Mapping spatial patterns in vulnerability to climate change-related health hazards

8th Annual Public Sector Climate Leadership Symposium
Plenary Session 4 - Collaborative Climate Vulnerability Assessments
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Vulnerability to climate change – related events

Complex interactions between

1. Hazard exposure (e.g. extreme heat, wildfire smoke, flood, ground level ozone)

2. Sensitivity (e.g. age, health status)

3. Adaptive capacity (e.g. SES, built environment, social network, community infrastructure)

> Not just about hazard exposure

> Factors influencing sensitivity and adaptive capacity could increase or decrease exposure impacts

> Expect variations even at small spatial units - neighborhoods and communities

HAZARD EXPOSURE

VULNERABILITY RESILIENCE

ADAPTIVE CAPACITY

SENSITIVITY
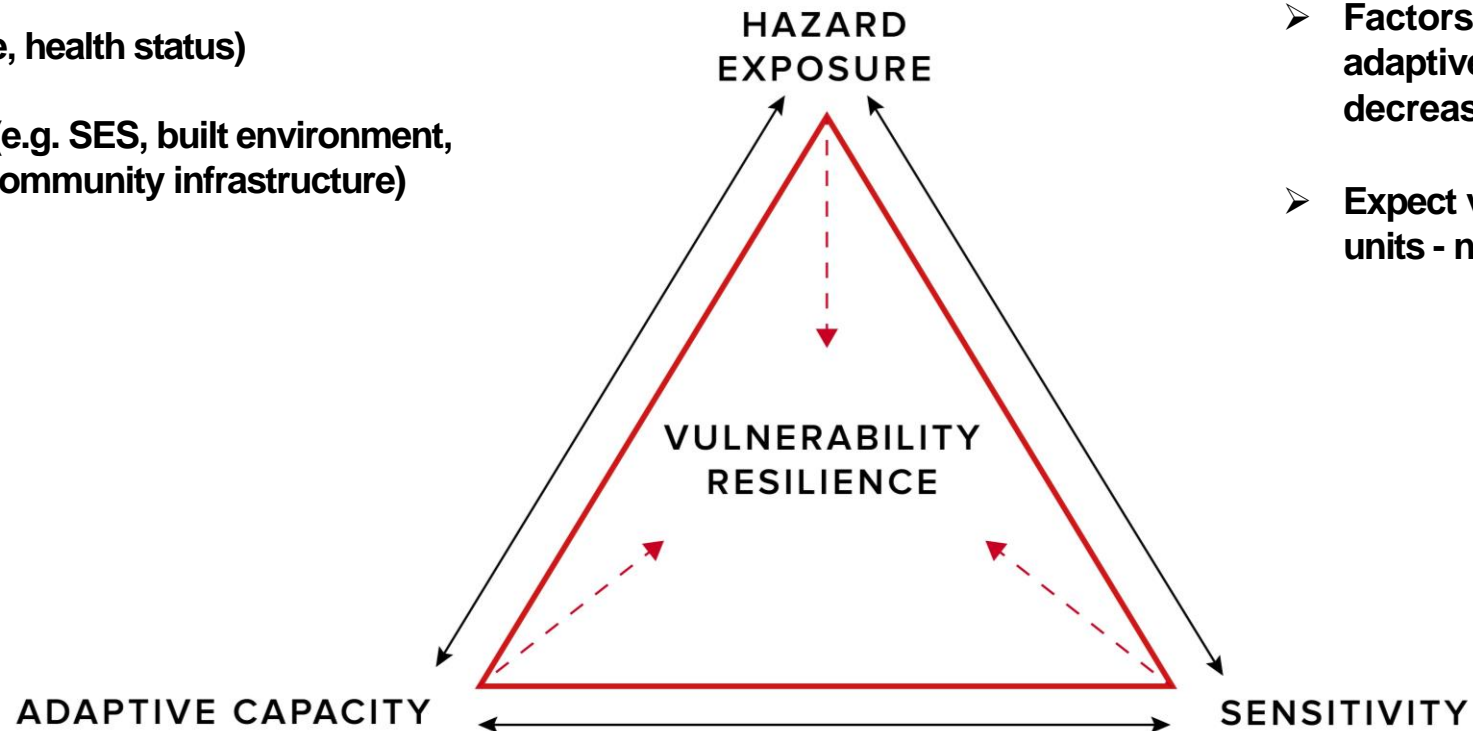
The climate change vulnerability mapping project

Overall goal: To promote awareness and improve response to population health impacts from climate change at the local community level

Specific objective: To create and map health vulnerability indices for:

◦ Inland flooding ; Sea Level Rise;

◦ Extreme heat;

◦ Wildfire smoke ;

◦ Ground level ozone air pollution

Scope: Geographic areas covered by VCH and FHA

The Mapping Project Team

UBC
◦ Michael Brauer, Prof, SPPH
◦ Jessica Yu, PhD cand, SPPH
◦ Kaitlin Castellani, MSc Geomatics
◦ Angela Yao, PhD cand, SPPH
◦ Krista Cawley, MSc cand, IRES
◦ Xuan Zhao, Med Student

Health Authorities
◦ James Lu VCH
◦ Emily Peterson VCH
◦ Sara Forsting VCH
◦ Geoff Ramler VCH
◦ Lisa Mu FHA
◦ Elden Chan, VCH
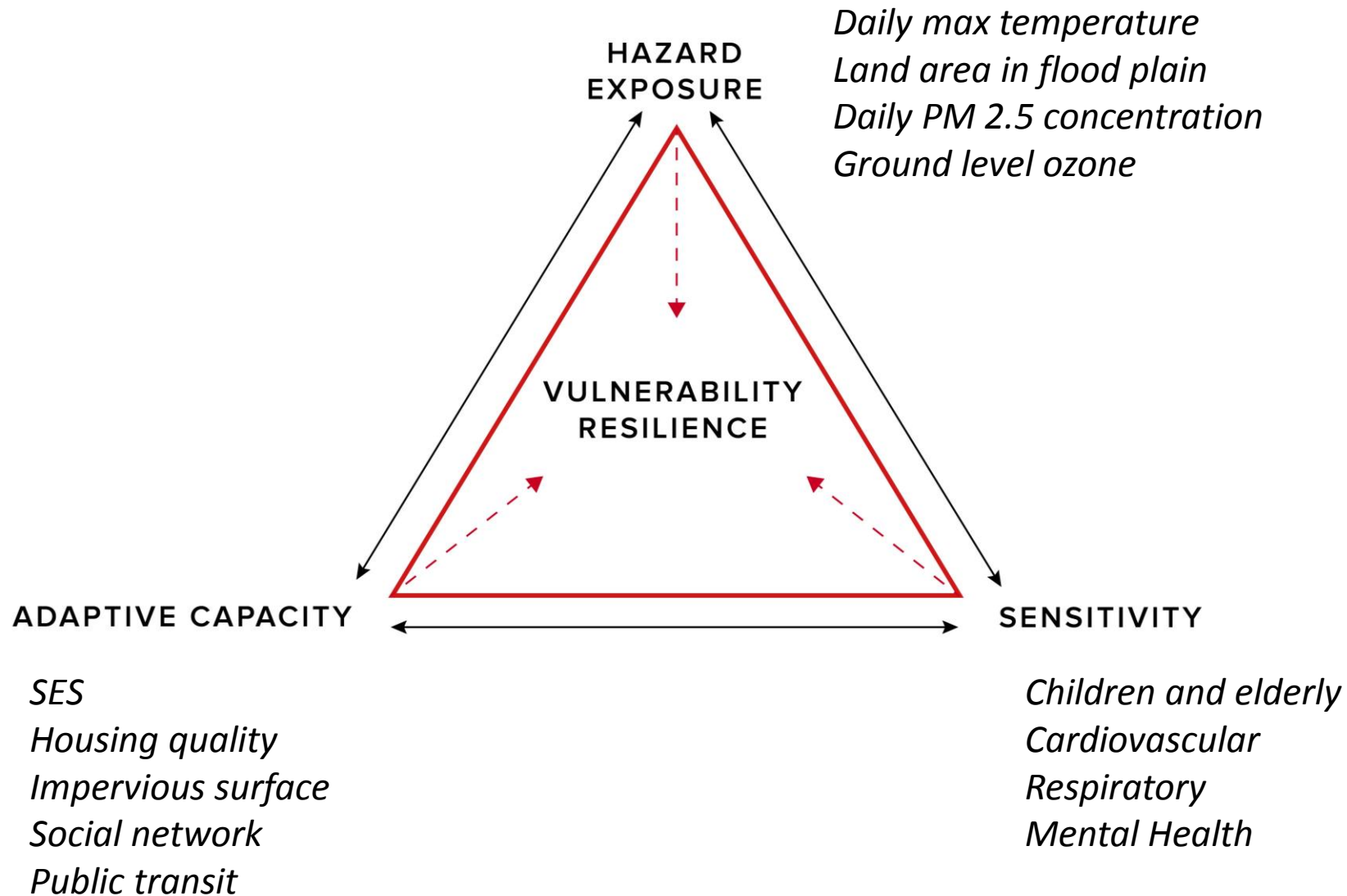◦ Duncan Lu, VCH
◦ Craig Brown, VCH / HealthADAPT

Methods

o Vulnerability constructs: exposure, sensitivity, adaptive capacity

o Question: How does one neighborhood / community compare to another

o Variables / Determinants
1. Literature search
2. Assembling available data to census DA level
3. Looking for variables that explain most of the differences in the data set
   --> principal component analysis (PCA)

o Indices
1. Separate index for each exposure
2. Weights from PCA
3. Relative scores of vulnerability – not scores of absolute risks

Data collected for 35+ variables
Examples:

HAZARD EXPOSURE

Daily max temperature
Land area in flood plain
Daily PM 2.5 concentration
Ground level ozone

VULNERABILITY RESILIENCE

ADAPTIVE CAPACITY

SES
Housing quality
Impervious surface
Social network
Public transit

SENSITIVITY

Children and elderly
Cardiovascular
Respiratory
Mental Health

Data sources

Strengths and Limitations

Limitations
- Relative vulnerability not absolute burden of illness
- Composite Indices
  - Oversimplification?
  - "Ground-truthing" essential
- Data availability
  - Different data sets have different granularity
  - Lack of granular data in general for rural and remote communities
  - **Air conditioning and outdoor work data**

Strengths
- Population-level open-source data
- Multiple sources of data and triangulation
- Ability to update with new data
- Interactive map

What are the pros and cons of composite indicators?

Pros

summarize complex or multi-dimensional issues to support decision-makers.

provide the big picture. Easier to interpret than trying to find a trend in many separate indicators. Facilitate ranking complex issues.

help attract public interest by providing a summary to compare across communities.

help reduce the size of the indicator list

Cons

misleading, if poorly constructed or misinterpreted. Sensitivity analysis can be used to test for robustness.

may invite simplistic policy conclusions. Composite indicators should be used in combination with the sub-indicators and local context

The construction of composite indicators should be transparent and based on sound statistical principles.

Results

Proportional contributions to variations in vulnerability between communities and neighborhoods

➤ Not just about hazard exposure

➤ Sensitivity factors explain >40% of the variations between DAs for wildfire smoke

➤ Adaptive capacity – probably most modifiable in the short term – contributes to a third of the variations

Heat
39.4% Exposure
27.2% Sensitivity
33.4% Adaptive Capacity

Smoke
22.5% Exposure
43.4% Sensitivity
34.1% Adaptive Capacity

Ozone
44.1% Exposure
16.4% Sensitivity
39.5% Adaptive Capacity

Flood
31.3% Exposure
34.8% Sensitivity
33.9% Adaptive Capacity

Categories:
- ■ Exposure
- ■ Sensitivity
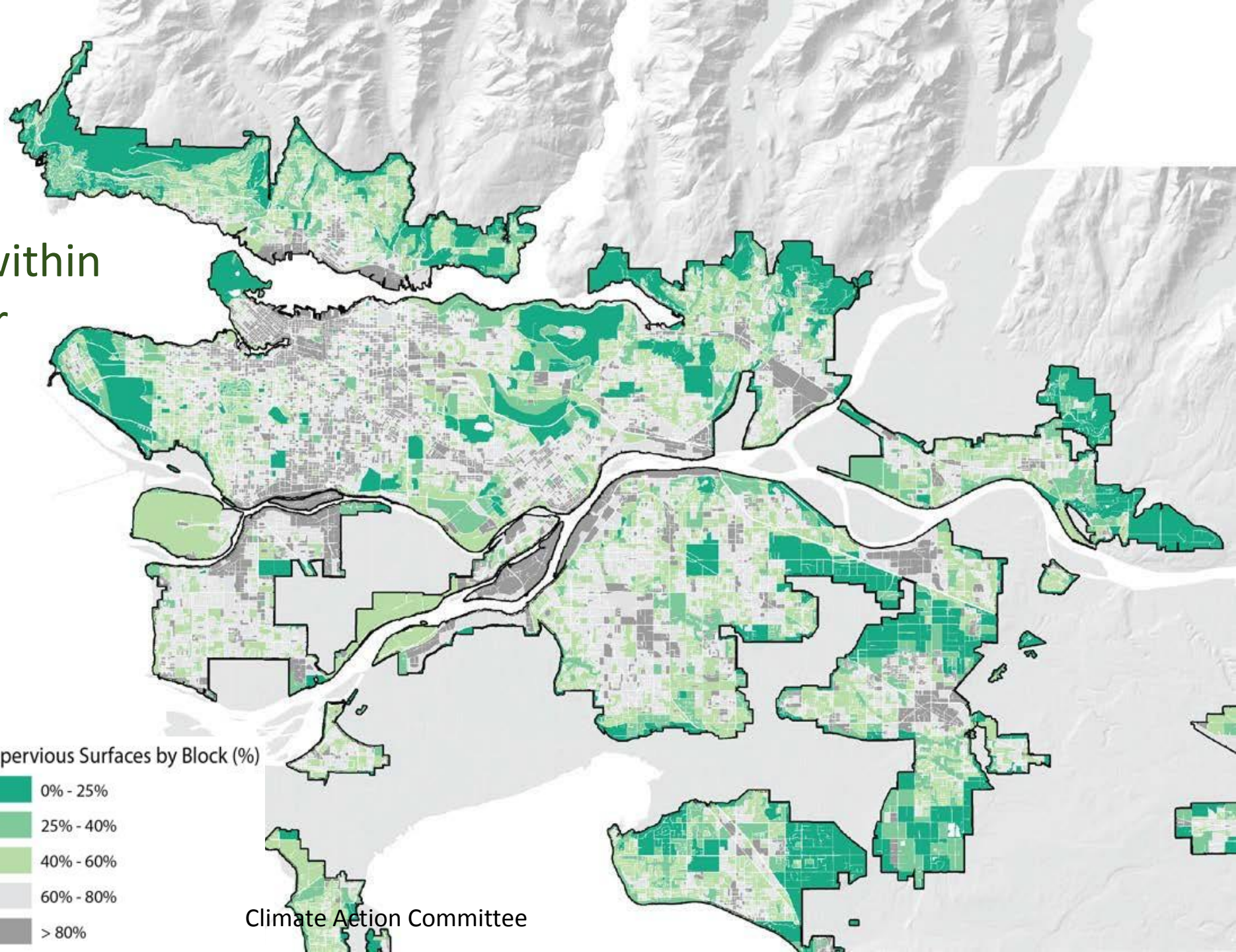- ■ Adaptive Capacity
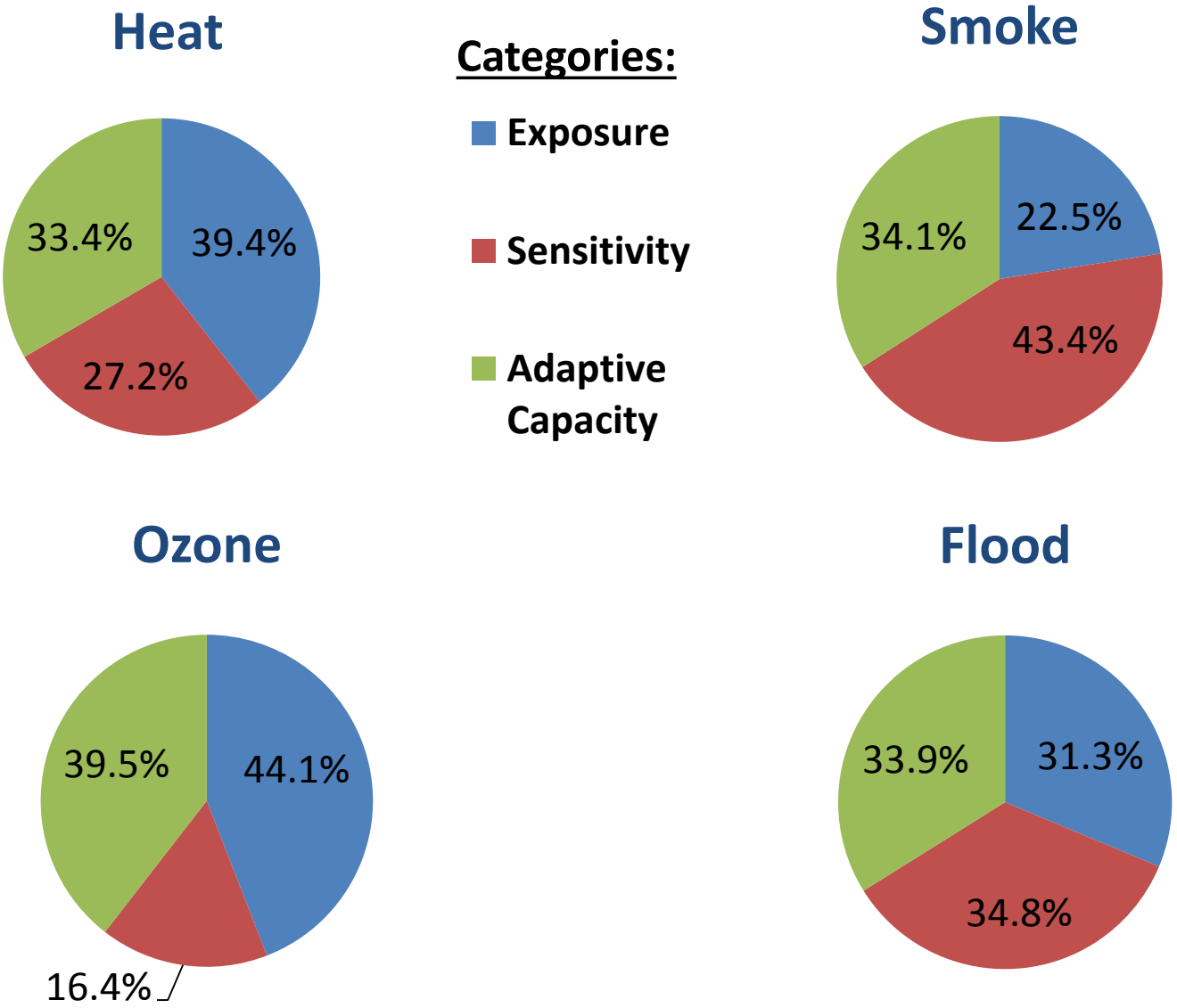
Interactive map under development – extreme heat
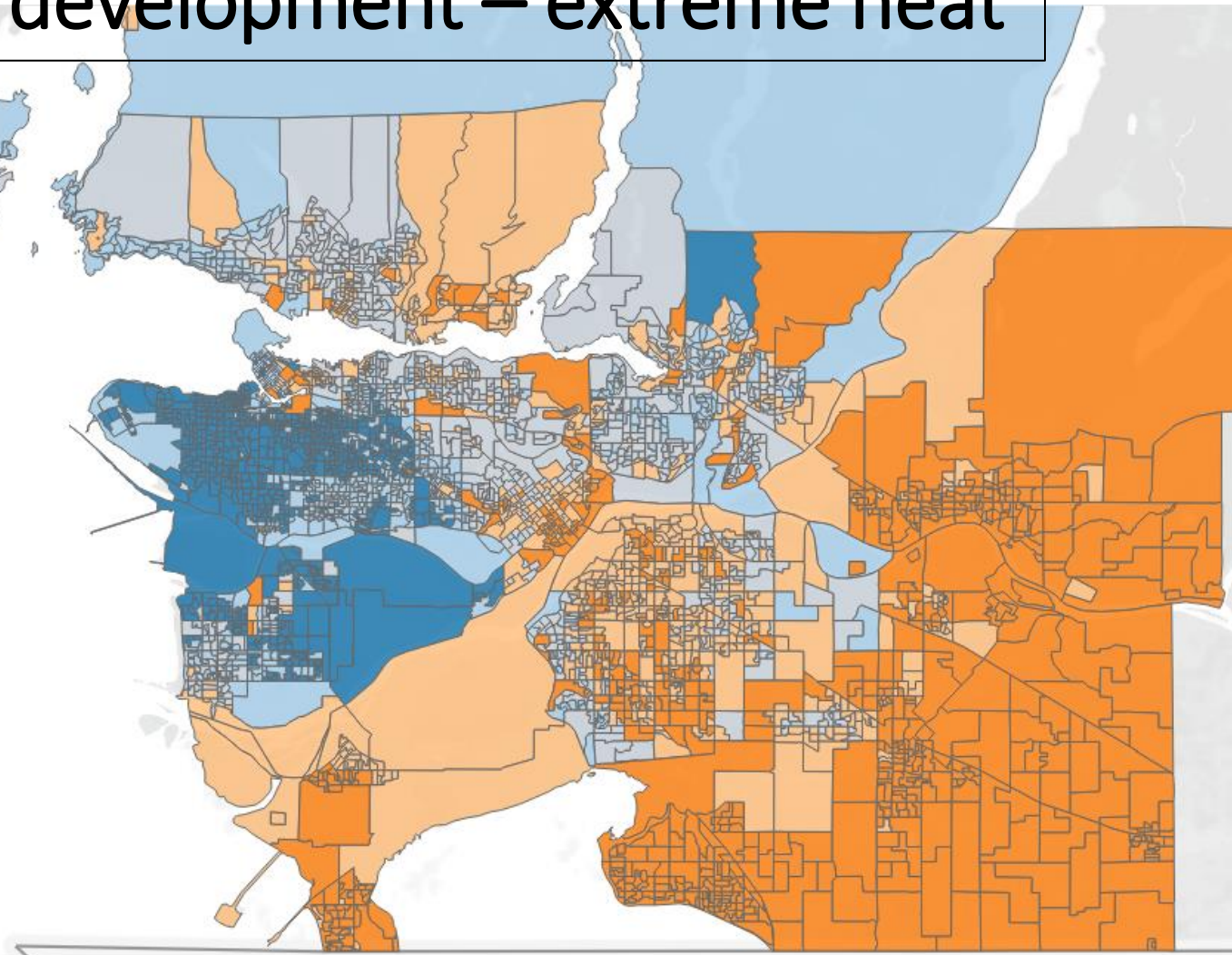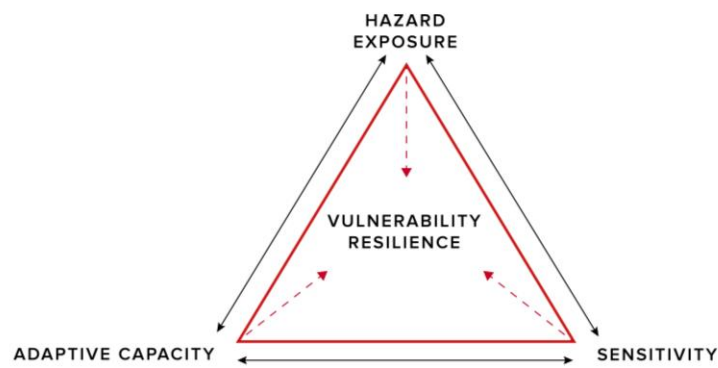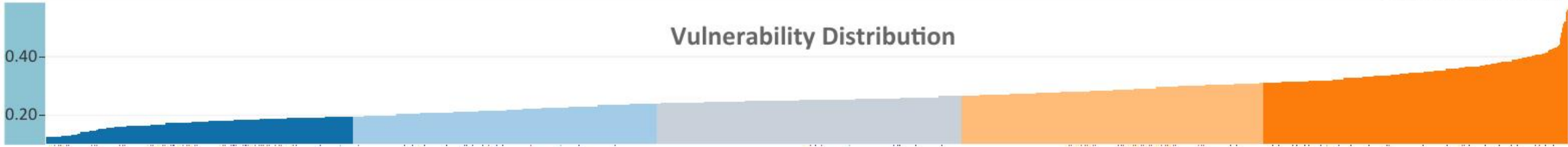
Unpacking vulnerability to extreme heat

Heat Exp; Top 3 Quintiles

Heat Exp + Sensitivity

Heat Exp + Adaptive Capacity
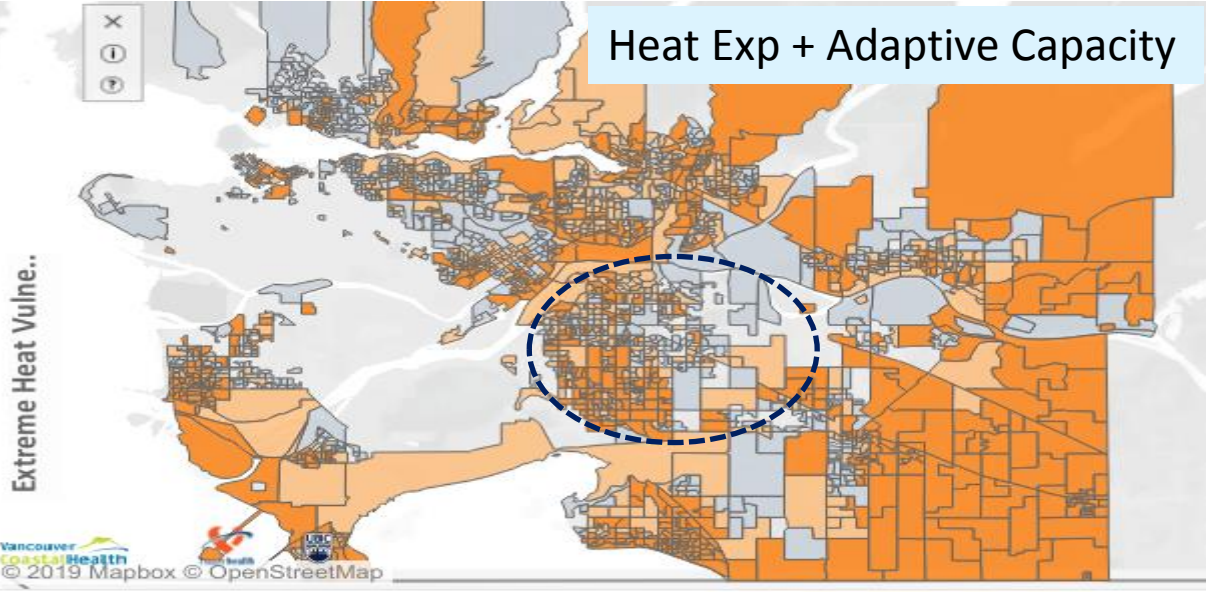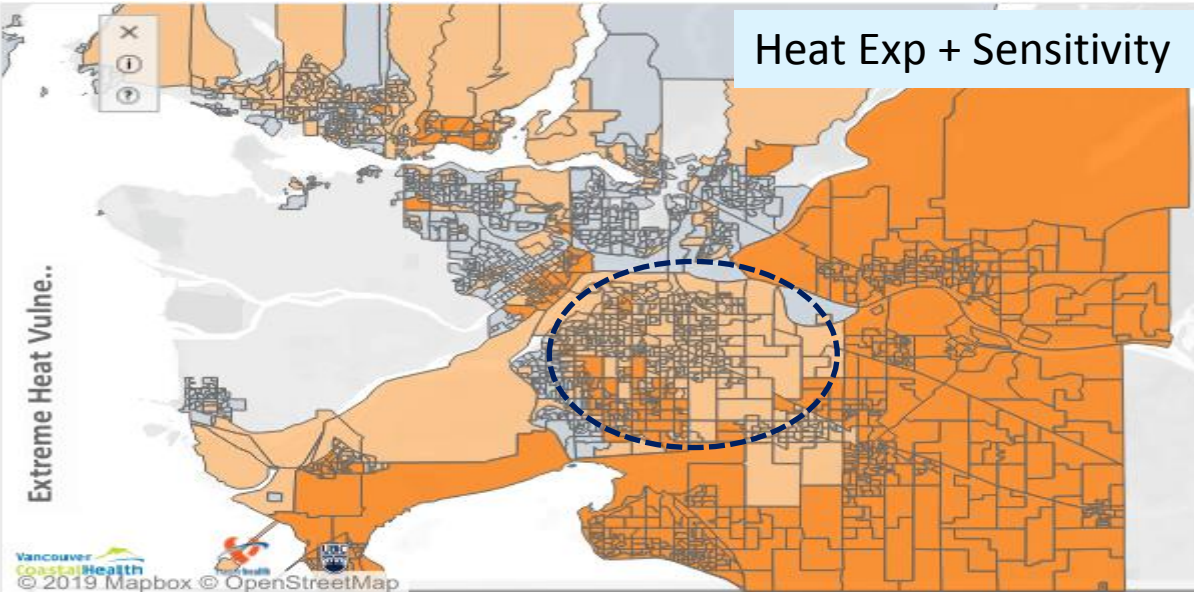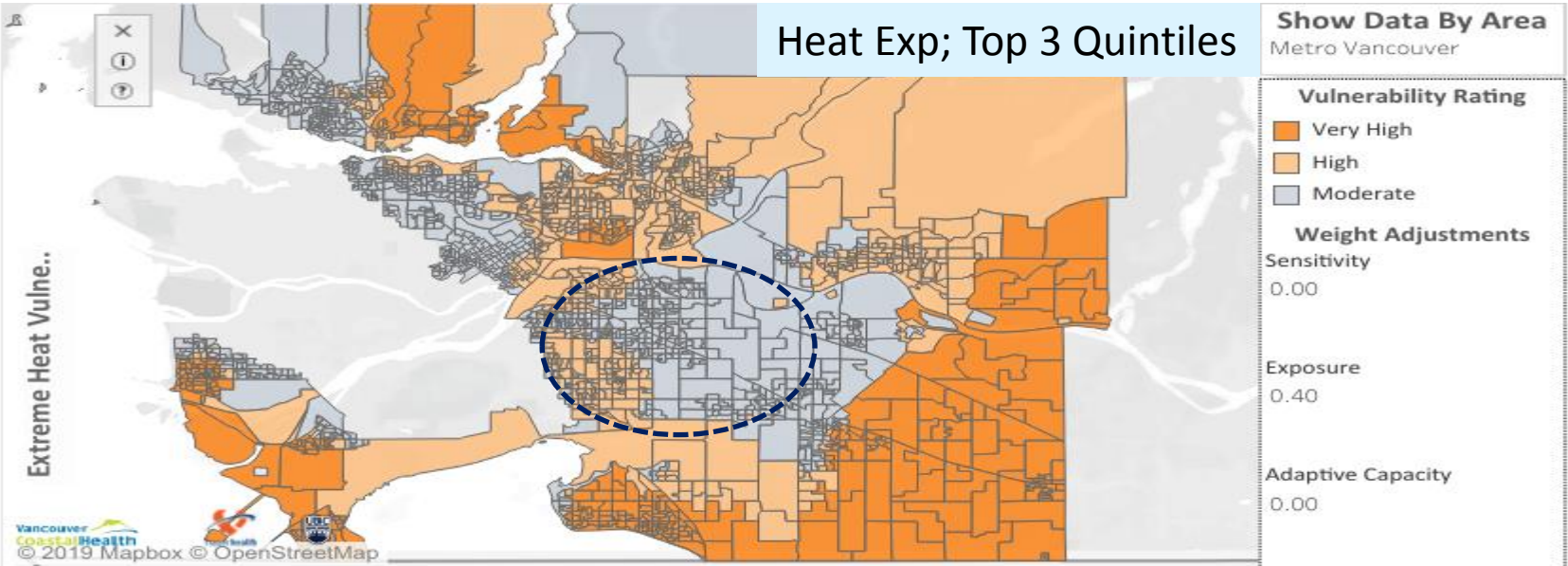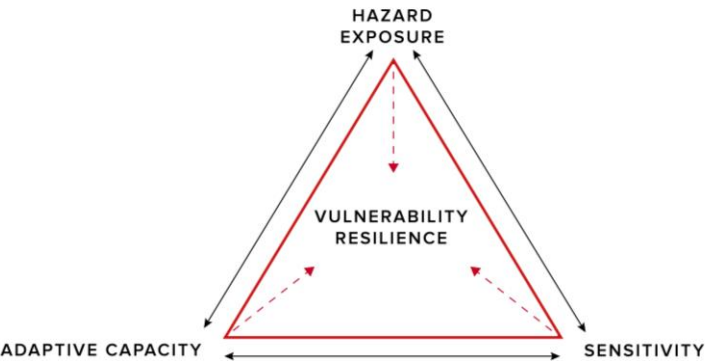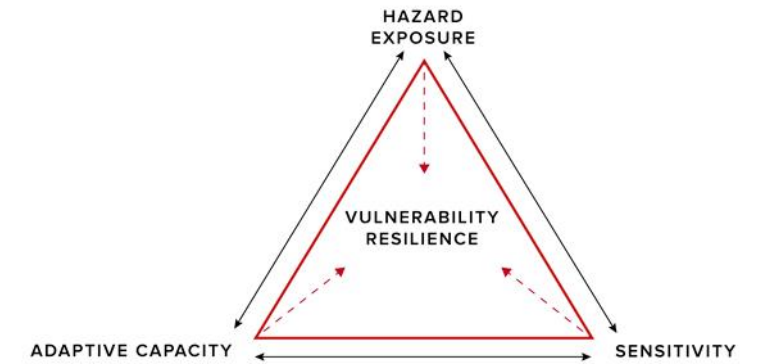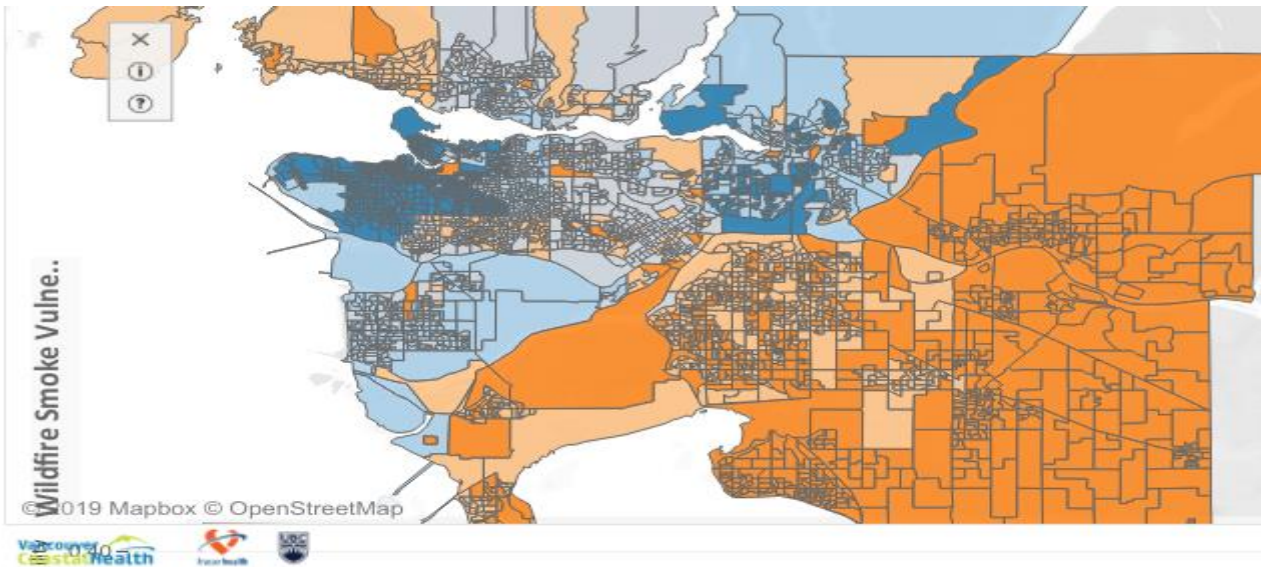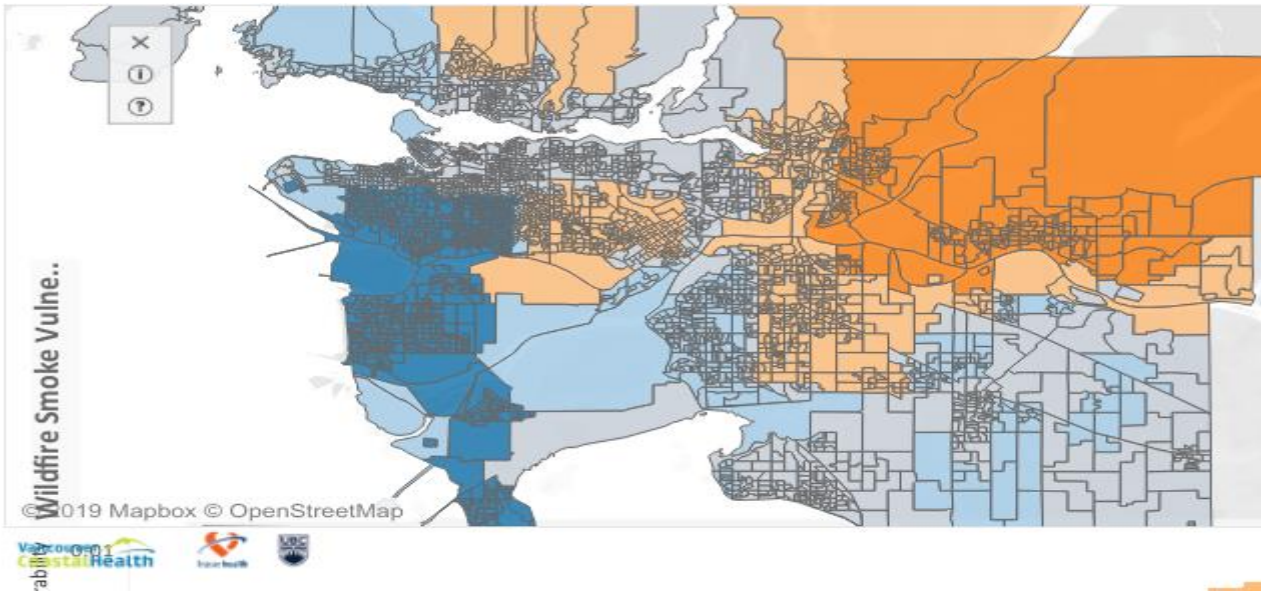
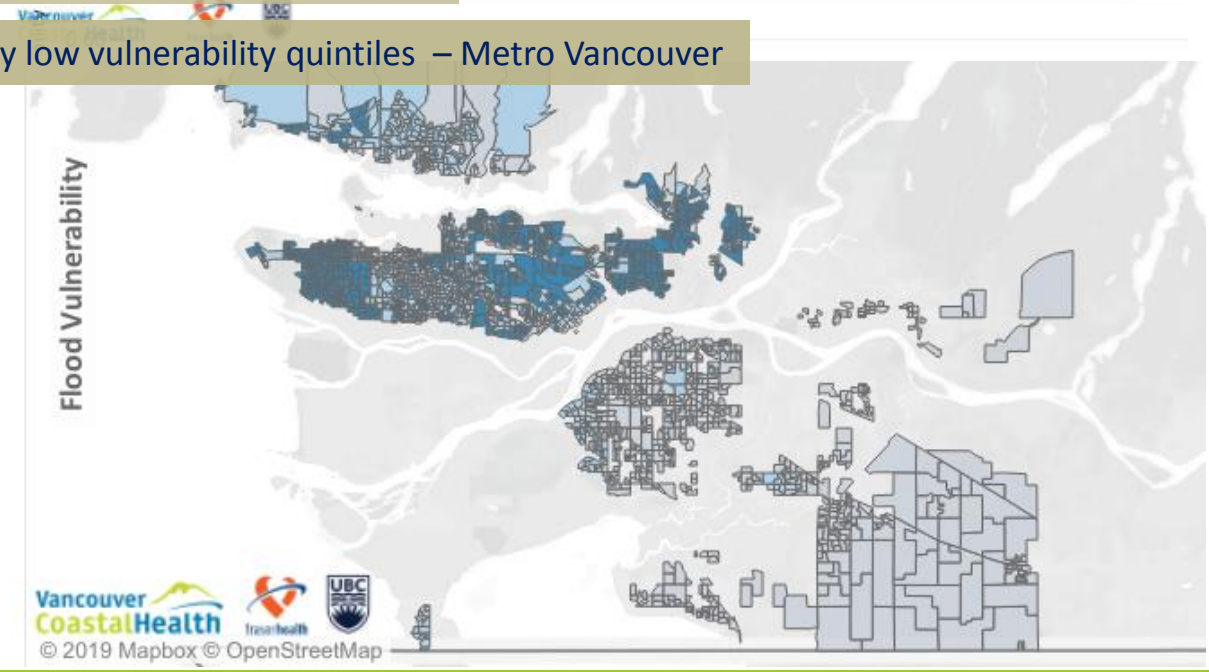# Impervious surface within the Metro Vancouver Urban Containment Boundary
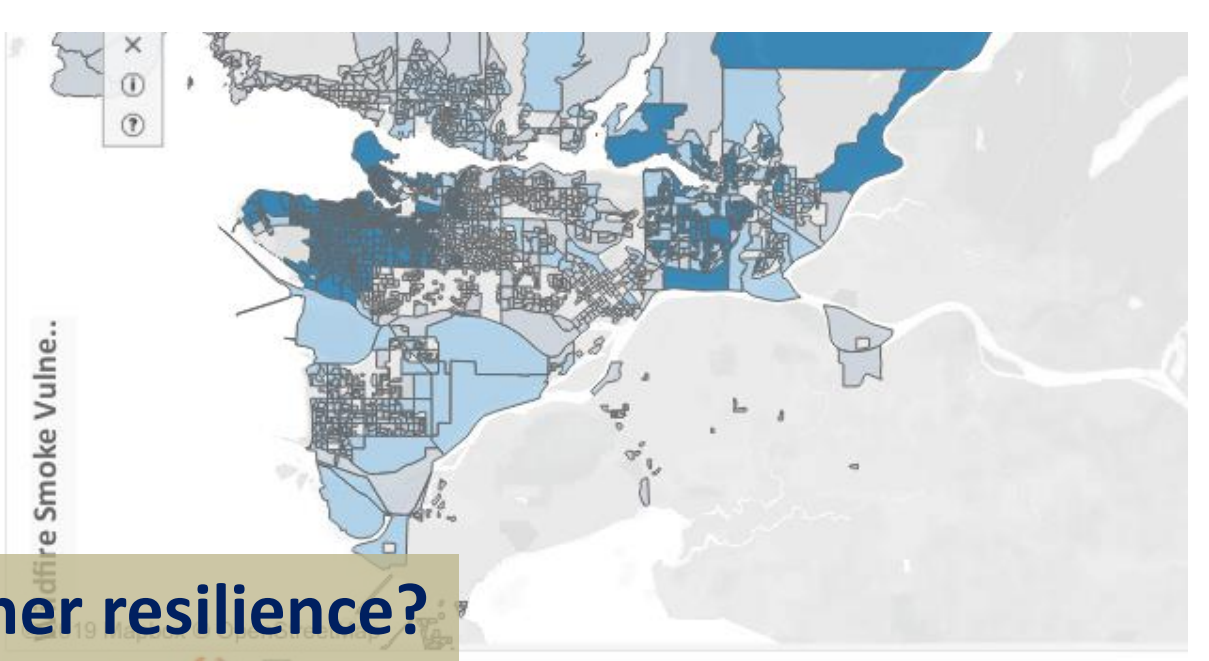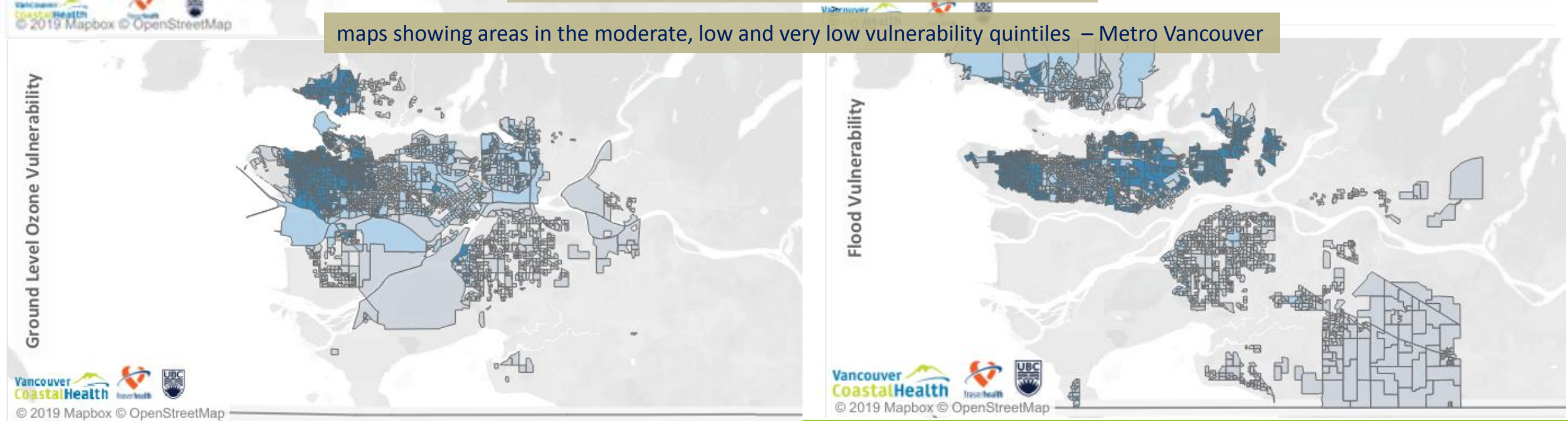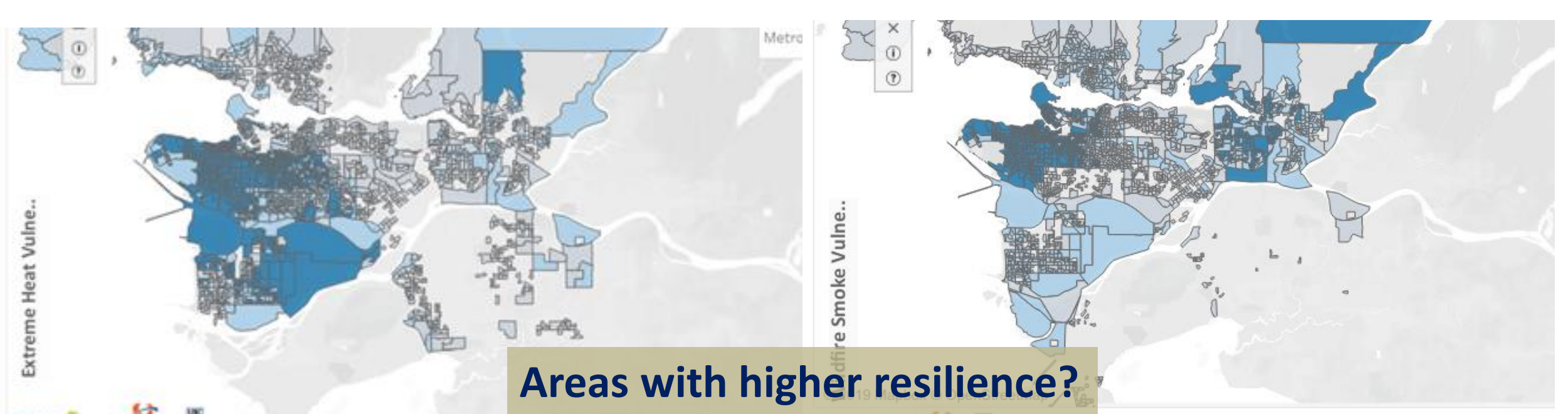
Source: Metro Vancouver

Impervious Surfaces by Block (%)

- 0% - 25%
- 25% - 40%
- 40% - 60%
- 60% - 80%
- > 80%

Climate Action Committee
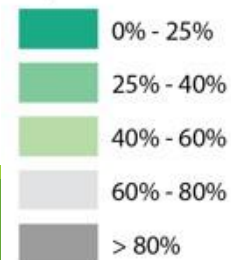
Wildfire Smoke - Exposure only

Wildfire Smoke Exposure + Sensitivity

Areas with higher resilience?

maps showing areas in the moderate, low and very low vulnerability quintiles – Metro Vancouver

Extreme Heat Vulne..

Wildfire Smoke Vulne..

Ground Level Ozone Vulnerability

Flood Vulnerability

© 2019 Mapbox © OpenStreetMap
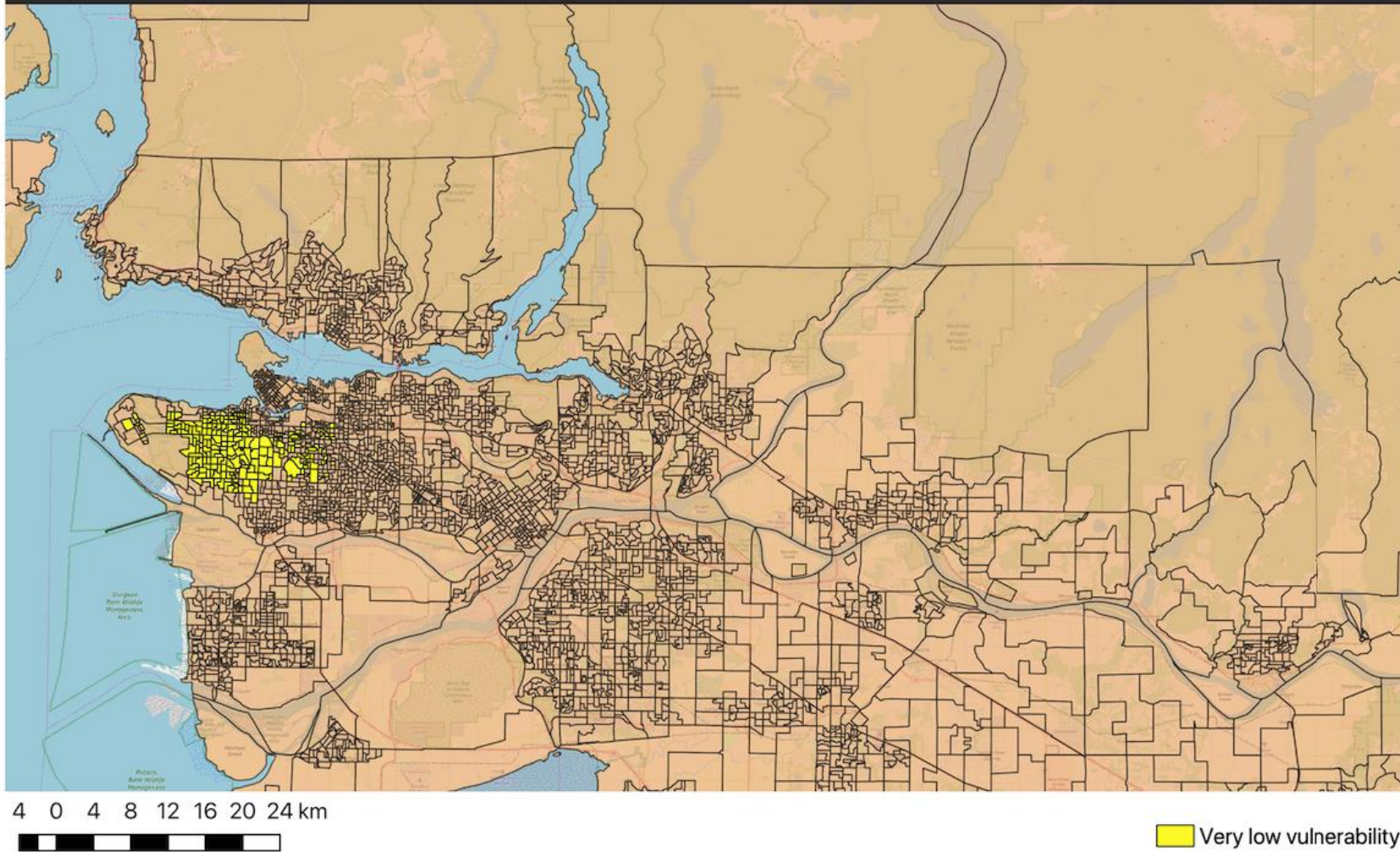
Spatial analysis possibilities:

Low vulnerability areas for all climate hazards – surprised?

CIHI – Combined (Material and Social) Deprivation Index
Vancouver CMA (2006)
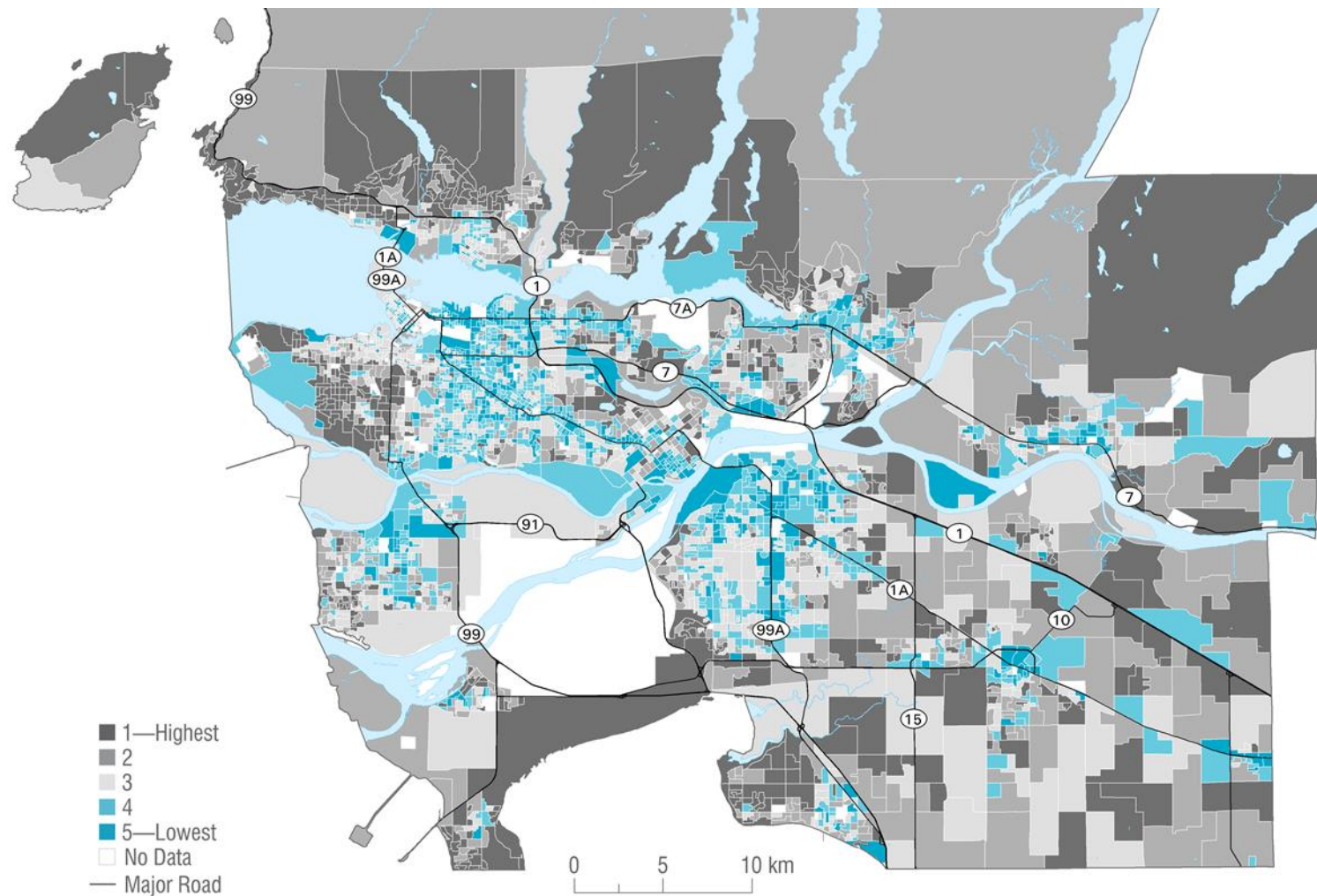
Concluding thoughts and questions

Are these maps useful?
- For what, for whom?
  - Planners?
  - Public at large?
- How can they be made more useful?
- Unintended consequences?
  - Local context, ground-truthing, dialogue

What do these maps tell about equity?

Next steps:
- Complete interactive maps
- Continue stakeholder engagement for feedback
- Make interactive maps accessible

Link to final report:
https://open.library.ubc.ca/cIRcle/collections/facultyresearchandpublications/52383/items/1.0380851
Link to interactive maps: TBD
Feedback / information:
j.yu@ubc.ca or james.lu@vch.ca