

Investigating Environmental (in)Justice in Oakland

Spatial visualizations of Hazardous Waste and Superfund Proximity using EPA's EJScreen

Jackson Coldiron

2025-10-06



Introduction

This report uses EPA's EJScreen (2023) block-group data to explore patterns of environmental (in)justice in **Oakland, CA**. The goal is to produce two clear, accessible maps—built in R

with `tmap` and `sf`—that communicate one cohesive story about how environmental burdens and social vulnerability intersect. I follow MEDS mapping best practices (informative titles, legible legends with units, appropriate continuous/discrete color scales, and scale/orientation cues) and summarize key takeaways in a brief narrative. EJScreen provides nationally consistent indicators but carries important caveats (screening—not a risk assessment; method and coverage limitations noted in the technical documentation). Results here are therefore exploratory and intended to support discussion and further inquiry, not definitive regulatory conclusions.

Data Overview

This analysis uses the U.S. EPA’s **EJScreen 2023** block-group dataset, which pairs environmental burden indicators with a Demographic Index (mean of % low-income and % people of color) to produce percentile-ranked “EJ Index” scores (0–100). We focus on two proximity indicators: Hazardous Waste Proximity (Environmental Burden Indicator) and Superfund Proximity (Environmental Justice Index). All percentiles are nationally referenced (i.e., values reflect a block group’s position relative to the entire U.S., not just the Bay Area). The unit of analysis is the Census block group; for Oakland-specific views, Alameda County records are clipped to the Oakland city boundary. These indicators are screening metrics, not direct measures of exposure or health risk, and proximity does not imply causation. Results may be sensitive to boundary effects (e.g., facilities just outside the city line still influence nearby block groups) and to EJScreen’s underlying national datasets and methods. Basemap tiles (when shown) are used purely for geographic context.

Data Citation: United States Environmental Protection Agency. 2015. EJSCREEN. Retrieved: October 5, 2025 from <https://www.epa.gov/ejscreen>

Data Preparation

```
# Load libraries
library(tidyverse)
library(sf)
library(tmap)
library(tmaptools)
library(ggspatial)
library(tigris)

# Set tmap mode to plotting (static maps)
tmap_mode("plot")

# Load EJScreen block group data (2023)
```

```

ej <- st_read(here::here("data", "EJSCREEN_2023_BG_StatePct_with_AS_CNMI_GU_VI.gdb"), quiet = FALSE)

# Filter to a state you are interested in
california <- ej |>
  dplyr::filter(ST_ABBREV == "CA")

# Filter to a county you are interested in
alameda <- california |>
  dplyr::filter(CNTY_NAME %in% c("Alameda County"))

# --- CRS and data (assumes `alameda` already exists) ---
alameda_3857 <- st_transform(alameda, 3857)

```

Map 1: Hazardous Waste Proximity in Oakland

Data Manipulation

```

library(sf)
library(dplyr)
library(tigris)
library(tmap)
options(tigris_use_cache = TRUE)

# 1) Oakland city boundary
places_ca <- places(state = "CA", year = 2023, class = "sf")
oakland <- places_ca |>
  filter(NAME == "Oakland") |>
  st_make_valid()

# 2) Clip EJScreen to Oakland city limit
alameda_oak <- alameda |>
  st_transform(st_crs(oakland)) |>
  st_intersection(oakland)

# 3) Legend bins & labels
breaks_tsdf <- c(0, 50, 80, 90, 95, 100)
labs_tsdf <- c("<50 percentile", "50 - 80 percentile",
              "80 - 90 percentile", "90 - 95 percentile", "95 - 100 percentile")

```

Map Execution

```

# Interactive map with a basemap
tmap_mode("plot")

alameda_oak_3857 <- sf::st_transform(alameda_oak, 3857)
oakland_3857     <- sf::st_transform(oakland, 3857)
osm_oak          <- tmaptools::read_osm(oakland_3857, type = "osm", ext = 1.05)

# Build the static map (with basemap first)
map1 <- tm_rgb(osm_oak) + # <- remove if not needed
tm_shape(alameda_oak_3857) +
  tm_polygons(
    col = "P_PTSDf",
    style = "fixed", breaks = breaks_tsdf, labels = labs_tsdf,
    palette = viridis::viridis(5),
    legend.reverse = TRUE,
    alpha = 0.80, # slight transparency over basemap
    border.col = "grey70", lwd = 0.2,
    title = "Hazardous Waste Proximity (percentile)"
  ) +
tm_shape(sf::st_boundary(oakland_3857)) + tm_lines(lwd = 1) +
tm_compass(type = "arrow", position = c(0.08, 0.08), size = 2) +
tm_scale_bar(position = c(0.2, 0.05), text.size = 0.8) +
tm_layout(
  legend.outside = TRUE,
  legend.frame = FALSE,
  frame = FALSE,
  inner.margins = c(0.03, 0.03, 0.08, 0.03)
)

map1

```

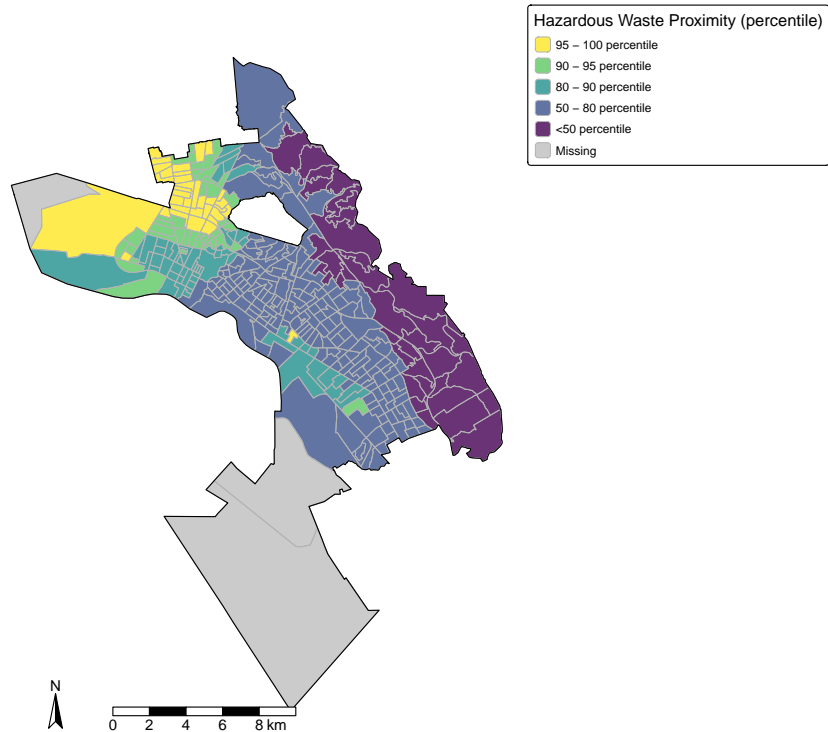


Figure 1: **Concentrated Hazardous Waste Proximity in Oakland’s Northwestern Neighborhoods.** This interactive map shows the city of Oakland and the percentiles for hazardous-waste facility proximity. It is an Environmental Burden Indicator that measures how close people might live to facility that handles hazardous waste. This indicator calculates the total count of hazardous waste facilities (TSDFs and LQGs) within 5km (or nearest within 10km), divided by distance. Colors reflect percentile ranks (0–100) nationwide; higher percentiles (lighter colors) indicate greater combined risk from nearby RCRA Treatment, Storage, and Disposal Facilities.

Map 2: Superfund Proximity Index

Data Manipulation

```
# 1) West Oakland bbox (adjust as needed), then to 3857
wo_wgs84 <- st_as_sfc(st_bbox(c(
  xmin = -122.345, # was -122.320 (more west, into the Bay/Port)
  ymin = 37.780,  # was 37.795 (more south)
  xmax = -122.255, # was -122.270 (more east toward downtown)
  ymax = 37.855   # was 37.835 (more north)
```

```

), crs = 4326))

wo_rect_3857 <- st_transform(wo_wgs84, 3857) # Transform bb of West Oakland to match alameda
wo_bb_3857 <- st_bbox(st_transform(wo_wgs84, 3857)) # Get bbox object for tmap
wo_rect_3857 <- st_as_sfc(wo_bb_3857) # Convert bbox to sfc for plotting

# 2) Custom legend for Superfund proximity
breaks_pnpl <- c(0, 50, 80, 90, 95, 100)
labs_pnpl <- c("Less than 50 percentile",
               "50 - 80 percentile",
               "80 - 90 percentile",
               "90 - 95 percentile",
               "95 - 100 percentile")

# 3) Formatting and colors
# Viridis color palette (5 colors)
pal_pnpl <- viridis::viridis(5)
fill_col <- "P_D2_PNPL"

# Global option: allow autoscaling of components if space is tight
tmap_options(component.autoscale = TRUE)

# 4) Create the two maps
# (a) Alameda overview
map_a <-
  tm_shape(alameda_3857) +
  tm_polygons(
    col = fill_col,
    style = "fixed",
    breaks = breaks_pnpl,
    palette = pal_pnpl,
    labels = labs_pnpl,
    colorNA = "grey85",
    textNA = "Data not available",
    border.col = "grey70", lwd = 0,
    legend.reverse = TRUE,
    title = "EJ Index - Superfund Proximity",
  ) +
  # Add in the bb of West Oakland for reference
  tm_shape(wo_rect_3857) +
  tm_fill(alpha = 0) +
  tm_borders(col = "black", lwd = 2) +
  tm_compass(type = "arrow", position = c("left", "bottom"), size = 1.5) +

```

```

tm_scale_bar(position = c(0.1,.08), text.size = 0.7) +
tm_layout(
  frame = TRUE,
  inner.margins = c(0.16,0.01,0.01,0.01),
  legend.outside = FALSE,
  legend.frame = FALSE,
  legend.position = c("right", "top"),
  legend.text.size = 0.75,
  legend.title.size = 1,
) +
tm_credits("a)", position = c("left","top"), just = c("left","top"), size = 1.0)

# (b) West Oakland zoom
map_b <-
  tm_shape(alameda_3857, bbox = wo_bb_3857) +
  tm_polygons(
    col = fill_col,
    style = "fixed",
    breaks = breaks_pnpl,
    palette = pal_pnpl,
    labels = labs_pnpl,
    legend.reverse = TRUE,
    colorNA = "grey85", textNA = "Data not available",
    border.col = "grey70", lwd = 0.2,
    legend.show = FALSE
  ) +
  tm_compass(type = "arrow", position = c("left","bottom"), size = 1.5) +
  tm_scale_bar(position = c(0.05, 0.08), text.size = 0.7) +
  tm_layout(
    title = "",
    inner.margins = c(0.24, 0.04, 0.04, 0.04), # extra bottom space for legend
    frame = TRUE
  ) +
  tm_credits("b)", position = c("left","top"), just = c("left","top"), size = 1.0)

```

Map Execution

```

tmap_mode("plot") # ensure plot mode

map2 <- tmap_arrange(

```

```
map_a,                # no legend/components
map_b,                # carries legend, north arrow, scalebar
ncol = 2,
widths = c(0.38, 0.62),
outer.margins = c(0.02, 0.02, 0.02, 0.02)
)
map2
```

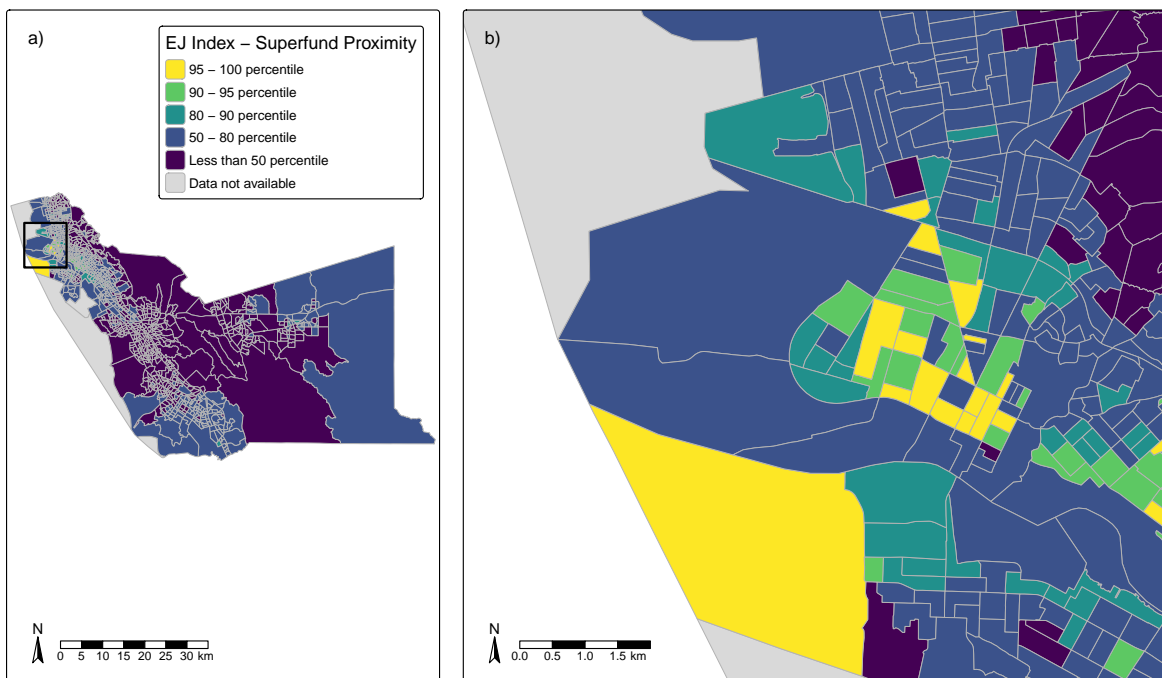



Figure 2: **EJ Index - Superfund proximity in Alameda County and West Oakland (EJScreen 2023)**. Both panels illustrate the the EJ Index of Superfund proximity which combines the environmental burden indicator for Superfund proximity with the demographic index (an average of % low-income and % people of color) for each census block group. The environmental burden indicator for Superfund proximity measures how close people might live to sites listed on the National Priorities List (NPL). This indicator calculates the total count of sites proposed and listed on the NPL within 5 km (or nearest within 10 km), divided by distance. EJScreen presents Superfund proximity using percentile rank, ranging from 0 (lowest) to 100 (highest) with lighter colors indicating higher percentiles of of index score. Panel (a) shows Alameda County overall, with the West Oakland area outlined for reference. Panel (b) zooms into West Oakland, revealing that many of its block groups fall into the highest proximity percentiles (90-100%), indicating significant Superfund exposure risk.

Discussion

For the first analysis, I mapped hazardous-waste facility proximity using only the Environmental Burden Indicator (EBI) from EJScreen. This metric summarizes how near each Census block group is to RCRA Treatment, Storage, and Disposal Facilities (and large quantity generators), weighting by distance and counting facilities within a 5 km radius (or the nearest within 10 km). Because EJScreen reports national percentiles (0–100), higher values indicate

block groups that rank closer to hazardous-waste infrastructure compared to most places in the U.S. After clipping Alameda County to the Oakland city boundary, the highest percentiles concentrate in the northwest industrial corridor (e.g., West Oakland/port adjacency), with a gradient that generally declines moving eastward and into hillside neighborhoods. This view isolates environmental proximity alone—useful for locating potential hotspots, but it does not yet account for who lives there or underlying social vulnerability.

To incorporate socioeconomic context, I then mapped the EJ Index for Superfund proximity, which combines the Superfund (NPL) proximity indicator with EJScreen’s Demographic Index (the mean of % low-income and % people of color). This shifts interpretation from “where facilities are near people” to “where proximity and social vulnerability coincide.” The Oakland results show many of the same West Oakland/Acorn tracts falling in the 90–100th percentiles, suggesting overlapping environmental burdens. This connection between hazardous-waste (ongoing industrial handling of hazardous materials) and Superfund (legacy contamination requiring long-term remediation) is plausible in waterfront and freight-oriented landscapes, where historic land uses and current logistics can co-occur.

Further work could incorporate examine site-level data to validate drivers within top-decile tracts. IT would also be interesting to layer additional stressors (e.g., traffic proximity, flood risk, or greenspace access) to assess cumulative impacts. Finally, this data is all from 2023, I would like to explore temporal changes over the decade.