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GES Final Assessment

Github page: https://pworster.github.io/

Github Repository: https://github.com/pworster

Github Final Project: https://pworster.github.io/talks/

The aim of this project is to investigate if there is a correlation between where flood zones occur and the local demographics. Are people of BIPOC communities at higher risk of living in flood zones than white communities?

Introduction

In 2020, flooding is recorded to have caused over 6,100 deaths worldwide (1). This includes direct fatalities due to drowning, but also indirect causes, such as building and infrastructure failure. As the effects from global warming increases, extreme storm events are predicted to increase and thus may increase fatalities and recovery spending (2). Additionally, predicted sea level rise will intensify these flood events due increasingly vulnerable coastlands (3). More frequent flooding events will in turn lead to an increase in spending to repair damaged property. Therefore, it's important to know which populations will be affected and to what extent.

Urban development, or urbanization, will often replace ecologically productive land with built structures, roads, and parking lots (4). These impervious surfaces will severely reduce the amount of infiltrated precipitation into the soil, and thus increase runoff (4). It should be noted that precipitation in urbanized areas does not necessarily lead to flooding, but that increased intense storm events will lead to stream flashiness (5). A stream is considered flashy when a relatively high amount of discharge occurs over a short amount of time. Therefore, the stream may flood over the banks and flood the land. In ecologically sustainable land, floods may be held in floodplains, such as swamps or riparian buffers, however, in urbanized land, floods can cause destruction to life and property (6). Additionally, recurring high discharge events will lead to erosion in the stream banks, which will cause properties located on or near the stream banks to become unstable (7).

In late May of 2018, Maryland was hit with a small but intense rainfall event in Ellicott City and South-West Baltimore, which lasted for about 18 hours (8). This caused intense local flooding and destruction of property (9). In response, Ellicott City received over 167 million dollars in repair funds, while South-West Baltimore is still recovering (9). It should be mentioned that Ellicott city is a primarily white affluent community, while South-West Baltimore is a primarily black community (8). Therefore, it may be argued that lower income black communities have not been given the same support as Ellicott City due to racial biases.

Methods

This project is conducted to compare selected Baltimore demographics to flood zones. The aim is to predict if the demographics of a community may affect where they are located compared to flood zones. For this assessment, median household income and percent white of a community is selected. Median household income is selected to investigate whether lower income communities are in closer proximity to flood than higher income communities. The percent white of a community is selected to represent how white a community is, but inversely BIPOC communities.

This study is limited to Baltimore City and Baltimore County. These counties were chosen to compare communities within a city, but also surrounding suburbs. This is crucial because developed cities may affect the spread of streams and their floodplains. Conversely, suburban communities may provide a larger area for floodplains. Additionally, the comparison between a city and suburbs is needed to compare potentially different demographics, such as in Ellicott City and West Baltimore.

The demographic data is used from the American Community Survey (ACS) in 2020. This data is retrieved from the ACS at the block group scale to increase higher resolution results. R software is used to pull data from the ACS using the ‘tidycensus’ R package.

Demographic data will be spatially compared to flood zones throughout Baltimore County and Baltimore City. Three flood zones groups will be analyzed, which will include floodways, 100-year flood zones, and 500-year flood zones. Floodways are areas of land which will often experience flooding during an intense rain event (10). Floodplain shapefile data is retrieved from FEMA data posted on the Maryland government website (11).

Using RStudio software, visual and statistical analyses will be conducted. Appropriate R packages will be used for this investigation, including tidycensus, tidyverse, ggplot, dplyr, and sf. Initial Baltimore geometries are retrieved from the ACS to include Baltimore City and Baltimore County and converted to a shapefile. Maryland FEMA flood data is downloaded form the data folder and projected to match Baltimore CRS. The flood zones are filtered to only include flood zones within Baltimore, and then filtered by flood zone type. The flood zones are displayed on a map using ggplot.

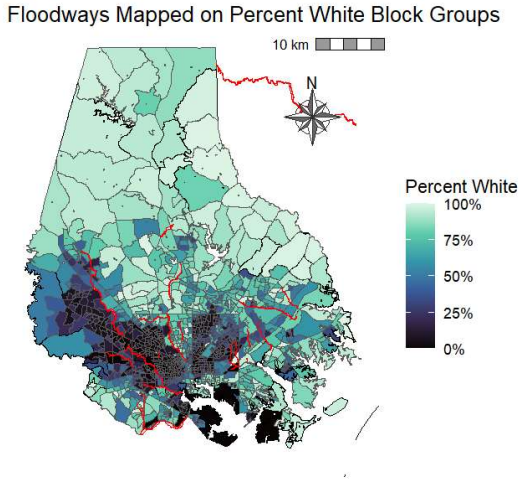
Baltimore median household income, white population, and total population is retrieved from the ACS and an additional variable of percent white is created by dividing the white population by the total population. A percent white population map is created which has filtered out bodies of water which may skew analyses of flood zones and flood zones are graphed on the map.

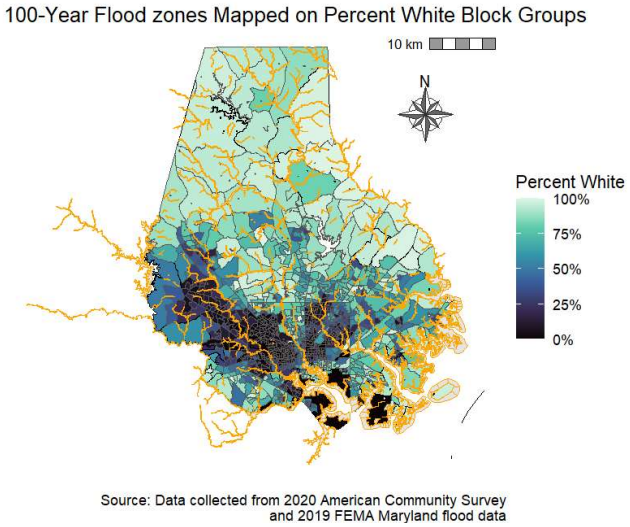
Block groups which are affected by the flood zones are extrapolated using the 'st_filter' function. These filtered block groups are analyzed using a histogram. The total population compared to vulnerable block groups are compared using a histogram line graph to view overlapping results. Due to differences in sample sizes, the shape of the histograms are compared using a Q-Q plot to compare flood zone types to the total population.

The method of analysis for percent white population is repeated for median household income.

Results

As a community decreases in percent white population, an increase in the percent of BIPOC communities can be inferred. Initial visual inspection of flood zones compared to percent white population may indicate a slight bias towards BIPOC communities.





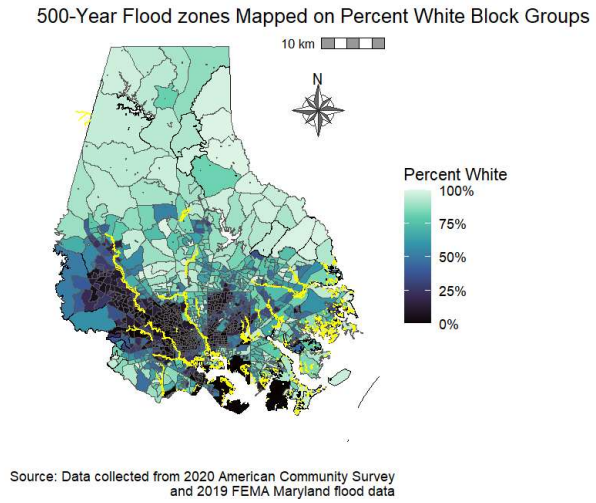


Fig. 1. Flood zones are graphed on a percent white map. Floodways are displayed in red, 100-year flood zones are displayed in orange, and 500-year flood zones are displayed in yellow. Three separate maps are created so that potential flood zone overlap will not obscure the extent of other flood zones.

In Figure 1, floodways and 500-year flood zones appear to affect BIPOC communities more than 100-year flood zones.

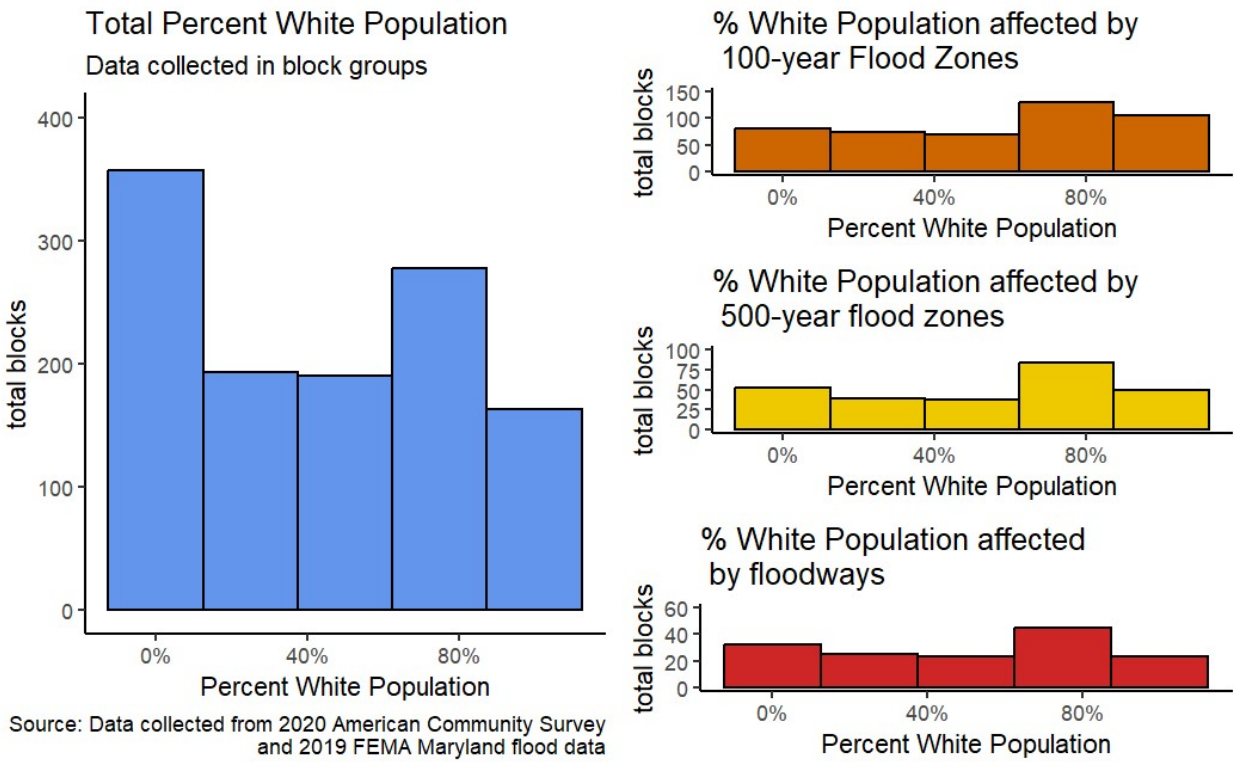


Fig. 2. Blue histogram display the spread of percent whiteness in Baltimore by block groups. The subsequent histograms on the right display the spread of whiteness by flood zone type.

In Figure 2, the histograms appear to follow a similar shape of high peak of BIPOC communities and a second peak at about 80% white communities. It should be noted that the blue represents the total Baltimore population by block groups and the histograms on the right display samples affected by flood zones. Therefore, an analysis of histogram shape is needed, rather than the frequency of block groups.

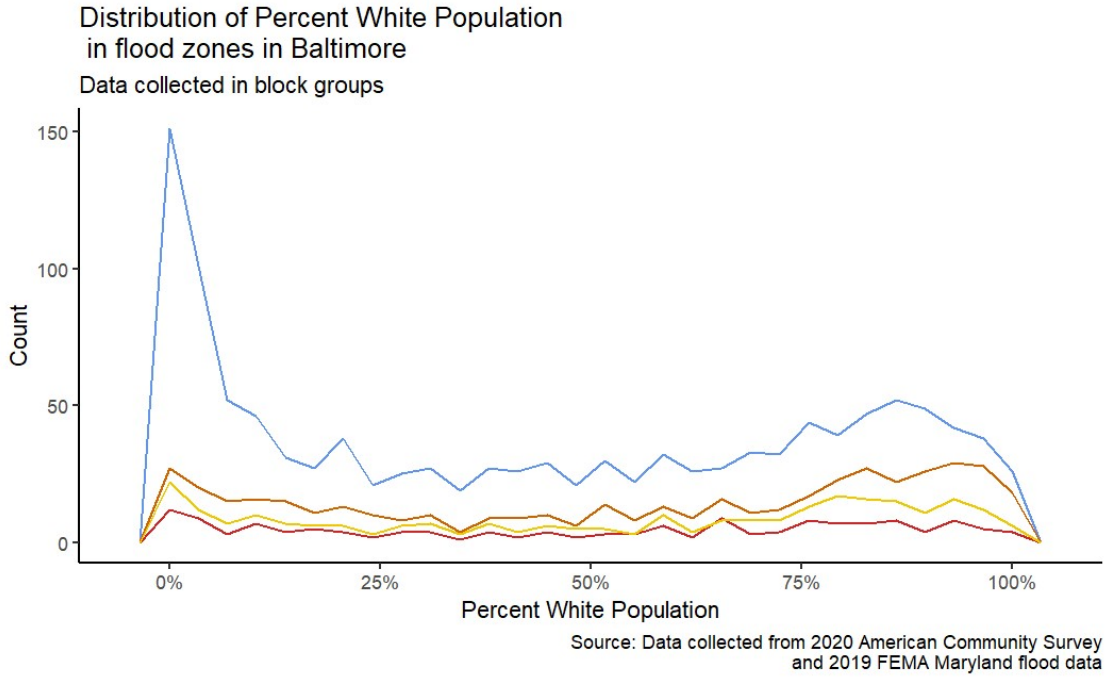


Fig. 3. Line graph representation of population and flood zone samples.

In Figure 3, the histograms are displayed as a line graph to view the overlapping shape of the bars. However, due to the different size of the total population compared the samples, it is difficult to visually compare the histograms.

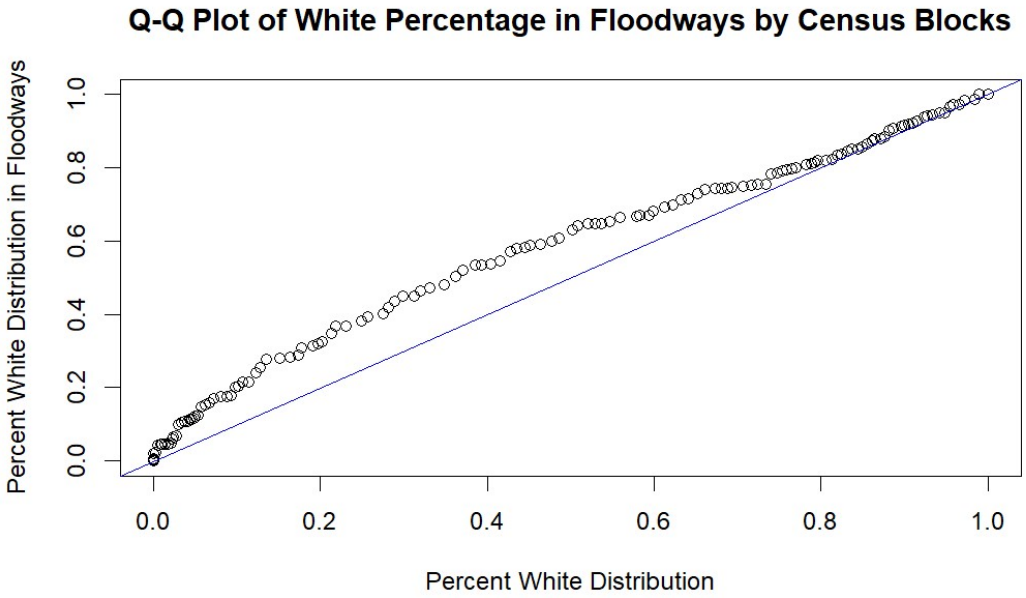


Fig. 4. Q-Q plot displays the percent whiteness of a block group in floodways compared to the total population. The floodway distribution is represented on the y-axis and total population on the x-axis.

Figure 4 Q-Q plot compares the shape of the floodway histogram to the total population. A linear correlation can be found at about 70% white block groups indicating that communities above 70% white will not experience any bias towards more or less floodways compared to the average population. However, when a community drops below about 70% white, there is an increase chances of a floodway existing. Therefore, BIPOC communities will experience higher floodway flood zones than white communities.

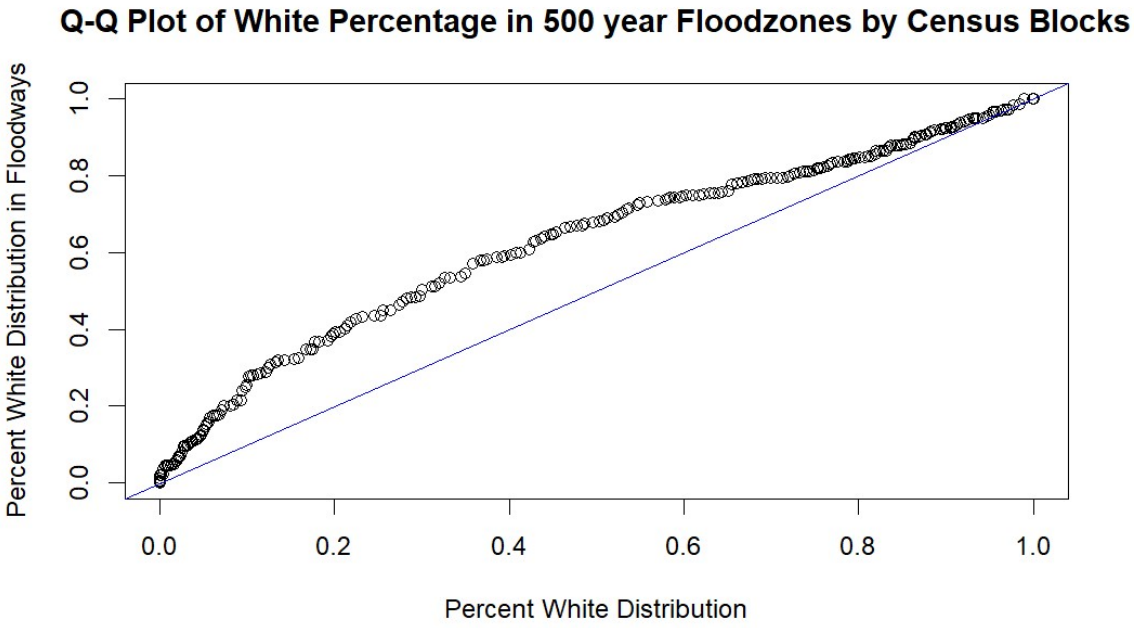


Fig. 5. Q-Q plot displays the percent whiteness of a block group in 500-year flood zones compared to the total population. The 500-year distribution is represented on the y-axis and total population on the x-axis.

Figure 5 displays a similar shape to Figure 4 in that a near linear correlation can be found at about 70% whiteness of a block group, and a flood zone bias towards BIPOC communities below about 70% white.

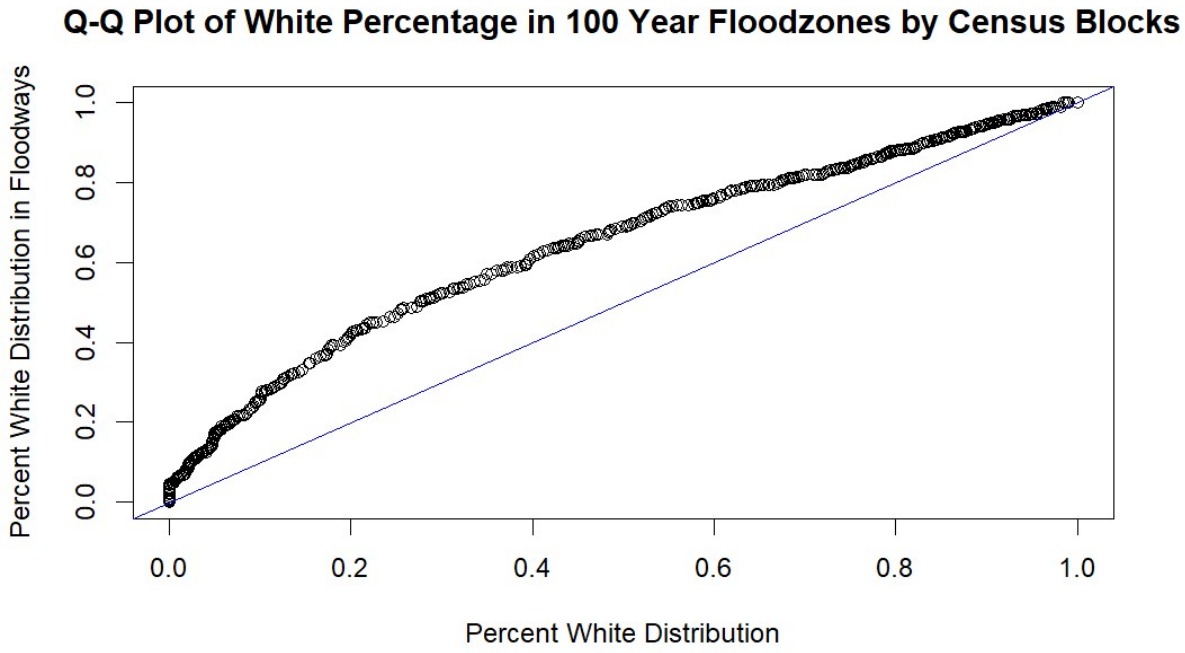
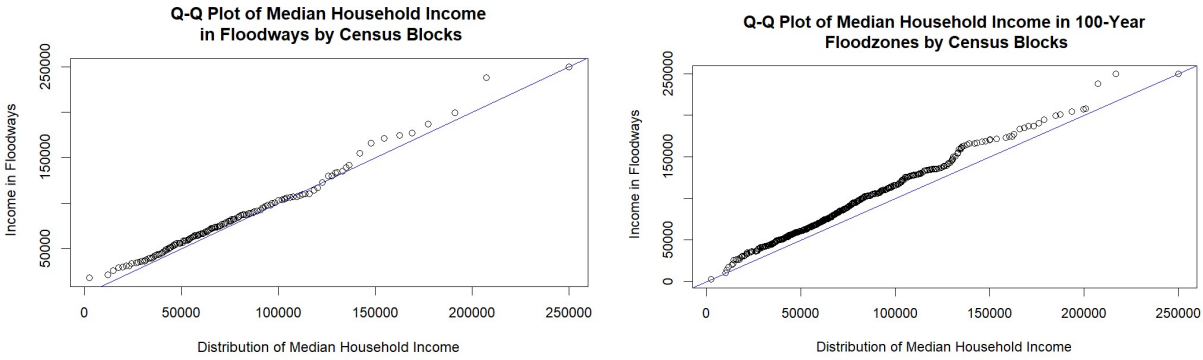


Fig. 6. Q-Q plot displays the percent whiteness of a block group in 100-year flood zones compared to the total population. The 100-year distribution is represented on the y-axis and total population on the x-axis.

The 100-year flood zones Q-Q plot displays the most dramatic results for flooding in BIPOC communities. There appears to be no linear correlation between percent white of a 100-year block group and the total population. This means that the higher percent white communities are much less likely to live in a 100-year flood zone than BIPOC communities.



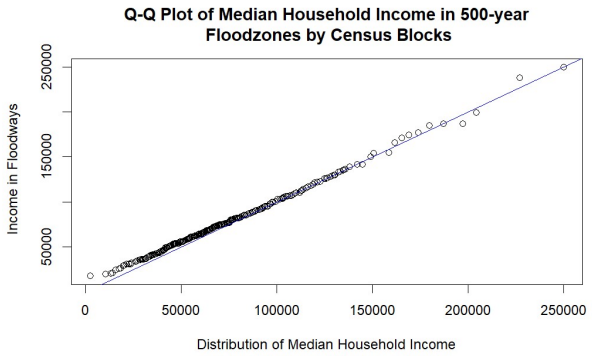


Fig. 7. Q-Q plot displays the median household income of a block group in flood zones compared to the total population. The flood zone distribution is represented on the y-axis and total population on the x-axis.

Unlike the racial demographics of block group communities, median household income appears to have a linear correlation of flood zones to the general population. This means that income does not affect whether you will live in a flood zone.

Conclusion

According to the Q-Q plot results of percent white of block group communities, BIPOC communities have an increased chance of living on flood zones than white communities. This means that BIPOC communities may face increased vulnerability to flooding, erosion, and property destruction. The results indicate that BIPOC communities are most vulnerable to 100-year floods than 500-year flood zones and floodways. Additionally, none of the results indicate that white communities are at an increased risk of flooding compared to BIPOC communities in any block group.

Interestingly, the median household income does not appear to affect the chances of living in a flood zone. The linear correlation of the Q-Q plots in all flood zones indicates that lower income block groups have the same chances of living in flood zones as higher income communities.

This study is limited to Baltimore County and Baltimore City. Further research is needed in other cities or communities to understand and confirm these trends at a national level. Additionally, this study may be conducted at a national level using the same methods used in this investigation. Higher resolution research may be more useful for understanding the demographics of people who live in flood zones.

Reflection

This project was a great way for me to use my R skills in a worthwhile manner. Unlike assignments, I had to decide how to manipulate my data to reach my goal. I believe that my approach to this project was valid, and my results were accurate. The process of obtaining my results was tedious at times, but it greatly improved my R skills. If I had more time I would have liked to include more statistical analyses to further explore my data. I would have also like to explore more population demographics, such as housing vacancies and age. Using more demographics could improve a profile of communities at risk of living in flood zones.

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This class provided me with a steep learning curve throughout the entire semester. I was unable to round my skills in all aspects of R, QGIS, and Github, but this provided me with a great first step to improving my skills in these fields. Though I need room for improvement, I have found that I'm more familiar with programs like R than peers currently working in Environmental consulting firms.

References

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Data

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