Ecommerce & Environmental Justice in Metro Seattle

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CIVIL & ENVIRONMENTAL ENGINEERING
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A quote to start us off...

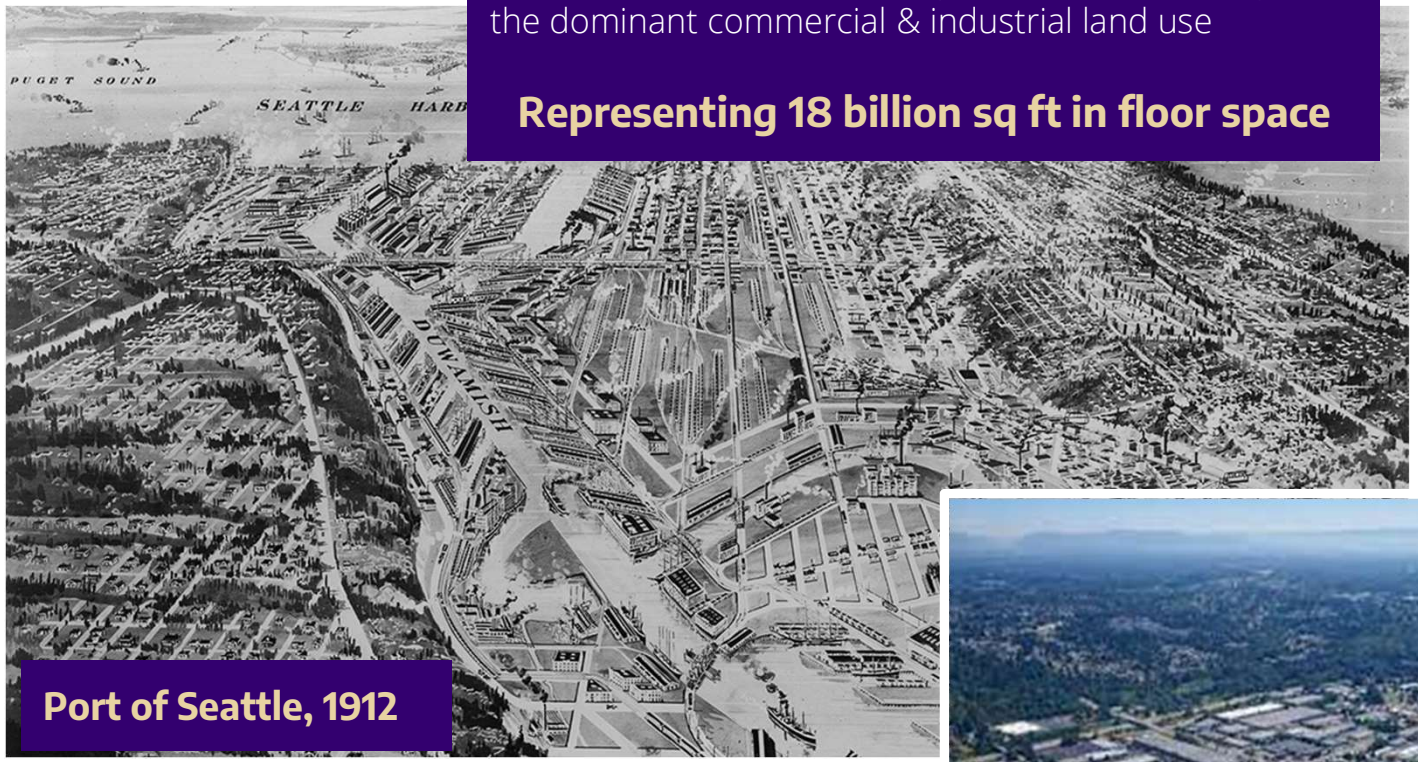
Discriminatory practices [do] not require evil people intentionally making biased decisions,
just well-trained experts following conventional procedures...

~ Ed Soja, UCLA (2010)

Logistics landuse: then and now

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

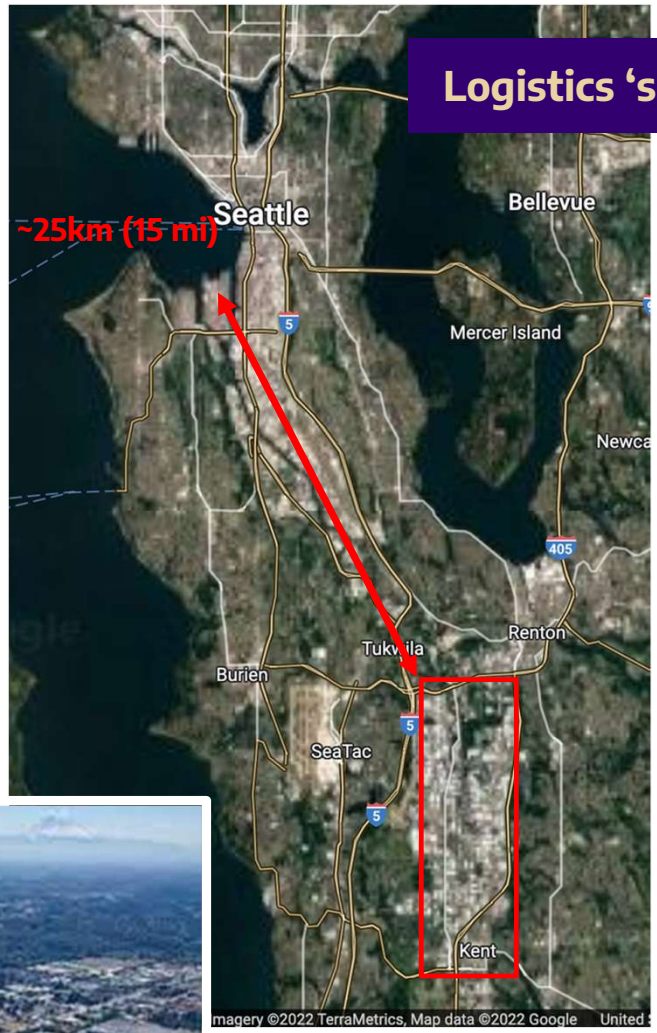
Representing 18 billion sq ft in floor space



Port of Seattle, 1912

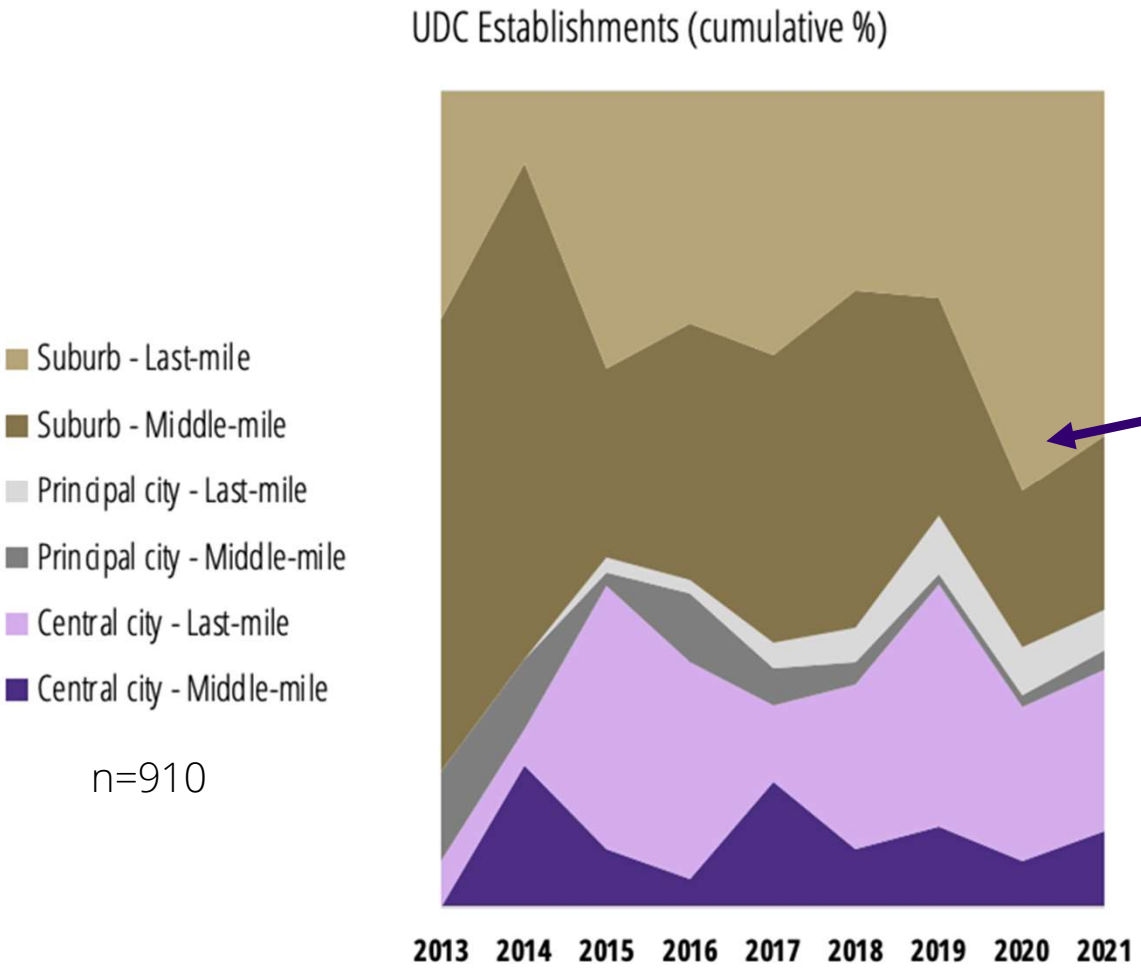
PHOTO: FreightWaves 2020

Logistics 'sprawl'



*Welch's t-test, $p < 0.05$

Last-mile delivery stations are too sprawling



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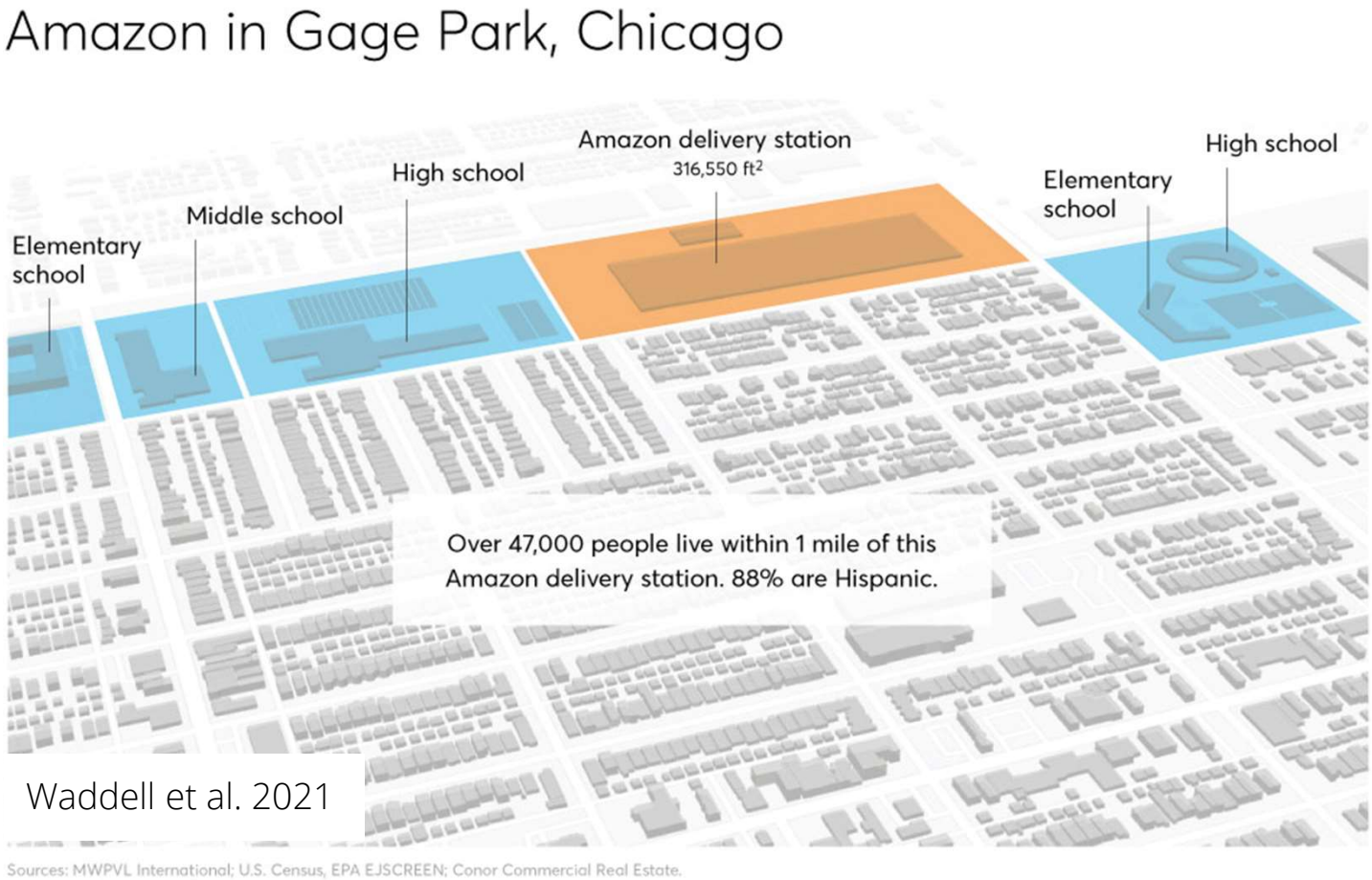
Last-mile delivery stations built after 2020 **5.0 km more dispersed from population centers***

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?

Disparate siting of ecommerce UDCs



Waddell et al. 2021

LA Metro (Yuan 2018a-b)

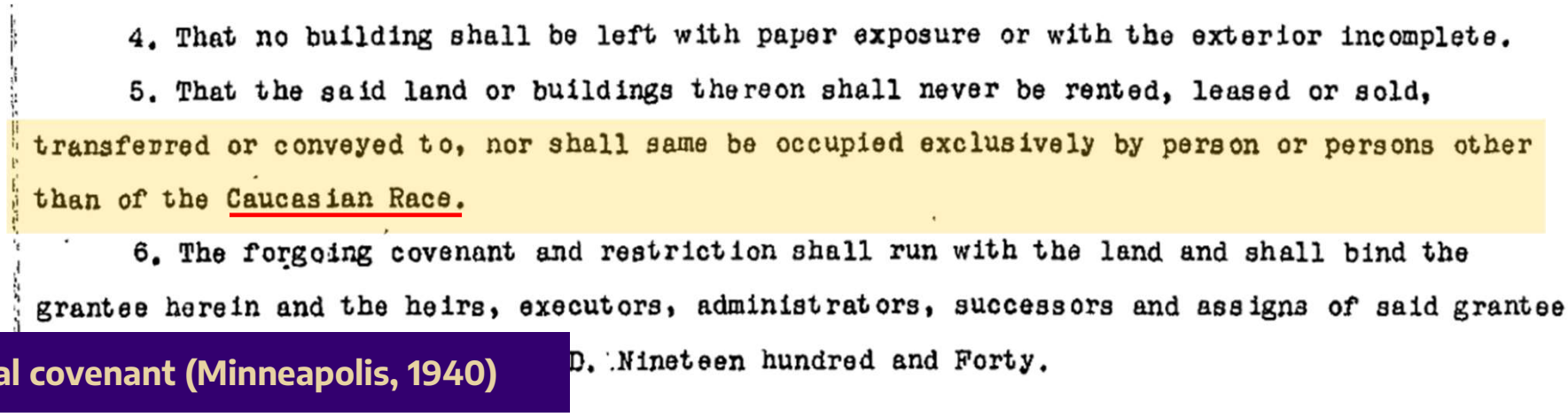
- Warehousing disproportionately located in POC-majority populations
- The trend was decades-long and one-way
- But did not analyze environmental impacts

Freight and air pollution

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

Source: Minet et al 2020. Photo: Jiffy Lube 2021

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.

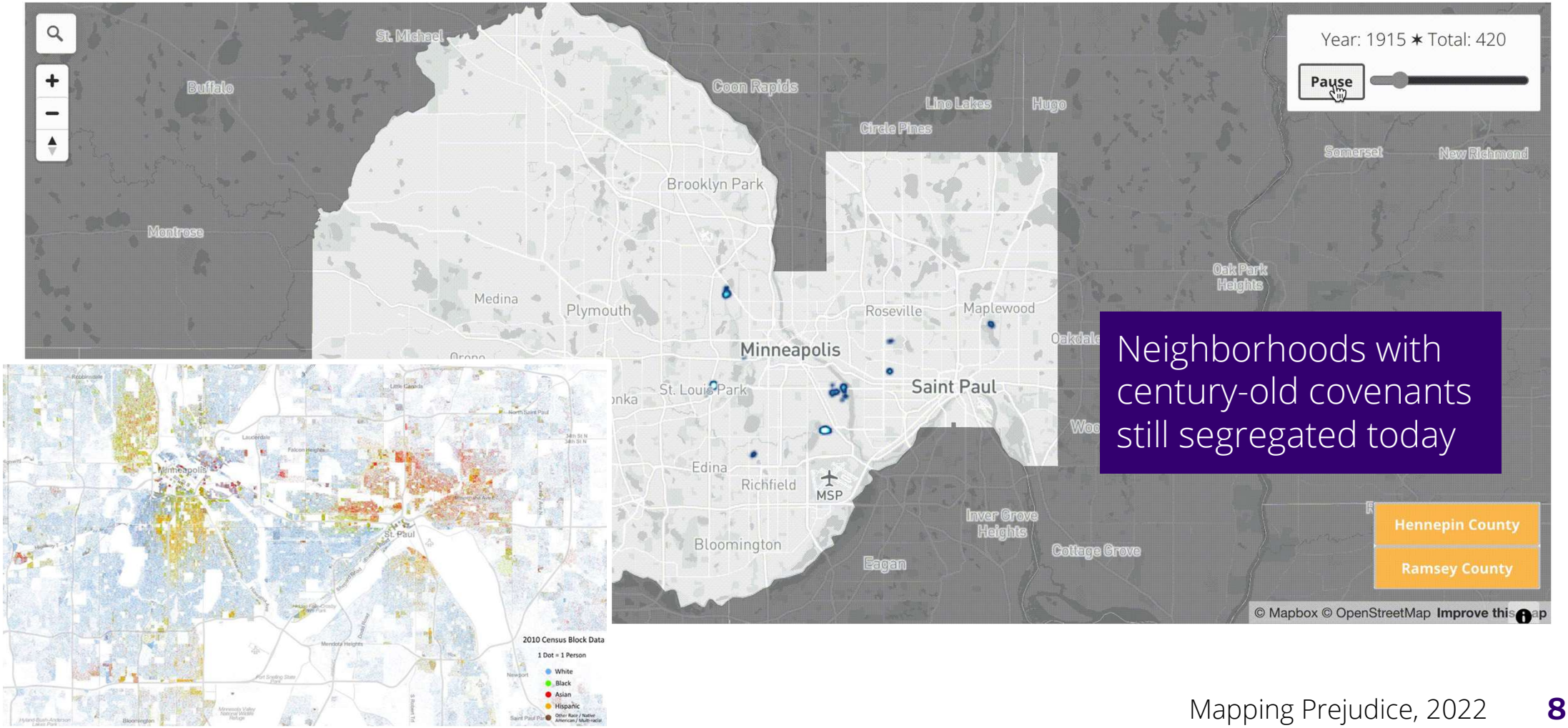
6. The forgoing covenant and restriction shall run with the land and shall bind the grantee herein and the heirs, executors, administrators, successors and assigns of said grantee

D. Nineteen hundred and Forty.

Racial covenant (Minneapolis, 1940)

- Early 20th century: Some practices shielded White homeowners from “Black and ethnic encroachment” and early industrial development
- Industrial zoning concentrated in predominantly black & immigrant communities
- Path dependency locked-in many of these land use patterns into modern day

Landuse lock-in



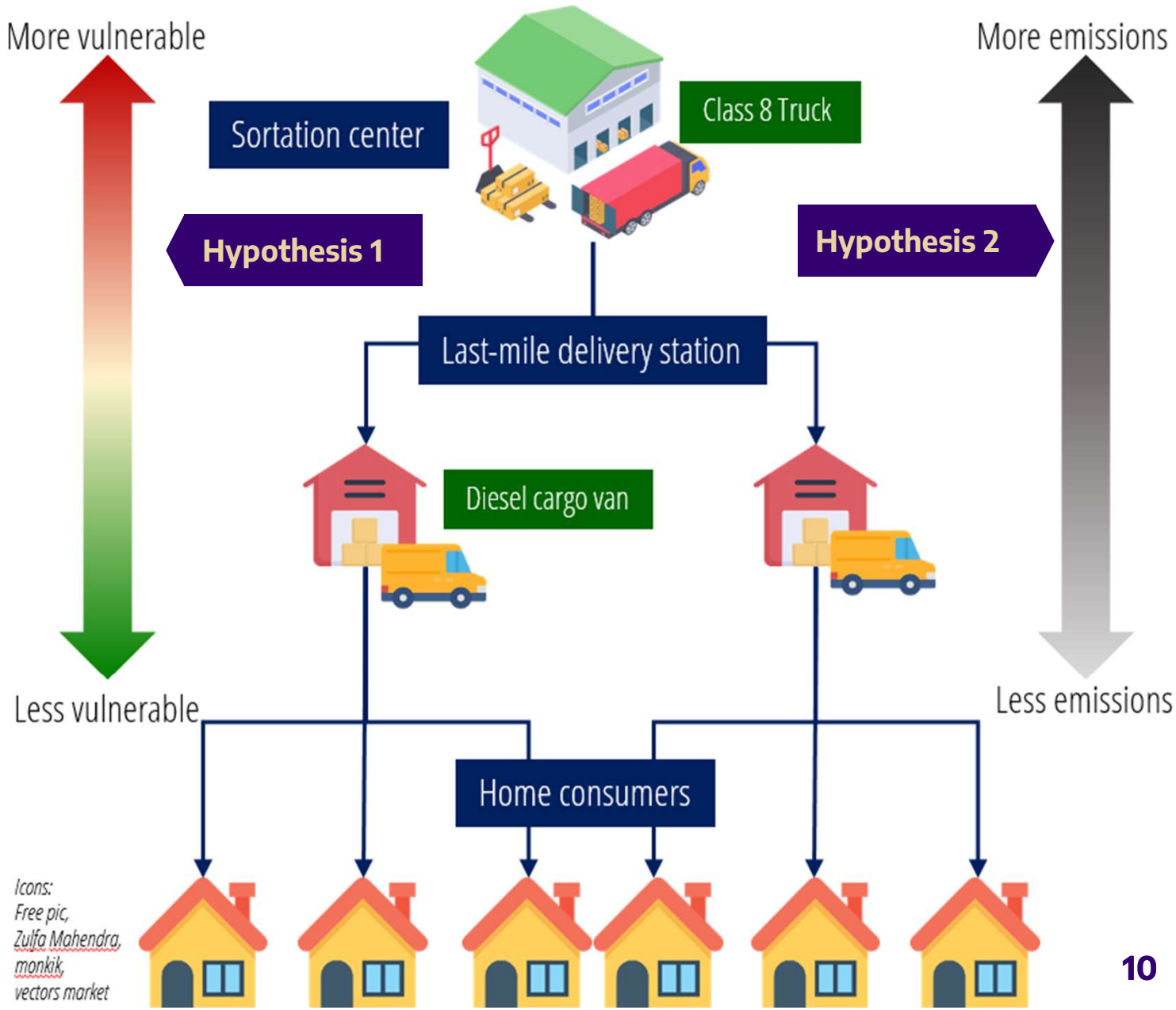
Neighborhoods with century-old covenants still segregated today

Research Question

> What are the distributional impacts of e-commerce, and what does it mean for equity and environmental justice?

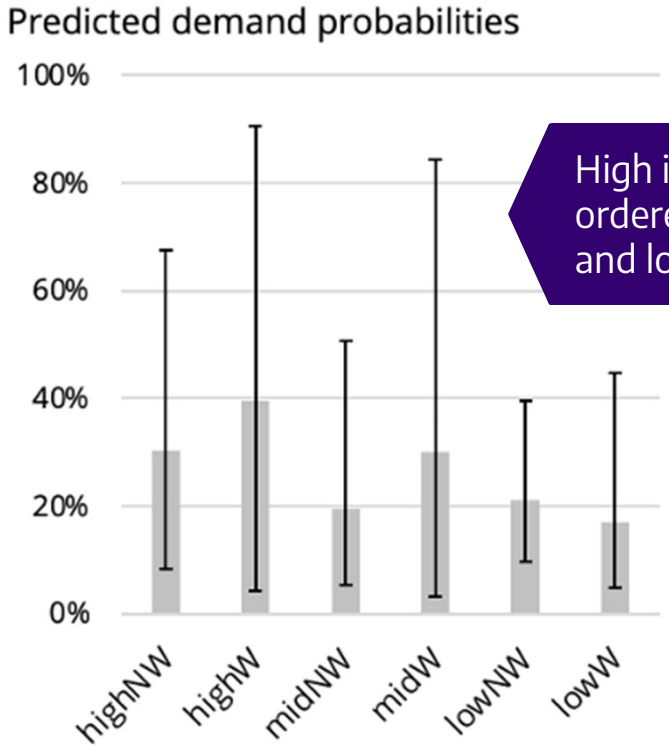
Measuring ecommerce emissions in Seattle

- **Data**
  - Amazon UDC locations and package volumes (MWPVL 2021)
  - Demographic data from U.S. Census, ACS 5-year
  - Logit-based delivery assignment based on PSRC travel survey data
  - OSM network analysis & approx. travelling salesperson (TSP) distance

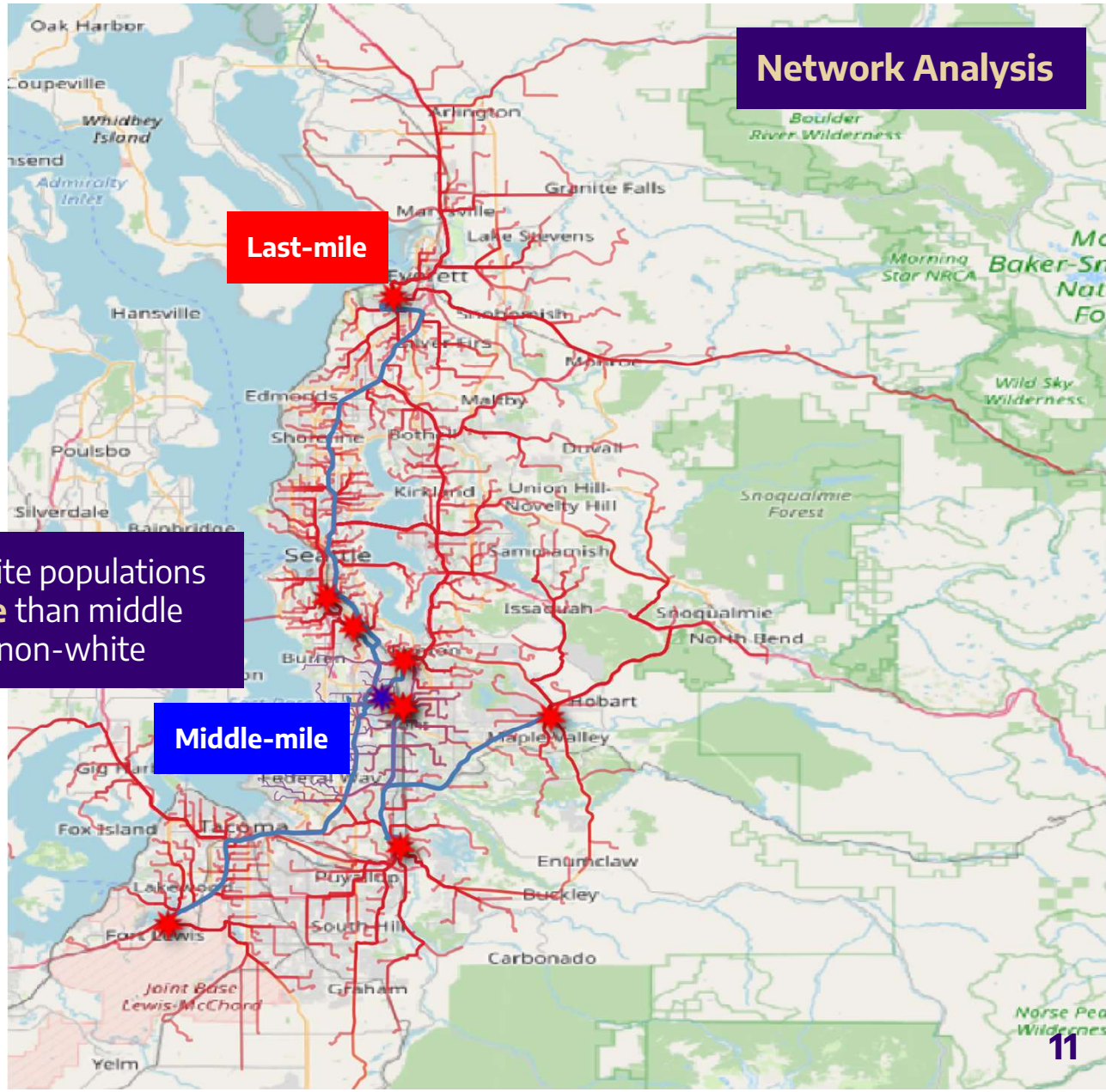


Logit-based delivery assignment

> Package demand derived using race:income, age, household size, and municipality

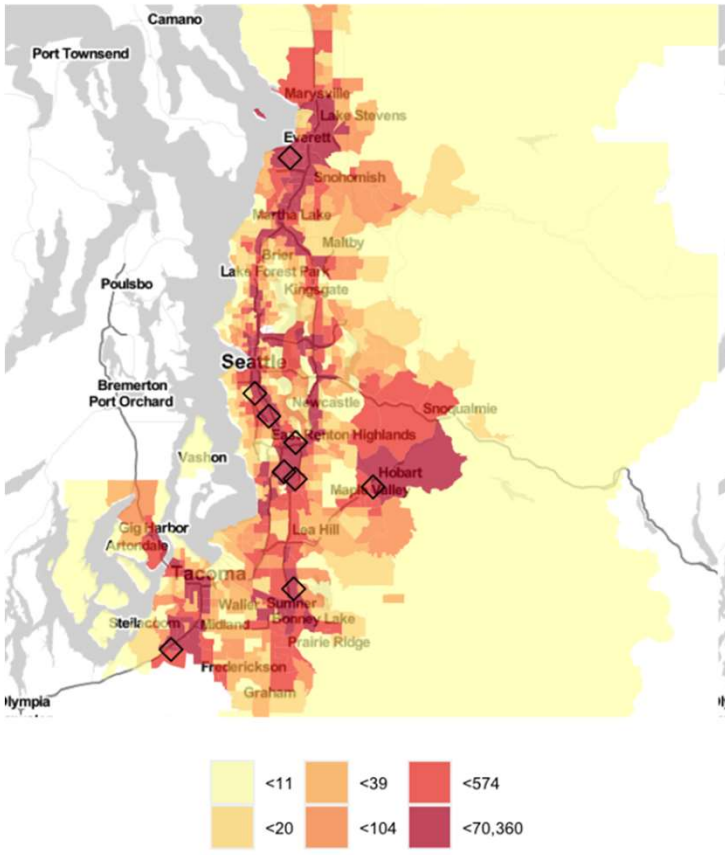


High income white populations ordered **2x more** than middle and low income non-white

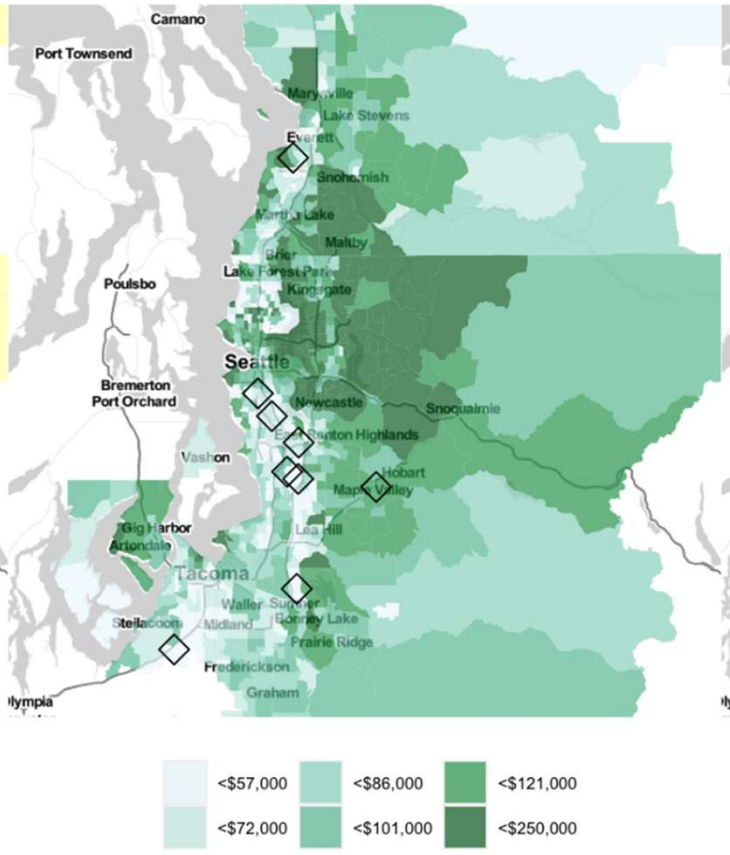


Lower incomes, higher POC % correlated with UDC location and VKT*

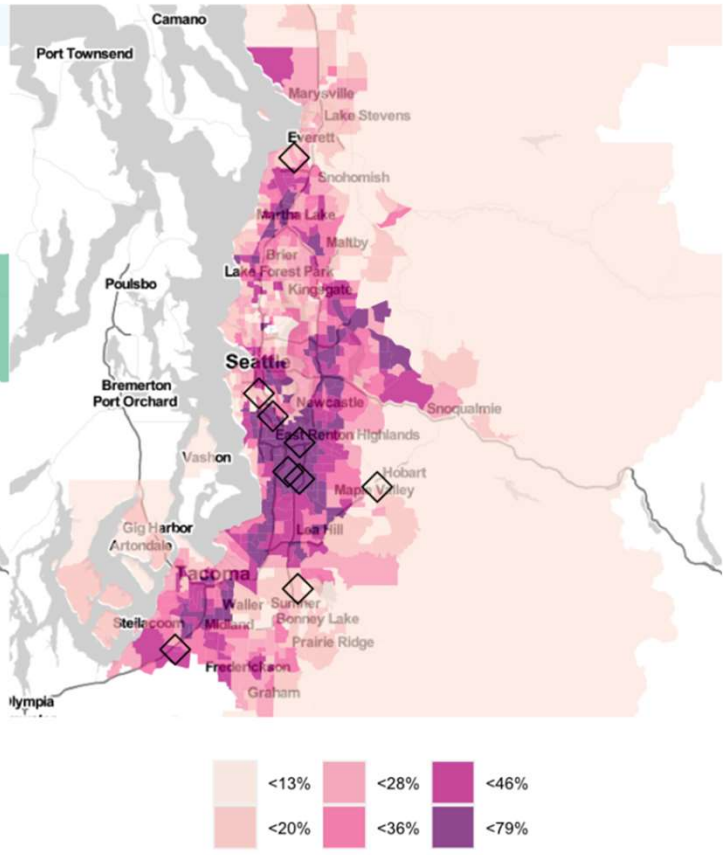
Total VKT per sq. km



Median household income



POC percent of population



*Pearson's R coeff., $p < 0.05$

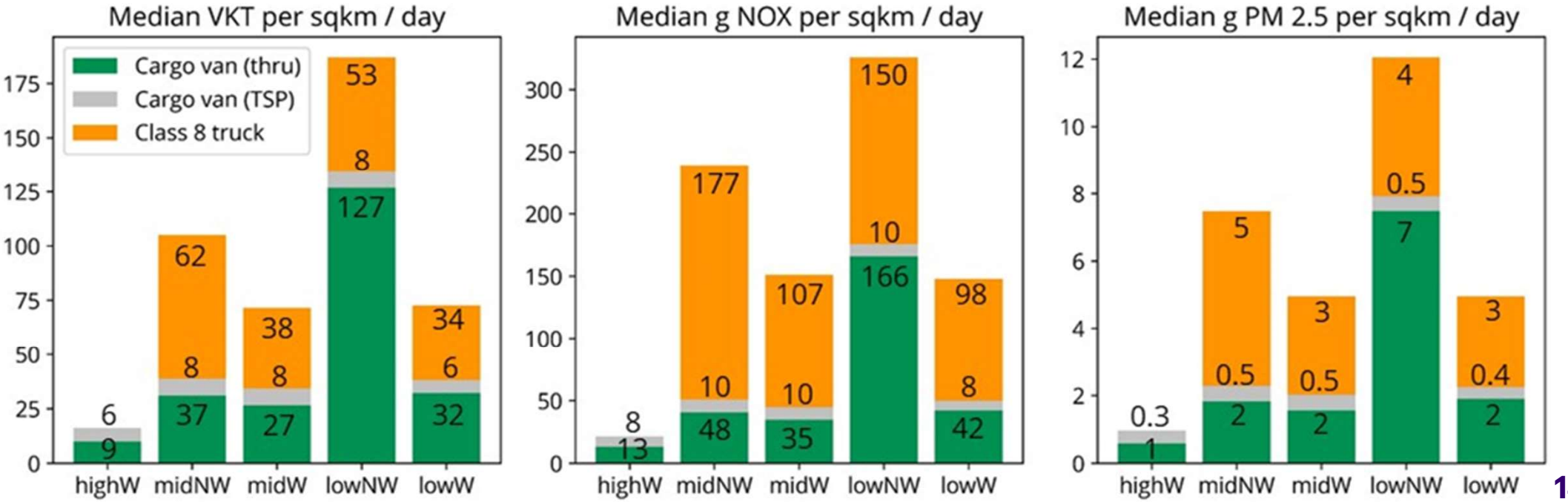
POC-majority tracts exposed to **3x more ecommerce-related traffic concentrations**

despite ordering 50% less
online than white populations.

*Dunn's test, $p < 0.05$

VKT, Emissions and Race

- Cargo van emissions comprised a majority of emissions: 95% NOx, 97% PM2.5
- POC-majority populations were more exposed than white populations, regardless of income*
- Middle-mile trucks had higher emission impact for middle-income POC pops, cargo vans had higher emission impact for low-income POC pops *



VKT, Emissions and Race

Race, highways and UDC proximity **stronger predictors for e-commerce VKT** than income and package demand*

PHOTO: Oscar Martinez

*OLS linear regression, $p < 0.05$

Future research direction

- Theorizing “freight justice”
  - What are guiding distributive principles? When is unequal unfair?
  - Where (i.e., what scale) are injustices (un)resolved?
  - Who’s (un)involved in the negotiations of outcomes?
- Longitudinal analysis: how do historic logistic land uses correlate to shifting demographics and today’s uses?
- Evaluating equity in urban cyclelogistics and microhub projects
  - Pilot studies in Seattle and Gothenburg
  - Food justice & accessibility - grassroots cyclelogistics in the Global North and South

PHOTOS: Urban Freight Lab

Thank you!

Questions? Email: tfried3@uw.edu

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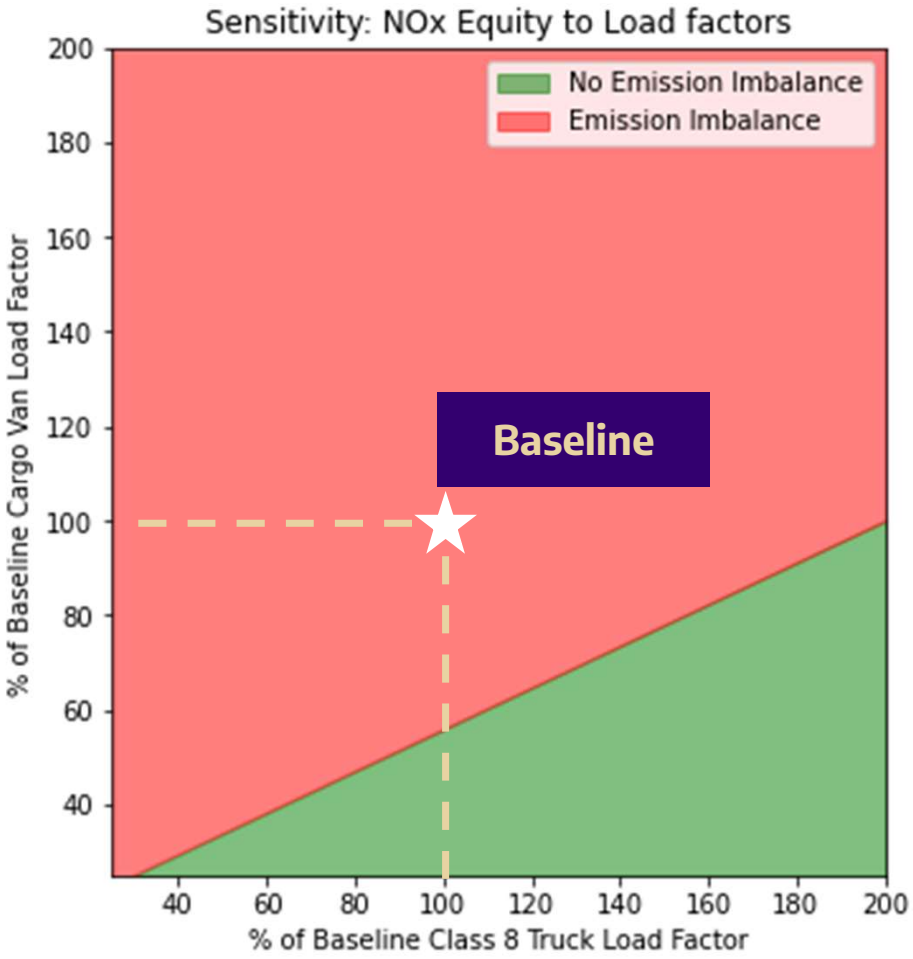
Findings

- Higher UDC intensity correlated with low incomes and high POC concentrations
- Middle-mile trucks an important pain-point
- POCs were more exposed to emissions than White populations, regardless of income and total packages ordered
- In line with past EJ 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

PHOTO: Oscar Martinez

Vehicle utilization and sensitivity analysis



> Discrepancies between race-income groupings more sensitive to fluctuations in truck utilization

Implications for urban freight solutions

PHOTOS: Urban Freight Lab

- 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!

Logistics “Sprawl”

Resulting sprawl added
15,000 tons CO_2 per year

- Dablanc (2008): Warehouses leaving the inner city for the ‘burbs
- Conceptually rooted in **urban sprawl and economics:** firm polarization/dispersion
- Tons of reasons. To oversimplify: **highways** and **land prices**
- What’s the impact?

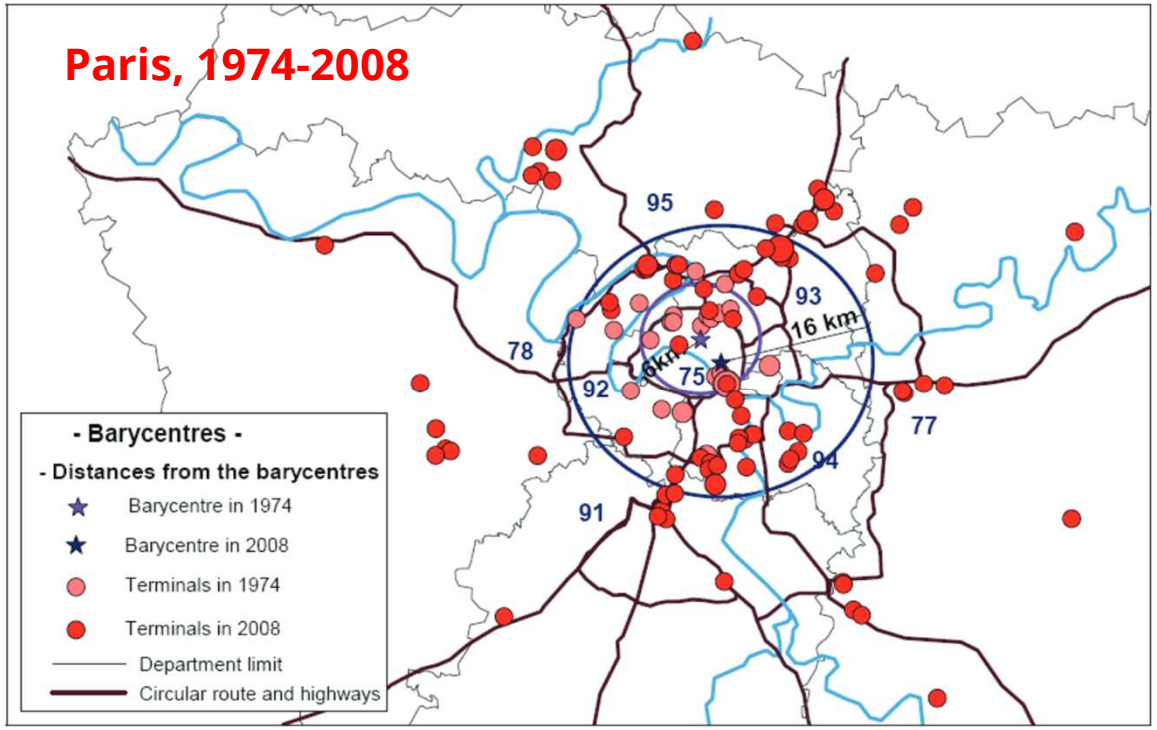


Figure 4 Displacement of barycentre and distance around barycentre

“Can’t ecommerce coming to town be a good thing? What’s the trade-off?”

- **The Good:**
  - Lots of people benefit from online shopping
  - UDCs create some jobs
  - Some UDCs are replacing unproductive commercial landuse (e.g., abandoned shopping malls and car dealerships); property/utility tax benefit
- **The Bad:**
  - Warehouse jobs are low density. Often they displace jobs rather than net-create.
  - Most UDCs are greenfield since retrofitting commercial real estate is costly
- **The Ugly:**
  - Jobs are low quality: wages and benefit are low, worker protections are flimsy
  - UDCs are more automated, leaving workers vulnerable to negative automation effects

Logit model

Daily package received (binary logit)

	Model 1		*Model 2 (w/o interaction)*		*Model 3 (w/ interaction)*	
	Coef.	Std. e	Coef.	Std. e	Coef.	Std. e
intercept	-2.73***	0.25	-2.58***	0.20	-2.05***	0.24
age [25-54]	0.28**	0.12	0.25**	0.11	0.27***	0.11
children [yes]	-0.21	0.12	-	-	-	-
hh size	0.25***	0.08	0.20***	0.05	0.20***	0.05
race [white]	0.27**	0.12	0.31***	0.12	-0.43*	0.24
income [mid]	0.47***	0.14	0.54***	0.14	-0.19	0.25
income [high]	0.83***	0.18	1.0***	0.16	0.35	0.28
num. trips	0.05***	0.02	-	-	-	-
education [graduate degree]	0.09	0.11	-	-	-	-
education [HS or less]	-0.06	0.16	-	-	-	-
renter [yes]	-0.12	0.11	-	-	-	-
lives in Seattle [yes]	0.21*	0.11	0.22**	0.11	0.20*	0.11
race [white]: income [mid]	-	-			1.01***	0.29
race [white]: income [high]	-	-			0.86***	0.33
N	2,185		2,224		2,224	
R^2 Tjur	0.05		0.04		0.05	
LL_0	-1,389.92					
LL	-1,161.68		-1,180.49		-1,174	
AIC	2,347.35		2,374.97		2,366.70	

OLS Model

OLS Linear Regression								
	Log(Total VKT / sqkm)		Log(Cargo van (thru) / sqkm)		Log(Cargo van (TSP) / sqkm)		Log(Class 8 truck VKT / sqkm)	
	Coef.	Std. e	Coef.	Std. e	Coef.	Std. e	Coef.	Std. e
intercept	3.75*	1.98	2.83	2.39	-1.09	0.87	5.69***	1.40
Log(%POC)	0.43***	0.11	0.39***	0.14	0.53***	0.05	0.19**	0.08
Log(income)	-0.01	0.19	-0.08	0.23	-0.02	0.08	-0.33**	0.13
Log(pkg demand)	0.10	0.14	0.34**	0.16	0.28***	0.06	-0.29***	0.10
Log(highway length/sqkm)	0.82***	0.06	0.93***	0.07	-0.16***	0.02	0.56***	0.04
Log(km from UDC)	-0.92***	0.09	-1.00***	0.11	-0.08	0.04	-0.28***	0.07
N	715		715		715		715	
R^2 adj	0.39		0.35		0.22		0.31	
LL_0	-1,577.22		-1,689.87		-898.34		-1,288.6	
LL	-1,398.50		-1,535.62		-808.61		-1,151.74	
AIC	2,811.10		3,085.24		631.22		2,317.47	