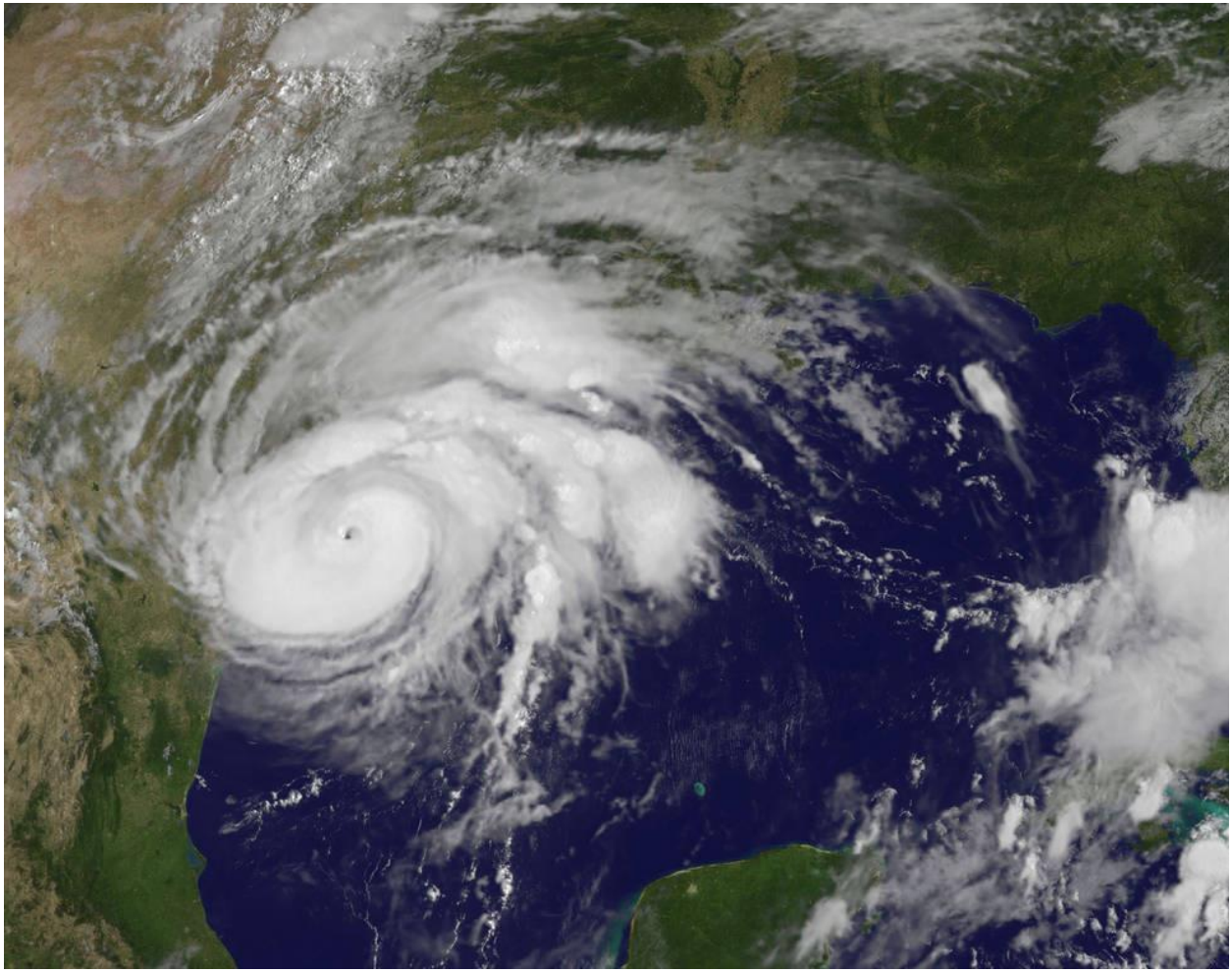


Analysis of Flooded Roadways from Hurricane Harvey



Introduction

Between August 25 and September 1st the Southeastern Coast of Texas was struck by category 4 Hurricane Harvey. For 7 days Harvey dumped up to 50" of rain on some parts of the region, creating massive floods. Floodwaters covered much of the area flooding houses and roads. People who were not evacuated quickly found themselves trapped, as the roadways around them became overrun with water. I want to analyze flood data to see how the flooding from Hurricane Harvey impacted the road network of the Houston area.

Data Collection

Data collected from:

Houston-Galveston Area Council GIS Datasets:

<http://www.h-gac.com/rds/gis-data/gis-datasets.aspx>

Texas Department of Transportation:

http://gis.txdot.opendata.arcgis.com/datasets/8b902883539a416780440ef009b3f80f_0

http://gis.txdot.opendata.arcgis.com/datasets/d4f7206d27af4358acb70cb1cc819d10_0

Dartmouth Flood Observatory, University of Colorado Boulder:

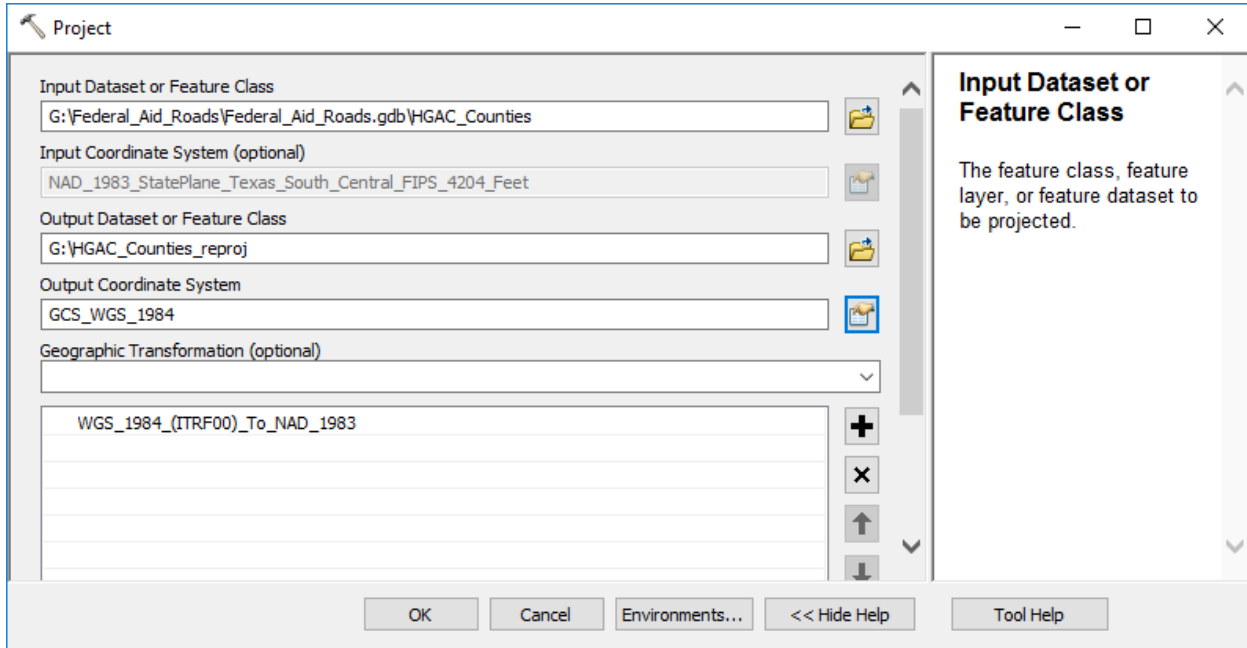
<https://floodobservatory.colorado.edu/Events/2017USA4510/2017USA4510.html>

Texas Water Development Board:

<http://www.twdb.texas.gov/mapping/gisdata.asp>

Data Processing

All the collected flooding data used the coordinate system WGS 1984. For ease of use all future imported data will be projected into this coordinate system. Therefore the map elements, counties, roads, and all future datasets were all projected into this coordinate system using the project tool in ArcCatalog.



The Houston-Galveston Area Council is an association of county governments surrounding Houston and Galveston. These 13 counties represent what could be considered the Houston-Galveston Metropolitan area so this was selected as our area of interest for the project. First there projected HGAC Counties were added as a base layer file.

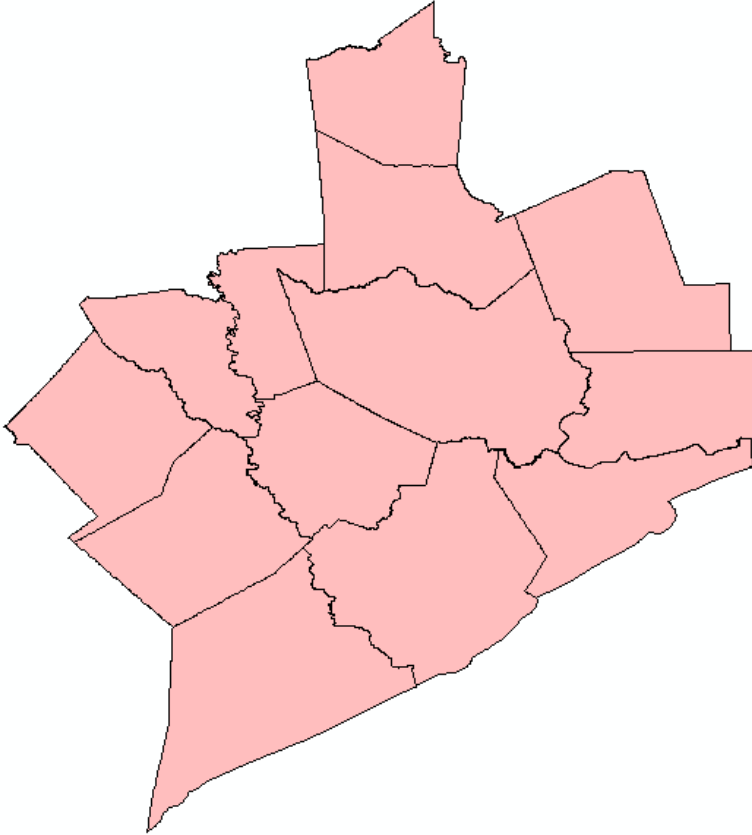


Figure 1. HGAC member counties

Next, the data from the flooding was added. Collected from the Dartmouth Flood Observatory, this collection of 8 shapefiles was collected by satellite imagery from a number of different agencies. For the purposes of this project we will consider the area that is covered by these polygons as the flooded regions.

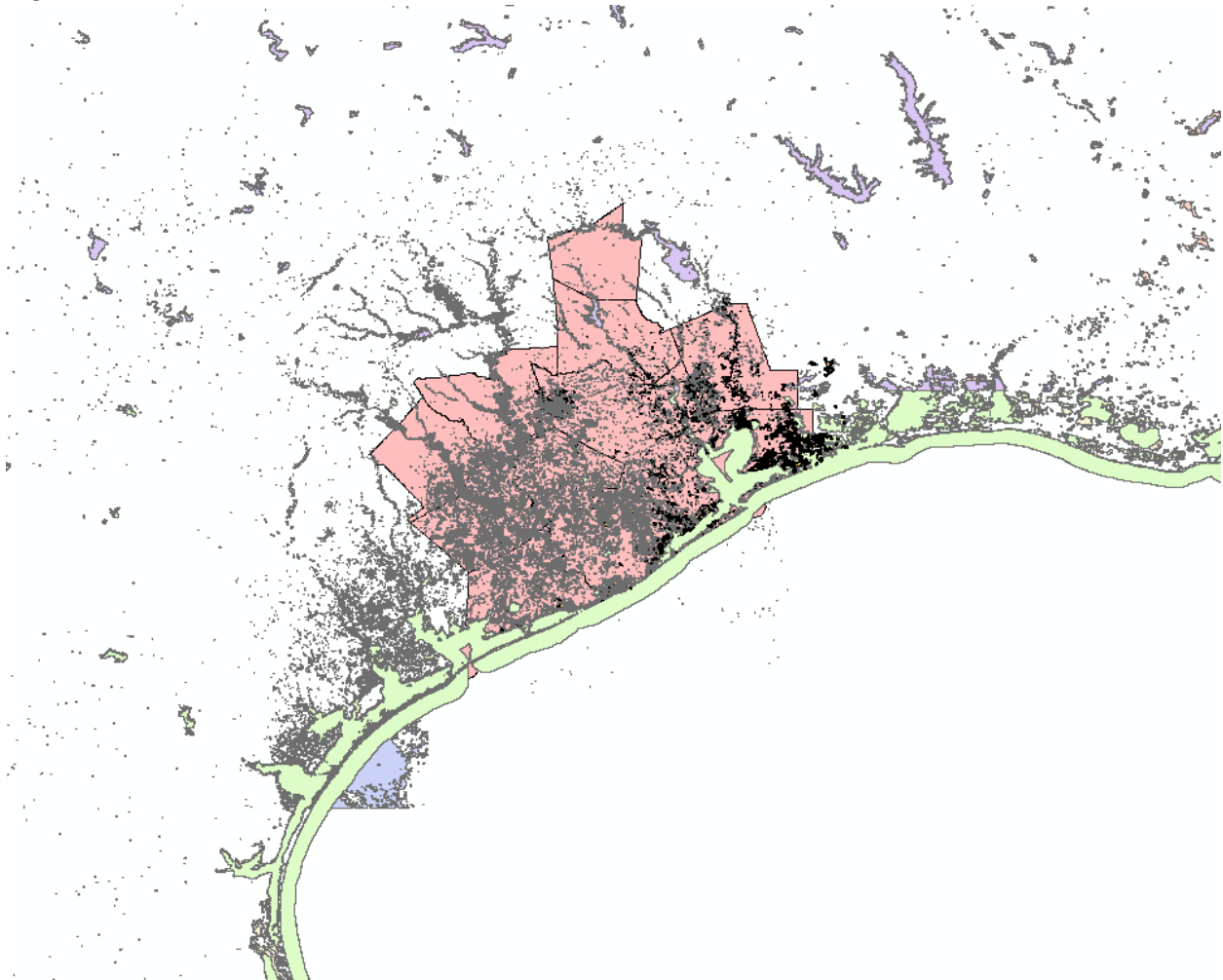


Figure 2. Flooding data added.

An issue that is obvious is the presence of data outside of our area of interest. We would like to reduce these shapefiles to lie within our area of interest. The clip tool was used to accomplish this. It should be noted that the counties shapefile shows political boundaries. The boundaries extend into the Gulf of Mexico and represent ocean. This will be corrected for in a later step.

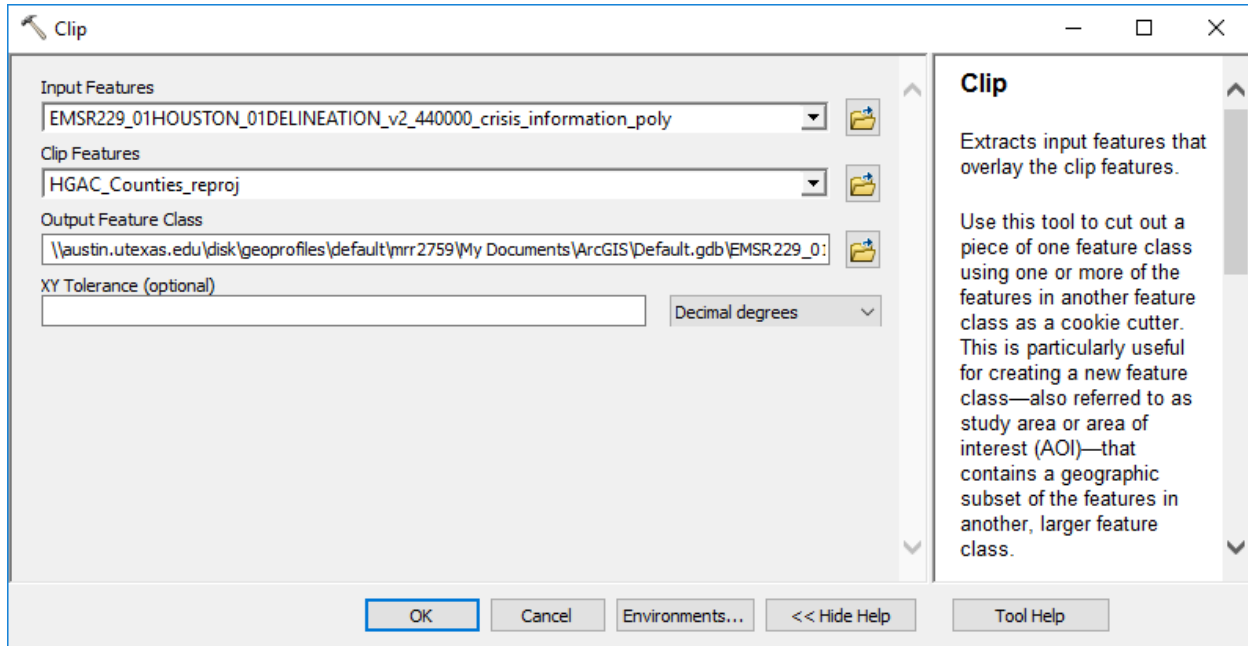


Figure 3. Screenshot of the clip tool being used to clip flood data.

This screenshot of the clip tool window shows how one flood extent dataset was clipped to the area of interest. This step was repeated for each flood dataset until they were all contained within the area of interest.

The resulting clip of all the datasets produces this image. The eight shapefiles have been clipped to lie within the area of interest. For this project we are only interested in the area covered by flood waters. Since each satellite collected different data from this event all the flood data will be combined together to represent the extent of the floodwaters.

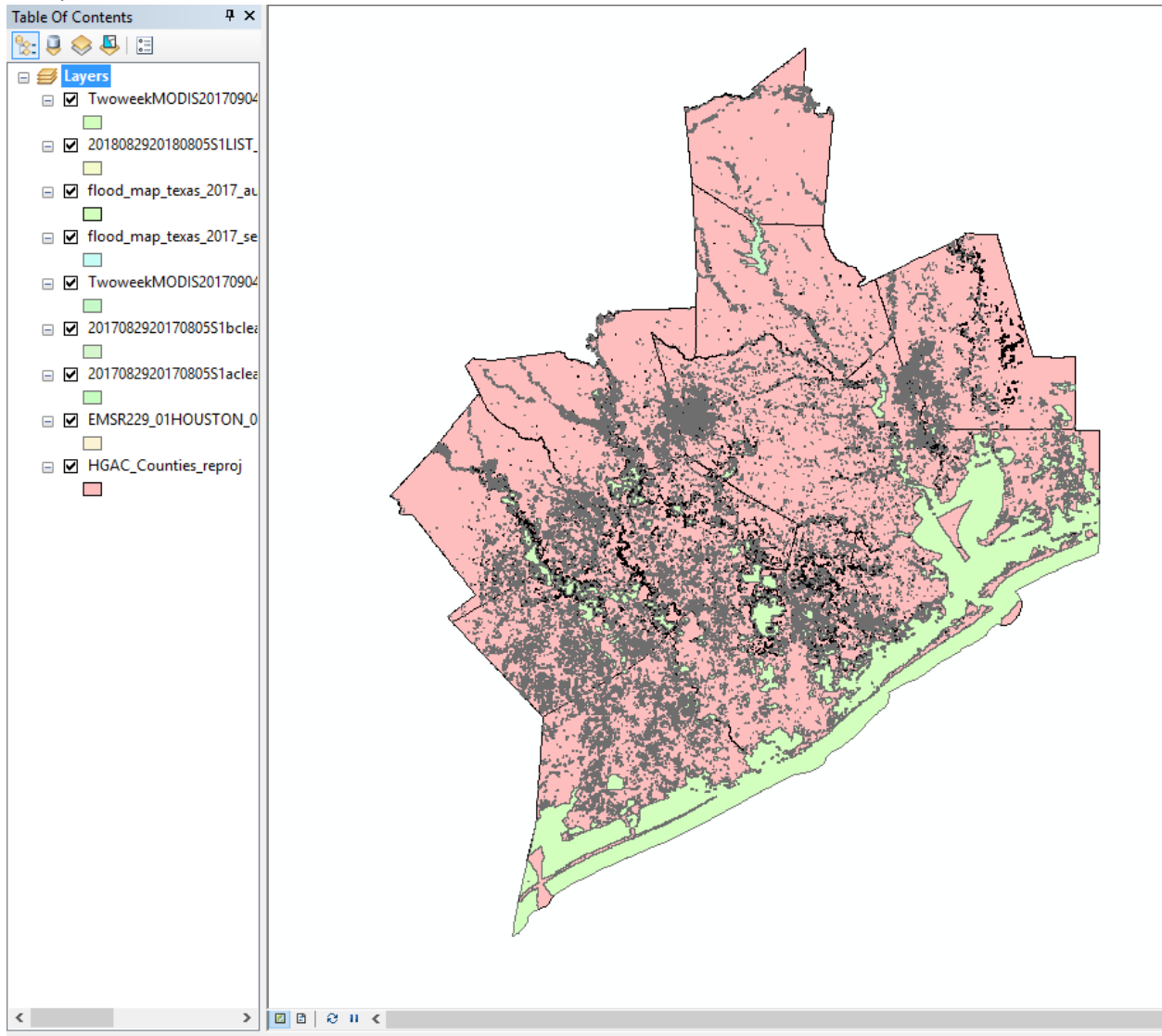


Figure 4. Clipped flood data to fit within area of interest

To combine all 8 datasets the merge tool in ArcToolbox is used.

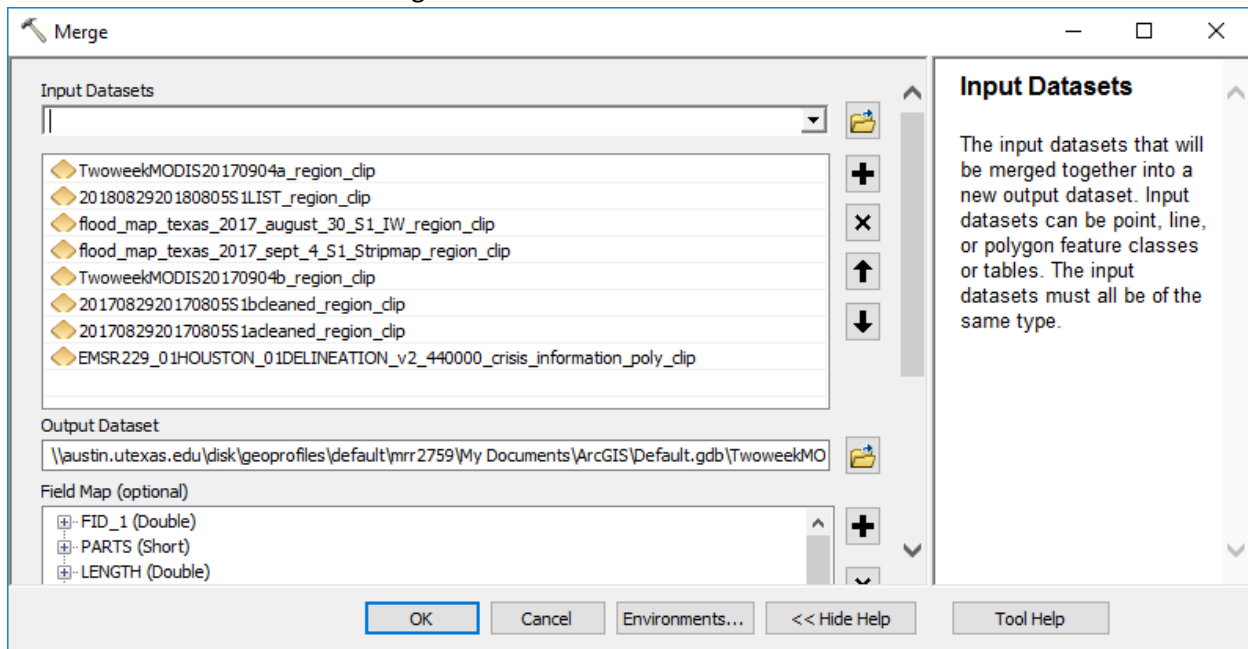


Figure 5. Merge tool used to combine flood datasets.

The result of this tool produces a single polygon that looks like this.

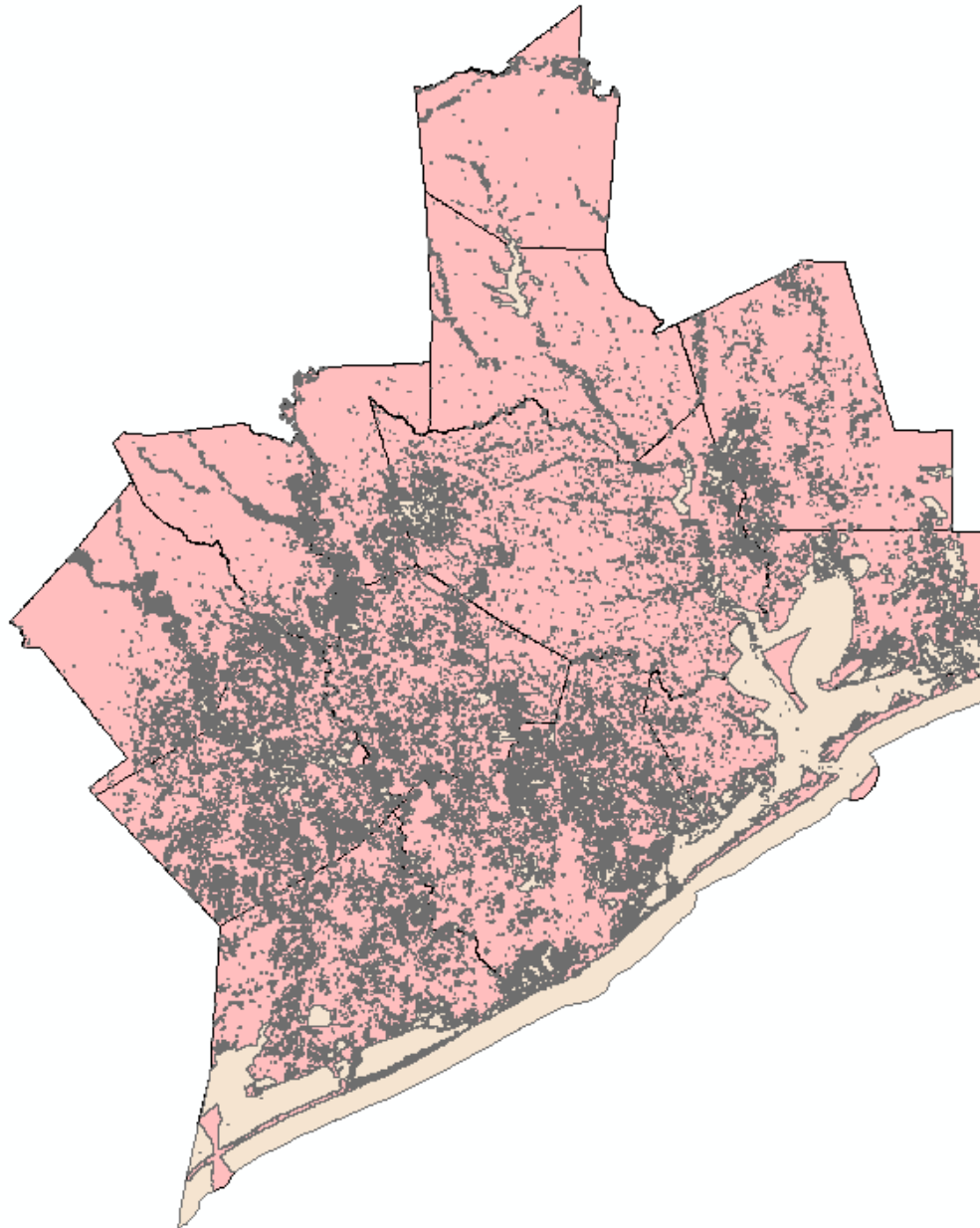


Figure 6. Resulting merge of all flood polygons.

By combining all flood datasets into one it allows for the table of contents to be cleaned up. One issue about this flood waters dataset is that it includes parts of the Gulf of Mexico and the Texas coastline. This is not considered flooding and will be removed. Taking a coastline shapefile from TxDot we can clip the merged flood polygons to the Texas Coastline. Using the clip tool like in Figure 3, a polygon that looks like this is produced.

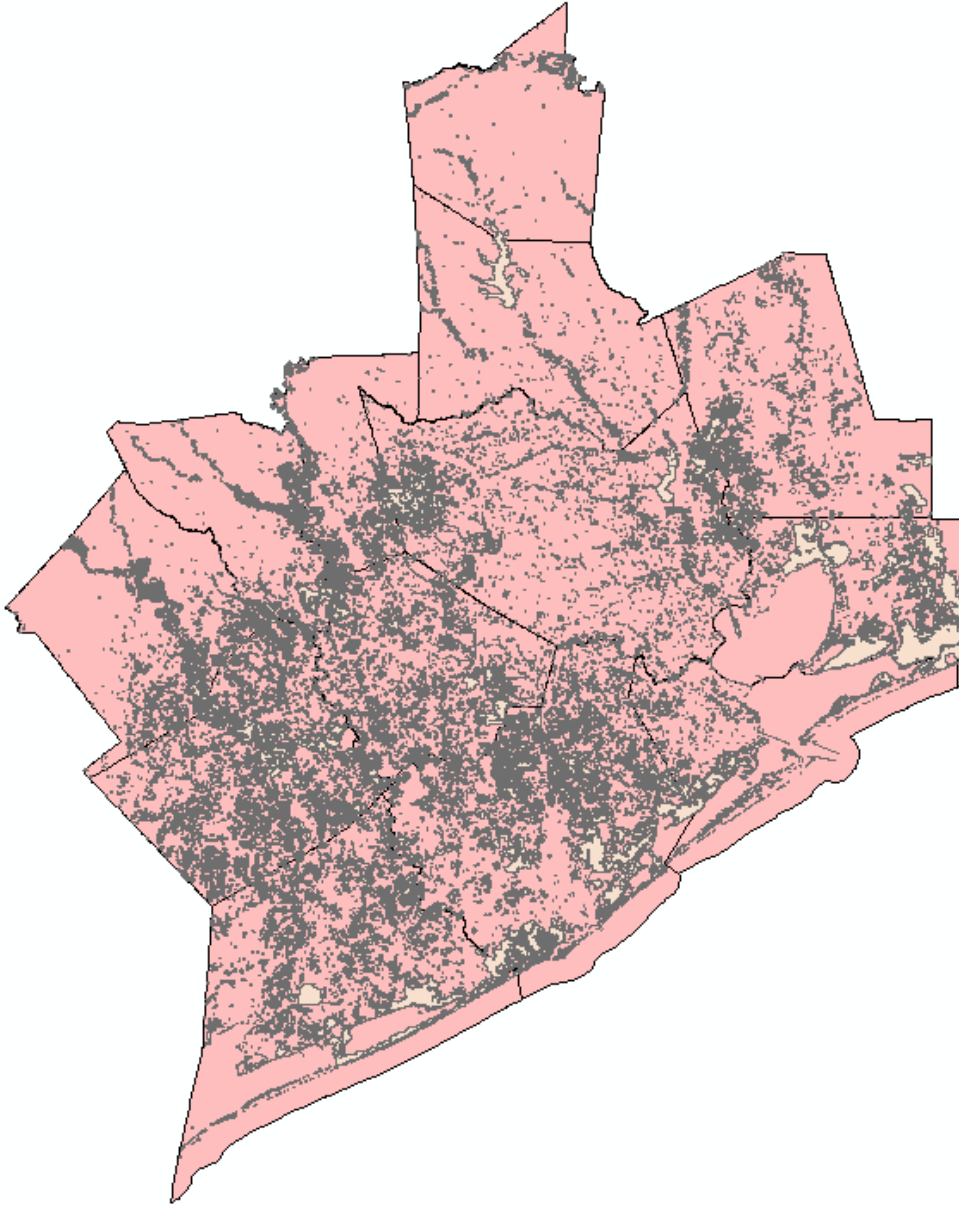


Figure 7. Clipped flood dataset to Texas coastline.

Now that the flood data is combined we can move on to the next step of adding Texas roads.

The Texas roads will need to be clipped to fit within the area of interest. Because of the large size of the file this clipping is done in ArcCatalog. Adding the clipped roads to the map produces this image.

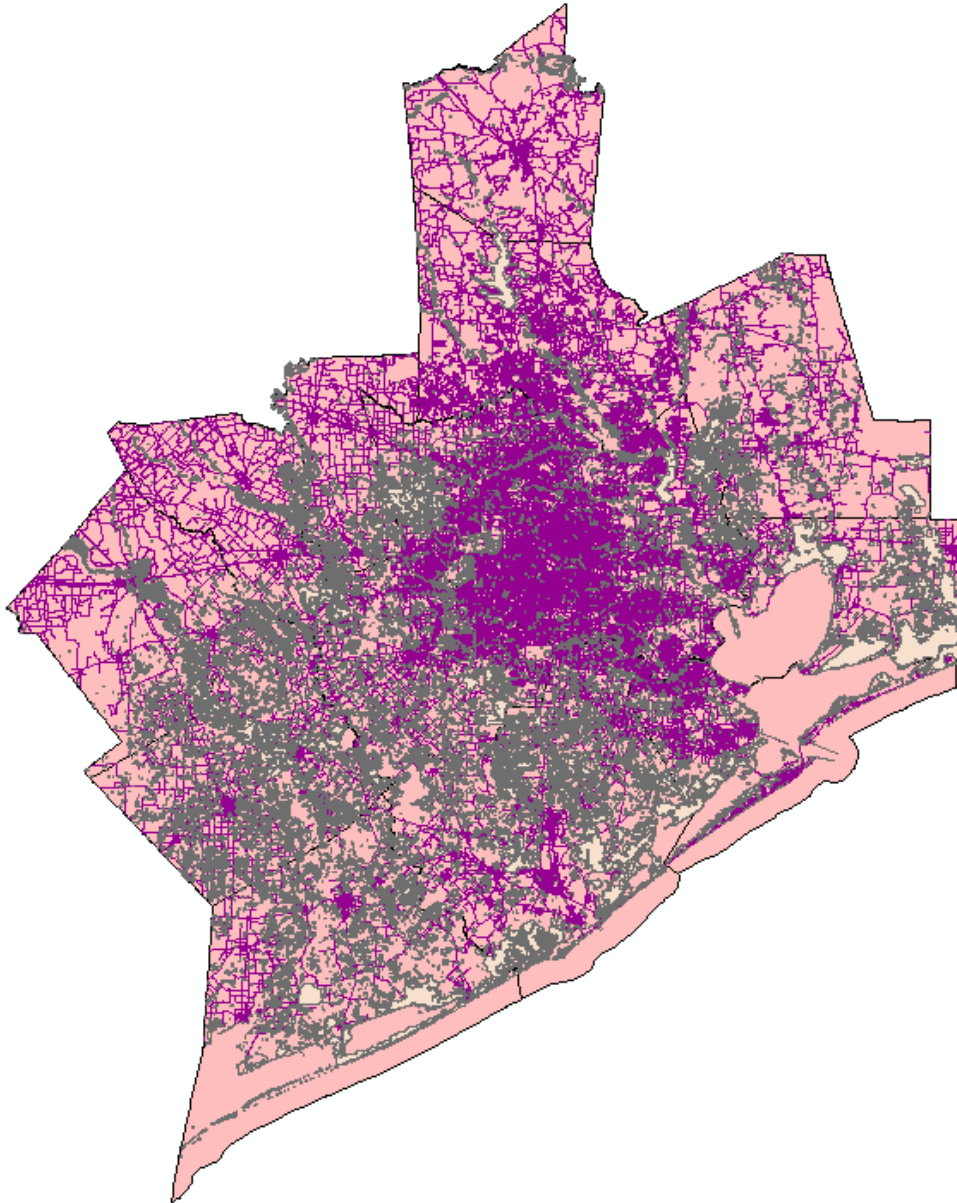


Figure 8. Clipped Texas Roads added to Area of Interest.

This is very messy but will be cleaned up for the final product.

The next, most important step is to clip the Texas roads to the flood polygons. This clip will give information about the roads that are flooded by producing a dataset of roads that intersect flooded areas. The resulting clip gives this data.

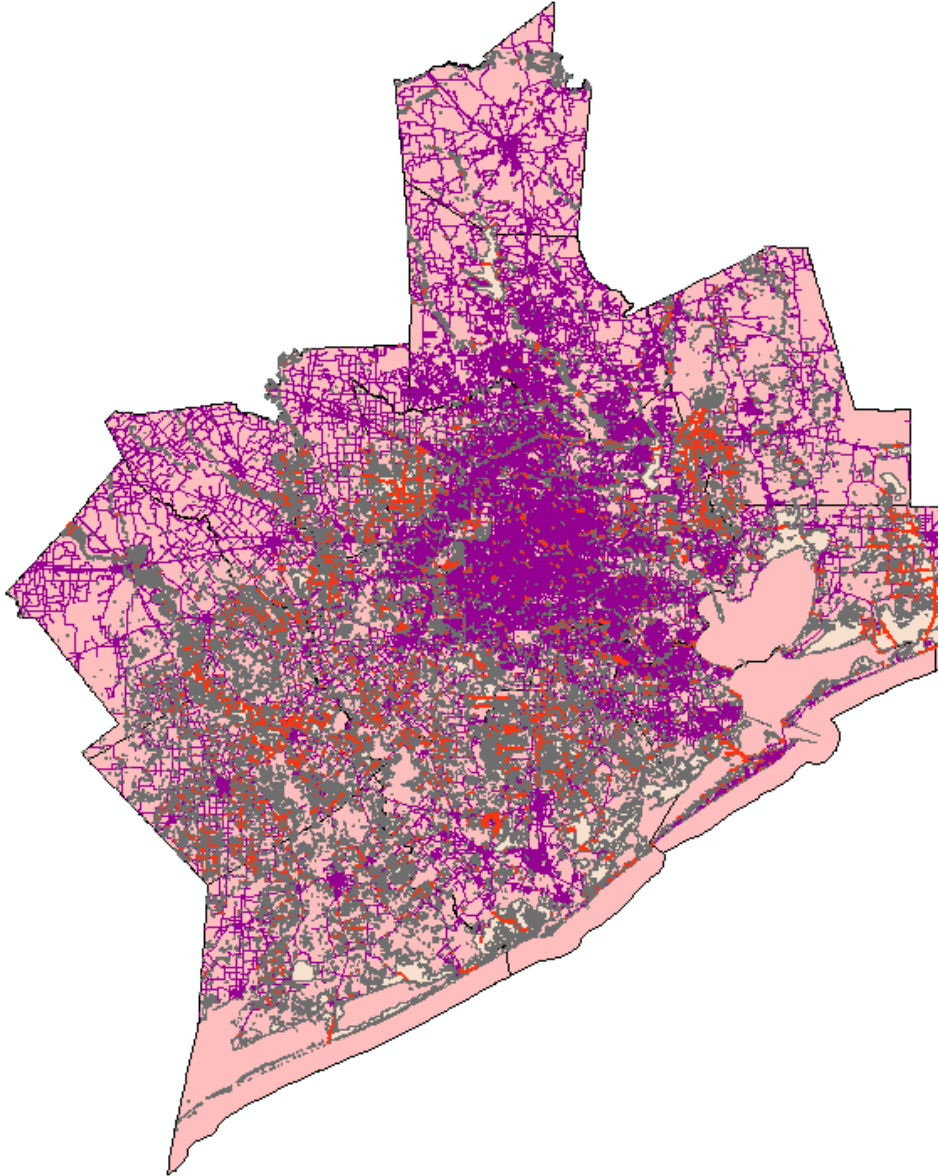


Figure 9. Red lines represent roads covered by floodwaters.

The red lines represent roads that have been covered by floodwaters.

Now that we have the data we need from the Texas roads file (flooded roads) it can be removed and substituted with data from HGAC. This dataset contains all the major Interstates and roadways for the area. This file contains a column in the attribute table named Road_Category which classifies each road to its respective description. We can symbolize these roads so that our map displays the major highways of the Houston area.

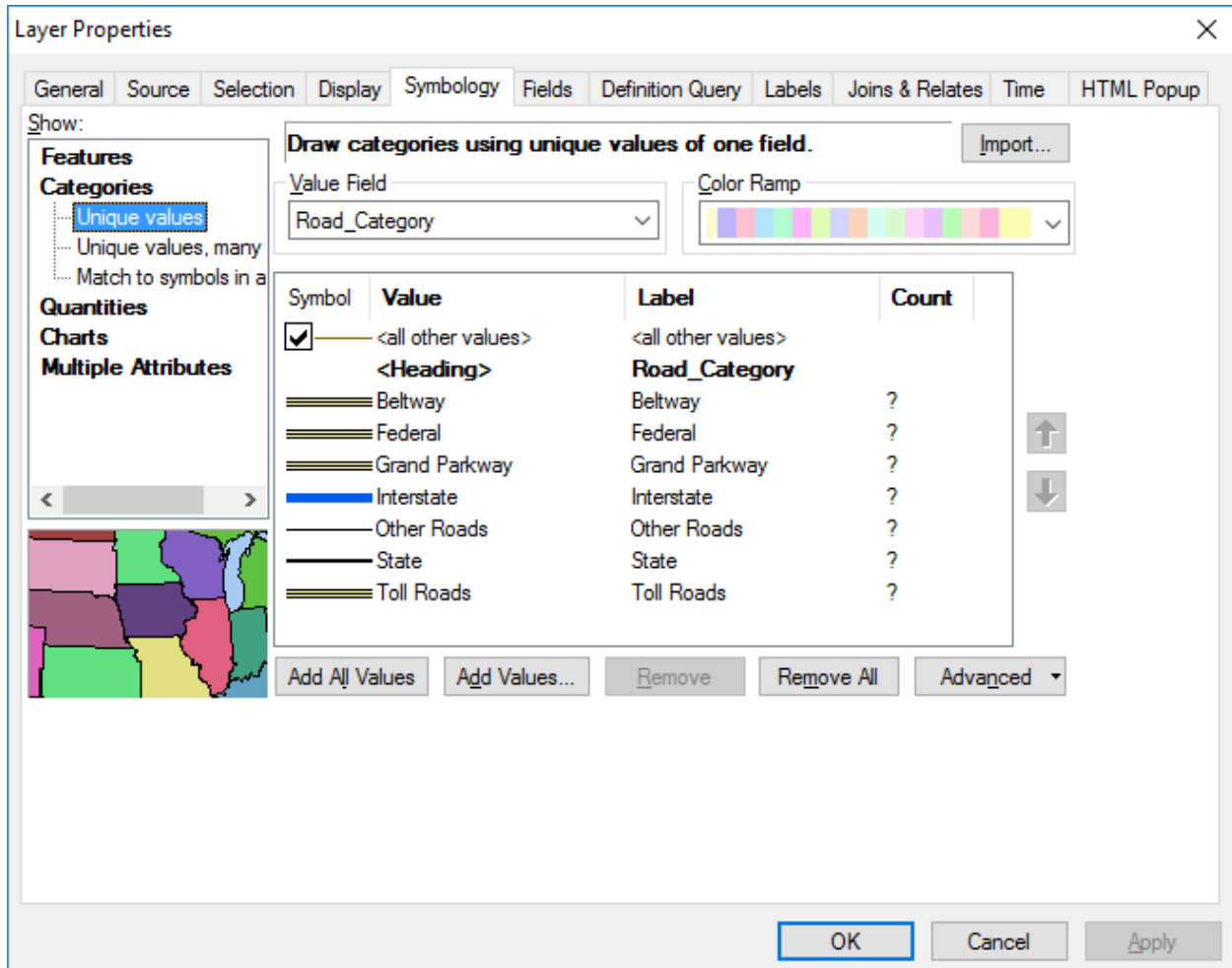


Figure 10. Symbolizing of Major Roads.

Some of the values (Beltway, Federal, Grand Parkway, Toll Roads) were symbolized the same. These roads can be considered to be more or less the same class of roads. For this project it is not important to differentiate between them so they were symbolized the same. County boundaries were also symbolized in this step.

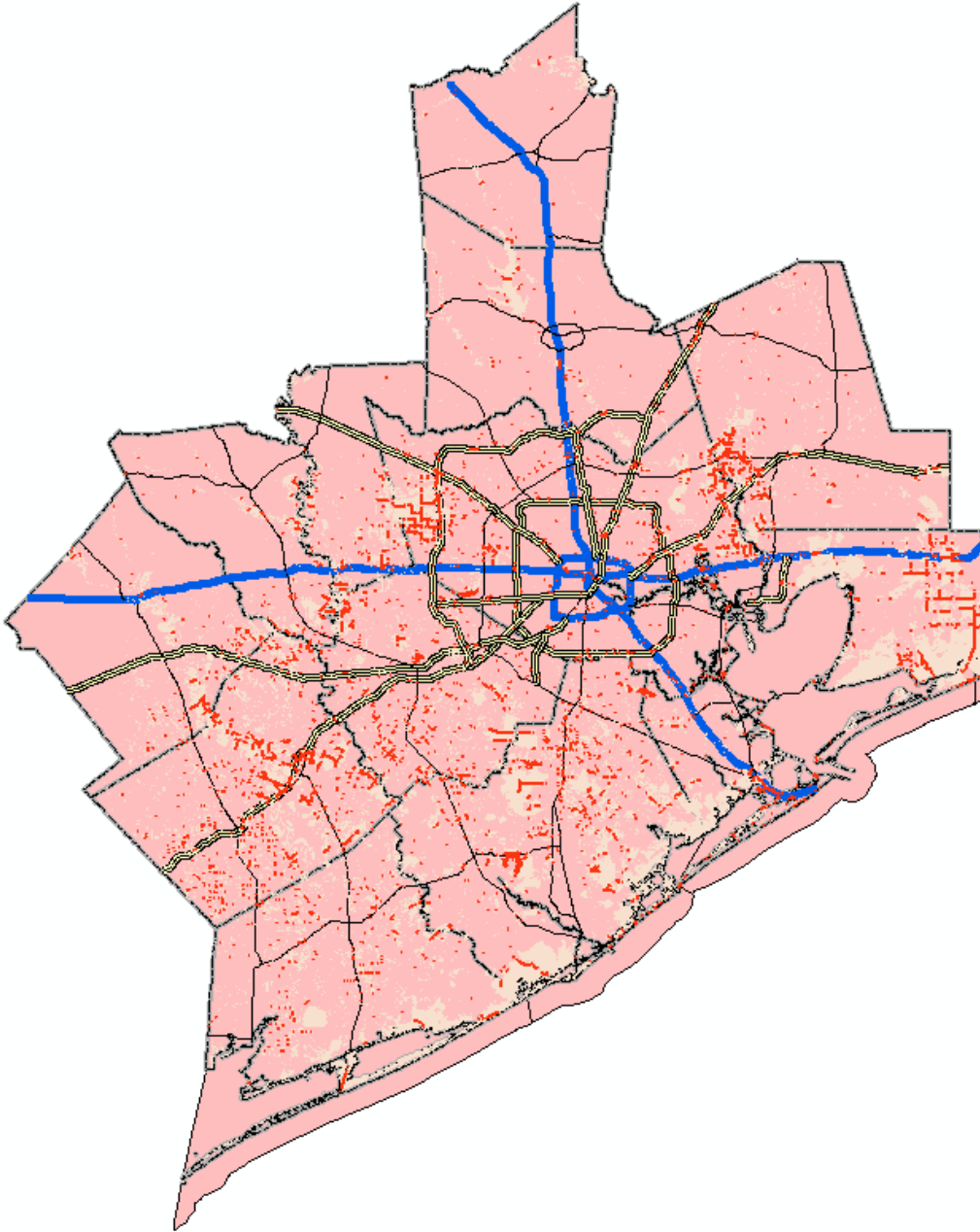


Figure 11. Symbolized Major Roads and County Boundaries.

Conclusion

At the start of this project I expected to see many more roads flooded. The pictures that came from Hurricane Harvey and the ensuing relief efforts made it seem like all of the roads in the Houston area were flooded. However, the map I created does not reflect what many, including me, felt happened. The flooded roads that I show match up with many of the real world road closures. One thing I suspect may have impacted the accuracy of the map is the satellite data. This data was collected over a period of intense rainfall and cloud cover. I do not know how much the cloud cover impacted the data collection. Another thing that could be explored would be high water marks from the hurricane. A correlation might be found between the high water mark data and road closures or flooded areas. Overall the results provide a way to see area impacted by the flooding of Hurricane Harvey. On a visual level they identify areas where road closures might be an issue in future flooding events.

Greater Houston Area and Flooded Roadways From Hurricane Harvey

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12/7/2017

