



# From the cell to the street: Addressing structural determinants to advance the science of environmental justice

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 @rmfrosch

# Social Justice Movements (Re)Shape Research & Policy Priorities



Getty Images



Julia Rendleman/Reuters



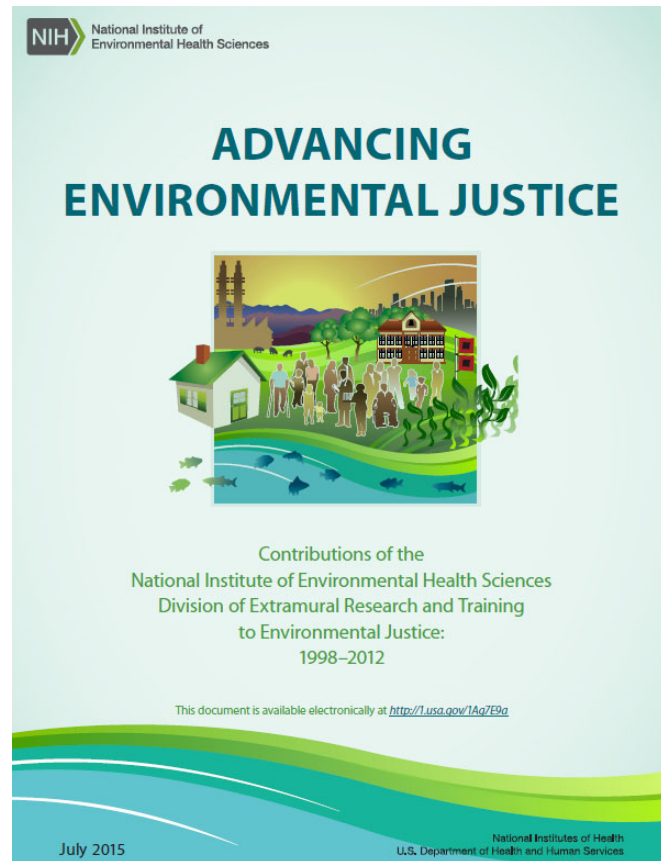
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Wanda Andrews Saunders (left) and Corshento Williams, Sept. 15, 1982.

Protesting Landfill Siting in Warren County NC

## Funding incentives for community-engaged research...

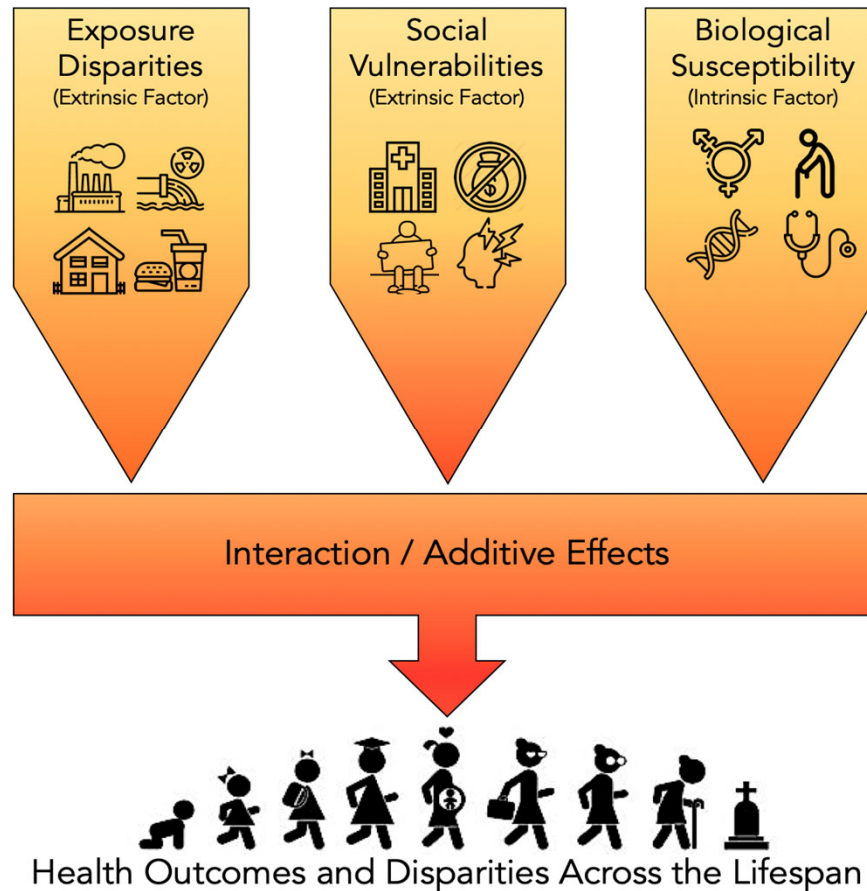


...change how scientists hypothesize and study environmental links to disease

# Triple Jeopardy and Environmental “Risescapes”

**Social Context:** Social inequality, segregation, discrimination

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



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

# In utero exposures to multiple toxic chemicals

- We know little about the extent of *in utero* exposures to multiple compounds and the degree to which chemicals are transferred from mother to fetus.



Woodruff et al. 2011

# ECHO/Chemicals in Our Bodies 2: Environmental Chemicals, Chronic Stress & Fetal Growth/Neurodevelopment in Offspring

## Prenatal Chemical Exposures

Per- Poly- fluorinated chemicals (PFASs) & PBDEs in maternal serum and phenols in urine

## Chronic Stress Exposures

- Maternal perceptions of chronic stressor exposures
- Neighborhood Stressors
- Biomarkers of stress response
  - Maternal Corticotrophin Releasing Hormone (CRH)
  - Telomeres in maternal and fetal cord blood leukocytes

## Fetal Growth and Developmental Outcomes

Association of chemical and stress exposures (and their potential interactions) and:

- effect biomarkers (telomeres and CRH)
- perinatal outcomes
- neurodevelopment (7-8 months/2 years/4 years)



**ECHO**  
Environmental influences  
on Child Health Outcomes

**UCSF**

University of California  
San Francisco



Program on Reproductive  
Health and the Environment



**School of  
Public Health**

UNIVERSITY OF CALIFORNIA, BERKELEY

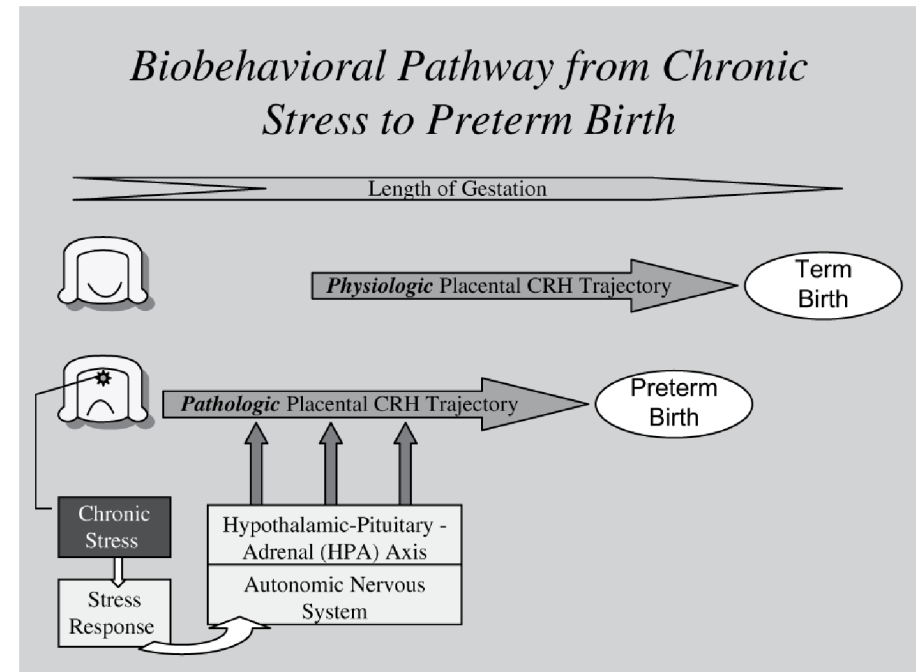


**Beckman Institute**

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Is elevated corticotropin releasing hormone (CRH) a physiologic response to chemical and non-chemical stressors?

- Stress activates HPA axis, increasing cortisol production and CRH
- Excess CRH → preterm birth
- CRH elevated in response to certain endocrine disrupting chemicals (phenols, phthalates, parabens)



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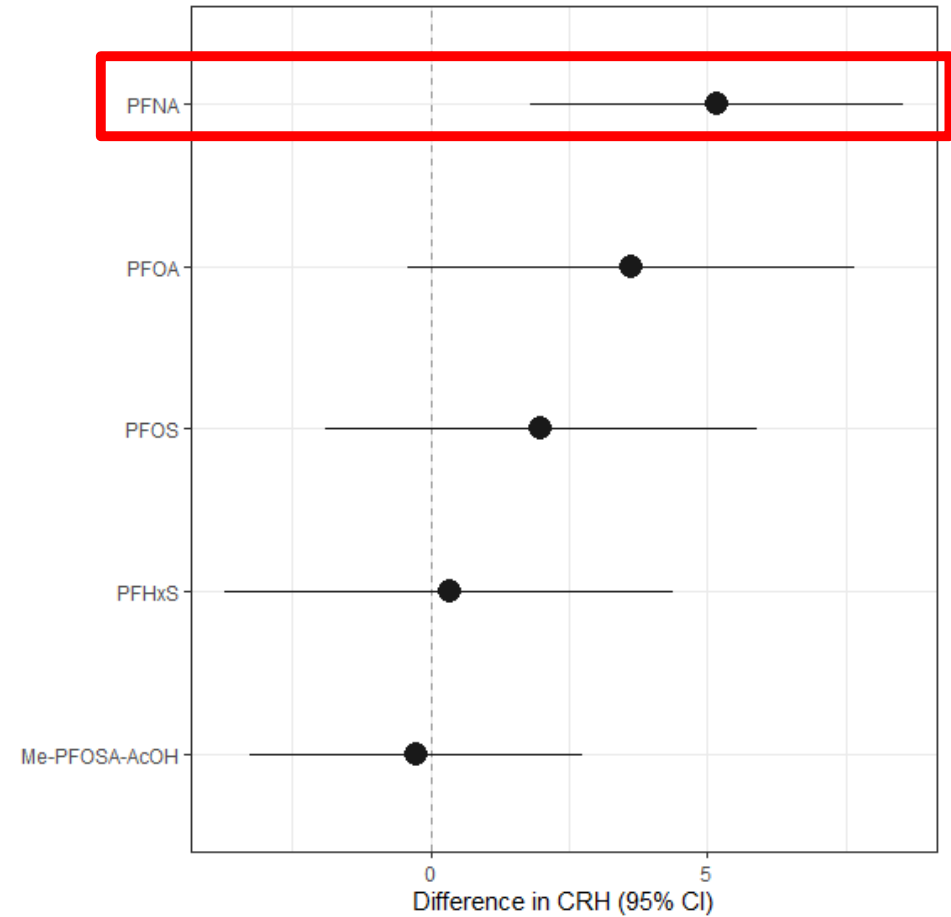
Slide courtesy of S. Eick

## Prenatal exposure to some PFAS associated with higher CRH

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dwyvlw/p dwhugdodjh/  
udfhzhwkqflw|/hgxfdwlrq/dgg sdulw|

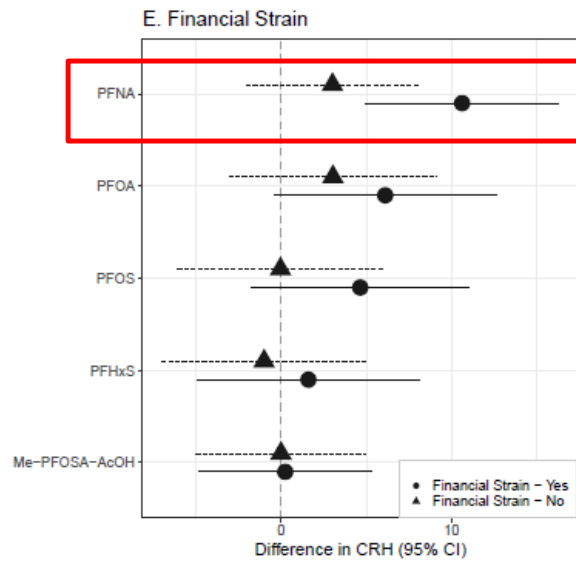
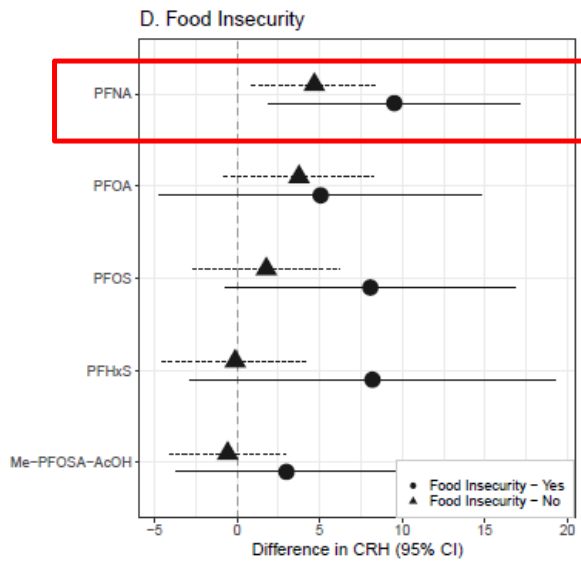
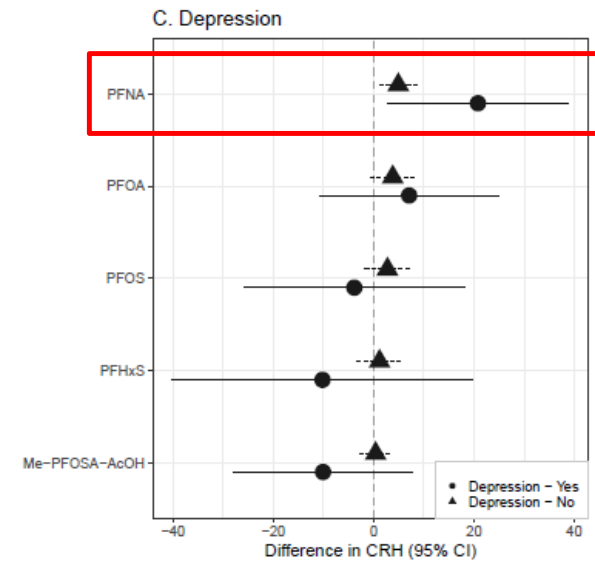
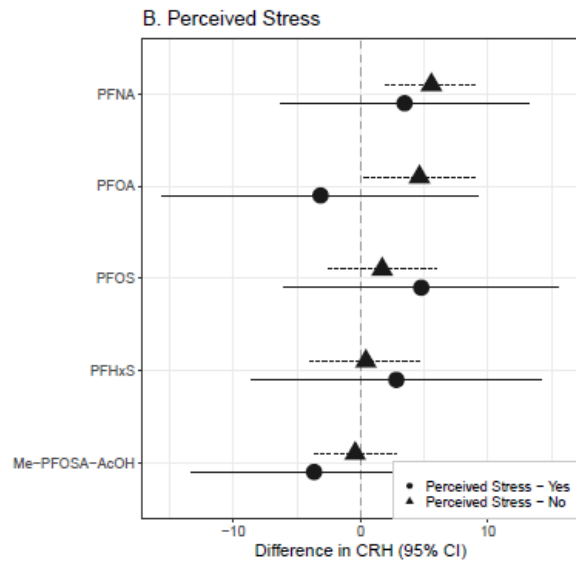
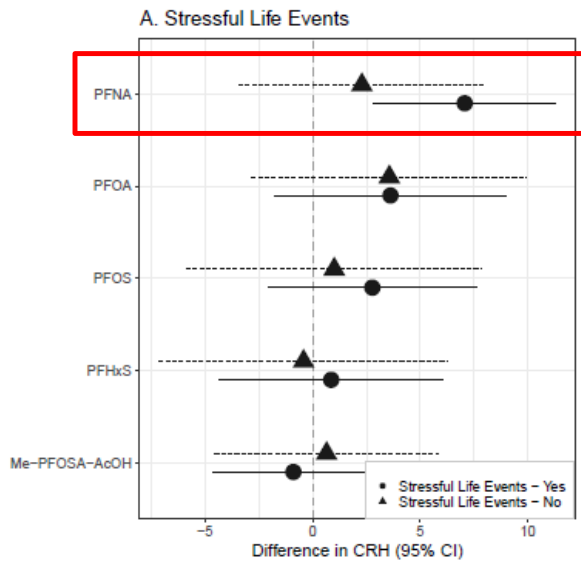
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Environmental Epidemiology.





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# Stressogens and depression during pregnancy

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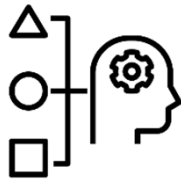
Increasing rates of perinatal mood and anxiety disorders

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Long-term health and economic impacts

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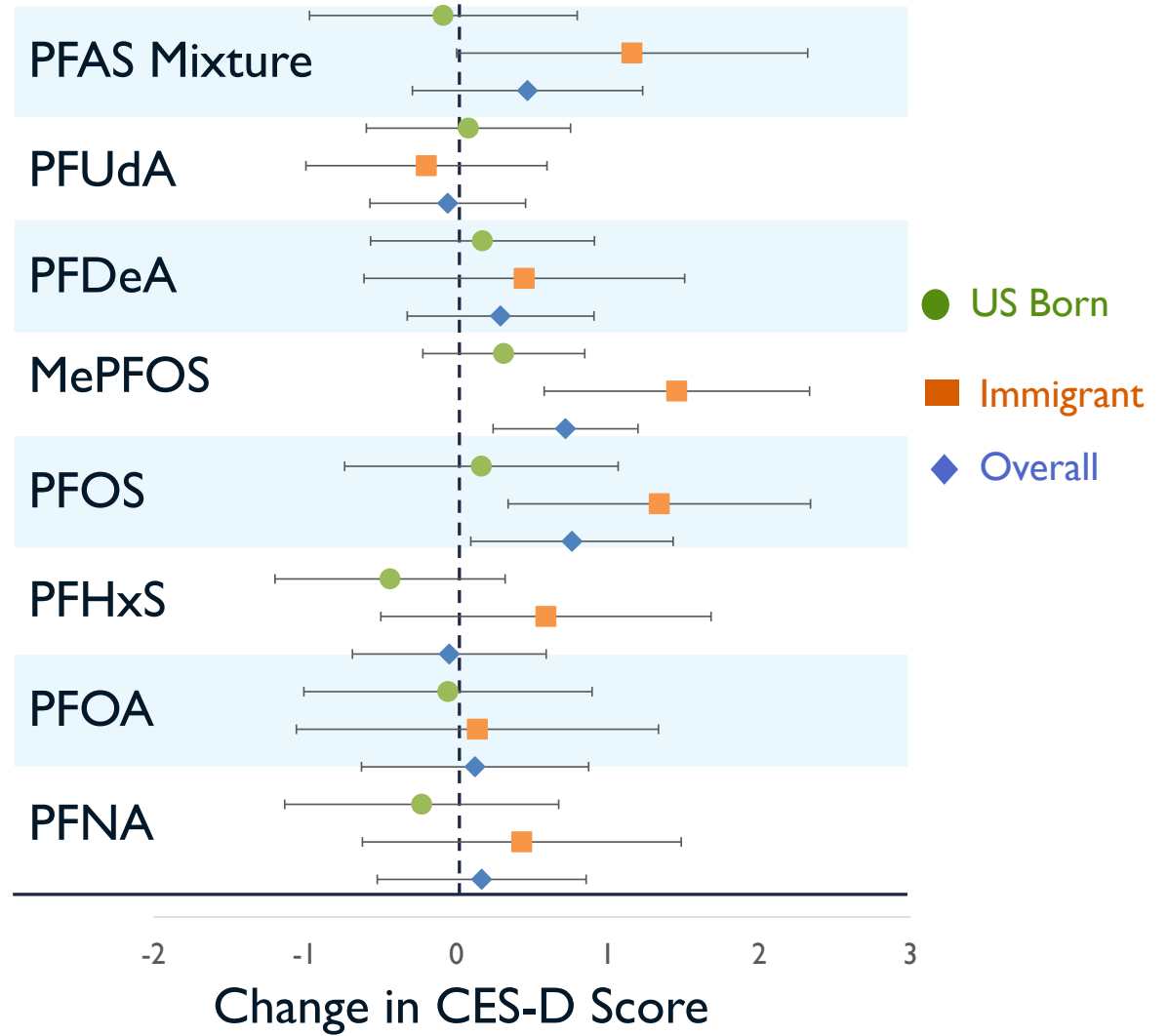


Multiple environmental and social factor influences

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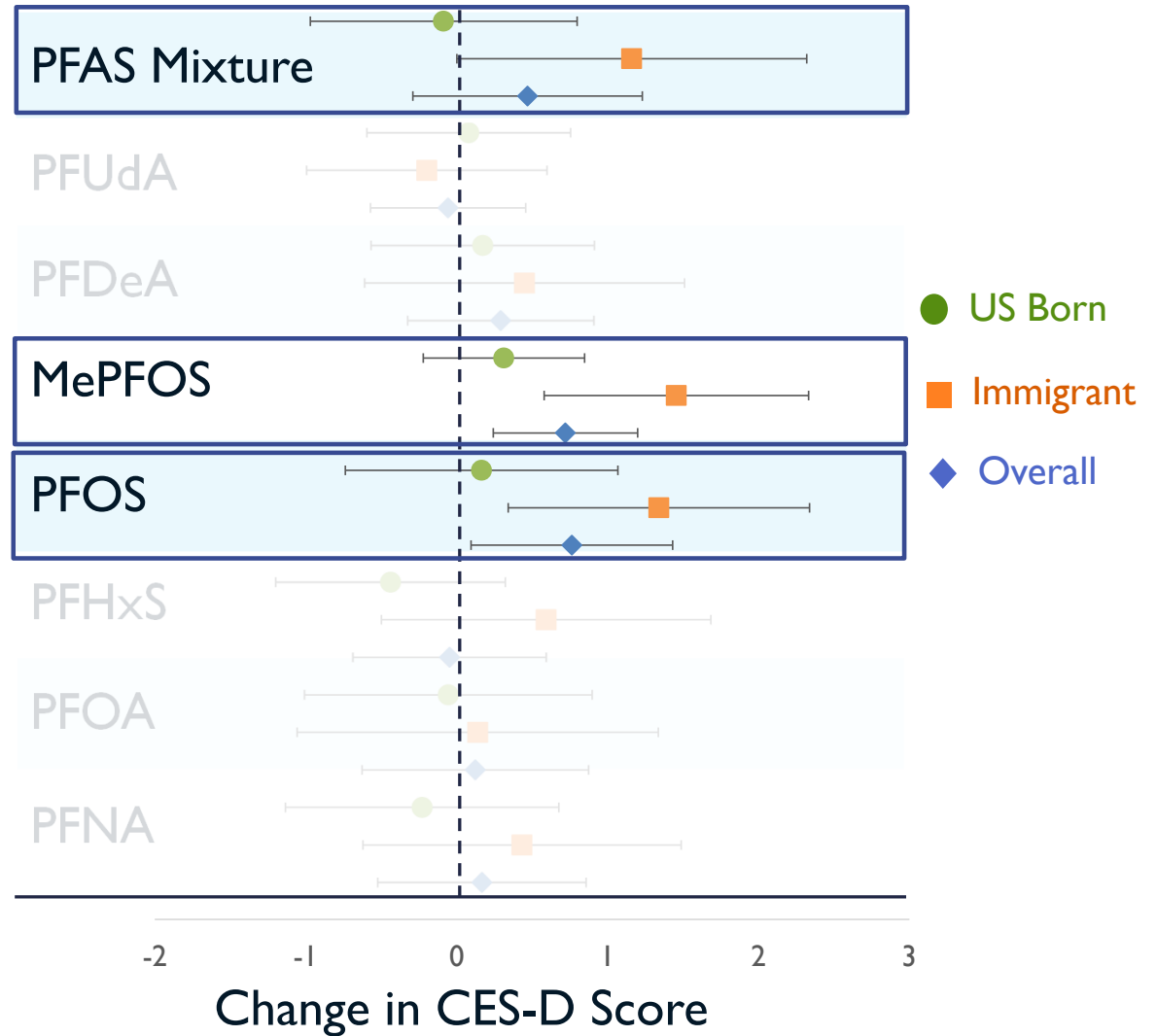


# Research Findings



Aung et al. 2023

# Research Findings



Aung et al. 2023

# Environmental (in)justice

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

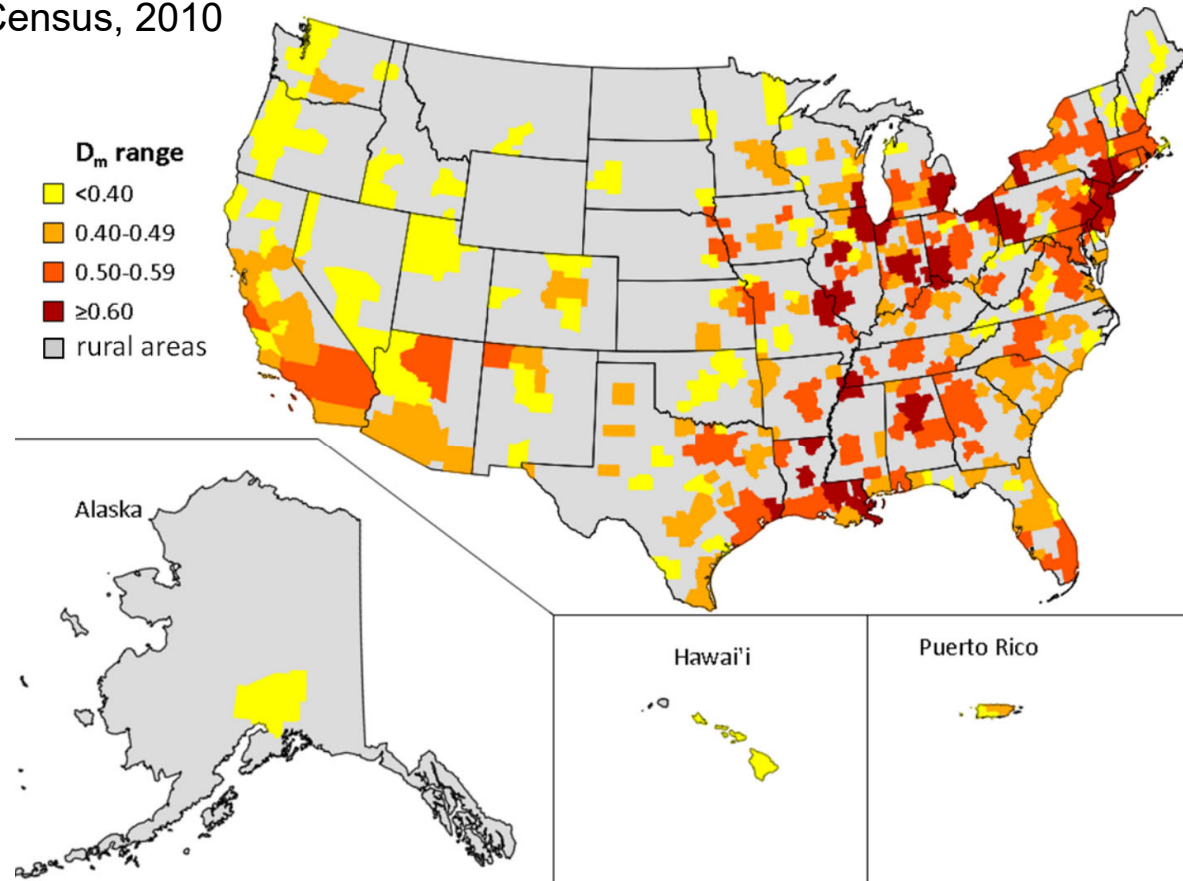
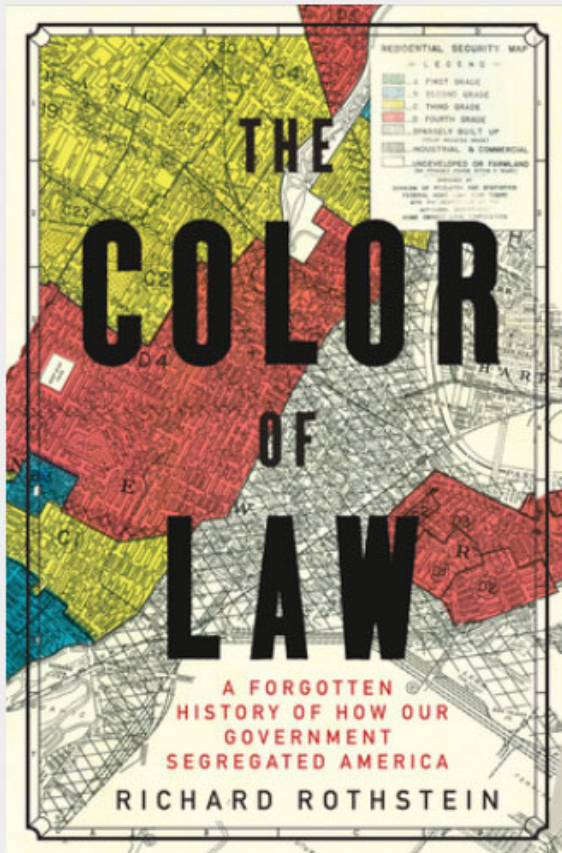
- Live near a hazardous waste treatment and disposal facilities
- Live near coal fired power plants
- Live near concentrated animal feeding operations
- Live in chemical disaster vulnerability zones
- Live in areas out of attainment with the Clean Air Act
- Experience increased cancer risks from air 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 ( $D_m$ ) by Metropolitan Area in the United States

US Census, 2010



# 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

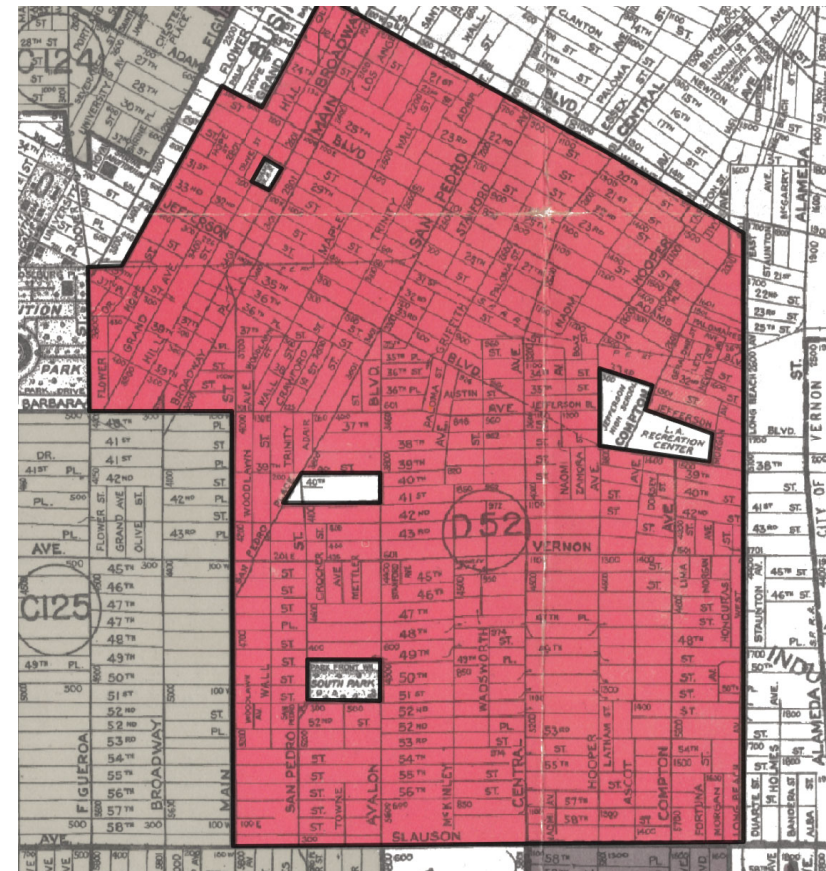
c. Foreign Families 40 % Nationalities Mexicans, Japanese and low class d. Negro 50 %  
Italians

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.

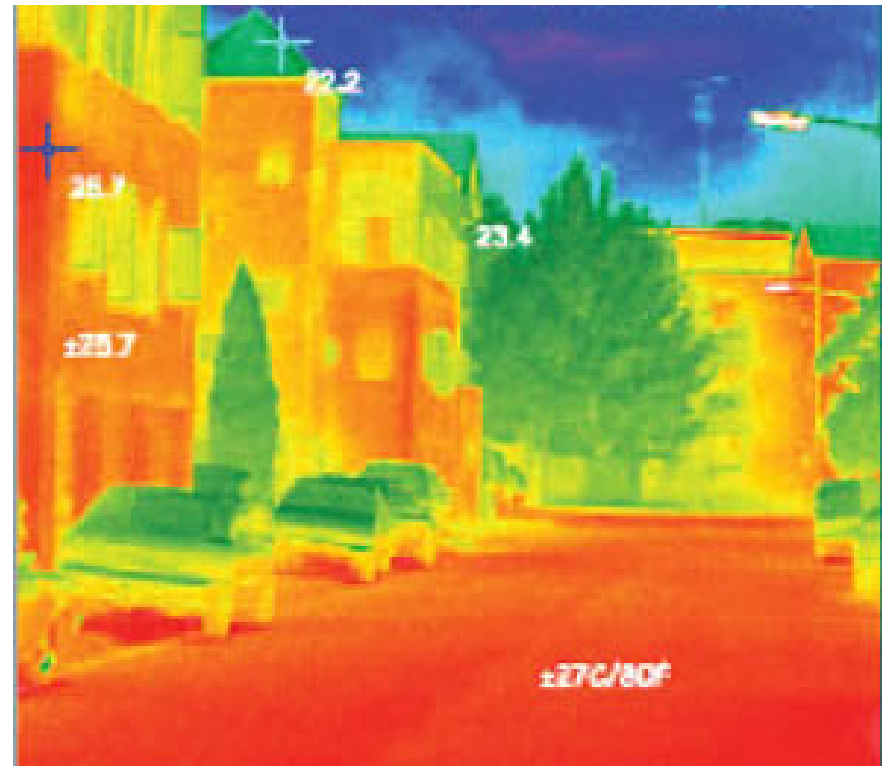
The area is accorded a "low red" grade.



Source: Mapping Inequality: Redlining in New Deal America

## The Color Line Reflected in Green

Green space and heat island risks are not distributed evenly across urban areas.

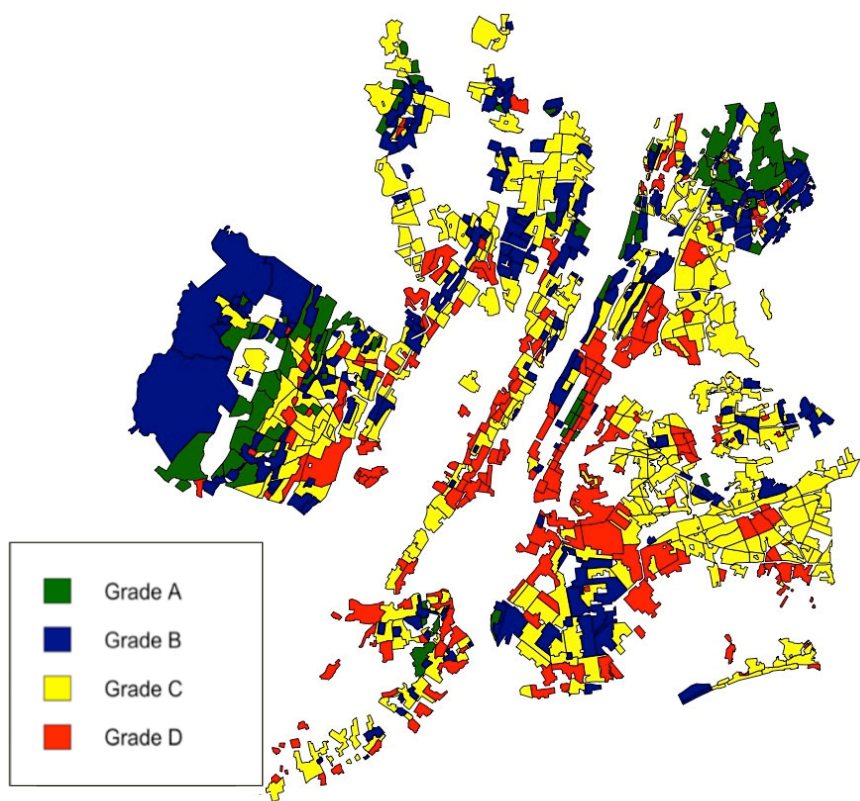




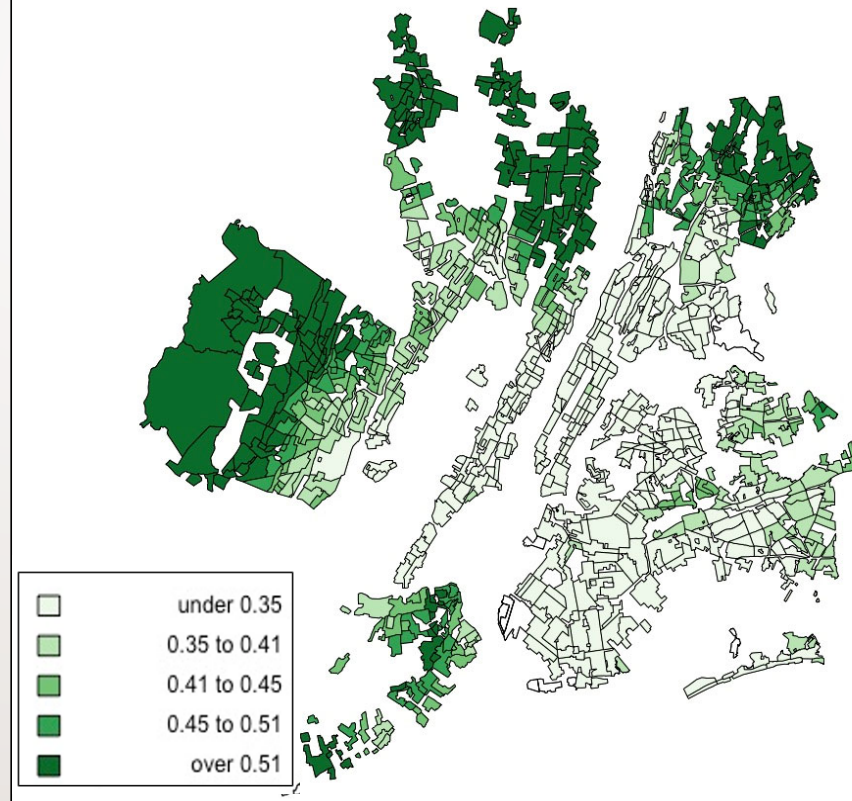
# Redlined neighborhoods have less greenspace

## Example-- New York City

Homeowner Loan Corporation (HOLC) grades



2010 greenspace quintiles



Nardone A, Rudolph KA, Morello-Frosch R, Casey JA (2021) Redlines and Greenspace: The Relationship between Historical Redlining and 2010 Greenspace across the United States. *Environmental Health Perspectives*. 129(1)

# The climate gap: extreme heat & preterm birth

- People of color are more likely to live in “high heat-risk” neighborhoods with **less trees** and **more impervious surfaces**, especially in more **segregated metropolitan** areas

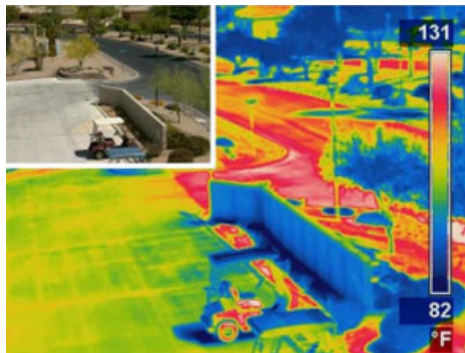


Image: ASU's National Center of Excellence on SMART Innovations

- Extreme heat is associated with increased risk of preterm birth, particularly in **early pregnancy** and in neighborhoods with the greatest concentration of **racialized poverty**



**ehp** Environmental Health Perspectives

The Racial/Ethnic Distribution of Heat Risk-Related Land Cover in Relation to Residential Segregation

Bill M. Jesdale  Rachel Morello-Frosch, and Lara Cushing

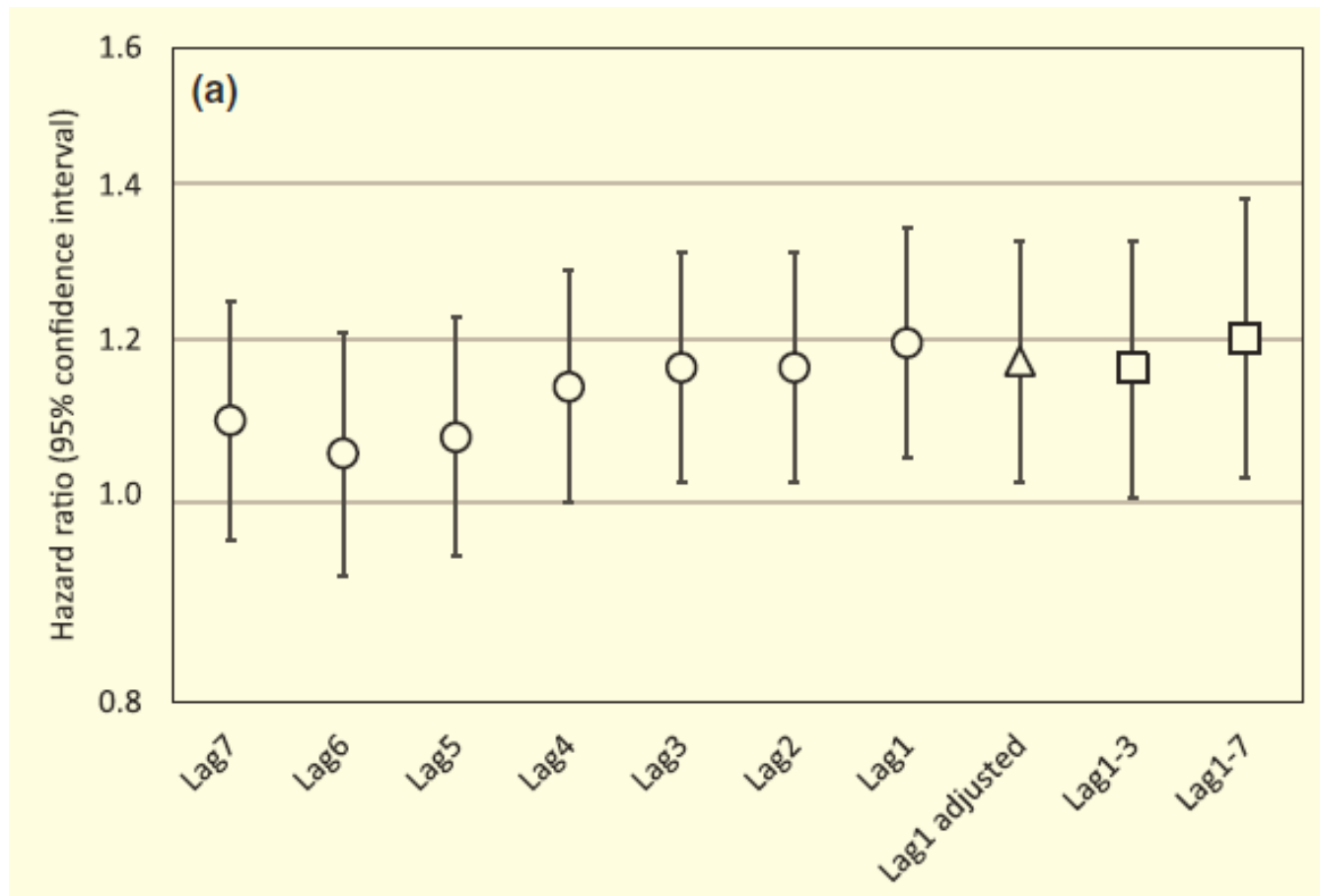
SPECIAL ISSUE ARTICLE

Paediatric and  
Perinatal Epidemiology

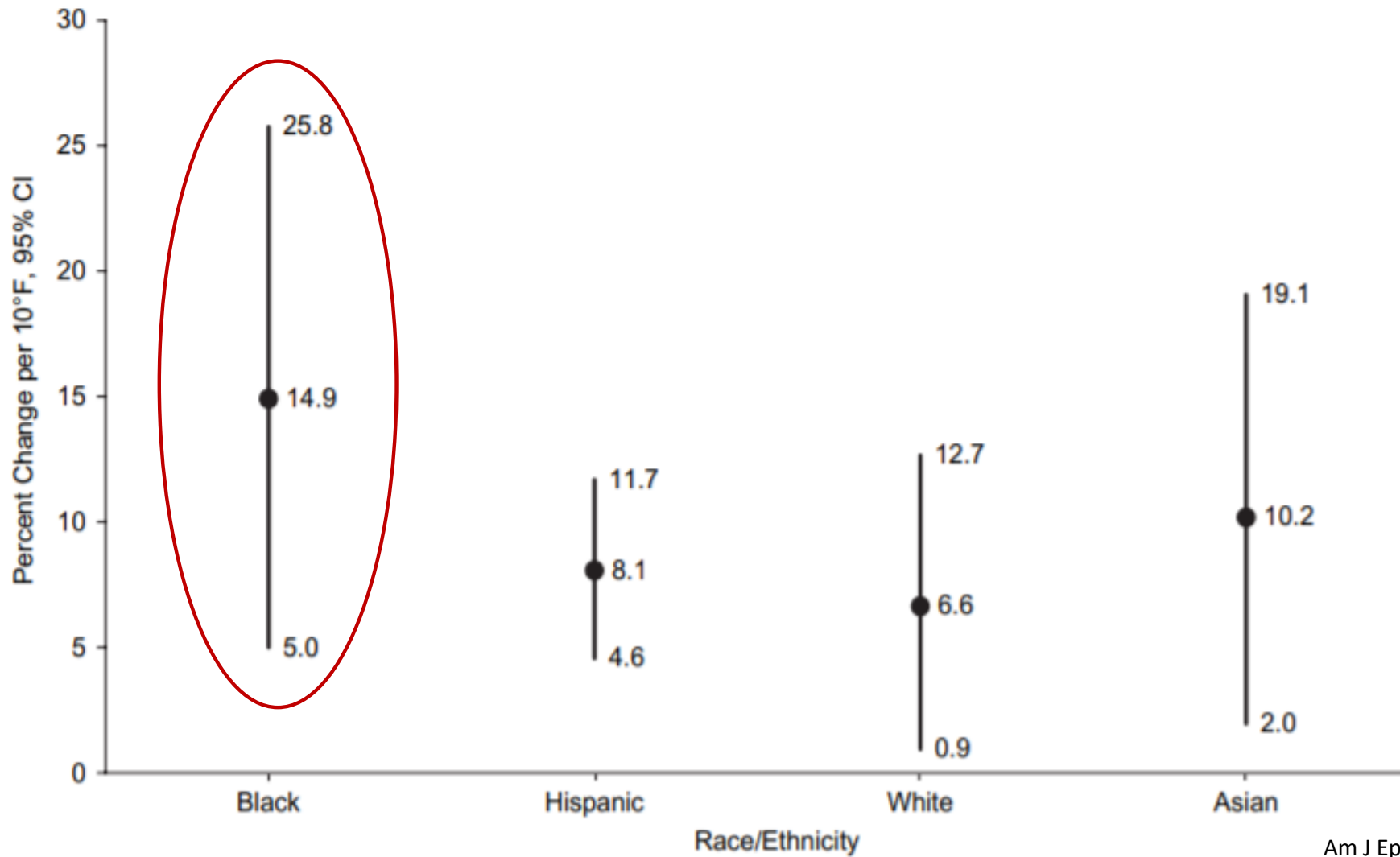
Extreme heat and its association with social disparities in the risk of spontaneous preterm birth

Lara Cushing<sup>1</sup>  | Rachel Morello-Frosch<sup>2,3</sup> | Alan Hubbard<sup>3</sup>

Heat waves associated with 10-20% increased risk of pre-term birth following unusually hot days defined as Maximum Apparent Temperature  $\geq 40^{\circ}\text{C}$  (compared to  $< 20^{\circ}\text{C}$ )

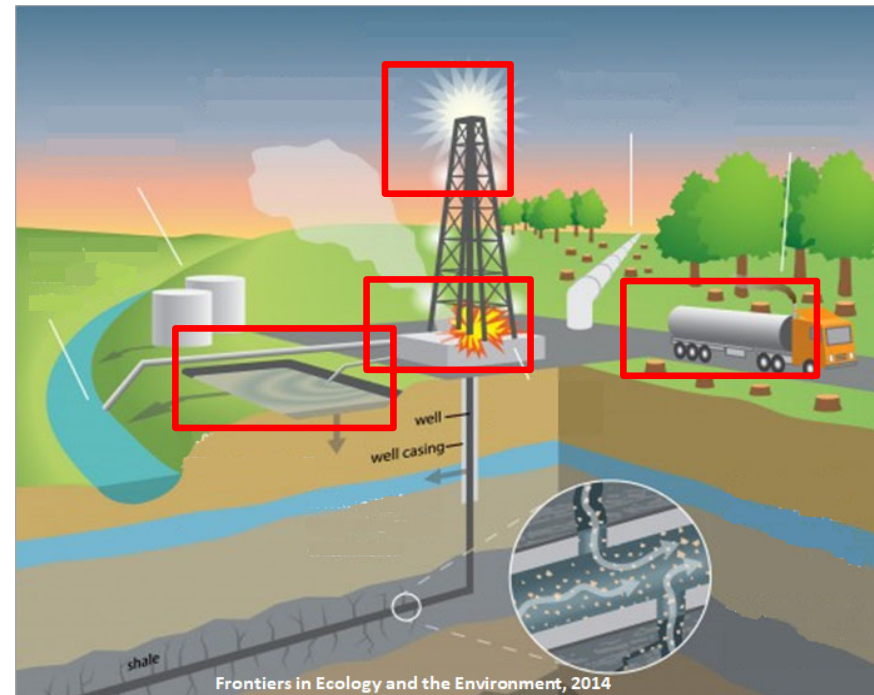


Cushing LJ, Hubbard A, Morello-Frosch R, (2022) *Paediatric and Perinatal Epidemiology*. 36:13–22.

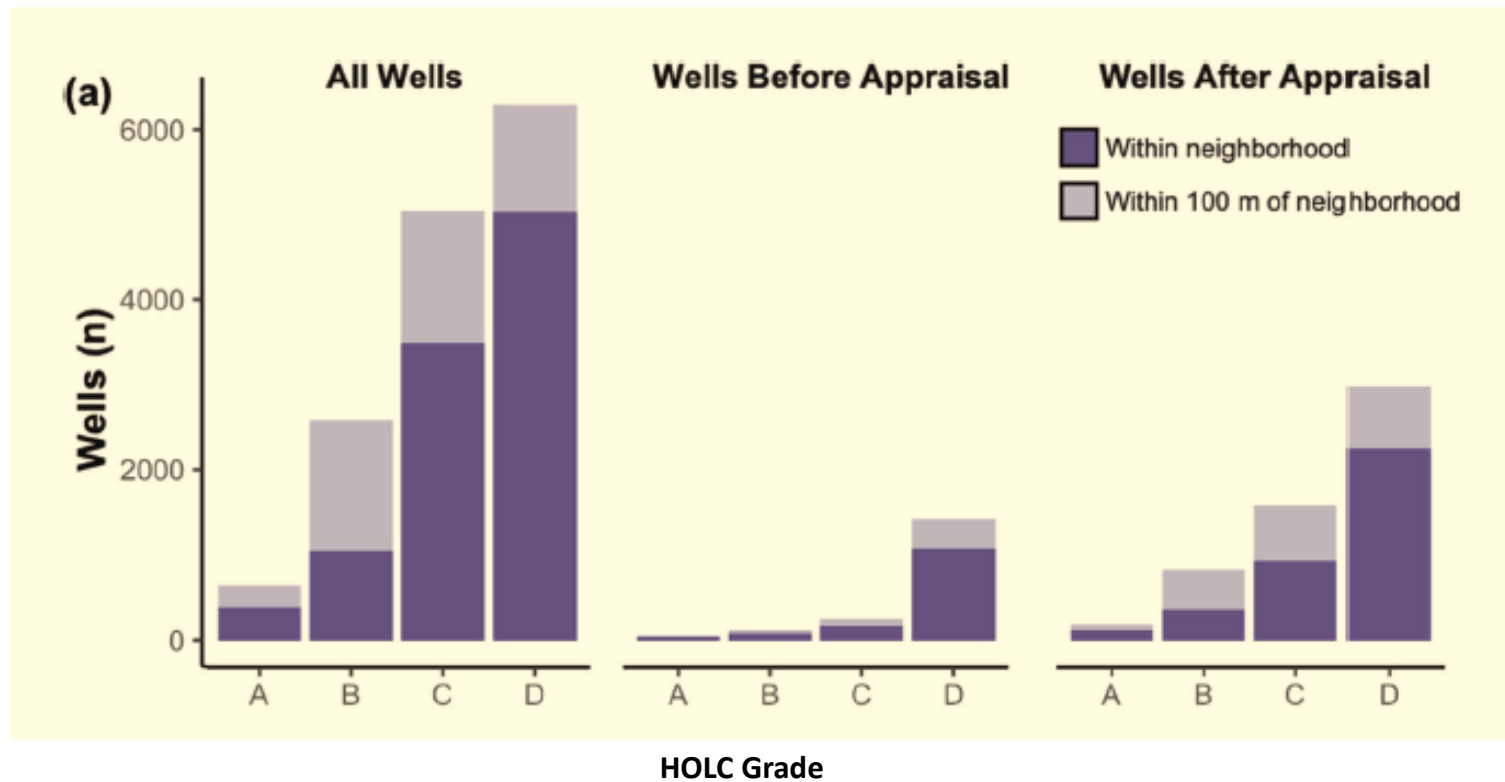


# Oil and Gas Development: Health Hazards

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



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



Gonzalez et al 2022 Journal of Exposure Science & Environmental Epidemiology;  
<https://doi.org/10.1038/s41370-022-00434-9>

## 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 are even stronger for pregnant people living near fracked wells
- Effects shown to be stronger among Latinx pregnant people (preterm birth)

### 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

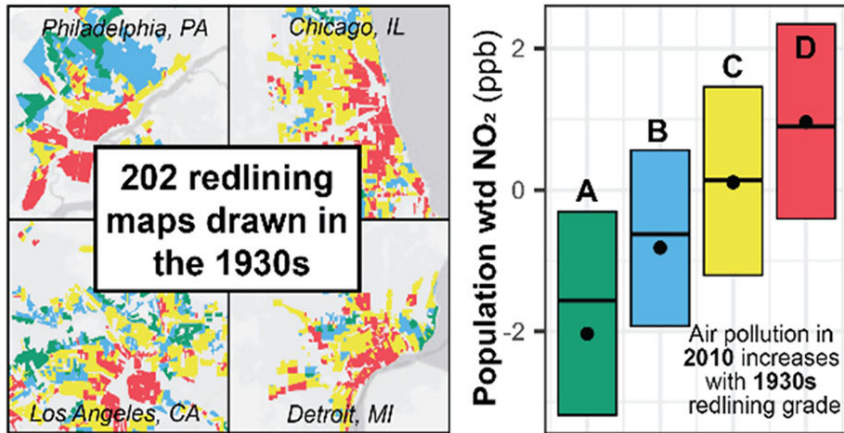


A recent study suggests that residing near oil and gas wells may put pregnant women at risk of having low birth weight babies.

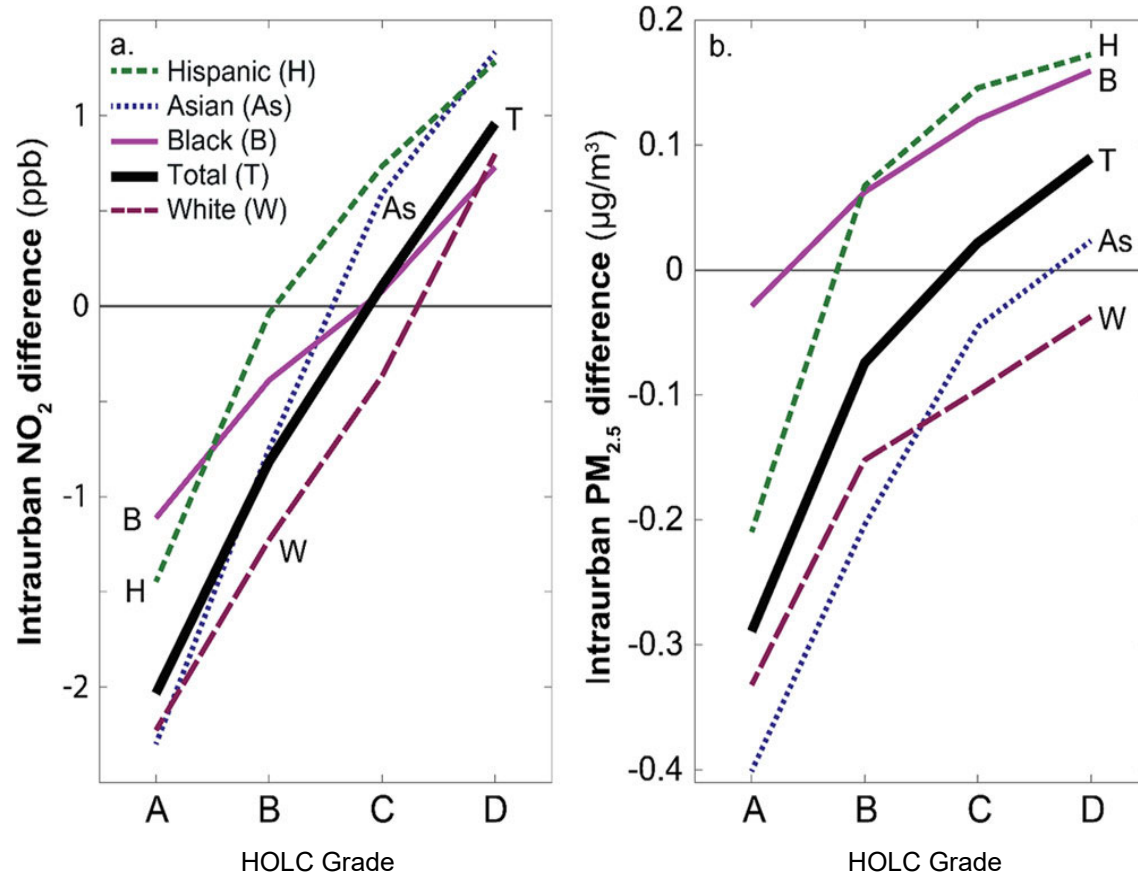
The researchers analyzed almost 3 million births to mothers living within 10 kilometers of at least one oil and gas well between 2006 and 2015. It included people in both rural and urban areas and people living close to active and inactive oil wells.

# Historical redlining and air pollution

Modern air pollution disparities in historically redlined areas



Population-weighted mean annual intraurban levels for (a) NO<sub>2</sub> and (b) PM<sub>2.5</sub> by HOLC grade and race/ethnicity

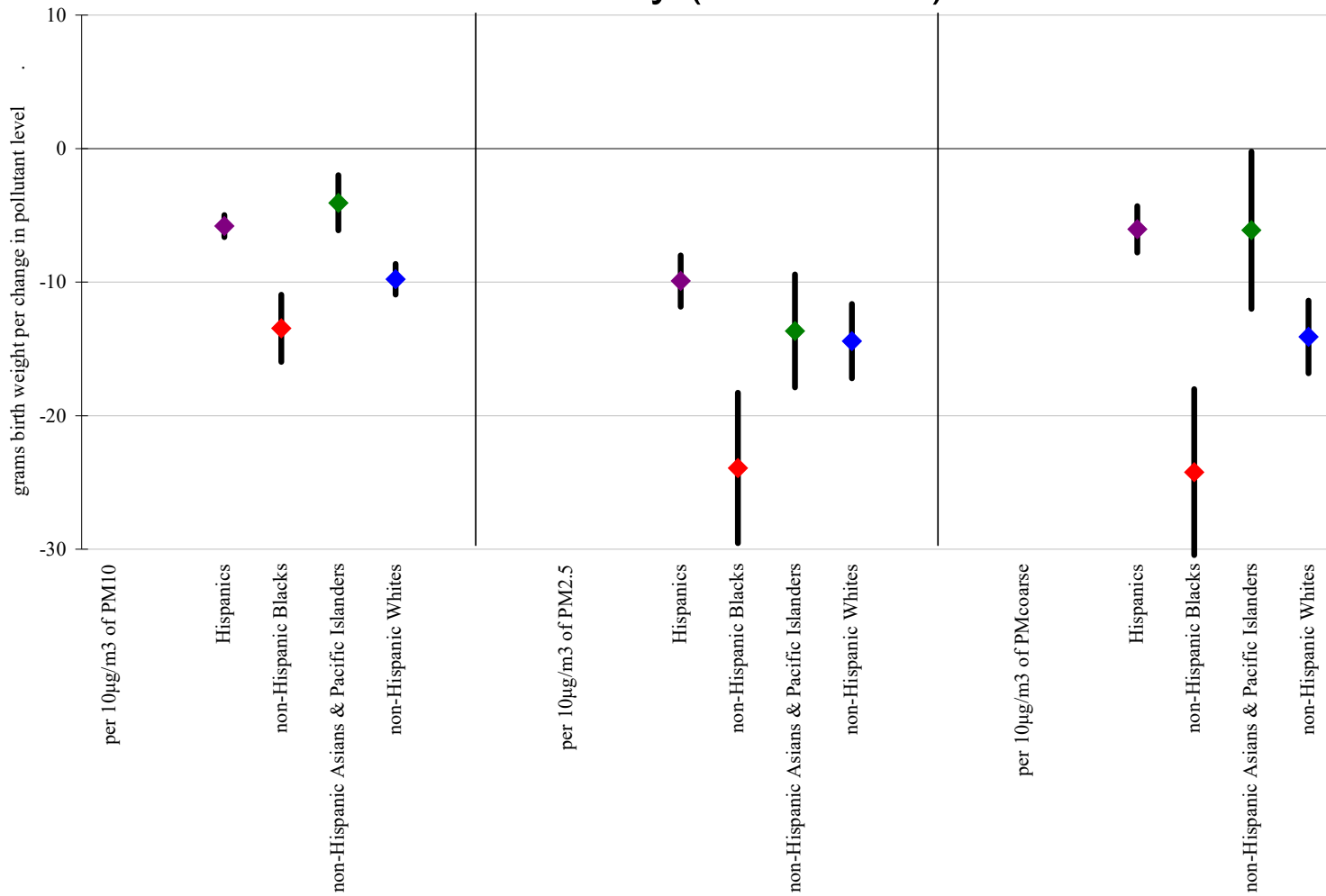


Lane et al. *Environ. Sci. Technol. Lett.* 2022

HOLC – Homeowner Loan Corporation

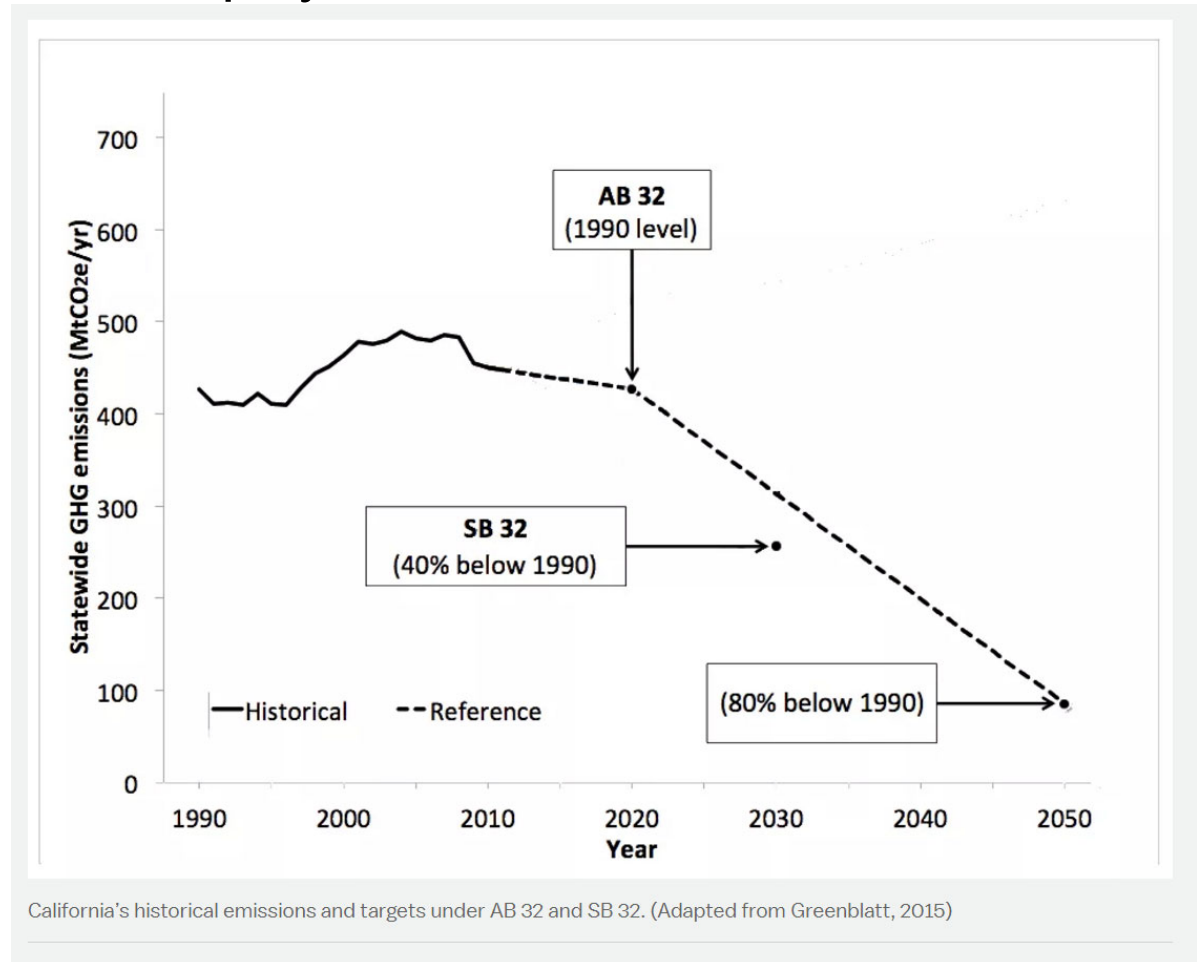


# Difference in birth weight (g) associated with full pregnancy particulate pollution exposures, stratified by maternal race/ethnicity (1996-2006)



Morello-Frosch et al.  
*Environmental Health* 2010

# AB 32 & SB 32 – California’s Global Warming Solutions Act: Health and Equity Benefits?

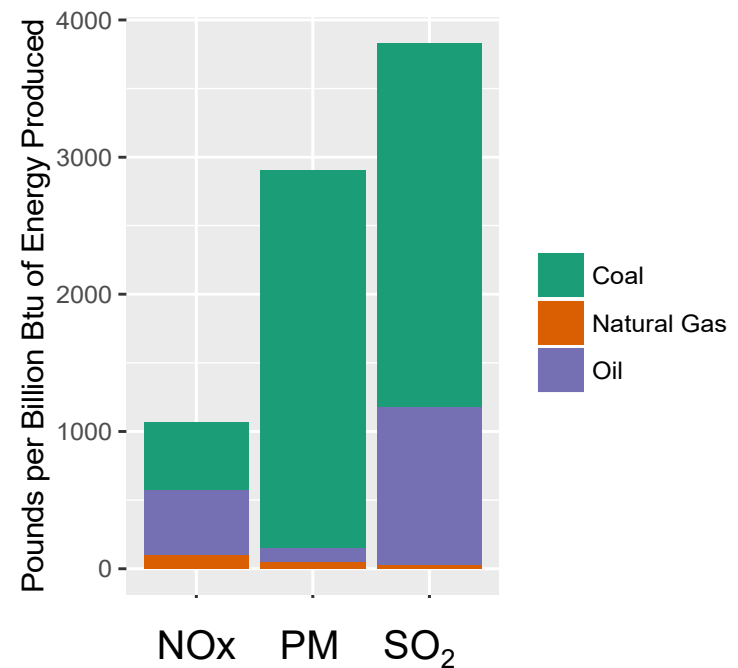


## Co-benefits of addressing climate change: power plants

- In addition to GHGs, power plants emit particulate matter (PM), NOx, SO<sub>2</sub>, benzene, mercury, lead, and other pollutants
- >10,000 deaths annually in the U.S. attributable to power plant emissions

Source: American Lung Association. Toxic Air: The Case for Cleaning Up Coal-fired Power Plants. 2011.

Pollutants/billion Btu energy produced

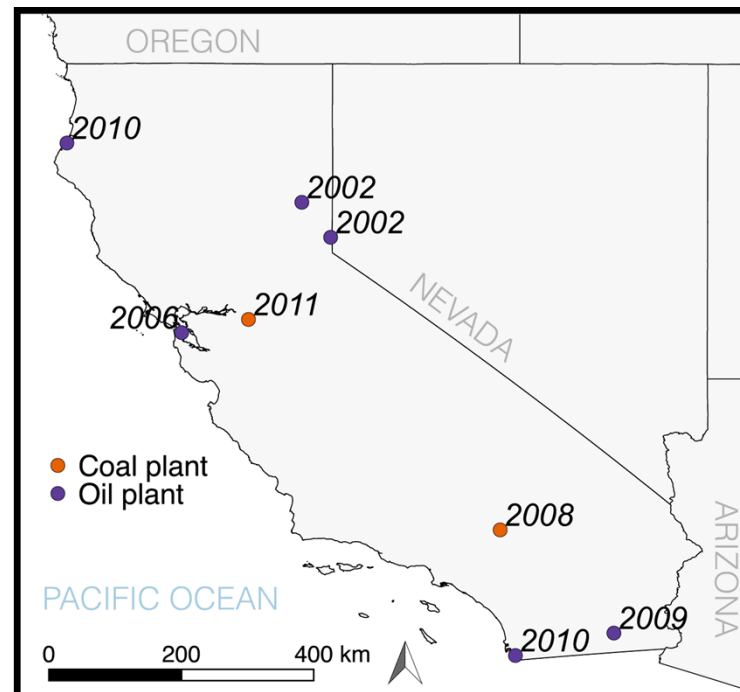


# Leveraging a “natural experiment” to assess short-term health benefits of power plant closures

CALIFORNIA: 8 OIL AND COAL RETIREMENTS (2001-2011)



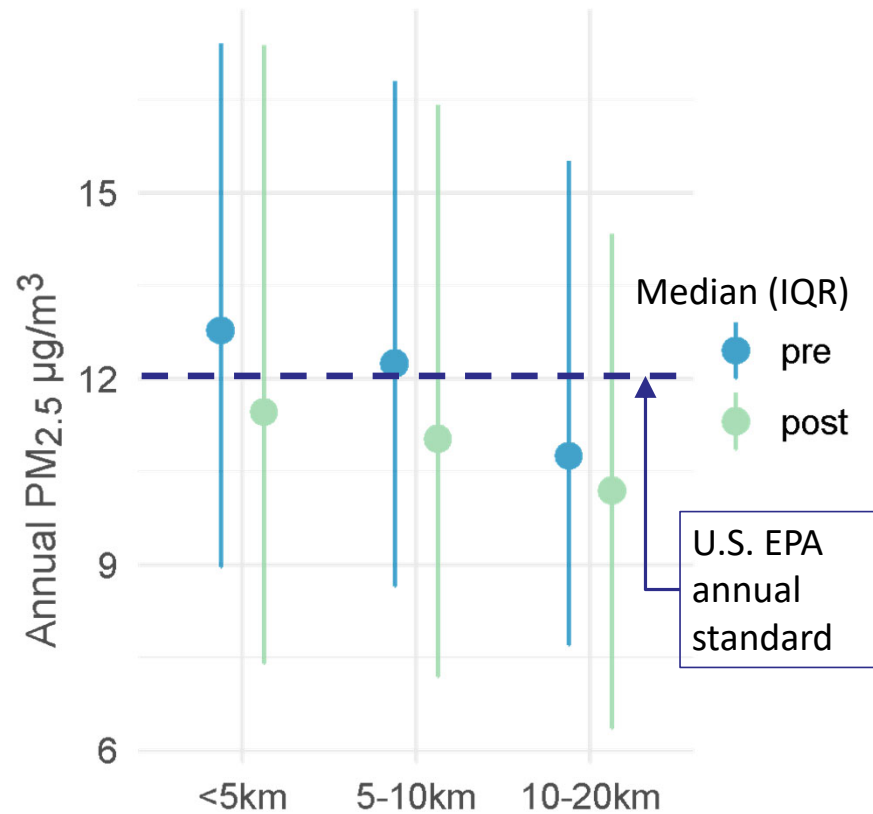
Hunters Point, San Francisco Retired: 2006



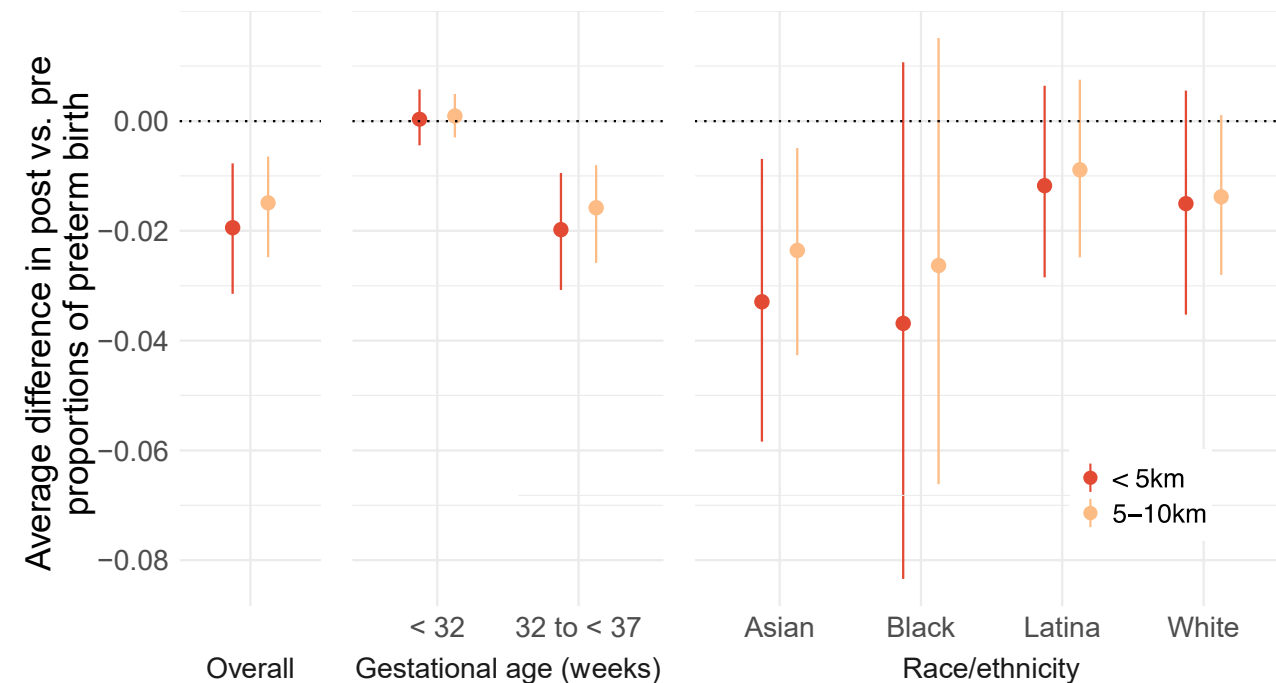
# Pollution Levels Declined in the Wake of Plant Closures

CHANGE IN  
MEDIAN  $PM_{2.5}$   
CONCENTRATIONS  
PRE/POST PLANT  
RETIREMENT

Data at the census tract level  
 $PM_{2.5}$  estimates from USEPA  
Community Multiscale Air Quality



# California power plant closures associated with 2% reduction in preterm birth rates - adjusted results



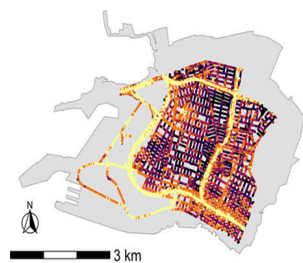
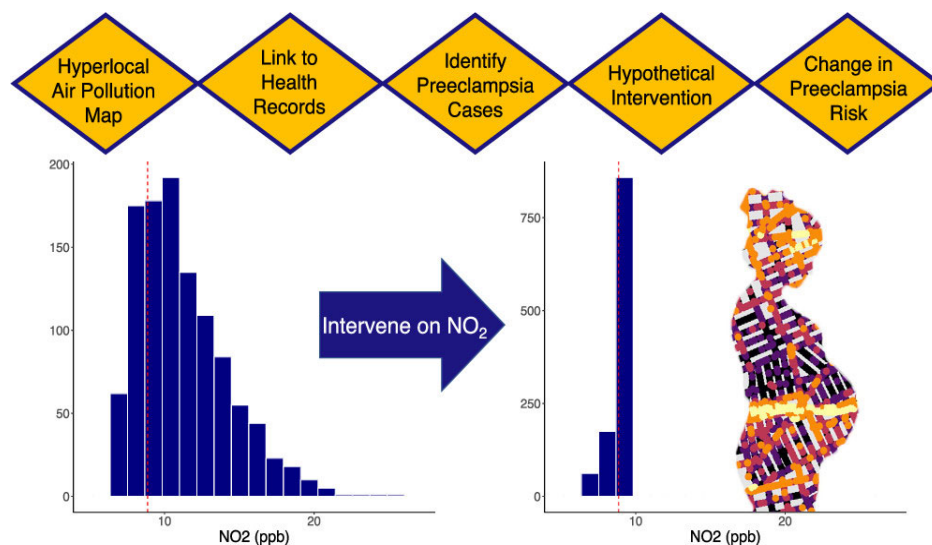
➤ Corresponds to a change from 7% in pre-retirement period to 5.1% preterm birth in the post-retirement period

➤ Benefits stronger for African American and Asian mothers

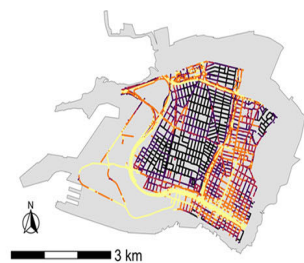
Casey JA, Karasek, D, Ogburn, EK, Goin D, Dang K, Braveman, PA, Morello-Frosch R (2018) Coal and oil power plant retirements in California associated with reduced preterm birth among populations nearby. *American Journal of Epidemiology*, doi: 10.1093/aje/kwy110.

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

Goin et al, ES&T, 2021



A. Black Carbon



B. Nitrogen Dioxide

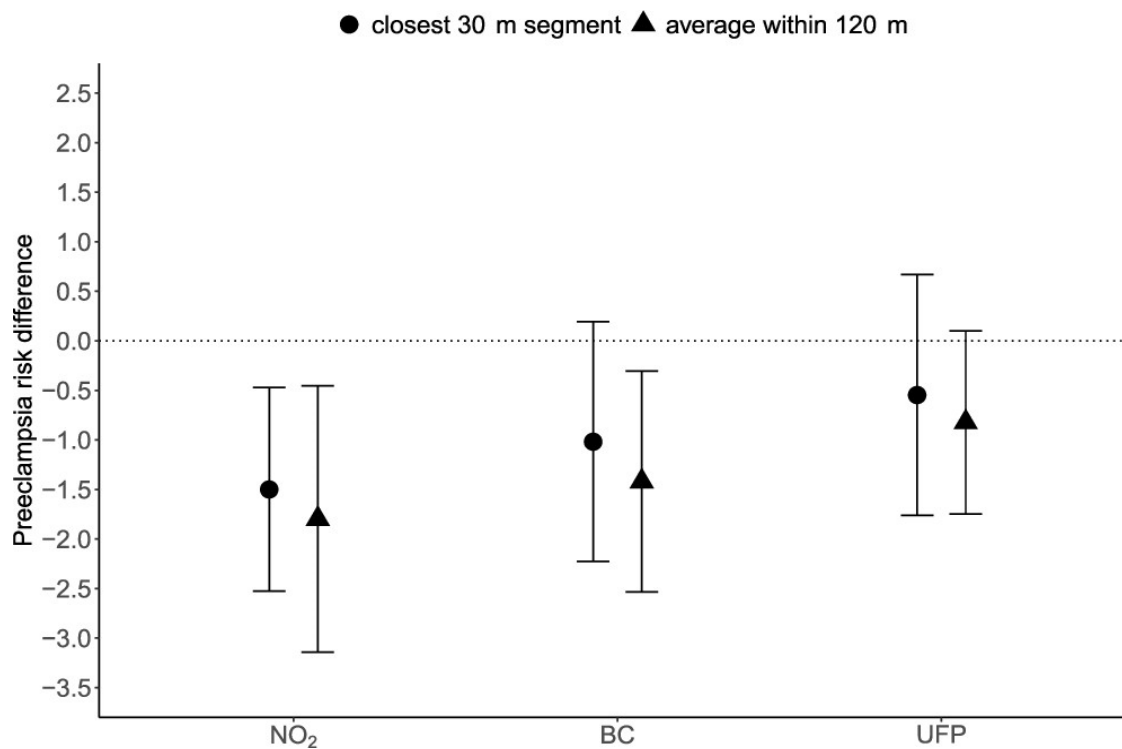


C. Ultrafine Particles

Distribution of black carbon (BC), nitrogen dioxide (NO<sub>2</sub>), 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

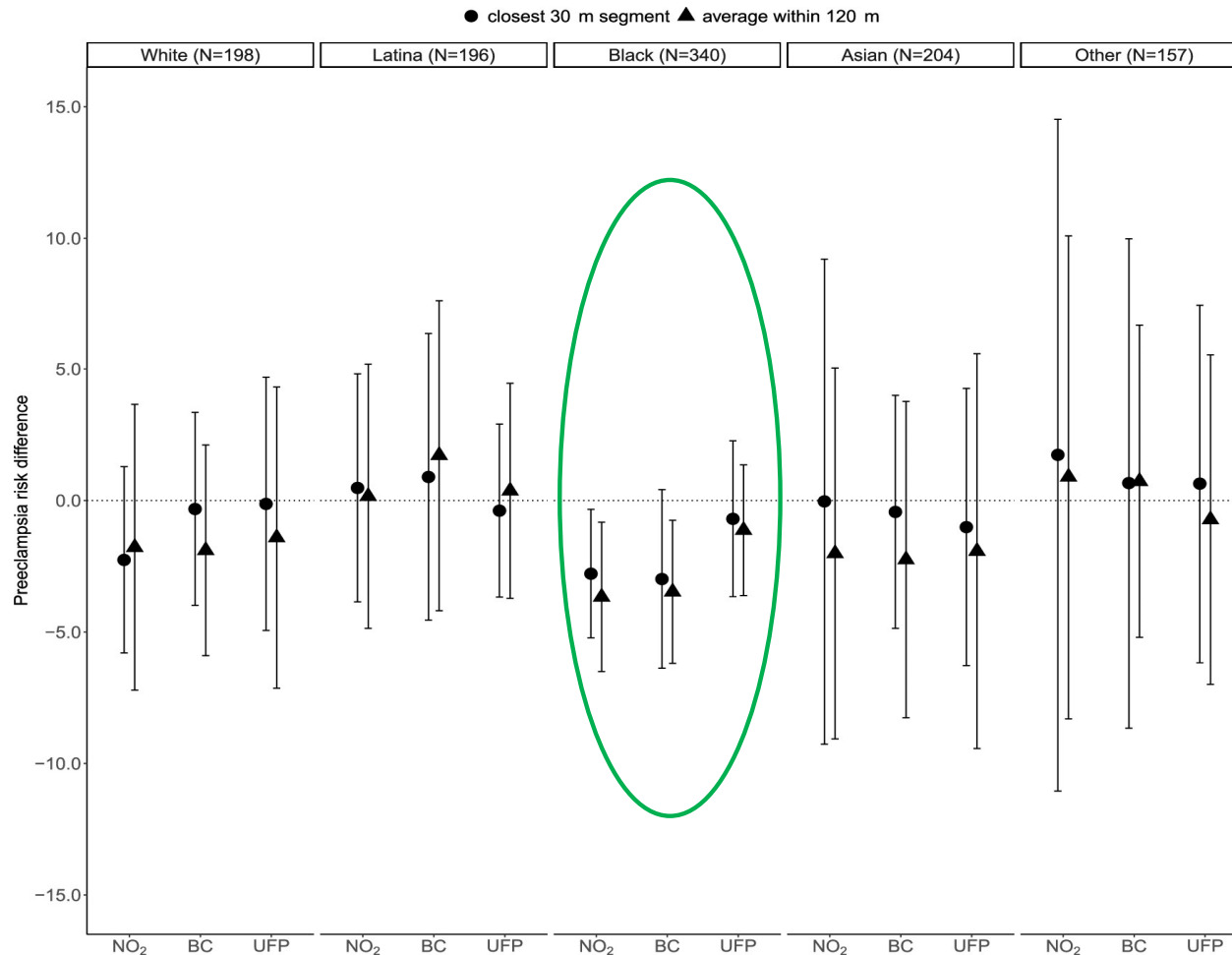
(Goin et al, ES&T, 2021)



- 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 NO<sub>2</sub>, 0.27  $\mu\text{g}/\text{m}^3$  for BC, and 26.6 #  $\times 10^3/\text{cm}^3$  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 strategies that integrate public health, sustainability, and environmental justice goals
- Target resources (e.g., CA’s Climate Change Investments & Biden Administration's Justice40 Initiative)



# Integrating Equity and Sustainability Goals in Climate Policy– California Climate Investments

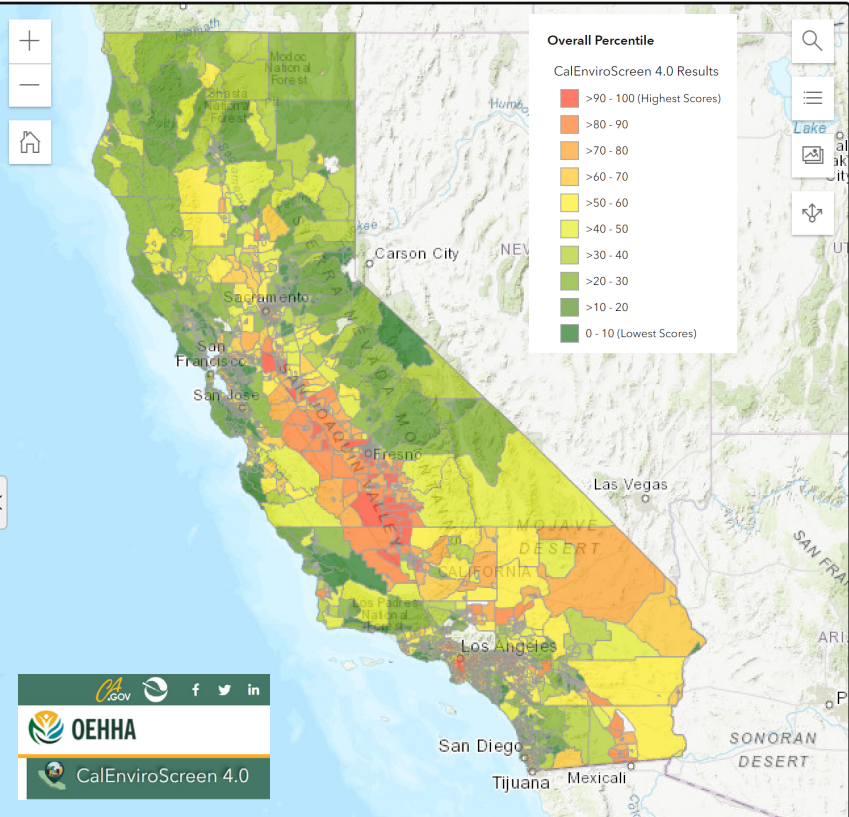
Revenue from regulation of industrial greenhouse gas emissions targeted for investment in projects that:

- Reduce pollution and greenhouse gas emissions
- Enhance co-benefits of greenhouse gas reductions
  - 35% of funds to benefit vulnerable groups
  - 20% invested in vulnerable neighborhoods directly



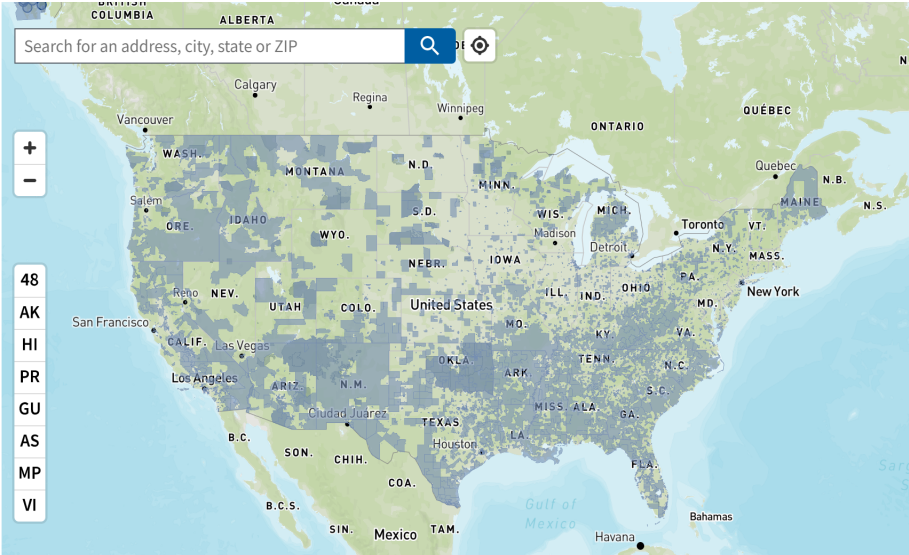
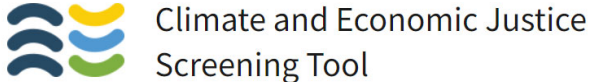
# CalEnviroScreen

## Mapping Disadvantaged Communities for CA Climate Investment Funds



# CEJST –Climate Equity and Economic Justice Screening Tool

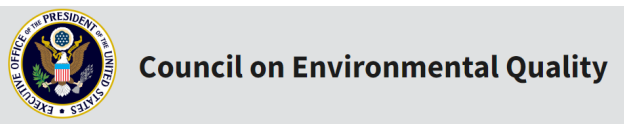
## Mapping Disadvantaged Communities for Justice40



**How to use the map:**  
 Zoom in + , search 🔍 , or locate yourself 📍 and select to see information about any census tract.

**Things to know:**  
 The tool uses census tracts 🗺️. Census tracts are a small unit of geography. They generally have populations 🧑 of between 1,200 - 8,000 people.

Communities that are disadvantaged live in tracts that experience burdens. These tracts are highlighted 🟡 on the map.



# California Climate Investments

## \$18.3 billion dollars appropriated to date

# 2022



### ANNUAL REPORT



Cap-and-Trade Auction Proceeds



#### Affordable Housing and Sustainable Communities, Riverside

The Mission Heritage Plaza project is using \$16.8 million to help local partners build 71 new energy-efficient, affordable homes in downtown Riverside. The project will also plant over 200 new trees, provide two miles of new bike lanes, and create a multi-modal transit hub that links local and regional transit systems in one convenient location.



#### Climate Adaptation and Resiliency Program, Contra Costa

The Contra Costa County Flood Control and Water Conservation District (CCFCWCD) received a grant of \$1,250,000 to restore 400 acres of coastal wetlands and adjacent habitat at the mouth of Walnut Creek and its tributary, Pacheco Creek.



#### Transformative Climate Communities, Fresno

The Transform Fresno initiative, with \$66.5 million in Transformative Climate Communities (TCC) investments, allowed a broad group of stakeholders to collaborate on an integrated suite of projects meant to reduce disparities in these neighborhoods.



#### Technical Assistance, UC Agriculture and Natural Resources

In a partnership with the Strategic Growth Council and the California Department of Food and Agriculture (CDFA), the University of California Agriculture and Natural Resources (UC ANR) is providing outreach, education, and technical assistance to farmers and ranchers across California.



#### Climate Change Research Program, Toxic Tides Project

The Toxic Tides research project, led by the University of California (UC), Berkeley Sustainability and Healthy Equity Laboratory is working to better understand how vulnerable communities living near hazardous sites may be affected under different sea levels rise scenarios.



#### Sustainable Agricultural Land Conservation, Brazelton ranch in Vacaville

The Brazelton family, in partnership with the Solano Land Trust, will ensure the Brazelton ranch in Vacaville remains intact in perpetuity by placing their property under a conservation easement. Conservation of farmlands that surround urban areas helps promote infill development, avoid GHG emissions, and maintain a viable



#### Transit and Intercity Rail Capital Program, Sonoma and Marin Counties

Sonoma and Marin Counties received an \$11 million grant to help pay for four newly manufactured rail passenger vehicles to complete the SMART Rail Car Capacity Project. Together with a newly launched 43-mile SMART passenger rail service across Marin and Sonoma Counties, these rail cars will connect communities, provide a transit



#### Climate Ready Program, Pauma Band of Luiseño Indians

The Pauma Band of Luiseño Indians are scaling up their carbon farming operations on Pauma Tribal Farms. This project includes funding for on-farm practices such as cropping, compost application, hedgerow installation, no-till, and a transition from row crops to trees for 35 acres of farmland.

<http://www.caclimateinvestments.ca.gov/2020-project-profiles>

BRIEFING ROOM

## Executive Order on Tackling the Climate Crisis at Home and Abroad

JANUARY 27, 2021 • PRESIDENTIAL ACTIONS

The United States and the world face a profound climate crisis. We have a narrow moment to pursue action at home and abroad in order to avoid the most catastrophic impacts of that crisis and to seize the opportunity that tackling climate change presents. Domestic action must go hand in hand with United States international leadership, aimed at significantly enhancing global action. Together, we must listen to science and meet the moment.

### WHITE HOUSE ENVIRONMENTAL JUSTICE ADVISORY COUNCIL

**Members:**

Richard Moore,  
Co-Chair

Peggy Shepard,  
Co-Chair

Catherine Coleman  
Flowers,  
Vice Chair

Carletta Tilousi,  
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LaTricia Adams

Susana Almanza

Jade Begay

Maria Belen Power

Dr. Robert Bullard

Tom Commons

Andera Delgado

Jerome Foster II

May 21, 2021

The Honorable Ms. Brenda Mallory, Chair  
The Council on Environmental Quality  
Executive Office of the President  
Washington, DC 20500

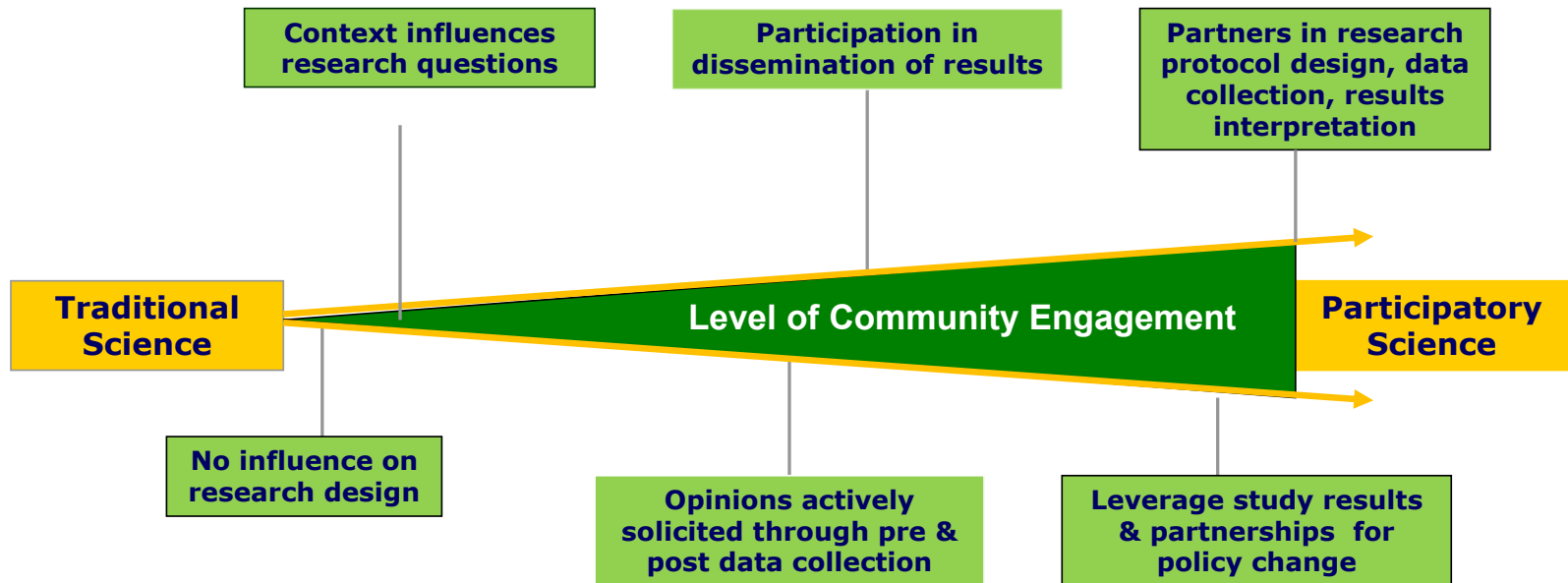
Dear Chair Mallory:

The White House Environmental Justice Advisory Council (WHEJAC) enthusiastically submits its final report to you and President Biden. This report is in response to a charge issued in March 2021, from The Council on Environmental Quality to provide recommendations on Justice40, Climate and Economic Justice Screening Tool, and Executive Order 12898 Revisions. Over the next few months, the WHEJAC will also consider and submit recommendations on the Scorecard, the administration and implementation of Justice40, and final recommendations on the Climate and Economic Justice Screening Tool.

The WHEJAC urges President Biden, Vice President Harris and the CEQ to consider the following requests:



# Continuum of community engagement in research and policy change



From *Translational* Research...

...to *Transformational* Research



# Thank You!

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 @rmfrosch

Sustainability and Health Equity Lab:  
<https://nature.berkeley.edu/morellofroschlab>



## Children's Environmental Health Centers

- US EPA (RD83543301)
- NIEHS P01 ES022841

NIH ECHO Program (UG3OD023272 and UH3OD023272)

California Strategic Growth Council (CCRP0022)

US EPA Science to Achieve Results Grant (RD – 84003901)

Centers for Disease Control and Prevention (5U38EH000481)

U.S. EPA Science to Achieve Results Fellowship (91744701-01)

California Air Resources Board

Cal-EPA Office of Environmental Health Hazard Assessment

