An Understanding of Pluvial Flood Inundation in Houston due to Hurricane Harvey

Hurricane Harvey posed unprecedented flood disasters in Houston, but the current flood mapping system, as a system of stream gages, does not accurately reflect the flood inundation situation throughout the storm event. Much of the flooding that occurred was pluvial in nature, as opposed to the typical fluvial floods that are modeled using traditional floodplain delineation methods, dependent on stream gages. Gaining an idea of the actual street and residential flooding that occurred during Harvey is critical for understanding the response of infrastructure to such a storm. Although this data is not available from official measurements, other data can be used to approximate extensive flood inundation by proxy. These data include rescue calls due to rising flood water in residential areas, and reported road closures throughout Houston. The goal of my term project is to create a time-associated picture of the flood inundation spread through Harris County. In addition, using storm water inlet and line shapefiles, flood dangers and access to storm water infrastructure will be compared to answer the question: does Houston's lack of substantial large-scale storm water infrastructure contribute to its repetitive flooding problems? An update on the progress of both these ideas is following.

With the intention of compiling crowd-sourced flood inundation data, I accessed rescue calls from the City of Houston 311 database and the Facebook group "Hurricane Harvey 2017 - Together We Will Make It; TOGETHER WE WILL REBUILD". The 311 Data was available from the City of Houston GIS portal (http://cohgis-mycity.opendata.arcgis.com/datasets/public-311-location), and sorted by type (flooding) and opening dates (8/24/2017-9/7/2017), before downloading as a shapefile. It is well known that emergency responders and local officials were unable to handle the large volume of rescue requests during the severe flooding from Harvey, so rescues requests from social media were fulfilled by citizens. One platform was well organized using Facebook and a Google My Maps application, with more that 100,000 people active on the group. This resulted in more than 5300 time-stamped, address points with severe flooding across the time and spatial extent of Hurricane Harvey. This Facebook group can be accessed here: https://www.facebook.com/groups/1982997775271266/ and the My Maps application can be accessed here: https://www.google.com/maps/d/u/0/viewer?mid=1qmepB5HrFSthl1DyK7lG9slEabY&ll=29.690950934799677%2C-95.29091127744147&z=11 (although the form used to request help is no longer available, and the exact query fields are unknown as a result). This data was downloaded from the My Maps application as a .kml file and converted to a layer using geoprocessing tools. Together, these rescue requests give a broad understanding of the areas of dangerous flood inundation during Harvey, as shown in Figure 1.

Over the next few weeks, I will be working on creating a time-series representation of the rescue call data with help from Andrew Austin-Peterson. We hope to be able to create a visual of the progression of the storm and the spread of flooding based on the rescue calls. I also hope to be able to create a cell-based synthesis of this data, with raster values representing the number of rescue calls within the cell extent. This will help compare this data with other information, such as the delineated floodplain, the inundated road network, and the storm water drainage system.

An overall picture of road network closures was obtained from TxDOT via Erika Boghici. She also improved upon the rather inadequate data provided by marking roads and road intersections that had elevations below the flood depth, or lay within the maximum flood extent.

The road closures are shown in Figure 2, while the road intersection closures are shown in Figure 3.

To get insights into the role of the storm sewer system in Houston on the severity of the flooding, case studies will be analyzed using flood rescue calls, and storm water lines. The storm water infrastructure for the city was downloaded from the ArcGIS portal at http://www.arcgis.com/home/item.html?id=ace9cbd6e03e48998cc51f295ba4af72. These data are not visible at a city-wide extent, so Figure 4 gives a screenshot of the data in one area of interest: Kingwood. In addition, Figure 4 shows the rescue requests in that area during Harvey.

Finally, in relation to the originally planned project relating land cover and flood inundation, the raster data from rescue calls can be compared to the National Land Cover Dataset (2011). Possibly, the effect of impervious cover on flood inundation can be quantified in some respect. This would be an interesting insight into the acute problems faced in large cities, and perhaps the results would increase interest in no harmful impact zoning laws.

In conclusion, there are multiple interesting ways to view and quantify the results of Hurricane Harvey with regards to inundation mapping. Not all of these ideas are necessarily feasible over the remaining length of this semester, but deserve an attempt. The data gathered is already useful for understanding the extent of flood inundation problems in Houston, and can be analyzed further for more detailed information.

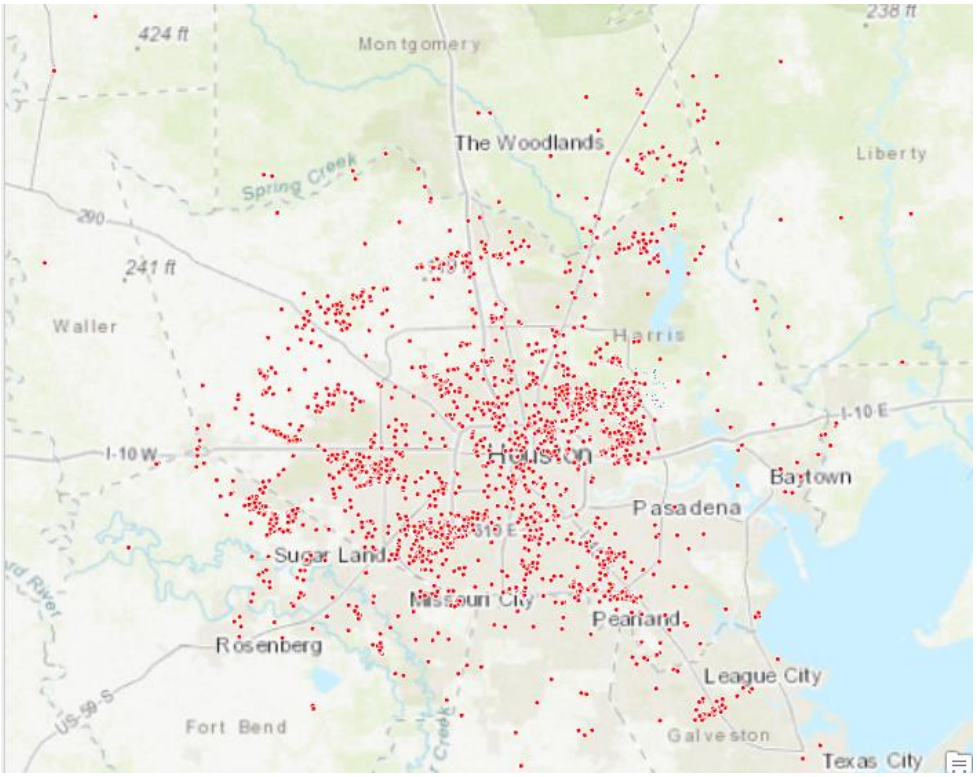

Figure 1: Rescue Calls in Harvey

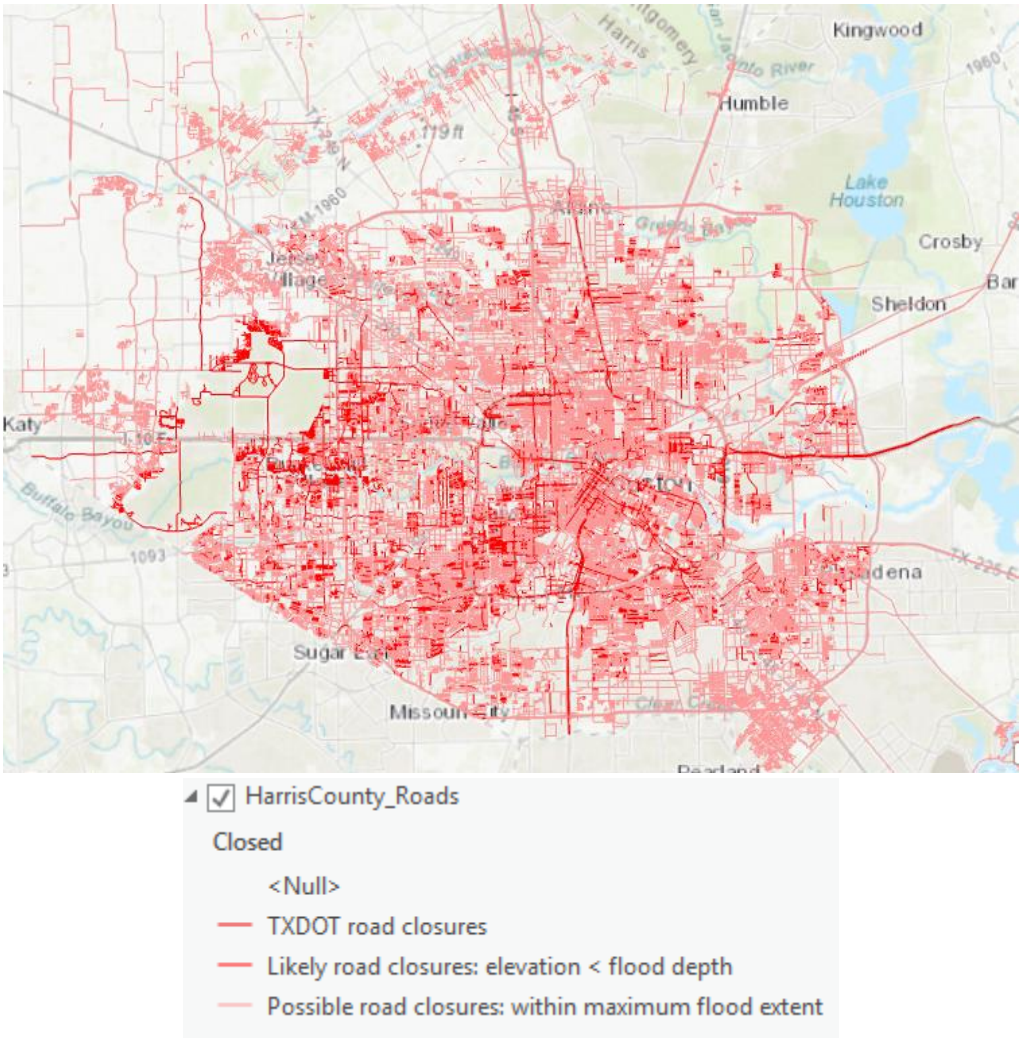

Figure 2: Road Closure Data

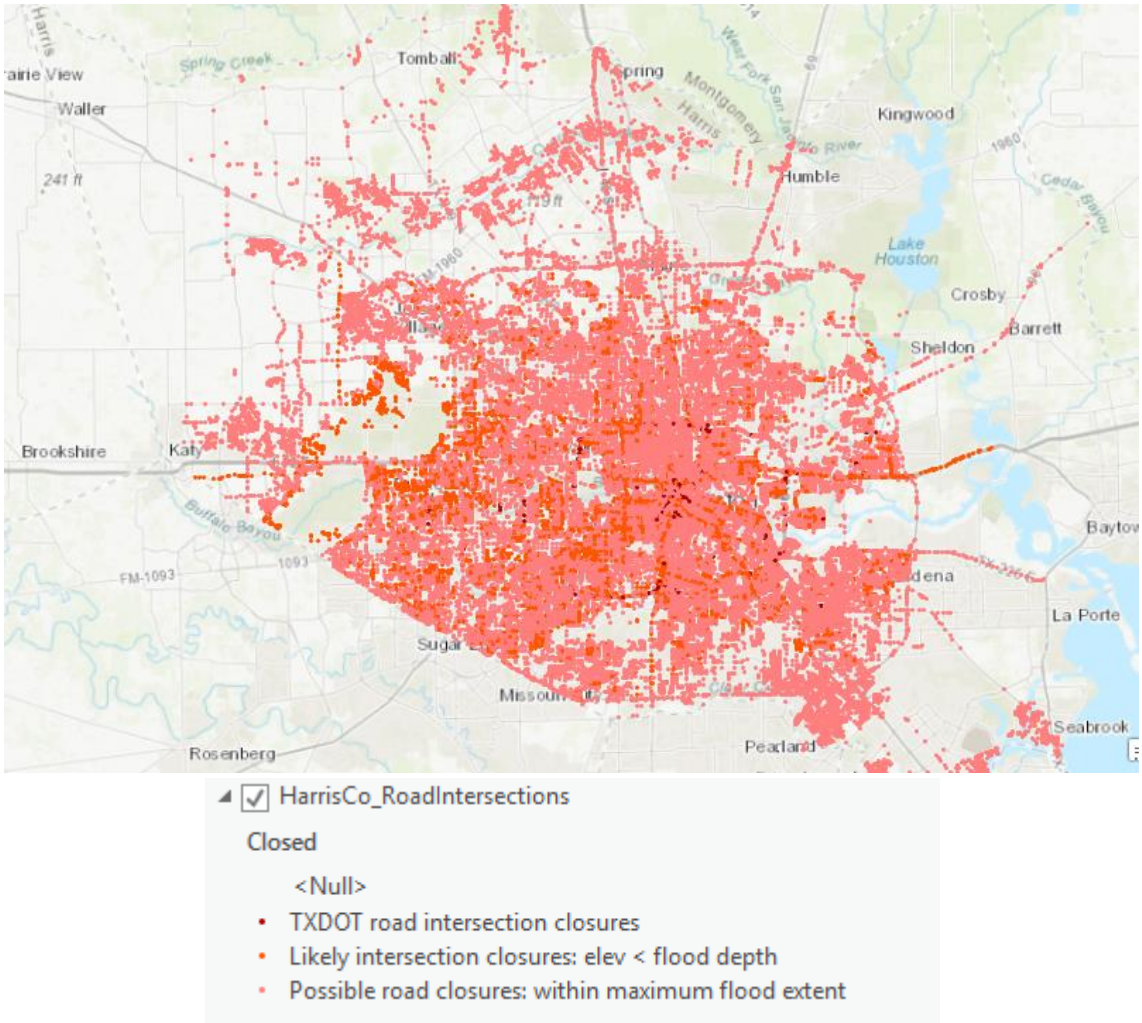

Figure 3: Road Intersection Closure Data

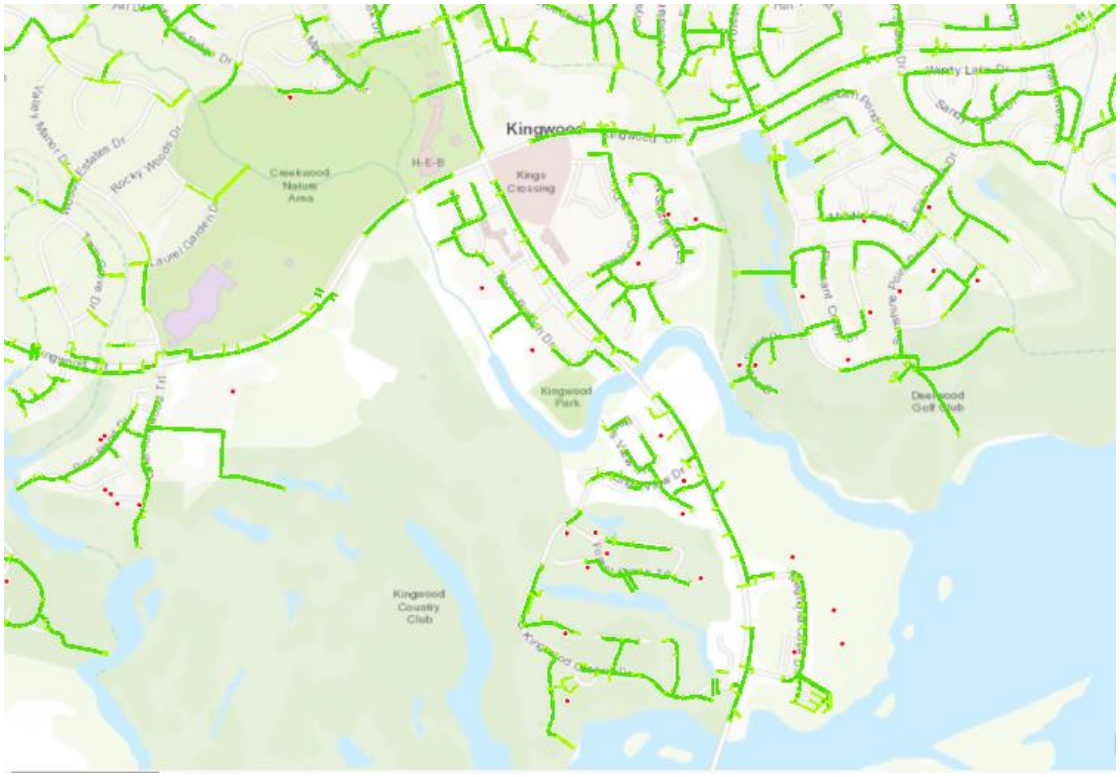

Figure 4: Kingwood StormWater Lines and Rescue Calls