



**W**

**“Just” cities:  
Traffic-related air pollution & justice  
in the context of urban sustainability**

Julian D. Marshall  
Kiely Endowed Professor  
Civil & Environmental Engineering  
University of Washington

COLLEGE OF ENGINEERING  
UNIVERSITY of WASHINGTON

## Acknowledgements

J. Apte, M. Bechle, L. Clark, J. Liu, D. Millet,  
N. Nguyen, E. Novotny, D. Paoella, C. Tessum,  
Y. Wang, H. Xu



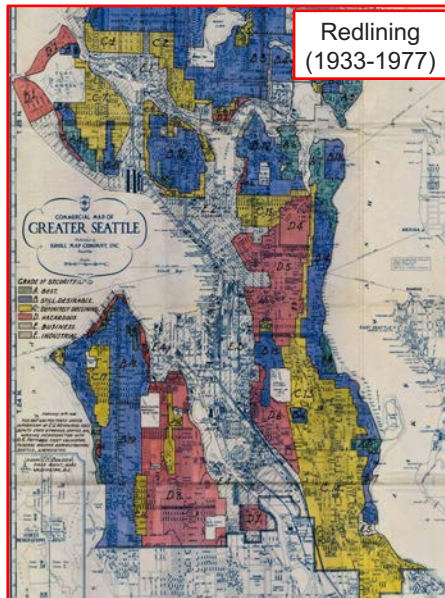
**W** CIVIL & ENVIRONMENTAL ENGINEERING  
UNIVERSITY of WASHINGTON  
College of Engineering



INSTITUTE ON THE  
**ENVIRONMENT**  
UNIVERSITY OF MINNESOTA  
Driven to Discover™



## Racial segregation: long-standing, structural



## Background: Housing segregation

---

- 1926: US Supreme Court supports restrictive covenants and exclusionary zoning
- 1933: Home Owners' Loan Corporation (redlining)
- 1934: Federal Housing Administration
- 1938: Federal Highway Aid
- 1948: US Supreme Court strikes down restrictive covenants
- 1949: Housing Act
- 1968: Fair Housing Act

5

## What is environmental justice?

---

Outcome

Local

Systemic

Process

6

## Outline

---



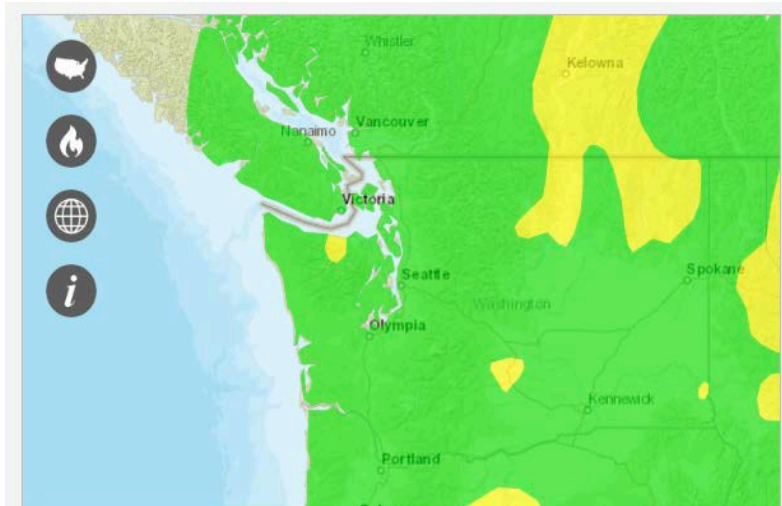
1. The way things are
  - Existing disparities
  - Who causes the pollution?
2. The way things could be
  - Emission-reductions by source & location to reduce impacts & disparities
3. Conclusions

7

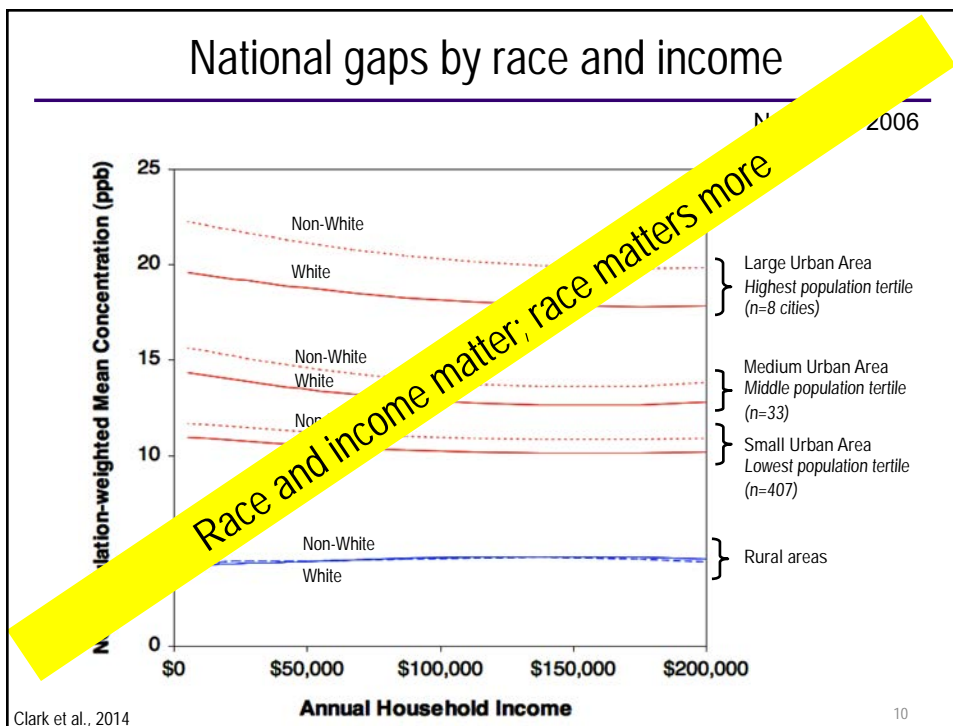
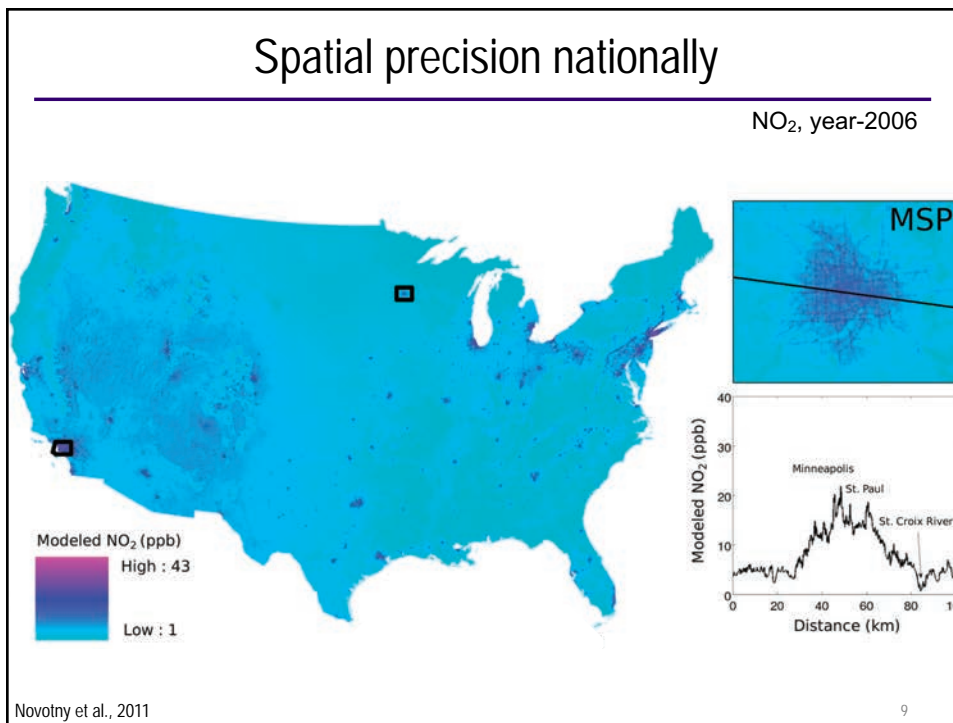
## Spatial precision nationally?

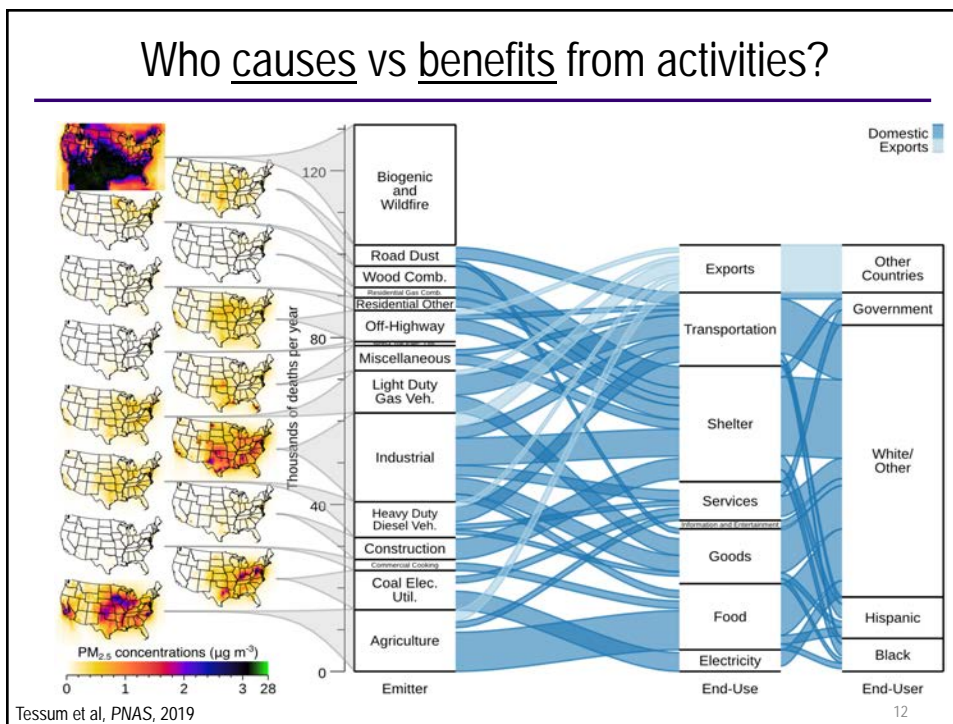
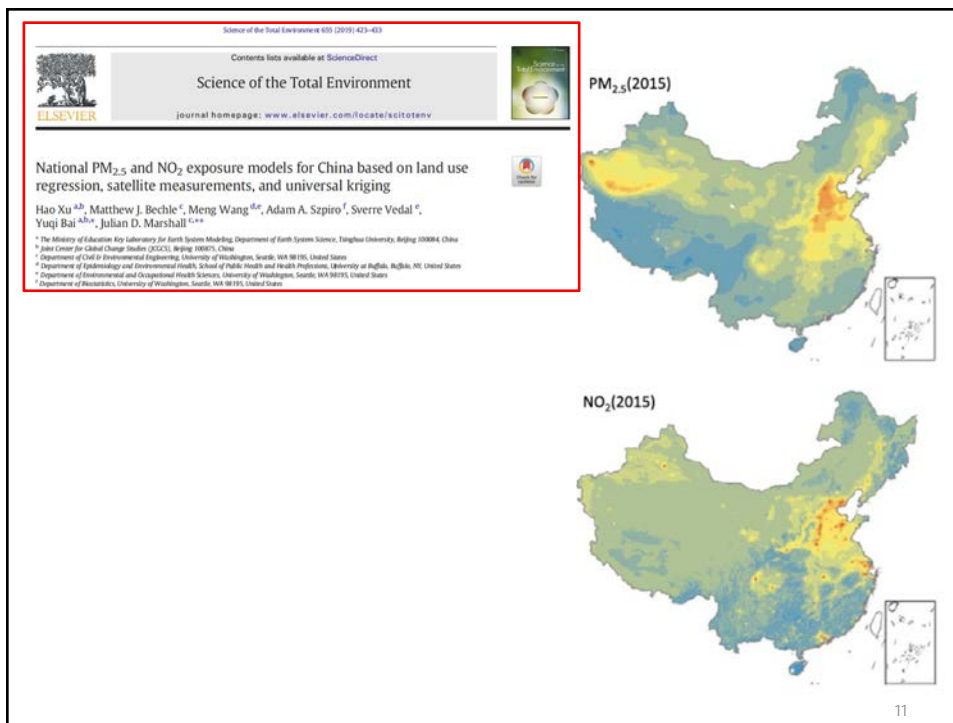
---

AirNow.gov – AQI for Seattle, WA

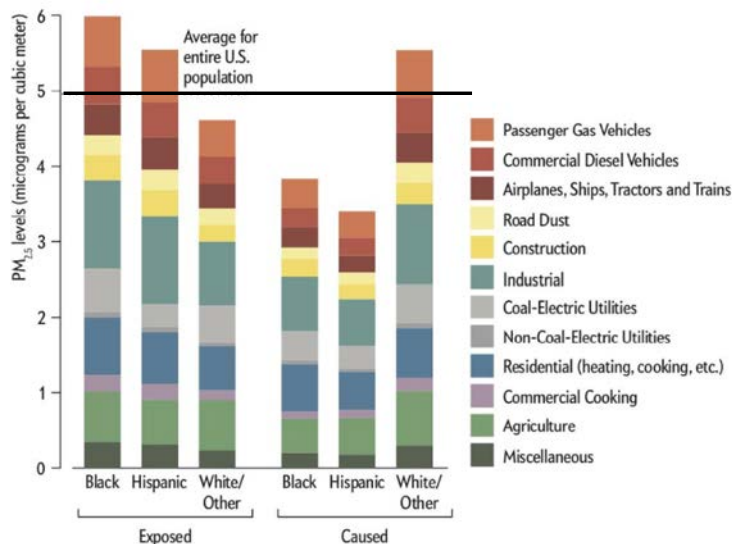


8





## Who causes vs benefits from activities?



Tessum et al, PNAS, 2019

13

## Outline



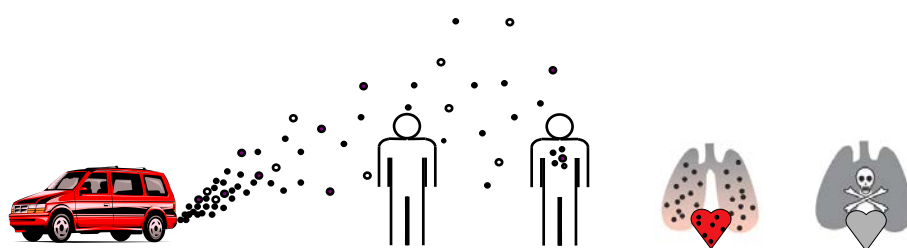
1. The way things are
  - Existing disparities
  - Who causes the pollution?

2. The way things could be
  - Emission-reductions by source & location to reduce impacts & disparities

3. Conclusions

14

## Air quality engineering: source control



emissions → concentration → exposure → intake → dose → health effects

Marshall and Nazaroff, 2007

15

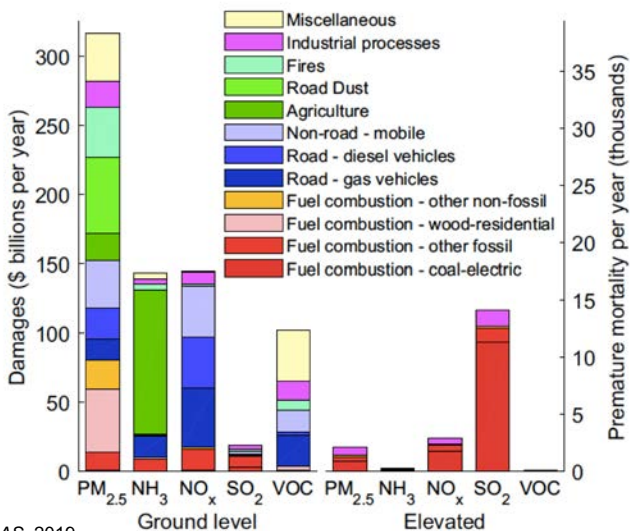
	Source	Location
Impact	Which sources/locations matter most for total health impacts?	
Marginal impact	Largest impact per emission reduction (“bang for the buck”)?	
Equity/justice	Are benefits distributed fairly; do they address existing inequities?	

16



## Impact by source

PM<sub>2.5</sub>, USA

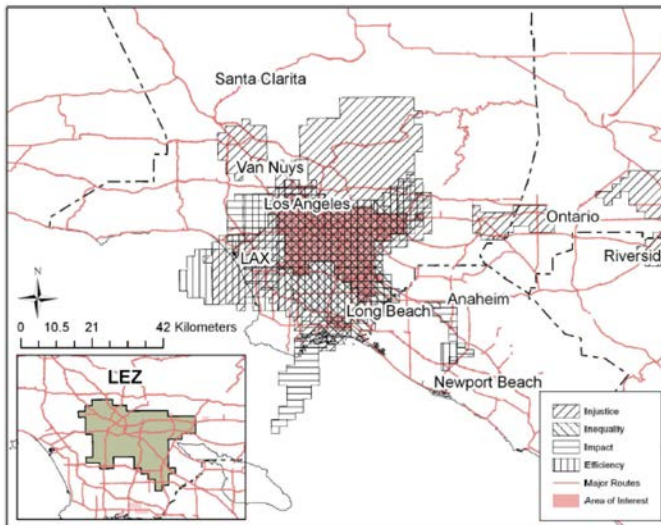


Goodkind et al., PNAS, 2019

17

## Where to target pollution reductions?

Diesel PM<sub>2.5</sub>, Southern California

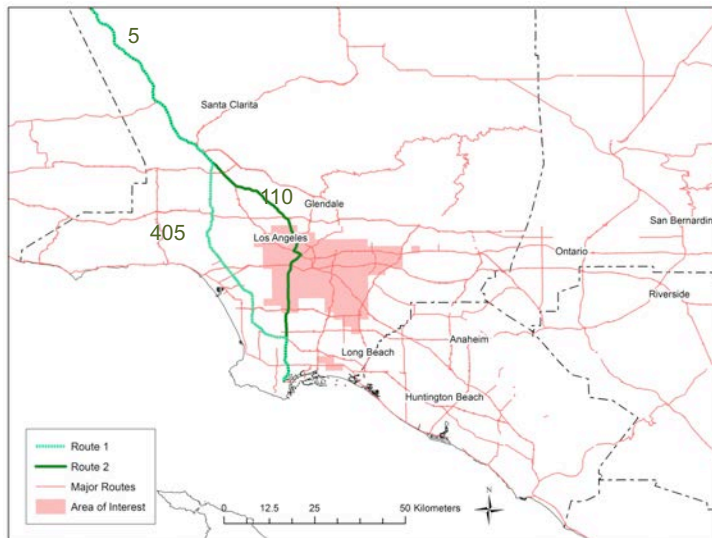


Nguyen et al., ERL, 2017

18

## Where to target pollution reductions?

Diesel PM<sub>2.5</sub>, Southern California



Nguyen et al., *ERL*, 2017

19

	Source	Location
Impact	Which sources/locations matter most for total health impacts?	
Marginal impact	Largest impact per emission reduction (“bang for the buck”)?	
Equity/justice	Are benefits distributed fairly; do they address existing inequities?	

20

### Role of electric vehicles?

---

Health impact =

$$[\text{people}] \left[ \frac{\text{km}}{\text{person}} \right] \left[ \frac{\text{energy}}{\text{km}} \right] \left[ \frac{\text{mass emitted}}{\text{energy}} \right] \left[ \frac{\text{mass inhaled}}{\text{mass emitted}} \right] \left[ \frac{\text{risk}}{\text{mass inhaled}} \right]$$

#### Conventional vehicle

#### Electric vehicle

### Role of electric vehicles?

---

Health impact =

$$[\text{people}] \left[ \frac{\text{km}}{\text{person}} \right] \left[ \frac{\text{energy}}{\text{km}} \right] \left[ \frac{\text{mass emitted}}{\text{energy}} \right] \left[ \frac{\text{mass inhaled}}{\text{mass emitted}} \right] \left[ \frac{\text{risk}}{\text{mass inhaled}} \right]$$

#### Conventional vehicle

#### Electric vehicle

EVs: long term advantages (→ cleaner electric grid)

Urban-EVs shift pollution to rural, low-income populations

## Summary

---

### 1. The way things are

- Spatial patterns of people (segregation) and pollution result in disparities by race / income / SES
- Cleaner air reduces absolute disparities

### 2. The way things could be

- Differences by emission source & location
- Impact, efficiency, disparities
- Improve air-quality, especially for those most at risk

23



*Publicity is... a  
remedy for social and  
industrial diseases.  
Sunlight is said to be  
the best of  
disinfectants; electric  
light the most  
efficient policeman.*

US Supreme Court Justice  
Louis Brandeis, 1913

24



**W**

**THE COLOR OF LAW**  
A HISTORY OF HOW OUR GOVERNMENT SEGREGATED AMERICA  
RICHARD ROTHSTEIN

**TA-NEBESI COATES**  
WE WERE EIGHT YEARS IN POWER  
AN AMERICAN TRAGEDY

THE NEW YORK TIMES BESTSELLER  
**So you want to talk about race**  
Ijeoma Oluo

**Thank you**

Julian D. Marshall  
Kiely Endowed Professor  
Civil & Environmental Engineering  
University of Washington