Puerto Rico and the Effects of Hurricane Maria

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Background

Hurricane Maria reached the island of Puerto Rico on September 20, 2017 as category 4 hurricane, making it the strongest hurricane to reach the island since 1928 (Pasch, et al., 2018). The hurricane caused severe damage to an island suffering from a severe financial crisis and had been hit a couple of days before by hurricane Irma. Maria brought high levels of inundation. From 6 to 9 feet above ground level in the municipalities of Humacao, Ceiba and Naguabo; from 4 to 7 feet in Yabucoa, Maunabo, Patillas and Arroyo and from 3 to 5 feet in municipality of Fajardo (Pasch, et al., 2018). Additionally, the island also received close to 38 inches of rain, which caused flooding and mudslides especially in the La Plata River (Pasch, et al., 2018).

Problem Definition

Before the hurricane, Puerto Rico was already going through a financial crisis that affected its infrastructure. Given the magnitude of the disaster and its continuing consequences, were the most affected areas, areas that had already been deemed prone to floods or landslides? Can GIS show that there was insufficient action from the government who did not prepare for the effects of Maria?

Data

The data used for the project was obtained from various sources. Inundation and landslide risk, census tracts were obtained from the Puerto Rican Government GIS database. The data for urban areas and municipalities was obtained from the Census's Tiger files data set. Hydrographic features for the island were obtained from New York's University Spatial Data Repository. Data on the bodies of water for the municipality of Utuado was obtained from the Census Tiger files. I was able to obtain the data of the concentration of landslides caused by Maria from the U.S. Geological Survey.

Analysis

In order to try to fully show the effect of Hurricane Maria, it was decided to pick the effects of rain and landslides. This decision was made based on data and information availability. The first step was the set up the map with its municipalities and bodies of water. The polygons of the bodies of water expanded beyond the line boundaries of the map. To erase them, I used the Advanced Editing option within the Editor toolbar.

The lack of data led me to gather information on the areas most affected by rain by looking at news reports. This meant that order to show these areas it was necessary to manually select them in the attribute table and create separate layers to be able to show the affected municipalities by the feet of rain received. I also wanted to see where the most populated areas are and compared that to the location of risk areas. I downloaded the population data from the U.S. census, but it only offered population by sub-divisions within municipalities. This layer made the map look extremely heavy since it had the population from each municipality. To create a cleaner map, I had to match the geocode of the sub-divisions with the first 5 digits from the municipalities' geocode by merging the information from the attribute table.

I then used the color gradient feature to show where the population highest concentration was located. I additionally wanted to overlap the location of the urban areas with the population data to see how dense or non dense cities are. To do this I used the transparency feature in the urban layer property, which allows for both layers to be feature on top of each other without compromising visualization. The color gradient feature was also useful to show the concentration of landslides after Maria. I the beginning I thought a black and white gradient would be better to show the places where the grader number of slides happened, but instead this color gradient made the data look confusing. Instead, I went with earth tones that made the distinction more clear. Lastly, I insert it a legend for each map. This made the maps easier to understand. Since most of the data was in Spanish, I had to translate the subtitles of the legends. To edit them, I change them to graphics and ungroup the different subtitles.

Challenges

Due to the classification of Puerto Rico as a Commonwealth, the data was not always offered in an standard way. Some sources offered information for the whole island, while others divided information by municipalities. An example of this was the information of population. Additionally, given that the hurricane happened fairly recently there is not a lot of information that has already been compiled into GIS data files. The only data on the effects that had already been compiled were the landslides that occured after the hurricane. This limited the analysis to only use the data available.

Conclusion

Given the geography of the island it was to be expected that urban and highly populated areas would be close to the coast. For the most part, the data did not show any new information, for example, in the first map we see that the areas that received the most feet of rain were those cities in the coast that were right on the path that the hurricane followed. While the map also shows that the risk of flood areas clearly follow the pattern of the island's bodies of water such as rivers and lakes, especially those close to the coast, it also shows that the interior of the island is also susceptible to floods. Given the population density of the coastal areas and their highly risk of floods it is important for authorities to expedite the recovery efforts for these areas before the 2018 hurricane season begins.

In map number two we see that the majority of landslides took place in the middle of the country, where there is a higher concentration of mountains shown by the top map. One interesting fact that the data revealed was the high concentration of landslides in Utuado (UTU) given the absence of known points of elevation. As a way to understand what happened in this particular municipality a separate map was created with the layer for the bodies of water specifically for this region. The map showed that the bodies of water from the region came from the neighboring Municipalities of Arecibo located in the island's coast. This could indicate that the river increasing its current as the hurricane made its way on the northern side of the island could have been one of the causes for landslides.

Given the island's geography, destruction from a hurricane as strong as Maria was almost imminent. With the exception of the landslides in Utuado, the island, the United States Federal Government, FEMA and other government agencies had information that pointed at which municipalities were going to be most affected. It is clear that the scale of the disaster in the island was due to the lack of preparation, which could have potentially stemmed from its deep financial crisis.

Sources

Government of Puerto Rico. Portal Datos Geograficos Gubernamentales. Retrieved from: http://www2.pr.gov/agencias/gis/Pages/default.aspx

New York University Spatial Data Repository (2011). Hydrographic Features (Polygons): United States and Territories. Retrieved from https://geo.nyu.edu/catalog/stanford-jx308gf9049

Pasch, R., Penny, A., Berg, R. (2018). National Hurricane Center Tropical Cyclone Report Hurricane Maria. *National Weather Service.*

U.S. Geological Survey (2017). Map data showing concentration of landslides caused by Hurricane Maria in Puerto Rico. Retrieved from: https://www.sciencebase.gov/catalog/item/59de6459e4b05fe04ccd39d8

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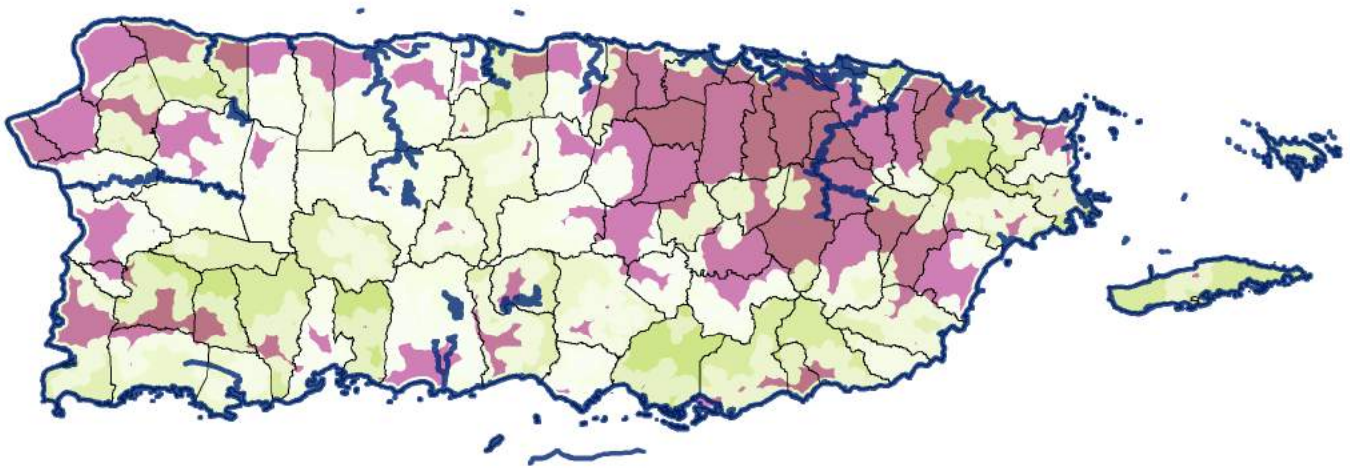
Bodies of Water



Bodies of Water

Bodies of Water

Population

Urban Areas

Municipalities

100 - 9,775

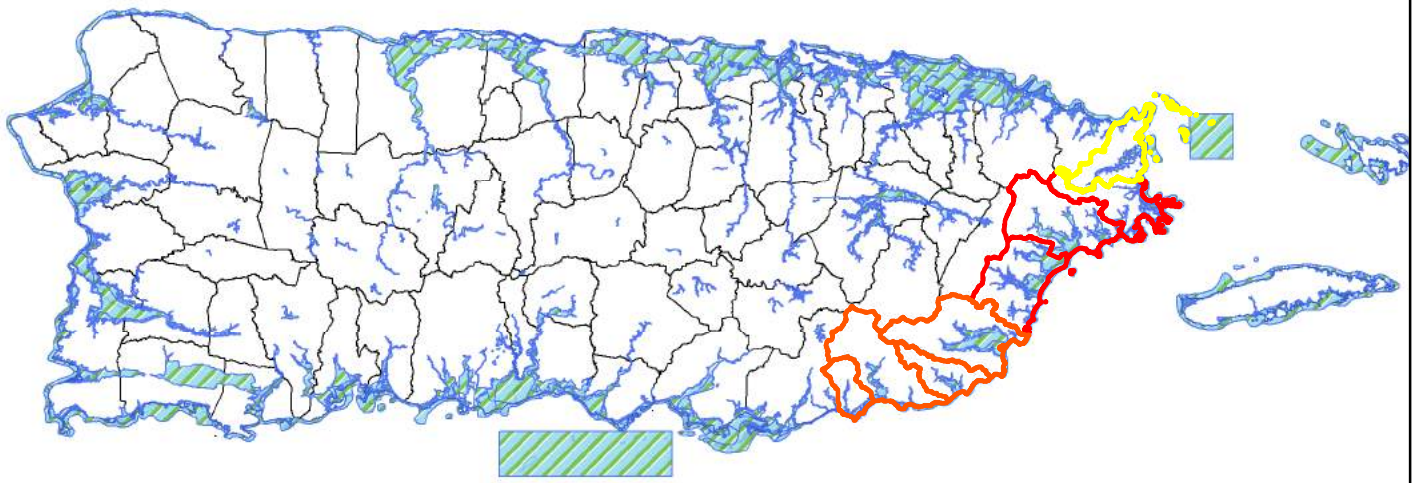
9,776 - 23,406

23,407 - 36,091

36,092 - 59,010

59,011 - 88,164

Areas Most Affected by Rain After Maria & Areas at Risk of Floods



Areas Most Affected by Rain

3-5 ft

4-7 ft

6-9 ft

Areas of Flood Risk

Municipalities

Map created by Andrea C. Avila

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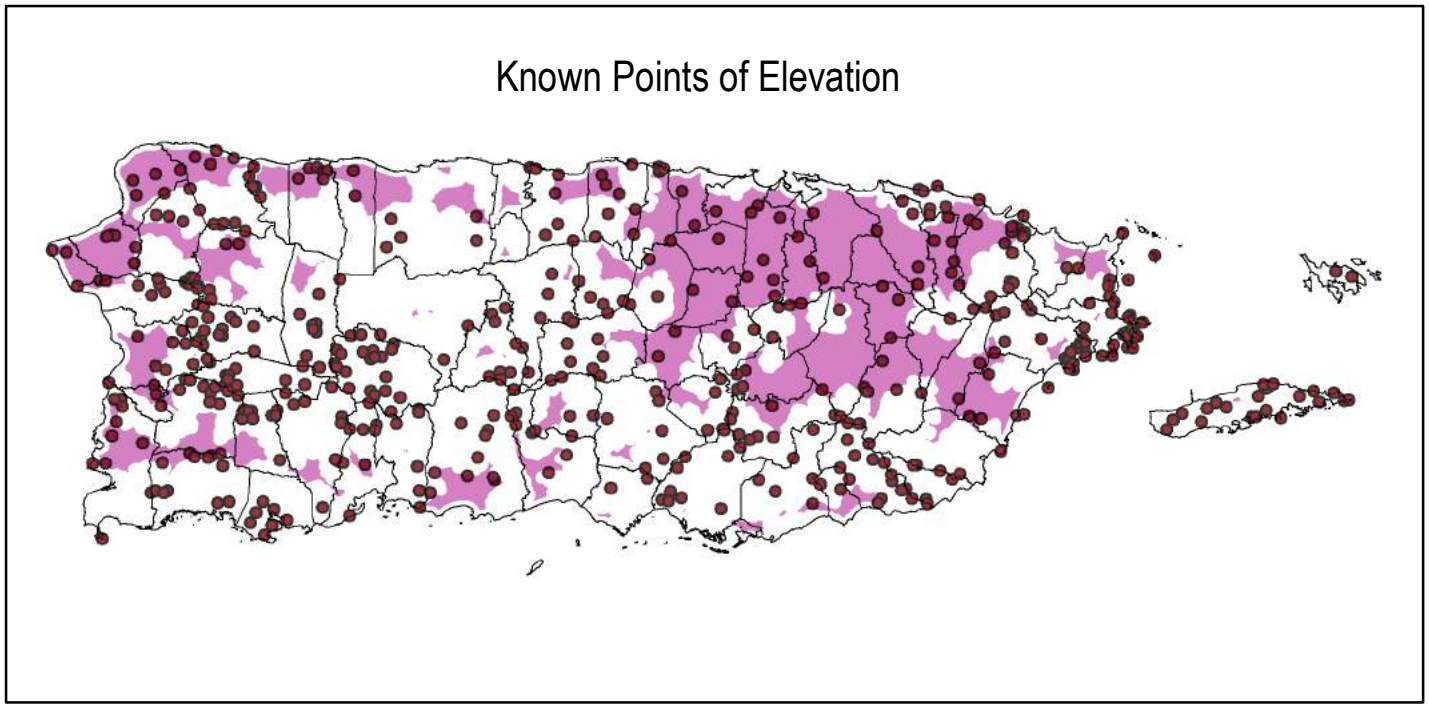
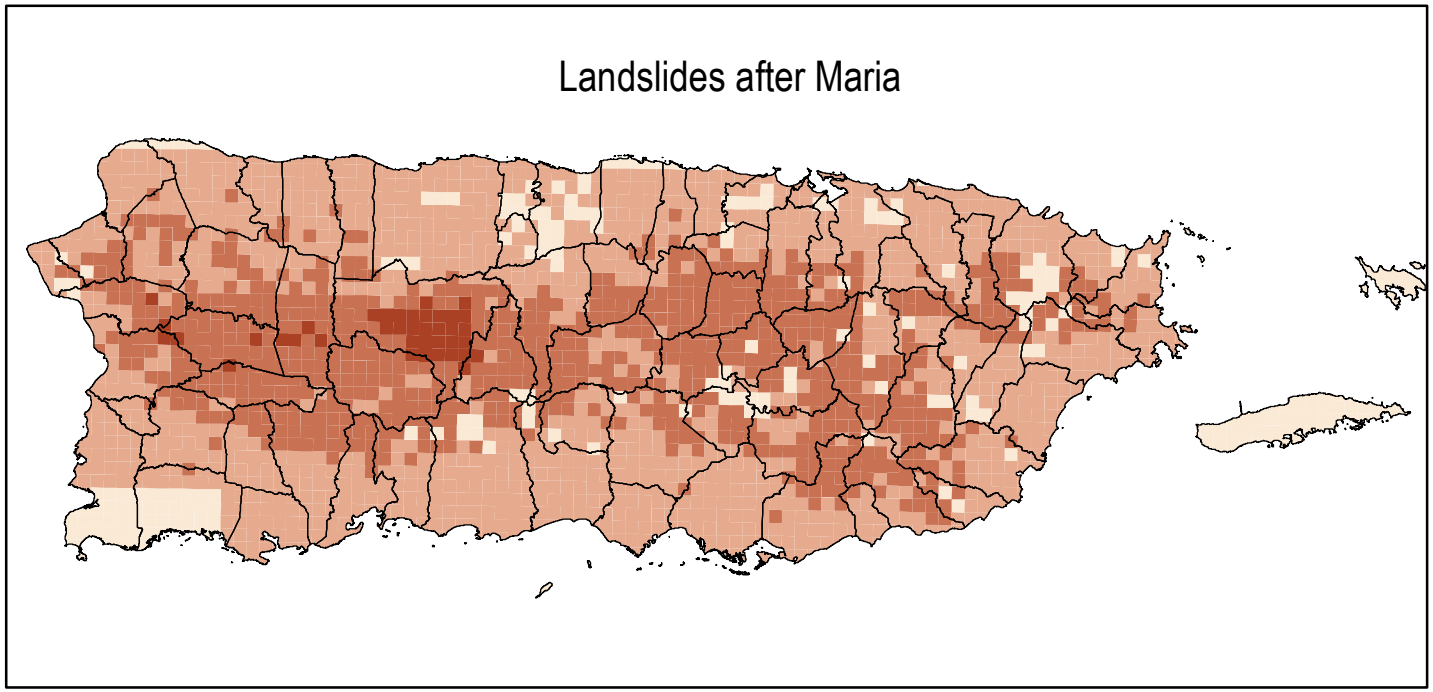
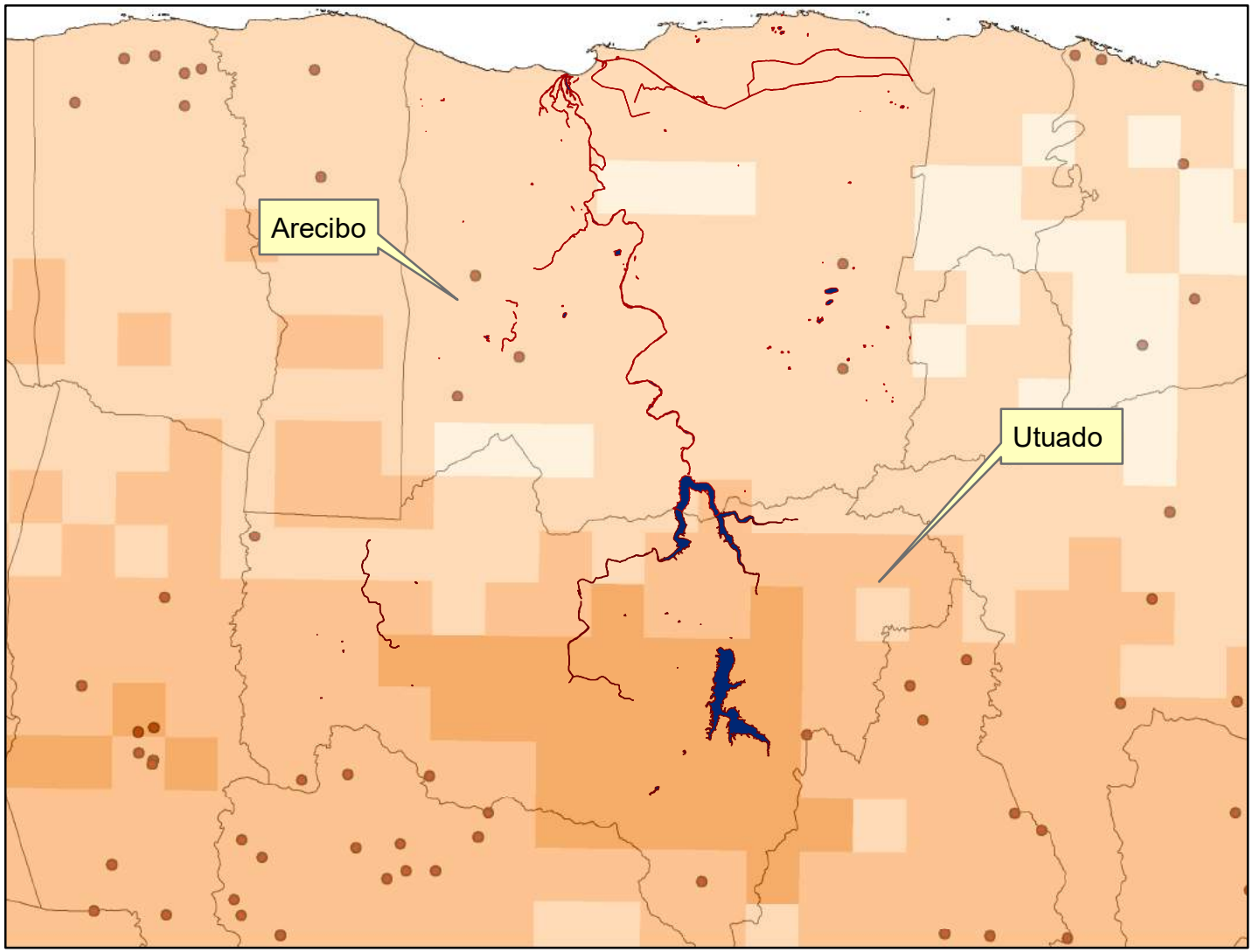




Map created by Andrea C. Avila

Arecibo and Utuado Municipalities



Bodies of Water

Landslides after Maria

- No data
- No Landslides
- < 25 landslides per sq km
- > 25 landslides per sq km
- Points of Elevation

Map created by Andrea C. Avila