Integrating Equity in Addressing Global Change:
The role of community perspectives in finding solutions

March 28, 2025
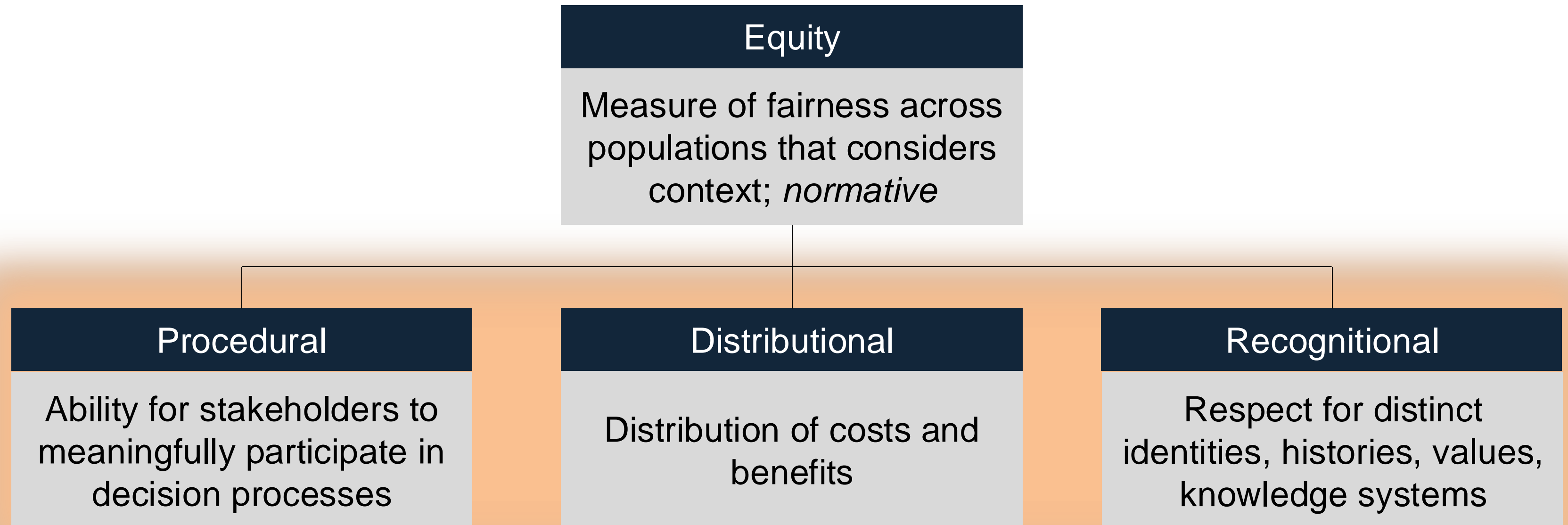
MIT Global Change Forum

Amanda Giang

University of British Columbia

amanda.giang@ubc.ca

Addressing equity in global change

Equity

Measure of fairness across populations that considers context; *normative*

Procedural

Ability for stakeholders to meaningfully participate in decision processes

Distributional

Distribution of costs and benefits

Recognitional

Respect for distinct identities, histories, values, knowledge systems

Local community and other perspectives that are often underrepresented are needed to inform understanding and action on distributional equity

Giang et al. 2024; Sonja et al. 2018; Friedman et al. 2018

Many major sources of **air pollution** are also major sources of **GHGs**
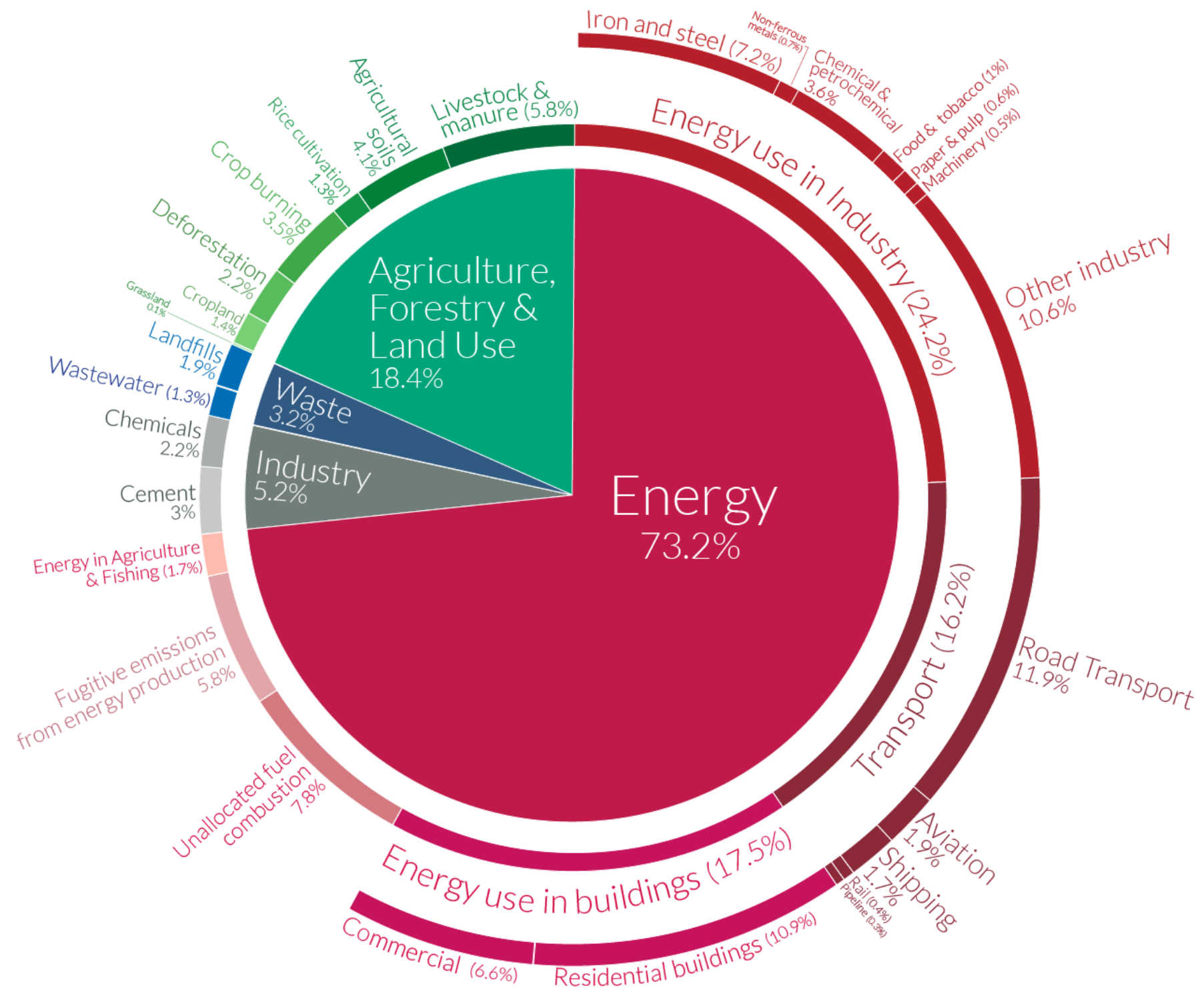
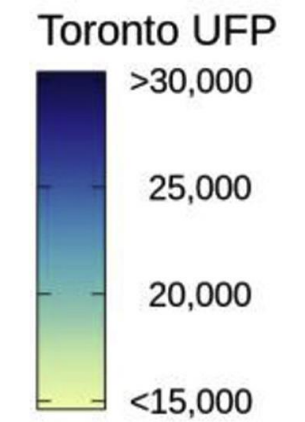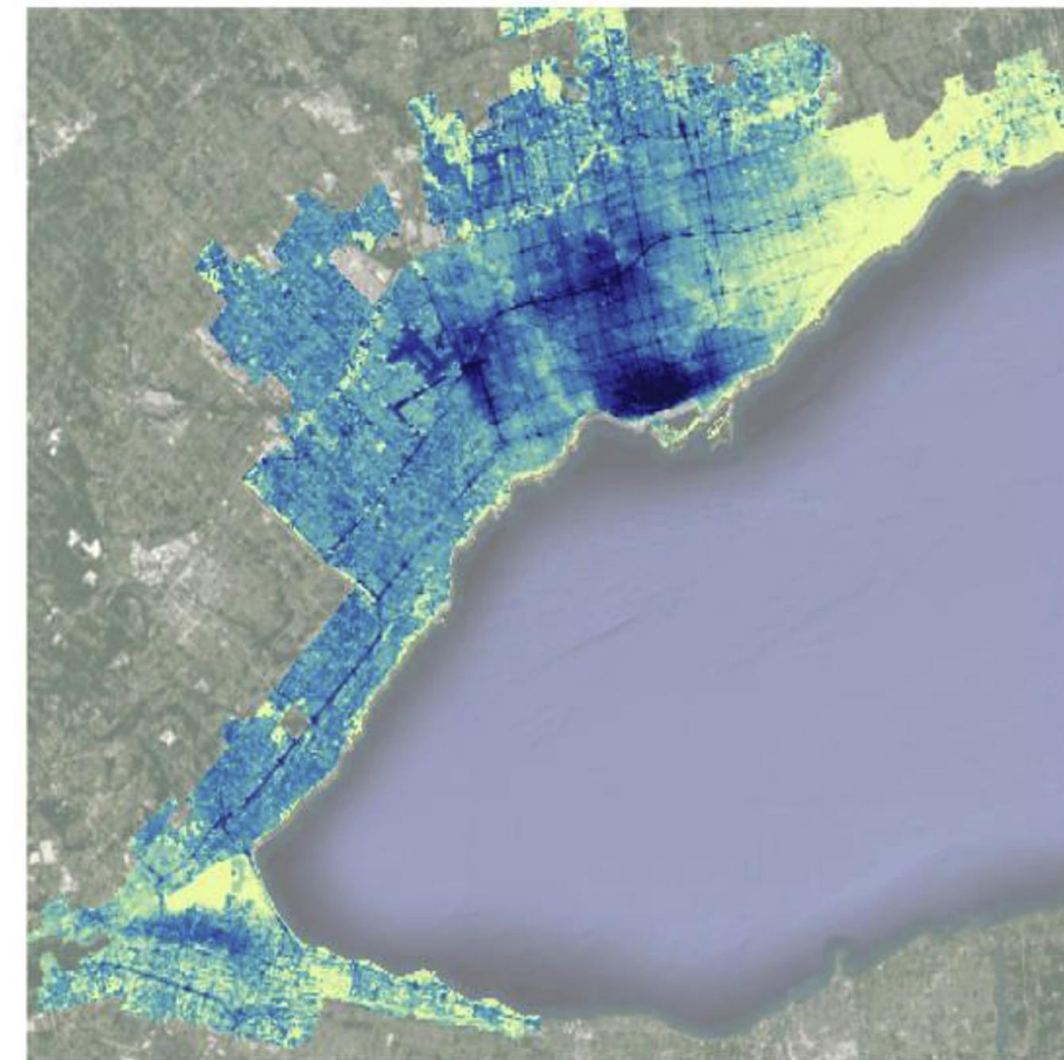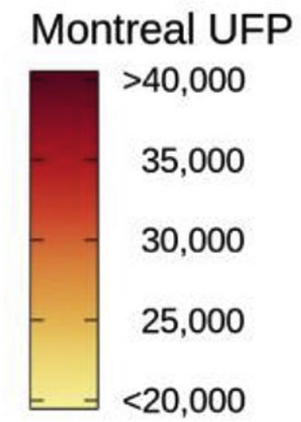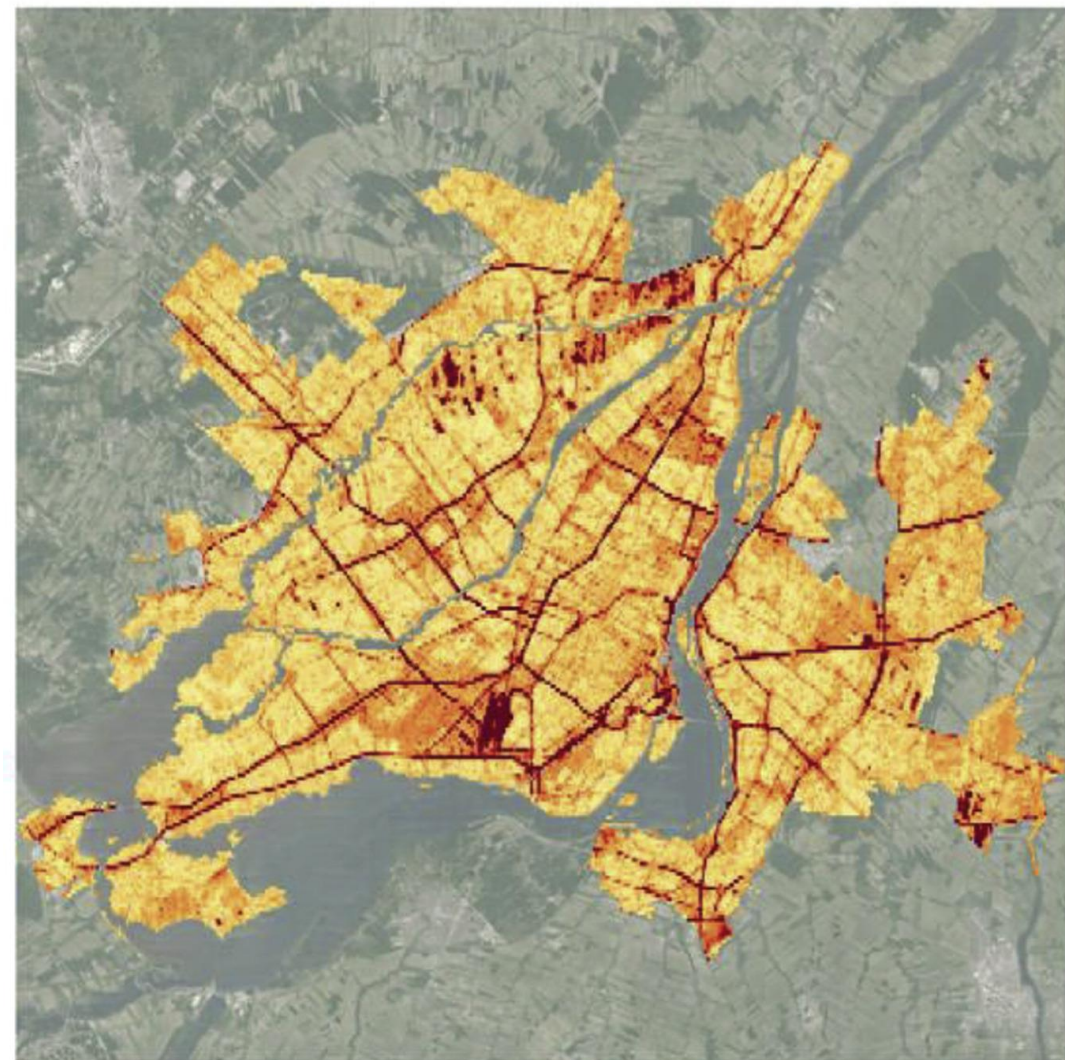Sectoral breakdown of global GHG emissions 2020

Air pollution is not distributed equally, or equitably
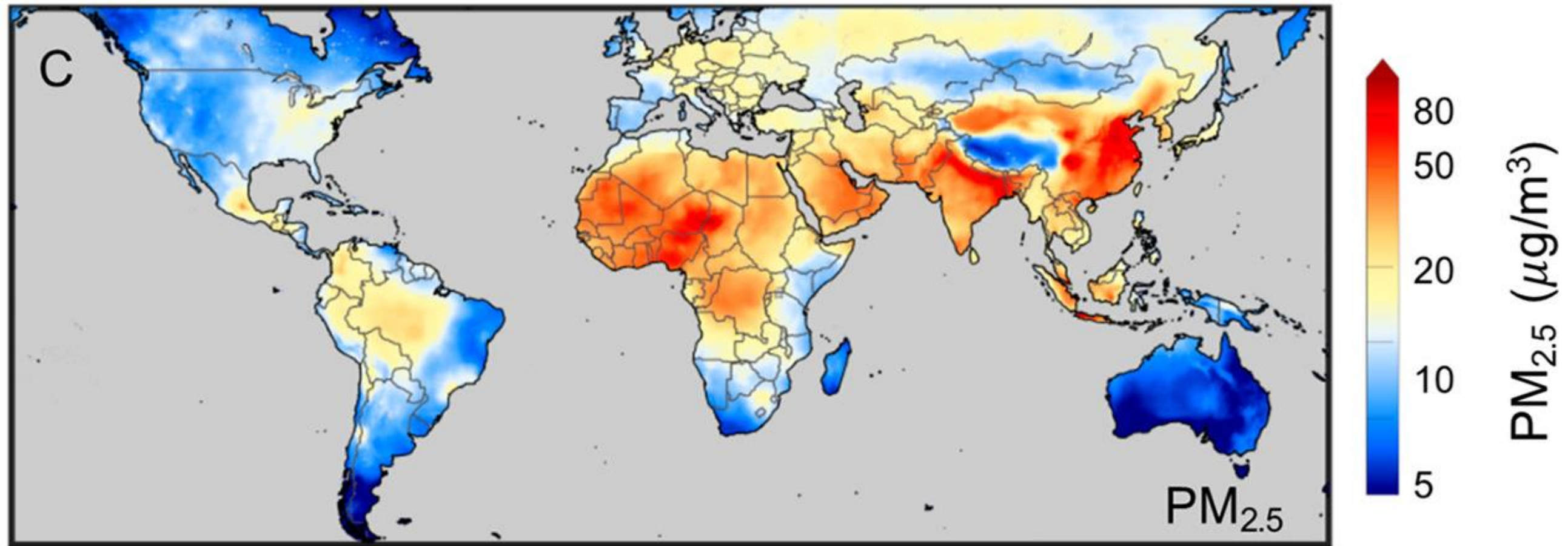
Global distribution of annual average fine particulate matter (1998-2018) from Hammer et al. 2020

Air pollution is not distributed equally, or equitably

Modelled ultra-fine particulate matter (particles/cm^3) from Hong et al. 2019

Can we achieve **"triple-wins"** ?

Improve Air Quality
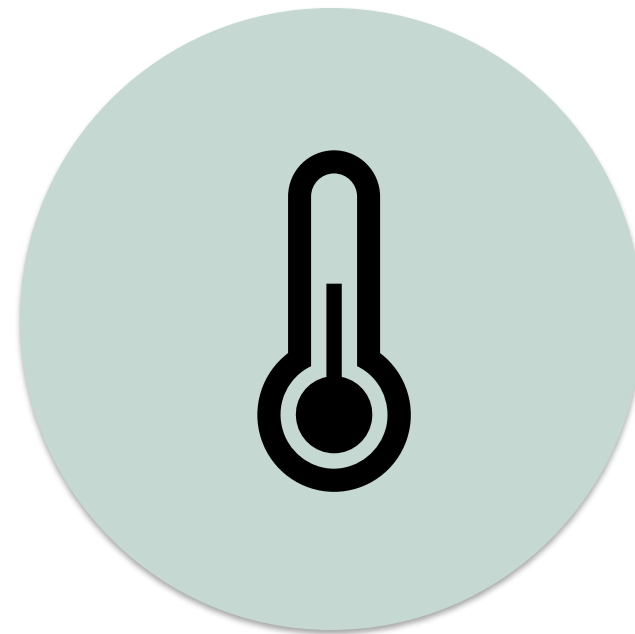
Mitigate GHG emissions
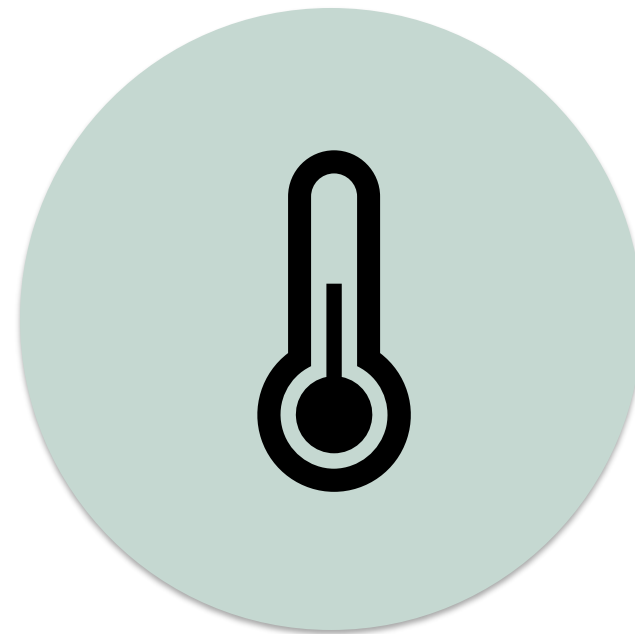
Reduce exposure disparities

Can we achieve **"triple-wins"** ?

Improve Air Quality

Mitigate GHG emissions

Reduce exposure disparities

Yes, but it will likely require **targeted interventions** and **systemic transformations**.

Koolik et al. 2024; Picciano et al. 2023

Air quality has improved overall over recent decades in North America, but exposure disparities persist

Example: PM$_{2.5}$ concentrations due to **on-road transportation** in **California**, from Koolik et al. 2024

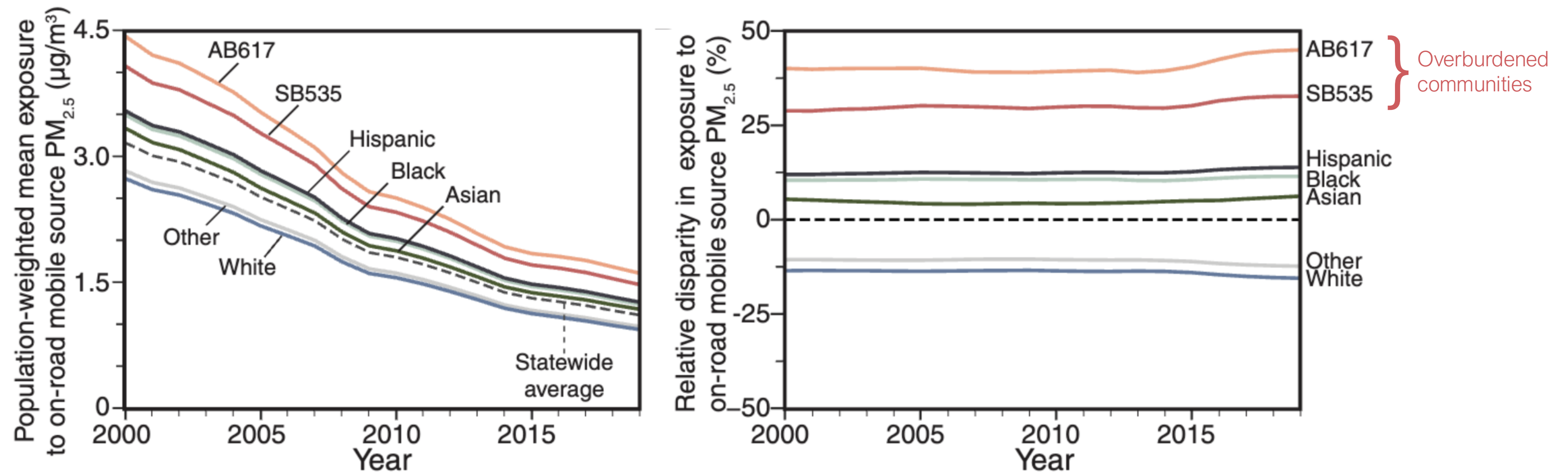# Air quality has improved overall over recent decades in North America, but exposure disparities persist
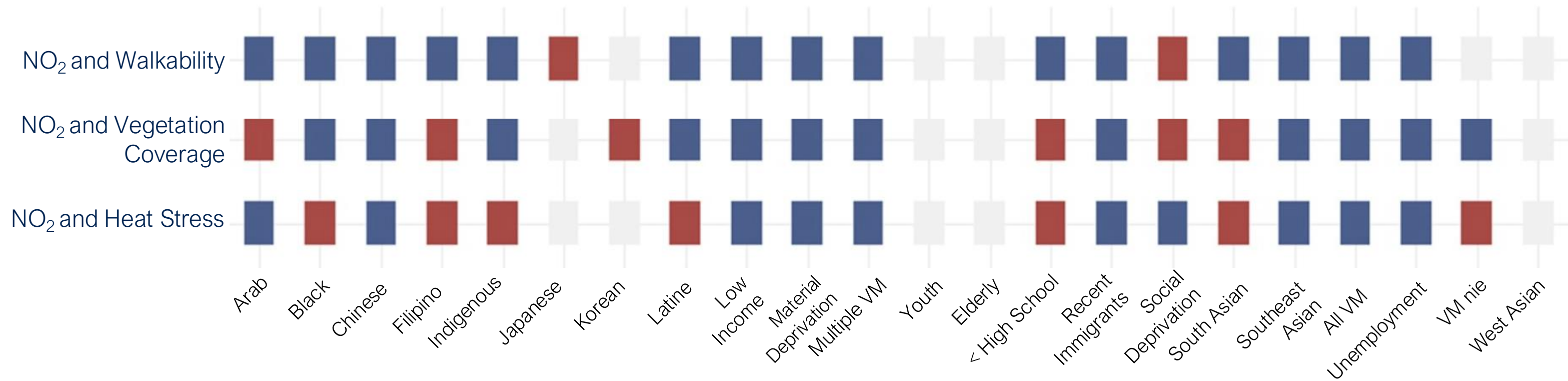
Example: Relative disparities for NO_2 in combination with other environmental risks/benefits

- decreased
- increased
- didn't change

in **Metro Vancouver** between 2006 and 2016, from Ren and Giang 2024

Shuoqi Ren

"Increased air quality equity is not an inevitable consequence of climate policy." Polonik et al. 2023

"Policies that address only about 50 percent of CO_2 emissions leave many polluting sources in place, and those that prioritize reductions for minorities tend to benefit the entire population," says Noelle Selin, supervising author of the study… "This means that **a large range of policies that reduce CO_2 can improve air quality overall, but can't address long-standing inequities in air pollution exposure.**"

Picciano et al. 2023; Wang et al. 2022; Polonik et al. 2023

MIT News
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Improving US air quality, equitably

Study finds climate policy alone cannot meaningfully reduce racial/economic disparities in air pollution exposure.

Mark Dwortzan | MIT Joint Program on the Science and Policy of Global Change
September 27, 2023

Can we achieve **"triple-wins"** ?

Improve Air Quality

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Reduce exposure disparities

Yes, but it will likely require **targeted interventions** and **systemic transformations**.

Koolik et al. 2024; Picciano et al. 2023

Community knowledge provides insights to target distributional inequity drivers
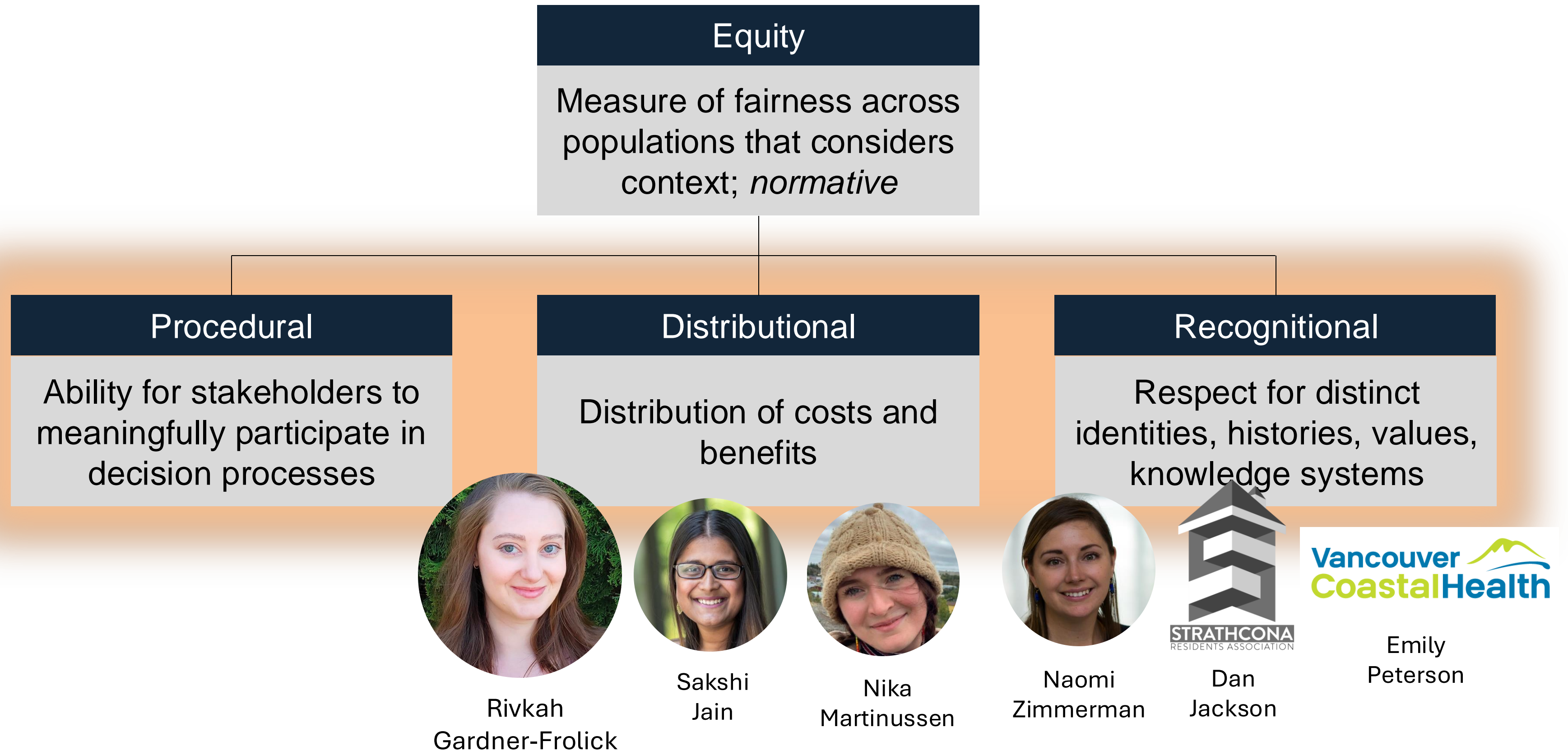
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Rivkah Gardner-Frolick

Sakshi Jain

Nika Martinussen

Naomi Zimmerman

Dan Jackson

Emily Peterson

Identifying triple-win interventions for freight transport

Photo: John Sinal

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Combining low-cost sensors and local knowledge for high-resolution air pollution mapping at the neighbourhood-scale

Air pollution sources	Groups highly impacted by air pollution exposure	Community assets and resilience
Port-related traffic (road, rail, marine)	Highest low-income rate	Strong sense of community and history of organizing
Industrial activity	Largest Indigenous population	Cultural richness
Construction	Many seniors and others with health vulnerabilities	Important community spaces

Photo: John Sinal

Community knowledge to identify sources of interest and vulnerable receptors

RAMP monitors

Industrial sources (port, produce warehouses)

Intersections of concern

Streets of concern

Rail lines

Collaboration with the Strathcona Residents' Association and Vancouver Coastal Health
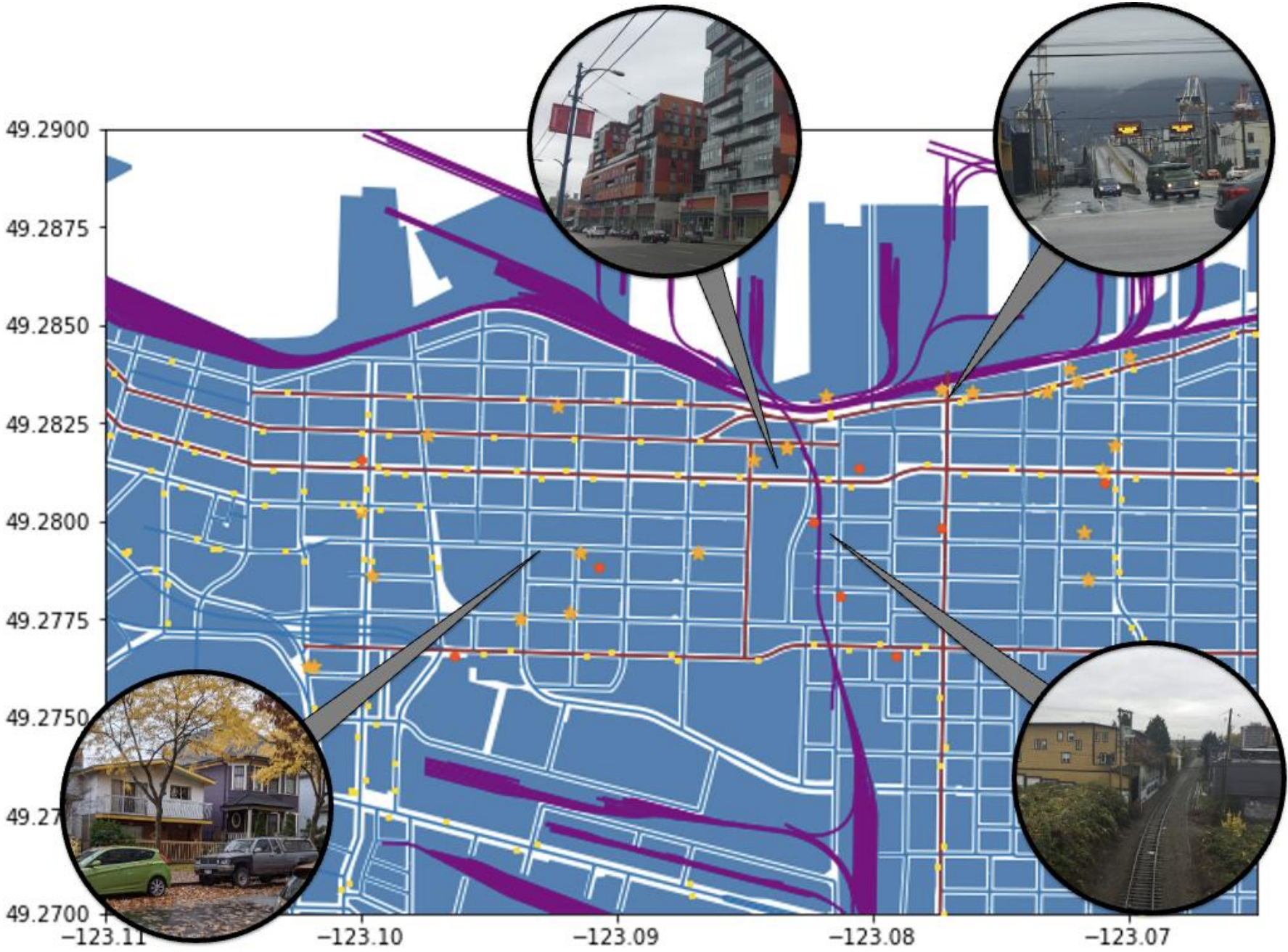

Ethics ID: H21-02425

Sensor network deployment May to November 2022: Calibration based on 2 weeks co-location with reference monitor pre- and post- deployment; CO, CO_2, $PM_{2.5}$, NO_x, O_3, RH, T

Jain et al. 2024, *Geohealth*

Community data co-interpretation event to understand spatial and temporal patterns

Co-mapping activity for sources and receptors

Key
- Location from community mapping event
- Smell Vancouver report from monitoring period
- Bus stop (priority identified in community survey)
- Road of concern identified in community survey
- Railway (priority identified in community survey)

Community data co-interpretation event to understand spatial and temporal patterns

- **Local knowledge on timing and location of sources, such as**:
  - (Illegal) truck and train idling
  - Construction sites
  - Wood stoves
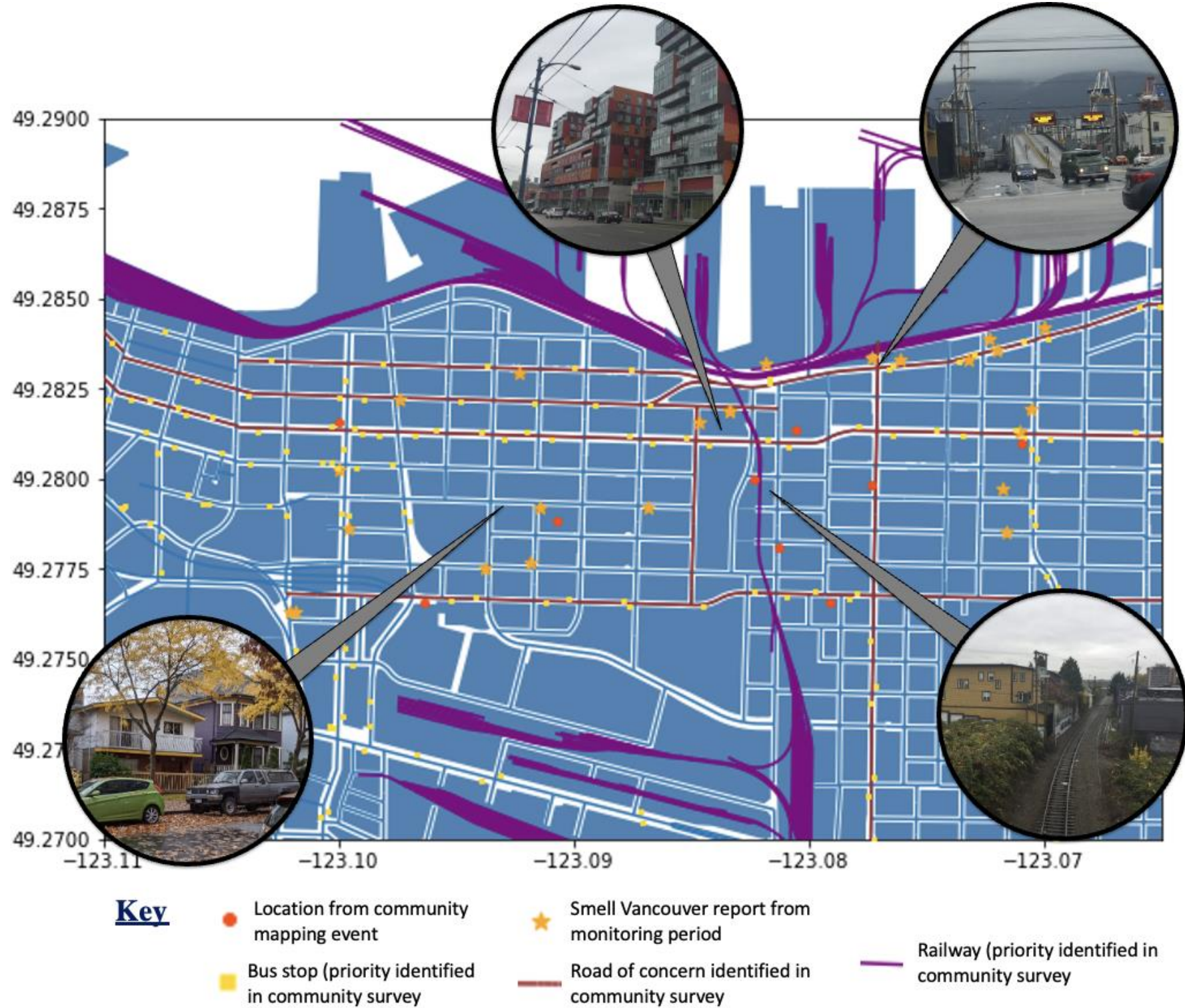 - Not represented in public data sets!

Key
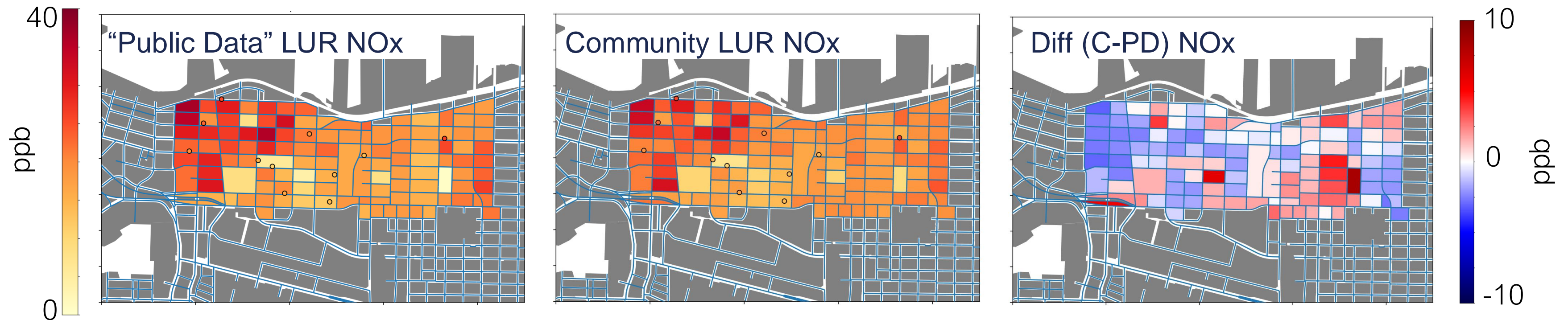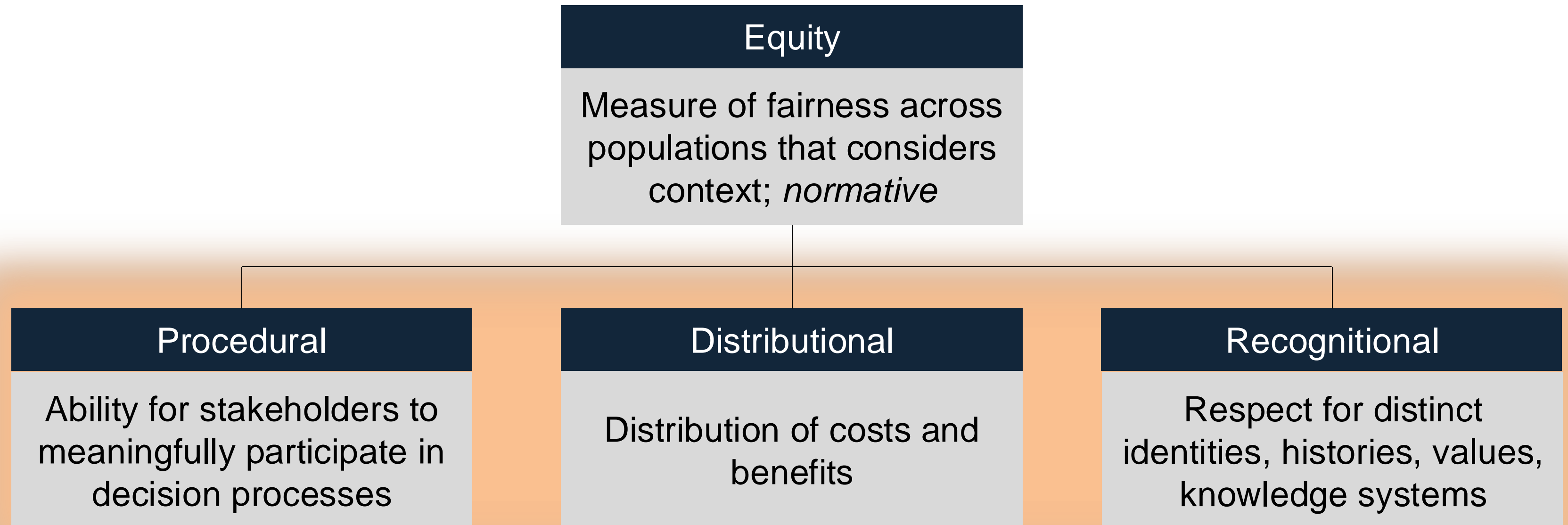- 🔴 Location from community mapping event
- ⭐ Smell Vancouver report from monitoring period
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Community knowledge of informal sources and vehicle operation improves land use regression spatial models

	Public Data Land Use Regression			Community Land Use Regression		
	NO_2	NO_x	$PM_{2.5}$	NO_2	NO_x	$PM_{2.5}$
Model Adjusted R^2	0.70	0.34	0.38	0.80	0.79	0.54
LOOCV R^2 Min	0.66	0.15	0.21	0.71	0.66	0.44
LOOCV R^2 Max	0.84	0.87	0.61	0.87	0.99	0.76

Leave One Out Cross Validation

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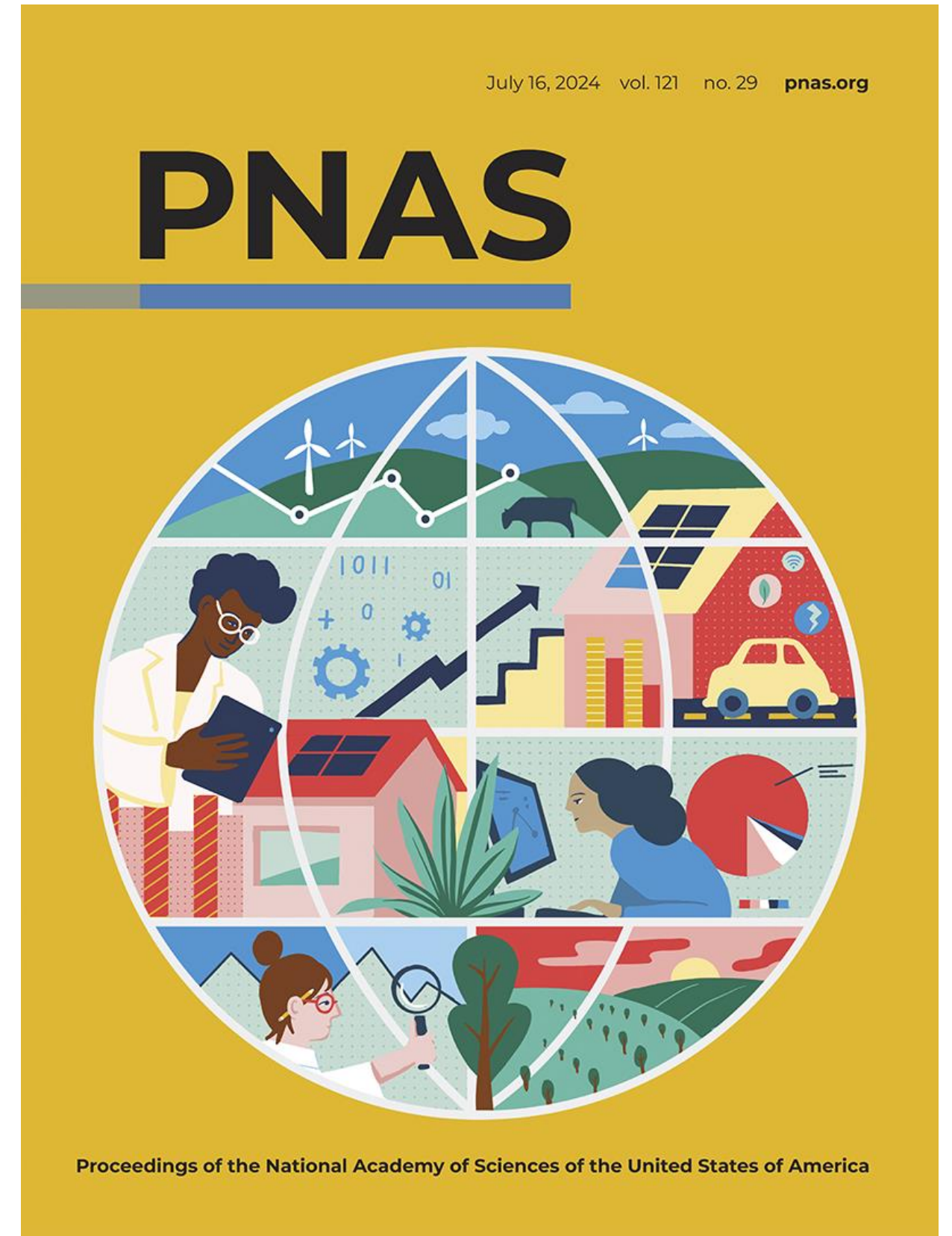Insights for action and research: compliance and enforcement!

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Equity and modeling in sustainability science: Examples and opportunities throughout the process

Amanda Giang[a,b,1], Morgan R. Edwards[c,d], Sarah M. Fletcher[e,f], Rivkah Gardner-Frolick[b], Rowenna Gryba[g,h,i], Jean-Denis Mathias[j], Camille Venier-Cambron[k], John M. Anderies[l], Emily Berglund[m], Sanya Carley[n], Jacob Shimkus Erickson[d,o], Emily Grubert[p], Antonia Hadjimichael[q,r], Jason Hill[s], Erin Mayfield[t], Destenie Nock[u], Kimberly Kivvaq Pikok[v], Rebecca K. Saari[w], Mateo Samudio Lezcano[u], Afreen Siddiqi[x], Jennifer B. Skerker[e], and Christopher W. Tessum[y]

More examples!

Proceedings of the National Academy of Sciences of the United States of America

Special Feature
Modeling Dynamic Systems for Sustainable Development

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Thank you for listening!

Amanda Giang (amanda.giang@ubc.ca)

- **Funding**
  - Environment and Climate Change Canada – Climate Action and Awareness Fund; NSERC Alliance Missions GHG; Canada Research Chair Program; SSHRC Insight Grant; UBC Public Scholars Initiative

LEAP Lab 2023-2025!