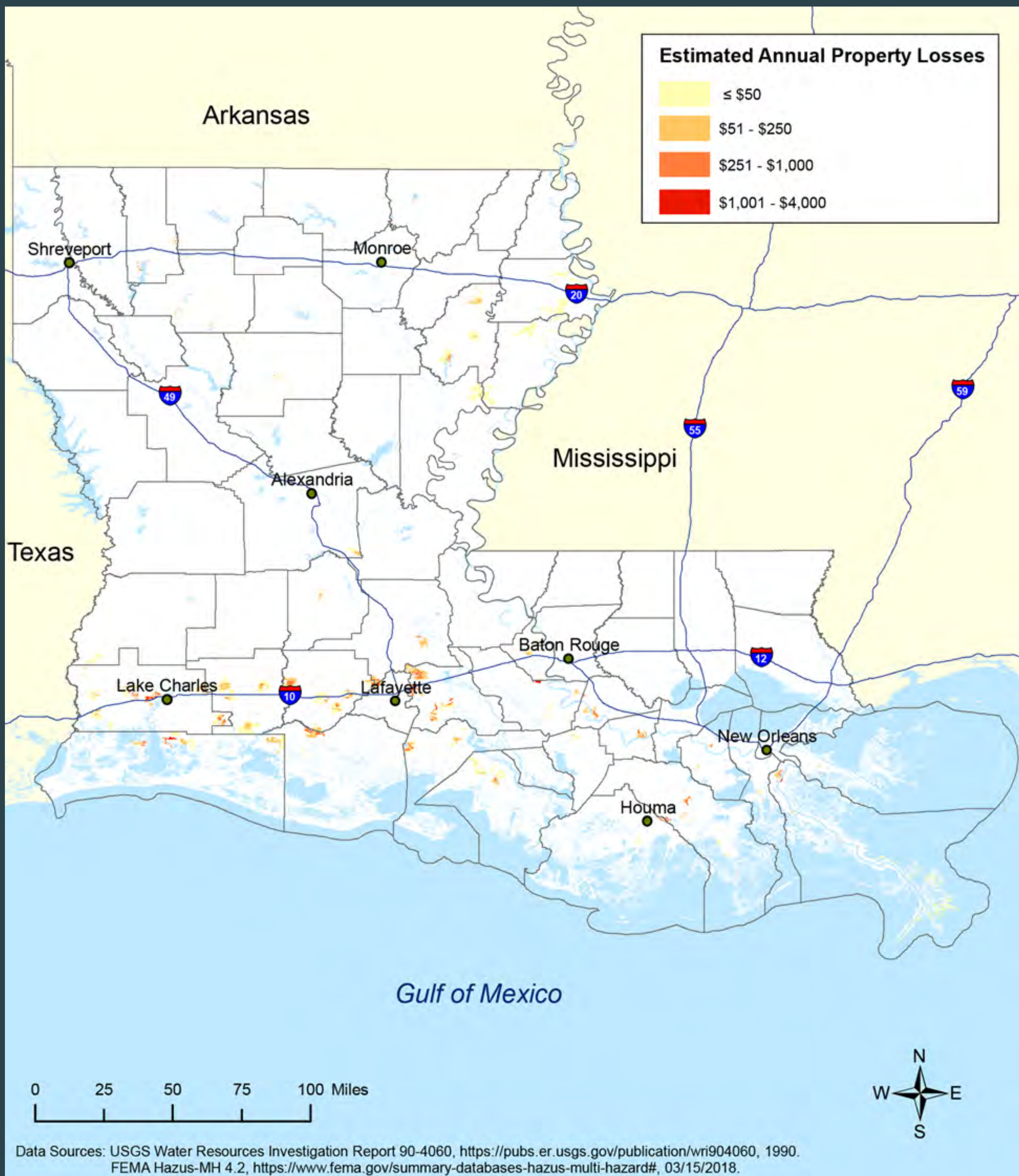
RISK ASSESSMENT

The projected property loss map shows the anticipated annual average losses due to sinkholes by census block.

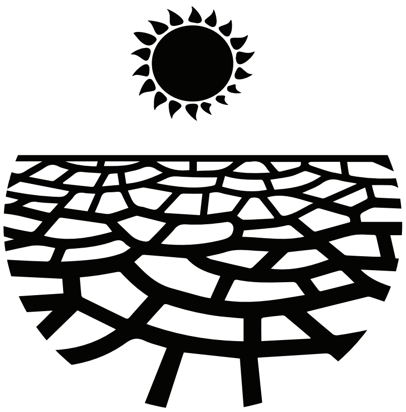
1990

Location of Salt Domes in Louisiana

2043 Predicted Annual Property Losses from Sinkhole by Census Block



Expansive Soil



OVERVIEW

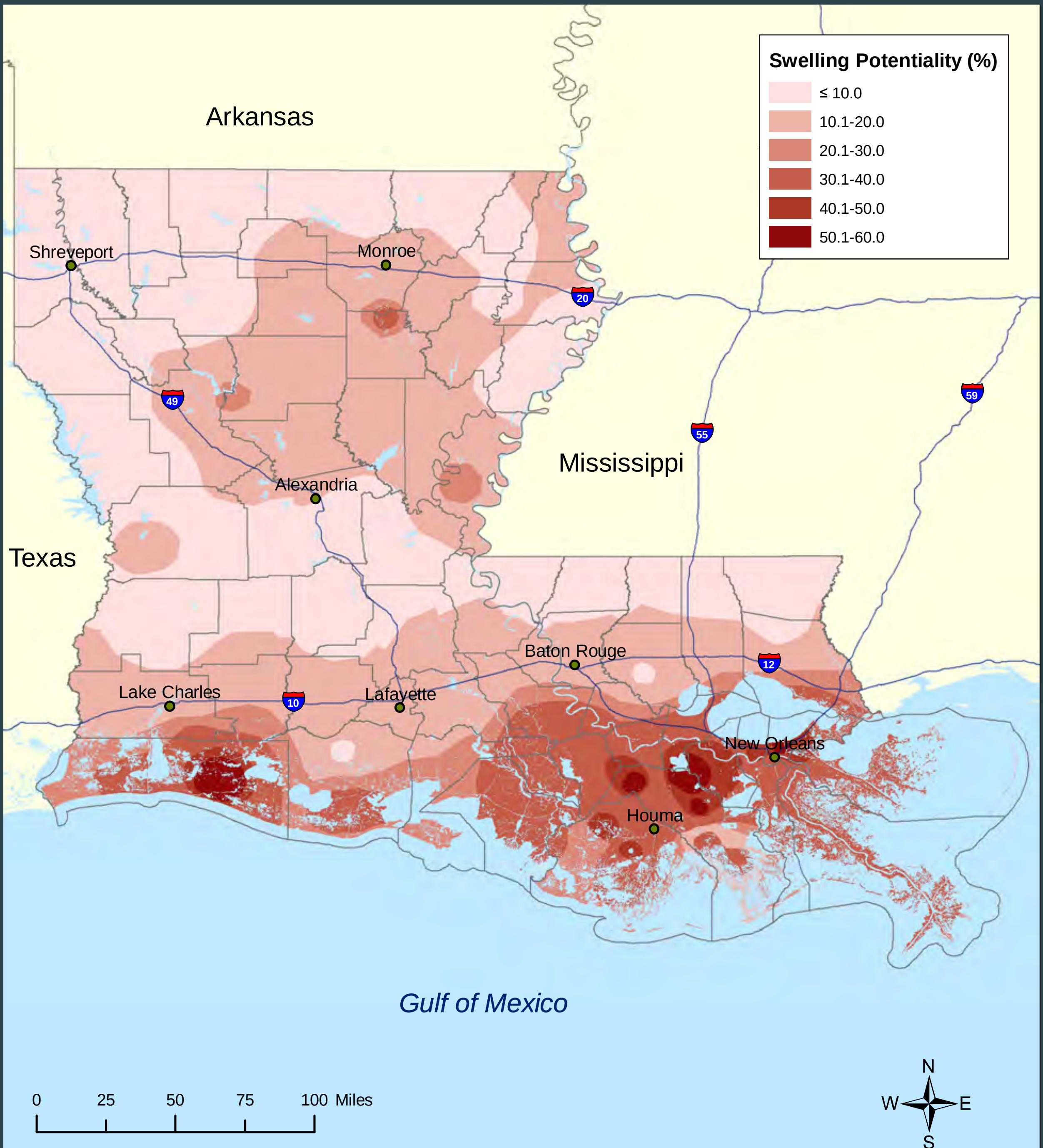
Soil and soft rock that tend to swell or shrink due to changes in moisture content are commonly known as expansive soil. Changes in soil volume present a hazard to lightweight structures built on top of expansive soil. Differential settlement of structures may occur, causing uneven shifting and settlement, cracks in the foundation and walls, and windows and doors that don't properly open. The American Society of Civil Engineers estimates that one-quarter of all homes in the United States are affected by expansive soil. Unlike the other hazards considered in this plan update, the effects of expansive soil are not manifested in a single event, but rather become evident over time. Therefore, no significant past events exist for discussion.

Researchers at Louisiana Tech University previously predicted the swelling potential of Louisiana soil. The following map indicates the existing severity of potential soil expansion. No increase in swelling potential is projected for 2043; therefore the current hazard map is used in the risk assessment.

RISK ASSESSMENT

The projected property loss map shows anticipated annual average losses due to expansive soil by census block.

1962 Expansive Soil in Louisiana: Swelling Potential Distribution



Data Source: Expansive Soils and Practice in Foundation Engineering, 2016, http://www.ltrc.lsu.edu/ltc_16/pdf/presentations/10-University%20Transportation%20Centers%20(Part%201)-Characterization%20of%20Expansive%20Soils%20in%20Northern%20Louisiana.pdf, 03/07/2016.

2043 Predicted Annual Property Losses from Expansive Soil by Census Block