The Complex Interactions Between Socio-Economic Position and Traffic-Related Air Pollution Effects

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Health is socially patterned

- Socio-economic gradients not confined to just ‘the poor’-seen across whole range
- Individual & area level social determinants
- Influences occur throughout life course
- Environmental (physical) exposures may contribute to observed gradients

Kawachi I, O'Neill MS. Exploration of health disparities. In: Goehl TJ, Olden K, Editors. Essays on the future of environmental health research: A tribute to Dr Kenneth Olden. http://purl.fdlp.gov/GPO/gpo4599

http://permanent.access.gpo.gov/gpo4599/p.%20100-107/7630.pdf.

Research Triangle Park, NC Environmental Health Perspectives. 2005.

Commonly used indicators of socio-economic position (SEP)

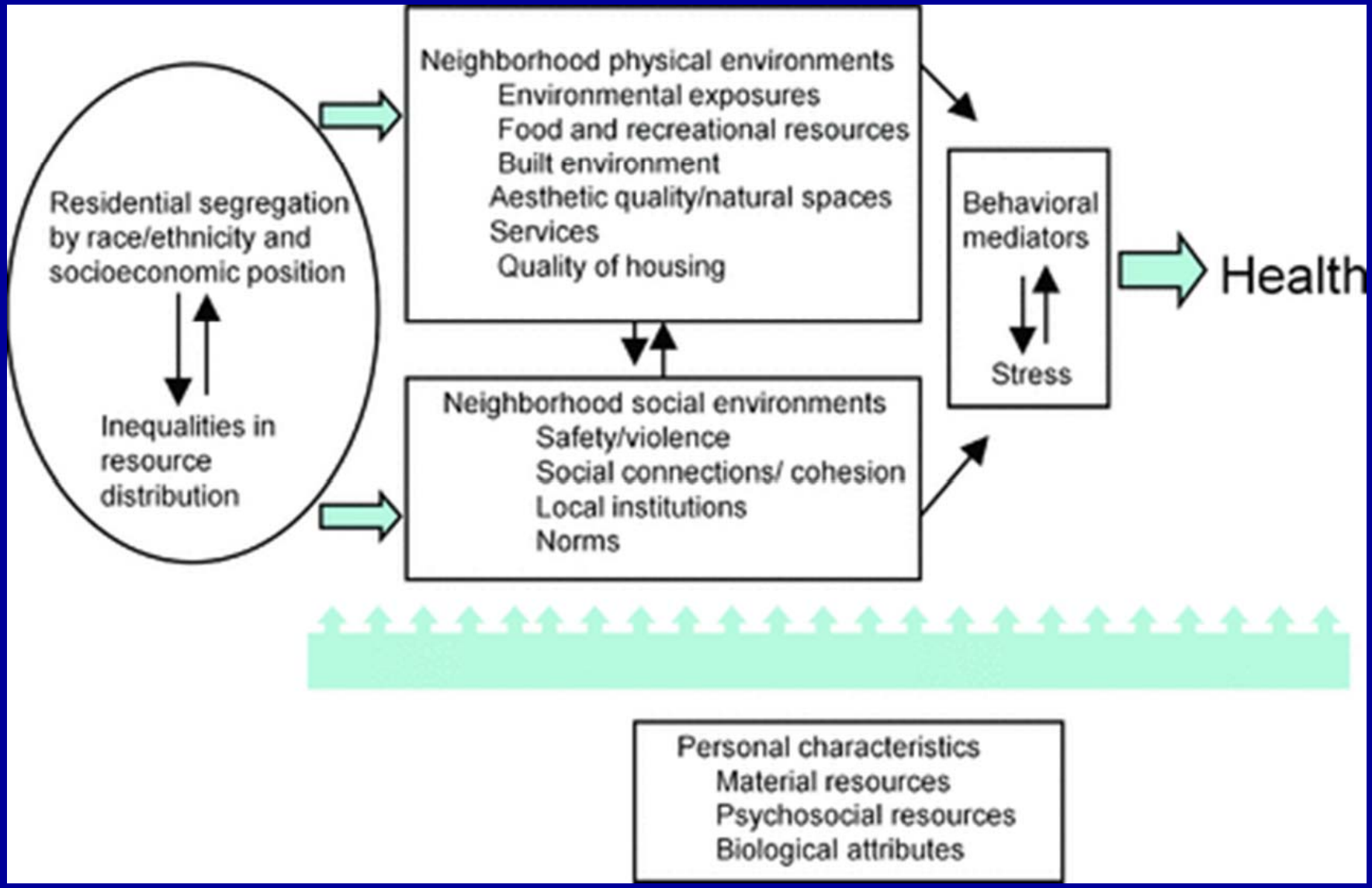
- Individual
  - education, occupation, income
- Neighborhood/area
  - Composition (% people with high school degree, % literacy, % poverty)
  - Contextual (features of the community or society, parks, food stores, crime rate, social networks)

Air pollution, health and SEP

- Different effects of air pollution on health by SEP may be observed because of different patterns of
  - Exposure
  - Susceptibility
  - Both

O'Neill MS, Jerrett M, Kawachi I, Levy JI, Cohen AJ, Gouveia N, Wilkinson P, Fletcher T, Cifuentes L, Schwartz J. (2003) Health, wealth, and air pollution: advancing theory and methods. Environmental Health Perspectives. 111:1861-70

Conceptual model: Neighborhoods and health



Diez Roux AV, Mair C. Neighborhoods and health. Ann. NYAS. 2010;1186:125-45.

Air pollution exposure can differ by socio-economic level

- proximity to roadways: ⬆ particle/NO_2 exposure, ⬇ O_3 exposure (scavenging)
- settlement patterns (center city vs. suburbs), topography/meteorology
- indoor and occupational exposures
- location-dependent
  - Mexico City: richer neighborhoods, high O_3
  - Santiago, Chile: poorer neighborhoods, high PM

Individual susceptibility patterned by socio-economic factors

- Medical conditions (diabetes, CVD, asthma)
- Age structure of population
- Life “choices”: smoking, diet, exercise
- Access to anti-oxidant rich foods
- Infections (crowding, sanitation)
- Life course experience

Potential pathways for low education to increase susceptibility & exposure

Low educational attainment

⇩

Lower health status (diabetes, hypertension)

⇩

Low wage job, low income neighborhood

⇩

- Higher levels of indoor pollutants (e.g., NO_2 from gas stove)
- Proximity to outdoor pollutant sources (e.g. diesel exhaust)
- Few nearby supermarkets with fresh fruits/vegetables
- Crowded living conditions (higher infection level)
- Low quality health care (access limited, prevention lacking)
- Violence/insecurity (in home or neighborhood) leading to stress

Research limitations

- Studies reveal patterns by education, but difficult to disentangle whether exposure, susceptibility or other factors contribute

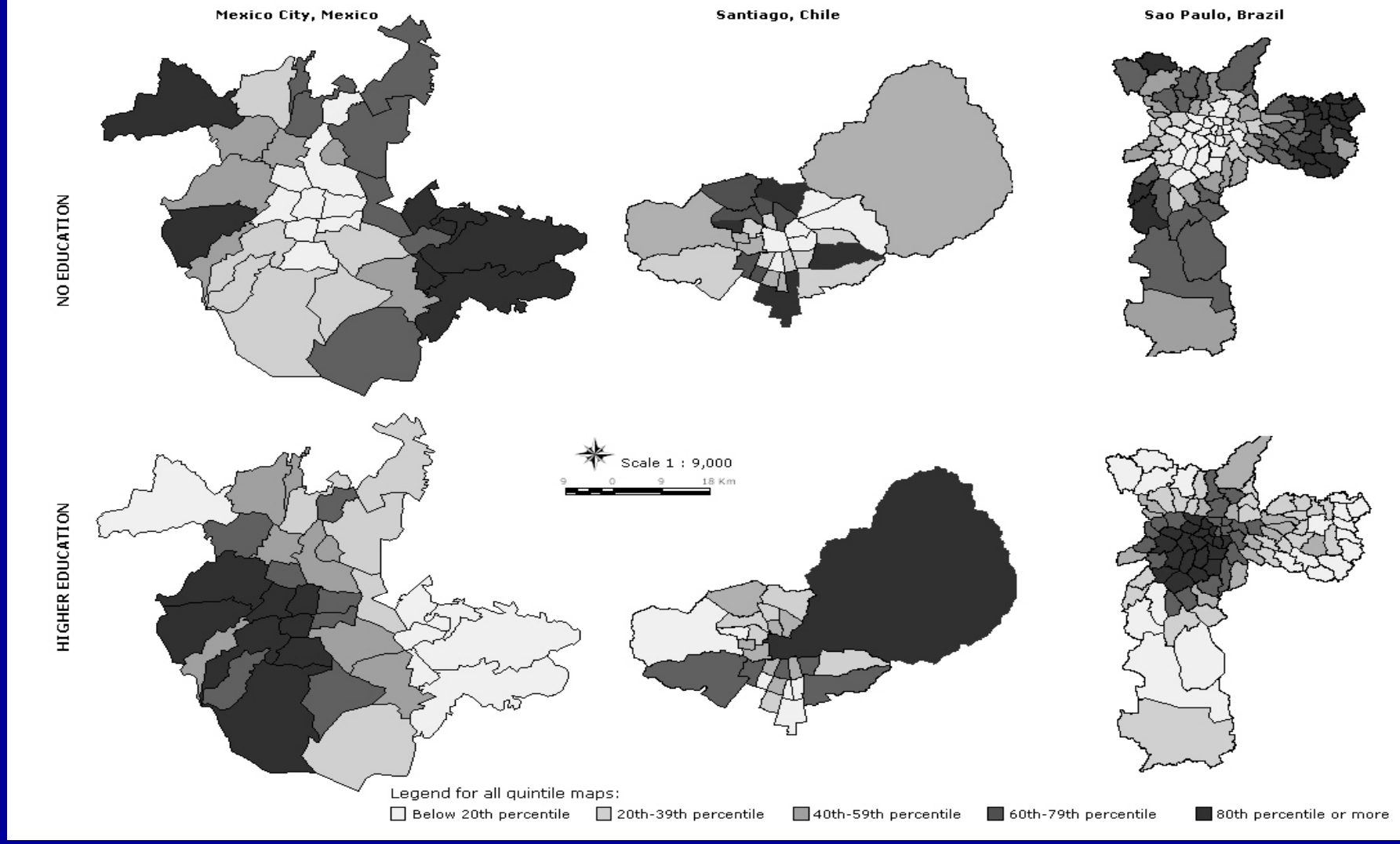
- Hoek G, Brunekreef B, Goldbohm S, Fischer P, van den Brandt PA. Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study. *The Lancet* 2002;360: 1203-09

-HEI. Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality (A special report of the Institute's Particle Epidemiology Reanalysis Project). Cambridge, MA: Health Effects Institute, 2000.

- Pope, C. A., 3rd, Burnett, R. T., Thun, M. J., Calle, E. E., Krewski, D., Ito, K., et al. (2002). Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. *JAMA, 287*(9), 1132-1141.

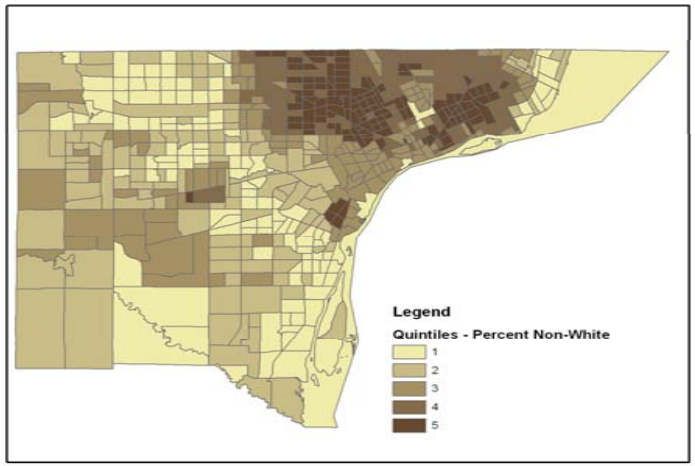
- Finkelstein, M. M. (2002). Pollution-related mortality and educational level.[comment]. *JAMA, 288*(7), 830.

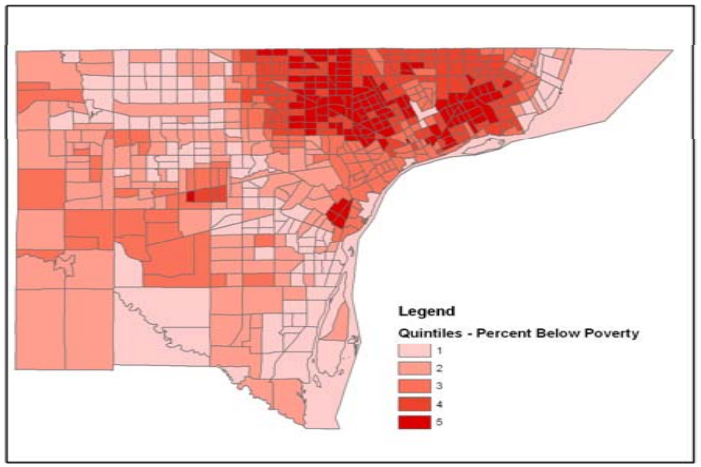
- Pope, C. A., 3rd, Burnett, R. T., & Thurston, G. D. (2002). Pollution-related mortality and educational level [author reply]. *JAMA, 288*(7), 830.

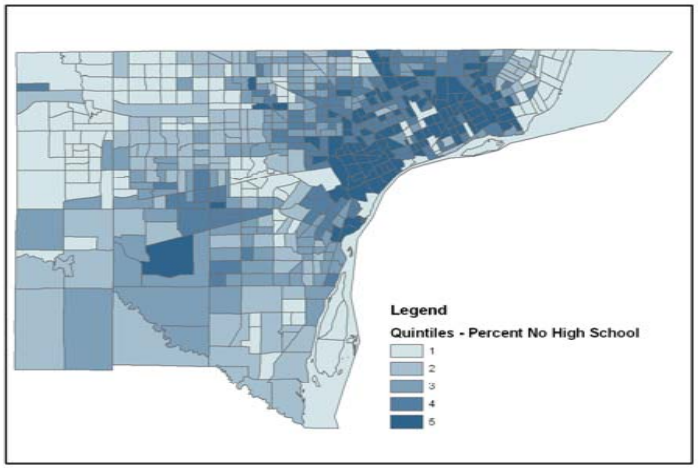


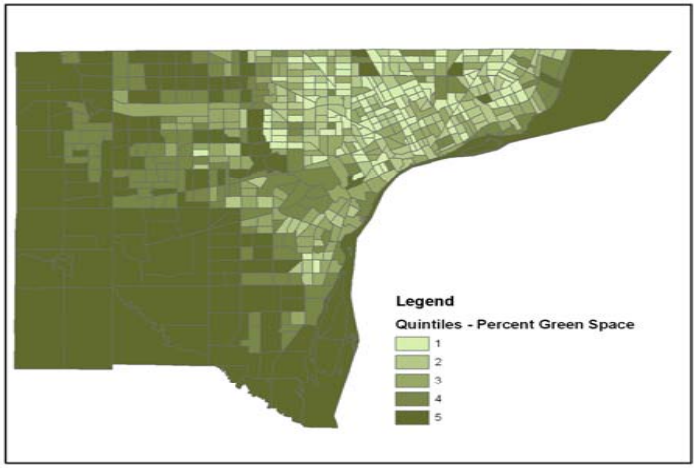
Educational attainment by area of residence among internal-cause deaths of adults over age 22 years in 3 Latin American cities, 1998-2002. O'Neill MS, Bell ML, Ranjit N, Cifuentes LA, Loomis D, Gouveia N, Borja-Aburto VH. Air pollution and mortality in Latin America: The role of education in three cities. Epidemiology. 2008;19(6):810-19.

Census tracts in Detroit showing green space and population characteristics relevant to vulnerability









White-Newsome, JL, O'Neill MS, Gronlund, CJ, Sunbury, TM, Rood, RB, Parker, EA, Brown, DG, Brines, SJ, Rivera, Z. (2009) Climate change, heat waves and environmental justice: Advancing knowledge and action. *Environmental Justice*, Vol 2, Number 4

Neighborhood Features Affecting Environmental Exposures

Impervious Surface

Vegetation

Housing Quality

World Health Organization Air Quality Guidelines Global Update 2005: Environmental Equity Chapter

O'Neill, MS, Kinney, PL, Cohen, AJ. (2008) Environmental equity in air quality management: Local and international implications for air quality and climate change. Journal of Toxicology and Environmental Health, 2008;71(9-10):570-577

- Other AQG chapters address
  - international inequalities in exposure
  - socio-economic factors as correlate or indicator of individual susceptibility

http://www.who.int/phe/health_topics/outdoorair_aqg/en/

Environmental justice/equity

- Like value of life, term has an ethical component
- More than 'inequality' in exposure/outcome
- Addresses procedural justice

  Ikeme, J. (2003). Equity, environmental justice and sustainability: incomplete approaches in climate change politics. *Global Environmental Change, 13*, 195-206.

- Implicit moral judgment that environmental inequalities are unfair and we need to rectify them
- Intranational, international, and intergenerational justice
- **Fairness** as a goal of environmental management

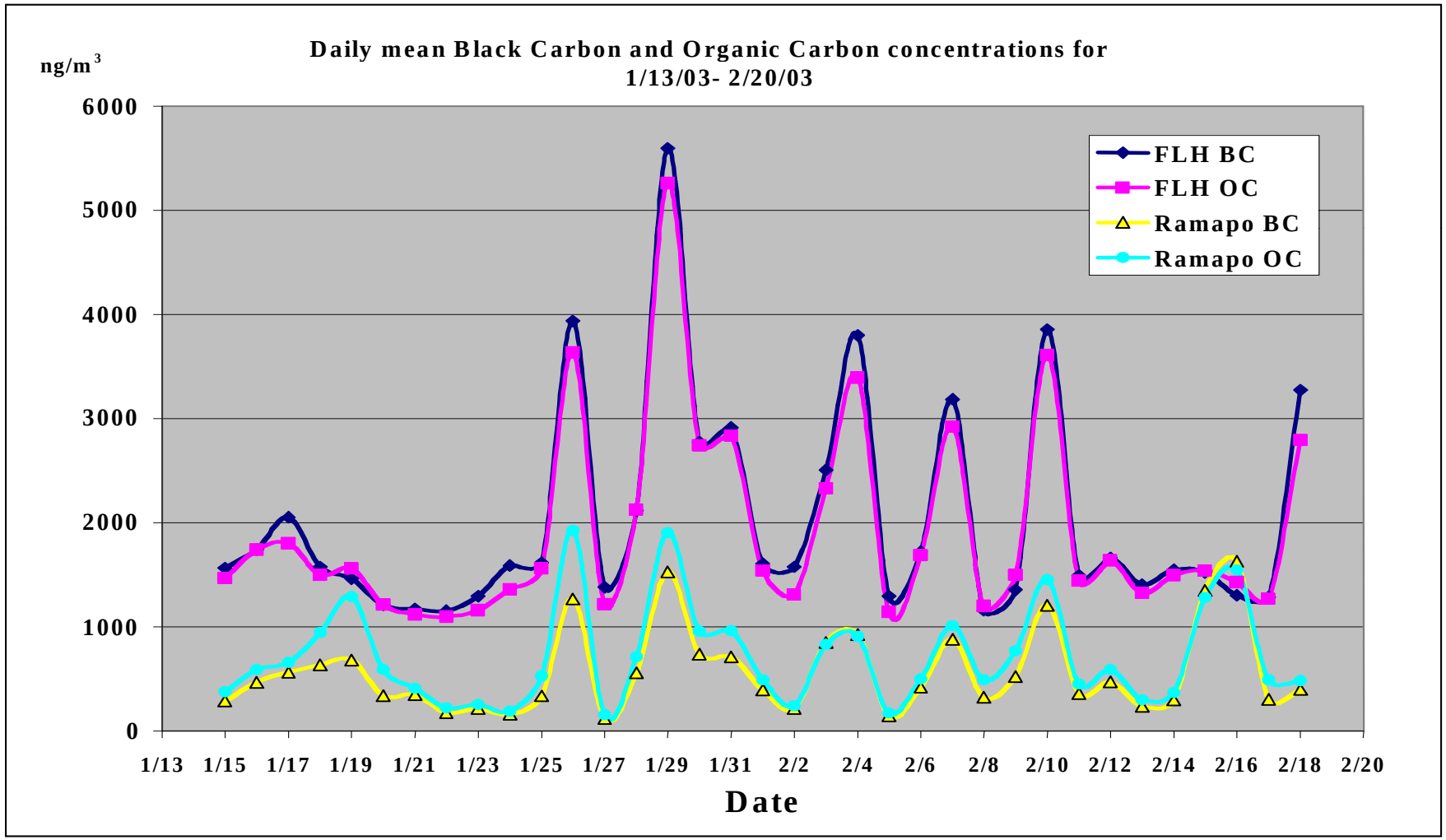
  (South African constitution, State of California law)

Policy applications for ‘environmental equity’

- National standards, international guidelines typically pick one level
- Equity concerns not often taken into account in risk assessments
- But: intra-urban spatial variability
  - ‘hot spots’, esp. relevant to motor vehicle emission

Black carbon in 2 New York City communities differing by traffic density and socio-economic level

(data of P.L. Kinney)



Conclusion of WHO AQG Environmental equity chapter

‘At present…insufficient data exist to incorporate these emerging findings (on SEP and air pollution) quantitatively into the setting of air guidelines *of general applicability*.’

2015 review had the same basic conclusion—and new recommendations

Hajat A, Hsia C, O'Neill MS. Socioeconomic Disparities and Air Pollution Exposure: a Global Review. Current Environmental Health Reports. 2015;2(4):440-50.

Recommendations

Hajat A, Hsia C, O'Neill MS. Socioeconomic Disparities and Air Pollution Exposure: a Global Review. Current Environmental Health Reports. 2015;2(4):440-50.

Conduct studies using individual and neighborhood SEP measures together

Hajat A, Diez-Roux AV, Adar SD, Auchincloss AH, Lovasi GS, O'Neill MS, et al. Air pollution and individual and neighborhood socioeconomic status: evidence from the Multi-Ethnic Study of Atherosclerosis (MESA).
Environmental Health Perspectives. 2013;121(11-12):1325-33.

Address spatial autocorrelation when evaluating whether inequities/injustices exist at small area units

Further explore reasons for heterogeneity in SEP/air pollution health effects associations

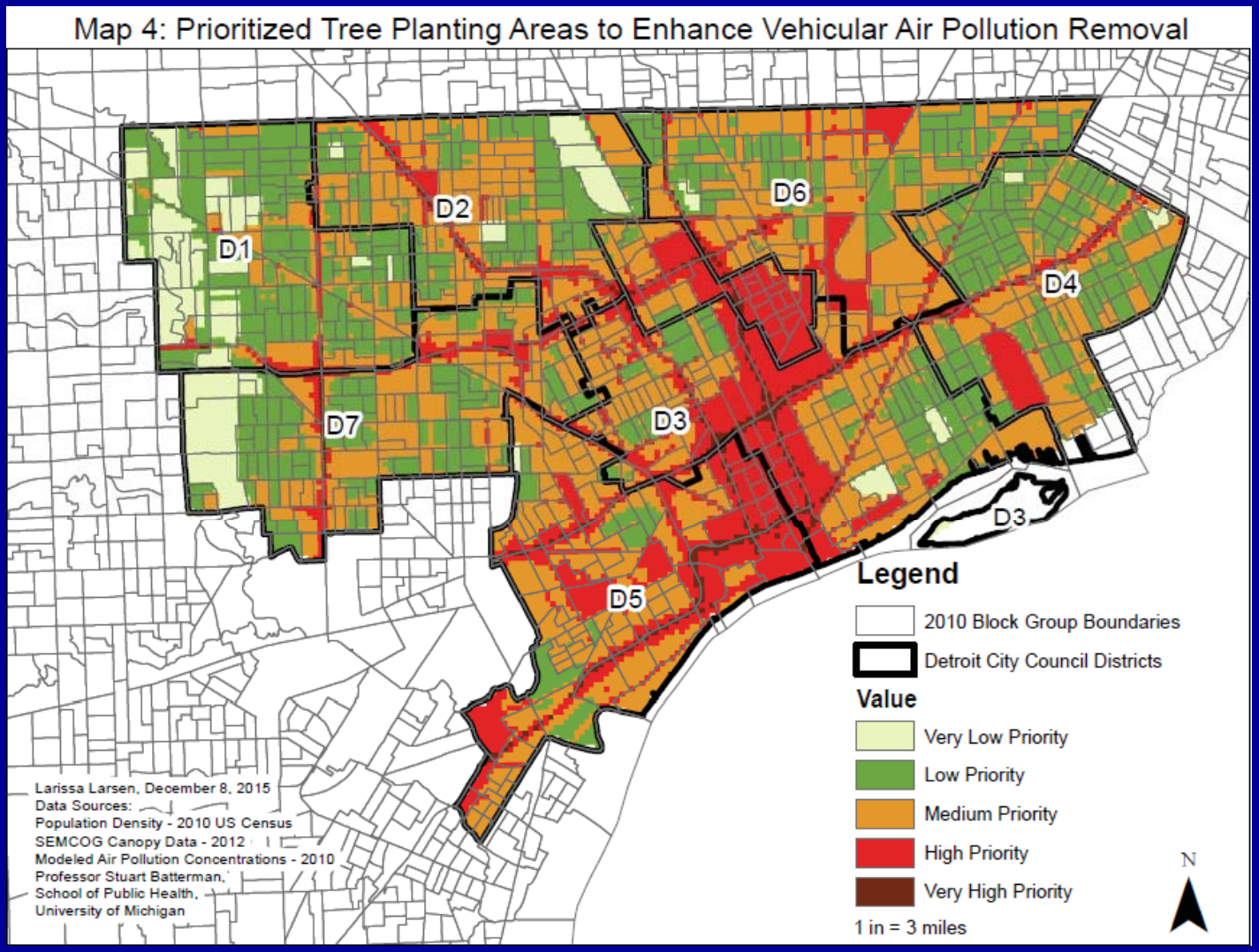
One solution: Community-based participatory research

- Questions designed jointly to address local problems
- Detroit Urban Research Center and affiliate projects

  Michigan professors present air pollution/asthma results at public hearings on important local policy issues

  http://www.detroiturc.org/

Policy applications-Detroit



http://caphedetroit.sph.umich.edu/wp-content/uploads/2016/02/NIEHS-Grantees-Meeting-Presentation-1-12-16-FINAL.pdf

Conclusions/Questions

- Heterogeneity in SEP and traffic pollution associations
- How can observed environmental inequities be translated to policy?
- What type of research would be useful for guiding specific policies?

Conclusions/Questions (2)

- Select SEP indicators relevant for policy decisions and interventions
  - "understanding whether differences in risk are more strongly driven by geography, demographics, or other factors (e.g., behaviors, co-exposures) is important in designing optimal interventions."

Harper S, Ruder E, Roman HA et al. Using inequality measures to incorporate environmental justice into regulatory analyses. Int J Environ Res Public Health. 2013;10:4039-4059

Select indicators in conjunction with local stakeholders

Clougherty et al 2014The Role of Non-Chemical Stressors in Mediating Socioeconomic Susceptibility to Environmental Chemicals Curr Envir Health Rpt (2014) 1:302–313

Conclusions/Questions (3)

- Goals for research
  - Comparability across regions
  - Applicability within a local area
- SEP index versus single variables
  - Capturing complexity, addressing correlations and cumulative risk
  - Communicating potential interventions on specific constructs
- Include multiple disciplines and sectors in design and conduct of research

Thank you!

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