Visual Analysis of Hazardous Waste Facility Proximity in Texas

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Table of contents

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Primary Objective

The state of Texas consists of 254 counties and is racially diverse. A topic of interest regarding environmental justice includes waste management impacts on communities, especially communities of color. Travis County, which includes the city of Austin, has been shaped by a legacy of systemic racism and exclusion that continues to affect communities of color today (City of Austin, n.d). The Environmental Justice Mapping and Screening Tool was created by the Environmental Protection Agency (EPA) to track and reveal environmental injustices based on several socioeconomic variables. The dataset was downloaded from the EPA website and contains environmental and demographic data at the block group level.

The goal of this assignment is to explore how people of color within Texas counties are significantly impacted by their proximity to toxic waste. The following research question was utilized to guide the analysis:

To what extent are communities in Texas counties within distance of a hazardous waste facility, especially communities of color and those within Travis County?

This analysis will consider the selected variables:

- `PTSDF`: Population-weighted average representing the ratio of total count of hazardous waste facilities in each block group within five kilometers of an average resident to the distance (EPA, 2023)
- `PEOPCOLOR`: Concentrations of people of color within a block group
- `D2_PTSDF`: Hazardous waste proximity EJ Index

Load the appropriate packages

```
library(tidyverse) # Load the tidyverse" for data cleaning
library(sf) # Load "sf" for GIS analysis
library(here) # Load "here" to locate and reference files
library(tmap) # Load "tmap" for functions to create and layer maps
```

Import Data and Initial Data Wrangling

1. Import the geodatabase and filter for counties within Texas.

```
# Read in geodatabase of EJScreen data at the Census Block Group level
ejscreen <- sf::st_read(here::here("data", "ejscreen",
"EJSCREEN_2023_BG_StatePct_with_AS_CNMI_GU_VI.gdb"))
```

2. Filter for the specified state and a county of interest (ie. Travis County) for the second map.

```
# Filter to specified state
tx <- ejscreen %>%
  dplyr::filter(ST_ABBREV == "TX")

# Filter to a county of interest
travis_county <- ejscreen %>%
  dplyr::filter(CNTY_NAME %in% c("Travis County"))
```

3. Group by each county within Texas to summarize the average proximity of hazardous waste at the block level (`PTSDF`) for each county.

```r
# Group by county name
texas_summary <- tx %>%
  group_by(CNTY_NAME) %>%
  # Run mean() on "PTSDF" to
  # determine the average proximity
  # of communities to facilities per county
  summarise(
    avg_PTSDF = mean(PTSDF, na.rm = TRUE),

  # Average the percentage of people of color
  #at the block level to obtain a singular
  #representative demographic value for each county
    PEOPCOLORPCT = mean(PEOPCOLORPCT, na.rm = TRUE)
  )
```

Map 1: Visualizing Average Hazardous Waste Proximity Based on County Demographics

4. Use functions in the `tmap` package to creat a map showcasing the average proximity of hazardous waste in each county based on the percentage of people of color for that county.

```r
tmap_mode("plot") # Mode to "plot" to create static map

tm_shape(texas_summary,
         bbox = texas_summary) + # Set boundaries of the map frame with
  #"bbox" parameter to texas_summary
  tm_polygons(
    "PEOPCOLORPCT",
    palette = "brewer.greens", # Color palette scale based on brewer
    title = "% People of Color" # Title for legend
  ) +
  tm_symbols(
    size = "avg_PTSDF", # Classify average proximity by size
    shape = 21, # Set the symbol shape to a circle
    col = "blue", # Each circle will be blue
    title.size = "Average Facility\nProximity (km)") + # Break legend title to new line
 tm_graticules( # Establish network
    col = "black",
    lwd = 0.3,
    alpha = 0.6
  ) +
```

```
tm_title("Hazardous Waste Proximity To Communities of Color in Texas Counties", size = 1
tm_layout(
  legend.outside = TRUE, # Ensure legend is outside map bbox
  inner.margins = c(.01,.01,.01,.2), #Margins to adjust for frame
  #width and height were experimented
  #with to fit all elements neatly
  component.autoscale = FALSE)# Prevent the title from
```

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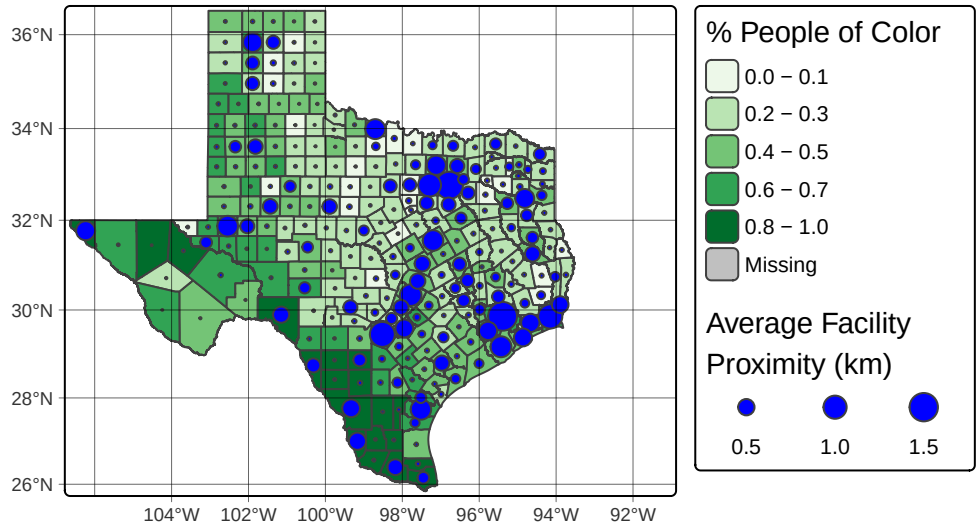



```
#automatically scaling with the figure
```

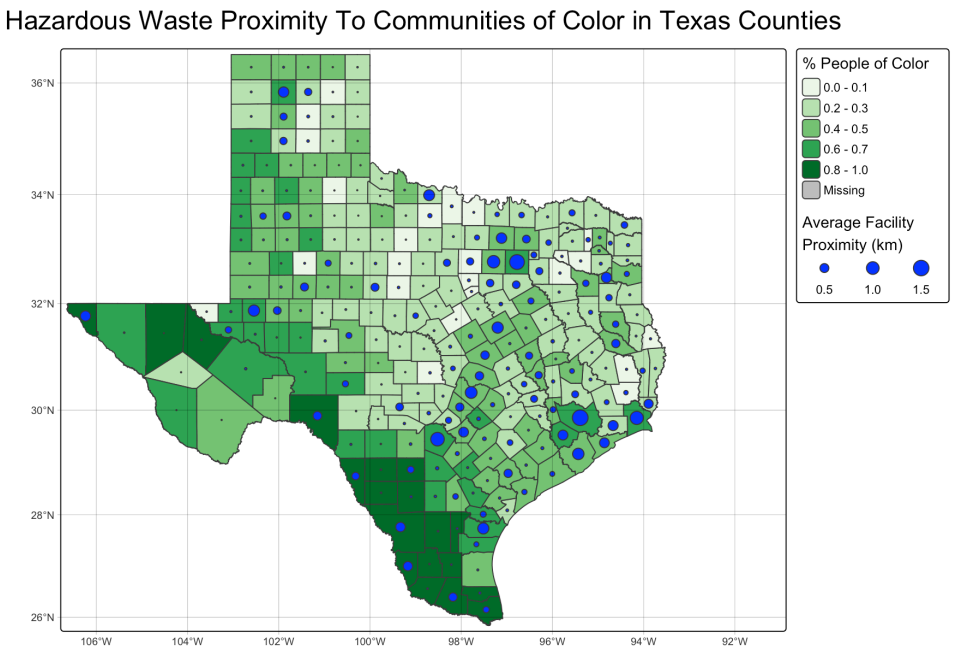


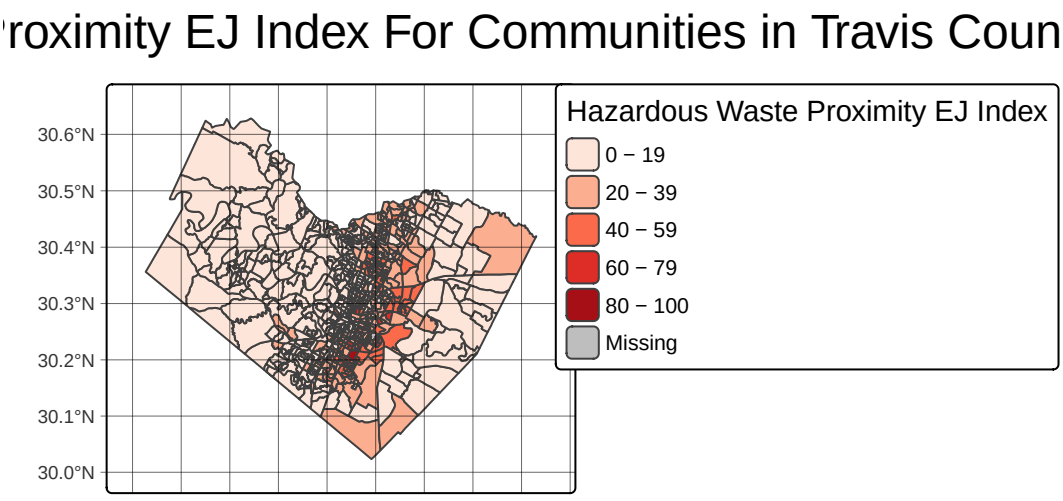
Figure 1. Formatted Map of Hazardous Waste Proximity To Communities of Color in Texas Counties.

Map 2: Visualizing Hazardous Waste EJ Index in Travis County

5. Use functions in the `tmap` package to visualize the hazardous waste EJ Index in each block group within Travis County

```
# Set travis_county as the base layer
tm_shape(travis_county) +
  tm_polygons(
    fill = "D2_PTSDF",
    fill.scale = tm_scale(values = "brewer.reds"),
    fill.legend = tm_legend(title = "Hazardous Waste Proximity EJ Index") # Set the
    #legend title
  ) +
   tm_graticules( # Establish network
    col = "black",
    lwd = 0.3,
    alpha = 0.6
  ) +
```

```
tm_title("Hazardous Waste Proximity EJ Index For Communities in Travis County",
         size = 1.5) +
tm_layout(
  inner.margins = c(.1, .1, .1, .1),
  component.autoscale = FALSE) # Prevent the title from
```




```
#automatically scaling with the figure
```

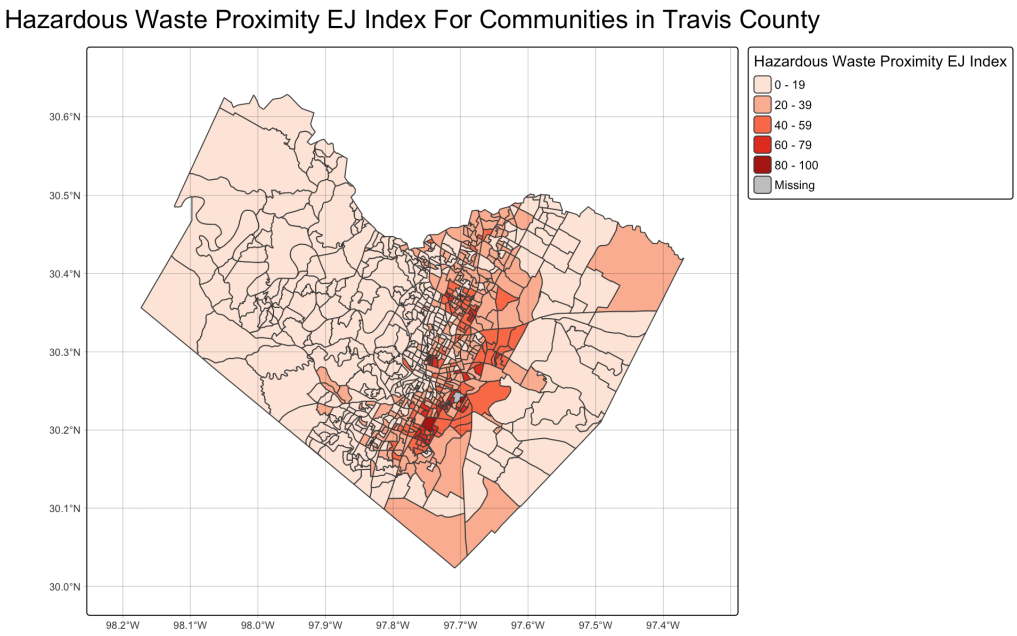


Figure 2. Formatted Map of Hazardous Waste Proximity EJ Index For Communities in Travis County.

Interpretation

Generally, there does not seem to be a consistent trend in an increased proximity to hazardous waste facilities for predominantly communities of color (POC communities). On average, residents are close to multiple hazardous waste management facilities in counties containing industrial cities and ports along the Gulf Coast. The Rio Grande Valley generally has a strong POC community presence and, on average, has residents close to multiple facilities. Central Texas and Gulf Coast counties, especially counties containing Austin and Houston, are moderately dominated by POC communities and have a significant amount of facilities within a close distance of residents. The Texas Panhandle notable has a lower presence of POC communities, with fewer or farther facilities within distance of the average resident. Experts may consider the health effects of inadequate waste management for POC Communities in Gulf Coast counties facing continued marginalization, particularly highly industrial cities like Corpus Christi that contain multiple facilities within a close distance of residents.

The capital city of Austin is located in Travis County. Based on the Hazardous Waste Proximity EJ Index, the center of Travis County (encompassing Austin) is closer to hazardous waste facilities and has more vulnerable populations compared to the national average. This indicates that the highly urbanized setting in Austin contains marginalized communities increasingly at risk of impacts from nearby hazardous waste facilities. The outskirts of Austin

present a lower EJ Index likely due to suburban areas within a larger distance of facilities. As such, marginalized communities in downtown Austin and the surrounding urban area are more likely to face impacts from close proximity to hazardous waste facilities compared to the suburban areas of Travis County. A separate analysis may explore the demographics of Travis County in relation to the Hazardous Waste Proximity EJ Index to determine whether human development and racial composition are elements influencing the impact level hazardous waste.