

Are warehouses closing in? New spatial patterns in ecommerce and equity

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CIVIL & ENVIRONMENTAL ENGINEERING

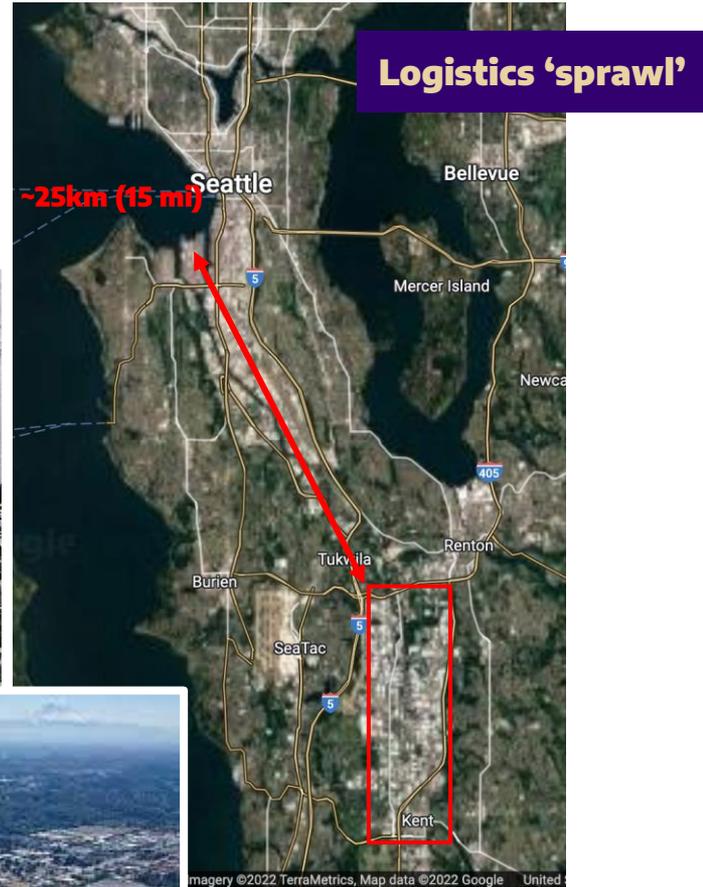
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Logistics landuse: then and now

In 2018, U.S. warehouses surpassed office buildings as the dominant commercial & industrial land use

Representing 18 billion sq ft in floor space



Race and Discriminatory Placement of Environmentally Hazardous Land Uses

4. That no building shall be left with paper exposure or with the exterior incomplete.

5. That the said land or buildings thereon shall never be rented, leased or sold, transferred or conveyed to, nor shall same be occupied exclusively by person or persons other than of the Caucasian Race.

6. The forgoing covenant and restriction shall run with the land and shall bind the grantee herein and the heirs, executors, administrators, successors and assigns of said grantee

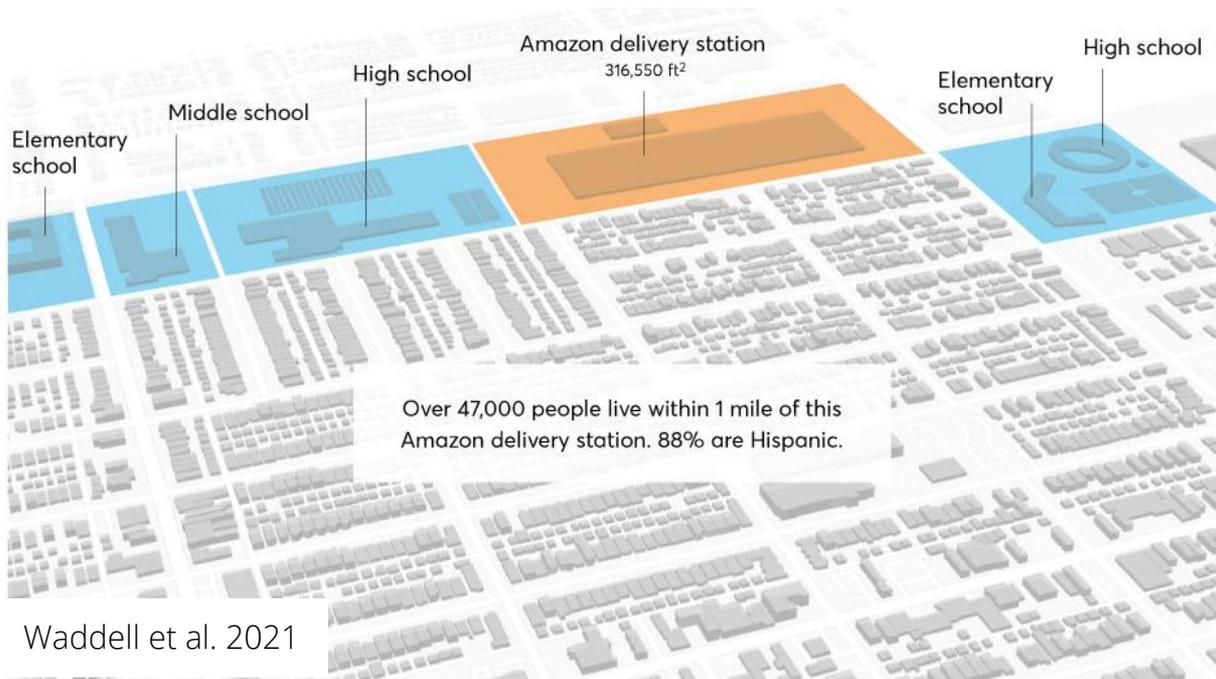
Racial covenant (Minneapolis, 1940)

D. Nineteen hundred and Forty.

- Early 20th century: city zoning ordinances and developers baked-in discrimination to protect homeowner property values
- Industrial zoning concentrated in predominantly black & immigrant communities
- Path dependency locked-in many of these land use patterns into modern day

Disparate siting of ecommerce UDCs?

Amazon in Gage Park, Chicago



LA Metro (Yuan 2018a-b)

- Warehousing disproportionately located in POC-majority populations but income effects were mixed
- Effect was one way: marginalized populations preceded the opening of the warehouses, not other way around
- But did not analyze environmental impacts

Freight and air pollution

An aerial photograph showing a large Amazon fulfillment center with a solar panel array on its roof. The building is white with green accents and has the Amazon logo on its side. A large parking lot filled with cars is in front of the building. In the foreground, there is a residential neighborhood with many houses. The sky is clear and blue.

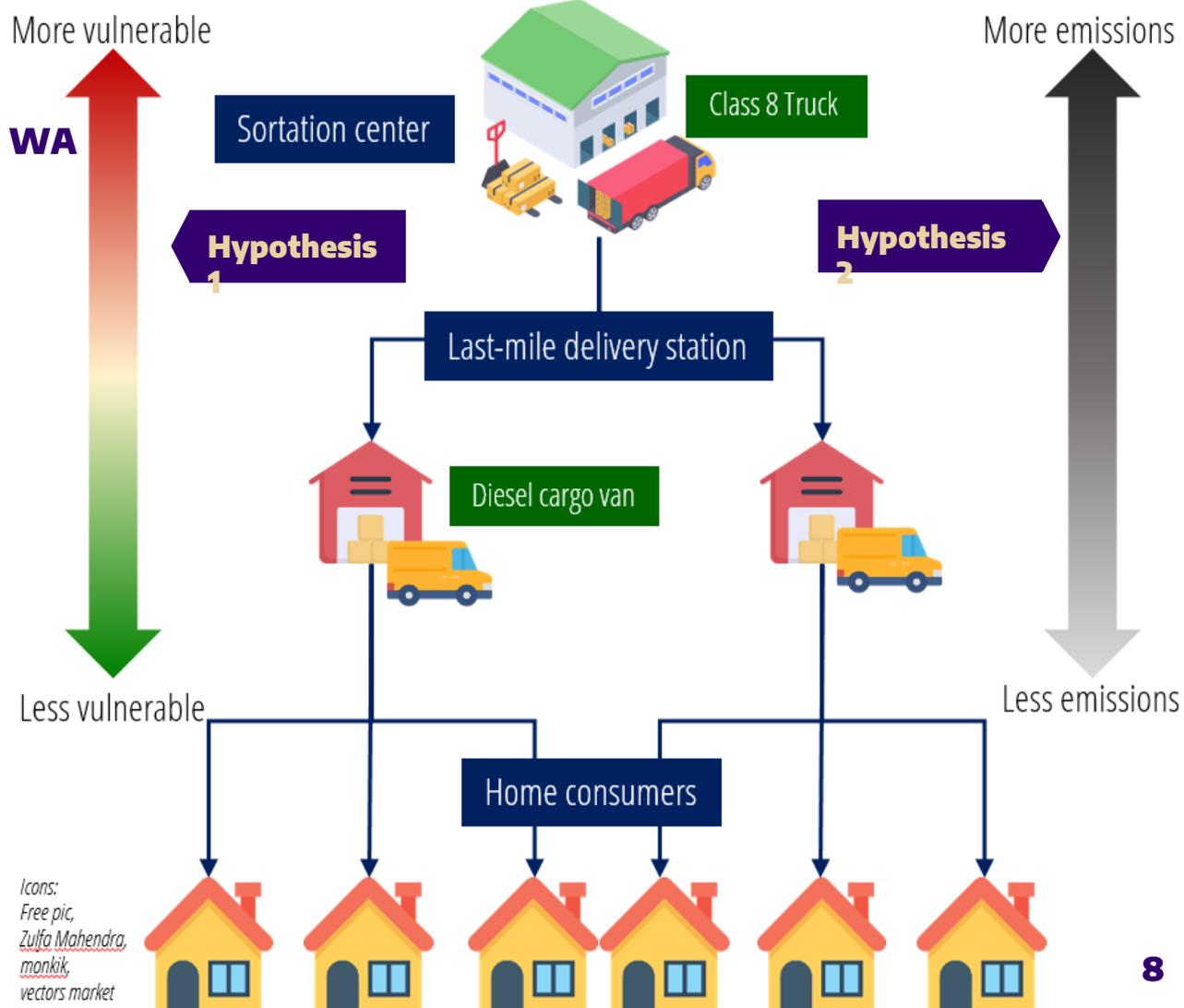
Toronto, ON: diesel exhaust represents **55% of NOx emissions** equating to 9,810 years lost per year

Research Question

> What does the spatial organization of ecommerce-related UDCs mean for equity and environmental justice?

Measuring Ecommerce emissions in King County, WA

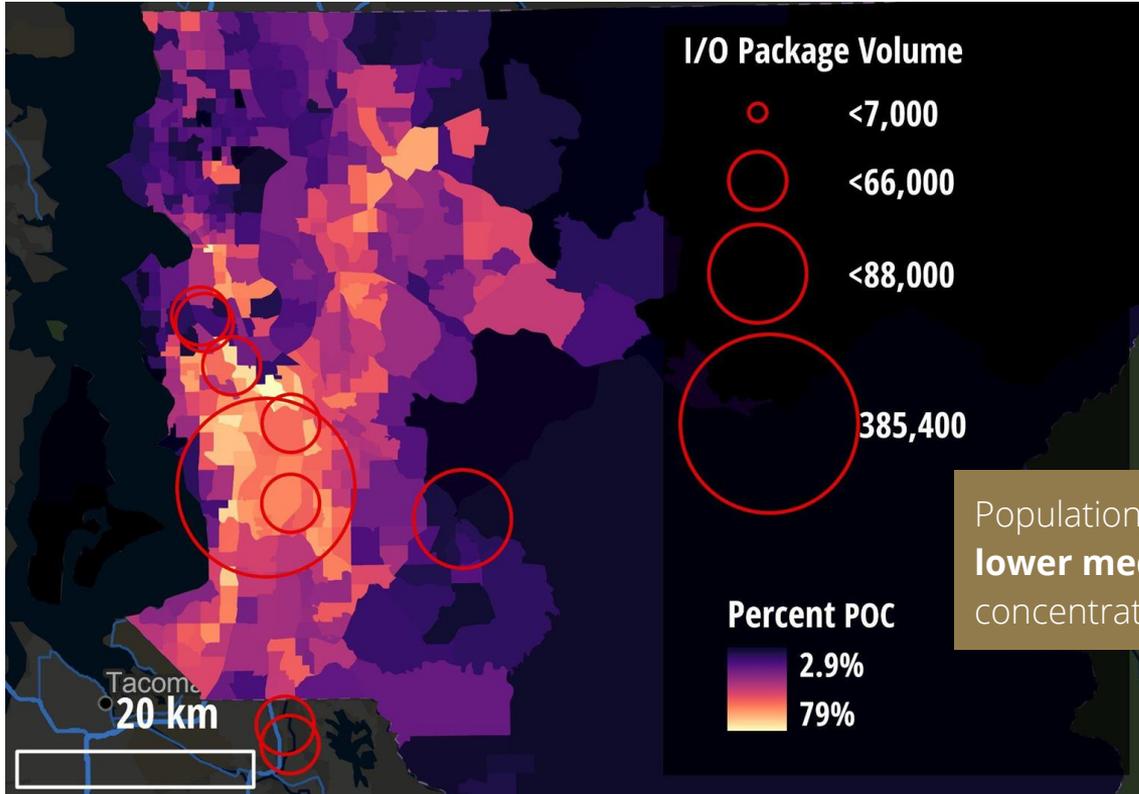
- **Data**
 - Amazon UDC locations and package volumes (MWPVL 2021)
 - Emission factors for diesel cargo vans and class 8 trucks (NOx and PM 2.5) (MOVES 2022)
- **First phase trip assumptions**
 - Euclidean distance linkages
 - Fully loaded vehicles
 - No atmospheric dispersion
 - Trip assignment is proportional to population
 - Destinations are population-weighted zipcode-centroids



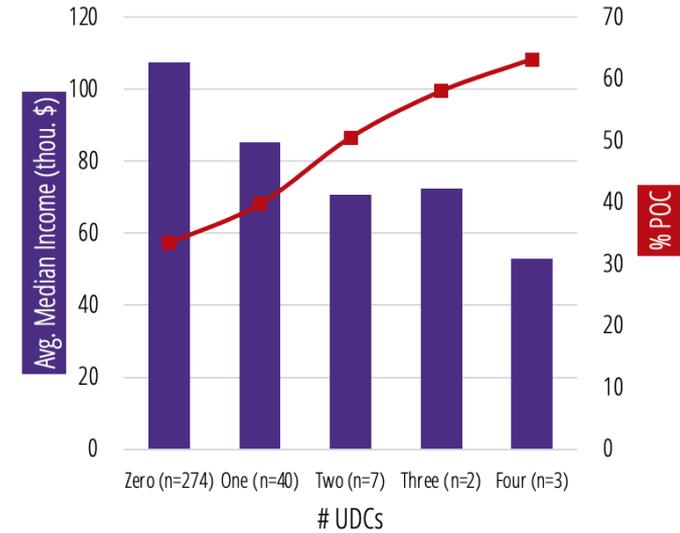
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Assumptions under-count effect & extent of cargo van and truck VKT

Lower incomes, higher POC % correlated with UDC intensity*



Tract characteristics based on 3km distance-containment



Populations exposed to three or four UDCs had **42% lower median incomes** and **86% higher POC** concentrations than non-exposed populations.

*Spearman's ρ test, $p < 0.05$

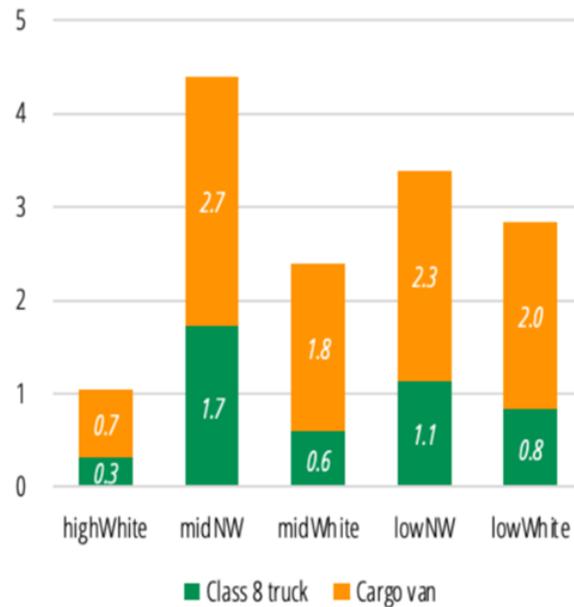
VKT, Emissions and Race

- > POC-majority populations were more exposed than white populations, regardless of income*
- > Did not find statistically significant difference between middle and low income POC groups
- > Middle-mile trucks had higher variable emission impact for POC pops than cargo vans*

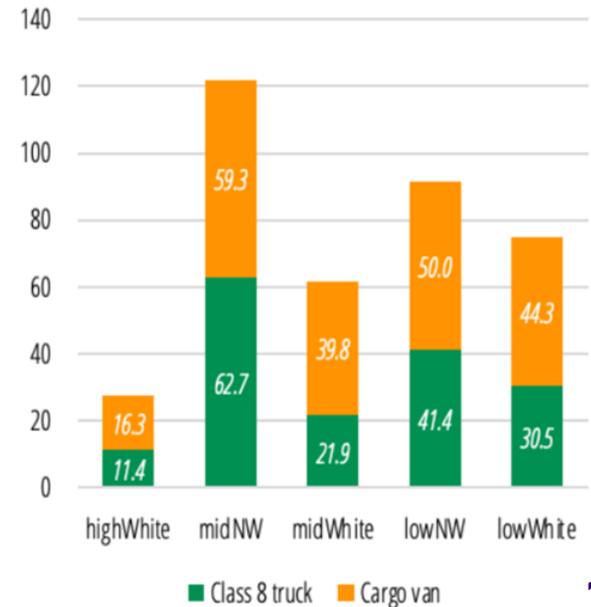
Avg. VKT/km²/day



Avg. PM 2.5 (g/km²/day)



Avg. NOx (g/km²/day)

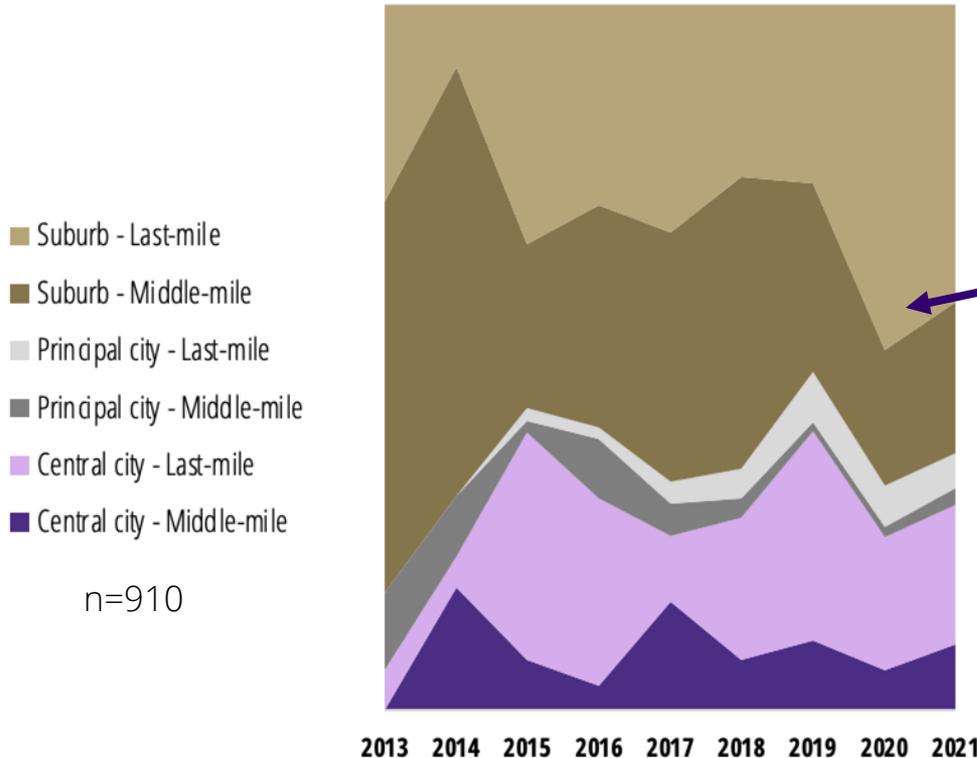


Findings

- > Higher UDC intensity correlated with low incomes and high POC concentrations
- > POCs were more exposed to emissions than White populations, regardless of income and especially from middle-mile trucks
- > But between POC groups the effects of income was mixed...
- > In line with past EJ research and my ongoing national-level research, racial makeup may affect disparate industrial siting more than socio-economic status. Also:
 - Opportunistic suburban municipalities encourage more UDC development, possibly exposing middle-class POCs

Last-mile delivery stations are sprawling

UDC Establishments (cumulative %)



Last-mile delivery stations built after 2020
5.0 km more dispersed from population centers*

After a major spike in central city LMDS in 2015, LMDS suburbanized at **twice the rate** they urbanized

Ongoing research: What does UDC equity look like for suburbs v. urban areas at a national scale?



Implications for urban freight solutions



- > Commonly proposed urban freight solutions seek to improve efficiency for last-mile deliveries in **dense urban centers**
- > How would this address equity outcomes?

Considerations moving forward

Companies:

- > Emphasize **up-chain** environmental mitigations
- > Consider UDC **placement** -> human health impacts

Government:

- > Provide guidance, best practices, coordination to municipalities
- > Municipalities evaluate industrial land use/permits
- > Consider localized environmental & economic effect
- > UDC-targeted air quality regulations (SOCAL and NY introduced policies, 2022)

Advocates:

- > Warehouse siting is an **environmental justice** issue
- > Don't forget about externalities for adjacent communities!

Thank you!

Questions? Email: tfried3@uw.edu

