CHAPTER 1

Introduction

Although it is a relatively small state (**Figure 1.1**), Louisiana experiences a wide array of annual and seasonal weather episodes. The state regularly sees more than its share of tropical depressions, tropical storms, hurricanes, severe thunderstorms, lightning, heavy rainfall, flooding, tornadoes, drought, heat waves, freezing rain/sleet events and economically devastating freezes. In fact, over the past 100 years hurricanes have hit Louisiana more often than any other state except Florida and Texas. The variety of severe weather events is attributed to the state's position along the central Gulf Coast of the United States. Louisiana, and the central Gulf Coast in general, may receive as great a variety of significant weather as any other region on Earth. Most of these events are enhanced by local atmospheric and water interactions, and/or the low-lying nature of the terrain, which elevates flood potential and makes it easy for cold air to penetrate into the state from the north and interact with warm, humid air from the Gulf of Mexico. This situation creates a good recipe for many types of significant and severe weather.

Not only does Louisiana experience a variety of weather events, but the *impacts* of those events can be devastating. Louisiana was affected directly or peripherally by 22 of the 106 weather events in the United States since 1980 that caused economic impacts of at least 1 billion dollars, an average of one such event every 1.5 years since 1980 (Ross and Lott, 2003). In fact, many of these were multi-billion dollar events! Of the $708.3 billion in total property losses incurred with these events, the 18 events that directly impacted Louisiana accounted for at least 36.7 percent ($259.6 billion) of the total. Although not all

Figure 1.1. State map of the United States highlighting the state of Louisiana.
Source: © Antenna International/ShutterStock, Inc.

damage from these events was restricted to the state, this total amounts to over $54,000 per Louisianian! Therefore, Louisiana is not only affected by frequent severe weather events, but many of these events represent some of the most catastrophic events, in terms of total property damage and loss of life, that occur in the contiguous United States. **Table 1.1** briefly chronicles all Louisiana-related billion-dollar weather events since 1980.

Louisiana's low-lying terrain (ranging from as low as –13 feet [–4 m] to only about 500 feet [150 m] above mean sea level), makes her susceptible not only to floods, but also to drastic landscape alteration due to long-term temperature increases that are indicative of global climate change. One scenario is that warming will cause large-scale melting of polar ice, which will in turn cause a significant rise in sea level. Even a small increase in sea level would result in large-scale inundation of coastal areas in Louisiana. Such a situation also would

Table 1.1 Billion Dollar Weather Events Affecting Louisiana Since 1980[1]

Event Year	Event Description	Areas Affected	Damage (Billions of $)	Total Deaths
2011	Tropical Storm Lee	LA, PA, NY	1.6	18
2008	Hurricane Ike	TX, LA, MS	27	43
2007	Drought	ND, SD, NE, KS, OK, TX, MN, WI, IA, MO, AR, LA, MS, AL, GA, NC, SC, FL, TN, VA, WV, KY, IN, IL, OH, MI, PA, NY	5.0	—
2007	South/East Severe Storms	CT, DE, GA, LA, ME, MD, MA, MS, NH, NJ, NY, NC, PA, RI, SC, TX, VT, VA	1.5	9
2006	Drought	ND, SD, NE, KS, OK, TX, MN, IA, MO, AR, LA, MS, AL, GA, FL, MT, WY, CO, NM, CA	6.2	—
2005	Hurricane Katrina	LA, MS, AL	133.8	1,833
2005	Hurricane Rita	LA, TX	16	119
2004	Hurricane Ivan	AL, FL, GA, LA, TX	13	25
2001	Tropical Storm Allison	TX, LA, MS, FL, PA	5.1	43
2000	Drought/Heat Wave	Southeastern U.S.	4.2	140
1998	Hurricane Georges	Caribbean, Gulf South	5.9–6.6	600 (total), 16 (U.S.)
1995	Heavy Rain, Floods, Hail May 1995, N.O. hardest hit with 10–25 in. rain	TX, OK, LA, MS	5.6	32
1994	Southeastern U.S. Ice Storm, February	TX, OK, AR, LA, MS, AL, TN, GA, SC, NC, VA	3–3.7	9
1992	Hurricane Andrew	FL, LA	27–35.6	61
1990	May Floods	TX, OK, LA, AR	1–1.4	13
1985	Hurricane Juan/Floods	LA – FL	1.5–2.8	63
1985	Hurricane Elena	LA – FL	1.3–2.4	4
1983	Gulf States Storms/Floods	TX to FL	1.1–2.2	≥50
Total	**18 Events**		**259.6–273.6**	**≥2,478**

Data from National Climatic Data Center.

affect many other areas of the physical and cultural landscape. Indeed, one could argue that perhaps no other state would be influenced by global warming as much as Louisiana. A proper understanding of long-term climate change impacts is vital for proper planning and the long-term livelihood of the state. Even small changes in world-wide climate may produce catastrophic results for Louisiana.

Present and future weather events may acutely affect Louisiana, especially given the primary economic activities in the state: agriculture (including fisheries), tourism, and oil/gas exploration, processing, and distribution.

Economic Impacts of Weather and Climate on Agriculture and Fisheries

Louisiana leads the nation in seafood exports, producing a high percentage of all indigenous seafood consumed in the United States. In the rich coastal waters of southern Louisiana, seafood production nets more than $120 million gross farm value on sales of shrimp, crabs, oysters, crawfish, and catfish (LSU AC, 2012). The bays and estuaries that provide breeding grounds and habitats for most of the profitable species are highly susceptible to disruption of their delicate ecosystems by severe weather and climatic changes. Significant harvest declines occurred after Hurricane Katrina (2005) and the Deepwater Horizon oil spill (2010).

Other, less dramatic environmental changes may greatly impact seafood harvests as well. For instance, in brackish estuaries and coastal regions, changes in average monthly rainfall may alter salinity levels and therefore displace organisms. Such occurrences may impact organism migration routes, perhaps leading to massive kills. In some cases, increases in precipitation-related runoff into these areas causes a hypoxic zone (an area deficient in oxygen), in part because the runoff carries nutrients from agricultural fertilizers that break down in the waters. This process uses oxygen, which in turn leads to oxygen-poor waters. Such conditions cause organisms to be displaced

farther from the coast. This frequently places many species in deep water conditions where lower temperatures and/or further deficiencies in oxygenated water cause widespread deaths. Because statewide economic repercussions can be devastating, monitoring even slight changes in weather/climate conditions is important.

Other notable and viable agricultural activities at the mercy of the unpredictable Louisiana weather include sugar production; growing of citrus strawberries, soybeans, and timber; rice cultivation; and catfish farming. Of these, perhaps sugar, oranges, and rice are most directly affected by severe weather events such as flooding, tropical cyclones, and freezes. The susceptibility of sugar and rice is related to the fact that these crops are typically farmed on flat regions in the southern part of the state. These areas, only a few feet above mean sea level, are especially prone to tropical cyclone storm surges that devastate the lowlands with saltwater intrusions and high winds. Also affected is the crawfish, a secondary "crop" typically harvested from flooded rice paddies during the off (non-growing) season. Floods generated by thunderstorms and/or mid-latitude storms also wreak havoc on these low-lying regions. Freezes can devastate orange groves with recovery times estimated at 12 years or more.

Economic Impacts of Weather and Climate on Tourism

The state depends heavily upon tourism as a source of revenue. In some cases, however, singular events impacted by unusual weather events disrupt tourism for many years. One example involves the 1984 New Orleans World's Fair, which was plagued by an unusually hot and humid late spring/early summer. This further cemented a national perception that New Orleans, and Louisiana in general, is unbearably hot and humid. The negative publicity associated with the weather of 1984, along with negative press tied to the downturn in the Louisiana oil/gas economy at that time, contributed to below-average attendance at the World's Fair, and tourism activities in New Orleans were well below normal for several years thereafter.

On the other hand, some have suggested that the tourism industry is healthy in years when pleasant weather occurs on Mardi Gras day.

Public perception of Louisiana's climate may also greatly affect the tourism industry. The general national perception of Louisiana's weather is "steamy" to say the least. This perception of an unbearably uncomfortable place, perpetuated by entertainment and the media, is usually exaggerated. This misinformation plagues the tourism industry, which depends heavily on many activities during quite pleasant times of the year. Events such as the Sugar Bowl, the Super Bowl (New Orleans has hosted this event more times [nine] than any other city), Mardi Gras, the Jazz and Heritage Festival, and many other food-oriented festivals (gumbo, shrimp, crawfish, strawberry, etc.) bring in much needed tourism dollars. Most take place during the "cool season" between October and March. Indeed, Louisiana's climate seems to give it an advantage as a "winter-season draw" for tourists.

Another important aspect of the state's tourism industry portrays Louisiana as "Sportsman's Paradise." The term is deserved in part because hunting, fishing, and outdoor recreational activities are possible during virtually all times of the year. Hunting and fishing seasons offset between the cool and warm seasons, respectively. Hunting seasons include deer, turkey, waterfowl, alligator, and many others. Waterfowl hunting alone is valued at $154 million per year throughout the Mississippi River Valley, with a high proportion in Louisiana (LDWF, 2008). The sport fishing season is important as well with over $100 million generated annually in the Mississippi River Valley. Again, much of that total is generated in Louisiana (Bemidji, 2003). Further, because of the warm climate and abundance of water sources, recreational activities such as boating, sailing, skiing, swimming, hiking, biking, and other related activities are year-round tourism draws. In total, over $446 million is generated annually by outdoor sporting activities (LDWF, 2008). As with other aspects of the tourism industry, many of these activities

are dependent, either wholly or partially, on weather and climate. Significant weather events and/or shifts in climate can greatly impact these resources.

Economic Impacts of Weather and Climate on the Oil and Gas Industry

Oil/natural gas represents one of the leading industries in Louisiana from an economic, employment, and tax base perspective, and weather/climate affects both the supply and demand for the product. Natural gas was first discovered in northern Louisiana in the late 1800s. The first oil well was established in 1901 in Jennings Field. With the advent of offshore drilling in 1947 came the extension of the oil and gas industry beyond the state boundary and even greater weather/climate impacts to the industry (LMOGA, 2003).

In reality, Louisiana's oil and gas industry includes four related activities: exploration/production, refining, marketing, and transportation. Louisiana ranks third in the nation in the production of natural gas and fourth in the production of crude oil. When the Gulf of Mexico is included, Louisiana ranks second and third in those categories, respectively (LMOGA, 2003). The refining segment involves taking raw materials and converting these into a usable product. Currently, Louisiana supports 19 active oil/gas refineries that account for 15 percent of the total refining capacity of the country. The Exxon-Mobil plant north of downtown Baton Rouge, for instance, is one of the largest oil refineries on Earth. The marketing and transportation segments of the industry involve creating and feeding the product user base. Literally, thousands of miles of gas and oil pipelines cross the state. These pipelines carry crude oil to Louisiana refineries from the Gulf of Mexico while other pipelines carry refined products to other states. Direct economic impacts from the oil/gas industry include taxes, royalties, fees, and other money directly spent in Louisiana from the industry. Indirect effects involve salaries earned by industry employees being spent in the state as well as associated service companies. In total, the industry represents a

$65 billion infusion directly to the state with another $3 billion originating from the offshore industry (Houma, 2009).

Weather and climate elements play a role in the oil and gas industry in a variety of ways. Most directly affected are the areas of exploration, production, refining, and transportation. Of these, perhaps transportation is most directly affected by atmospheric variations. For example, during the spring of 1973, the Lower Mississippi River remained above flood level for 76 days (Trotter et al., 1998). The severity of the flood came very close to undermining the Old River flood control structure north of Baton Rouge. Had the structure collapsed, the Mississippi River would have been captured by the Atchafalaya River basin, effectively cutting off the supply of fresh water to New Orleans, and salty Gulf waters would have intruded the Mississippi River channel well north of the city. At the same time, the dramatic, near-instant increase in Atchafalaya flow would have been an ecological disaster as well as a cultural and economic nightmare to lower basin communities, and even to the nation as inundation would have effectively cut oil and gas pipelines crossing the Atchafalaya basin.

The Mississippi River Flood of 1973 affected, at least in part, production and refining of oil, gas, and petrochemicals. Of major concern to civic planners and emergency management officials were 28 petrochemical plants and the nuclear power plant located on a 13-mile stretch of the river in St. Charles Parish (USACE, 2003). That concern took on very real consequences as the river crest moved through that area during the night of 19 March when 42 barges broke loose near Laplace, narrowly missing the Waterford Three nuclear power plant intake valves. In all, over 134 barges caused destruction of wharves, intake facilities, and loading platforms. In one instance, the release of ammonia from a ruptured pipeline necessitated the evacuation of a dozen homes along the river (Trotter et al., 1998).

Individual weather events may affect the production of oil and gas by temporarily shutting down wells and refineries. Tropical cyclones

cause evacuation of virtually all offshore oil platforms while other types of weather close facilities in the wake of severe events. For example, Hurricane Betsy in 1965 caused widespread destruction of Louisiana's oil and gas industry. Over 3,000 workers had to be evacuated from the more than 4,800 offshore well sites that extend to 95 miles (153 km) from the Louisiana coast. During the storm, major losses to the supply bases occurred and most of the marine fleet was beached or damaged. Three refineries were deemed inoperative after the storm due to water damage to electrical installations.

A more notable example occurred in 2005 when Hurricane Katrina devastated much of southeastern Louisiana. The storm damaged offshore docking facilities, gas and oil refineries, pipelines, offshore rigs, and transportation routes important to the oil and gas industry. The devastation culminated in then-record-high gas, natural gas, and oil prices for the entire nation over the following year.

The reality of a changing climate dictates that Louisiana's environmental future will change. Potential impacts of changing annual and/or seasonal temperature and rainfall patterns, changing frequencies and magnitudes of severe weather, the prospect of coastal inundation and accelerated coastal erosion, and many related issues must be anticipated. Such widespread changes would ultimately affect all aspects of the oil and gas industry and many other industries in the state, causing long-term economic impacts.

Book Goal

While attention will be given to all aspects of Louisiana weather and climate in this book, particular emphasis is placed on the processes that produce severe weather events. It is intended to both inform the layman and provide some in-depth understanding of weather processes to professionals. All significant severe weather events are covered, with one chapter devoted to each topic. Each chapter concludes with a discussion of significant weather events of that type recorded through the last century or so. We hope that the

book will appeal to residents of the state, prospective visitors, and various professionals in need of weather- and climate-related reference materials.

State weather and climate books have been written for a few states, notably, *North Carolina Weather and Climate* (P. Robinson, 2005), and *Mississippi Weather and Climate*, (Sherman-Morris et al., 2012). In addition, texts such as *Atlas of Oklahoma Climate* (Johnson and Duchon, 1995) take a largely cartographic approach to describing the climate of that state. On the other hand, *Thunder in the Heartland : A Chronicle of Outstanding Weather Events in Ohio* (Schmidlin and Schmidlin, 1996) provides a historical approach to summarizing the impacts of past weather events in Ohio. While we include aspects that are similar to those mentioned above, this book is more similar in scope to *Texas Weather* (Bomar, 1995) and *The Climate and Weather of Florida* (Henry et al., 1994). Those books serve to educate the interested public on the types and processes of weather that occur in those states with particular focus on noteworthy past weather events. In addition, the book is also written in a way that would make it useful as a convenient reference manual for research purposes.

Although a goal of the book is to provide a convenient weather reference manual, we will not dwell on overly technical aspects of weather processes. We seek simply to explain factors important in the generation of the various types of weather that occur in the state and focus on important past events, primarily over the past century.