Miami R Shiny App Writeup

Introduction

The negative impacts of climate change have become more heavily pronounced since the industrial revolution, especially in the past two decades. These effects manifest globally, however the changes in local weather patterns caused by climate change are more easily observed at the local level. While we do not experience climate and the implications of its changes, even anecdotally, individuals notice over the course of their lifetime shifts in weather patterns, especially with respect to weather events such as hurricanes, floods, and droughts. These events indicate the impact global climate change can have at a local level, and alarm residents worldwide. This paper seeks to investigate Miami-Dade county with respect to sea-level rise, and the potential impact to the population.

Background and Motivation

Many cities worldwide are exceptionally vulnerable to the effects of climate change, especially those along the coast with low elevation. These regions are vulnerable to the effects of climate change, including local warming, reduction in biodiversity, ocean acidification and most notably, sea level rise. Of the cities predicted to be significantly impacted by global climate change, Miami is deemed to be the "most vulnerable coastal city worldwide," (Cusick, 2020). Even in the period between 2019-2020, the effects of climate change have become more pronounced, as the city faced increased frequency and damages from hurricanes, floods, and storm surges in addition to higher temperatures than the baseline two decades ago (ibid). This environmental damage is predicted to increase in the next decade should current greenhouse gas emissions remain at current levels.

Despite these predictions, Miami has become one of the fastest growing cities in the United States. Between 2014 and 2018, the population of the city grew by 9.43% and housing units grew by 10.11% (SmartAsset, 2019). The rate of urban growth in Miami's central business district outranks that in other major American cities, such as New York City, Los Angeles, Boston, and Chicago (PMG, 2020). Billions of dollars are being poured into the development of infrastructure, culture and arts, and housing, with that estimate on the rise for the period between 2020-2030. The local government is extremely *laissez-faire,* focusing solely on economic growth that favors economic futures, thereby allowing corporations to expand in the city despite the strong predictions of future obstacles related to climate change. The story of business growth is only made more complex when one takes into account existing racial and socioeconomic inequities. As any major city can attest, there are growing pains that often affect members of society of lower socio-economic status more profoundly. The city of Miami is one of the most inequitable in the country, with a Gini score of .57 out of 1 (US News and World Report, 2020). It occupies the 2nd spot on the list of inequitable cities, after San Juan, Puerto Rico and tied with Atlanta. Areas housing historically black and latinx communities have become increasingly gentrified or populations have been pushed to areas in which environmental disaster in inevitable.

Keenen *et al.* describe the effects of climate change on communities by arguing there has been climate-based gentrification in Miami-Dade County that will only become worse in the next decade. They provide several hypotheses on how land pricing has become impacted by projections of environmental degradation (Keenen *et al.*, 2018). First, their Elevation Hypothesis finds that single family homes at a higher elevation will become more expensive than those at a lower elevation, simply because they are more durable to flooding. Next, the Nuisance

Hypothesis suggests that rates of appreciation in low-elevation cohorts will not keep up with rates of appreciation in high-elevation cohorts. The authors describe the interconnection between the built environment and wealth as subject to the conditions of the natural environment, oftentimes to the detriment of the socioeconomically disadvantaged.

There is a long literature documenting environmental racism, or the heightened impact of environmental factors disproportionately affecting communities of color. The study of environmental racism was first conducted in the 1980's in Houston by Bullard *et al.* where the researchers investigated hazardous disposal sites in Houston and discovered 100% of locations were within predominantly black and latinx neighborhoods (Bullard *et al.*, 1983). Since them, several studies have been conducted in varied locations, and an overwhelming number indicate the trend that race-based segregation intersects with environmental injustice (Bullard *et al.* 2007, 2009, Park and Kwan, 2017, Cusick, 2020).

Goals, Objectives and Research Question

These two narratives present immensely different scenarios: one of the cataclysmic effects of climate change on Miami should climate change proceed at the present rate, and the other of urban growth and accumulation of capital, regardless of climate change. At present, business interests are winning out as climate change rages on at both a national and local level at unforeseen rates. These conflicting accounts of urban growth vs environmental deterioration must be addressed before it is too late. Therefore, these opposing priorities drive the question; how do economic interests decrease environmental hazard visibility and what effect does this have on the local population? In this paper I will investigate how sea level rise affects communities across the

Data

In this paper, I used the 5-year ACS for 2014-2019 accessed through the Natural Historical GIS (NHGIS) data finder on the Integrated Public Use Microdata Series (IPUMS). I obtained data on the variables population, which is broken down by race and total, value of housing units, income per capita, and public assistance rate. For race, I made a per capita rate for white residents vs non-white residents; in the future going more in depth about race would be more preferred, especially performing a cross-tabulation between race and ethnicity for number of people of latinx decent, however, the percent white gives a diagnostic of community (Reardon *et al.*, 2017). Additionally, I downloaded the US shapefile from IPUMS at the tract level for 2019, this is the most up to date tract-level information available.

I then downloaded a dataset from the National Oceanic and Atmospheric Association (NOAA) with contour data and flood data with respect to sea level rise. I used this dataset to project sea level rise for one to five feet. This dataset is based on flood data and contours of the earth. In the future, experimenting more with higher elevations, or the Coastal Dataset for the Evaluation of Climate Impact (CoDEC) could provide more insight, as the information is more targeted to SLR based on local observations.

Methods Used

I began my investigation by sorting through the IPUMS NHGIS finder for selected variables of race, public assistance, per capita income, and value of owner occupied units for the ACS 5-year. I downloaded this data as well as a shapefile to my computer.

I then went on to clean the data in Carto, a SQL based program in the web browser. This language is user-friendly, and straight forward. I used the following commands to clean my data, labeled with what each query does:

```
>Drop excessive columns
CREATE TABLE NHGI_SCLN AS
SELECT gisjoin, state, county, tracta, name_e, aluce001, alxle001,
alx5e001, ALUCE002
FROM nhgis0003_ds244_20195_2019_tract

>Create Miami-Dade table
CREATE TABLE _MIAMIDADE AS
SELECT *
FROM NHGI_SCLN
WHERE County = 'Miami-Dade County'

>Rename Columns
ALTER TABLE _MIAMIDADE
RENAME COLUMN name_e TO "Area Name"
RENAME COLUMN aluce001 TO "Race"
RENAME COLUMN alxle001 TO "Public Assistance"
RENAME COLUMN alx5e001 TO "Per Capita Income"
RENAME COLUMN aluce002 TO “White”
```

I then exported the file and opened it in R. I also loaded in my shapefile for the US. I performed a join on the column "*geojoin*" and saved the new shapefile with the selected variables, and exited the program. I opened the US shapefile with the Miami data in QGIS and sorted through the columns with the county number 17, which signified Miami-Dade county, and saved the selected features as a new shapefile. I immediately exited out of the program and entered the new, cleaned shapefile in GeoDa. In GeoDa, I opened the calculator tool, and calculated the ratio of white residents to non-white residents per tract in Miami by dividing by 3000. In Miami, the average number of residents per tract is 2937, so choosing to divide by 3000 made the number round and easy to work with. Similarly, I divided the public assistance and value columns by the rate to create an index for the value of the housing in each tract. I saved the shapefile in GeoDa and closed the program.

I then did the remainder of the work in R. I loaded in my cleaned shapefile in R and converted to a spatial data frame. I then loaded the NOAA data into R and began cleaning it. Because of the large size of the dataset, and the limited processing power on my machine I dropped every column in the elevation over 8 ft, as I was primarily interested in investigating SLR at 1-6 feet. I set matching CRS and location data for the two files. Then, I quickly plotted SLR by demographic data to ensure the datasets were properly functioning.

I then composed the R shiny object with the demographic data. Due to time constraint, I could not plot sea level rise on demographic data, however, I was able to compare based on my quick plots.

Results

Value of owner-occupied housing units can be seen in figure one. There is a concentration of higher-value units near the sea, as beachside property is considered desirable. Lower income units are clustered to the south east and north, areas that have considerably lower elevation (Cusick, 2020).

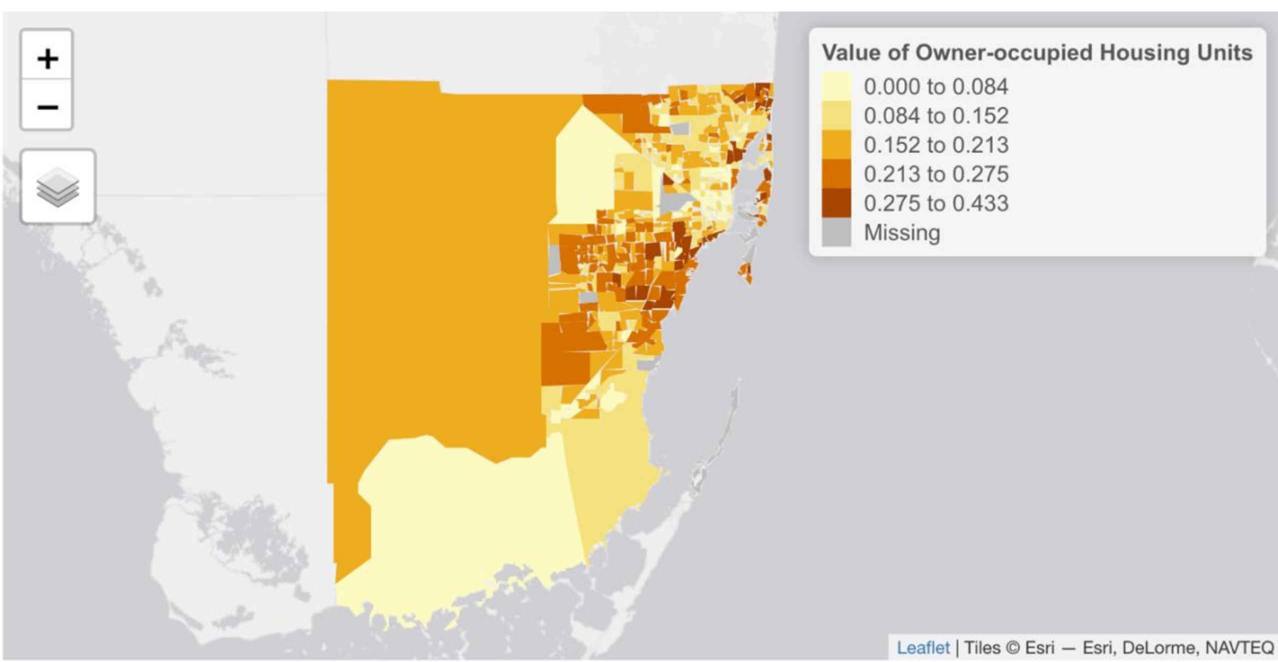


Figure two shows the interactive dashboard and public assistance per capita. Overall, public assistance units are clustered in the same region where the value of housing units is lower. This is typical spatially, as many cities have high rates of concentrated poverty. These units are concentrated in the northeast.

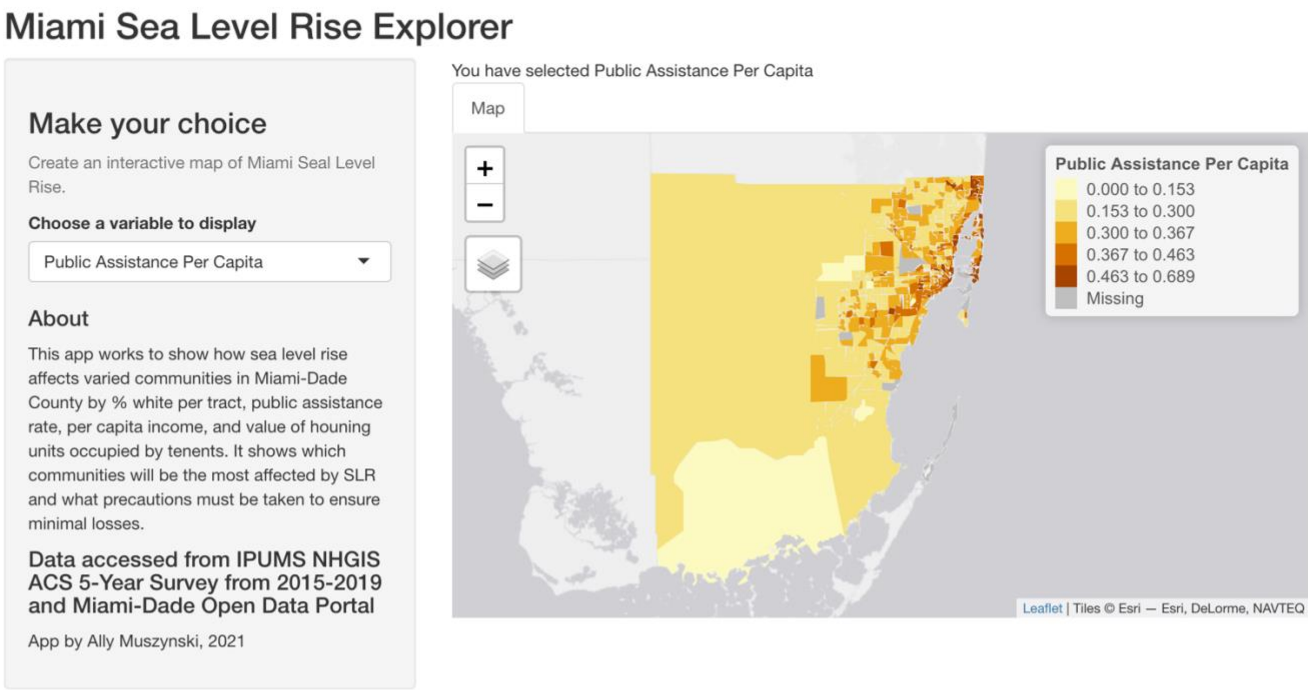


Figure three shows the rate of white residents. This image additionally shows the sea level rise slider widget. While not the ideal variable for analysis, especially in a community as diverse as Miami, investigating rates of Caucasian dwelling speak to the overall quality of the neighborhood. Aliprantis *et al.*, 2021 ond Reardon *et al*, 2017 investigated income patterns with respect to race. They found that higher income families of color tend to live in neighborhoods that more closely resemble lower income white neighborhoods. Bullard *et al.*, 1983 found that typically, incidences of environmental hazard are located in communities of color regardless of income level. There are pockets that are majority white in the center of the city, and areas predominantly occupied by white people negatively spatially correlate with lower housing value units and high rates of public assistance in communities.

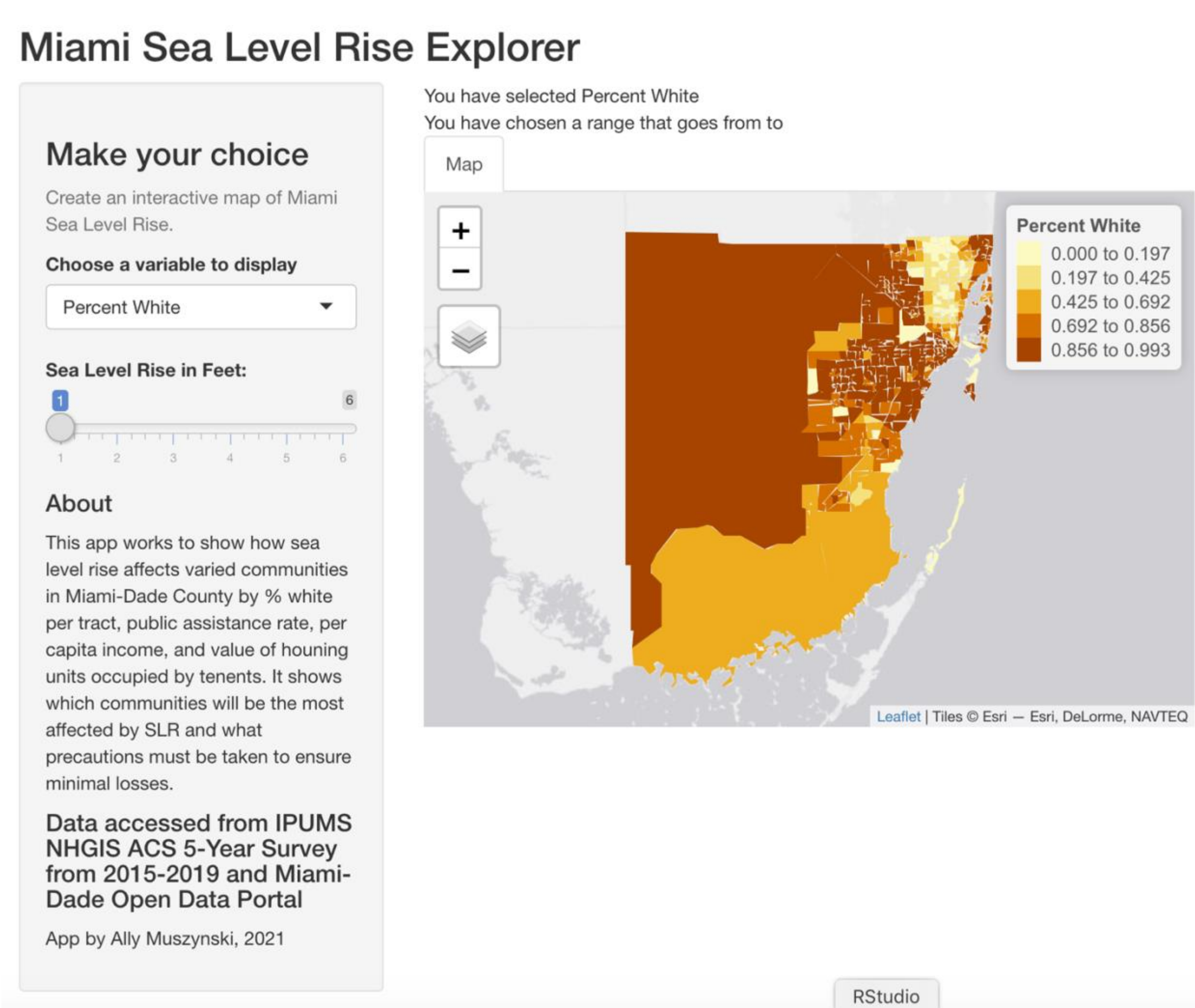
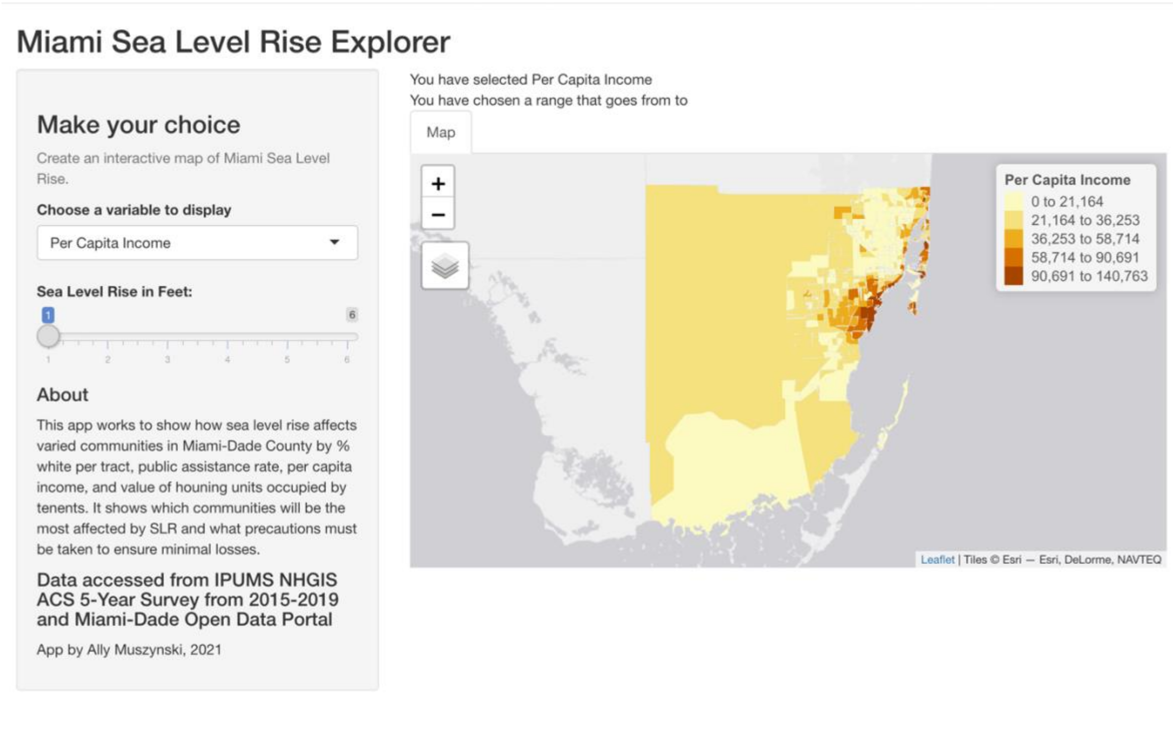


Figure four shows per capita income rates. There is a concentration of wealth tin the crnter of the city that overlaps with the area with the highest concentration of white residents. Areas predominantly occupied by residents of color have lower per capita income relatively.



Figures five through nine show sea level rise. Figure five shows two feet, figure six shows three feet, figure seven show four feet, and figure eight shows five. The overlap between sea level rise in these communities and lower income as well as race is substantial.

Figure 5: 2 ft SLR

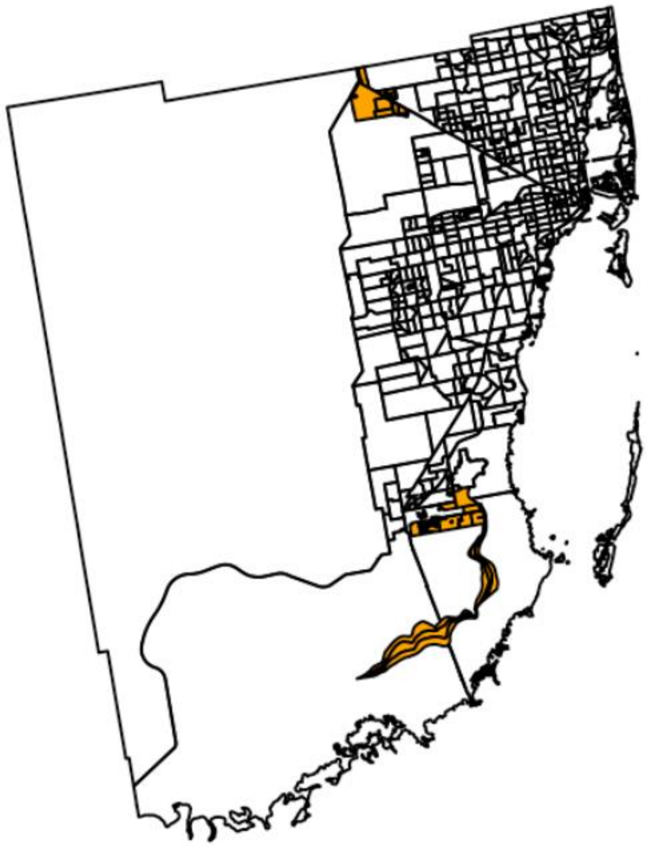


Figure 6: 3 ft SLR

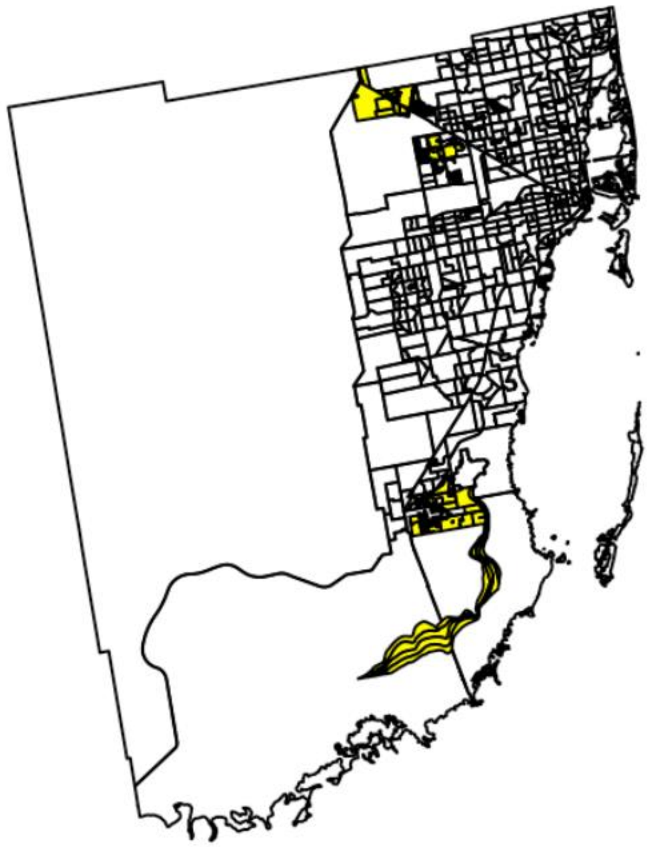


Figure 7: 3 ft SLR

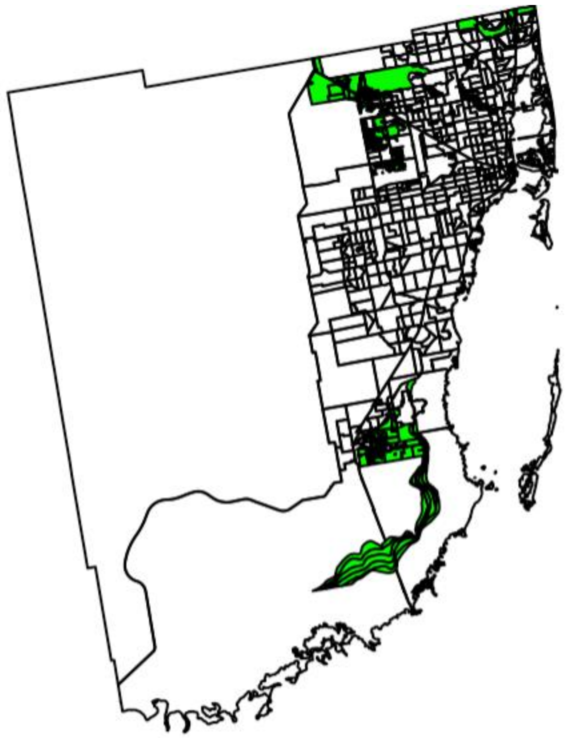


Figure 9: 4 ft SLR

Discussion

High spatial autocorrelation of poverty is concentrated in the north east, and the south. These same areas intersect with race, as communities of color are more lively to live in these areas. Overall, sea level rise highly spatially correlates with lower income as well as rate of communities of color. Planning for the future, policymakers must take demography into account with respect to sea level rise; the wealthy can afford to move, the poor will be pushed out. This study is important, as it provides a tool for investigating Miami-Dade county and better understanding the impact of sea level rise.

Limitations, Future Work, Conclusion

This study is just a beginning for investigating sea level rise and other climate change related in Miami-Dade County. This provides a tool for residents, policymakers and stakeholders to prepare for changes in sea level. This study does not take into account the spatiotemporal dimensions of climate change; the maps are simply estimations of the impacts of climate change at different elevations. It does not provide an estimate on what degree of climate change will cause each level of sea level rise. This is intentional, as estimations vary greatly by agency one consults. The tool created shows an apolitical estimation of sea level rise based on elevation.

This study is limited due to the contour projection, as the lines are 5 feet apart. This loses out on some degree of sea level rise. In the future, using a 2-foot contour would provide a more full picture of warming patterns.

Additionally, this paper points to the disproportionality of climate change, but cannot possibly speak to the climate-based gentrification and how lower income families ended up in lower elevation regions of Miami. This would require a historical analysis that takes into account the changes in composition of the city. This would be a great opportunity for future study, looking at the changes in the composition of housing in Miami with respect to race and socioeconomic status to better understand how climate-based gentrification has occurred.

Works Cited

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