

## Better hurricane forecasting and preparedness mean fewer deaths

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What seemed impossible decades ago is now true: When they make landfall, big hurricanes aren't killing many people. Only truly exceptional storms — or more likely exceptionally poor preparedness — spawn large numbers of fatalities in the United States when one comes ashore. The big death tolls are now from flooding, often days later.

Of the top 30 killer hurricanes that have struck the U.S. mainland since 1850, only three (Floyd in 1999, Katrina in 2005, and Harvey in 2017) were in the past four decades. Half of the top 10 killer storms occurred before the widespread adoption of radio.

The lesson? Surviving a landfalling hurricane is becoming easier, thanks to communication, better forecasting and preparation.

Ten years ago, Category 5 Hurricane Dean slammed into Mexico's Riviera Maya and killed no one. The lowest barometric pressure at landfall was 26.72 inches. If it had hit the United States, Dean would have barometrically ranked third on the all-time monster list, behind the 1935 Labor Day hurricane in the Florida Keys, and 1969 Hurricane Camille on the Mississippi coast.

A half-century before Dean, Category 5 Hurricane Janet hit in the same spot, had a similar central pressure, and killed an estimated 500 people. So what changed?

Preparation was the key. Dean was a well-behaved and well-forecast storm, and the Mexican government embarked upon a massive evacuation of vulnerable cities, towns and 80,000 tourists. Undoubtedly, this saved a large number of people, as some of the coastal towns were virtually wiped out. The government of Mexico was rightfully proud of its remarkable achievement.

Irma's death toll currently stands at 75, tragic but remarkably low considering the tremendous reach of its damaging wind field, all the way from Key West to Atlanta, affecting more than 20 million people. At landfall, when the storm's center first crossed the coast, there were nine fatalities in the Keys, but half appear to have been from natural causes.

Apparently, there were only two deaths when Category 4 Harvey slammed into Rockport and Corpus Christi, Texas. Subsequent inland flooding, associated with about 80 fatalities, could just as easily have occurred with a mere tropical storm. For example, in 1979 Tropical Storm Claudette drenched Alvin, Texas, also near Houston, with 43 inches of rain in 24 hours, still the national daily rainfall record.

Which goes to show that prediction makes all the difference. Even with adequate communication, a bad forecast is deadly. An abominable one resulted in about 700 fatalities (United States and Canada) in the 1938 Great New England Hurricane. The 1935 Labor Day hurricane pretty much came out of nowhere, and more than 400 people died in the Florida Keys.

A bad forecast and bad communication is the worst-case scenario. In 1900 in Galveston, Texas, an estimated 8,000 to 12,000 people perished in a Category 4 storm not dissimilar to Harvey at landfall. When warned by Cuban forecasters that a huge hurricane was on track between there and the Gulf Coast, Washington's Weather Bureau brushed them off with an imperialist flick. By the time the Galveston forecast office issued a hurricane warning, the island was already overwhelmed.

Since the 1950s, forecasts have improved incrementally, and mega-killers have become rare. Hurricane Audrey in 1957, a top-30 killer, unexpectedly pummeled Lake Charles, La., and led to an increased research effort that greatly improved forecasts.

Since then, the distance between where a hurricane is forecast to be and where it winds up has been reduced to about 200 miles for four and five days in advance. Official three-day forecasts didn't even become operational until 1964, and five-day forecasts began in 2001. The combination of improved forecasts and mass communication has been enhanced by the internet and 24-hour news and weather channels that clamor for your attention by maximizing plausible threats.

Storms with substantial mortality are now true freaks, or their effects are enhanced by old-fashioned human bungling.

The 2005 Hurricane Katrina had elements of both. It was well forecast, but that didn't matter. While it was technically a Category 3 storm at landfall, it was huge in extent and piled up tremendous amounts of water in its northeastern quadrant, unleashing it on the Mississippi and Alabama coasts. In both places, the storm surge reached the U.S. record of 27.8 feet high, and water surged a remarkable six miles inland. Altogether, 238 people died in Mississippi. Under any circumstance, Katrina was going to be a big killer there.

But New Orleans was where human bungling came in. In 1965, Category 3 Hurricane Betsy struck New Orleans, killing nearly 60 people in floods. Levees that were supposed to hold back a wind-whipped Lake Ponchartrain and the Mississippi River failed. In response, the U.S. Army Corps of Engineers promised a new levee system that would withstand such a storm.

The new levees failed utterly in Katrina. Congress didn't appropriate enough money, and the Corps drilled pilings supporting the flood walls to only half the planned depth to ensure stability. As a result, about 1,000 residents (the true number will never be known) perished in a storm in which the local airport never even recorded a hurricane-force wind.

Floods, human-assisted or otherwise, that can occur days after a storm hits, are now the killers. Absent an extreme storm or poor planning or infrastructure, we are now to the point where hurricanes that previously killed hundreds or thousands as they came ashore now produce few fatalities, testimony to our abilities to increasingly adapt to these terrible storms with better communication and better science.

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