



Catastrophic hurricanes and public health dangers: lesson learned

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Hurricane Harvey made landfall in Houston, Texas initially on Aug. 25 and subsequently along the coast of Louisiana with winds recorded up to 130 miles per hour (MPH) and over 51.9 inches of rain. The flooding from Hurricane Harvey was catastrophic, causing over 80 deaths and numerous injuries (*Table 1*). The US National Weather Service called it unprecedented and the Secretary of Health and Human Services declared a public health emergency. Hurricane Harvey is over but there are several short- and long-term health risks that remain.

A disruption in the drinking water supply resulted in widespread water shortages. Bottled water in some instances was sold for as much as \$99. The Environmental Protection Agency reported that floodwater was contaminated with sewage and chemicals as reservoirs spilled over into sources of drinking water. High humidity and summer climate combined with floodwaters in Houston may aggravate indoor environments and make houses especially hospitable to mold.

Many people who fled from Harvey's flooding waited hours in water mixed with sewage, oil and gasoline. Emergency services reached the highest capacity and people were advised not to call 911 unless it is life-threatening.

Apart from the contaminated floodwater, other dangerous chemical leaks were caused. Houston is home to the largest U.S. refinery and is a major hub of petrochemical industry; both especially vulnerable to environmental disasters. Residents living in a 1.5-mile radius around the plant were ordered to evacuate as a cause of tons of toxic air pollutants spewed into the region's atmosphere. A leak of an unspecified amount of fuel at a Kinder Morgan facility poses a health risk in the near future to the millions of people living there.

Hurricane Irma also recently swayed the U.S. First

responders in the Everglades area were faced with this crisis, for many families spent days in 10 feet of mud and toxic storm water that has caused widespread infection. Statewide, there had been a total of 36–42 known deaths due to Hurricane Irma, and those are just the ones that have been accounted for (5). To continue, about 7 million people ended up having to evacuate in order to escape hurricane Irma, while rainfall reached up to 16 feet in certain Areas of Florida (6). Irma produced winds at highest were 142 MPH in Naples, Florida. It is estimated through incident reports that 28 million gallons of untreated water flowed into the streets (7).

Power outages have caused great concern for the health and safety of Florida's four million senior citizens. At a nursing home in Hollywood Hills, eight residents passed away due to the extreme heat after the air conditioning and power went out, and around 100 had to be treated for dehydration and exhaustion (8).

A tremendous source of preparedness amongst citizens was through the use of social media such as Twitter, Facebook and YouTube to educate people not to approach to fallen power lines and report them to electric companies. Portable generators were used, posing a concern of the inhalation of carbon monoxide (9). To avoid breathing the gas, it was advised to operate the generators outdoors and 20 feet from doors or windows. However, these warnings and street signs were not necessarily followed by the entire population as dozens of cars were submerged; including a family of six that drowned in their car from the floodwater (10).

The onset of such a devastating storm with dangerous consequences as mentioned can cause poor mental health outcomes in the population affected. Approximately ten percent of people who suffered through Hurricane Katrina had post-traumatic stress, disorder, depression, and six

Table 1 A comparison of challenges from Sandy, Katrina, and Harvey (1-4)

Challenges	Harvey	Irma	Sandy	Katrina
Evacuated	30,000	7 million	375,000	1.2 million
Rainfall	51.9 inches	16 inches (in FL)	7 inches (over land)	8–12 inches
Deaths	82+	73+	233	1,833
Gas supply	Disrupted	Disrupted	Disrupted	Disrupted
Running water	Disrupted	Disrupted	Disrupted	Disrupted
Economic loss	190 billion (USD)	58–83 billion (USD)	49.9 billion (USD)	108 billion (USD)
Number of shelters	30,000 beds in 230 shelters	120 government and red cross shelters	73 shelters	62,000 travel trailers
Home loss/applied for federal assistance	200,000 people	127,000 people	651,000 homes in NY and NJ	850,791 homes
FEMA personnel	12,400	21,800	1,500	2,000 (firefighters)
Health and Human Services (HHS) personnel	550	500+	2,300	1,100
911 received call	>56,000 calls in just 15 hours	Told not to call 911	20,000 per hour (in NY)	22,000 calls
National guard deployed	14,000 (Texas)	31,000 total in US	45,000 (7 states)	10,000

percent reported an increase in suicidal thoughts (11). The long-term fallout may include stress-related illnesses among those traumatized and displaced by the hurricane.

The scientific reality of attributing a role to climate change in worsening the impact of hurricanes is also hard to tease out. These are rare events and there is not significant historical data available. The Clausius-Clapeyron equation says that a hotter atmosphere holds more moisture (1). For every extra degree Celsius in warming, the atmosphere can hold 7% more water, which tends to make rainfall events even more extreme when they occur (1). The warmer atmosphere, and ocean temperatures provides a very dangerous hotbed for future tropical storms. In addition, the measurements of extreme rainfall, the most ever recorded in U.S. history, caused by this hurricane further solidify the evidence that climate change has been an important player in the onset of tropical storms.

Harvey and Irma are prime examples of climate change in modern times, where many refuse to believe its significance. If we do not talk about the climate in the context of hurricanes in 2017 those hit the USA, we will not be able to prevent future disasters with the infrastructure that is present. If an evacuation is ordered, countless thousands of people will not have the means or ability to act. There is simply no way to safely evacuate a metro area the size of Houston (6.5 million residents) in a timely manner to save

lives. By continuing to attempt to engineer our way out of the worsening flooding problem with bigger dams, more levees, and higher-powered pumping equipment, we are not attacking the root of the problem that is climate change.

The Federal Emergency Management Agency (FEMA) and the National Guard showed tremendous action, both deploying the largest amount of people and troops ever for a natural disaster (*Table 1*). Vulnerable groups deserve a considerable amount of attention as we work to shore up the social, capital, and public infrastructure necessary to protect our communities before the next disaster strikes. County, state and federal disaster departments along with people living in coastal areas need to be serious about preparedness, adaptation, and mitigation in these specific areas.

With climate change fueling more powerful storms, and development paving over natural flood barriers like wetlands, leaders must act swiftly. The answer is likely to be found in combination of better resiliency planning and serious greenhouse gas mitigation. The truth is that estimated cost of Harvey will be more than \$190 billion (2), the most expensive in U.S. history (3), while dumping the most rainfall ever seen in the U.S. (*Table 1*). These proposed solutions will take more experience and ultimately time before any observable improvement is achieved. Leaders must be more conscious in the development of future

environmental policies and putting infrastructure in place before hurricanes strike to attempt to reduce the adverse effects of these storms.

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Footnote

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