



# Racism and environment through the lens of epidemiology

Graduate Students in Environmental and Radiological Health Sciences

Colorado State University

Diversity Symposium

October 21<sup>st</sup>, 2020



COLORADO STATE UNIVERSITY

# Background and Introduction

Kellin, Peter, and Sherry



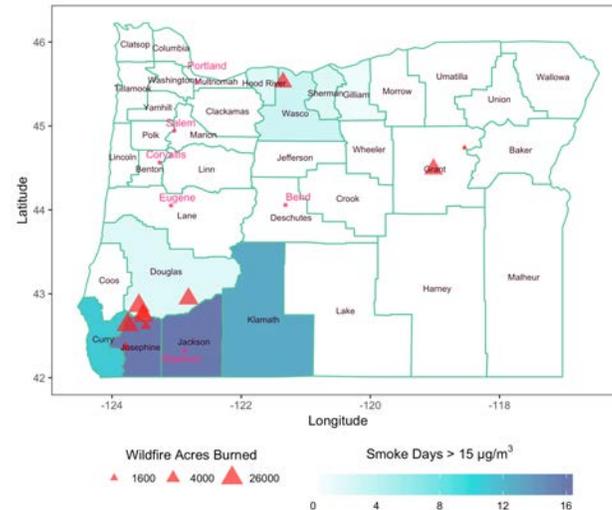
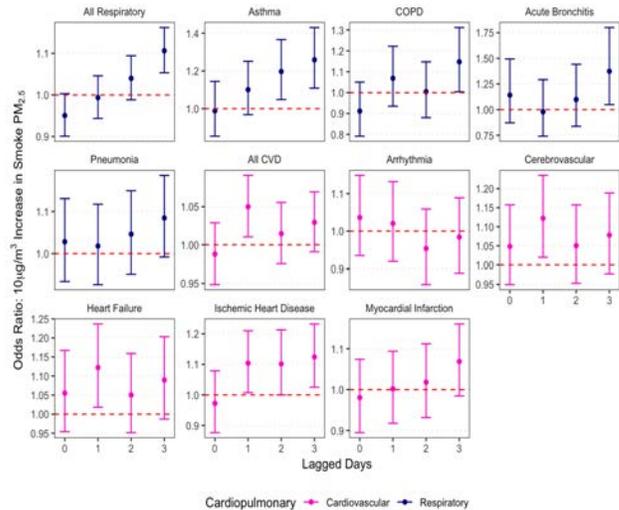
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# What is epidemiology?



# Epidemiologists

Public health professionals who use quantitative methods to find the causes of health outcomes and diseases in populations.

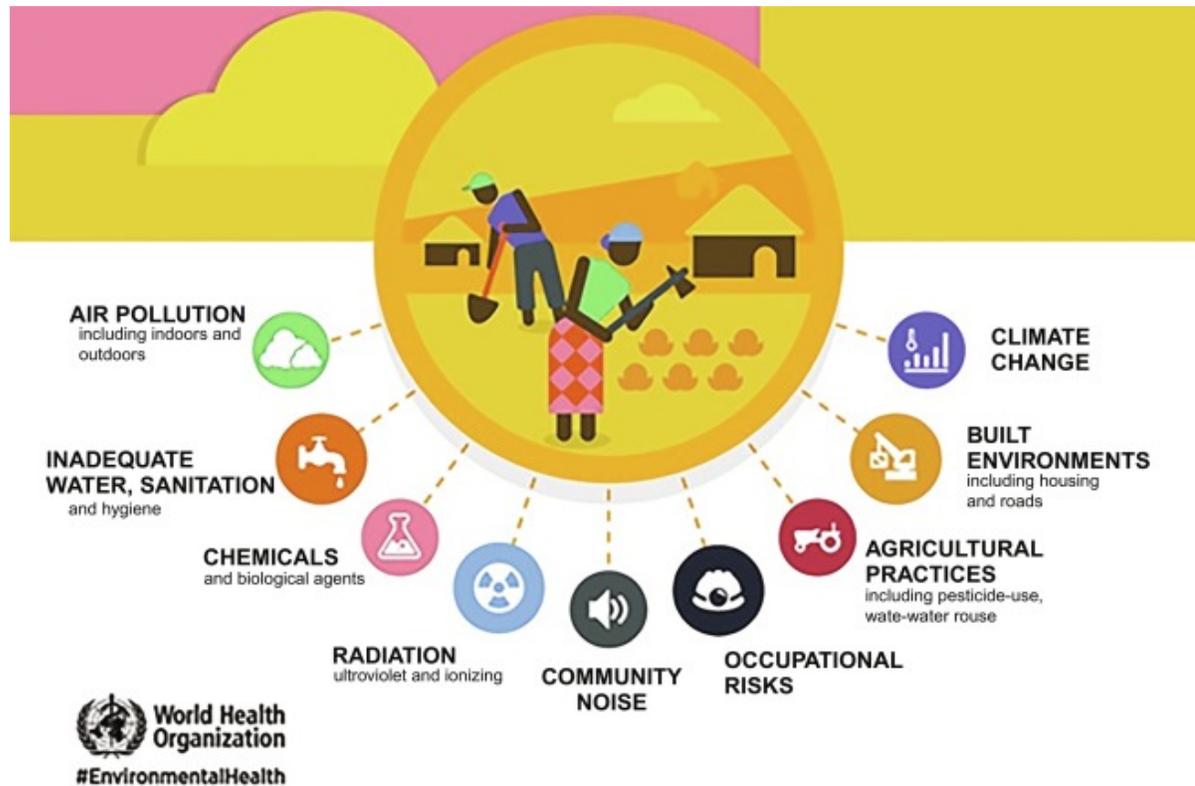


Front Range Cardiopulmonary Deaths and Strata Proportion

out_name	All	F	M
Asthma	101	68.3	31.7
Cardiac Arrest	157	58.0	42.0
Cerebrovascular	3443	60.1	39.9
COPD	4056	51.2	48.8
CVD	18122	49.9	50.1
Heart Failure	1395	59.5	40.5
Ischemic Heart Disease	7520	39.9	60.1
Myocardial Infarction	1948	40.9	59.1
Respiratory	7025	50.5	49.5

# Environmental Epidemiology

Epidemiologic studies on the effects of environmental exposures of human populations.



- Examine specific populations or communities exposed to different ambient environments.
- Clarify the relationship between physical, biologic or chemical factors and human health.

# Environmental Racism

Minority communities and socially disadvantaged persons in society are often burdened disproportionately by environmental hazards.



Mining operation in Cerro de Pasco Peru. Photo credit [desinformemonos.org](http://desinformemonos.org)

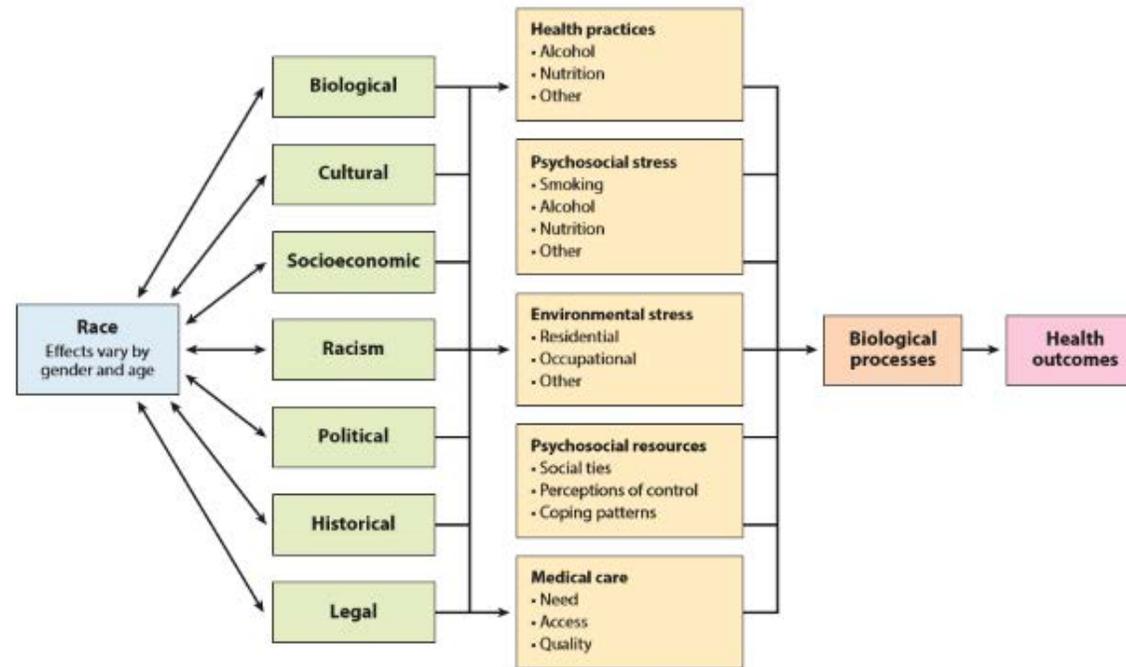
# Environmental Justice

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

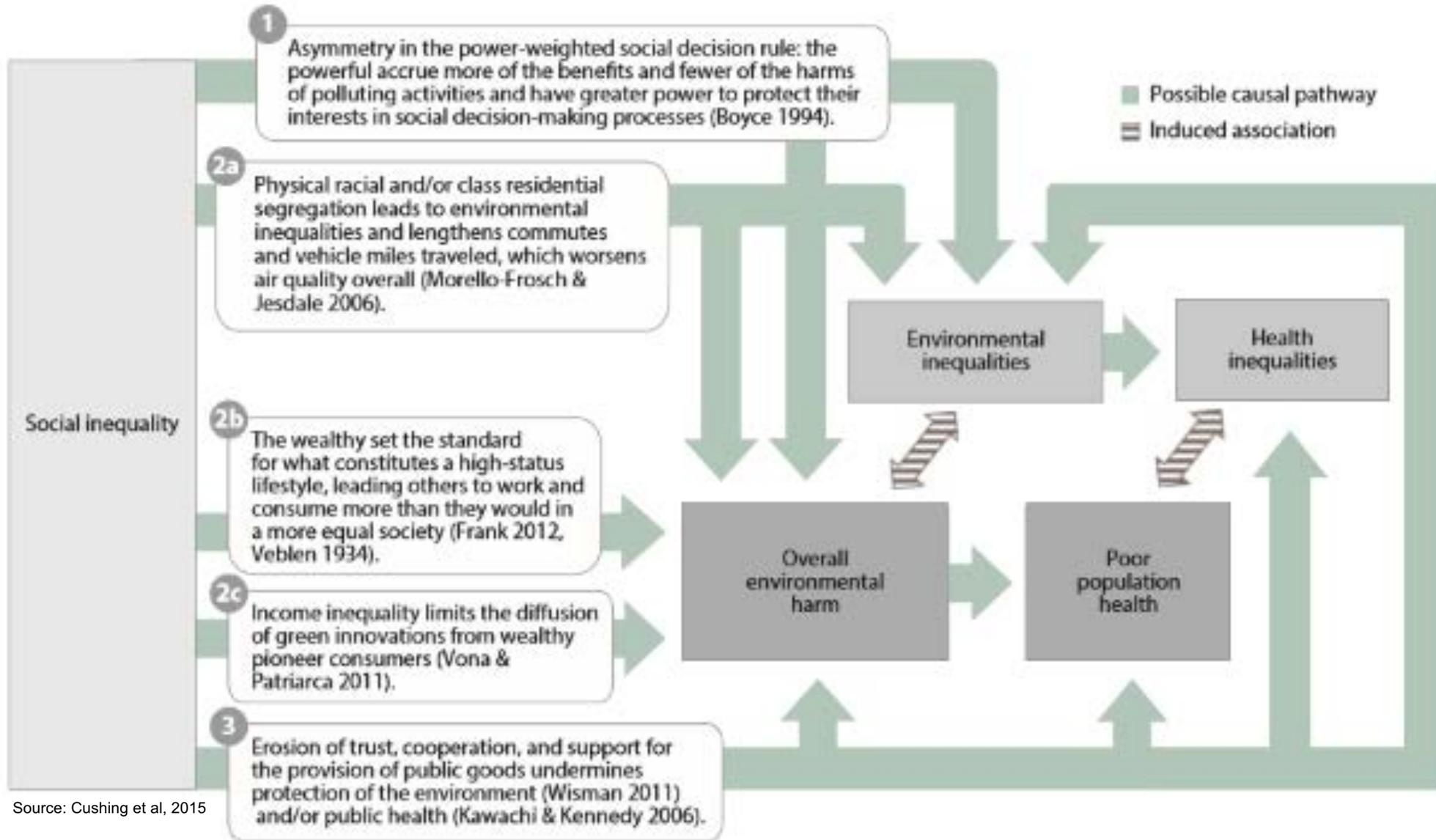


# Social Determinants of Health

- There are many different factors that go into determining health.



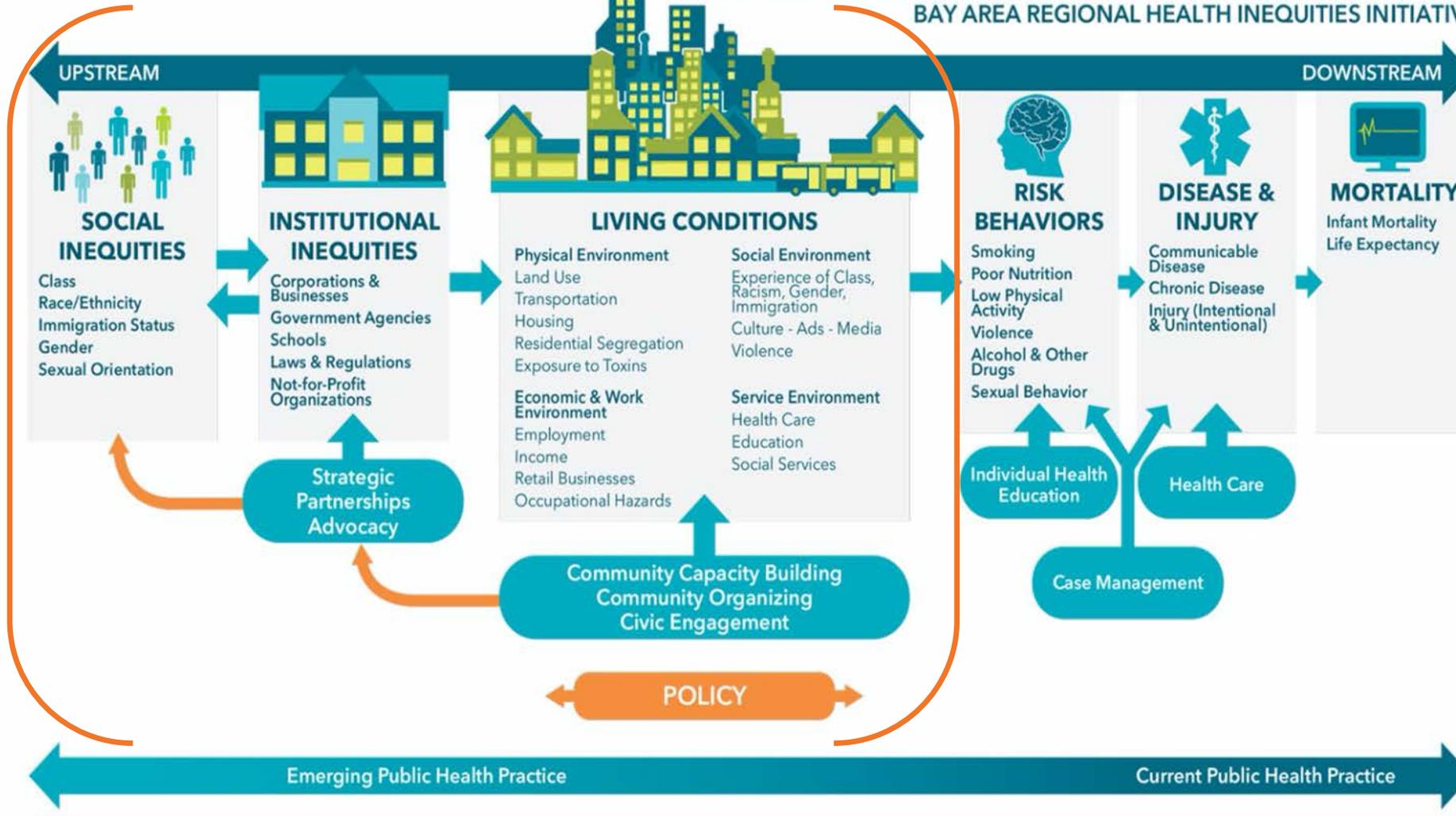
Source: Nuru-Jeter et al, 2018



Source: Cushing et al, 2015



A PUBLIC HEALTH FRAMEWORK FOR REDUCING HEALTH INEQUITIES  
BAY AREA REGIONAL HEALTH INEQUITIES INITIATIVE



Source: Bay Area Regional Health Inequalities Initiative,  
<https://letsgethealthy.ca.gov/sdoh>

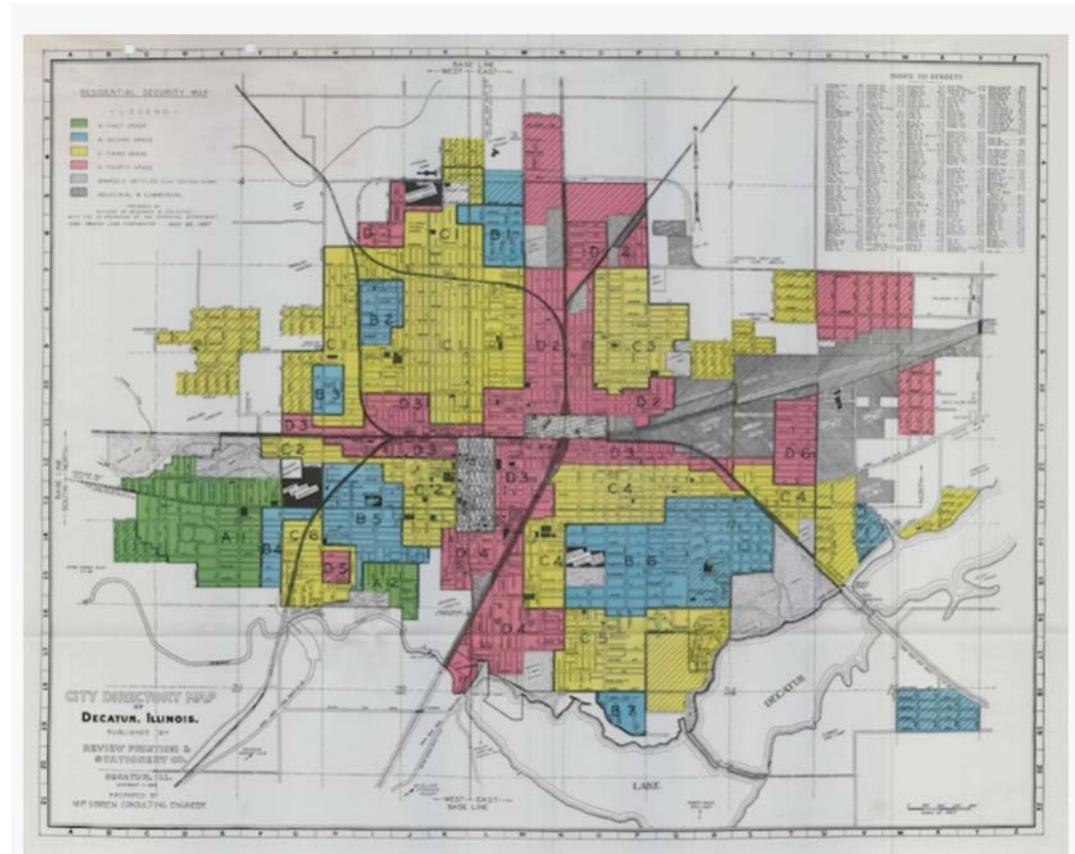
# Redlining



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Redlining: 1930s, federal government color-coded hundreds of cities, rating riskiness of neighborhoods for real estate investment by **best**, **still desirable**, **declining** or **hazardous**.

This practice disproportionately effected black, brown, and immigrant communities



Home Owners' Loan Corporation (HOLC) map for Decatur, Illinois

# Because of Redlining.....

## Health Disparities:

- Higher instances of Asthma
- Higher rates of heat stroke
- Higher rates of gun violence
- Less likely to have access to green spaces
- More likely to experience chemical exposure
- Higher rates of certain types of cancer
- Life Expectancy

New spatially continuous indices of **redlining** and racial bias in mortgage lending: links to survival after breast cancer diagnosis and implications for **health disparities** research

*Health & Place*, July 2016, ...

First available on 9 May 2016

Kirsten M. M. Beyer, Yuhong Zhou, Kevin Matthews, ... Ann B. Nattinger

The impact of historical racism on modern gun violence: **Redlining** in the city of Louisville, KY

*Injury*, October 2020, ...

First available on 25 June 2020

Matthew Benns, Matthew Ruther, Nicholas Nash, ... Keith Miller

Associations between historical residential **redlining** and current age-adjusted rates of emergency department visits due to asthma across eight cities in California: an ecological study

*The Lancet Planetary Health*, January 2020, ...

First available on 27 January 2020

Anthony Nardone, Joan A Casey, Rachel Morello-Frosch, ... Neeta Thakur

867: Modern echoes of historic institutionalized racism: Associations between previously "**Redlined**" districts and current obstetric outcomes

*American Journal of Obstetrics and Gynecology*, January 2020, ...

First available on 31 December 2019

Stefanie J. Hollenbach, Lorelei L. Thornburg, J. Glantz, Elaine L. Hill



# Earth

Matt & Beth

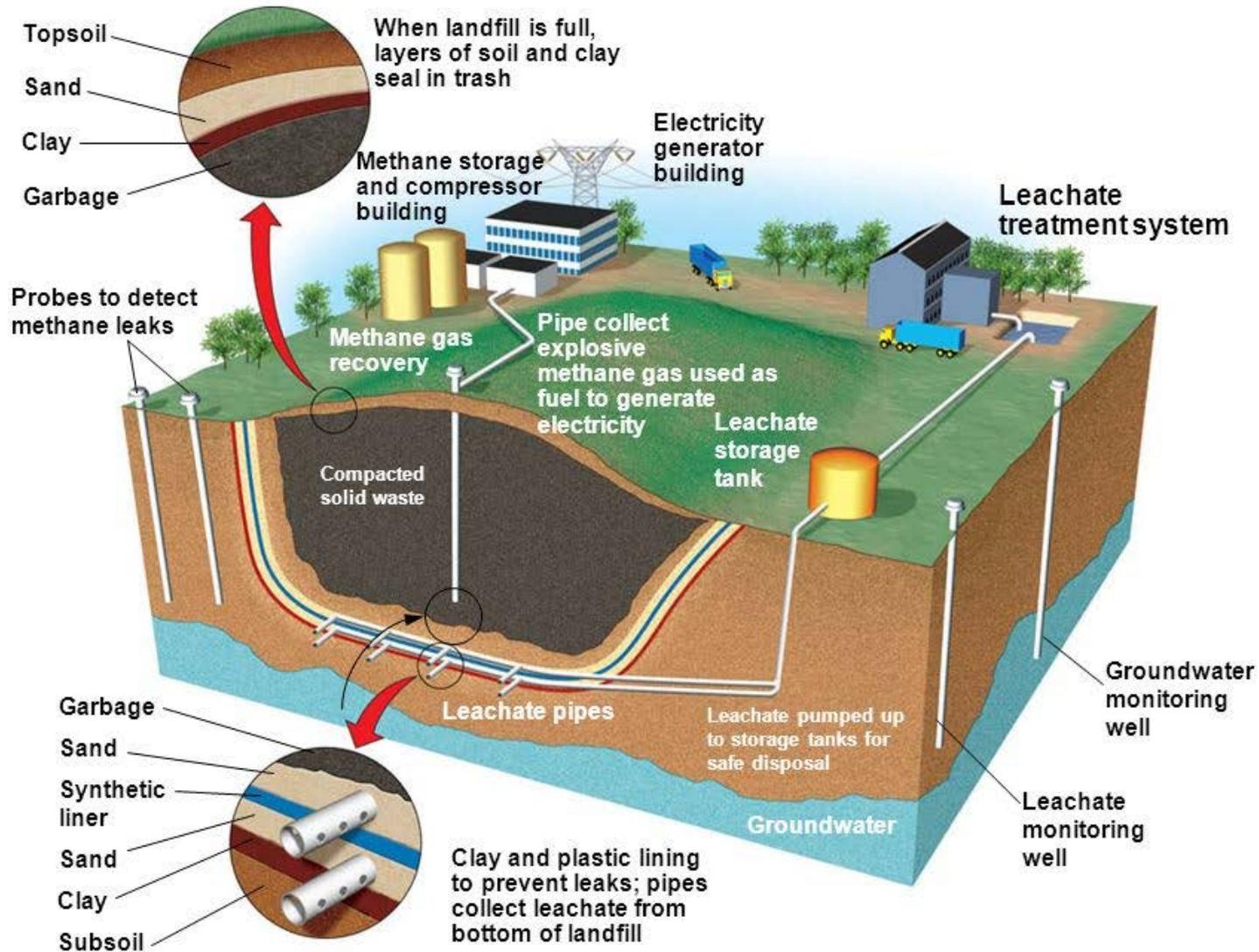




# Poll Question

- How many Superfund sites are in Colorado?
  - 0 – 25
  - 25 – 50
  - 50 – 100
  - More than 100

# Sanitary Landfill



© 2006 Brooks/Cole - Thomson





# Landfill Health Risks

- Wild animals carrying zoonotic disease
- Fires emit air pollutants
- Groundwater contamination from leaching materials





# What is a Superfund Site?



- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).
- Enacted by Congress on December 11, 1980.



# Environmental Justice Concerns



- Communities of color and lower SES are usually located closer to these sites
  - African-Americans are 75 percent more likely than others to live near facilities that produce hazardous waste.

# Health Concerns



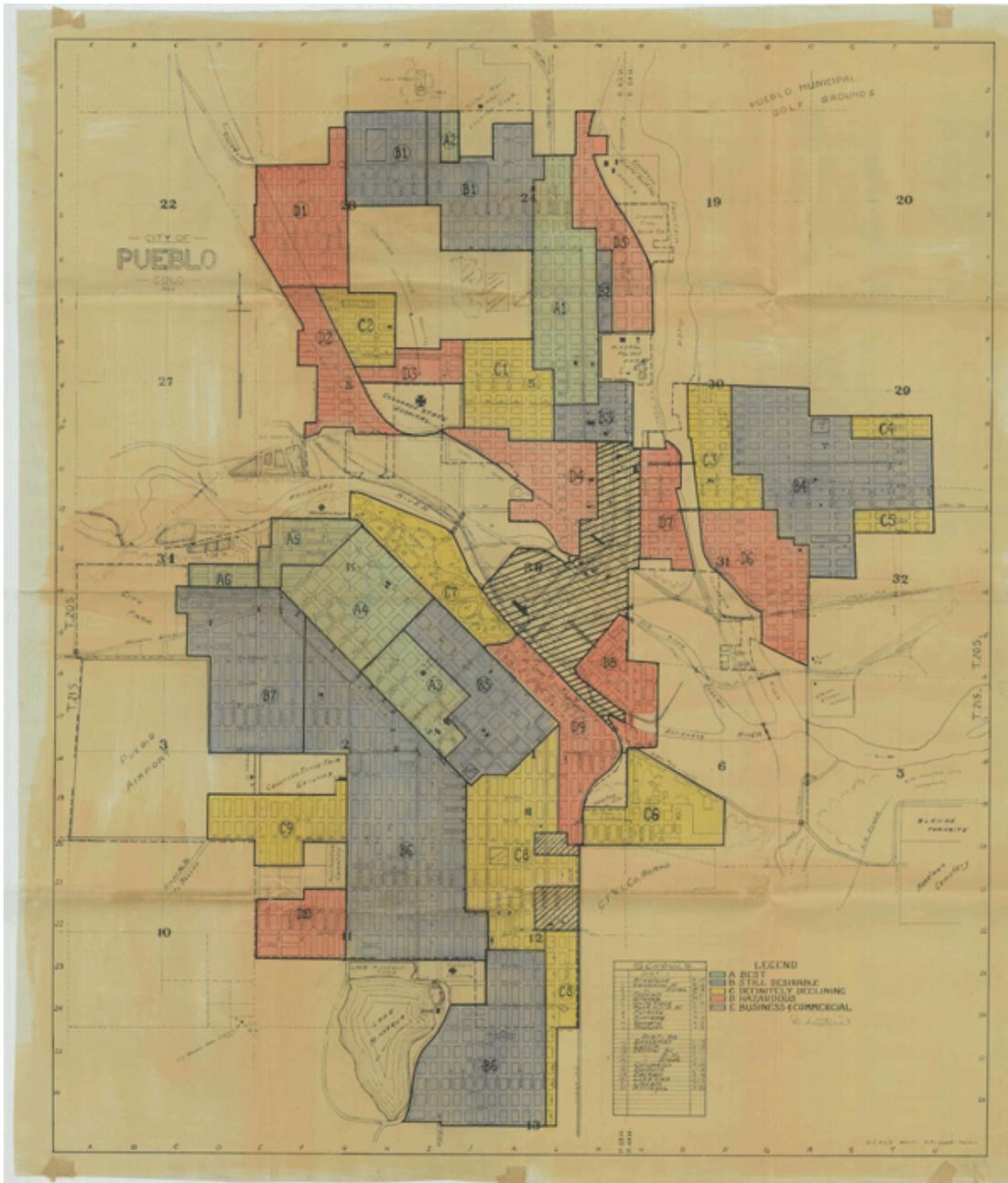
- Carcinogens
- Neuromuscular illness
- Bioaccumulation
- Slowed growth and development
- Learning and behavior problems
- Hearing and speech problems

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# Brief Look into Colorado

- Colorado Smelter, Pueblo
  - Arsenic, cadmium, copper, pentachlorophenol
- California Gulch, Leadville
  - Lead, arsenic





# Toxic Triangle, Denver CO

- Contaminated soil and groundwater from toxic metals as a result of two different smelting plants
- Dog food factory
- Includes the Cole, Clayton, Elyria/Swansea, Globeville and Curtis Park neighborhoods. All primarily lower SES communities.
- January 2017 saw the beginnings of remediation work with the excavation of soil and landfill debris at Denver Coliseum



Air Monitoring Locations for VB I-70 OU2 Removal Action/GLO Project

# Uranium Mines on Navajo Nation

- 30 million tons of uranium extracted from Navajo Nation between 1944 and 1986
- Over 500 abandoned uranium mines on Navajo Nation today
- Homes and water sources on the Navajo Nation are contaminated with elevated levels of radiation
- Superfund Program has provided assistance to Navajo Nation since 1994





# Map of Uranium Contamination on Navajo Lands



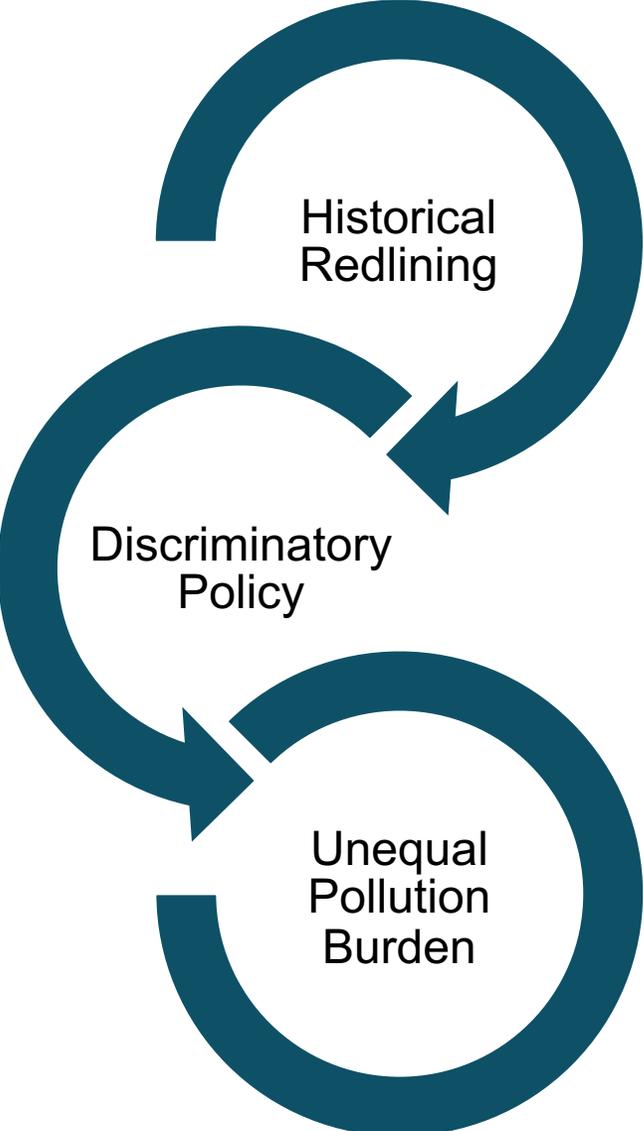


# Air

Robert and Cristina



# How does historical redlining lead to poor air quality



# Comparison of asthma incidence

- San Francisco and Oakland Redlined Areas
- Data shows that emergency room visits for asthma are 2.4x more likely in “high risk” rated areas

Contributors to asthma incidence, prevalence, and severity:

- Low neighborhood socioeconomic status
- High psychosocial stressors
- Neighborhood violence



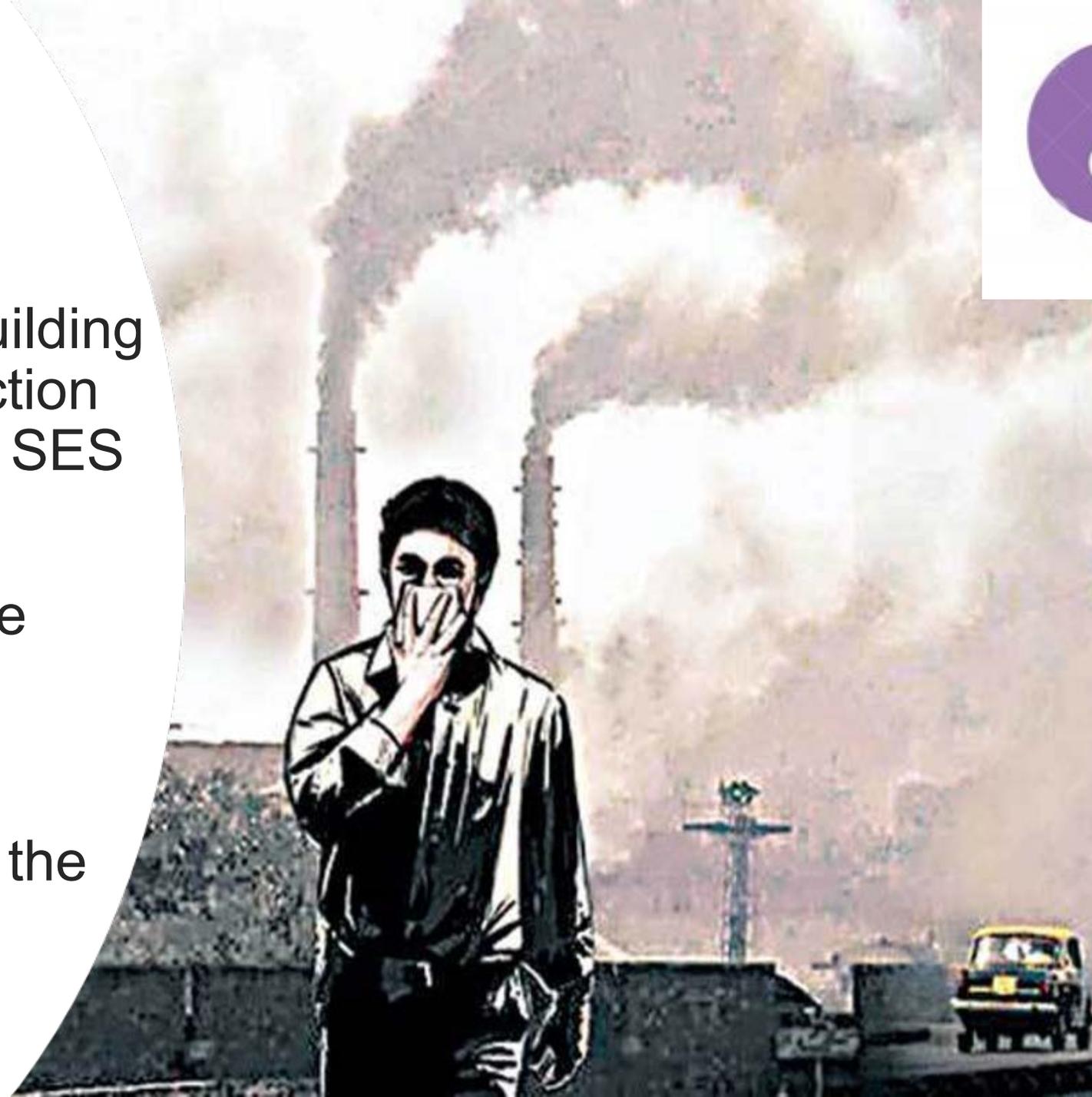
Left: redlined maps

Right: emergency room visits



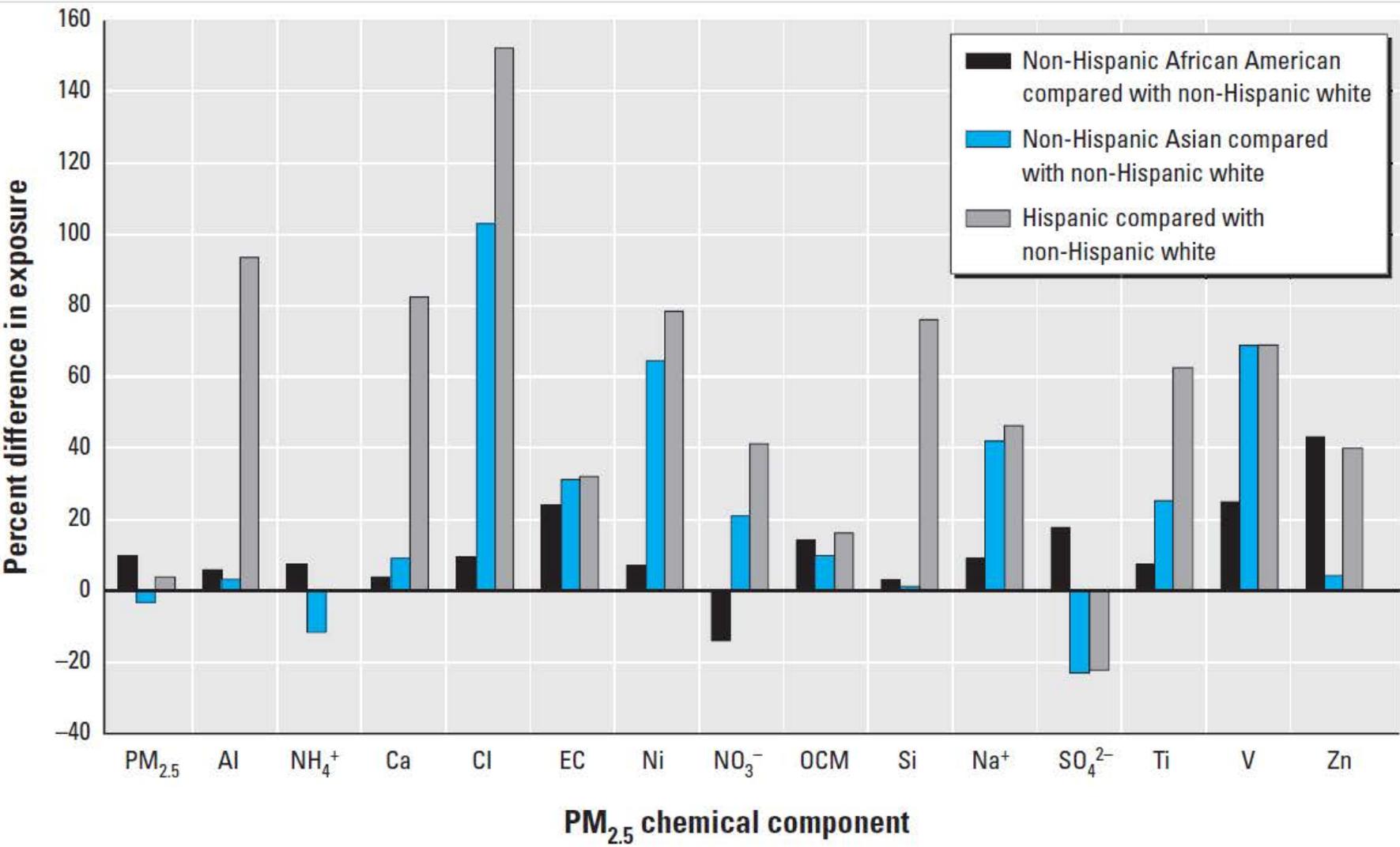
# Policy

- Federal programs incentivize building of roadways and major construction projects in urban areas of lower SES
- Throughout the mid-1900s, large building complexes like housing units, university campuses, and industries were also placed in redlined areas, largely because the land was cheaper.





Citation: **Inequity in consumption of goods and services adds to racial-ethnic disparities in air pollution exposure.**  
Christopher W. Tessum, Joshua S. Apte, Andrew L. Goodkind, Nicholas Z. Muller, Kimberley A. Mullins, David A. Paoella,  
Stephen Polasky, Nathaniel P. Springer, Sumil K. Thakrar, Julian D. Marshall, Jason D. Hill  
Proceedings of the National Academy of Sciences Mar 2019, 116 (13) 6001-6006; DOI: 10.1073/pnas.1818859116



- Bell and Ebisu 2012
- Is airborne particulate matter exposure related to race and ethnicity?
- Focused on **exposure**

**Figure 2.** Percentage differences in exposure by race/ethnicity category, comparing non-Hispanic African American and non-Hispanic Asian to non-Hispanic white.

**TABLE 1—Mean Absolute and Proportional Burdens From Facilities Emitting PM in the 2011 National Emissions Inventory, Selected Subgroups: American Community Survey, United States, 2009–2013**

Variable	Proportion of Population, %	PM <sub>2.5</sub> Burden, Absolute (Proportional)	PM <sub>10</sub> Burden, Absolute (Proportional)	Facility Burden, Absolute (Proportional)
Overall population	1.00	22.4 (. . .)	29.2 (. . .)	5.7 (. . .)
<b>Race/ethnicity<sup>a</sup></b>				
White	0.63	18.8 (0.84)	24.7 (0.85)	4.1 (0.72)
Non-White	0.37	28.6 (1.28)	37.0 (1.27)	8.5 (1.49)
Black	0.12	34.5 (1.54)	43.6 (1.49)	6.2 (1.09)
Hispanic	0.17	26.9 (1.20)	35.9 (1.23)	9.8 (1.70)
<b>Poverty level</b>				
Above poverty	0.85	20.9 (0.93)	27.2 (0.93)	5.5 (0.95)
Below poverty	0.15	30.3 (1.35)	39.3 (1.35)	7.2 (1.26)

Mikati I, Benson AF, Luben TJ, Sacks JD, Richmond-Bryant J. Disparities in Distribution of Particulate Matter Emission Sources by Race and Poverty Status. *Am J Public Health*. 2018 Apr;108(4):480-485.



# References

- Bell ML, Ebisu K. Environmental inequality in exposures to airborne particulate matter components in the United States. *Environ Health Perspect*. 2012 Dec;120(12):1699-704. doi: 10.1289/ehp.1205201. Epub 2012 Aug 10. PMID: 22889745; PMCID: PMC3546368.
- Mikati I, Benson AF, Luben TJ, Sacks JD, Richmond-Bryant J. Disparities in Distribution of Particulate Matter Emission Sources by Race and Poverty Status. *Am J Public Health*. 2018 Apr;108(4):480-485. doi: 10.2105/AJPH.2017.304297. Epub 2018 Feb 22. PMID: 29470121; PMCID: PMC5844406.
- Nardone, et al. Associations Between Historical Residential Redlining and Current Age-adjusted Rates of Emergency Department Visits Due to Asthma Across Eight Cities in California: An Ecological Study (2020)
- Tessum, C., Apte J. S., Inequity in Consumption of Goods and Services Adds to Ethnic Disparities in Air Pollution Exposure (2018)



# Water

Elizabeth





# Poll Question

- In what ways could water pose a threat to public health?
  - Infectious Disease
  - Property Destruction
  - Toxin Exposure
  - All of the Above



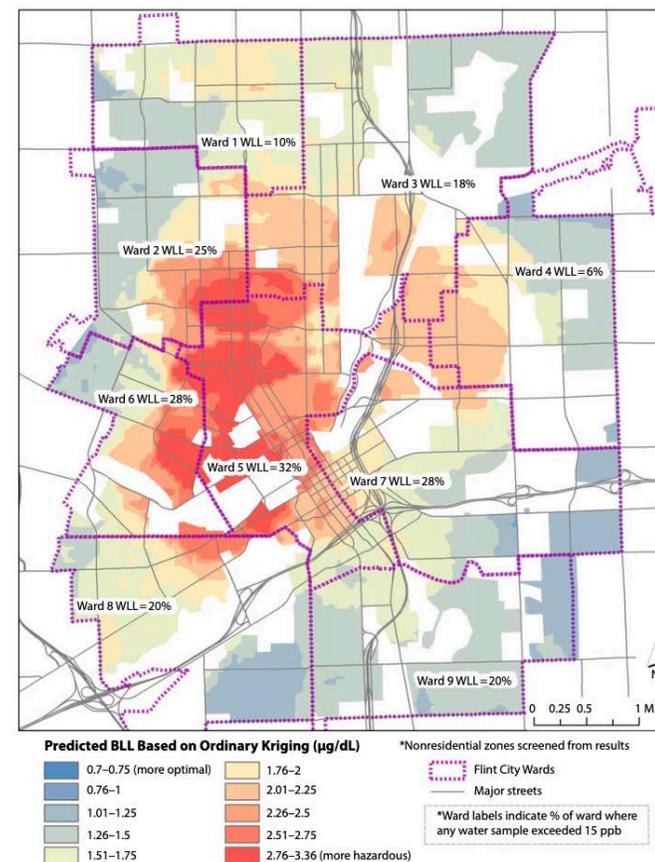
# Flint Water Crisis

- Flint is a city near Detroit, Michigan
  - Nicknamed “Vehicle City” for its booming automobile manufacturing industry
    - City economically collapsed when the industry collapsed
- In 2014, the City of Flint began sourcing water from the Flint river
  - Cheaper option
  - More corrosive than Detroit municipal water from Lake Huron
- Many of the water pipes in Flint were lead
  - In 1897 the city passed an ordinance that all pipes were to be lead
    - Most of the pipes were not updated by 2014



# Lead Poisoning

- Exposure to lead can lead to irreversible damage
  - Brain development in children
  - Kidneys and nervous system
  - High levels can lead to seizures or death
- Approximately 99,000 Flint residents were exposed to lead



Note. BLL = blood lead level; WLL = water lead level.

**FIGURE 2—Predicted Surface of Child Blood Lead Level and Ward-Specific Elevated Water Lead Level After (Post) Water Source Change From Detroit-Supplied Lake Huron Water to the Flint River: Flint, MI, 2015**

Hanna-Attisha, M., LaChance, J., Sadler, R. C., & Champney Schnepf, A. (2016). Elevated blood lead levels in children associated with the Flint drinking water crisis: a spatial analysis of risk and public health response. *American journal of public health, 106*(2), 283-290.

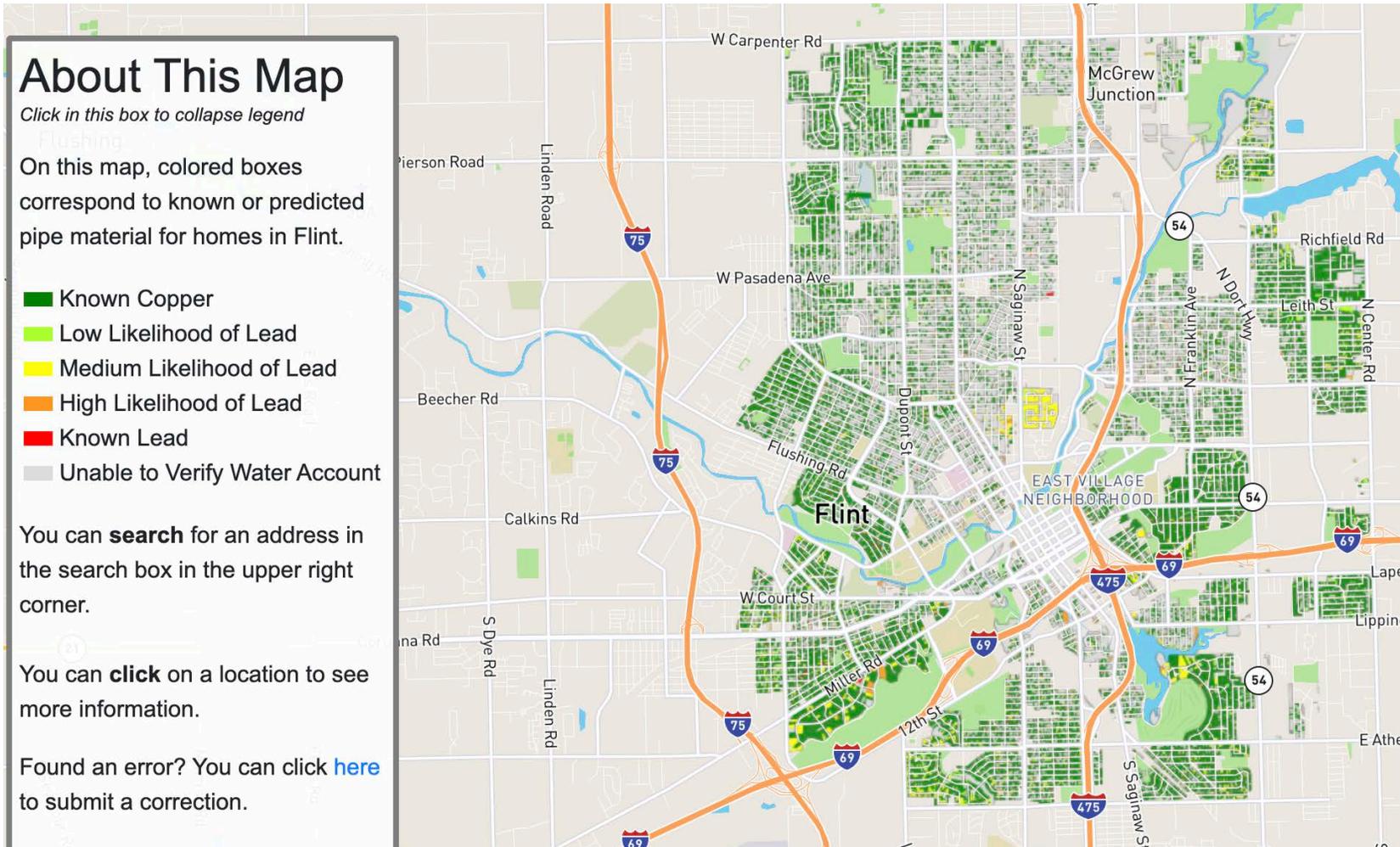


Image from: [flintpipemap.org](http://flintpipemap.org)

# A compounded issue

- Ingestion of lead has been a main focus of the Flint Water Crisis
- The water source and pipes created other problems as well...
  - Flint River water had higher levels of *L. pneumophila* than Detroit tap water

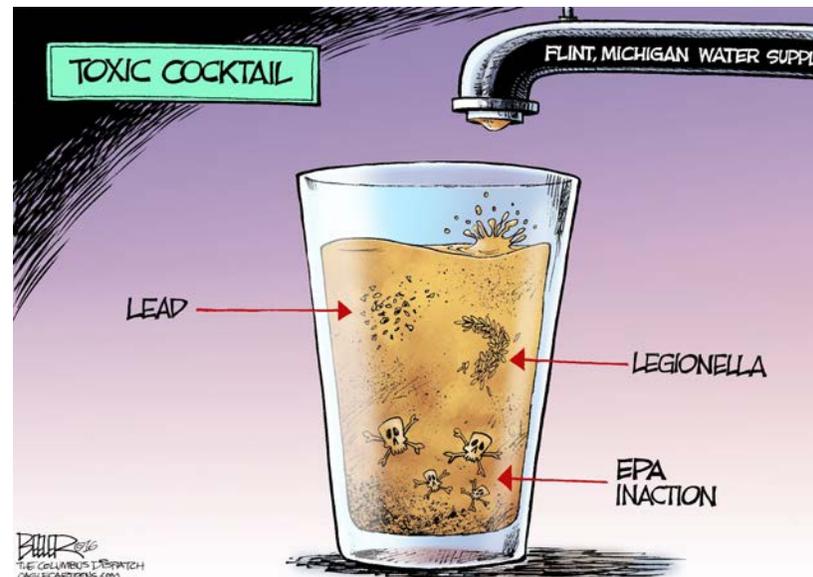


Image by: Nate Beeler



# Legionnaires Disease

- Outbreaks in the summer of 2014 and 2015
- 91 cases and 12 deaths in Genesee County
  - 6-13 cases and no deaths from 2009 to 2013
- Copper pipes killed the bacteria
  - Chlorinating the water also important to control bacterial growth



# Closer to home

- 2013 Big Thompson flood



Image from: [KDVR.com](http://KDVR.com)



# Big Thompson Flood

- Flood waters destroyed a sewage treatment plant
- Elevated levels of E. coli found through the South Platte basin out to Nebraska two weeks after the flood
- Residents told to stay out of flood waters and boil drinking water
- Redlining?
  - Possibly, but flooding in Northern Colorado has disproportionately affected those in lower income settings
    - 1997 Spring Creek Flood



# Fire

Daniel



# Audience poll question

During a heat wave, how great of a temperature increase (°F) do you think is needed to increase the risk of death?

Choose one:

- 1 degree
- 5-10 degrees
- Over 10 degrees

# Heat Waves



**During a heat wave, every 1-degree increase increases death risk by 2.5%**

Heat is the nation's #1 deadliest weather event, killing up to 12,000 people a year (CDC 2013)

Neighborhoods that are poorer and have more residents of color can be **5 to 20 degrees Fahrenheit hotter** in summer than wealthier, whiter parts of the same city

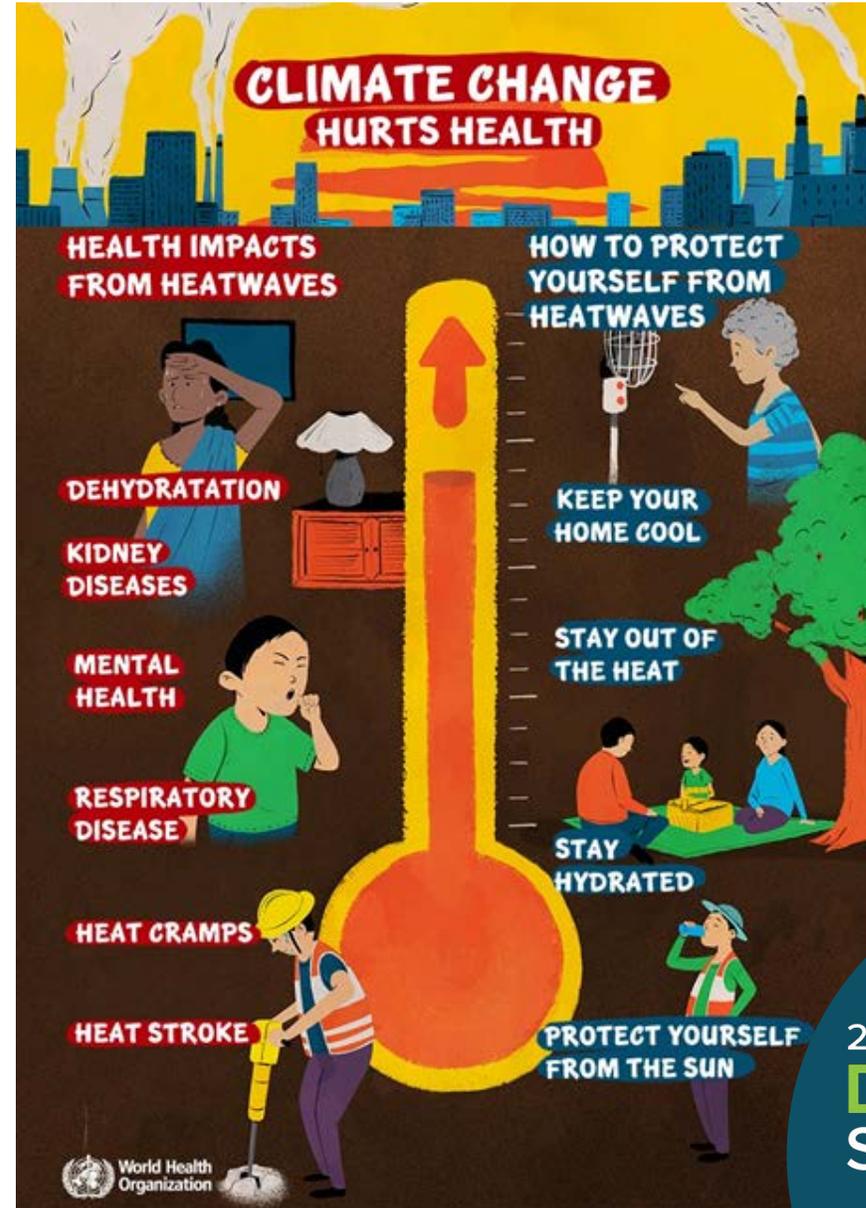
(NYT 2020)



# Health Impacts of Heat Waves

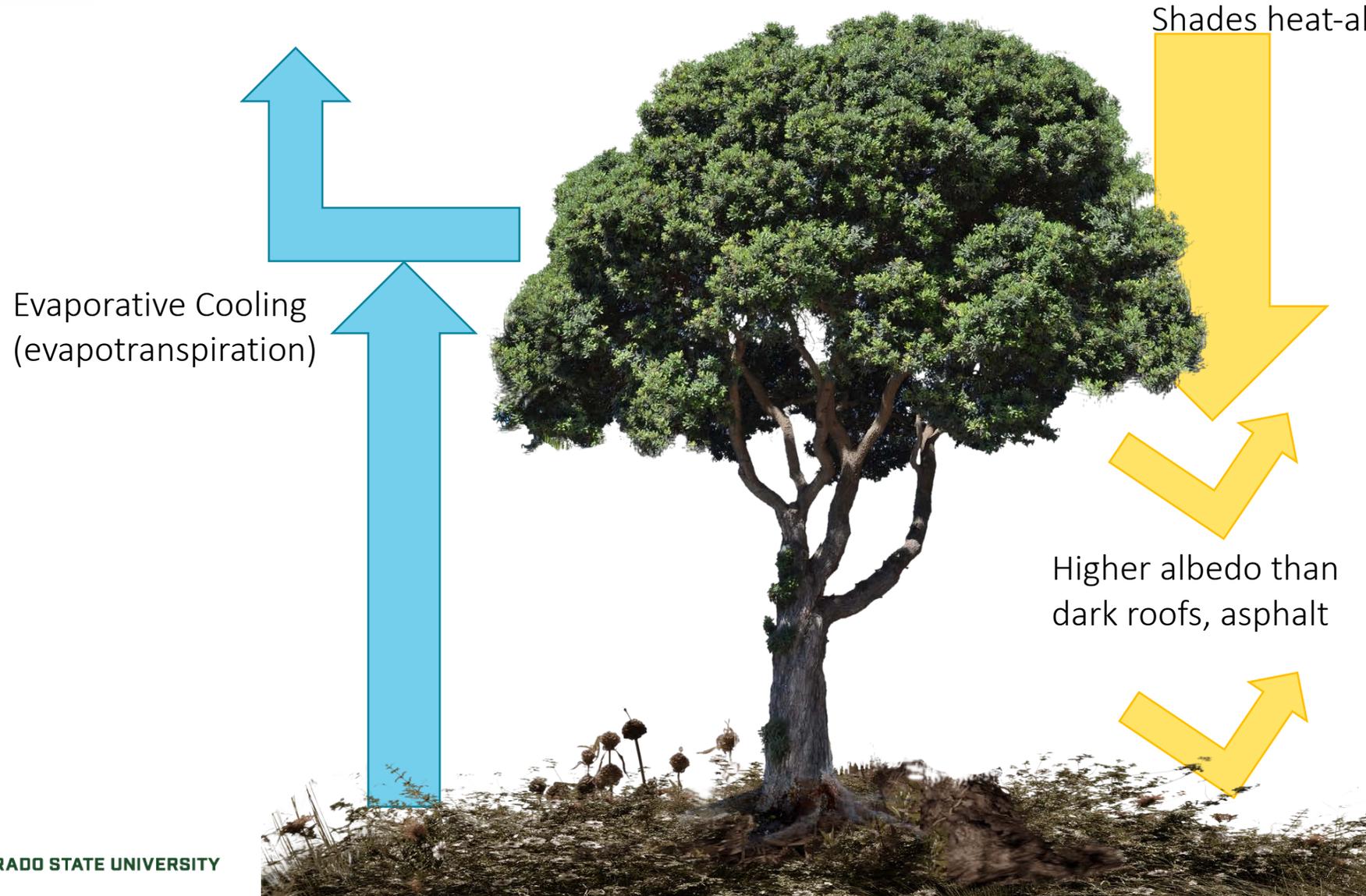
## Specific Mechanisms:

- Direct Heat-related illnesses
  - Heat stroke, hyperthermia, heat exhaustion
- Increase risk of dehydration and related conditions
- Cardiovascular disease risk
- Links to stress, violent crime
- Correlated to a wide range of hospitalizations, from diabetes to some kidney diseases.





# How can Trees and Green Space Cool Cities?



## Green spaces have additional benefits including

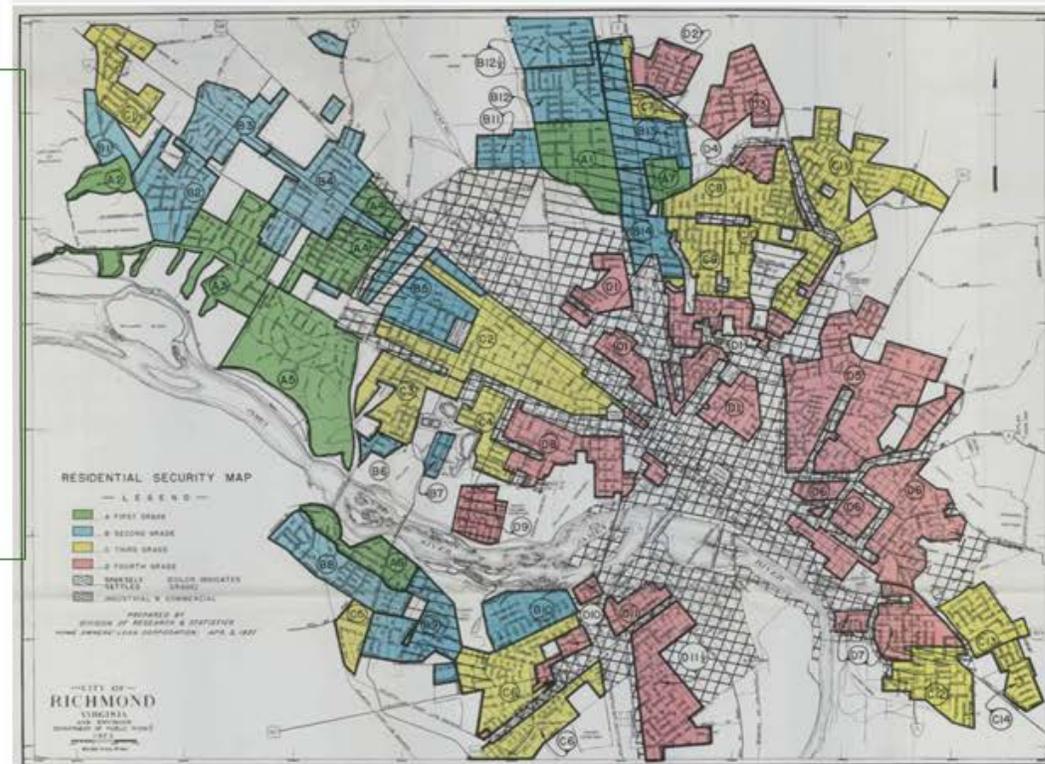
- improved air quality (some pollutants are absorbed),
- Facilitate physical activity and social interactions
- Calming/attention-restoring effects



# Redlining's Legacy: less green space and stronger heat waves in historically redlined neighborhoods

Green areas: desirable for investment, remain wealthier and predominately white.

**Green space: 42%**



Map of Richmond, Virginia

Redlined areas: still poorer, majority Black, lower rates of homeownership.

**Green space: 12%**



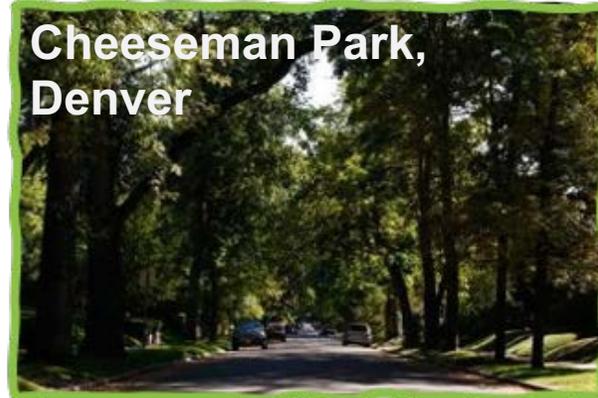
# Redlining's Legacy: less green space and stronger heat waves



Baltimore rowhouses in 1938.  
(John Vachon/Farm Security Administration/Library of Congress)

**Congress banned redlining with the Fair Housing Act of 1968, but cities still show its legacy.**

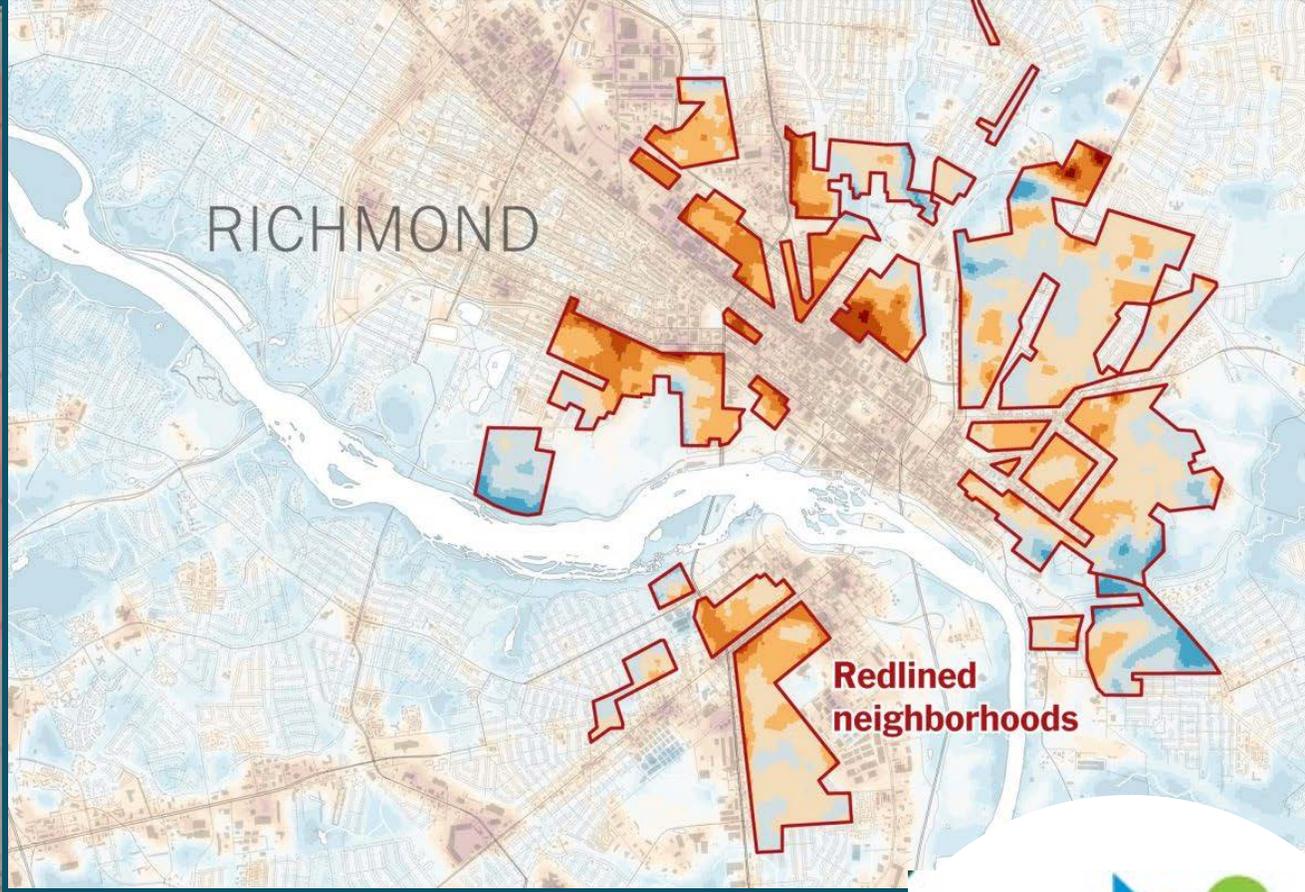
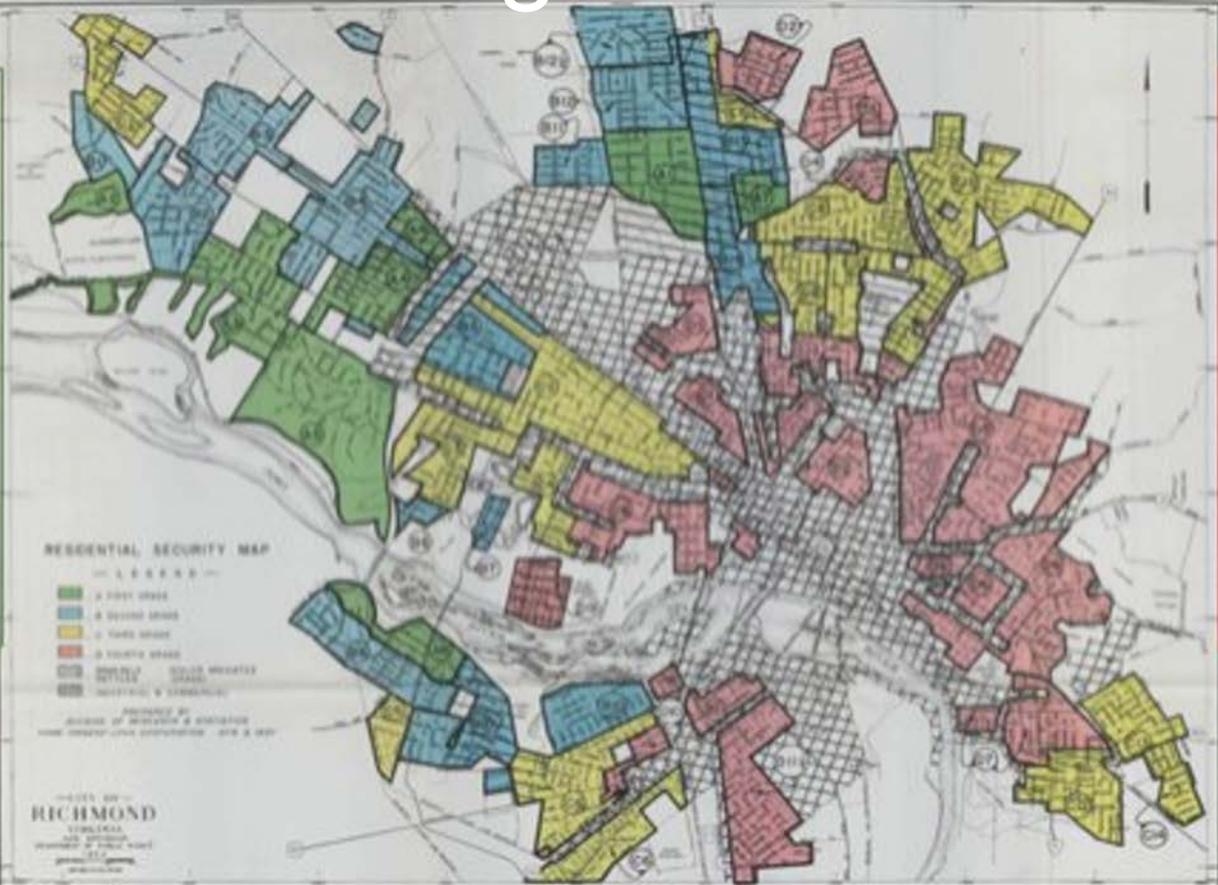
- City planners targeted redlined areas as cheap land: industry, highways, warehouses, public housing.
- Decline in homeownership, no investment by landlords in green space.
- Reduced lobbying power made for fewer tree-lined sidewalks and parks.
- More heat-absorbing surfaces (asphalt, dark roofs, etc.).
- Continue to have lower investments; also less-amenable existing infrastructure, and concerns about property value





FIRE

# Redlining's Legacy: less green space and stronger heat waves



Neighborhoods that are poorer and have more residents of color can be **5 to 20 degrees Fahrenheit hotter** in summer than wealthier, whiter parts of the same city

(NYT 2019)

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# Some cities are trying to address their redlining histories

- **Volunteers** using monitors on cars to measure temp and humidity to help **create heat maps**
- Projects could plant more trees, build shade structures and parks, closer grocery stores, community gardens
- **Redesign** buildings to increase air flow, reduce number of paved lots, use standalone shade structures, and use more light-colored pavement to reflect the sun's energy.
- **Redevelop** the public housing complex into a more walkable mixed-income neighborhood
- Denver [passed a new sales tax to fund parks and tree-planting](#), and city officials say they would like to add more green space in historically redlined areas.



# References

- Madrigano, J., Ito, K., Johnson, S., Kinney, P. L. & Matte, T. A Case-Only Study of Vulnerability to Heat Wave–Related Mortality in New York City (2000–2011). *Environmental Health Perspectives* **123**, 672–678 (2015).
- <https://www.nytimes.com/2020/09/30/climate/city-parks.html> (**Denver Wants to Fix a Legacy of Environmental Racism**)
- <https://www.nytimes.com/interactive/2020/08/24/climate/racism-redlining-cities-global-warming.html> (**How Decades of Racist Housing Policy left Neighborhoods Sweltering**)
- Shindell, D. *et al.* The Effects of Heat Exposure on Human Mortality Throughout the United States. *GeoHealth* **4**, (2020).
- Harlan, S. L. & Ruddell, D. M. Climate change and health in cities: impacts of heat and air pollution and potential co-benefits from mitigation and adaptation. *Current Opinion in Environmental Sustainability* **3**, 126–134 (2011).
- [https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6231a1.htm?s\\_cid=mm6231a1\\_w](https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6231a1.htm?s_cid=mm6231a1_w) (**Heat Illness and Deaths – New York City, 2000-2011**)

# Resources

- Explore Historical Redlining in Interactive Maps: <https://dsl.richmond.edu/panorama/redlining/#loc=5/39.623/-99.404>
- Page describing citizen science heat island mapping efforts: <https://www.citizenscience.gov/catalog/501/#>
- EPA impacts of heat islands: <https://www.epa.gov/heatislands/heat-island-impacts>
- CDC Overview of extreme heat event impacts: <https://www.cdc.gov/disasters/extremeheat/index.html>



# Moving Forward: Global, Academic, and Personal Changes

How can we be a part of the change we want to see?

# Environmental Racism Is Nothing New

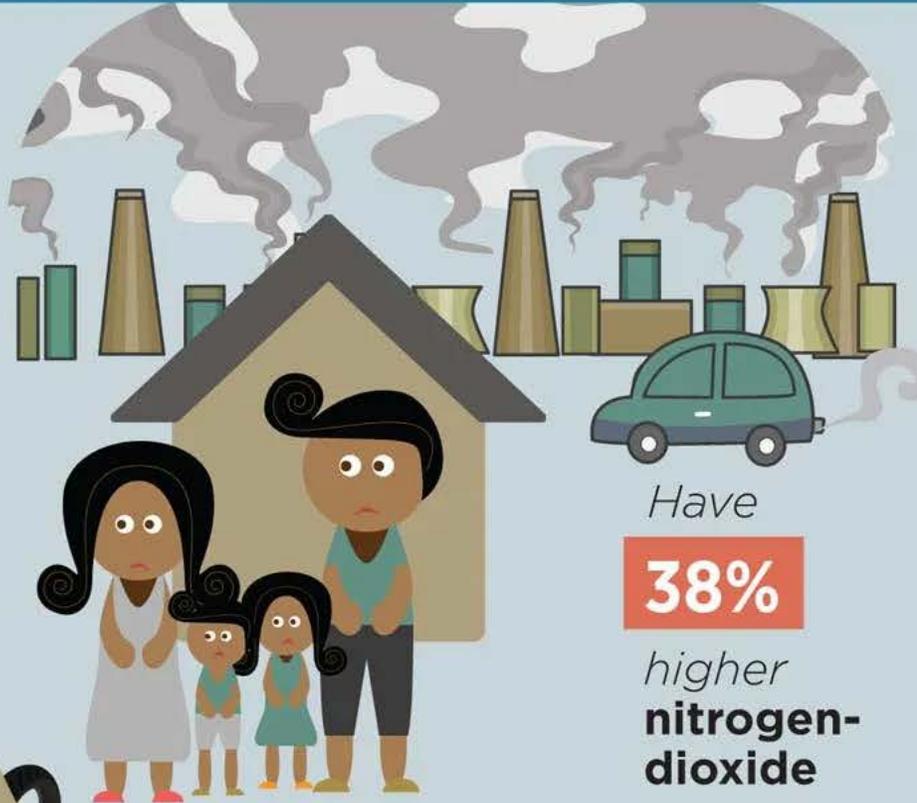
Race is the most significant predictor of a person living near contaminated air, water, or soil.

**56%**

of the population near **toxic waste sites** are people of color.



**THE Nation.**  
150  
INVESTIGATING PROGRESS SINCE 1865



People of color:

Have seen

**95%**

of their claims against polluters denied by the EPA.

Have

**38%**

higher **nitrogen-dioxide** exposure.

Are

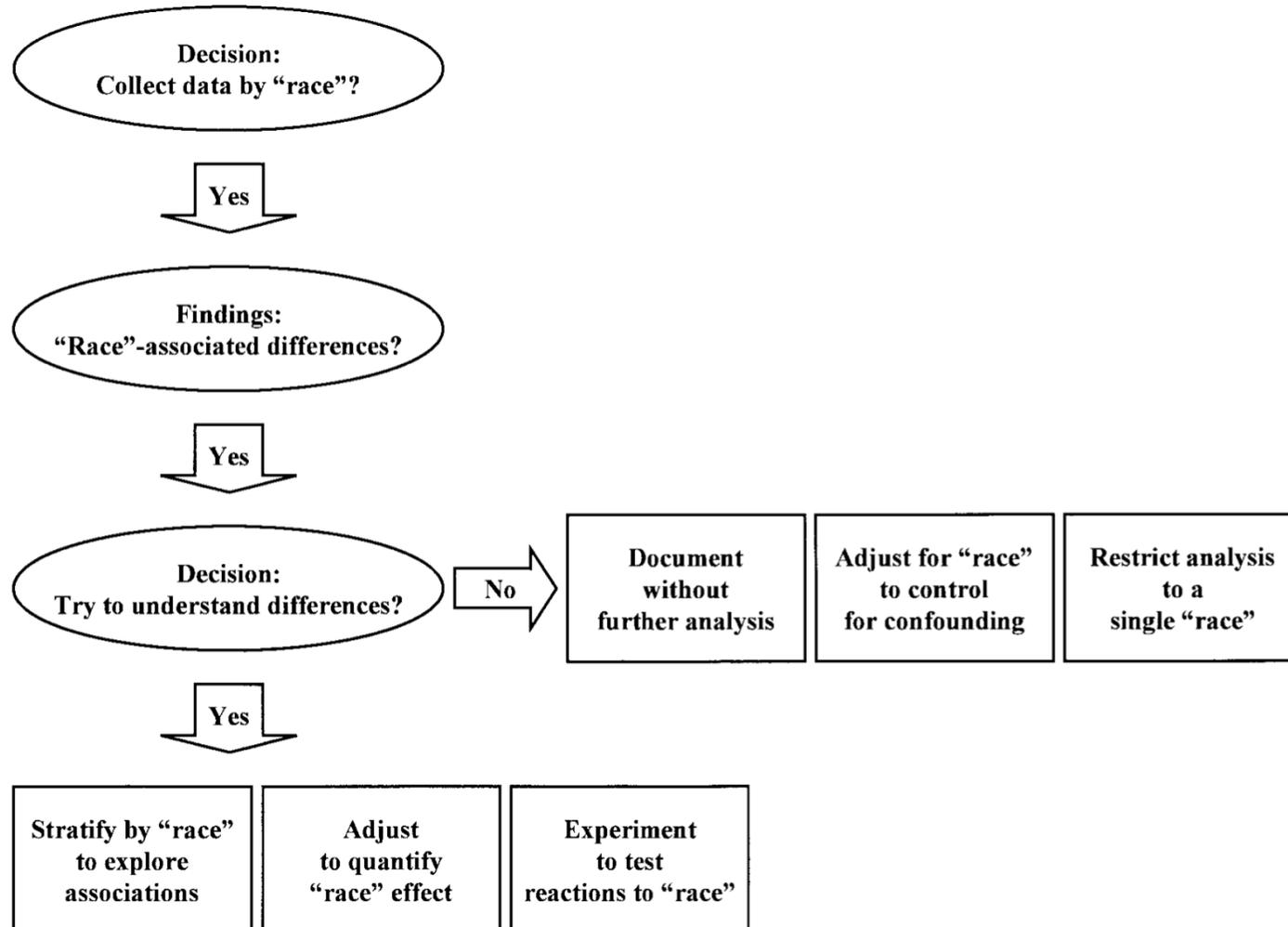
**2x**

more likely to live without **potable water** and **modern sanitation**.





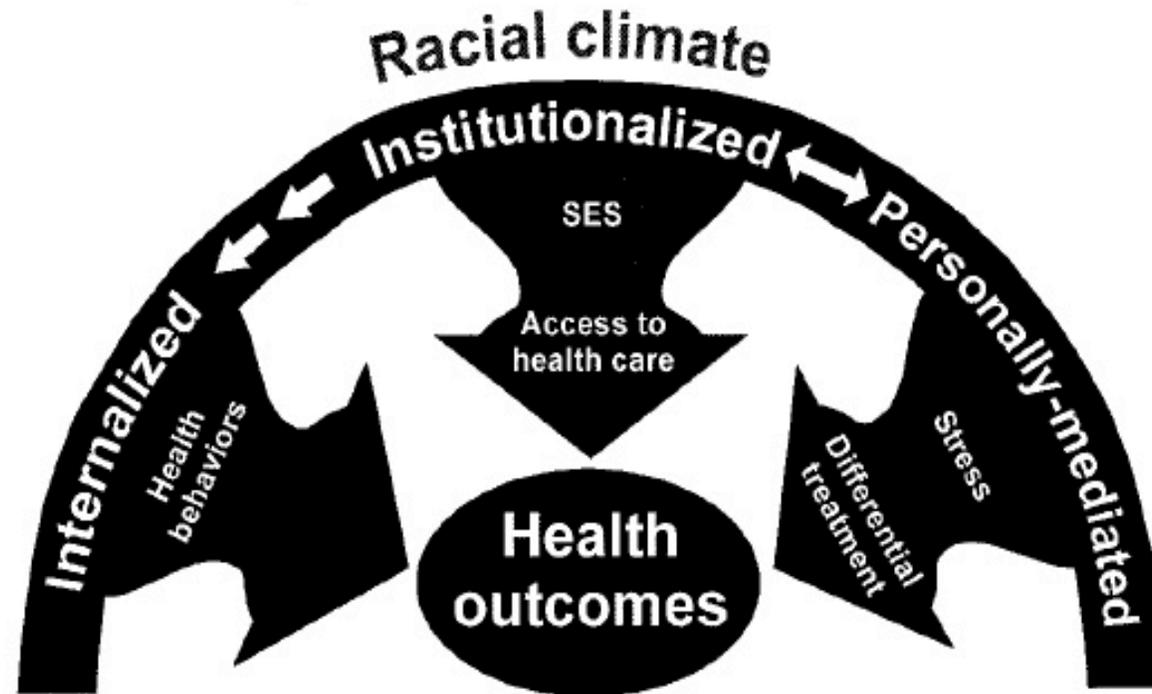
# Changes in Academia



# New Methods and Considerations When Discussing Race, Gender, SES, ETC

- 1.) Investigate the basis of observed, race associated differences in outcomes
- 2.) Acknowledge race as a social construct, Race is contextual
- 3.) Acknowledge diversity within racial groups
- 4.) Acknowledge associations between race and social class
- 5.) Acknowledge racism today beyond historical context
- 6.) Be precise about the use of race and continue to record disparities based on race as long as race exist
- 7.) Diversify Epidemiology as a profession
- 8.) Partner with/ Work for communities

# The Impacts of Racism on Health



**FIGURE 1.** The impacts of racism on health, illustrating the relation between institutionalized racism, personally mediated racism, and internalized racism and various factors that contribute to race-associated differences in health outcomes. SES, socioeconomic status.

*Invited Commentary: Race, Racism and the Practice of Epidemiology (Jones 2001)*

# Thank you!



# EVALUATIONS

**Wednesday, October 21** Sessions:  
<https://col.st/lqtBR>