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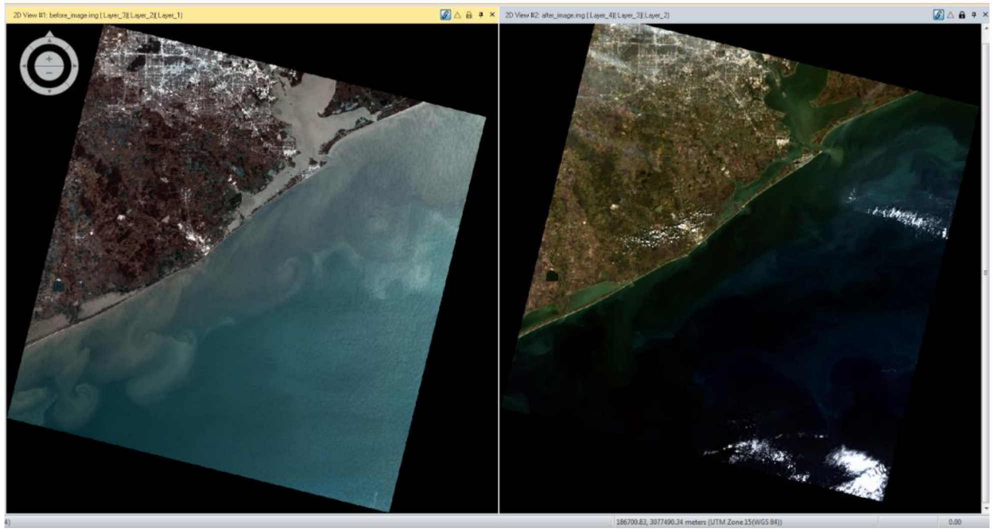
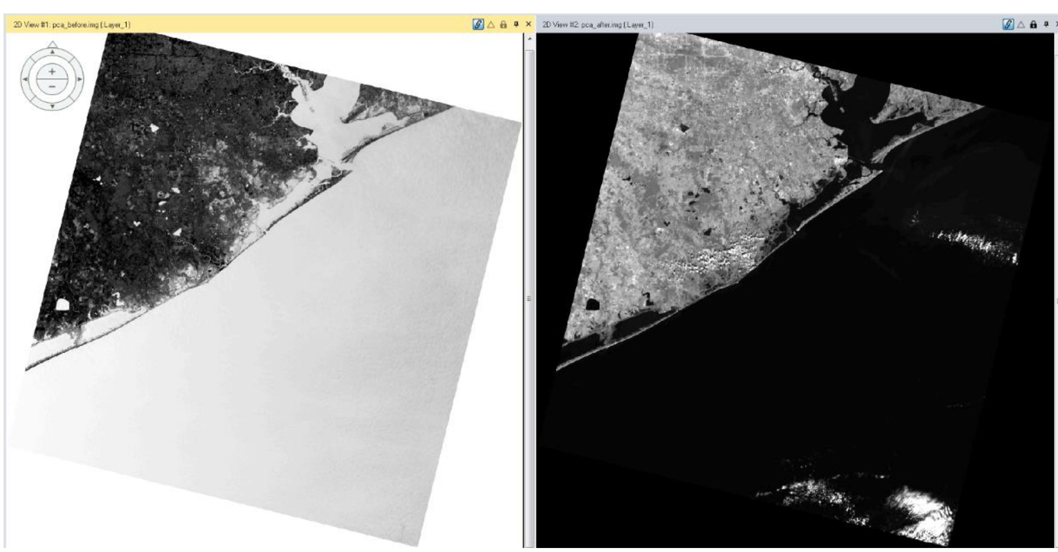
Hurricane Harvey's Effect on South Eastern Texas: A Land Change Analysis

Each year is different for hurricane season, bringing about tens of hundreds of storms that form in the Atlantic Ocean and occasionally make landfall here in the US as well as other places in the Caribbean. Hurricane Harvey was first observed by meteorologists in the South Atlantic Ocean on August 13th 2017 and by August 25th, it had hit the mainland of Texas as a category 4 hurricane. The raw power of these hurricanes are witnessed when they are still in the ocean, as there is nothing to stop them. Hurricanes slow down noticeably once they hit land, as there is no source of water to continuously feed from, and also wind force also decreases as you move away from the shore. These forces of nature also cause many other side effects on the landscape such as tornados, flooding, and erosion which can be both deadly and extremely expensive to repair. Hurricane Harvey was the deadliest, most powerful natural disaster to happen to Texas since Hurricane Ike in 2008, inflicting ~$125 billion and killing at least 107 people (NOAA).

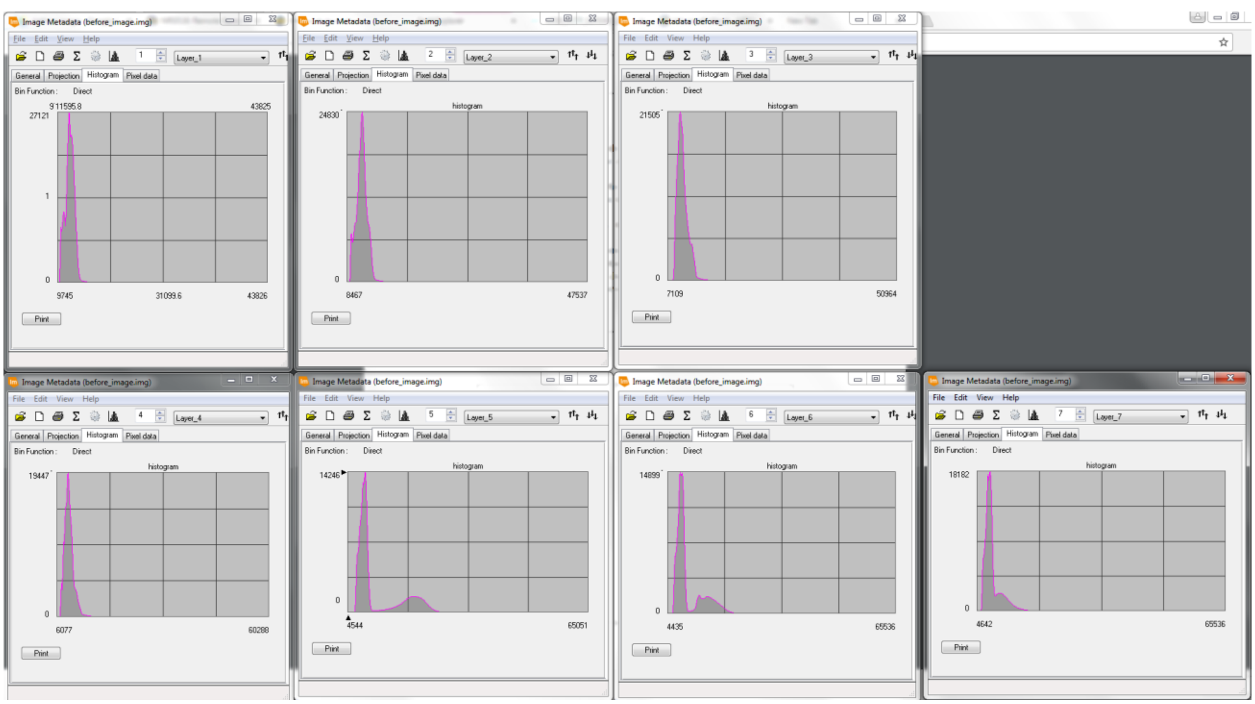
The images I chose for my analysis were of Galveston, and a little bit further to the North East is Houston Texas. An important part to mention are the dates of the before and after images. The image taken before Hurricane Harvey was taken on May 26th, and the other being taken on December 4th of the same year. The two images I used seem to have a lack of cloud cover, which is super useful, and they were the closest images I could find from Landsat 8 that had less than 20% cloud cover.



Some of the techniques we have learned in class will prove to be quite useful to us in the land change analysis. The first tool I used when looking at these two images was PCA, and interestingly enough, the two images were polar opposites when running PCA. As you can see in the image below, the image from May has the landscape as black and the water as white, while the image taken in December has landscape as white and the water as black. Although PCA is not meant to be an overall deciding factor when making judgements about land change, it is useful for showcasing overall landscape changes to people who do not know as much about the area as the one studying it.



Visuals are not the only tool we can use to decipher changes that occurred to the landscape. Histograms are used for each different band of what a sensor captures, having the range of values on the X axis and the frequency of said values on the Y axis. The following images show the histograms for the first 7 bands of each image. What is worth noting is the lack of high pixel value pixels in the “after” image, whereas the image before the Hurricane seems to have a health amount of pixels of different spectral values. I am pretty skeptical about the meaning of this because there are many factors that play into how these values are determined. There can be a lot of “noise” in a sense that there are many miles of distance between the land and the sensors that capture waves that carry the data from these images, and in that span there can be clouds that disrupt the path of the waves, the ocean can interfere with how the blue wavelength gets captured, or maybe even solar radiation can play a part. The important take-away is that these values are not completely accurate; there will always be some form of error with the technology that is available for the moment.



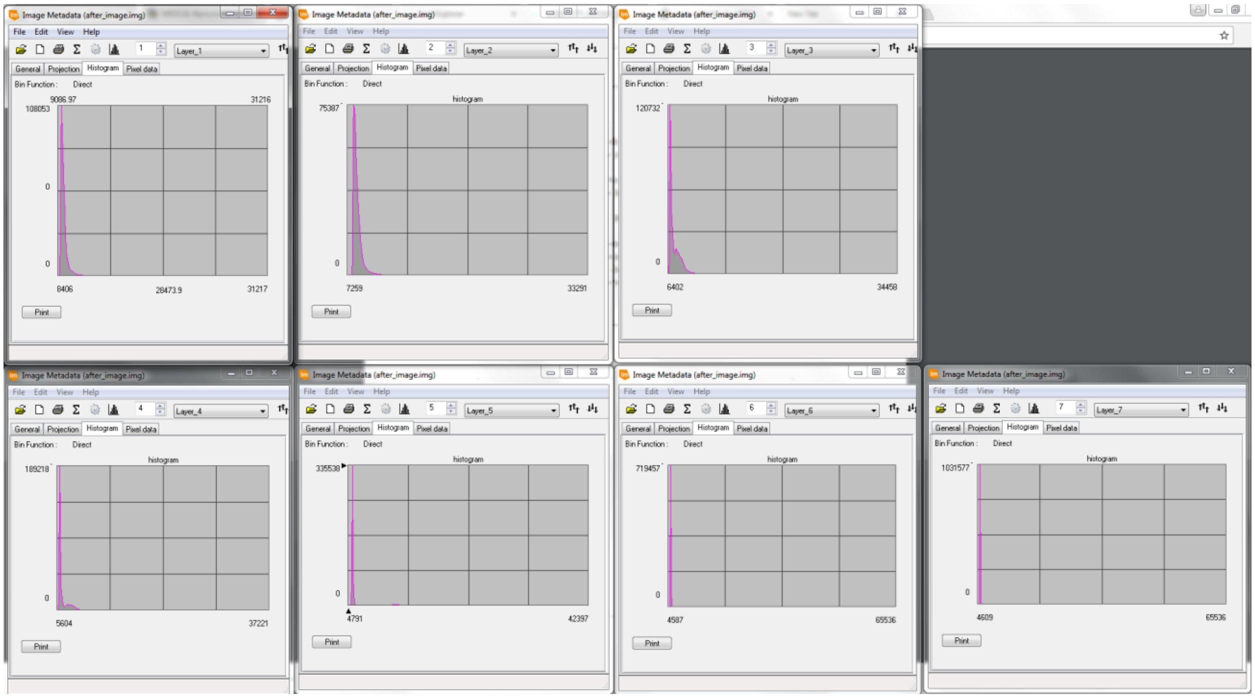
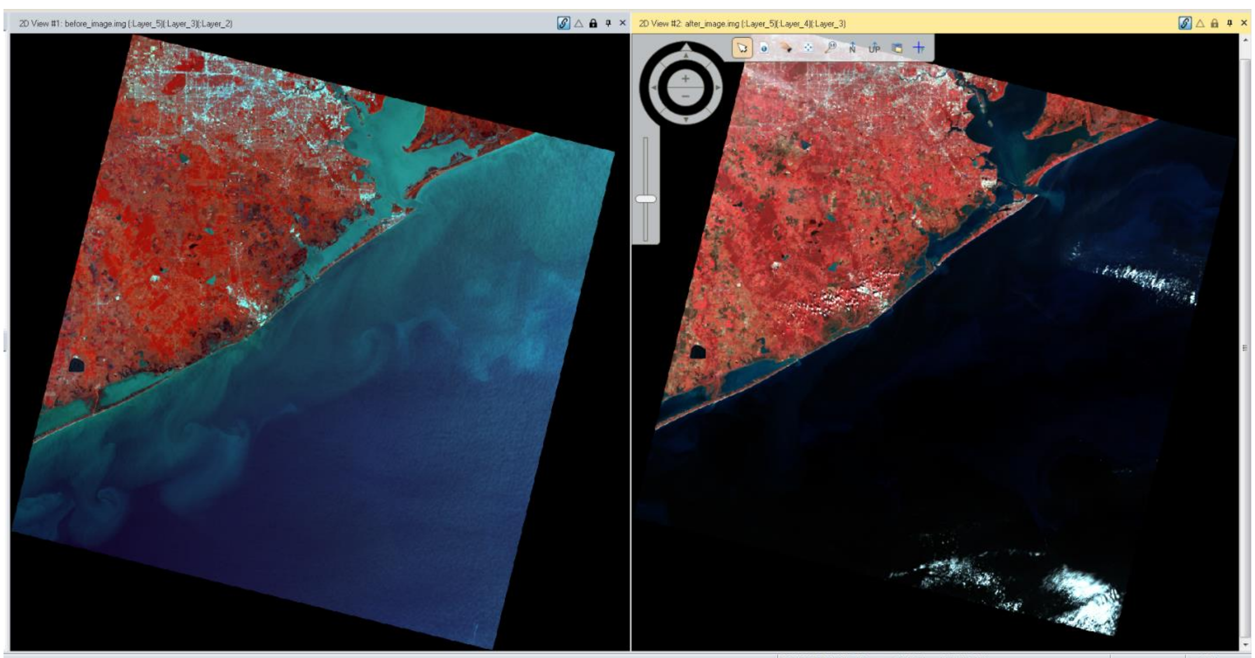
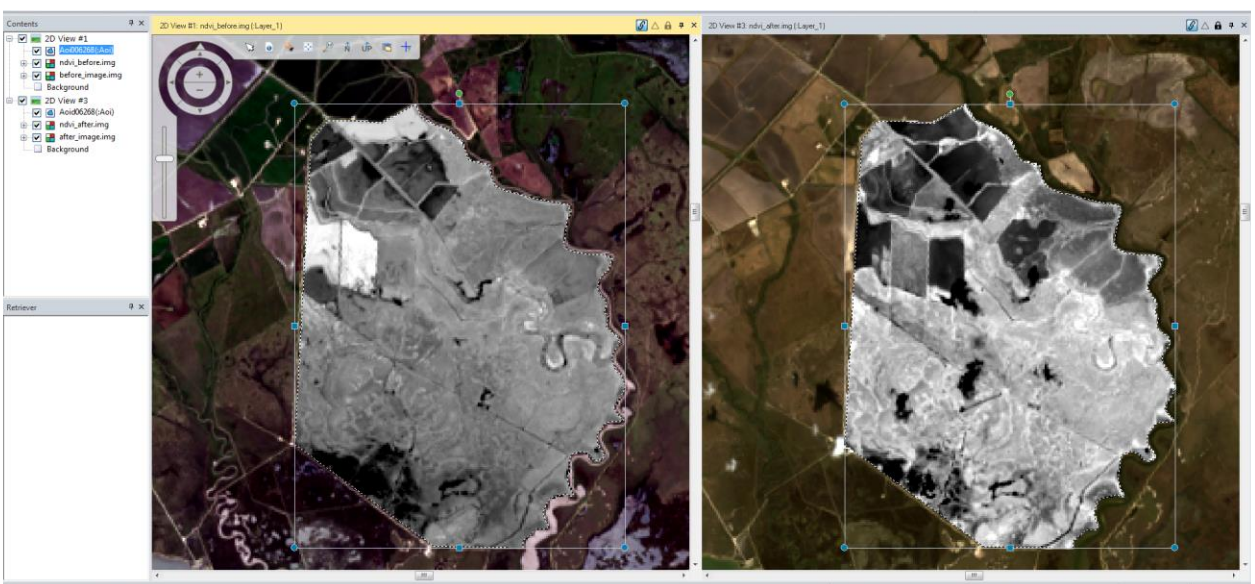
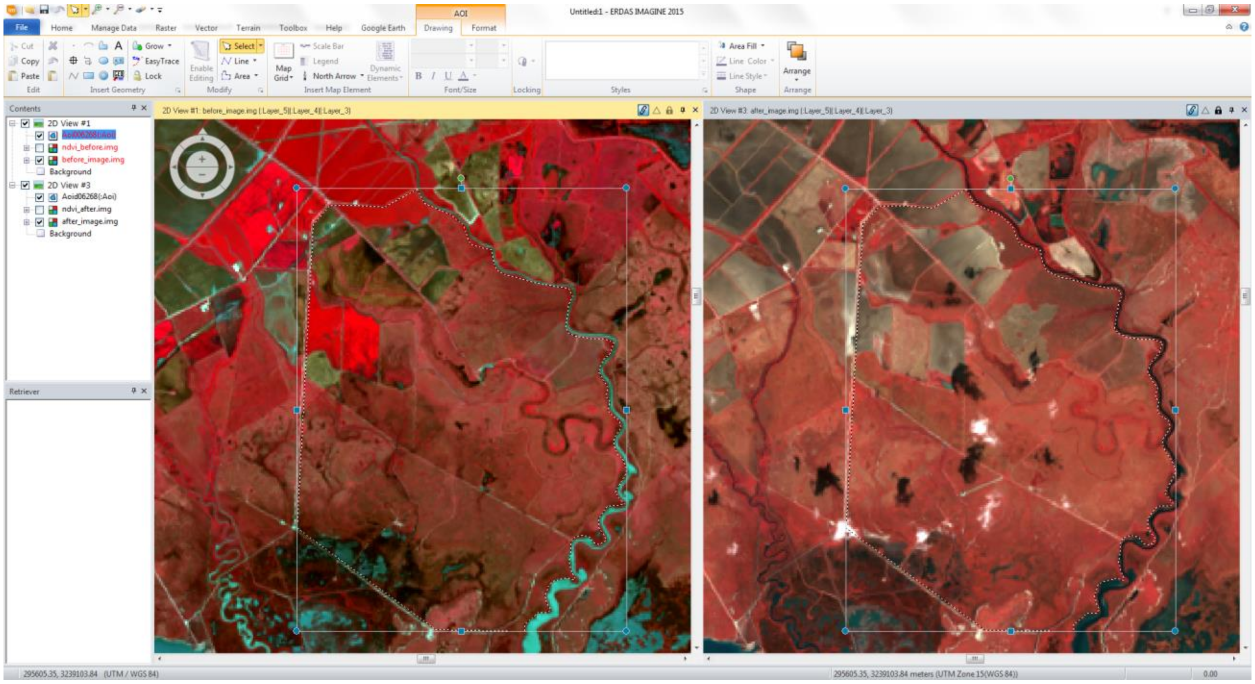


Image Metadata (after_image.img)
General
Projection
Histogram
Pixel data
Bin Function : Direct
histogram
Print


2D View #1: before_image.img
2D View #2: after_image.img

One of my favorite processes of using ERDAS Imagine is delineating a certain chunk of landscape and looking at the final results once you are done delineating. In the images below, I did a delineation on a smaller scale of what looks to be a farmland / pasture area, and ran NDVI on the delineation. Once again, the image on the left is the one from before the Hurricane, and the one on the right is 3 months afterwards. What is fascinating to me is the difference in brightness of the landscape, and the darkness of certain areas as well. My theory about why this is so is that Hurricane Harvey brought a lot of landscape devastation, yes, but it also created a massive problem with runoff and erosion, which means a lack of control of nutrients. These nutrients, when in a high enough concentration, means that plants uptake a lot of nutrients such as ones containing Nitrogen and Phosphorus, and can grow at a more rapid rate than before. That, I believe, is why the overall brightness of the pasture area seems to be greater in the "after" image than the "before" image. Other areas are darker though than before, and my hypothesis as to why that is includes harvesting of crops and potential lack of proper soil to continue using that area as farmland. The hurricane could have devastated soils to make them unusable for farming until they returned to normal, hence some areas lack any vegetation at all.



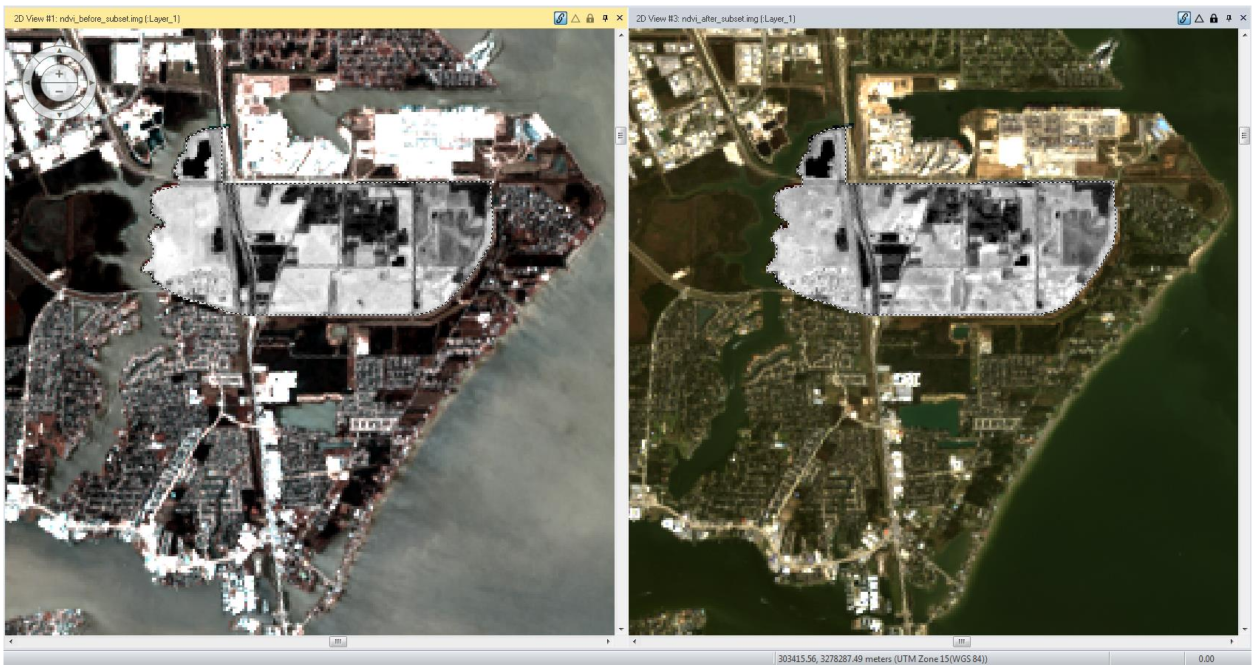


Turning to more urban areas, it seems as though there is a reverse effect compared to that of the farmland / pasture area in terms of vegetation biomass. Below are screenshots from Houston Texas where rainfall reached a record high of 16 inches (NWS Houston), and devastated the area with mass amounts of flooding. Citizens were told to evacuate, or the consequences would be extremely severe. One news station was given an emergency warning of

"Anyone who chooses to not heed this directive cannot expect to be rescued and should write their social security numbers in permanent marker on their arm so their bodies can be identified," wrote Blanchette. "The loss of life and property is certain."

The reason the amount of vegetation to not grow back completely could be because in the farmland area, farmers use fertilizers that contain a high amount of Nitrogen and Phosphorus, as discussed earlier, that helps plants grow, and since fertilizer would be less common in urban areas, only pollutants and storm water runoff affected the vegetation in the city. I ran another subset of NDVI on the Houston area to determine the difference in vegetation.

Contents
2D View #1
Aoi006268(:Aoi)
ndvi_before.img
before_image.img
Background
2D View #3
Aoid06268(:Aoi)
ndvi_after.img
after_image.img
Background
Retriever
2D View #1: before_image.img (:Layer_5)(:Layer_4)(:Layer_3)
2D View #3: after_image.img (:Layer_5)(:Layer_4)(:Layer_3)
299150.16, 3285480.96 meters (UTM Zone 15(WGS 84))
0.00



2D View #1: ndvi_before_subset.img (:Layer_1)
2D View #3: ndvi_after_subset.img (:Layer_1)
303415.56, 3278287.49 meters (UTM Zone 15(WGS 84))
0.00

References

"Costliest U.S. Tropical Cyclones Tables Updated." National Hurricane Center, 26 Jan. 2018, www.nhc.noaa.gov/news/UpdatedCostliest.pdf.

"East Texas County Tells Residents 'GET OUT OR DIE!'." *KSBW*, KSBW, 11 Oct. 2017, www.ksbw.com/article/east-texas-county-tells-residents-get-out-or-die/12142731.

US Department of Commerce, and NOAA. "Hurricane Harvey Info." *National Weather Service*, NOAA's National Weather Service, 24 Apr. 2018, www.weather.gov/hgx/hurricaneharvey.