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An Analysis of Hurricane Harvey

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Abstract

In August of 2017, a category 4 hurricane formed off the coast of West Africa. It soon made its way to the Gulf of Mexico and on August 25th, it made landfall in southeastern Texas. The ensuing aftermath of Harvey's landfall culminated in several days of constant rain over Houston and the surrounding areas, barraging a 10,000 square mile metropolitan area, the fourth largest in the United States, with massive flooding of near-biblical proportions. The end result was over 100 human lives lost and over \$125 billion in damage to a city that had seen explosive population growth as a result of Houston's rapid expansion and development renaissance. This paper seeks to analyze the ways in which emergency and disaster management agencies and professionals prepared for and responded to the second costliest and most destructive natural disaster in United States history. This paper also analyzes if local, state, and federal governmental agencies tasked with managing emergencies have applied lessons learned from previous modern disasters in order to effectuate the Harvey response and recovery effort, as well as if lessons learned from Harvey are being applied today, just three years removed from the disaster.

A Disaster in the Making

A review of the literature on Hurricane Harvey paints a very vivid, detailed picture of the years leading up to Harvey, preparations for flooding, Harvey's impact, the response at all levels, and the recovery efforts that were made in the days, months and years following Harvey's impact. The years leading up to Hurricane Harvey were seen as transformative years for the city of Houston. Houston went from being just another big Texas city to a cultural and technological powerhouse. The country's fourth largest city now serves as America's energy headquarters and a cultural and artistic megapolis. Houston's heavy expansion came with a price. Numerous warnings from engineering and city planning experts about the meteorological risk of explosive development went largely unheeded by city leaders and developers. After Harvey occurred, research concluded that years of inadequate emergency planning and oversight as well as explosive overdevelopment created a perfect storm for the havoc that Harvey had wreaked upon Houston and much of the Texas gulf region. Texas Monthly writer Mimi Swartz, in her September 2018 chronicling of the events of Harvey, described Harvey as an 'equal opportunity hurricane', one that destroyed homes and businesses not just in the poorer, lower lying areas, but even in newer, wealthier communities, destroying even the mayor's gated villa community home.

Houston has never been a stranger to flooding. Devastating floods occurred four times up to 1940 that caused significant damage to the city, even in the downtown and city center. In 1940, the Harris County Flood Control District was formed, and in a partnership with the US Army Corps of Engineers developed a flood control plan, resulting in the construction of two dams on the west end, Barker and Addicks. The initial plan was to preserve and build around the wetlands that surrounded the outskirts of Houston and preserve its geography. These wetlands and marshes served as natural sponges, absorbing vast amounts of rainwater, and were key in

preventing devastating floods. These plans were soon abandoned, however, and explosive commercial and real estate development soon took over these wetlands. What once served as natural flood barriers was now paved and built over.

Originally forming off the west African coast, by the time Harvey made landfall in Texas on August 26th, 2017, it had already developed into a Category 4 hurricane according to the National Weather Service. Over the course of four days, Harvey brought over 40 inches and 1.2 trillion gallons of rain to Houston with wind velocities hitting as much as 70 miles per hour. Much of the total precipitation and devastation occurred within a 48-hour timespan. The National Oceanic and Atmospheric Administration (NOAA) reported that Harvey was quickly declared as the most expensive natural disaster in American history next to Hurricane Katrina, causing over \$125 billion in damage to Houston and the surrounding areas. NOAA and NWS also estimate that anywhere from 300,000 to half a million homes and vehicles were destroyed (2017). The barrage of rain and flooding also caused Houston to sink two centimeters, but the city returned to its natural elevation once the flooding subsided. As one geophysicist described it, it “caused the Earth’s crust to flex” (Milliner et al, 2017).

The Environmental Protection Agency released its own damage report on the havoc that Harvey wreaked as a result of its impact. According to the EPA, 203 boil-water advisories were put into effect as 61 drinking water facilities and 40 wastewater treatment facilities were rendered inoperable. Harvey also caused 150 million gallons of sewage to overflow and created 266 hazardous material spills (Cook and Crossland, 2018). The Texas Commission on Environmental Quality’s After-Action Review Report on Harvey estimated that nearly 16 million cubic yards of storm debris had to be cleared as a result of the extreme winds and flooding (2018).

The Response

FEMA described the federal, local, and state response to Harvey as the largest in the history of the state of Texas. FEMA gave a very detailed report of the federal response in its Hurricane Harvey report (2017) which are summarized below:

- United States Coast Guard – 2060 personnel, including 50 aircrafts and 75 boats. The USCG rescued over 11,000 people and nearly 1,400 pets.
- Federal Emergency Management Agency (FEMA) – 28 Urban Search and Rescue teams were deployed to assist with local and state rescue agencies. FEMA’s teams rescued nearly 6500 people and 237 animals. FEMA also supplied 3 million meals, 3 million liters of water, 9900 blankets, 8840 cots, and over 10,000 hygiene kits to survivors.
- Department of Health and Human Services (HHS) – Deployed over 1100 personnel with medical supplies, aiding nearly 5400 residents who were living in flood-contaminated housing with relocation to local shelters.
- American Red Cross – Provided over \$45 million in funds to 100,000 disaster survivors and deployed over 3,000 staff and volunteers. The Red Cross served nearly one million meals and operated shelters throughout the Houston area.

Numerous sources also indicated that there was a strong state and local response to Harvey. Texas Governor Greg Abbott activated the entire Texas National Guard, which allowed for the deployment of over 12,000 Guard members to assist in community aid and recovery efforts (Pollock, 2017). The state’s Emergency Operations Center (EOC) was also quickly activated and was staffed with members of various local, state and federal agencies, including FEMA, the Texas Division of Emergency Management, the Texas Commission on Environmental Quality

(TCEQ) and the Centers for Disease Control (CDC). Once the EOC was activated, a unified response was quickly able to come to fruition (Texas Commission on Environmental Quality, 2018).

Houston mayor Sylvester Turner, in a move that surprised many, made the decision to not issue a mandatory evacuation order for the city of Houston. This was done for two main reasons. The first reason was because Harvey was not expected to make landfall within the Houston metro area, which it ultimately did not. The closest that Harvey made landfall to Houston was 200 miles south in the city of Rockport. The other major reason was to prevent needless loss of life. During Hurricane Rita in 2005, over 100 people died in a frenzy trying to flee the storm, mainly due to being stranded in their vehicles in sweltering heat. Mayor Turner's decisions may have been a surprise to many, but time proved that not issuing evacuation orders was the correct course of action (Gelino, 2017).

The Aftermath and Recovery

Hurricane Harvey had a devastating impact on southeastern Texas. Over 100 people lost their lives because of the storm and its destruction, and the flooding forced 32,000 people from their homes. As previously mentioned, when adjusted for inflation, Harvey stands as the second costliest storm in United States history, second only to Katrina. A year later in 2018, 8 percent of displaced residents were still unable to return to their homes (Amadeo, 2020). Recovery funds were soon made available to help the state of Texas, Houston, and those who had survived the storms but lost everything they had. On September 1st, President Trump requested \$7.9 billion in emergency spending to help Texas and Louisiana recover from the storms, and a few weeks later H.R. 601 was passed into law which freed up an additional \$15 million in funds (PBS NewsHour, 2017). In 2019, the President enacted a \$5.5 billion tax reform for Texans who were

impacted by the hurricane, as well as granted an extension of the National Flood Insurance Program for homeowners (Harvey Disaster Aid Timeline, 2018).

Hurricane Harvey vs. Katrina: Did We Learn Anything?

The response to Hurricane Harvey naturally drew many comparisons to 2005's Hurricane Katrina due to its impact and its geographical location. As such, many seek to compare the two storm responses to identify what went right and what needs to improve, and most importantly, if those tasked with emergency preparedness, response and recovery have learned anything since the bungled mess that was the Katrina response. During Katrina, many decried the poor leadership and lack of cooperation from the Mayor of New Orleans and the Governor of Louisiana, who were openly resentful of one another and failed to put political differences aside during a time of crisis and disagreed at every decision one made during the response effort. However, with Harvey it was different. The elected officials in Texas and Houston acted swiftly and in close cooperation with local, state, and federal agencies. While Harvey still made a major impact, the actions that leadership took was the difference between bad and worse. Effective leadership and coordination were seen this time around as the key reasons why the Harvey response was so much stronger than Katrina's (Cooper, 2017).

The federal response to Katrina was also marked with many failures. During the Katrina response and recovery efforts, FEMA and federal officials were simply not well enough prepared. Federal agencies were unfamiliar with their roles and did not take steps to be proactive or well prepared. There were also a myriad of equipment and supply issues, so federal agencies had little ability to effectively communicate or coordinate with each other to effectuate an organized response once they were on the ground in Louisiana. Supply chain failures also mounted as places that were sheltering displaced residents had to wait for weeks to get FEMA

supplies, and FEMA also wasted large amounts of supplies due to logistical errors, such as sending millions of pounds of ice to cities far away from where they actually needed to be. FEMA also ordered 25,000 temporary housing units to set up as shelters, however due to FEMA's own regulations restricting housing in flood plains, the trailers sat unused. It was also widely reported that federal officials refused and obstructed third party relief efforts (Edwards, 2015).

By the time Harvey made landfall twelve years later, FEMA and the federal government had had plenty of time to implement lessons learned and become better prepared for another Katrina. The director of FEMA this time around was an experienced emergency manager who knew what actions needed to be taken. Another major shift in the FEMA administration was the involvement of the private sector, especially as it pertains to recovery and community aid. Many notable Texas businesses deployed their services to help deliver food and supplies to responders and survivors. FEMA also had been authorized to make better preparations post-Katrina, and FEMA had supplies and resources pre-staged and disaster-prone regions. Shelters were better utilized and coordinated. While FEMA still has internal issues and is still trying to shake off its Katrina reputation, many would agree that FEMA was much more prepared, coordinated and focused during Harvey (Roberts, 2017). In the years since Katrina, local, state, and federal agencies have realized the importance of key fundamental factors in emergency response: Competent leadership, being prepared, and the importance of interagency communication and private sector partnerships.

Findings

Part I: Major Reports

The first official report by the National Weather Service provides a detailed timeline of the events that transpired during Hurricane Harvey and the extent of its impact in the Texas and Gulf regions. The main intent of the report was to provide an overview of how well NWS performed during the events, but it also describes in great detail how local, state and federal agencies collaborated in order to provide an effective emergency response, as well as local communities, private organizations, and the news media. The United States Geological Survey (USGS) and Federal Emergency Management Agency (FEMA) collaborated to report on research conducted to determine the magnitude, the probability of occurrence, and map the extent of the flooding impact in Texas as a result of Hurricane Harvey. The report also ranks how the impact of flooding and precipitation in the region ranks historically with other major precipitation events in the region. Another FEMA publication dedicated to Hurricane Harvey also provides multiple facts, figures and reports regarding Harvey's economic impact and reports surrounding the response and recovery efforts as well as recommendations for future emergency preparation and recovery efforts.

Part II: Statutes, Presidential Directives, and Executive Orders

State and federal response to Harvey was rather swift. On August 28th, Texas Governor Greg Abbott activated the entire Texas National Guard, a total of 12,000 service members to assist in rescue and recovery efforts; particularly involving search and rescue for hurricane victims who had gone missing or were in immediate danger (Pollock, 2017). Before making landfall, FEMA had pre-staged disaster supplies and personnel in Texas that were tasked to coordinate with various public and private sector agencies and organizations such as hospitals, nonprofit and faith-based community aid organizations, as well as the Texas Division of Emergency

Management. President Trump immediately issued a Major Disaster Declaration in response to Harvey's impact. This allowed various federal agencies the mobility to deploy personnel to Texas to assist in response and recovery (Federal Emergency Management Agency, 2017).

On September 1st, days after the hurricane impact, Trump requested \$7.9 billion from Congress in emergency spending to aid Texas and Louisiana in recovering from Harvey's catastrophic wind and flood damage. Seven days later he signed H.R. 601 into law which designated up to \$15 billion for Harvey relief (PBS News Hour, 2017). Unfortunately, these funds were bottled up due to administrative roadblocks within the Trump administration, and it wasn't until nearly two years later in June 2019 when Congress ordered the President to finally release the Harvey relief funds (Houston Chronicle Editorial Board, 2019). In 2018, the state of Texas signed into law a \$5.5 billion tax relief program targeting Texans impacted by the hurricane, as well as legislation that extended the National Flood Insurance Program for Texas homeowners. An additional two national-scale federal aid packages would be passed in the year following Harvey as well (Harvey Disaster Aid Timeline, 2018).

Part III: Federal Plans and Acts

The federal government as well as the Texas state legislature took swift action in response to the aftermath of Harvey. President Trump signed H.R. 601 on September 8th, which designated \$15 billion in Harvey relief funds to be deployed. Senator John Cornyn devised language which would secure an additional \$4 billion in funding to authorize the U.S. Army Corps of Engineers' hurricane risk reduction project in affected areas, authorized and signed into law at the federal level in October of 2018 (Hurricane Harvey: Recovery and Rebuilding, 2018).

Recovery and rebuilding legislation continued to be passed into 2019. In March, the Texas Senate unanimously approved a trio of bills that would approve funding and authorization for recovery and preparedness construction projects.

- Senate Bill 6 – Requires the Texas Division of Emergency Management to create guides for local officials on disaster response and recovery.
- Senate Bill 7 – Helped to accrue more than \$1.6 billion in recovery funds as part of the Texas Infrastructure Resilience Fund.
- Senate Bill 8 – Created an official statewide flood plan. The goal of the plan would be to manage flood control projects and both assess and repair unsafe dams and other infrastructure in the state (Collier, 2019).

Part IV: Organizational Impacts and Changes After Harvey

After Hurricane Harvey, there were many lessons learned, and it was apparent that governmental preparations at the federal, state, and local levels failed to address key vulnerabilities. This was especially apparent in the areas where Houston received much of its flooding, many of which were outside of FEMA's designated flood zones. Much of this flooding was attributed to, along with climate change, the skyrocketing growth of population in the Houston metro area, which led to major residential and commercial overdevelopment. Local building officials disregarded warnings from scientific groups and allowed for relaxed building requirements. Large swaths of land which once served as natural drainage for rainwater had been paved over (Shaw and Song, 2018). To add insult to injury, many Texans affected by the floods did not have flood insurance. This was a major lesson learned identified by FEMA, one that the organization pledged to address moving forward, stating that addressing the importance of the National Flood Insurance Program to the public would be a high priority, as well as educating

the public on what public assistance resources were available in the event of a flood or disaster (Robinson, 2018).

As a result of Harvey's impact, counties in Houston and the surrounding impacted areas have adopted stricter development and drainage requirements in order for developers to address flooding caused by increasing rainfall (Rice, 2020). Scientists have also pointed to the fact that an ever growing disconnect exists between actual rainfall locations and FEMA's flood plain maps, as well as inequality in the distribution of FEMA aid between white victims and victims of color in poorer, more vulnerable areas (Moon, 2018). While FEMA has yet to specifically address these issues, much of it in part due to Harvey's recency, experts and officials agree that changes to federal disaster response need to more specifically address the issues presented by climate change and the growing disparity of wealth in the Houston area, and how a natural disaster can exploit such vulnerabilities.

Conclusion

The devastating impact of Hurricane Harvey highlighted several strengths of the state of emergency management and disaster response at the time. One of the most important, if not the most important strength in the response was that strong leadership was shown among all levels of government. Whereas with previous major hurricanes, most notably Katrina, leaders bickered and quarreled over what decisions to make during the response, which ultimately stymied the efficiency and effectiveness of the response and recovery effort, led to more death and destruction. This time around, many administrative hurdles had been removed, and federal, state and local leadership presented a unified front and allowed for an integrated response, even involving the assistance of private sector businesses throughout communities that were in need of aid and supplies.

While much needed leadership and structural changes allowed for an adequate response to Hurricane Harvey, pressure is mounting on officials at all levels of government to address the impact that climate change had on the severity of Harvey. Research points to climate change being a direct cause of increases in total annual precipitation as well as worsening storms. Harvey dropped a record amount of rainfall in Texas, and studies show that precipitation of Harvey's magnitude is three times more likely today than in the early 20th century (Waldman, 2017). Explosive development in areas that once served as natural flood barriers and water absorbers have removed these natural defenses, creating a one-two punch recipe for worsening devastation whenever a hurricane or severe precipitative event strikes. Such evidence expresses a dire need for officials tasked with preparing, mitigating, and responding to disasters to acknowledge this new reality. The most effective acknowledgement must come in the form of policy changes, the modification and strengthening of existing infrastructure, and the allocation of funding for projects that will inhibit the inevitable effects of climate change in highly populated coastal and low-lying areas.

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