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2.5 LESSONS LEARNED: EVACUATIONS MANAGEMENT OF HURRICANE GUSTAV

Gina M. Eosco[1], Mark A. Shafer[2], and Barry Keim[3]
[1]Department of Communications, University of Oklahoma
[2]Oklahoma Climatological Survey, University of Oklahoma
[3] Department of Geography and Anthropology, Louisiana State University

Experience is what you get when you don't get what you want. The experience of Hurricane Katrina was not what anyone in New Orleans wanted, yet three years after New Orleans was struck by Hurricane Katrina, the city proved they were ready for the next big one. As the National Hurricane Center forecasts started indicating a possible category 3 or stronger hurricane heading towards Louisiana, the city began preparations for evacuation. Gulf coast residents responded with the largest evacuation in U.S. history. Given the contrast with Katrina, why was the response to Gustav so much better?

It is true that government officials learned from Katrina, but Katrina was just one milestone along the way toward making New Orleans safer. This paper examines prior recent experience with hurricanes in Louisiana, events surrounding Hurricane Gustav, and how we have learned from other disasters. Not only did Louisiana officials learn from prior hurricanes, but those far-removed from the area of impact learned from their own disaster experiences to manage the influx of evacuees. The progression of events highlights the trust officials placed in projections, the role of planning, and the extent of learning from prior experience.

1. Hurricane Georges

In September 1998, Hurricane Georges seemed to take dead aim on New Orleans before veering sharply to the east, making landfall in Biloxi, Mississippi. On a nearly two-week trek across the Atlantic, Georges peaked at a strong category 4 hurricane with winds of 155 mph, leaving an enormous swath of damage across the Caribbean islands and 600 dead. Although it never regained its prior strength, it still struck the Gulf Coast as a Category 1 storm with winds below 95 mph.

Although Georges missed making landfall in Louisiana, it highlighted how ill-prepared New Orleans was for a major hurricane. Evacuation for hurricane Georges was uncoordinated and chaotic. Each parish had its own separate response plan. Some parishes called for mandatory evacuations while others did not. Some opened shelters, while others did not. The timing of evacuations was not coordinated between parishes, with the result that roadways became clogged and those most vulnerable had great difficulty getting out.

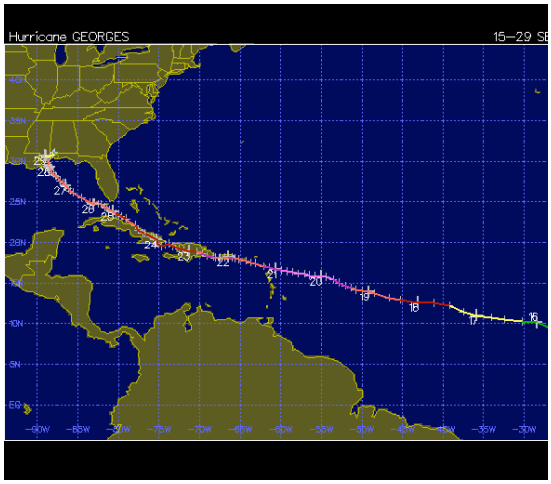

Figure 1. Track of Hurricane Georges, September 20-27, 1998 (Image source: Unisys http://weather.unisys.com/hurricane/).

Georges highlighted the need for coordinated planning and improved evacuation procedures. These would be tested when the next major storm approached New Orleans – Hurricane Pam in 2004.

2. Hurricane Pam

Hurricane Pam wasn't even a real hurricane at all; rather it was a computer-based exercise developed by Colonel Michael L. Brown, former deputy director of emergency preparedness in Louisiana (Cooper and Block 2006). The exercise was spurred on by the obvious failures in response to Georges. In the projection, a slow-moving Category 3 hurricane struck New Orleans directly, pushing its storm surge over the top of the levee system and filling the city with up to 20 feet of water.

* *Corresponding author address*: Mark Shafer, Oklahoma Climatological Survey, 102 David L. Boren Blvd., Suite 2900, Norman, OK 73072; e-mail: mshafer@mesonet.org

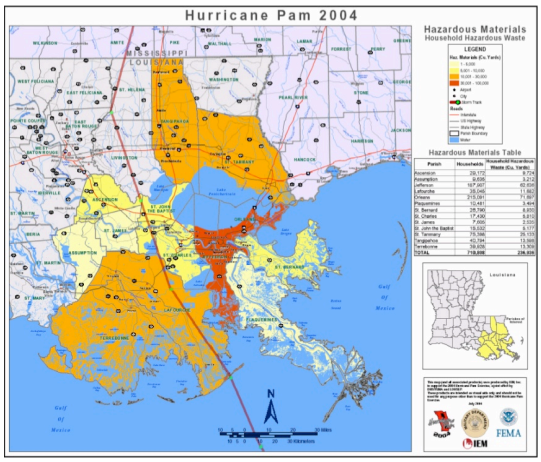

Figure 2. Hurricane Pam exercise (Source: Integrated Emergency Management 2004).

Cooper and Block (2006) describes the fate of most hurricane plans dumped on Louisiana by the federal government: "the common practice among governmental bodies in Louisiana was to accept such studies without comment, agree to adopt them by unanimous vote, and store them on a shelf, along with the budget books and other effluvia of local bureaucracy." Hurricane Pam was different from previous plans, in that it presented the scenario and left it to the participants to figure out how to respond.

The exercise spanned eight days during July 2004 and involved up to 270 people, representing federal agencies, state officials, local emergency personnel, officials from adjoining states, utilities, and relief organizations. During the scenario, it was assumed that 65% of the metropolitan area would evacuate, leaving 600,000 people behind to ride out the storm. The Louisiana Superdome, the only shelter for the city, proved incapable of handling the numbers left homeless from the storm. Water from the overtopped levees combined with excessive rainfall overwhelmed the city's drainage pumps, knocking out 80% of the pumps and leaving the city covered in water for more than a month. More than 200,000 are stranded on rooftops in need of rescue and 61,290 people perish.

Through Hurricane Pam, the participants learned the difficulties of identifying and obtaining needed equipment. One of the ground rules was that if something was needed, such as a generator, the participants had to identify from where they would obtain it; nothing could be assumed to show up. However, realistic as it was, local officials often turned toward FEMA officials who said there were contracts in place and they could deliver the resources – 100,000 beds, mobile communications centers, or video uplinks to establish teleconferences. Even for its thoroughness, the exercise left some questions unanswered: temporary housing, relocation of displaced people from the Superdome to longer-term shelters, post-event security from looting, reentry to the city by returning residents, and FEMAs promised stockpiles of provisions.

Hurricane Pam was about as thorough and realistic an exercise as could have been attempted. It highlighted weaknesses in current plans, identified needed resources for response, and most importantly engaged officials in dialogue. According to Cooper and Block (2006): "In subsequent disasters in Louisiana, the locals have excelled in the areas that were covered during the Pam workshop. That's particularly true of evacuations, which improved markedly in the state following the Hurricane Pam drill."

The problem with exercises is that no matter how realistic the scenario, participants know that it is not a real event. Consequently, there is a tendency to look at exercises as an inconvenience, much like a fire drill interrupting important work. While they do a great deal of good, there are some who do not take them seriously.

3. Hurricane Ivan

Shortly after the Hurricane Pam exercise, the plans were put to the test. Hurricane Ivan threatened a direct assault on New Orleans in September 2004. Ivan had become a Category 5 hurricane, with sustained winds reaching 170 mph as it tracked across the Caribbean. It weakened slightly as it entered the Gulf of Mexico but still maintained Category 4 strength. It made a right turn and weakened just before landfall, coming ashore at Gulf Shores, Alabama with 120 mph winds.

New Orleans was spared a direct hit from Ivan and barely got a drop of rain. However, the experiences of trying to evacuate the Louisiana coast taught some valuable lessons. As Ivan approached, Louisiana ordered mandatory evacuations in 7 parishes and voluntary evacuations in six others. More than half the residents of New Orleans evacuated. Special needs patients were moved to the Louisiana Superdome during the storm.

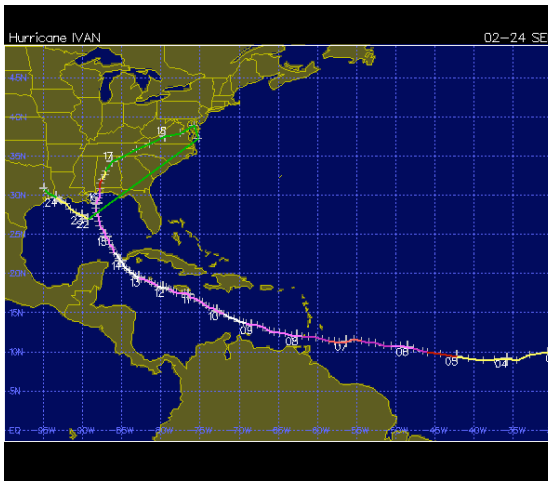

Figure 3. Track of Hurricane Ivan, September 2-24, 2004 (Image source: Unisys http://weather.unisys.com/hurricane/).

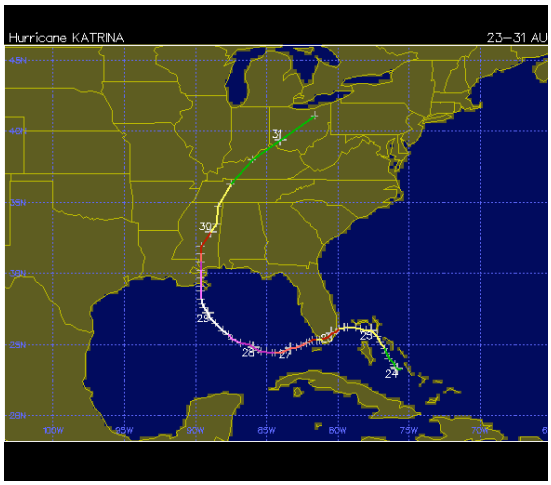

Figure 4. Track of Hurricane Katrina, August 23-31, 2005 (Image source: Unisys http://weather.unisys.com/hurricane/).

While Louisiana had vastly improved coordination of its state and parish evacuation plans, Louisiana officials had failed to do the same level of coordination with neighboring states. As is now common practice in mass evacuations, the inbound lanes of major highways are turned outbound, a process known as contraflow. This doubles the capacity of the highways to get people out of harm's way. While Louisiana implemented contraflow for its evacuation efforts, I-59 in Mississippi did not. Consequently, a bottleneck developed that could have had disastrous impacts had Ivan not veered to the right. Officials would take from this lesson as Katrina approached the following year.

4. Hurricane Katrina

While Katrina is well-known for being among the worst U.S. disasters, there is an often untold story of the success of the evacuation. Hurricane Katrina formed over the Bahamas and tracked across southern Florida before entering the Gulf of Mexico. Once in the Gulf, Katrina rapidly intensified to a Category 5 hurricane with winds of 175 mph. Unlike Ivan, Katrina was a much larger hurricane. It weakened to a Category 3 hurricane with sustained winds of 125 mph just south and east of New Orleans (Buras, LA), with a second landfall of 120 mph at landfall at the Louisiana – Mississippi border.

What made Katrina so deadly was its storm surge. The surge contributed to the failure of nearly every system in New Orleans and neighboring parishes. The storm and floodwaters claimed at least 1,836 people and caused $81.2 billion in damages; the deadliest hurricane since the 1928 Okeechobee Hurricane and costliest ever.

The Katrina evacuation was extraordinary. Over 1 million from the New Orleans metropolitan area were evacuated within 36 hours, representing more than 80% of the region's population. This was much higher than the 65% evacuation rate expected in the Hurricane Pam exercise. Unlike their experience with Ivan, coordination of evacuations between neighboring states improved traffic flow, even though more people across a much larger area of coastline evacuated.

The difficulties for New Orleans lay in those who were not able to evacuate by their own means. Rental cars, busses and ambulances were in short supply and many public transportation systems were shut down well in advance of the storm. The city opened the Superdome as a shelter of last resort for those unable to leave the city. Damage from the storm severed transportation arteries going into and out of New Orleans, leaving those in the city stranded.

Through the experiences of Pam, and Ivan, Louisiana officials had worked out many of the evacuation issues which plagued them during Georges. Consequently, that portion of the response to Katrina worked well. However, little attention appeared to have been paid toward securing the resources needed to evacuate those unable to do so on their own. Local resources were in short supply and federal resources failed to materialize as promised. Among the criticisms leveled at officials were insufficient provisions at designated shelters and delaying issuing

the mandatory evacuation order until 19 hours before landfall.

5. Hurricane Gustav

Almost exactly three years after Katrina struck New Orleans, another hurricane had the city in its sights. Hurricane Gustav, which had formed as a tropical depression on August 25, 2008 near Haiti, tracked in a nearly straight line across the Gulf of Mexico toward the city. Hurricane Gustav struck the Louisiana Coast on September 1, 2008, causing more than $8 billion in damages across the Caribbean and United States and triggering the largest evacuation in United States history.

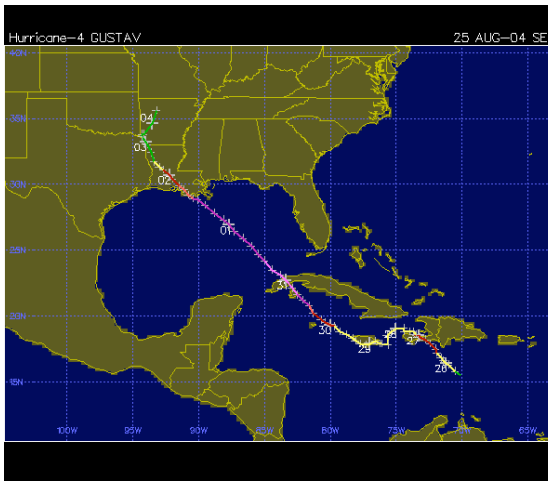

Figure 5. Track of Hurricane Gustav, August 25 – September 4, 2008 (Image source: Unisys http://weather.unisys.com/hurricane/).

While Katrina may have been "the perfect storm", Gustav was perhaps the perfectly-forecasted storm, at least in its track. From almost the moment it formed, it was clear that Gustav was headed towards Louisiana. Two days before landfall, Mayor Nagin urged residents to "get your butts out of New Orleans." Nearly two million residents along the Gulf Coast followed this advice, the largest evacuation of the U.S. coastline in history. Although Hurricane Gustav weakened before landfall, there was still substantial risk of flooding or levee breaches that kept the city on edge.

The following timeline details the hurricane's development, emergency preparations and response, and media coverage for the event.

August 25

Gustav became a tropical depression at 11 a.m. on August 25. By 2 p.m. it had become a tropical storm and by the end of the day it was nearly a hurricane. At this point, preparedness procedures focused on Haiti and Cuba. Most media coverage was in the international sections of wire services.

August 26

Gustav continued rapid intensification, reaching 90 mph sustained winds by 8 a.m. on August 26. Although weakening was expected as it neared Haiti, there were concerns that it would enter the Gulf of Mexico and intensify into a major hurricane. That morning's forecast track from the National Hurricane Center placed Gustav entering the Gulf of Mexico on the morning of August 31.

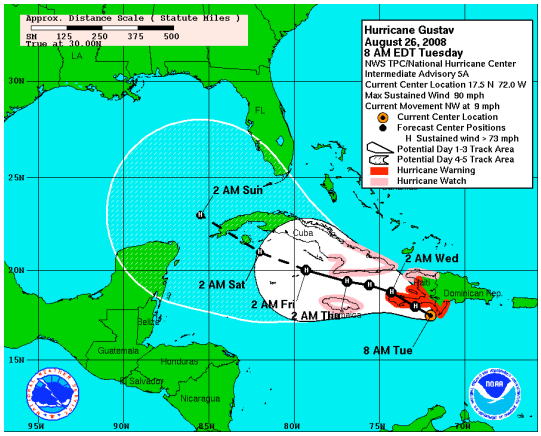

Figure 6. 5-day forecast track issued Tuesday morning, August 26.

Louisiana officials were already concerned. Briefings from 10 a.m. that morning from the Baton Rouge Emergency Operations Center stated that Gustav "is about 5 days away from possible landfall" and that "a Category III to Category IV seems almost certain if Gustav enters the warm waters of the Gulf of Mexico." The briefing also noted that the change in track was not significant and advised citizens to "watch the whole cone and not just the center of Gustav." Their briefing put landfall around the morning of September 2 with effects as early as the 30th.

At the briefing, Louisiana State Police noted their preparations:

> "The State Police and GOHSEP are working with local government to provide information, support, and manpower. A meeting was held yesterday and it was agreed that the state and local government will work together to help the contra flow move more smoothly than with Hurricane Katrina. Communication is key, therefore a system has been established and implemented so that communication will not fail

as it did during Hurricane Katrina. Col. Edmondson also introduced the newest class of Police Officers that where scheduled to graduate on Tuesday 9-2-08 but instead will graduate on Friday 8-29-08 so the extra man-power will be available."

Notice the references to Katrina – an example of learning from experience.

The Mayor's Office in Baton Rouge prepared for impacts as coastal areas evacuated:

> "We will see local communities and the State of Louisiana pull many triggers that will directly impact East Baton Rouge Parish and its' residents. Evacuation, Migration, Economic and Social Impacts will affect our community based on these triggers for a storm that's tentatively a week away."

The Office also noted difficulties would be compounded by not only a weekend, but a holiday weekend. It urged agencies to submit staffing and callout rosters to the EOC as soon as possible and began coordinating shelters.

The plans called for evacuation to northern shelters, following the state contra flow plan, noting that Baton Rouge remained at high risk. It also tasked the EOC with coordinating media requests to assure accurate and timely reporting "as well as rumor control." Local officials were preparing for the work case scenario situations and there was evidence in the briefings of coordination with Mississippi to improve traffic flow. It also prepared Baton Rouge to local governments from South Louisiana. Officials were taking no chances: "***many lessons were learned from Katrina. The most important lesson is that accurate and timely communication is key.***"

August 27

By the 27th, New Orleans was within the cone of uncertainty on the 5-day track maps. Although Gustav had weakened to tropical storm status, it was expected to increase to wind speeds of at least 115 mph by Day 3 of the forecast. An extension of the center of the forecast track would place landfall near New Orleans. No watches or warnings for the Gulf Coast had been issued.

By the afternoon, newspaper wire services were mentioning evacuation possibilities for New Orleans. Coverage had moved from the international section to domestic and business sections. Newspaper services mentioned a possible pending state of emergency declaration by Louisiana Governor Bobby Jindal, with assisted evacuations possibly beginning within 48 hours and exercising contracts for as many as 700

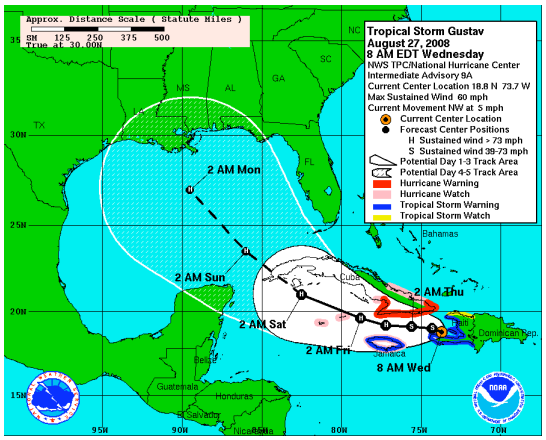

Figure 7. 5-day forecast track issued Wednesday morning, August 27.

buses. Later that evening, Associated Press reported that New Orleans was drawing up evacuation plans, "hoping to prevent the chaos it saw after Hurricane Katrina struck three years ago." (*Gustav kills 22; New Orleans makes evacuation plan*)

August 28

The next day, Gustav remained at tropical storm levels and the track, though wobbling slightly, remained roughly the same. Track forecasts placed landfall along the Louisiana coast early morning on September 2 with wind speeds near 140 mph. There were still no watches or warnings posted for the U.S. coastline.

Media began picking up on the threat to New Orleans. Coverage shifted from discussion of the possible track and actions being taken to human stories:

> "I'm panicking," said Evelyn Fuselier of Chalmette, whose home was submerged in 14

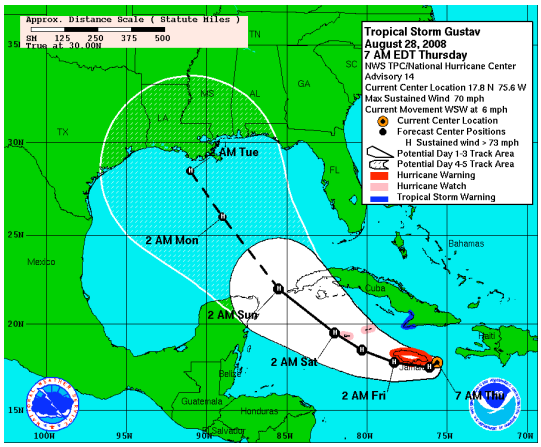

Figure 8. 5-day forecast track issued Thursday morning, August 28.

feet of floodwater when Katrina hit. Fuselier said she's been back in her home one year this month, and called watching Gustav swirl indescribable.

Steve Weaver, 82, and his wife stayed for Katrina — and were plucked off the roof of their house by a Coast Guard helicopter. This time, Weaver has no inclination to ride out the storm. "Everybody learned a lesson about staying, so the highways will be twice as packed this time," Weaver said. (Associated Press, *New Orleans is preparing for Gustav*)

Reports noted that New Orleans planned to institute a mandatory evacuation order if a Category 3 or stronger storm was projected to come within 60 hours of the city. It also was reported that there would be no shelter of last resort in New Orleans, and that the state had arranged for buses and trains to evacuate people from the city.

August 29

As Gustav moved closer toward the Louisiana coast, there were still no warnings or watches issued by the National Hurricane Center. During the day, Gustav returned to Category 1 hurricane strength. Its track remained roughly the same, although progressing slightly more westward during the day. Although there were no official watches or warnings, discussions began mentioning "interests throughout the Gulf of Mexico should monitor the progress of Gustav." At 5 p.m., a tropical storm watch was issued for the Florida Keys. By early on the 29th, New Orleans and the State of Louisiana had begun evacuating hospitals from the projected strike zone.

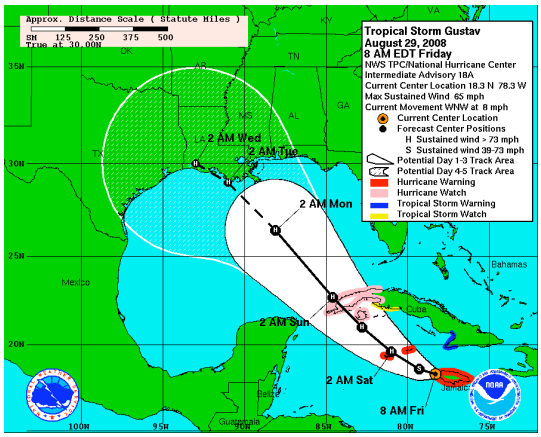

Figure 9. 5-day forecast track issued Friday morning, August 29.

August 30

With projected landfall just three days away, there were still no hurricane watches or warnings. Gustav intensified rapidly from a Category 1 hurricane that morning to a Category 4 with winds of 150 mph by the evening. Forecast tracks continued to zero in on the southern Louisiana coast near New Orleans. First official mention of a possible hurricane watch was at 11 a.m.: "a hurricane watch could be issued for portions of the northern gulf coast later today". Projected landfall was for the morning of the 2nd with wind speeds of 155 mph. A watch was finally issued at 5pm that day.

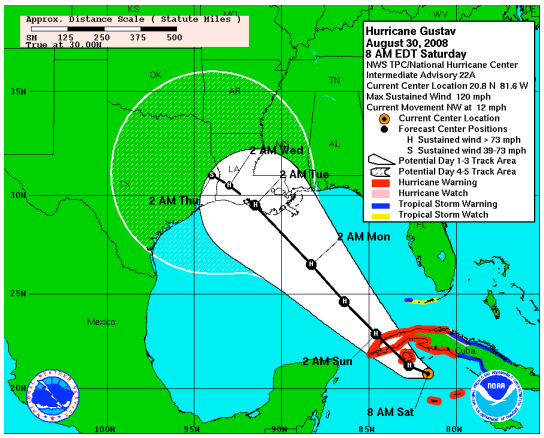

Figure 10. 5-day forecast track issued Saturday morning, August 30.

By this time, New Orleans and the Louisiana coast were fully mobilized in an evacuation. Mayor Nagin spoke in clear terms of the threat, calling Gustav "the mother of all storms" and that staying would be "one of the biggest mistakes you could make in your life." Even before a mandatory evacuation order was issued for New Orleans late in the day, an estimated 1 million people evacuated from the coast. Perhaps the most convincing evidence that officials were taking Gustav seriously was that the LSU season opener football game was moved up six hours, so the game would be complete before contra-flow on I-10 went into effect. Only a major hurricane could mess with LSU football.

August 31

By the morning of August 31, Hurricane Gustav weakened slightly to a Category 3 hurricane with wind speeds of 120 mph, but still on a direct course toward New Orleans. Hurricane warnings for the Louisiana coastline eastward to the Alabama-Florida border were issued at 4 a.m., giving only 24 hours warning to those in the path. The warning urged that preparations "should be rushed to completion"; the first mention of preparing in any of the advisories. At

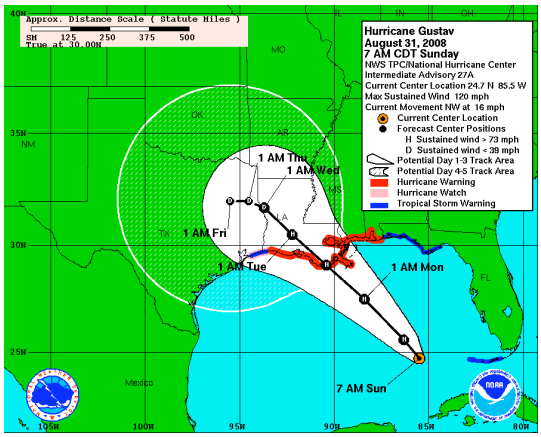

Figure 11. 5-day forecast track issued Sunday morning, August 31.

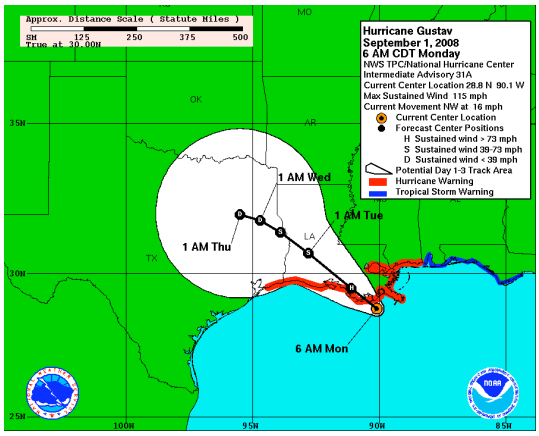

Figure 12. 5-day forecast track issued Monday morning, September 1.

4 p.m. that afternoon, the hurricane warning was extended westward to High Island, Texas.

With the outer bands of Gustav only a day away, evacuation procedures began wrapping up. Helicopters and ambulances were positioned for triage. Equipment, which had been procured over the preceding week, was positioned. Double shifts were started in the Baton Rouge sheriff's office. First responders, urban search groups, and fire personnel were housed in Baton Rouge, along with the emergency operations centers for the parishes of Orleans, St. Bernard, Jefferson, and Plaquemine. The attention to detail was extraordinary; the East Baton Rouge Parish attorneys urged everyone "to follow procedures and document everything."

September 1

Gustav made landfall at about 8 a.m. on September 1, almost precisely at the location projected five days in advance. Wind speeds were reported at 110 mph by the National Hurricane Center, making Gustav a very strong Category 2 storm. The forecasts of both track and intensity were amazingly accurate.

Actions within Louisiana shifted from evacuation to rescue and recovery. The American Red Cross, Louisiana Homeland Security and police were on standby. The National Guard had 300 soldiers in Baton Rouge and another 200 by air, awaiting orders. Seven thousand National Guard soldiers were deployed statewide.

Shelters in the area were full, but most were withstanding the onslaught. Some roof failures and structural damage were reported in a few school shelters, hospitals, and emergency operations centers, but no reports of injuries were received from any of those facilities. Communications were hampered and of some concern, but appeared to remain functional among first responders.

New Orleans was spared the damage that officials expected was possible. Although levees were overtopped slightly, they held and the city and surrounding parishes avoided the extensive flooding associated with Katrina. The media packed up and moved on to the next story. But they missed an important footnote. While attention was focused on New Orleans, they did not realize the level of damage sustained in Baton Rouge.

On the morning of September 1, the Baton Rouge Mayor's Office noted not much change in the forecast, saying Gustav was "not as bad as it could be." The National Weather Service forecast noted that winds were not going to be as strong as expected, although rainfall could be heavier. But as the storm cleared, the extent of the damage was immense. The city was hit like it hadn't been since at least 1965 in Hurricane Betsy, and perhaps as far back as 1947. Wind gusts in Baton Rouge were measured at 91 mph with sustained wind speeds in the 70s over a protracted period of time. The amount of damage was immense, with trees down and extensive damage all across the city. Power was out for more than a week, which was even worse considering that Hurricane Ike was tracking their way.

6. Sheltering Evacuees

Moving two million people out of the path of a hurricane is an immense undertaking. Most of the evacuees were moved inland within Louisiana or neighboring states (Figure 13). Some were transported as far away as Tennessee, Oklahoma City,

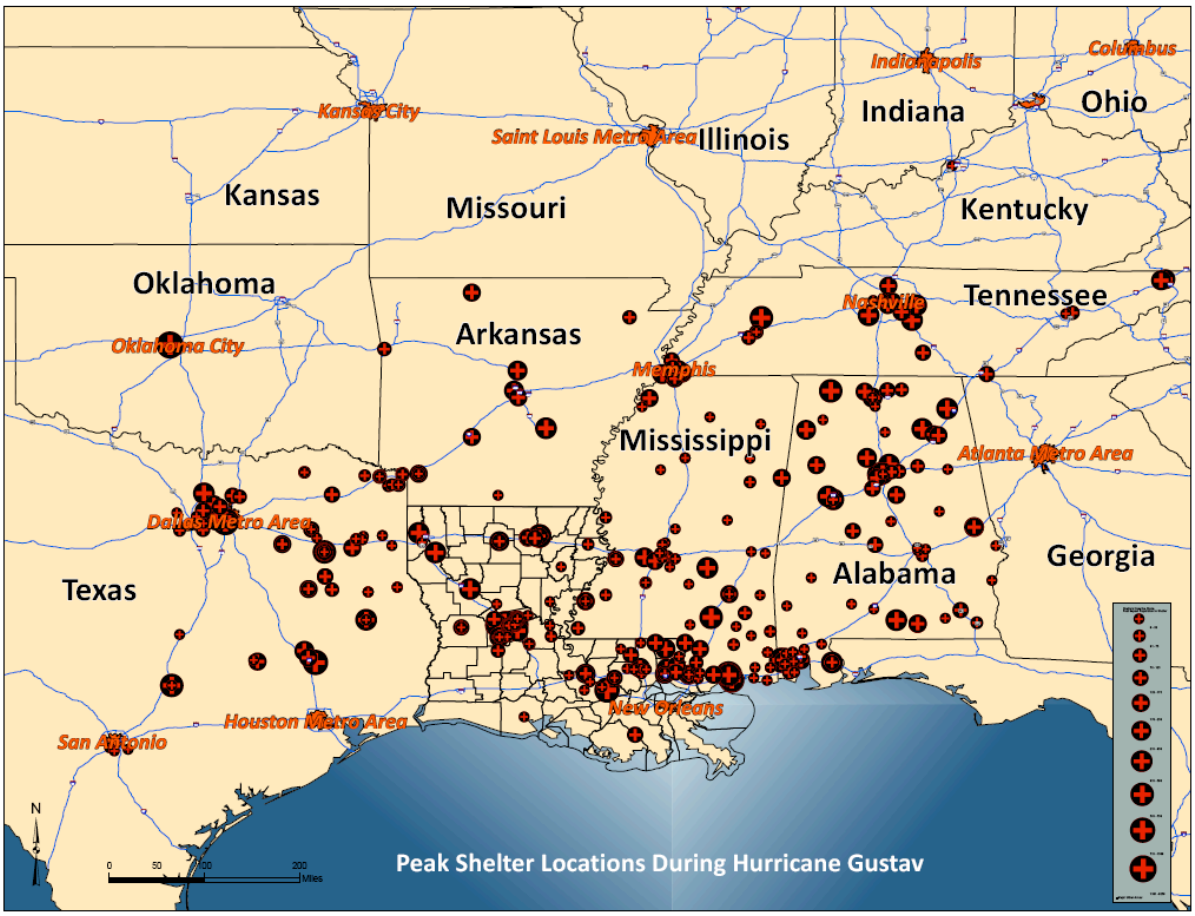

Figure 13. Locations of shelters opened for Hurricane Gustav evacuees. The size of the dot is proportional to the number of evacuees received at each shelter.

Kansas City, Saint Louis, Indianapolis, and even Columbus, Ohio.

Those who were transported to Oklahoma ended up at a single shelter in Oklahoma City. The State of Oklahoma opted for a single facility, located at a former manufacturing facility in Oklahoma City, capable of providing food and shelter for 4,000 people. During a devastating ice storm in December 2007, city officials learned that a single shelter provided better services to their citizens than multiple shelters throughout the city. Resources and disaster assistance organizations could be concentrated in a single location and individual needs could be better tracked. FEMA took note of the model, and recommended that it be adopted as a model for hurricane evacuations.

This new model was put to the test as the shelter was assembled in less than 24 hours. On Sunday, August 31, city officials began preparing to receive what they expected to be about 8 busses carrying 400 evacuees. By Monday morning, that figure swelled to 34 busses carrying 1,800 evacuees. Although some supplies ran short, officials were able to procure what they needed within a matter of hours.

It was not just the logistics of the event that were impressive, it was also in the details. During news briefings, management officials referred to the people as “guests” and made every effort to make them feel welcomed. Pets were transported separately to nearby animal shelters and arrangements were made for visitation. City officials provided extra security and assistance to help guests find their way around the city for those who desired to find restaurants or simply walk around.

Although New Orleans had become a virtual ghost town, there were some who chose not to evacuate. Other than a few hearty souls who preferred to ride out the hurricane, some of those left behind were those with outstanding warrants and illegal immigrants. Shelters checked evacuees for outstanding warrants, so those wanted by the police

may have been hesitant to be transported to the shelters. Likewise, despite assurances that immigration status would not be checked, some feared deportation and chose to remain behind.

7. Hurricane Ike

Hurricane Ike, although it did not make landfall in Louisiana, proved to be a bit of a quagmire. Following closely on the heels of Gustav, uncertainty in the forecast track hampered evacuation decisions. It only was about one day before landfall that Louisiana officials could relax. From the period of Fay in mid-August through Ike in mid-September, officials in Louisiana were in operations mode for 31 days.

Even though Ike's landfall missed the Louisiana coast, it revealed some limitations of our ability to manage evacuations. Storm surge projections were well short of those observed. Consequently, decisions made on the projections, and recognizing that likely landfall was in Texas, left some areas unexpectedly vulnerable.

Projected storm surges of 20 feet with Gustav failed to materialize. Maximum storm surges ended up in the range of 8-10 feet, perhaps as high as 12 feet in areas where surge waters were confined within levees. However, evacuation decisions were still wise; 12-foot storm surges are capable of overtopping levees so the population in the area was at risk whether surges peaked at 12 feet or 20 feet.

By contrast, storm surge along the Louisiana coast was higher from Hurricane Ike, which made landfall some 60 miles west of the border. The unexpectedly large 15-foot surge put people at risk that should have been evacuated. The surge propagated inland as far as Lake Charles, LA.

Figure 14. Track of Hurricane Ike, September 1-14, 2008 (Image source: Unisys http://weather.unisys.com/hurricane/).

8. Lessons Learned

From Hurricane Gustav, we learned that with proper planning it is possible to evacuate large population areas along our coastlines, including those who are not capable of evacuating by themselves. Coordination between Louisiana, her neighbors, and the federal government moved those in need to shelters far away from New Orleans and then returned them safely within a matter of days.

Lessons were drawn not only from Hurricane Katrina; rather it was a progression of learning that began more than a decade before. Hurricane Pam highlighted the dangers of assuming resources would materialize. Hurricane Ivan showed needed coordination with neighbors to improve traffic flow away from the region. Hurricane Katrina showed that more attention and planning had to be focused on those incapable of evacuating by themselves. Hurricanes Gustav and Ike showed difficulties of relocating wanted felons and illegal immigrants and the need for better storm surge models to more precisely target areas where evacuation is needed.

Through each event and simulation, evacuation strategies were refined, culminating in the most successful evacuation of a region in history. The seriousness with which officials took the situation, at the first indication of a threat, kept them ahead of events. Forecasts were critical to decision-making, but institutional policies regarding the issuance of watches and warnings should be reviewed. It is possible to find flaws in event the best management, but in Gustav, the successes far outweighed the minor challenges that remain.

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