Wendy Prudencio

GES 687 Final Project

May 21, 2021

Topic

The Impacts of Hurricane Irma and Hurricane Maria on Household Compositions

Introduction

Puerto Rico is a United States territory located in the Caribbean Sea, a part of the Atlantic Ocean. As of 2019, Puerto Rico had a population estimate of 3,193,694 with 1,192,654 estimated households (U.S. Census Bureau, n.d.). In September 2017, Puerto Rico was devastated by Hurricane Irma a category 5 storm and fourteen days later Hurricane Maria, also a category 5 storm, destroyed Puerto Rico. Hurricanes Irma and Maria impacted critical infrastructure, essential life-lines, and households. It was recorded that roughly 780,000 homes sustained damages from Hurricane Irma and Maria (Habitat for Humanity, n.d.). It has been reported that in 2020 thousands of homes that were impacted by both hurricanes still remain damaged (Coto, 2020).

This project looks at household composition in terms of median incomes, total insurance, and housing units from years 2014, 2016, 2018, and 2019 in Puerto Rico to determine if the impacts of Hurricanes Irma and Maria changed household composition.

Data

Census tracts for total population for years 2019 and 2014, median household income in the past 12 months (In 2019 inflation-adjusted dollars and 2014 inflation adjusted dollars), total and health insurance coverage status by sex by age variables were attained from the American Community Survey (ACS) U.S. Census Bureau. The percentage of housing units for years 2016 and 2018 were obtained from the Social Vulnerability Index provided by Centers for Disease Control and Prevention. Additionally, Comma Separated Values (CSV) on the damages per-household were computed using data obtained from the U. S. Department of Housing and Urban Development.

Transformation

The Census tracts and CSV datasets were transformed into geographic information system maps projected in World Geodetic System 1984/Pseudo-Mercator EPSG: 3857.

Analysis

In RStudio, a bivariate choropleth map was created using the total population, median household income and total insurance coverage for years 2014 and 2019. The bivariate choropleth map shows that the areas of San Juan, Ponce, Rincón, Aguadilla, and Carolina have a higher median household income using total insurance coverage. Areas that are more mountainous such as Cerro de Punta have a lower to no median household income using total insurance coverage. The map is accurate in that the areas with higher median household income are big cities in Puerto Rico.

Using QGIS a choropleth map was created using the total population insured in Puerto Rico for years 2014 and 2019. The map shows that areas such as Fajardo, Patillas, Arecibo, and Caguas have a higher rate of insured individuals compared to Lajas, Florida, and Adjuntas, which have a lower number of insured individuals. In QGIS another bivariate choropleth map was created using housing units for years 2016 and 2018 to show the differences before and after Hurricanes Irma and Maria. The map shows that in municipalities such as Fajardo, Caiba, Toa Baja, and Arecibo there was a substantial decrease in housing units from 2016 to 2018.

Future

I am working on combing the maps that were created in this project with fixed effects regression models on housing units and crowdedness in households. I intended to create additional maps to determine if crowdedness was a direct impacts of the damages per-household units. I want to be able to publish these maps and paper during the summer of 2021.

References/ Links

Coto, D. (2020). Thousands in Puerto Rico still without housing since Maria. Retrieved from https://apnews.com/article/ap-top-news-puerto-rico-latin-america-caribbean-hurricanes-a2cf35e2f8893592ec4b59d90baae1ac

Habitat for Humanity. (n.d.). Hurricane Maria recovery. Retrieved from

https://www.habitat.org/our-work/disaster-response/hurricanes/hurricane-maria

Social Explorer. (n.d.). American Community Survey Tables 2010- 2014 (5-Year Estimates).

Retrieved from https://www.socialexplorer.com/data/ACS2014_5yr/metadata/

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U. S. Census Bureau. (n.d.) Puerto Rico QuickFacts. Retrieved from

https://www.census.gov/quickfacts/PR

U. S. Department of Housing and Urban Development. (2018). Housing Damage Assessment

and Recovery Strategies Report *Puerto Rico*. Retrieved from http://spp-pr.org/wp-

content/uploads/downloads/2018/07/HUD-Housing-Damage-Assessment-Recovery-

Strategies-6-29-18.pdf

R Notebook

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Setup

```
library(tidyverse)
```

```
## ── Attaching packages ──────────────────────────────── tidyverse 1.3.1 ──
```

```
## ✓ ggplot2 3.3.3     ✓ purrr   0.3.4
## ✓ tibble  3.1.1     ✓ dplyr   1.0.5
## ✓ tidyr   1.1.3     ✓ stringr 1.4.0
## ✓ readr   1.4.0     ✓ forcats 0.5.1
```

```
## ── Conflicts ──────────────────────────────────── tidyverse_conflicts() ──
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(tidycensus)
library(ggplot2)
library(sf)
```

```
## Linking to GEOS 3.8.1, GDAL 3.1.4, PROJ 6.3.1
```

```
library(sp)
library(biscale)
```

Settings for tidycensus

```
options(tigris_class = "sf")
options(tigris_use_cache = TRUE)
census_api_key("3efcfb0ddc4c895edaac8221c73a40ca59dd392c")
```

```
## To install your API key for use in future sessions, run this function with `install = TRUE`
## .
```

```
"install = TRUE"
```

```
## [1] "install = TRUE"
```

Census Data is provided by (https://www.socialexplorer.com/data/ACS2019_5yr/metadata/?ds=ACS19_5yr)

Download Census Data for 2015-2019

```r
pr_population19 <- get_acs(geography = "tract",
    variables = c("total_pop19" = "B01003_001", #Total Population
                  "median_hh19" = "B19013_001", #Median Household Income in the Past 12 Month
s
                  "total_ins19" = "B27001_001" #Total Health Insurance Coverage
                  ),
    year = 2019,
    survey = "acs5",
    state = c(72),
    geometry = TRUE, # download the shapefile with the data
    output = "wide") # need this
```

```
## Getting data from the 2015-2019 5-year ACS
```

Download Census Data for 2010-2014

```r
pr_population14 <- get_acs(geography = "tract",
    variables = c("total_pop14" = "B01003_001", #Total Population
                  "median_hh14" = "B19013_001", #Median Household Income in the Past 12 Month
s
                  "total_ins14" = "B27001_001" #Total Health Insurance Coverage
                  ),
    year = 2014,
    survey = "acs5",
    state = c(72),
    geometry = TRUE, # download the shapefile with the data
    output = "wide") # need this
```

```
## Getting data from the 2010-2014 5-year ACS
```

Reprojection to web-mercator

```r
pr_total_pop<- st_transform(pr_population19, 3857)
```

Here is the beginning of my FINAL

```r
pr_population19$inspct <- pr_population19$total_ins19E / pr_population19$total_ins19E

filter_na = pr_population19 %>% filter(!is.na(pr_population19$median_hh19E))

max(filter_na$median_hh19E)
```

```
## [1] 101125
```

```r
max(filter_na$inspct)
```

```
## [1] 1
```

```
filter_na <- bi_class(filter_na, x= total_ins19E, y= median_hh19E, style = "quantile", dim = 3
)
```

```
hghst_con = filter_na %>% filter(median_hh19E == 101125)

map1pr <-ggplot() +
  geom_sf(data = filter_na, mapping = aes(fill = bi_class), color = "white", size = 0.1, show.
legend = FALSE) +
bi_scale_fill(pal = "DkBlue", dim = 3) +
  labs(
    title = "Median Household Income in P.R.",
    subtitle = "Using Total Insurance Coverage"
  ) +
bi_theme()

  map1pr
```

Median Household Income in P.R.
Using Total Insurance Coverage
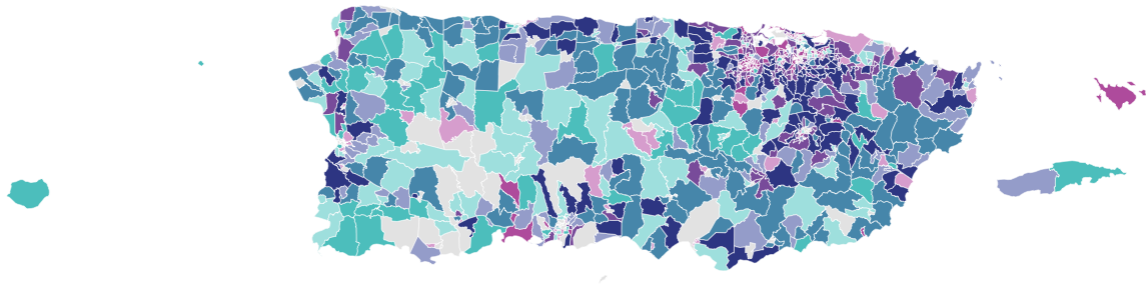
Legend

```
library(cowplot)
library(biscale)

legend <-bi_legend(pal = "DkBlue",
                    dim = 3,
```

```
                xlab = "Higher Median Income",
                ylab = "Higher Insurance Coverage",
                size = 7)
```

```
finalplot <- ggdraw() +
  draw_plot(map, 0, 0, 1, 1) +
  draw_plot(legend, 0.2, .65, 0.2, 0.2)

legend
```
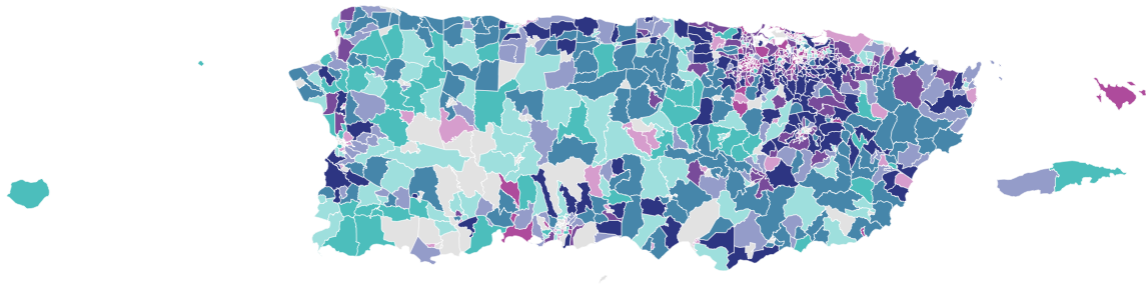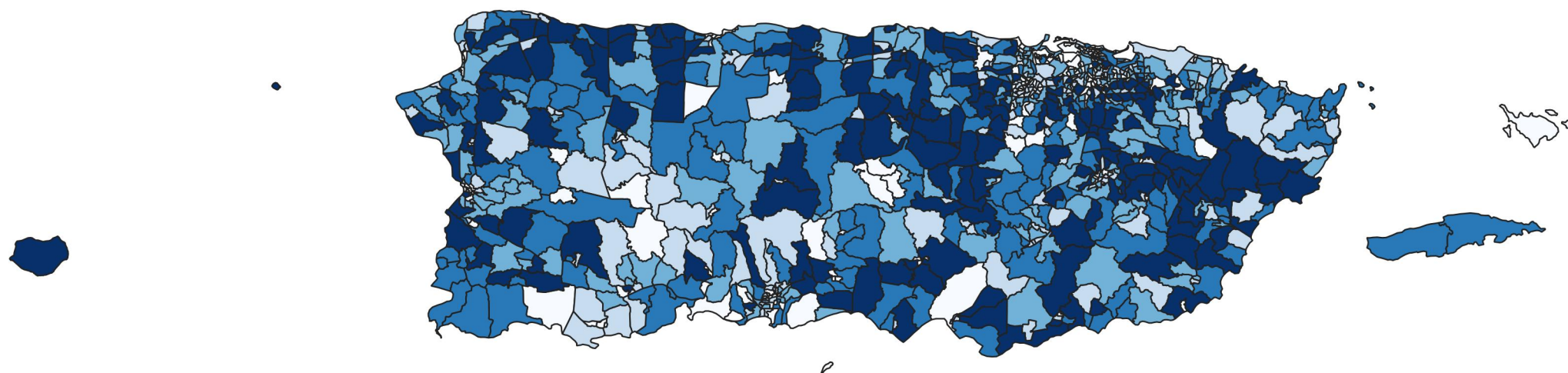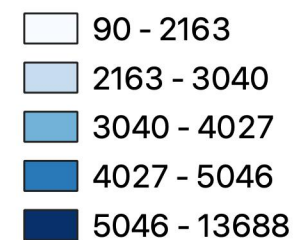


```
map1pr
```
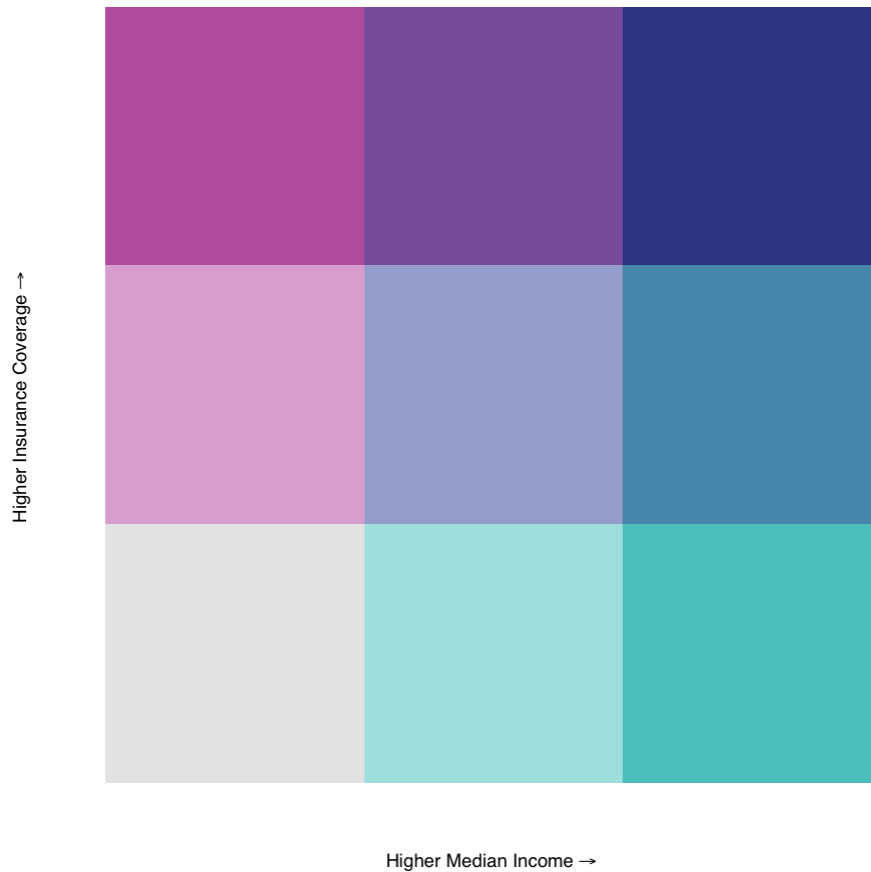
Median Household Income in P.R.
Using Total Insurance Coverage

Total Population Insured in Puerto Rico

Legend

- ☐ 90 - 2163
- ☐ 2163 - 3040
- ☐ 3040 - 4027
- ☐ 4027 - 5046
- ☐ 5046 - 13688
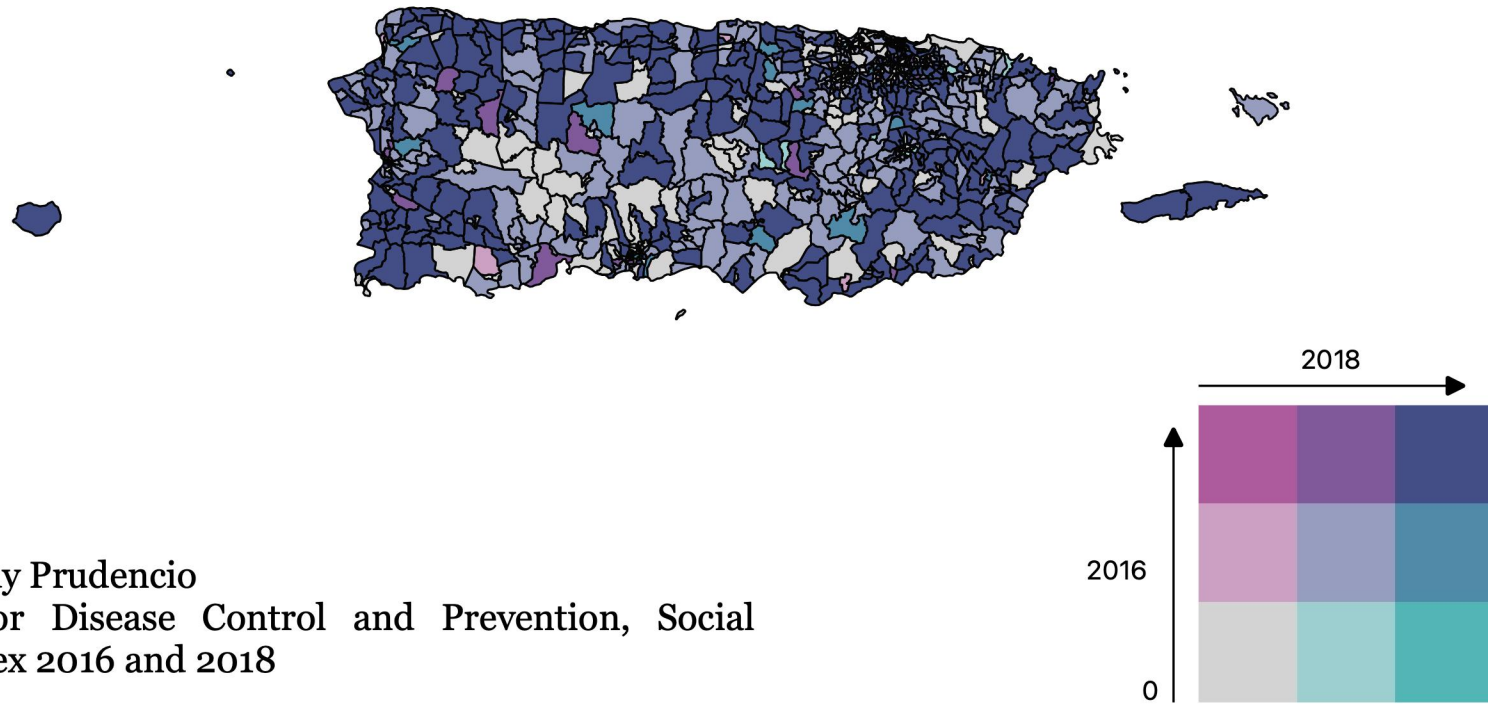
Created by: Wendy Prudencio
Data: American Community Survey 2014 and 2019

Household Units Before and After Hurricanes Irma and Maria in Puerto Rico

2018

2016

0

Created by: Wendy Prudencio
Data: Centers for Disease Control and Prevention, Social Vulnerability Index 2016 and 2018