

The Mothers of All Disasters

Massive hurricanes striking Miami or Houston. Earthquakes leveling Los Angeles or Seattle. Deadly epidemics. Meet the “maximums of maximums” that keep emergency planners up at night.

David A. Graham, *The Atlantic*, 9-2-15

For years before Hurricane Katrina, storm experts warned that a big hurricane would inundate the Big Easy. Reporters noted that the levees were unstable and could fail. Yet hardly anyone paid attention to these Cassandras until after the levees had broken, the Gulf Coast had been blown to pieces, and New Orleans sat beneath feet of water.

The wall-to-wall coverage afforded to the anniversary of Hurricane Katrina reveals the sway that a deadly act of God or man can hold on people, even 10 years later. But it also raises uncomfortable questions about how effectively the nation is prepared for the next catastrophe, whether that be a hurricane or something else. There are plenty of people warning about the dangers that lie ahead, but that doesn't mean that the average citizen or most levels of the government are anywhere near ready for them.

The biggest disasters seem so far out of the range of the normal possibilities of daily life that it's nearly impossible to even envision the scale of the destruction and upheaval, even for people who have survived one. Huge hurricanes could all but wash major cities away. Earthquakes on the West Coast and even in the center of the country could knock out power for months, make running water a distant memory, and deprive residents of the roofs over their heads. A deadly epidemic, such as the U.S. hasn't seen in 97 years, could take the lives of tens of thousands. A terrorist could unleash an improvised nuclear device in a major city, killing thousands—an event without historical precedent.

The people who try to keep the nation ready for these doomsday scenarios call them the Maximums of Maximums, or the MOMs. You might call them the mothers of all disasters. The term comes from the Federal Emergency Management Agency, and for the feds, it generally includes a small universe of possibilities: a major hurricane, a major earthquake, or an improvised nuclear device.

Some—like a major earthquake hitting Southern California—are inevitable, given enough time. Others, such as a dirty bomb, seem distinctly unlikely. Still others are tough to even gauge: *Could a solar flare wreak unprecedented havoc on the electrical grid?* But they are the scenarios that present the biggest conundrum for planners. Even in the case of excellent preparation, they could kill thousands, leave hundreds of thousands homeless or without basic services, and disrupt the nation's economy for months on end. Yet when I asked FEMA Director Craig Fugate what disasters keep him up at night, he peered at me impassively and said, “Nothing.”

People who haven't spent their careers dealing with emergencies may not have the same stomach. A script for a FEMA table-top exercise gaming out a triple Maximum of Maximums scenario, featuring sub-Sorkinian news voiceover, is a mix of slapstick and horrifying. The exercise imagines a huge hurricane barreling up the Atlantic Coast from the Outer Banks to New England. Then a large earthquake strikes Puerto Rico, followed by a huge, 700-mph tsunami on the East Coast. FEMA's drill anticipates tens of thousands dead, a factor more missing, millions without power, and 13 states pleading for federal disaster assistance.

It wouldn't require a triple-threat like that to create a human tragedy, as Katrina proved 10 years ago. Several

things tie such MOMs together. Experts worry that there's inadequate preparedness among the public. In most cases, it is the poor who are hit hardest—again and again, planners told me they worried about affordable housing. “I know of no community that did not have affordable-housing issues before a disaster, and none of them got better—they always got worse,” Fugate said. And in almost every case, it is not the immediate human death toll, however ghastly, that truly worries the experts. It's the massive disruption to the life and livelihood of the survivors.

In a rebuke to a techno-utopian age, natural disasters remain a greater threat than almost anything humans can produce.

“As you look at the scale of things, short of a full-scale nuclear attack, Mother Nature still produces the worst scenarios for response,” Fugate said.

Of course, those natural disasters are often abetted by humans. Construction in floodplains, lax building codes, lack of preparation, the malign effects of climate change, and even underinsurance exacerbate the impact of the disasters. The number of weather-related disasters that cost more than \$1 billion has been gradually increasing over the last few decades:

But the most fearsome threats are the ones that have existed forever, and which humans are powerless to prevent: hurricanes and earthquakes.

“To me it's about numbers,” Fugate said. “How big can the numbers get? [Those] will produce the biggest numbers.”

Hurricane Katrina was a category 5 storm, the strongest on the Saffir-Simpson scale. It killed more than 1,800 people, cost about \$108 billion, and turned tens of thousands of lives upside down. In some ways Katrina was a monstrous storm, and its 28-foot storm surge set records. But Katrina wasn't as large by area as some other hurricanes, it faded to category 3 by the time it made landfall, and New Orleans is a midsize city. Consider what would happen if a storm as big—or larger—struck a bigger city? In particular, planners worry about Miami, Houston, and New York City. Katrina was a strong storm, and it hit a vulnerable city. But despite New Orleans' outsize role in the American cultural imagination, it's a comparatively small city—even before Katrina, it had fewer than a half million residents. New York, Houston, and Miami are, respectively, the first, fifth, and eighth largest metropolitan areas in the country, and each is critical to the nation's economy.

Let's start with Houston. There's no need to imagine what happens when a major storm hits the area, because history books have a record of it. On September 8, 1900, a hurricane struck the Texas coast at Galveston, just southwest of Houston. The gales from the storm are estimated at 120 miles per hour, but the exact number is unknown: The anemometer was blown away. A 15-foot storm surge hit the city, destroying thousands of houses. When the storm passed, rescuers and surviving residents found that the city hardly existed anymore. A Western Union official cabled: “First news from Galveston just received by train which could get no closer to the bay shore than six miles where the prairie was strewn with debris and dead bodies. About 200 corpses counted from the train. Large steamship stranded two miles inland. Nothing could be seen of Galveston. Loss of life and property undoubtedly most appalling.”

Officials who heard initial predictions that the death toll could reach 500 assumed that people on the ground were exaggerating. In fact, the early estimates were way off, but in the opposite direction: Historians now think between 6,000 and 12,000 people were killed. It was impossible to bury so many bodies, so corpses were thrown into the sea. When they washed ashore, a new tactic was adopted: mass funeral pyres. It remains the deadliest U.S. hurricane on the record and, by one measure, the third most costly.

No storm would ever hit Houston with so little warning today, thanks to improved forecasting and communication tools. But the area is also far more populated now, and it includes some essential industrial capabilities, including the Houston Ship Channel—the nation’s second-largest port by tonnage, and a major point for storing and transporting petrochemicals. On the west side of Galveston Bay is NASA’s Johnson Space Center, sitting on low ground. That means a storm today could be far more costly, even if the immediate human toll was lower.

In fact, a storm called Ike did hit Houston in 2008, causing \$25 billion in damages. And that was only a category 2 hurricane.

“Ike [was] a pretty devastating blow, but in a lot of ways, Ike missed Houston,” said Phil Bedient, a professor of engineering at Rice who directs the university’s Severe Storm Prediction, Education, and Evacuation from Disasters (SSPEED). Most importantly, it hit some 30 miles northeast of the most vulnerable place on the Gulf Coast—a scary near miss.

It isn’t as if industries in the ship channel are unaware of the threat from hurricanes. Most of the channel has protection to avoid catastrophic damage if the storm surge is 15 feet or less. Doing much more could be costly, and either requires companies to balance what they’re willing to spend now against a scenario that might not come to pass for decades, or requires government to impose costly requirements. Besides, that’s usually plenty of defense; Ike’s surge was 13 feet. But what if the surge is stronger, approaching Katrina’s record 28 feet?

“We think you can easily get up to 25 feet of surge in the ship channel if you start cranking those winds and get a really serious storm in,” Bedient said. “That level of inundation in the ship channel is absolutely devastating, because the ship channel is mostly protected to about 15 feet. Anything above that, you start flooding out tanks, you start flooding out industries ... The environmental and economic disaster would be off the charts.”

Meanwhile, NASA would be inundated. High water and high winds would sweep past the ship channel into downtown Houston, with its more than 2 million people. The city’s suburbs, hundreds of miles of densely populated areas, would be flooded. Houston would bear the immediate brunt, but drivers on the East Coast would see the cost of filling up their cars spike quickly. It would take weeks or months for the oil industry to bounce back. And that’s only a category 3 storm.

Katrina and Ike, plus 2005’s Hurricane Rita, did three important things for researchers in Houston. First, Katrina’s massive wall of water brought home the importance of storm surge, which Bedient quips (with mild exaggeration) wasn’t even in the vocabulary before. Second, a botched and ultimately unnecessary evacuation from Rita, driven by panic after Katrina, showed the importance of having a careful hurricane plan. By the time Ike hit, scientists were ready to closely monitor it, learning a great deal about surges. That storm also highlighted the importance of serious preparations in Houston.

The most popular of those is what’s called the “Ike Dike,” a seawall along the outer coast. But SSPEED thinks that would have some weaknesses. In a report released Tuesday, it calls for a more elaborate system, including further lines of defense closer to the ship channel. The plan would top out at more than \$10 billion. That’s a lot of money, but it’s less than the \$25 billion in damages Ike caused, and a small fraction of what a direct hit on the ship channel would inflict, which SSPEED has estimated would “easily” surpass the \$100 billion mark.

“I think everyone in the community is in agreement here—politicians, engineers, people in leadership positions—they’re all in agreement that we need to do something,” Bedient said. “But it’s been seven years

and really very little has been done.”

“I’m actually fairly optimistic that something will be done, because it needs to be done. Now, whether that will be done before the next big one hits?” Bedient trailed off. “Houston now sits where New Orleans sat in 2004.”

Miami, too, has been repeatedly struck by hurricanes—but not, perhaps, “the big one,” at least not recently. That happened in 1926, when a storm slammed Miami, moved across Florida to Tampa, and then continued on to hit the panhandle. The storm only killed 372 people, but the economic toll was steep: Using the same measure that ranks the Galveston hurricane as the third most costly, the Great Miami Hurricane was the most expensive ever, nearly half again as expensive as Katrina, at an estimated \$164.8 billion, adjusted for inflation. But that happened at a time when Miami was still a sleepy, newish resort town of about 100,000. Now the metropolitan area has more than 5.5 million people and far more development. What if a storm of Katrina’s size hit it squarely today?

“It won’t survive,” Fugate told *USA Today* last year. A CoreLogic study found that \$103 billion worth of homes alone might be destroyed.

The only metropolitan area with more real estate at risk? New York, of course (\$251 billion, for the record). Unlike Miami, the Big Apple doesn’t have long experience to draw on in the case of a hurricane. Just look at the experience of Superstorm Sandy, which had weakened to less-than-hurricane-force by the time it hit the New York-New Jersey area, yet still managed to inflict \$50 billion of damage and cripple parts of the area for days. Another area of concern is Norfolk, Virginia, which is home to both a large civilian port and the world’s largest naval base.

“We live in a flood zone, we also live in a hurricane zone, but the good news here is we don’t live in an earthquake zone,” Bedient said. “I’ll take a hurricane any day.”

There’s no way to stop hurricanes, but one saving grace of the modern age is that they’re easier and easier to predict. Meteorologists can tell with ever-greater precision when a hurricane is forming, when it will make landfall, and where exactly it will strike—allowing for carefully targeted evacuations and other methods. As a result, hurricanes are far less lethal than they were in the 19th and 20th centuries. (That’s also one reason Katrina was such a shock to the public: It’s the only post-1960 hurricane to kill more than 300 people in the United States.)

Earthquakes are a different matter. “I have yet to see anybody invent a way, except in the Marvel universe, to either create or stop an earthquake,” Fugate said. The biblical horror of the ground shaking under foot imbues them with a particular dread, and “early warning” might only constitute a few seconds. The major areas of earthquake risk in the U.S. come in three varieties: the classic, the rising star, and the dark horse.

The classic, of course, is the one fault line practically every American can name: the San Andreas, running through California. The San Andreas is responsible for some of the nation’s most famous tremors—from the San Francisco quake of 1906 to the 1989 Loma Prieta quake—as well as the recent, eponymous blockbuster movie. One of the more interesting reviews of that film came from Lucy Jones, a USGS seismologist who fact-checked the science. Jones has long been one of the most urgent voices calling for better preparation for the quake—which, she emphasizes, is a when-not-if situation. Jones just finished a yearlong project with Los Angeles Mayor Eric Garcetti, trying to better position the city for the big one. In 2008, she collaborated with a team on the sort of project that many scientists would be nervous to undertake: a fact-based, fictionalized story of what might happen in a 7.8 magnitude quake.

It's perhaps even scarier than the movie—if nothing else because it so carefully sticks to a science-based scenario. The initial shaking would go on for almost a minute. Freeways would become impassible, as would rail connections. L.A.'s legendary gridlock would come to a true standstill. Oil and gas pipelines would snap, bursting into flames, as would water and sewage pipes underwater. Hundreds of buildings would collapse, and many more would slide off their foundations. There would be tens of thousands of aftershocks large enough to feel in the coming months. The quake would ignite 1,600 fires, and while most of them would be out within three days, a few would remain: “super-conflagrations,” encompassing hundreds of blocks of the city. After a month, tens of thousands of Angelenos would still be without a job or shelter. The water might not be safe to drink for nearly a year.

In a phone conversation, Jones sketched out some more complications. Most of L.A.'s water comes from outside the area, on aqueducts that cross the fault line. “All the aqueducts will break when the earthquake happens, and they'll all break at the same time,” Jones said. “The city itself owns one aqueduct crossing the fault. The good news is it has only one fault crossing. The bad news is it's a 1908 wooden tunnel.” Just like in Houston, shipping would be an important casualty. The Los Angeles and Long Beach ports receive a third of all U.S. container traffic. For those containers to get anywhere, they have to get on trucks and railways, but both will be broken.

One thing missing in all of this discussion is the nasty business of death. That's not a coincidence. The death toll in the California earthquake might not be that high, thanks in part to building codes requiring that in a major quake, edifices not collapse on people inside them (though not that they remain economically usable afterwards—another problem). It's not that there's no danger. An excellent 2013 investigation by the *Los Angeles Times* looked at the more than 1,000 buildings in the city that are built of old, inadequately reinforced concrete that could be badly damaged in a major quake. The city's stock of affordable housing also constitutes some of the most vulnerable structures in the city, though new rules for retrofitting should help to alleviate that danger.

But what really concerns Jones isn't the initial toll, but the economic collapse that might follow. “It's not like we're all going to die. Most of us won't,” she said. “What we are talking about is an economy that collapses.” But when you haven't been able to shower in a month, your home is badly damaged, your workplace no longer exists, you can't get consistent cellphone service, and period aftershocks mean you're constantly on edge, why would you stay in Los Angeles, rather than just pick up and move? Many people might, she figures.

San Francisco presents a cautionary tale for Los Angeles. After the 1906 quake, the city took decades to recover. Or perhaps it never recovered, depending on how you reckon. Before the quake, San Francisco was the most economically powerful city on the West Coast, a position it couldn't reclaim—but its loss was Los Angeles's gain. It would be a bitter irony if Los Angeles lost its prominence just the way it won it: with a catastrophic earthquake.

Los Angeles isn't the only West Coast hegemon threatened by seismic activity. A widely read *New Yorker* story in July awakened many lay readers to the threat of a huge earthquake in the Pacific Northwest that could devastate Seattle and Portland, though disaster planners have been fretting over it for years. “When you look at the types of things that could happen, everything from the San Andreas, Loma Prieta, to the Great Alaska Earthquake scenario, the major hurricane landfalls, the one that stands out just from the sheer numbers, number of states, and the secondary impacts is the Cascadia Subduction Zone,” Fugate said.

The New Yorker's Kathryn Schulz lays out the danger clearly: A quake with a magnitude of 9 or greater. Buildings not constructed for an earthquake, like those in Los Angeles. An impact area of 140,000 square miles, with 13,000 dead. And the real clincher: A massive tsunami sweeping in after the quake.

There's some disagreement among experts about just how urgent this threat is. No one disagrees that there could be a quake, nor that the tsunami would be bad. They're relieved that people are now starting to discuss the danger of a Cascadia quake, though some of them think that disaster managers have exaggerated just how pressing, and just how deadly, the quake would be. Is a quake truly past schedule, based on the historical recurrence of quakes about every 250 years there? "Portland and north are not overdue," said John Vidale, a seismologist at the University of Washington. "We're well in the window, but it's not overdue." How big will the quake be? Even if there is a quake every quarter-millennium, said Jones, they can't all be a 9 on the Richter scale. Besides, Jones said magnitude isn't an ideal way to measure quakes. She prefers to measure shaking, and thinks a San Andreas quake would be more dangerous than a Pacific Northwest quake because the fault runs right through populated areas—although she notes the tsunami in the north would be dangerous.

Seismologists particularly disagreed to the FEMA regional director's statement that "operating assumption is that everything west of Interstate 5 will be toast." Vidale chuckled at that. "It's toast in the sense that you might have to go a few days or weeks before someone brings in a croissant," he said. "Thousands would probably die, but millions live west of I-5."

What worries disaster planners is getting supplies in after a disaster. They assume north-south roads would be destroyed west of the Cascade Mountains. That means supplies have to come in from the east over the mountains, which requires a huge airlift. The tsunami, meanwhile, will likely cause destruction not just around the quake, but in Alaska, Hawaii, and Japan.

"The most important thing in the first days is just survival, just keeping people alive," Fugate said. "Any talk about 'we're going to be recovering'? You obviously don't know how bad it is. We're not picking a Tom Clancy scenario. This is just a hazard that's very well studied."

Seattle, like Los Angeles or Houston, is a major port, and knocking it out would disrupt shipping. Planners also worry about disruption to the tech industry crippling IT infrastructure around the country. Despite her hesitations about the doomsday scenario, Jones wouldn't write it all off. "These are professional paranoids," she said of disaster planners. But still, she asks, "What is overdone? all of this is possible."

A glance at the USGS Seismic Hazard Map shows that the nation's biggest danger zone is a long line of activity all along the West Coast. But there's also one strange outlier, a misshapen bullseye of bright red in the middle of the country. That's the New Madrid seismic zone. It's a much lesser-known hazard than the San Andreas and Cascadia zones, in part because seismologists like Vidale who have studied New Madrid don't see much sign of major activity right now. That's good, because a major earthquake around New Madrid could shake Memphis and St. Louis and spread devastation across seven states. One reason the zone is less well-known is that, just like in the Pacific Northwest, there hasn't been a major quake there since the time many European-Americans moved into the area. But the last time there was major activity around New Madrid, in 1811 and 1812, the tremors strongly shook some 50,000 square miles. The shaking was strong enough to ring church bells in Boston. In some places, the ground subsided by more than 16 feet. Boatmen reported that the Mississippi River ran backwards in places as the ground shifted under it.

What makes each of these scenarios so scary is that they're inevitable. Not the results: There are ways to prepare that can help prevent some of the damage and save many lives, though not all. But it's practically certain that a huge hurricane will hit Miami or Houston, and that a huge earthquake will hit Los Angeles or the Northwest.

The other major menaces tend to fall into the category of possible, but not certain. Take the improvised nuclear device, the third category of event that FEMA classifies as a Maximum of Maximums. How likely is

it that a terrorist group is able to detonate a dirty bomb in a population center? That's very tough to predict.

“Even though it's mainly fallen off the screen because there are too many new shiny objects and too little attention span, you can still imagine a terrorist organization bringing a bomb and blowing up a city,” said Graham Allison, a political scientist at Harvard's Kennedy School and nuclear weapons expert. “But if you can describe how practically this could happen, and you can identify perps who might want to do this, which you can, then I think this is—when the president gets a threat matrix this is on it, and it should be.”

Or how about a huge epidemic? Disease hysteria swept the nation during the Ebola outbreak in 2014 and 2015. Ebola, however, did not sweep the nation. That's not a coincidence. Dr. Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases, was one of the government's most prominent leaders on Ebola, and consistently downplayed the danger of a major outbreak in the United States. Fauci points out that the way Ebola is transmitted means that it would be highly unlikely for there to be an outbreak in the U.S. system.

What's scarier is a repeat of the 1918 Spanish influenza.

“The doomsday scenario of what keeps me up is another form of a pandemic, respiratory transmitted, highly lethal virus,” Fauci said. If the death toll from that pandemic were extrapolated to today's world population, it would be a matter of hundreds of millions of dead.

“That would be a real catastrophe,” he said. “But the chances of that happening, both from an evolutionary standpoint as well as from the fact that we have much greater tools right now to take care of people, to develop vaccines quickly, etc., that is unlikely but not impossible.”

The next 1918 is a lot like the next Bob Dylan: Many have been saddled with the title, but none have lived up to it. Heralded viruses have fizzled, including SARS, which ultimately killed fewer than 800 people globally, and none in the United States. Fauci is much more concerned about the rise of another virus like HIV, which could be extremely lethal, but wouldn't represent an acute event in the same way that a brief, deadly pandemic would be.

The frustrating paradox for disaster planners is that even though people are fascinated by the risk of natural disasters, they seldom do much to prepare for them. That's a problem that extends from the upper reaches of government down to individual citizens.

The most deadly earthquakes around the world usually occur in places where the seismic risk is well-known. Scientists had warned for decades of the danger to Kathmandu before the April 2015 earthquake that flattened much of Nepal's capital city, but still few precautions were taken.

“Most of these disaster areas, nothing is unknown,” said Won-Young Kim, a senior research scientist at Columbia University's Lamont-Doherty Earth Observatory. “Most of the time people knew beforehand that something could happen, but political or social problems prevented them from preparing for it.”

But it's hard to mobilize the government to spend what seems like a lot of money upfront for a disaster that feels remote right up until the moment it hits. “There's a feeling we have to exaggerate, because these long-term risks aren't something people will adequately prepare for,” he said. He was glad for the renewed focus on seismic risk in the Pacific Northwest, but worried that as soon as a new disaster struck elsewhere, the focus would shift and preparation would remain years behind countries like Japan—and years behind where it should be.

Planners worry that ordinary citizens don't prepare adequately for disasters, and that they can fall prey to the

same complacency traps.

“Somebody in emergency management in Mississippi told me after Katrina that the thing that killed the most people from Katrina was Hurricane Camille in 1969,” said Russ Paulsen, executive director of community preparedness and resilience services at the American Red Cross. “People remembered that whatever they did kept them safe, so they did it again. Only this time, there was a much bigger storm surge. Those people who were okay from a mostly-wind event in 1969 were not okay when there was 30 feet of water coming at them.”

One thing the Red Cross has focused on recently is trying to spread better awareness by trying to get people better prepared for a fire in their house or apartment. Each year, there are hundreds of thousands of residential fires in the U.S., and they kill 2,500 people—more than Katrina. Just thinking about that can help a great deal when a mass disaster strikes.

“Being prepared for a home fire doesn’t prepare for an earthquake really, completely, but it goes a long way to the mentality that there are things I can do to protect myself, my family, and my neighbors,” Paulsen said. “There are so many free things people can do that will make their lives so much better.”

A fire might only render your family homeless, as opposed to a storm that renders the whole neighborhood homeless. But the result for your family is still highly traumatic. Anyone would rather their house be flooded by an inch of water than a 30-foot storm surge, but even the inch can turn a life upside down.

Once the earthquake has hit, or the hurricane has passed, or the bomb has landed, the problems become distinctly familiar.

This is one of the most surprising things that emerges from conversations with emergency responders and the scientists who study disasters: the disconnect between the event and the results. Once the earthquake has hit, or the hurricane has passed, or the bomb has landed, the problems become distinctly familiar.

Think about Craig Fugate’s warning that the real challenge is what to do about affordable housing once the storm waters recede, to avoid a years-long trailer saga like the one that followed Katrina. Think of Lucy Jones’s worry that what will really kill Los Angeles isn’t the lives lost when the fault splits open, but a mass exodus when people can’t take a shower or get to work. It’s no surprise that one of FEMA’s top priorities after a massive storm is to get basic medical services and major businesses in the affected zone back up and running as quickly as possible: People still need food, they still get sick, and they still have to pay the bills.

Each of these Maximum of Maximum scenarios represents a disaster larger than any the United States has ever seen. The swath of destruction they would create seems too large to imagine outside of the pleasantly unreal confines of a Hollywood blockbuster. In reality, however, not only are they imaginable, but there are people who spend their days imagining them. The challenge of preparedness is convincing people who are not movie directors or emergency managers to do the same.