JOINT EFFECTS OF AIR POLLUTION & SOCIAL FACTORS ON CARDIOVASCULAR HEALTH USING A CBPR APPROACH

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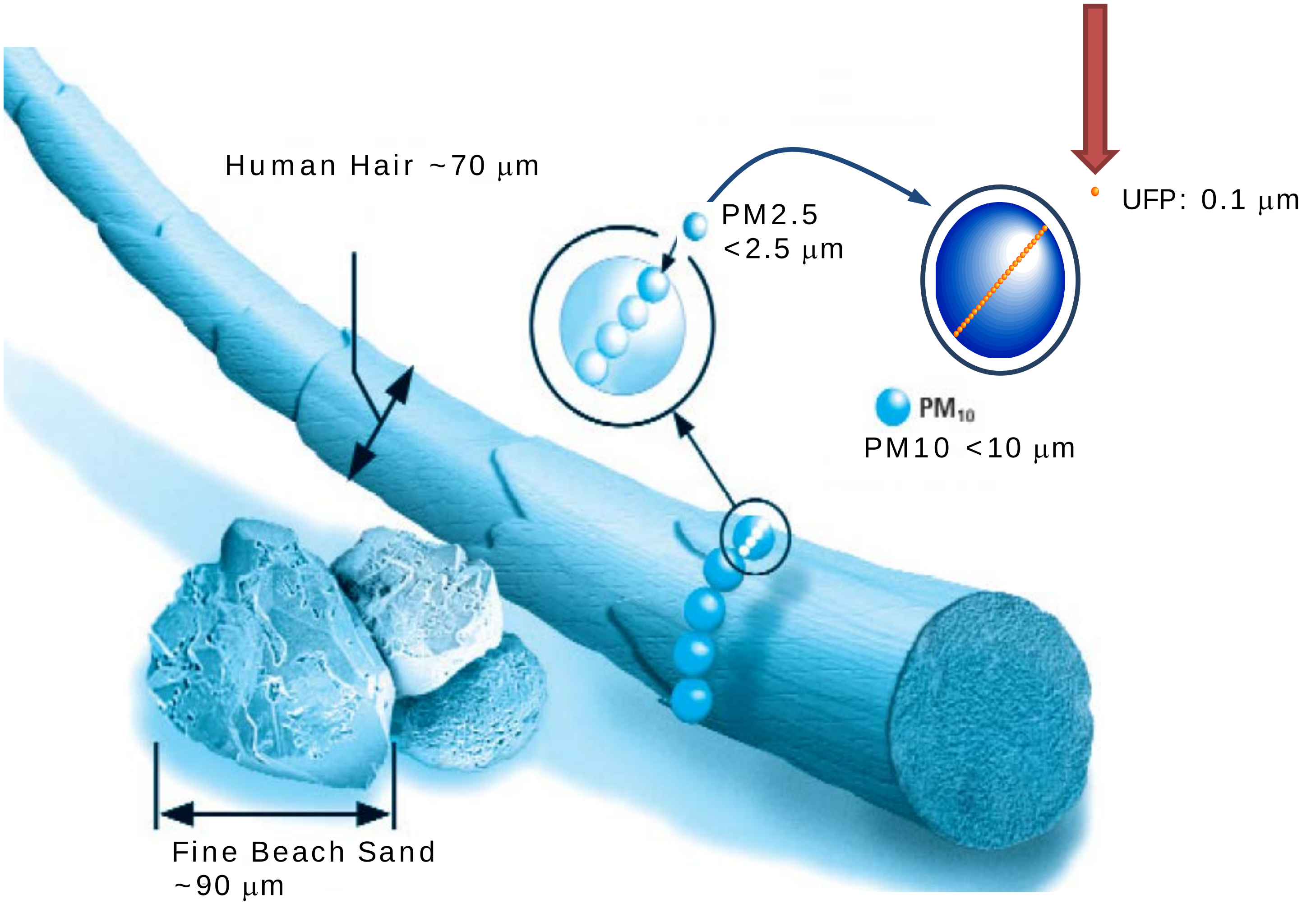
Presentation to the University of Kentucky's Center for Appalachian Research in Environmental Science

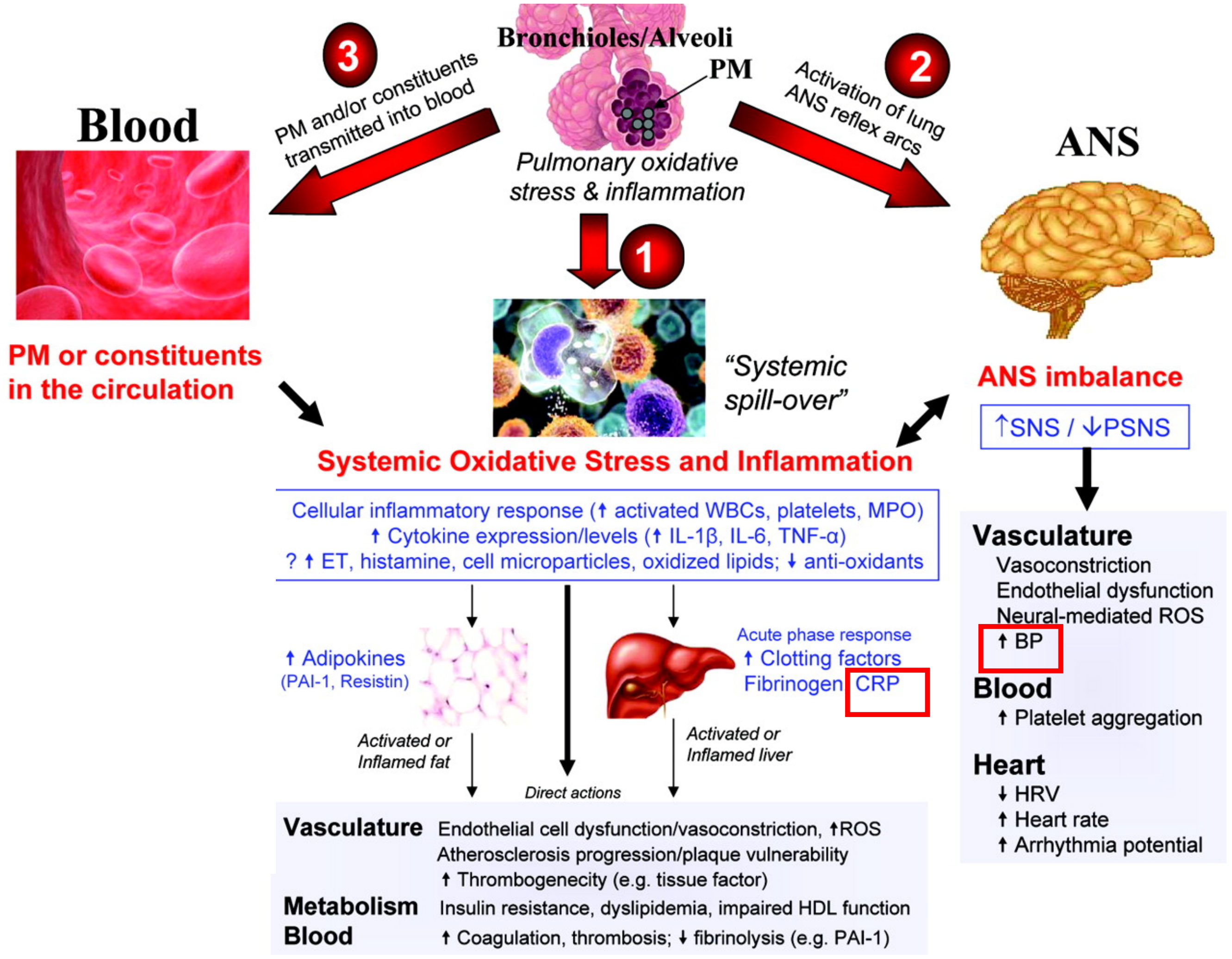
September 15, 2021

Need	Daily Amount	Maximum Deprivation
Food		
Water		
Air		



Source: U.S. Environmental Protection Agency

CARDIOVASCULAR EFFECTS



Adapted from Brook *et al,* Circulation 2010;121:2331-2378

Boston Puerto Rican Health Study (BPRHS)

- Established group of researchers and community partners comprised the Boston Puerto Rican Center for Population Health and Health Disparities (2003-2017) now based at the UMass Lowell Center for Population Health (UML-CPH).[1]
  - The BPRHS was focused on the role of stress on physical disability, cognitive decline and metabolic conditions.[2]
  - The project was broadened to evaluate air pollution as an important environmental risk factor for disease.
- Aim 1: Test the association between particulate air pollution and cardiovascular disease markers in the BPRHS.
- Aim 2: Evaluate effect modification by psychosocial stressors.

REVIEW Open Access

CrossMark

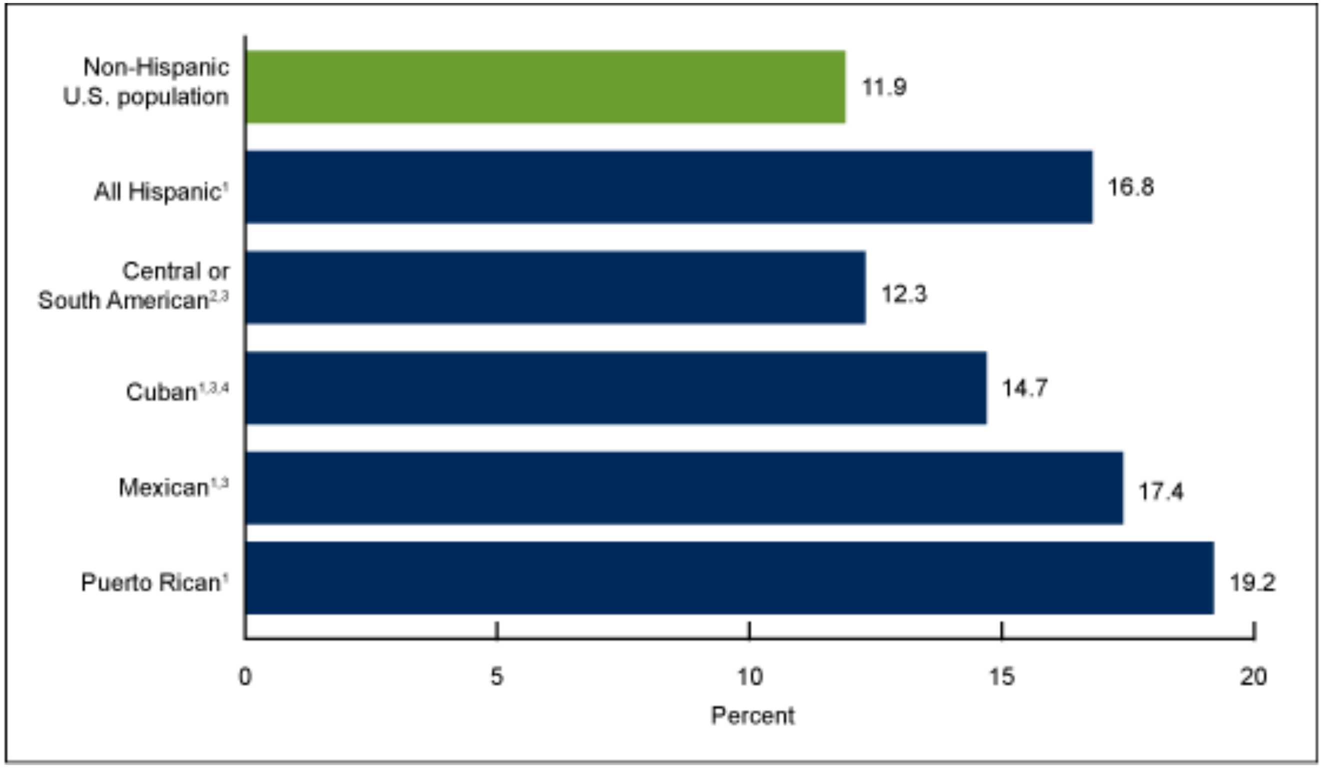
Air pollution, cardiovascular endpoints and susceptibility by stress and material resources: a systematic review of the evidence

Christina H. Fuller[1*], Karla R. Feeser[1], Jeremy A. Sarnat[2] and Marie S. O'Neill[3]

[1] https://www.uml.edu/Research/UML-CPH/

[2] Tucker *et al*. **The Boston Puerto Rican Health Study, a longitudinal cohort study on ... disparities in Puerto Rican adults: challenges and opportunities**. BMC public health.

Age-adjusted percentage of adults aged 18 and over who were in fair or poor health, by ethnicity and Hispanic subgroup: United States, 2010–2014



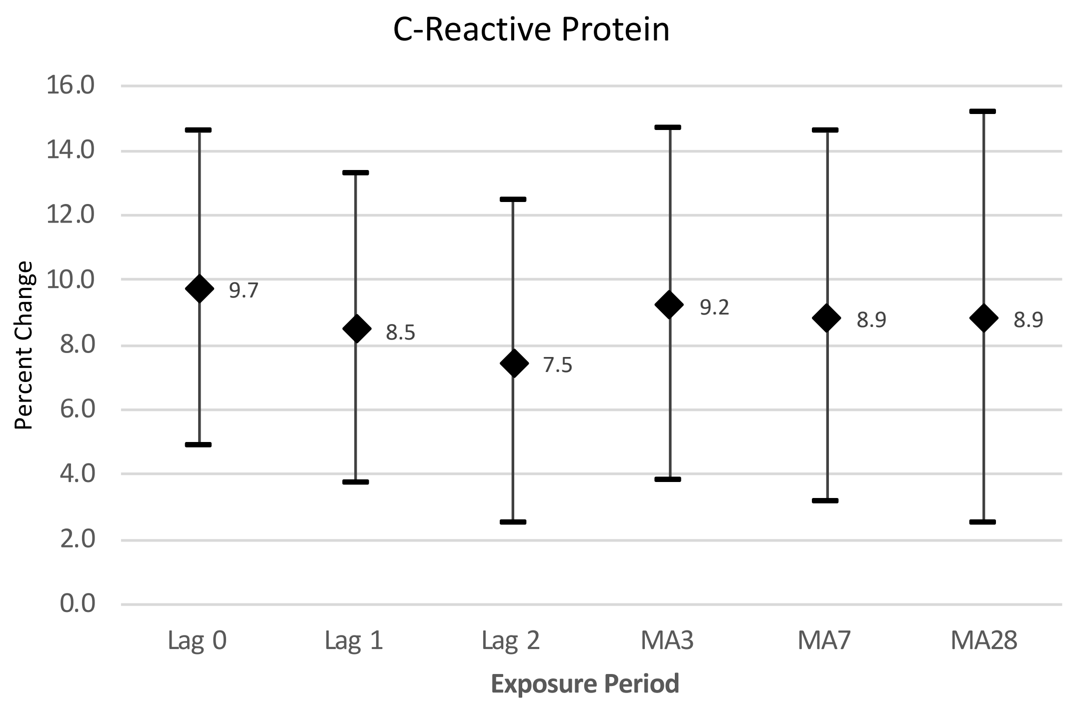
SOURCE: NCHS, National Health Interview Survey, 2010–2014.

Table 2: Repeated measures for cardiovascular and stress markers in the Boston Puerto Rican Health Study (BPRHS) (N=1499)

Characteristic	Baseline Mean (SD) (N=1499)	2 year Mean (SD) (N=1258)	5 year Mean (SD) (N=891)	Intra-Class Correlation
Cardiovascular health markers				
Systolic blood pressure (mmHg)	134.9 (19.2)	135.8 (13.9)	134.1 (18.5)	0.53
C-reactive protein (mg/L)	6.3 (8.7)	6.3 (11.5)	6.9 (9.8)	0.39
Paper based stress measures				
Depression score	20.3 (13.2)	18.2 (12.5)	16.5 (11.1)	0.53
Perceived stress scale	23.6 (9.4)	22.9 (8.7)	27.1 (7.2)	0.27

[3] Fuller CH *et al*. **Sex differences in the interaction of short-term particulate matter exposure and psychosocial stress on C-reactive protein in a Puerto Rican cohort.** Social Science & Medicine- Population Health 2019; 9: 100500.

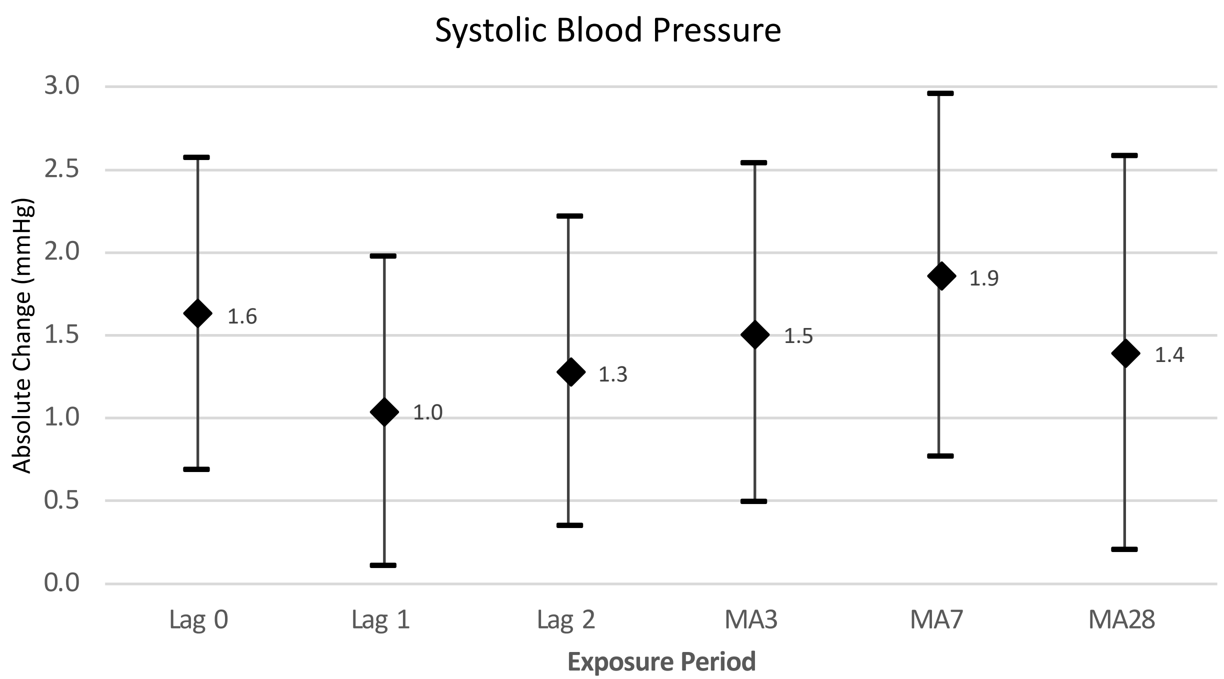
Findings: C-reactive protein



Adjusted for age, sex, waist-hip ratio, diabetes and medications.

Fuller CH *et al*. **Estimation of ultrafine particle concentrations at near-highway residences using data from local and central monitors**. Atmospheric environment 2012, 57:257-265.

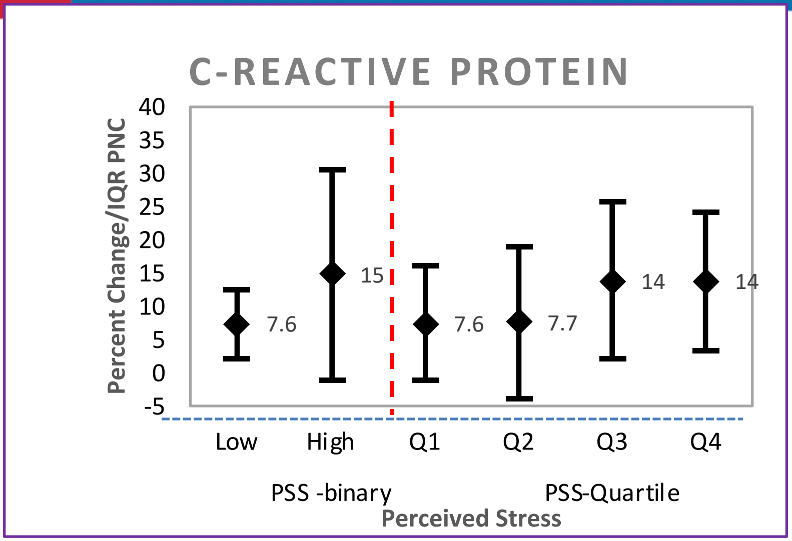
Findings: Systolic blood pressure

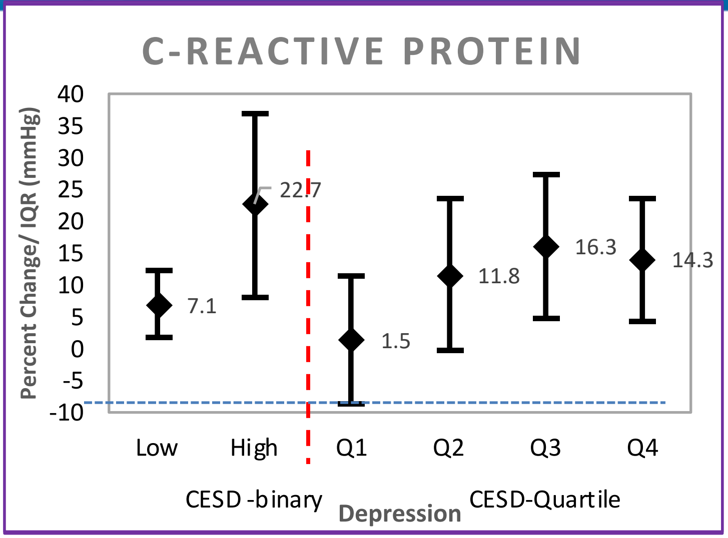


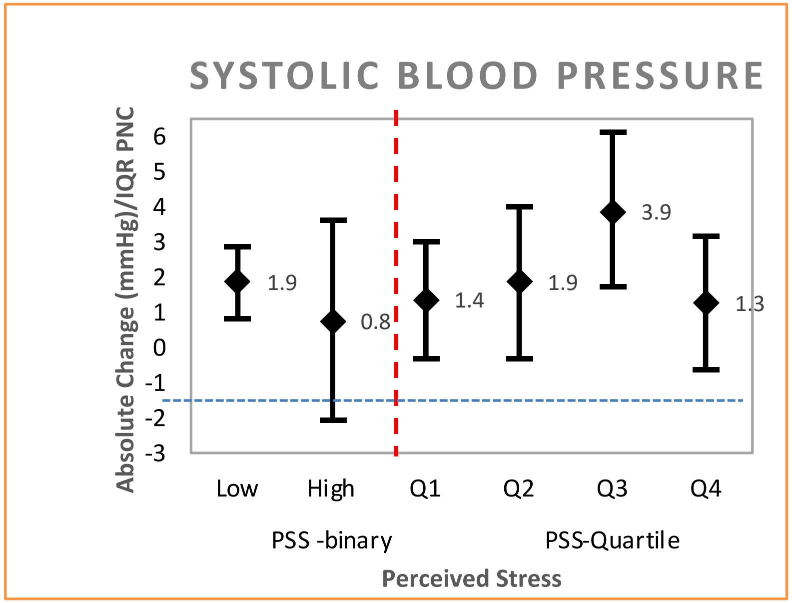
Adjusted for age, sex, waist-hip ratio, education and medications.

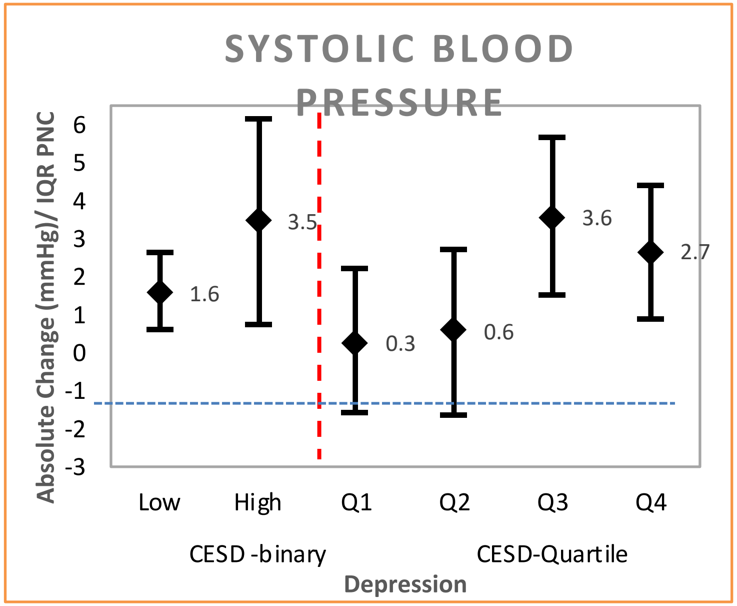
Fuller CH *et al*. **Estimation of ultrafine particle concentrations at near-highway residences using data from local and central monitors**. Atmospheric environment 2012, 57:257-265.

Possible modification by psychosocial stressors









[3] Fuller CH *et al*. **Sex differences in the interaction of short-term particulate matter exposure and psychosocial stress on C-reactive protein in a Puerto Rican cohort.** Social Science & Medicine- Population Health 2019; 9: 100500.

Interpretation

- Increases in UFP were associated with higher levels of cardiovascular markers: C-reactive protein and systolic blood pressure.
- Effects were stable across exposure periods, contrary to some past studies[3,4]
- Sources of variation remain in this population based on indicators such as perceived stress and depression.
- Further examination can yield insight into susceptibilities and opportunities for interventions.

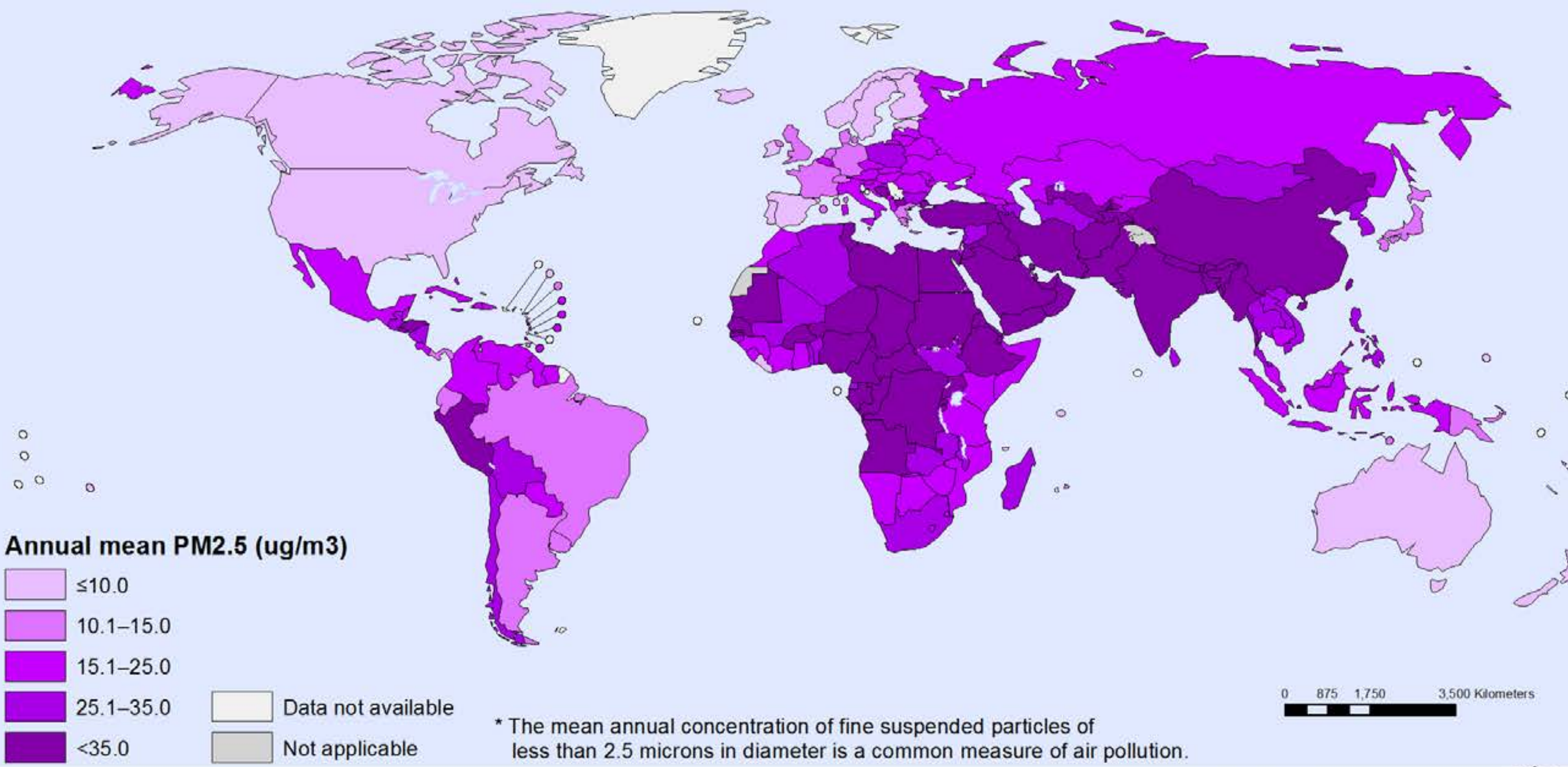
[1] Hertel S *et al*. **Influence of short-term exposure to ultrafine and fine particles on systemic inflammation.** European journal of epidemiology 2010, 25(8):581-592.

[2] Fuller CH *et al*. **Estimation of ultrafine particle concentrations at near-highway residences using data from local and central monitors**. Atmospheric environment 2012, 57:257-265.

[3] Fuller CH *et al*. **Sex differences in the interaction of short-term particulate matter exposure and psychosocial stress on C-reactive protein in a Puerto Rican cohort.** Social Science & Medicine- Population Health 2019; 9: 100500.

AIR POLLUTION DISPARITIES

Annual mean concentrations of fine particulate matter (PM2.5) in urban areas (µg/m3), 2014*

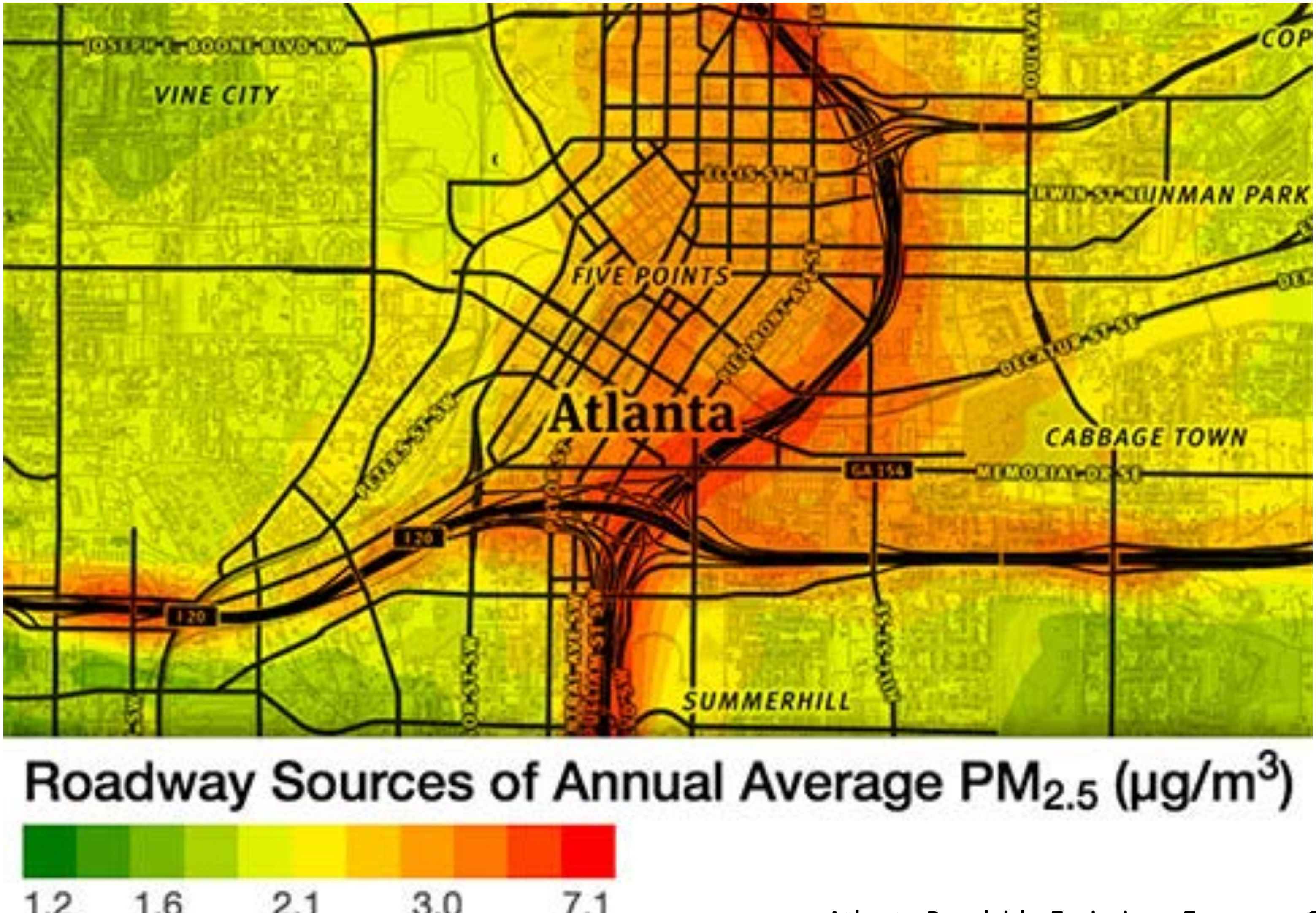


* The mean annual concentration of fine suspended particles of less than 2.5 microns in diameter is a common measure of air pollution.

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Information Evidence and Research (IER)
World Health Organization

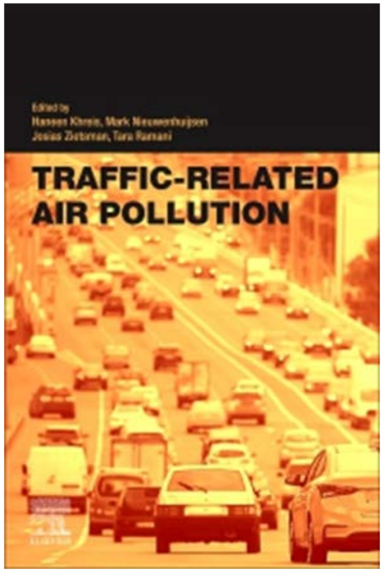
World Health Organization



Atlanta Roadside Emissions Exposure Study,
Atlanta Regional Commission

Reasons for air pollution disparities

- Concentration of industry
- Redlining
- Land pricing
- Zoning
- Historically poor and minority communities are close to sources

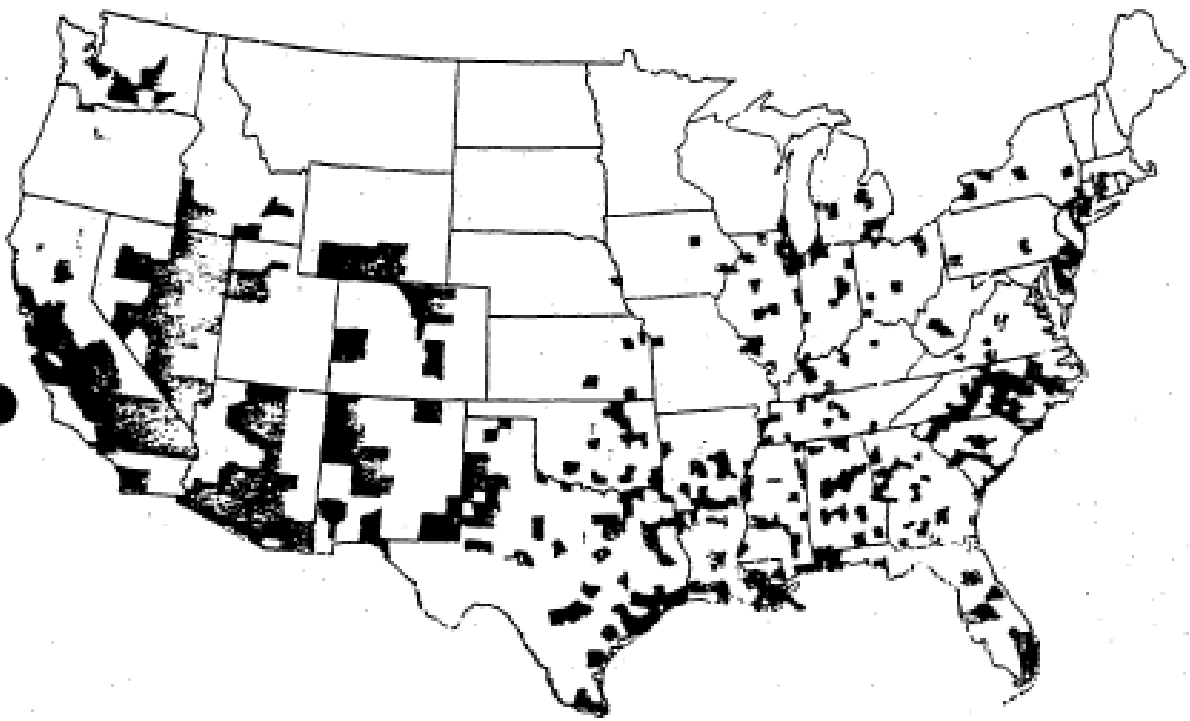


Fuller & Brugge, Chapter 20, Traffic-Related Air Pollution (edited book)

The Environmental Justice movement

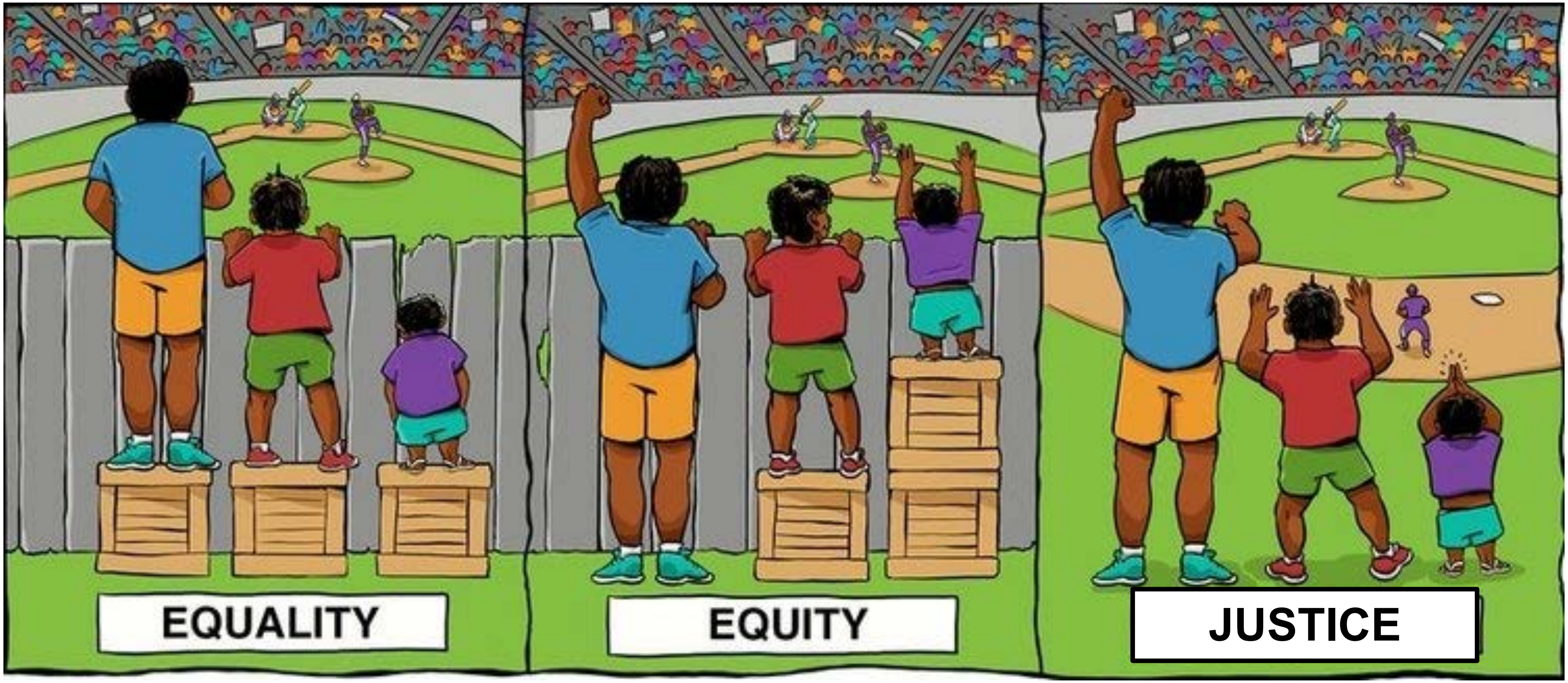
TOXIC WASTES AND RACE
In The United States

A National Report on the Racial and Socio-Economic Characteristics of Communities with Hazardous Waste Sites



EJ Movement

Environmental Justice purpose

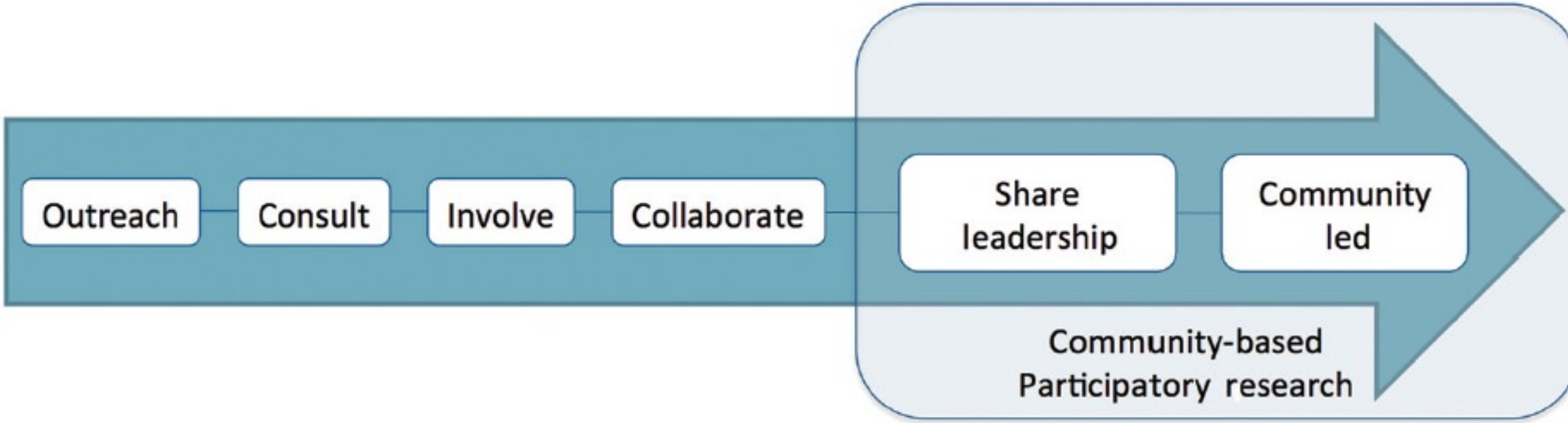


OPPORTUNITIES THROUGH COMMUNITY ENGAGEMENT

Principles of Environmental Justice

- 5) **Environmental Justice** affirms the fundamental right to political, economic, cultural and environmental **self-determination** of all peoples.
- 7) **Environmental Justice** demands the right to **participate as equal partners** at every level of decision-making, including needs assessment, planning, implementation, enforcement and evaluation.
- 16) **Environmental Justice** calls for the **education of present and future generations** which emphasizes social and environmental issues, based on our experience and an appreciation of our diverse cultural perspectives.

Continuum of community involvement in research



Community involvement can range from outreach to research collaboration.

In community-based participatory research, community members share leadership as equals or lead the research.

COMMUNITY ASSESSMENT OF FREEWAY EXPOSURE AND HEALTH (CAFEH)

Five-year cross-sectional study of ultrafine particle concentrations near a highway and markers of inflammation and blood pressure.

Community-based Participatory Research study (CBPR)

Neighborhoods involved

Somerville

South Boston/Dorchester

Chinatown/Malden

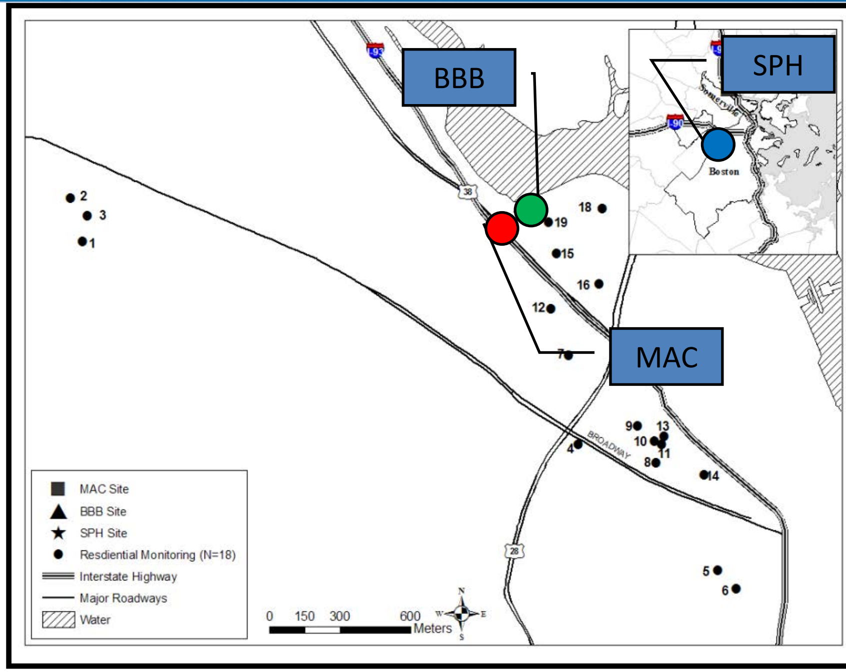
New housing next to the I-93 tunnel exit

www.cafehresearch.org

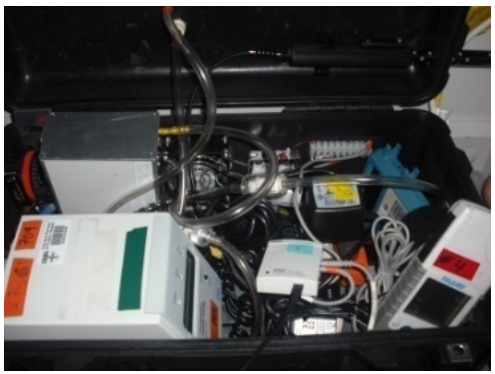
Pollution Monitoring

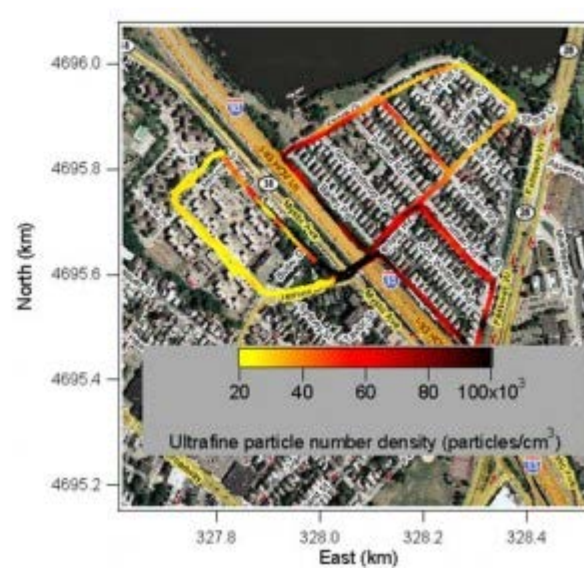
<u>Monitored pollutants and parameters</u>

- Particle concentration and size, PM mass, wind speed, wind direction, temperature, humidity

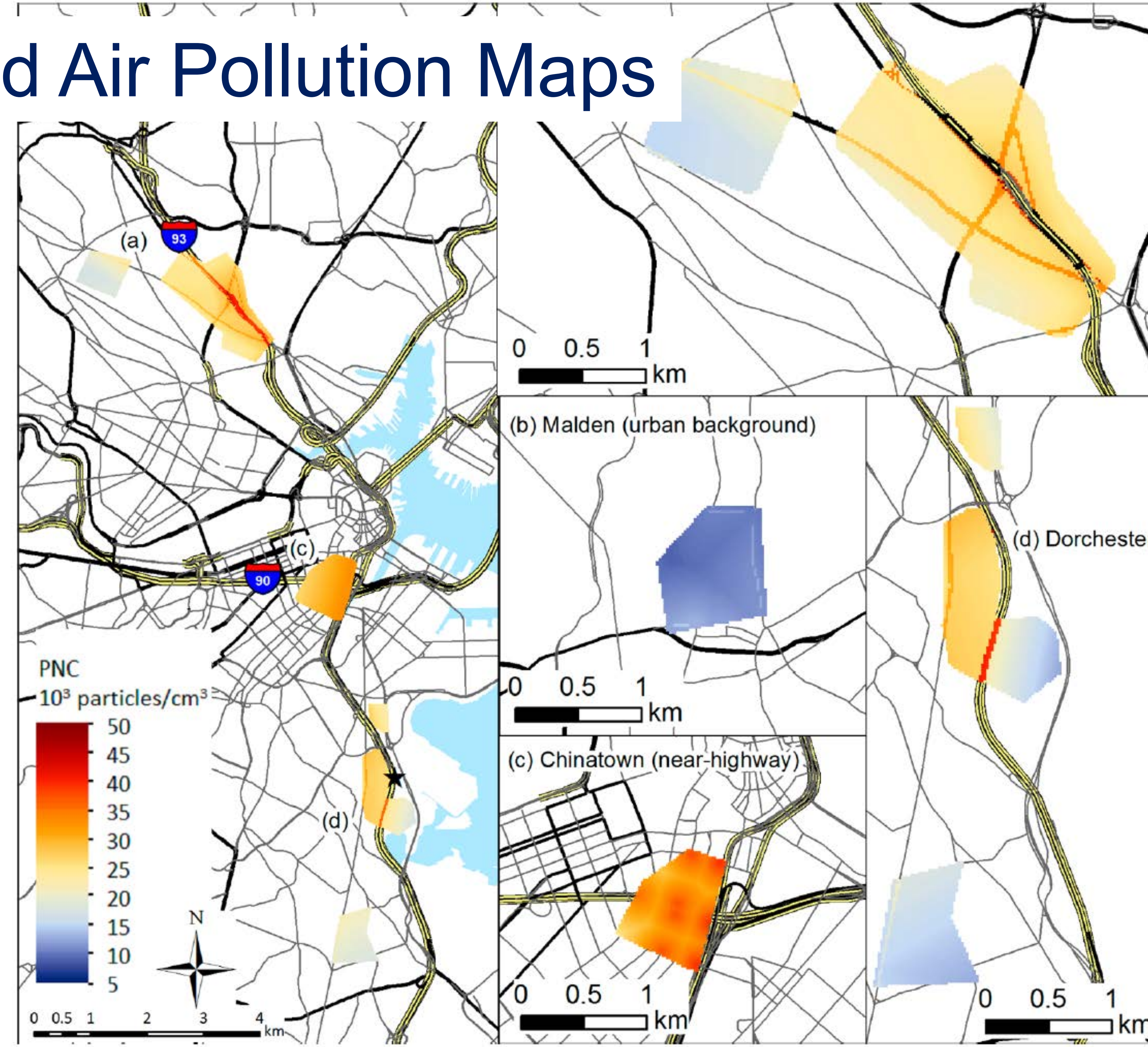


- Stationary, mobile and residential monitoring



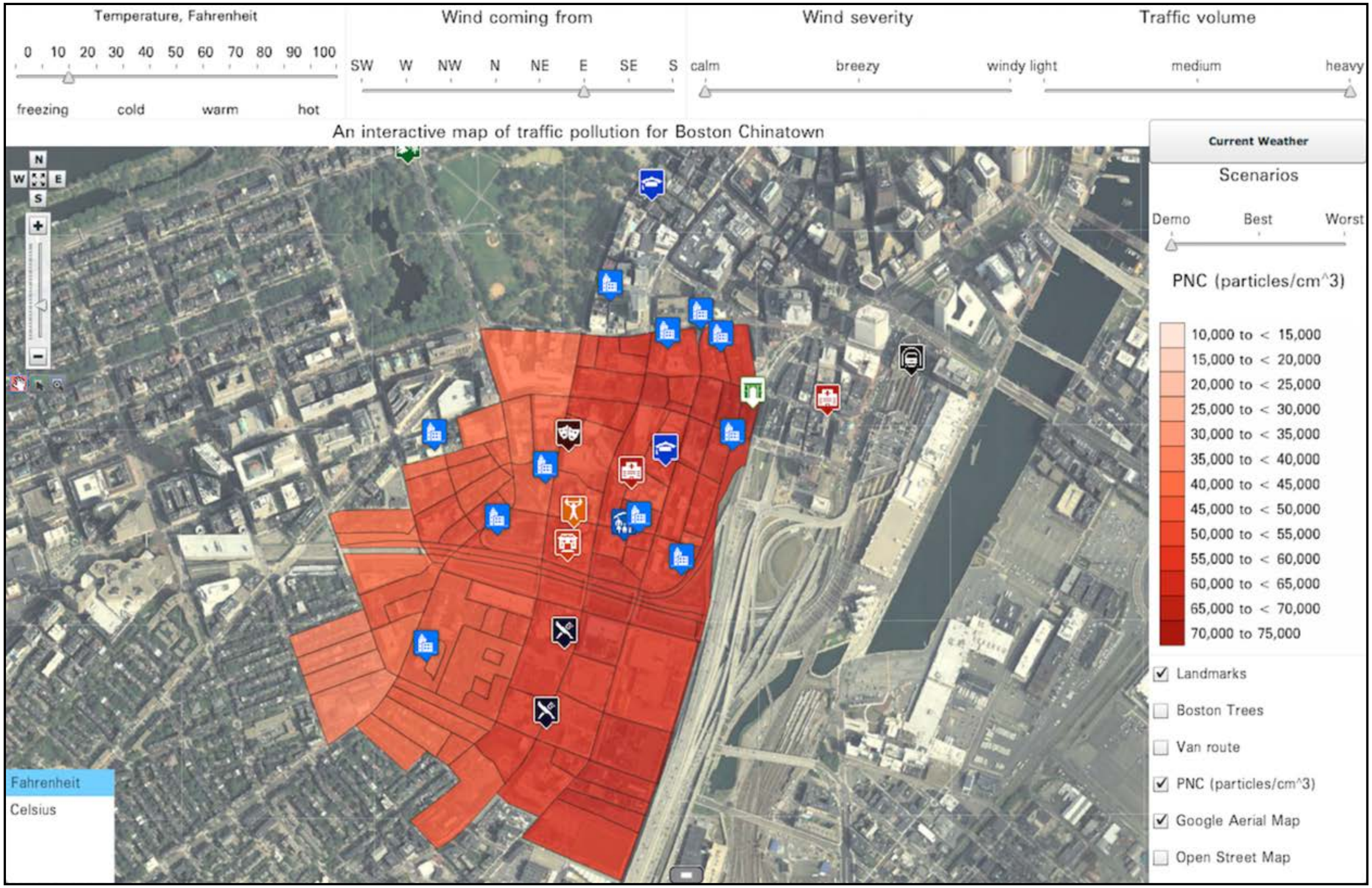


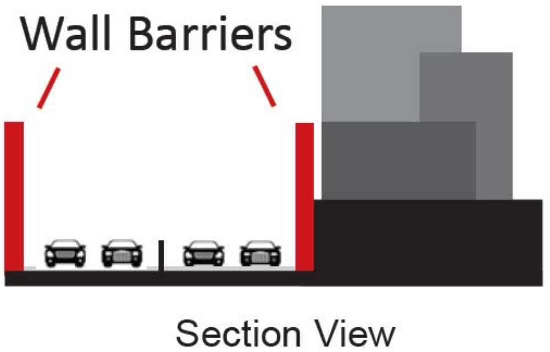
Detailed Air Pollution Maps

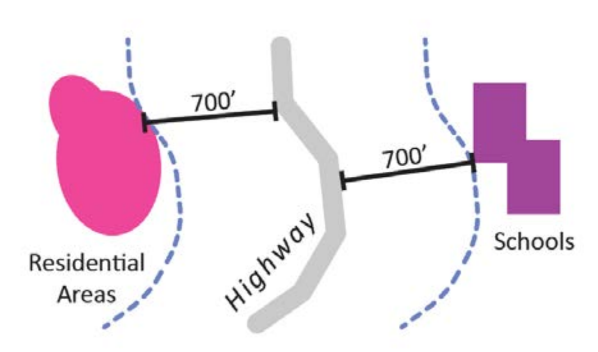


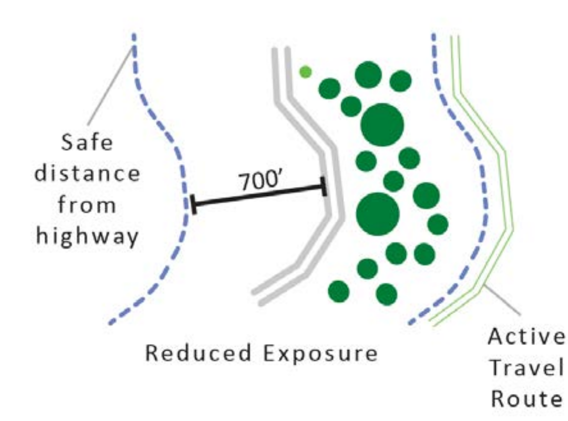
Patton AP, Zamore W, Naumova EN, Levy JI, Brugge D, Durant JL*Environmental Science and Technology* (2015).

Interactive Map of Chinatown Traffic Pollution



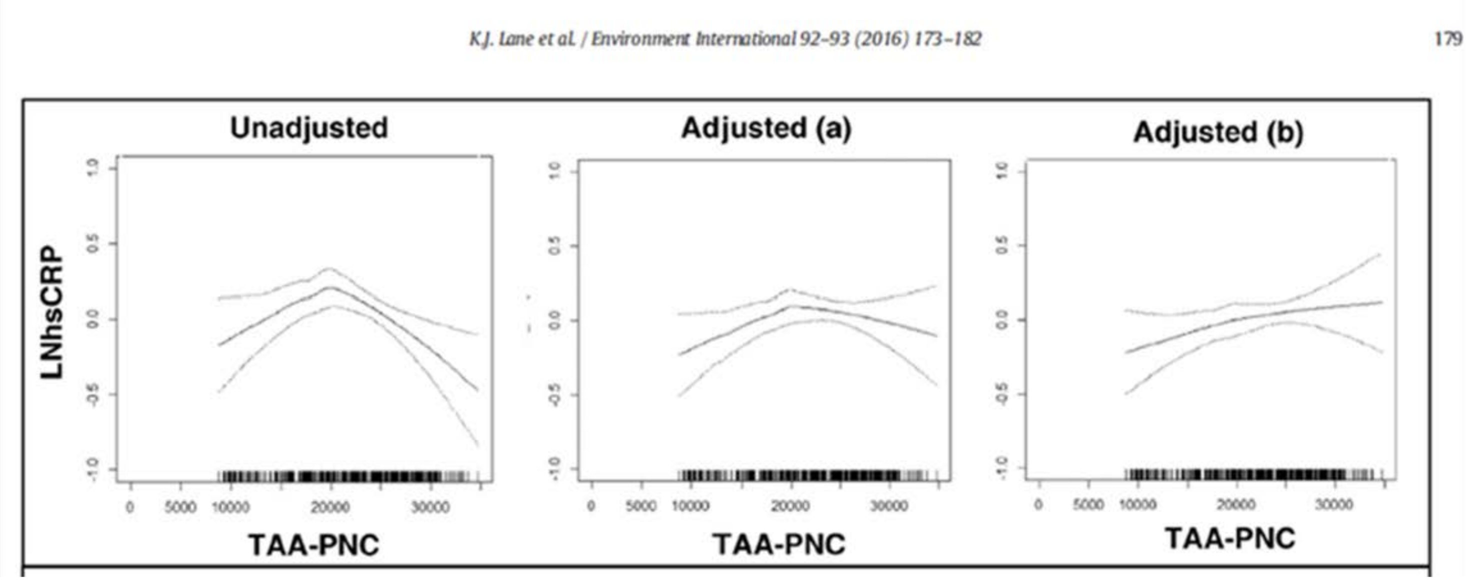






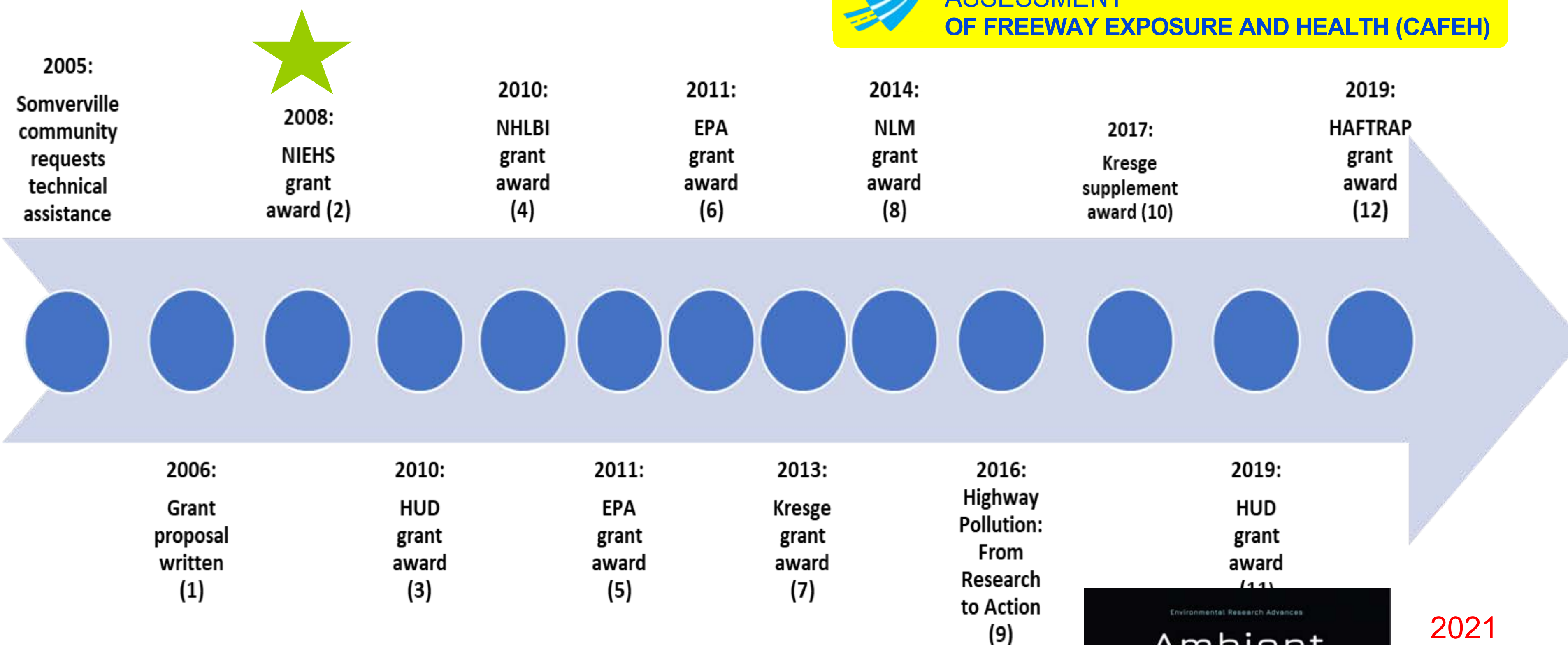
Design charrettes with architects, designers, planners, environmental health experts, agencies, and community members

Estimated Health Impacts from UFP

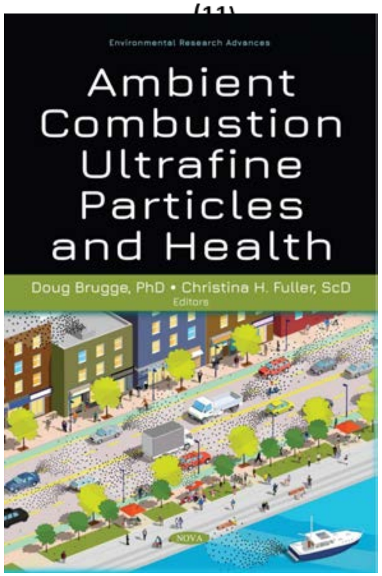


Condition	Expected cases over 5 years
Coronary heart disease (CHD)	22 (0-52)
Death from CHD	44 (17-78)
Ischemic stroke	32 (1 to 78)
Death post-stroke	5 (0 to 11)
Type 2 diabetes	1 (7 to 256)
Lung cancer	16 (2 to 36)
Childhood asthma	52 (3 to 138)
Childhood autism	4 (0 to 11)

COMMUNITY
ASSESSMENT
OF FREEWAY EXPOSURE AND HEALTH (CAFEH)



2021



Approximately 60 journal articles on UFP monitoring and modeling, exposure assessment, environmental justice, health literacy, Reviews, Methods, Policy and CBPR

Brugge D, Fuller CH editors: Ambient Combustion-Related Ultrafine Particles and Health. 1st edition. Hauppauge, NY: Nova Science Publishers; 2021.

Trees as an intervention

Measure the differences in particulate matter next to tree barrier sites, combination sites (tree and sound barrier sites) and sites without barriers.

Atlanta Researcher Looks To Trees To Help Ease Highway Air Pollution

By Molly Samuel | WABE News

Link

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality

Table 1: Average particle number comparing roadside and behind barrier locations at multiple sites in the Atlanta (USA) metropolitan area

Site	Date	Barrier type	Roadside mean(sd)	Barrier mean(sd)	Absolute difference behind barrier	Percent difference behind barrier
S1	7/17/2020	Tree	6,965 (2,519)	6,768 (2,234)	-197	-2.9%
S1	7/22/2020	Tree	19,345 (15,613)	20,373 (18,514)	1027	5.0%
S1	7/24/2020	Tree	22,974 (14,547)	15,748 (9,915)	-7225	-45.9%
S1	9/3/2020	Tree	15,938 (10,975)	15,489 (9,491)	-449	-2.9%
S3	9/8/2020	Combo	10,136 (4,059)	10,902 (2,016)	-63	-0.6%
S3	8/20/2020	Combo	7,982 (2,456)	7,234 (1,807)	-747	-10.3%
S5	9/1/2020	Tree	5,800 (981)	7,067 (3,213)	1266	17.9%
S5	8/27/2020	Tree	29,848 (11,869)	27,176 (12,887)	-2672	-9.8%

Benefits of CBPR

for the Community

1) Demystify science and enhance citizen understanding

2) Increase scientific literacy -> people will appreciate science when it is for and with the people

3) Empower the community to take action

for the Research

A) Pursue relevant research questions

B) Incorporate specific knowledge concerning exposures and outcomes

C) Catalyze solutions that can be more readily adapted by communities

Challenges

- Time, time, time!
- Balancing research and community priorities
- Long-term versus short-term goals
- Changing the power dynamics
- Resource sharing
- Respect from the scientific community

Thank you

<u>Funders</u>

CAFEH

Tisch College Educating Active Citizens
PEO
Tufts Community Research Center
United States Environmental Protection Agency
NIEHS National Institute of Environmental Health Sciences
THE KRESGE FOUNDATION
U.S. Department of Housing and Urban Development
NIH National Heart, Lung, and Blood Institute
NATIONAL LIBRARY OF MEDICINE
Tufts University Institute of the Environment

TREE

NIH National Institute of Environmental Health Sciences

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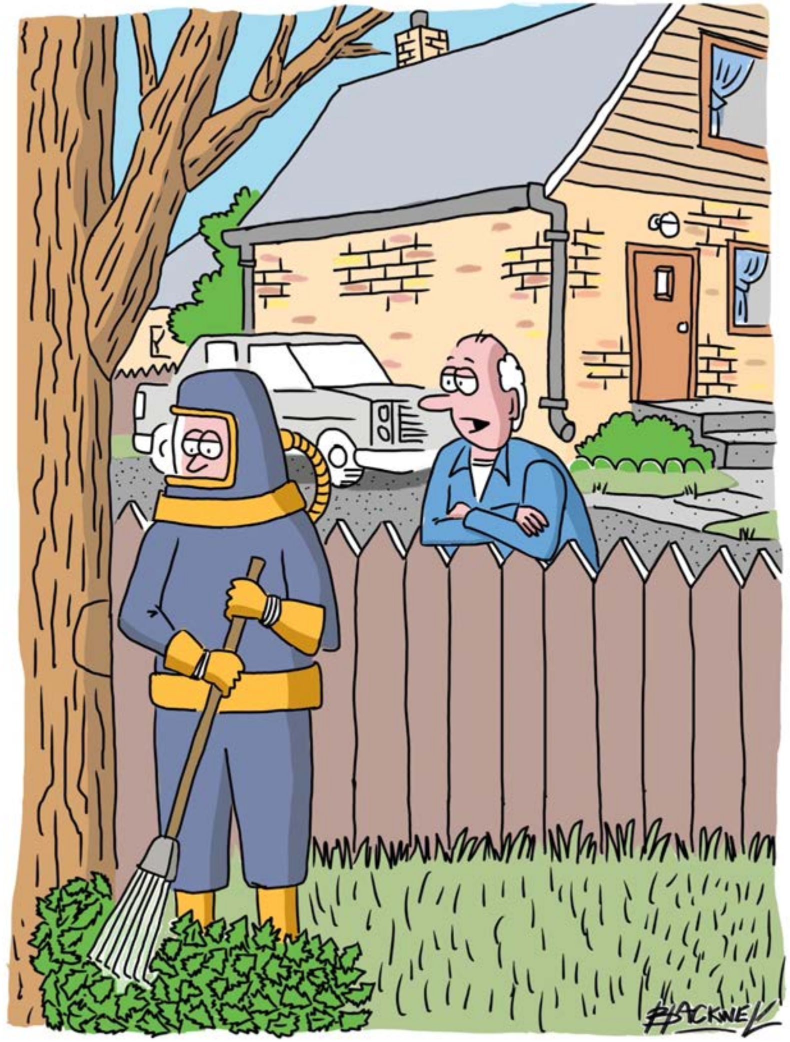

"I GUESS YOU HEARD THE AIR QUALITY WARNINGS?"

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UNITED
Van Lines
UNITED
CLEARANCE
93
TUNNEL
3 MILES