

Homework Assignment 2

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2025-10-19

Exploring patterns of environmental justice

Set Up

```
# Librarys used to complete this homework
```

```
library(sf) # for vector data
library(tmap) # for static and interactive maps
library(here)
library(spData)
library(tidyverse)
library(dplyr)
library(gt)
library(viridis)
```

```
# Spatial data object to plot
```

```
# EJScreen
```

```
ejscreen <- st_read(here("data/ejscreen/EJSCREEN_2023_BG_StatePct_with_AS_CNMI_GU_VI.gdb"))
```

```
# HOLC Redlining
```

```
holc <- st_read(here("data/mapping-inequality/mapping-inequality-los-angeles.json"))
```

```
# Biodiversity observations: Bird data
```

```
birds <- st_read(here("data/gbif-birds-LA/gbif-birds-LA.shp"))
```

Checking if CRS matches & Transforming before spatial operations.

```

# Stop if CRS is missing
if (is.na(st_crs(ejscreen))) stop("EJScreen is missing CRS assign before continuing.")
if (is.na(st_crs(holc))) stop("HOLC is missing CRS assign before continuing.")
if (is.na(st_crs(birds))) stop("Birds is missing CRS assign before continuing.")

# Warning if CRS mismatch. Then transform to EJScreen's CRS
if (st_crs(holc) != st_crs(ejscreen)) {
  warning("CRS mismatch detected: trnasforming HOLC to match EJScreen.")
  holc <- st_transform(holc, st_crs(ejscreen))
}

if (st_crs(birds) != st_crs(ejscreen)) {
  warning("CRS mismatch detected: transforming birds to match ejscreen.")
  birds <- st_transform(birds, st_crs(ejscreen))
}

# Checking if holc, bird and ejscreen CRS match.
if(st_crs(holc) == st_crs(ejscreen) &&
  st_crs(birds) == st_crs(ejscreen)) {

  print("CRS match confirmed for holc, birds, and ejscreen.")
} else {
  print("CRS does not a match")
}

```

Part 1: Legacy of redlining in current environmental (in)justice

Exploring historical redlining in Los Angeles and its legacy on present-day environmental justice.

1. Map of historical redlining neighborhoods, including:

- neighborhoods colored by HOLC grade
- an appropriate base map
- a clear title and legend

```

tmap_mode("plot")

tm_shape(holc) +
  tm_polygons(
    col = "grade",

```

```

    palette = c("darkgreen", "blue", "orange", "red"),
    title = "HOLC GRADE"
  ) +
  tm_layout(
    main.title = "Historical Redlining in Los Angeles",
    main.title.position = 'center',
    main.title.size = 1.5,
    legend.outside = TRUE
  ) +
  tm_scale_bar(position = c("left", "bottom")) +
  tm_compass(position = c("right", "top")) +
  tm_basemap("OpenStreetMap")

```

2. Spatial join and summary table

Assign census block group in EJScreen to the HOLC grade it falls inside. - Performed a spatial join to assign each bird observation to an HOLC grade polygon - `st_join()` method will be used here because we want polygon attributes

```

# Assign HOLC grade to each census block group

ej_holc <- st_join(ejscreen, holc['grade'])

# Drop geometry after join for table and statistics

ej_holc_df <- st_drop_geometry(ej_holc)

# summary table: % in each HOLC grade plus % with no grade

grade_summary <- ej_holc_df %>%
  mutate(has_grade = !is.na(grade), "None", grade) %>%
  group_by(grade) %>%
  summarise(n = n()) %>%
  ungroup() %>%
  mutate(
    pct = n / sum(n) * 100
  )

# Table summary

grade_summary %>%

```

```
gt() %>%
  tab_header("Percentage of Block Groups by HOLC Grade")
```

3. Summary statistics and visualization summaries

```
# Compute means by HOLC grade

ej_mean_grade <- ej_holc_df %>%
  group_by(grade) %>%
  summarise(
    mean_low_income = mean(LOWINCPCT, na.rm = TRUE),
    mean_pm25 = mean(P_PM25, na.rm = TRUE),
    mean_lifeexp = mean(LIFEEXPPCT, na.rm = TRUE)
  ) %>%

# print(ej_mean_grade) checking results

pivot_longer(
  cols = c(mean_low_income, mean_pm25, mean_lifeexp),
  names_to = "variable",
  values_to = "mean_value"
)

# Creating a faceted ggplot

#Graph 1.

ggplot(ej_mean_grade, aes(x = grade, y = mean_value, fill = grade)) +
  geom_col() +
  facet_wrap(~ variable, scales = 'free_y') +
  labs(
    title = "Mean EJScreen Variables by HOLC Grade",
    x = "HOLC Grade",
    y = "Mean Value",
    fill = "HOLC Grade"
  ) +
  theme_minimal() +
  theme(
    strip.text = element_text(size = 12, face = "bold"),
```

```
axis.text.x = element_text(angle = 0, hjust = 0.5),
plot.title = element_text(size = 14, face = "bold")
)
```

4. Reflection paragraph

Historical redlining in Los Angeles show continuous existence environmental and socioeconomic disparities. Census block groups located in formerly redlining neighborhoods, HOLC grade D and C, have high percentages of low_income residents, elevated particular matter (PM 2.5) exposure, and lower life expectancy percentage compared to areas with high historical grades (A or B). This pattern suggest that discrimination continues to shape environmental justice outcomes, while correlation does not imply causation, these observations align with literature demonstrating that historic housing redlining influences inequalities in exposure to pollution and socioeconomic vulnerability.

Part 2: Legacy of redlining in biodiversity observations

Exploring the legacy of historical redlining in Los Angeles on the collection of bird observations from 2021-2023.

1. Percent observation summary of redlining neighborhoods within each HOLC grade.

```
# Assigning each bird observation to a HOLC grade
birds_holc <- st_join(birds, holc["grade"])

# Replacing NA grades with "None"
birds_holc <- birds_holc %>%
  mutate(grades = ifelse(is.na(grade), "None", grade))
```

3. Bird observation per HOLC grade percent (%) summary.

```
bird_summary <- birds_holc %>%
  st_drop_geometry() %>%
  group_by(grade) %>%
  summarise(n = n()) %>%
```

```

ungroup() %>%
mutate(pct = n/ sum(n) * 100)

print(bird_summary)

```

4. Visualization

```

# Changing label for NA grades so it doesnt show "NA" in the plot

bird_summary <- bird_summary %>%
  mutate(grade = ifelse(is.na(grade), "Outside HOLC", grade))

# Graph 2.

ggplot(bird_summary, aes(x = grade, y = pct, fill = grade)) +
  geom_col(show.legend = FALSE) +
  scale_y_continuous(labels = scales::percent_format(scale = 1)) +
  # format y-axis to display % instead of raw numbers
  scale_fill_viridis_d() +
  labs(
    title = "Percentage of Birds Observations by HOLC Grade (2021-2023)",
    x = "HOLC Grade",
    y = "Percent of Observations"
  ) +
  theme_minimal(base_size = 14)

```

5. Reflection

The results show that most bird observations occurred outside historically redlining areas. Those observation that do fall withing HOLC graded neighborhoods, Grade C contained the highest share at 3.72%, following Grade A and D at 2.35 % each, and Grade B at 1.88%. Unlike Ellis-Soto et al. (2023), we do not observe a clear gradient of reduced biodiversity observations in formerly redlining areas because here we only focused on a small geographic scale, LA county while Ellis_Soto study accounted for a larger geographic scale, 38 states.