From the cell to the street:
An environmental justice and health perspective on cumulative impacts

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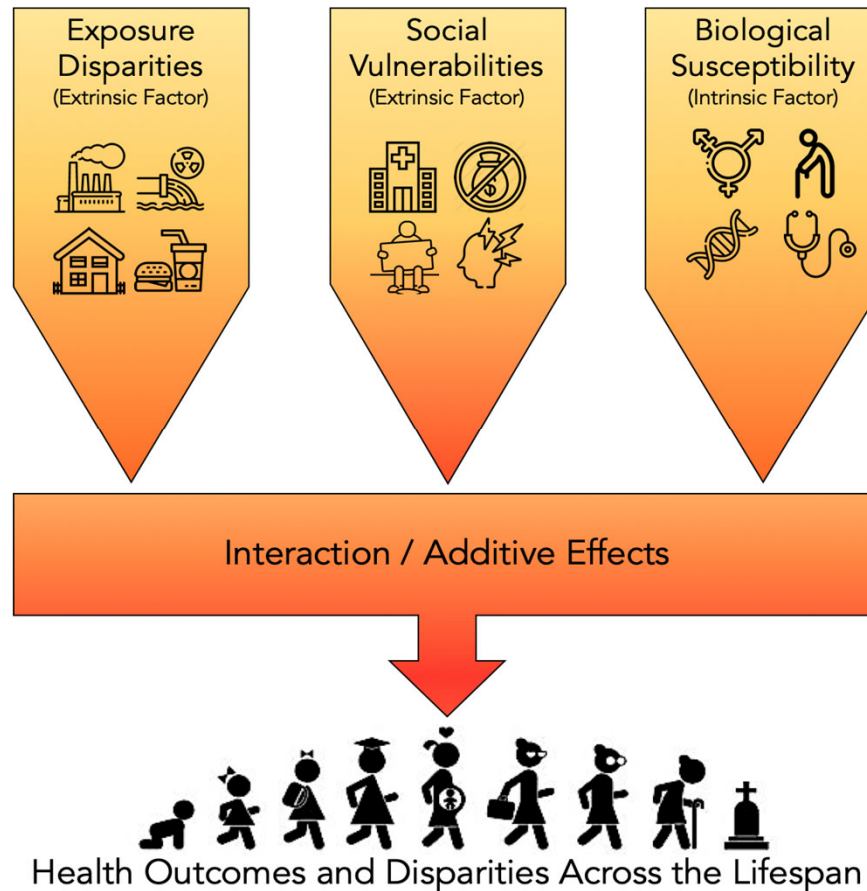rmf@berkeley.edu
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Triple Jeopardy and Environmental "Riskscapes"

Social Context: Social inequality, segregation, discrimination

Demographics: Race/ethnicity, immigration status, income, wealth, geography

Exposure Disparities (Extrinsic Factor)

Social Vulnerabilities (Extrinsic Factor)

Biological Susceptibility (Intrinsic Factor)

Interaction / Additive Effects

Health Outcomes and Disparities Across the Lifespan

Morello-Frosch et al., 2011
Gee and Payne-Sturges, 2004
O'Neill et al. 2003
IOM, 1999

Intrinsic and extrinsic factors can increase disease risk
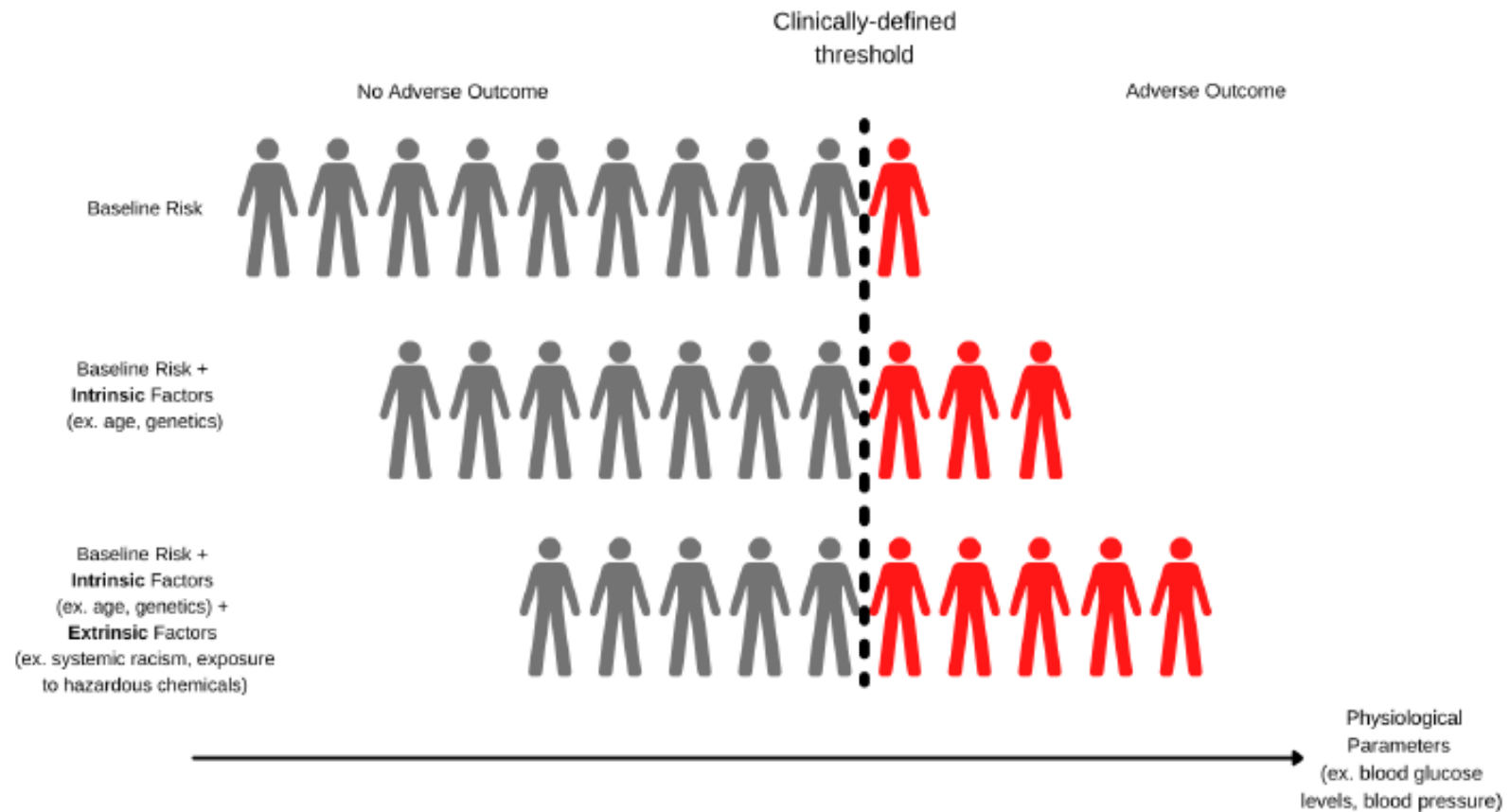
Varshavsky et al. Environmental Health 2023

Environmental (in)justice

Studies consistently show that people of color are more likely than White people to:

- Live near a hazardous waste treatment and disposal facilities
- Live near coal fired power plants
- Live near concentrated animal feeding operations
- Live in chemical disaster vulnerability zones
- Live in areas out of attainment with the Clean Air Act
- Experience increased cancer risks from air toxics
- Breathe air with elevated rates of traffic-related pollutants
- Lack access to clean drinking water
- Lack green space in their neighborhood

Drivers of Environmental Inequities:
Racial Segregation in US Cities and Redlining
Multi-group Dissimilarity (Dm) by Metropolitan Area in the United States
US Census, 2010

D_m range
- <0.40
- 0.40-0.49
- 0.50-0.59
- ≥0.60
- rural areas

Alaska

Hawai'i

Puerto Rico
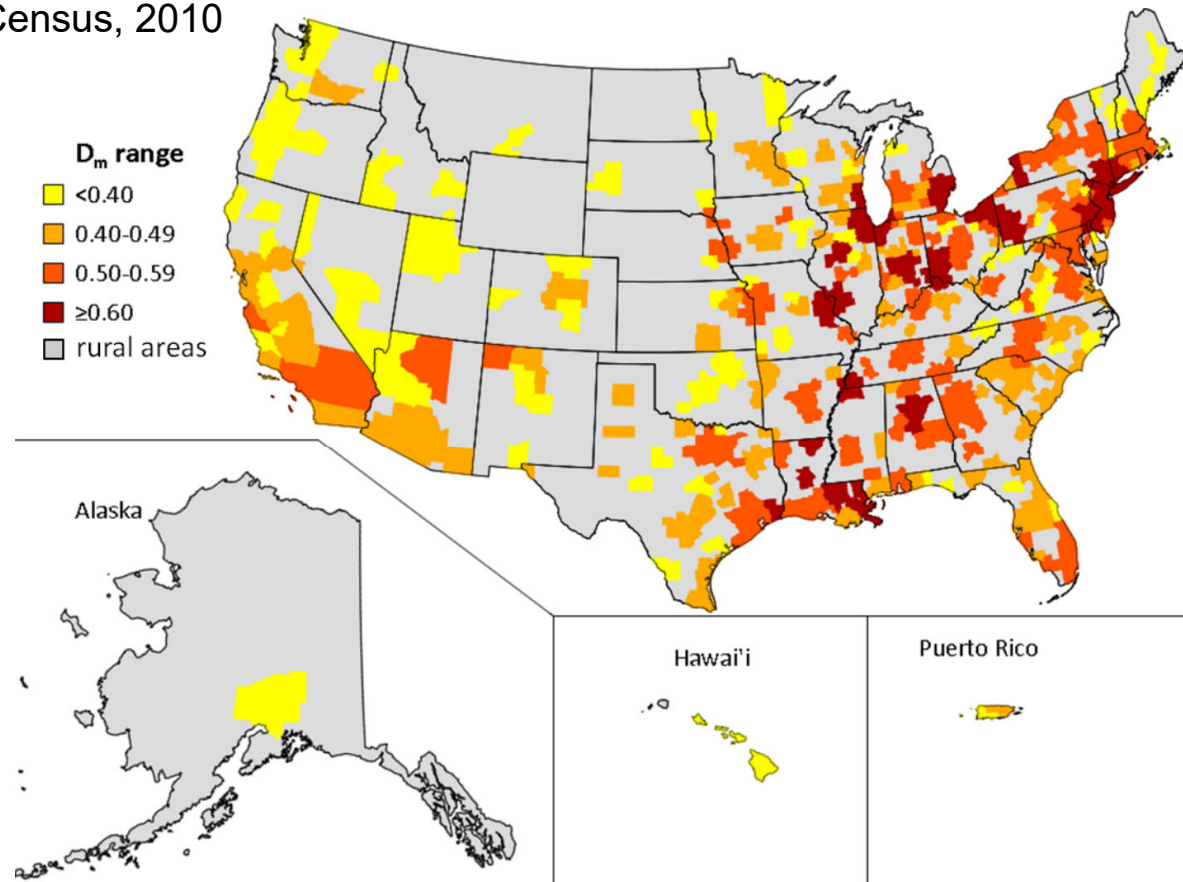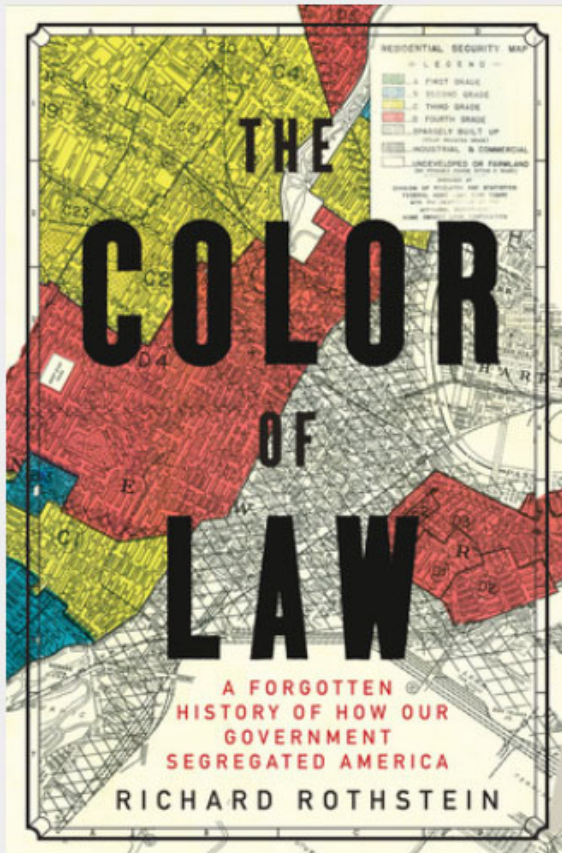
Racist criteria used by Home Owner Loan Corporation (HOLC) to grade neighborhoods in the 1930s: Los Angeles

AREA DESCRIPTION

Security Map of _____ LOS ANGELES COUNTY

1. POPULATION: a. Increasing ___ - ___ Decreasing ___ - ___ Static ___ Yes

b. Class and Occupation ___ WPA workers, laborers, low scale clericals, factory workers, etc
Income $700 to $1500

c. Foreign Families 40 % Nationalities Mexicans, Japanese and low class d. Negro 50 %
Italians

e. Shifting or Infiltration ___ Encroachment of industry a threat.

8. DESCRIPTION AND CHARACTERISTICS OF AREA:

Terrain: Level. No flood or construction hazards. Land improved 90%. Zoning is mixed, but improvements are largely single family dwellings. Conveniences are all readily available. This is the "melting pot" area of Los Angeles, and has long been thoroughly blighted. The Negro concentration is largely in the eastern two thirds of the area. Original construction was evidently of fair quality but lack of proper maintenance is notable. Population is uniformly of poor quality and many improvements are in a state of dilapidation. This area is a fit location for a slum clearance project.
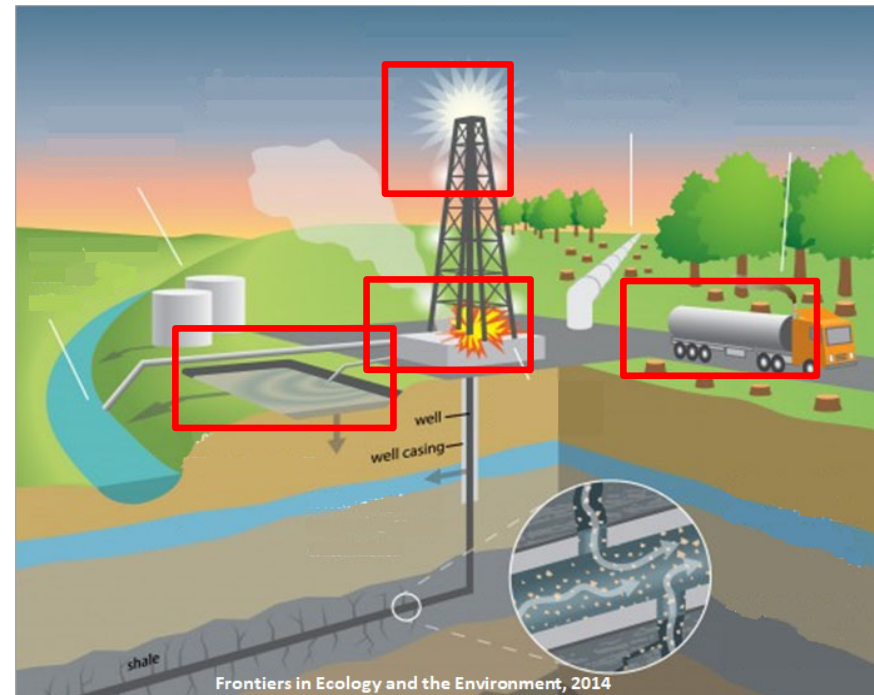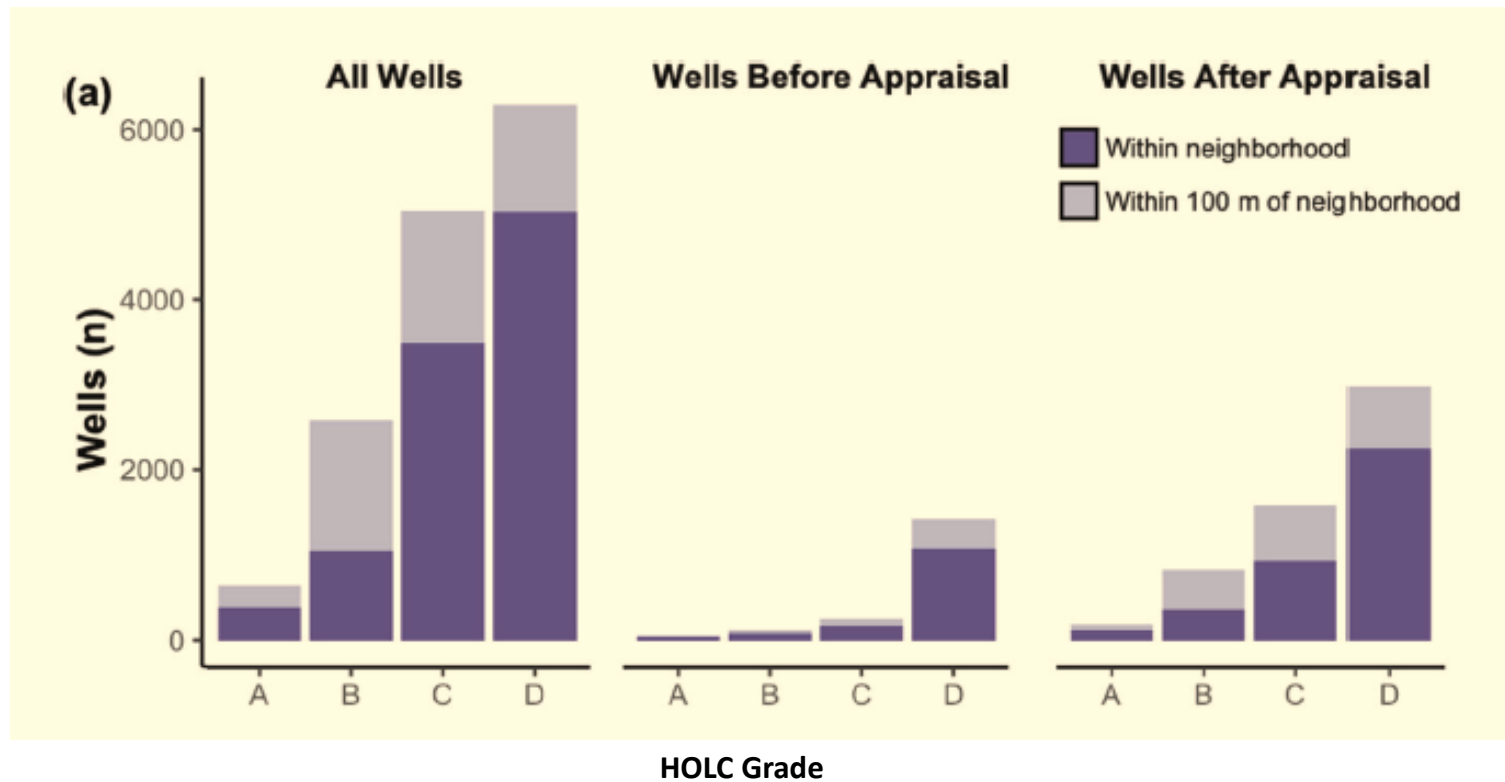The area is accorded a "low red" grade.
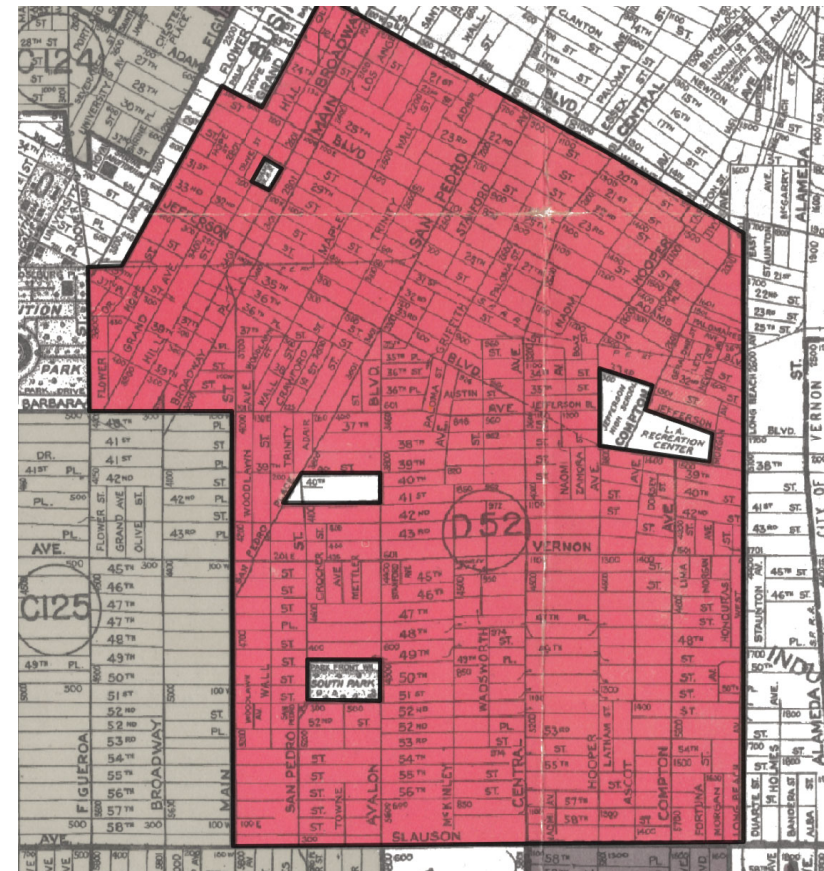
Source: Mapping Inequality: Redlining in New Deal America

Oil and Gas Development: Health Hazards

- Air pollution
- Water pollution
- Excessive light at night
- Other social stressors

Frontiers in Ecology and the Environment, 2014

Distribution of exposure to wells by HOLC neighborhood grade (N=33 US cities)

Oil and Gas Development in CA Adversely Affects Birth Outcomes

Approximately 3,080,713 (7.9%) of Californians live within 1 km of an active oil and gas well

- 40% more likely to have a low-birth-weight baby

- 20% more likely to have a small for gestational age birth

- 10% increased risk of preterm birth

- Effects sometimes shown to be stronger among Latinx pregnant people (preterm birth) and rural populations (birth weight and small-for-gestational age)

Tran et al. EHP 2020, Tran et al. Environmental Epidemiology 2021, Gonzalez et al. Environmental Epidemiology 2021

Living Near Oil and Gas Wells Linked to Low Birth Weight in Infants

June 10, 2020 · 578 views · No tags · Health Trends , Maternal and Child Health
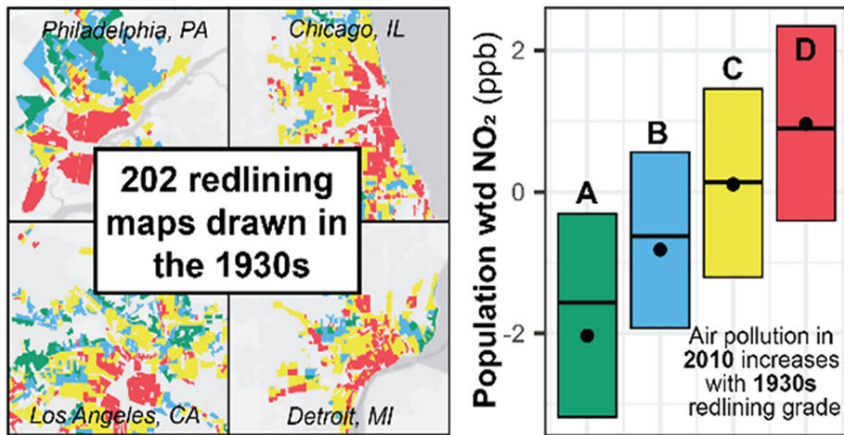

A recent study suggests that residing near oil and gas wells may put pregnant women at risk of having low birth weight babies.
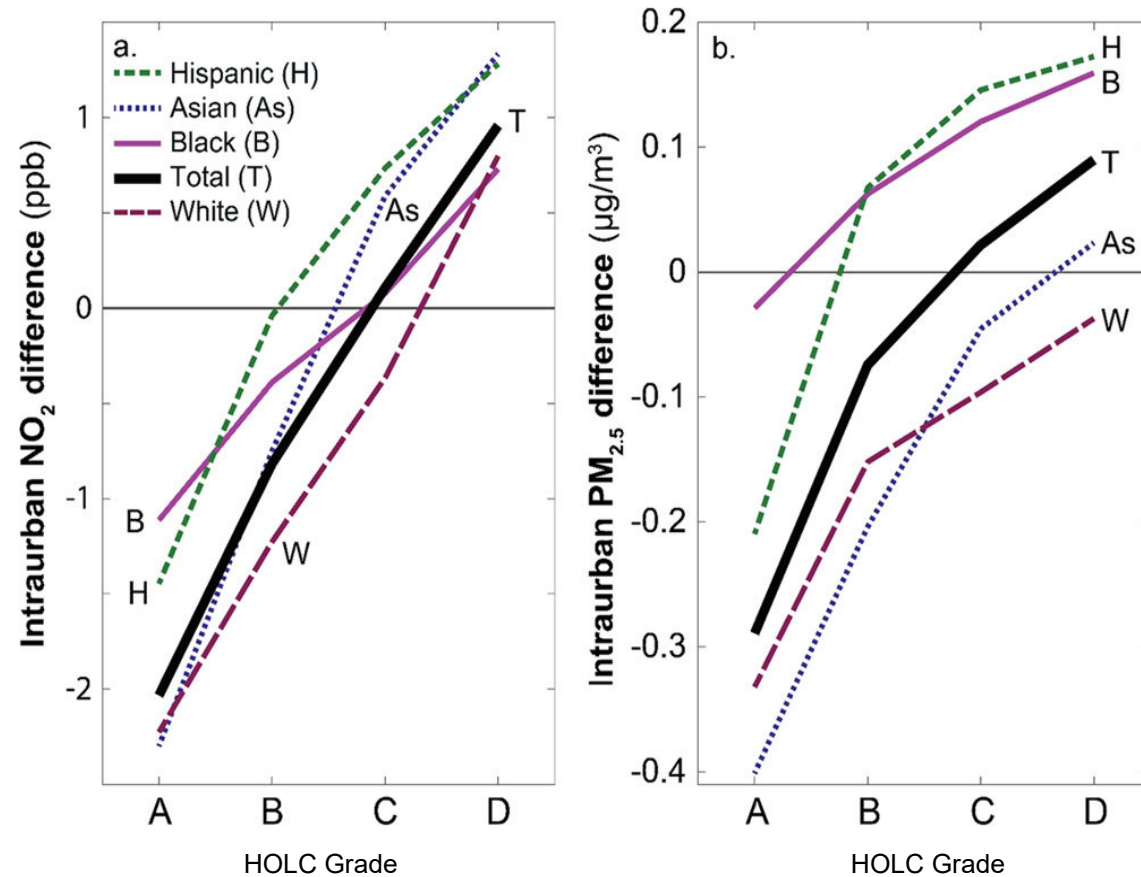
The researchers analyzed almost 3 million births to mothers living within 10 kilometers of at least one oil and gas well between 2006 and 2015. It included people in both rural and urban areas and people living close to active and inactive oil wells.

Historical redlining and air pollution


Population-weighted mean annual intraurban levels for (a) NO_2 and (b) $PM_{2.5}$ by HOLC grade and race/ethnicity

Modern air pollution disparities in historically redlined areas

Philadelphia, PA   Chicago, IL

202 redlining maps drawn in the 1930s

Los Angeles, CA   Detroit, MI

Population wtd NO_2 (ppb)

Air pollution in **2010** increases with **1930s** redlining grade

a.
- - - Hispanic (H)
······ Asian (As)
——— Black (B)
——— Total (T)
- - - White (W)

Intraurban NO_2 difference (ppb)

HOLC Grade

b.

Intraurban $PM_{2.5}$ difference (μg/m³)

HOLC Grade

Lane et al. *Environ. Sci. Technol. Lett.* 2022
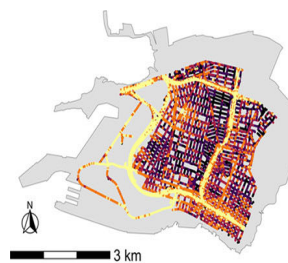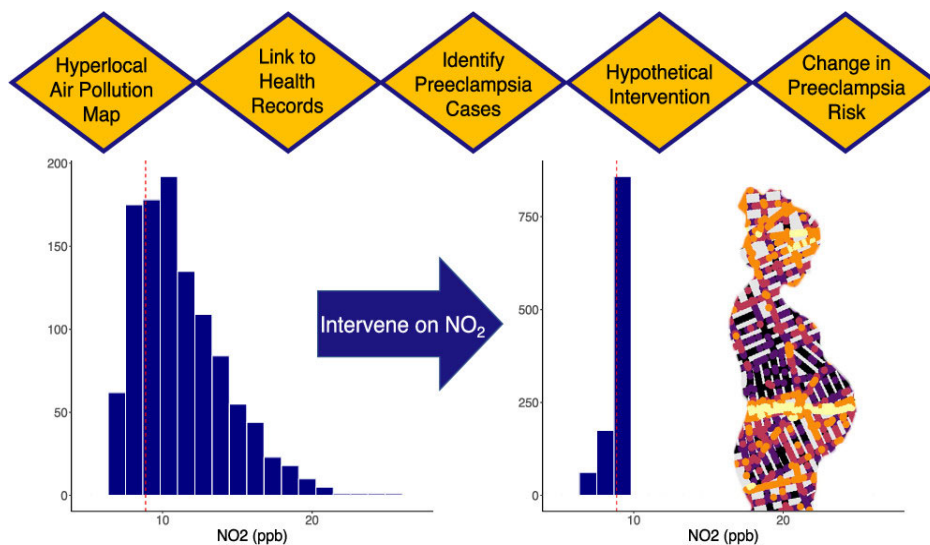
HOLC – Homeowner Loan Corporation

Difference in term birth weight (g) associated with full pregnancy particulate pollution exposures, stratified by maternal race/ethnicity (1996-2006)
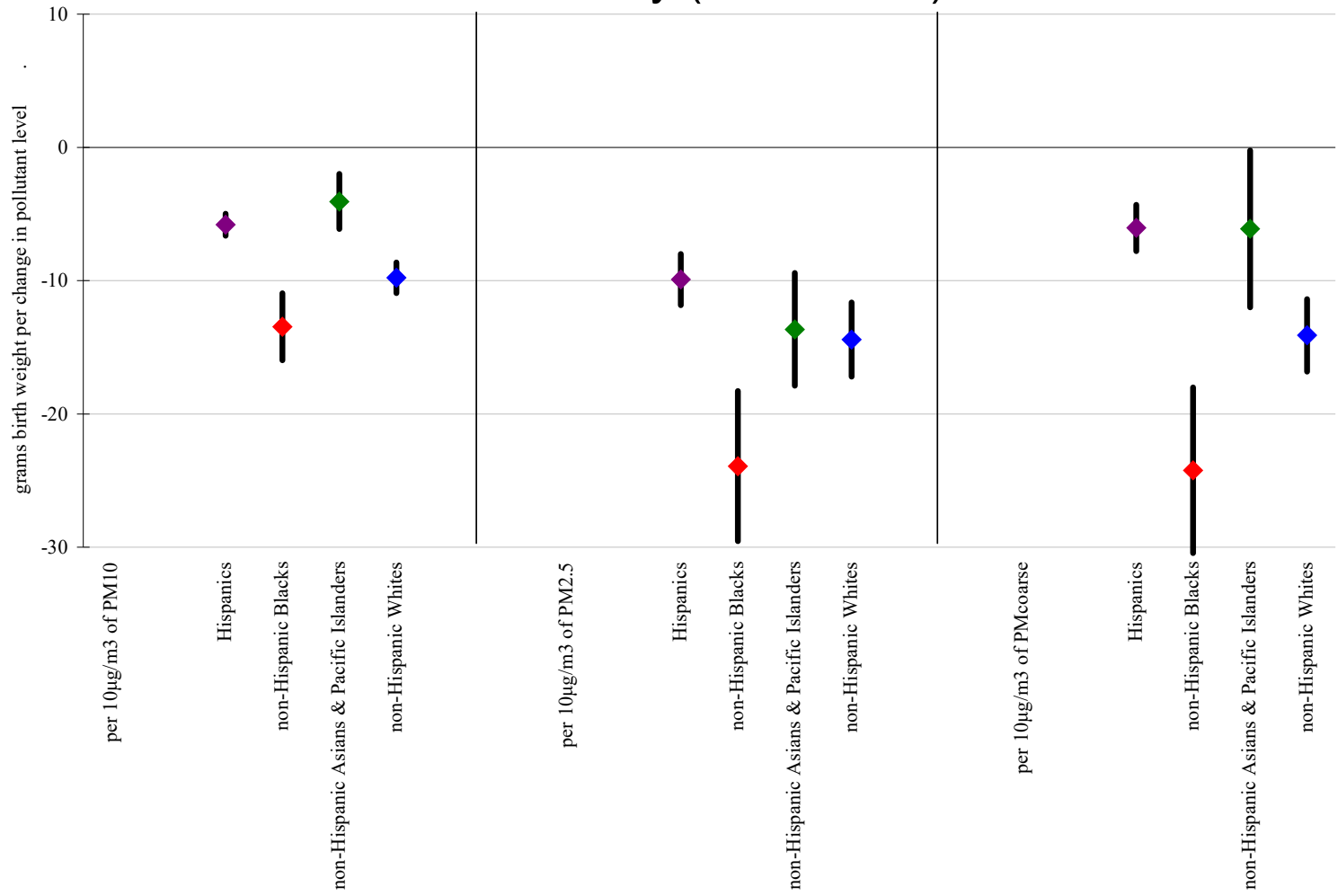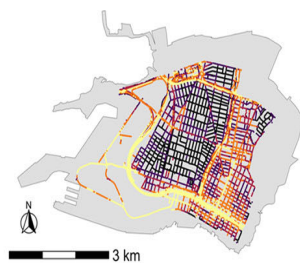
Morello-Frosch et al.
Environmental Health 2010

# Hyper-localized Measures of Air Pollution and Preeclampsia in Oakland, CA

Goin et al, ES&T, 2021

Goin et al, ES&T, 2021

Distribution of black carbon (BC), nitrogen dioxide (NO2), and ultrafine particles (UFPs) within Downtown and West Oakland, CA

Preeclampsia risk differences (95% CI) per 100 women associated with hypothetical intervention reducing pollutant levels to the 25th percentile versus observed levels by exposure characterization distance
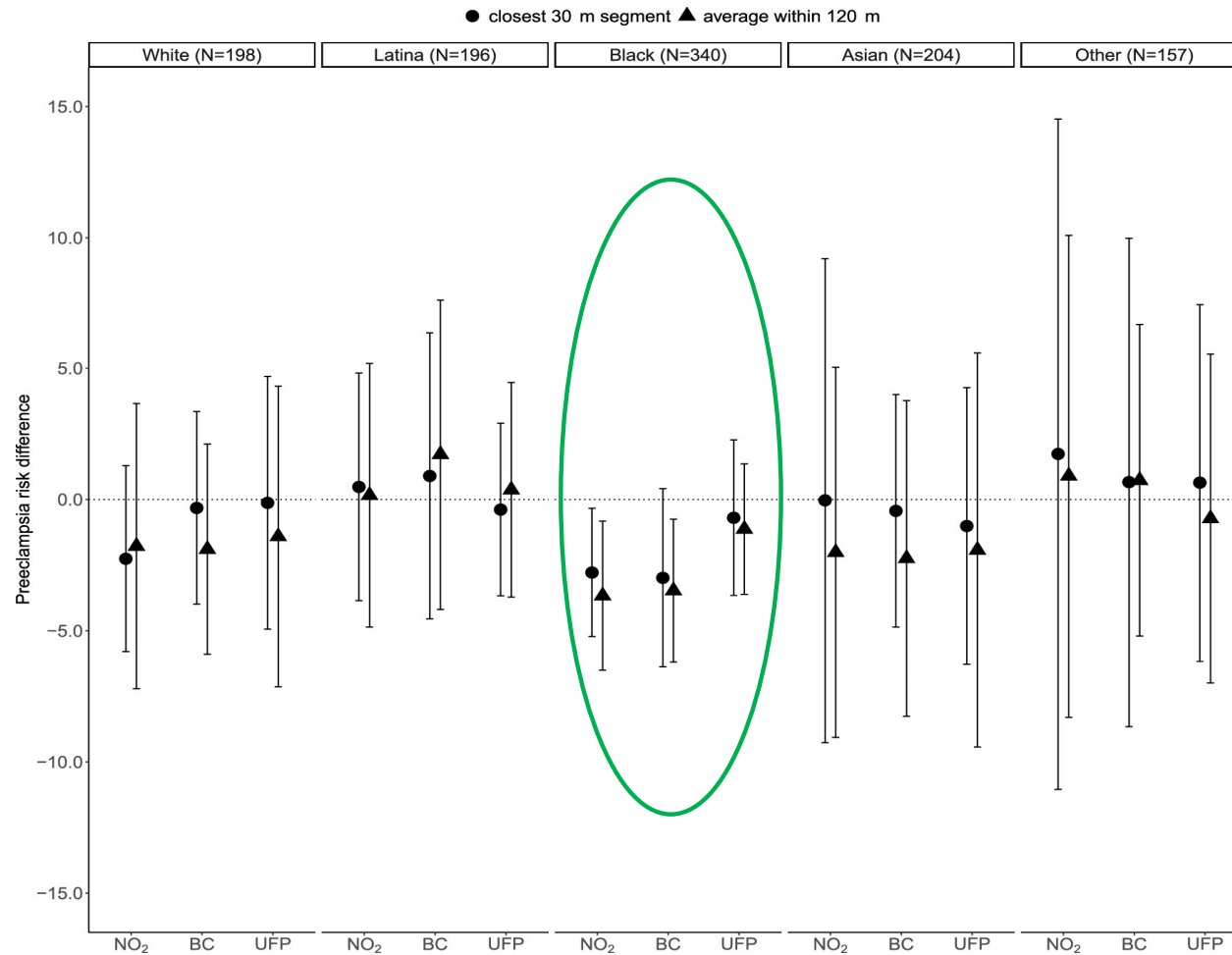
(Goin et al, ES&T, 2021)
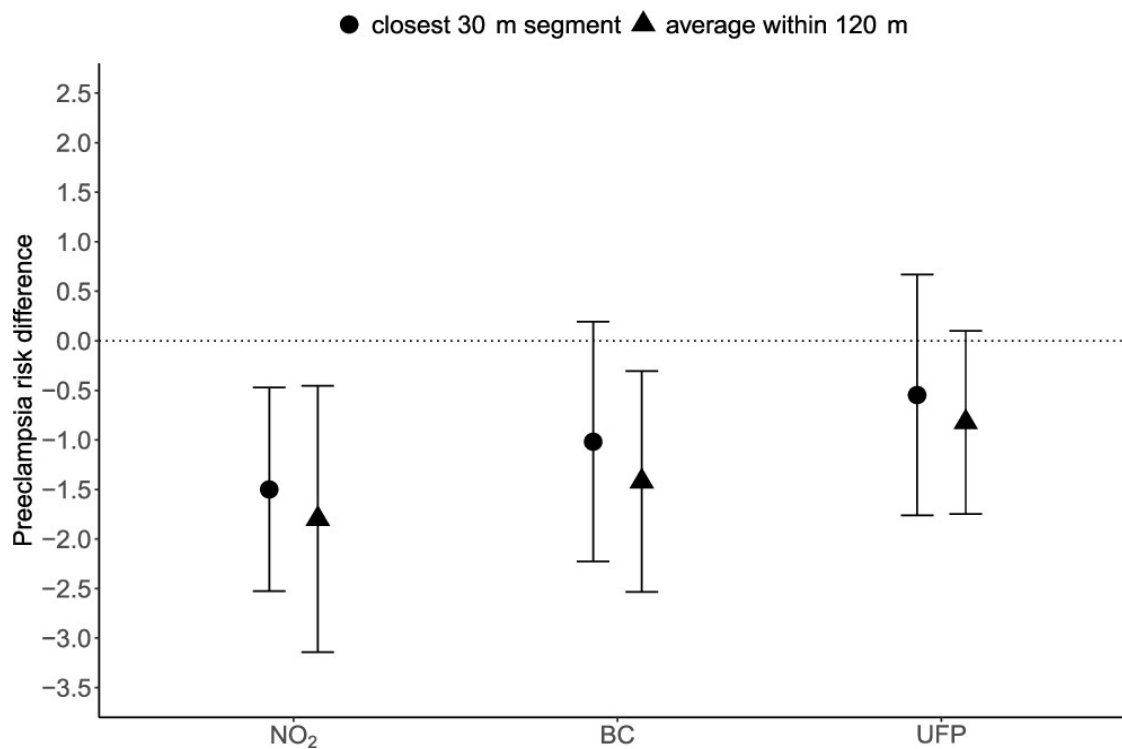
Goin et al, ES&T, 2021

- Estimates shown for each pollutant averaged within 120 m and within 30 m of maternal residence at delivery.
- The 25th percentile was 9.0 ppb for NO2, 0.27 µg/m3 for BC, and 26.6 # × 103/cm3 for UFPs.
- Adjusted for maternal race/ethnicity, insurance type, age at delivery, age squared, smoking history, parity, season of conception, proportion of census block with educational attainment less than high school, and proportion of census block living below the poverty line

Preeclampsia risk differences (95% CI) per 100 women associated with hypothetical intervention reducing pollutant levels to 25th percentile versus observed levels – stratified by race/ethnicity

Goin et al, ES&T, 2021

Implications for addressing cumulative impacts & advancing environmental justice

Underlying science takes awhile…

Communities can't wait until scientists sort it all out.

Community- and data-driven tools support action-oriented science to:

- Integrate place – level measures of environmental and social "stressogens"

- Highlight communities of regulatory concern

- Target regulatory strategies and resources that integrate public health, sustainability, and environmental justice goals

Thank You!

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Sustainability and Health Equity Lab:
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