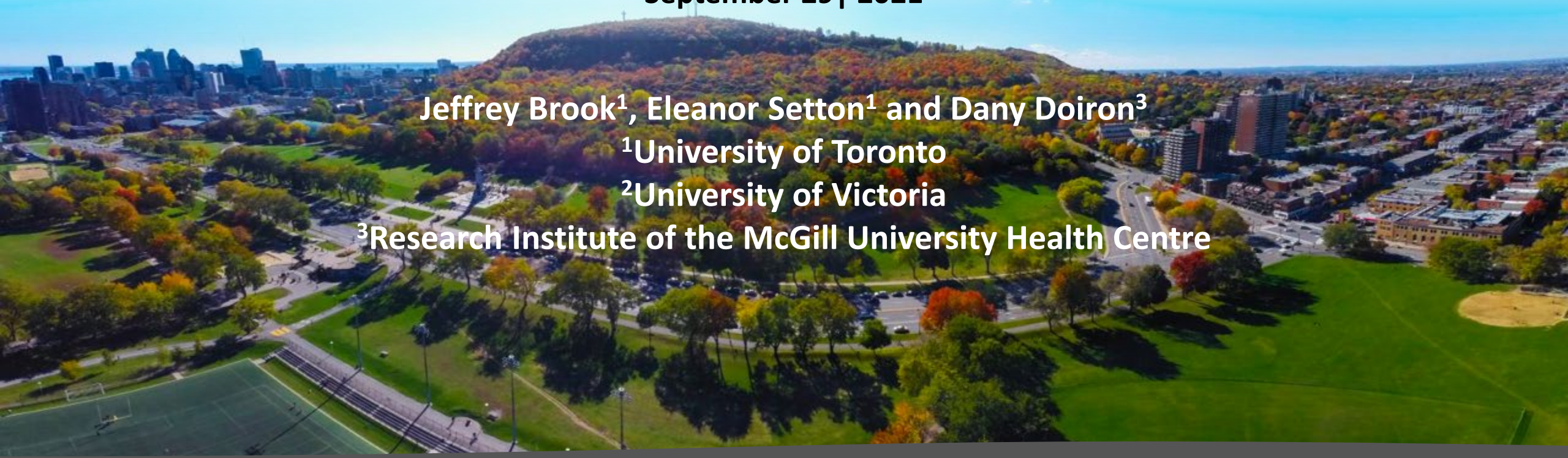
CANUE

Mobilizing Environmental Data to Build Healthier Cities for All

September 29| 2021



Jeffrey Brook[1], Eleanor Setton[1] and Dany Doiron[3]

[1]University of Toronto

[2]University of Victoria

[3]Research Institute of the McGill University Health Centre

Presentation overview

Jeffrey Brook | CANUE Scientific Director and Nominated Principal Investigator

Eleanor Setton | CANUE Managing Director and Environmental Exposure Expert

Dany Doiron| CANUE Data Linkage Lead and Environmental Epidemiologist

Leadership:
Jeff Brook (PI)
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Michael Brauer
Howard Hu
Kim McGrail
Dave Stieb
PJ Subbarao

Key contributors:
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Markey Johnson - Health Canada
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Tim Takaro – Simon Fraser University
Paul Villeneuve – Carleton University
Lorien Nesbitt – University of British Columbia
Matilda van den Bosch- University of British Columbia
Audrey Smargiassi - University of Montreal
Hugh Davies - University of British Columbia
Tor Oiamo – Ryerson University
Michael Widener – University of Toronto
Daniel Fuller – Memorial University
Marianne Hatzopoulou – University of Toronto
Darren Scott – McMaster University
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Meghan Azad – University of Manitoba
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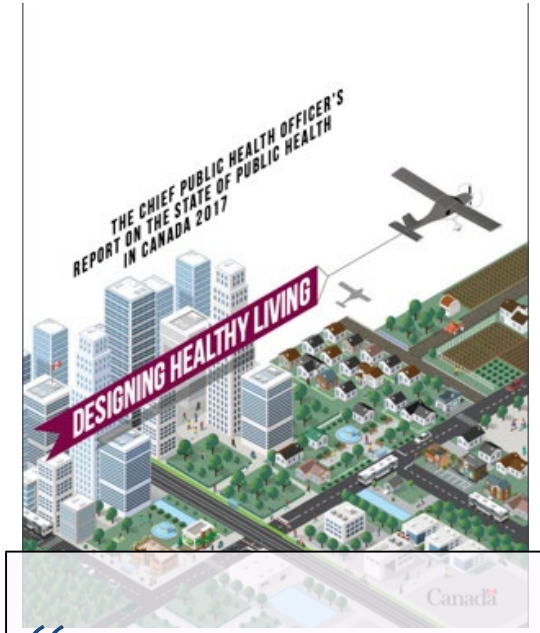
Paul Demers - Cancer care Ontario - UofT
Doug Manuel – University of Ottawa
Daniel Rainham – Dalhousie University
Greg Evans – University of Toronto
Larry Frank - University of British Columbia
Trevor Dummer - University of British Columbia
Piushkumar Mandhane – University of Alberta
Zachary Patterson – Concordia University

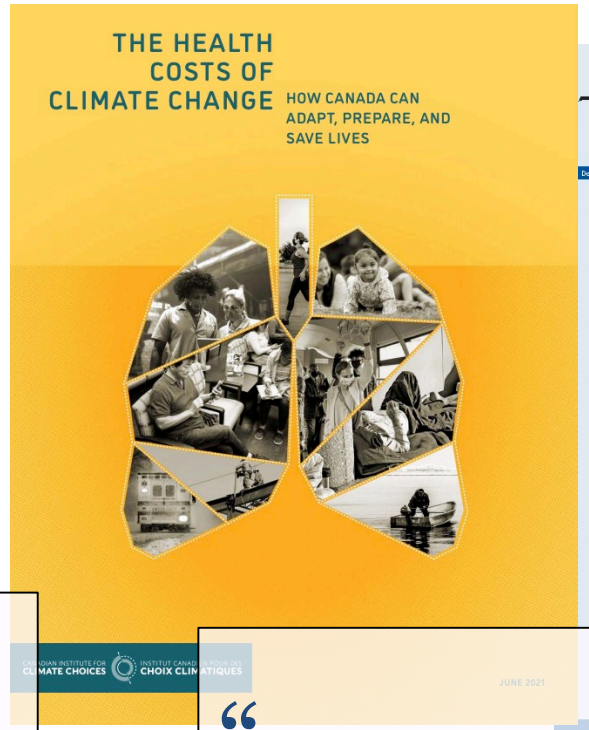
Big questions for the future of Canadian cities

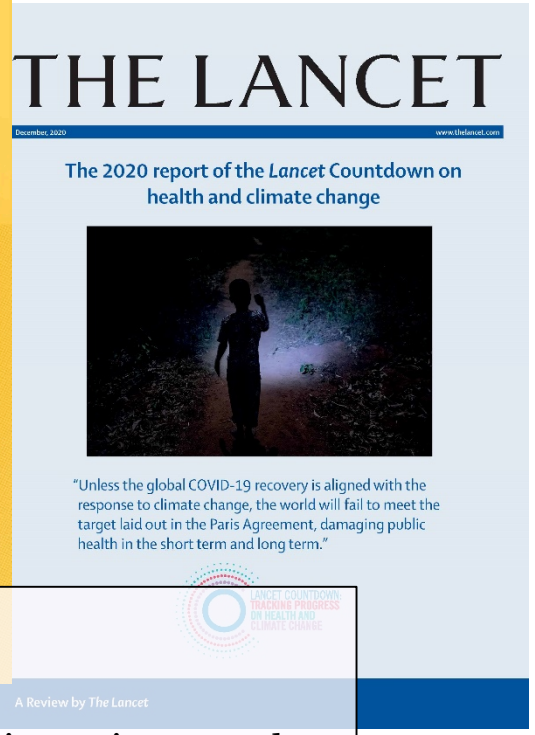
- How to steer investments in urban infrastructure towards **better health and equity for all** Canadians?
- What **environmental risks are most responsible for Canada's chronic disease burden** and for who, at what ages are policy interventions most effective or conversely less likely to reverse or halt progression?
- How to **maximize public health benefits** in the measures taken by Canadian cities to achieve **net zero carbon** emissions and adapt to climate change?
- How best to **compile and share the environmental data** needed to address these questions and to accelerate and evaluate progress?

Data are an essential element to addressing these questions



"Standardized, open data collection would support knowledge sharing and identification of approaches that can be effective across different communities.





"Governments should invest in research on emerging, unknown, and local climate change health impacts.

"Evaluating the effectiveness of UHI-reduction actions to public health is important and remains an area for further work [...] There's a need for heat-health vulnerability maps to municipalities.

"Groups that are disadvantaged because of disproportionate exposure to hazards […] and poverty are often more vulnerable to the health risks of climate change"

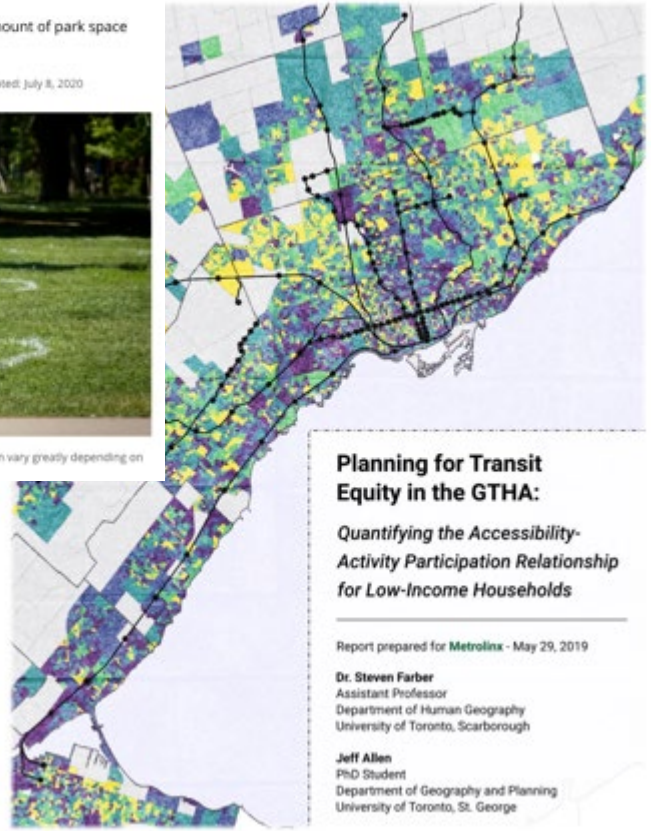
Toronto

Finding a patch of green: COVID-19 highlights inequities in Toronto park space, experts say

CBC analysis finds many Toronto neighbourhoods with least amount of park space per capita are downtown

Nicole Brockbank · CBC News · Posted: Jul 08, 2020 4:00 AM ET | Last Updated: July 8, 2020

The amount of nearby green space available to get outside and socialize safely can vary greatly depending on where you live in Toronto. (Evan Mitsui/CBC)



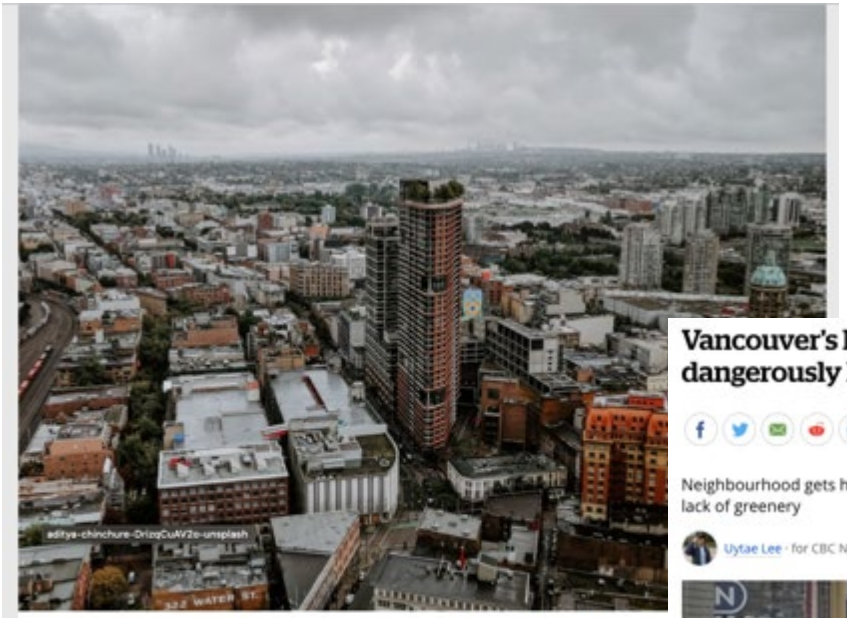
Planning for Transit Equity in the GTHA:

Quantifying the Accessibility-Activity Participation Relationship for Low-Income Households

Report prepared for **Metrolinx** - May 29, 2019

Dr. Steven Farber
Assistant Professor
Department of Human Geography
University of Toronto, Scarborough

Jeff Allen
PhD Student
Department of Geography and Planning
University of Toronto, St. George



Marginalized groups experience higher cumulative air pollution in urban Canada

SCIENCE, HEALTH & TECHNOLOGY

Dec 21, 2020 | For more information, contact **Sachintha Wickramasinghe**

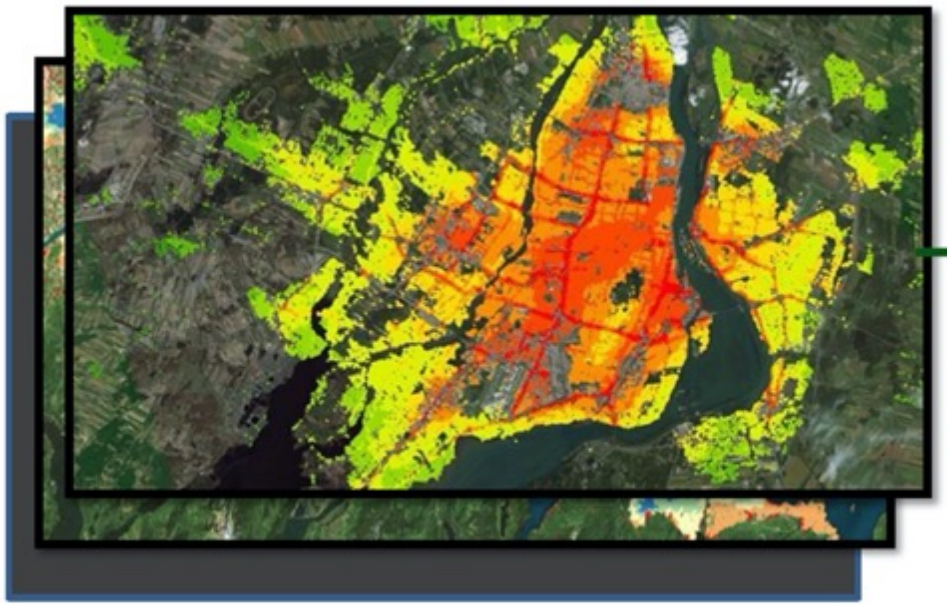
Vancouver's Downtown Eastside can get dangerously hot; the answer is more trees

Neighbourhood gets hotter than other parts of Metro Vancouver due to trapped heat, lack of greenery

Uytae Lee · for CBC News · Posted: Jun 18, 2019 12:22 PM PT | Last Updated: June 18, 2019

A summer sidewalk scene of East Hastings Street in Vancouver's Downtown Eastside, between Columbia and Carrall streets. (Rafferty Baker/CBC)

CANUE is advancing efficient, local to national application of environmental health data



Epidemiological studies

Is there a relationship with health? If so, how strong and who is most vulnerable?

Population exposure surveillance

Where are the biggest issues and how many people live there? How is it this changing over time?

Knowledge transfer /exchange to move policy

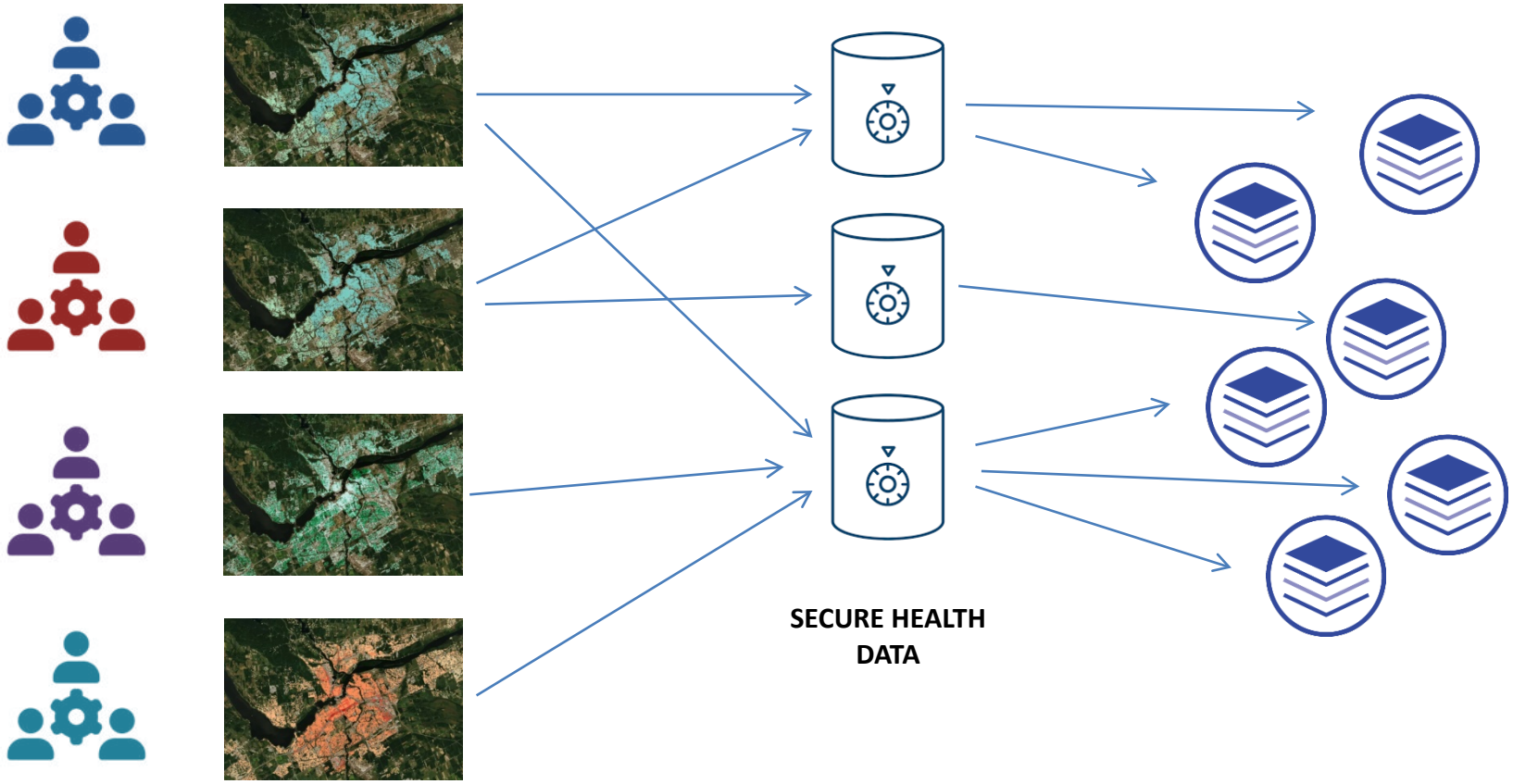
How can changes in urban form:

- improve health and equity?
- reduce or increase exposures?
- reduce healthcare costs?
- engage communities?

What investments in our cities can mitigate impacts of climate change on health?

Environmental Health research landscape in Canada

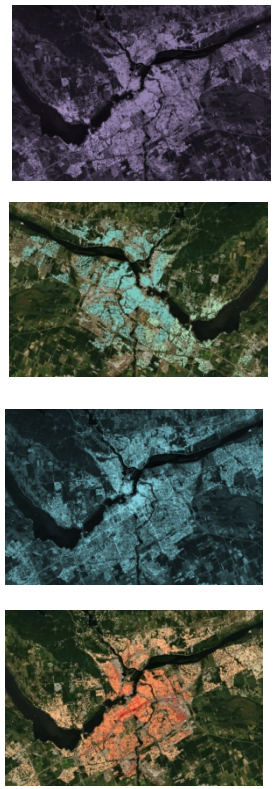
BEFORE CANUE: *siloed exposure data, ad hoc linkage to health databases*



- DIFFICULT TO COMPARE
- DIFFICULT TO REPRODUCE
- DIFFICULT TO REUSE
- TIME-CONSUMING or REDUNDANT LINKING

Environmental Health research landscape in Canada

WITH CANUE: *"FAIR" data: **F**indable, **A**ccessible, **I**nteroperable, **R**eusable*



INDEXED TO POSTAL CODES → ACADEMIC USE

CANUE

SECURE HEALTH DATA

- STANDARD METRICS
- STUDIES CAN BE REPRODUCED
- CAN BE USED BY MANY RESEARCHERS
- EFFICIENT FOR HEALTH DATA HOLDERs

The Canadian Urban Environmental Health Research Consortium

CANUE

ADVANCING RESEARCH ON URBAN LIVING AND HUMAN HEALTH

INCREASED SCIENTIFIC UNDERSTANDING of the interactions among the physical features of the urban environment and health will lead to cost-effective actions promoting healthy childhood development and aging, reducing the burden of chronic disease, and minimizing the impact of changing environments.

DATA AND TOOLS

We use and develop tools to process complex data from diverse sources into a simple, easily readable common format.

LINKING TO HEALTH

We provide data directly to researchers and a wide range of health data organizations who pre-link and distribute data securely.

NEW CAPACITY AND EVIDENCE

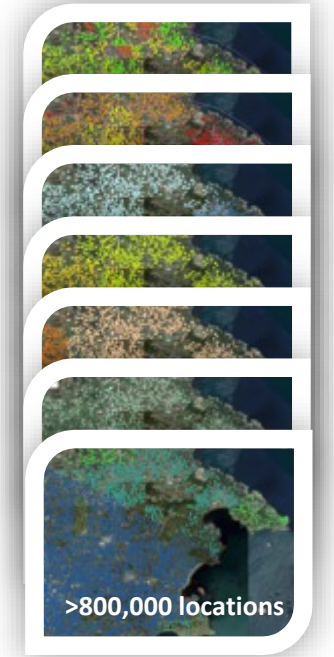
We are a pan-Canadian initiative bringing together individuals across different sectors and providing a one-stop shop for environmental exposure data in Canada.

CANUE DATA PORTAL

- Nitrogen Dioxide
- Fine Particulates
- Sulfur Dioxide
- Ground-level Ozone
- NDVI greenness
- Nighttime Light
- Heat & Cold events
- Rain, Snow & Soil Moisture
- Local Climate Zones
- Material & Social Deprivation
- Marginalization
- Gentrification
- Active Living Index
- Access to Employment
- Ultraviolet

COMING SOON

- Food environment
- Noise
- Transportation
- Hi-res satellite-derived metrics



HEALTH DATA PARTNERS

CANUE data are sent directly to health data organizations so researchers can have one-stop access to environmental and health data:

CLSA ÉLCV — CANADA'S LARGEST AGING COHORT

CanPath Canadian Partnership for Tomorrow's Health — CANADA'S LARGEST POPULATION COHORT

populationdata BC; NB-IRDT New Brunswick Institute for Research, Data and Training; Manitoba Centre for Health Policy — ADMINISTRATIVE HEALTH DATA

CHILD — CANADA'S LARGEST BIRTH COHORT

We are now working on the next wave of pre-linking with Canada's wealth of census-based cohorts, surveys, and administrative health data via the Pan-Canadian Real-World Health Data Network.

> 260 members

From academia, governments, and NGOs

10 Canadian provinces

9 Countries

Multiple disciplines including data science, environmental exposure assessment, public health, urban planning, public policy and more…

COLLABORATING NOW TO BUILD THE FUTURE

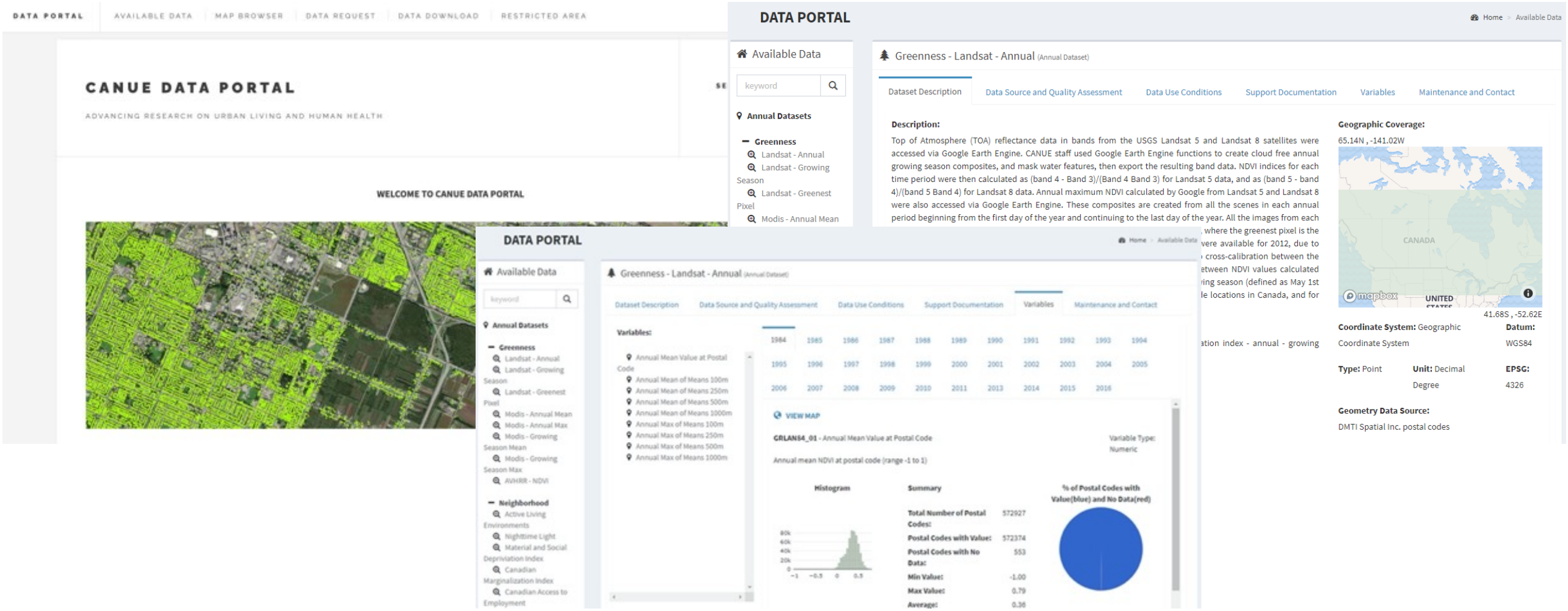
We see the future as a global living laboratory that connects international environmental health researchers and knowledge users with a common goal to increase human wellbeing . We are looking to connect with major cohorts and data initiatives around the world.

CONTACT: info@canue.ca

https://canue.ca

CANUE Data Portal and Tools

Canada's prime source for nationally-consistent urban environmental data



New Canadian-specific evidence in urban environmental health

From **2017 to 2021** ... **> 250** Data requests ... **> 80** scientific publications

12 MSc and PhD theses

Environment-health association studies

Urban greenness and mortality in Canada's largest cities: a national cohort study

THE LANCET Planetary Health

Environmental Research

Ambient air pollution and incidence of early-onset paediatric type 1 diabetes: A retrospective population-based cohort study

Environmental Health

Low concentrations of fine particle air pollution and mortality in the Canadian Community Health Survey cohort

Landscape and Urban Planning

Research Paper

Greenspace access does not correspond to nature exposure: Measures of urban natural space with implications for health research

Environmental Health

Road proximity, air pollution, noise, green space and neurologic disease incidence: a population-based cohort study

Early life exposure to air pollution and incidence of childhood asthma, allergic rhinitis and eczema

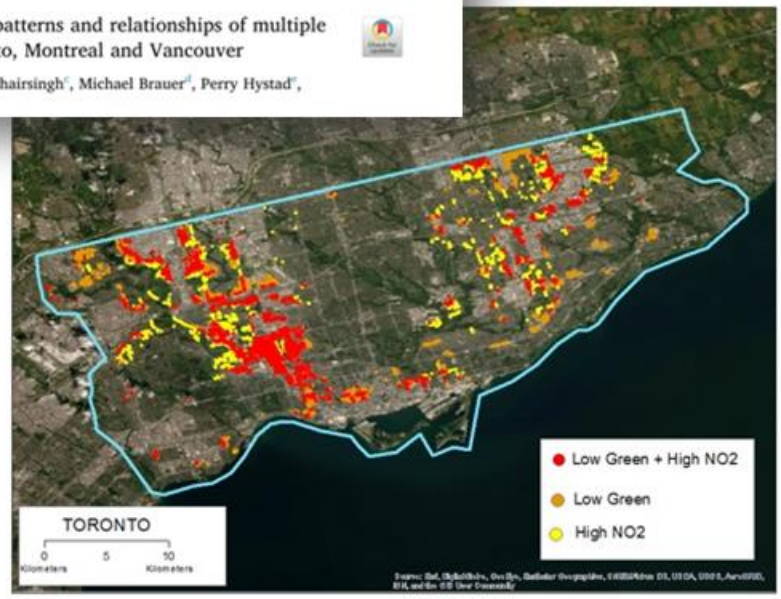
Environment International

Complex relationships between greenness, air pollution, and mortality in a population-based Canadian cohort*

Environmental equity research

Environment International

Healthy built environment: Spatial patterns and relationships of multiple exposures and deprivation in Toronto, Montreal and Vancouver

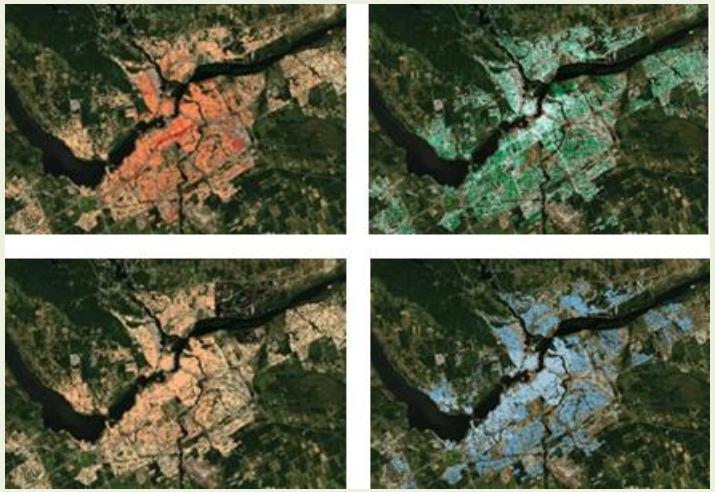


HealthyDesign.city: leveraging CANUE data for “actionable” tools

CANUE

CANUE

Nationally-standardized datasets



Healthy Design .City

TOOLS THAT SUPPORT AN EQUITABLE AND HEALTHY BUILT ENVIRONMENT

Supported by:

Public Health Agency of Canada

Agence de la santé publique du Canada

Enhanced Surveillance for Chronic Disease Program (ESCDP)

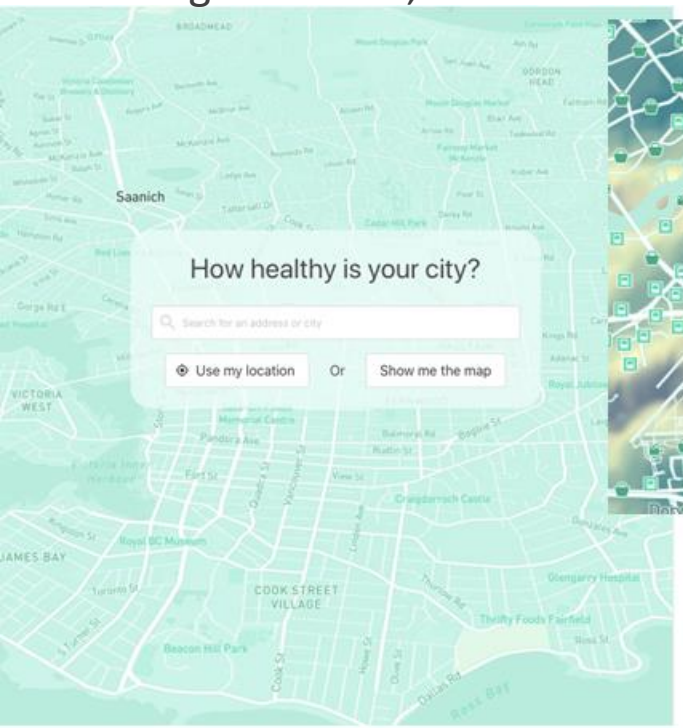
HealthyDesign.City: Two Tools

HealthyPlace.City

- **Aim:** Communication, public engagement, awareness
- **Audience:** Public health professionals, community organizations, members of the public

HealthyPlan.City

- **Aim:** Analysis and reporting tool with a focus on equity
- **Audience:** Public health professionals, urban planners, policy makers



HealthyDesign.City: Built environment characteristics and equity

CANUE

Built Environment Characteristics

Amenities

Diversity of destinations to walk/bike to:

- Schools
- Services
- Shopping

Heat

Heat modifying built environment features:

- Large buildings and pavement
- Tree canopy and large water bodies

Parks and Recreation

Infrastructure that promotes physical activity:

- Recreation centres
- Parks
- Non-car pathways

Noise and air pollution

Point sources and continuous surfaces:

- Traffic-related pollution
- Noise

Demographic Characteristics

Populations

- Male/Female
- Under 15/Over 65
- Unemployed/Low-Income/Rent >30% of income
- Indigenous identity
- Visible minority

Reporting Areas

Reporting Areas

- National
- Large, Medium and Small Cities

HealthyDesign.City: Timeline

March 2021 – December 2021
- Review data options
- Prioritize indicators
- Review/prioritize existing KT
- Select tool functions

July - December 2022
- Review feedback and results of UX testing
- Address pain points
- Improve usability

Develop tools		User testing		Refine Tools		Final Tools

January 2022
- Recruit ~100 users (50 per tool)
- Conduct one-to-one UX testing
- Determine pain points
- Feedback and recommendations

January 2023

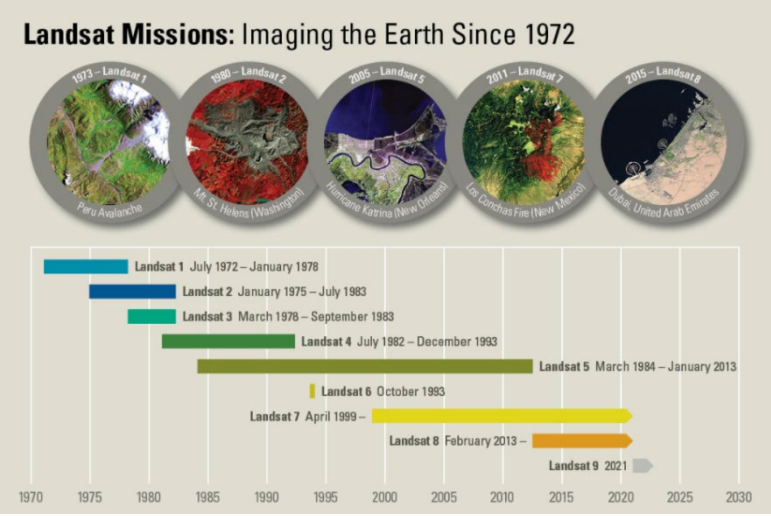
New frontiers for urban data

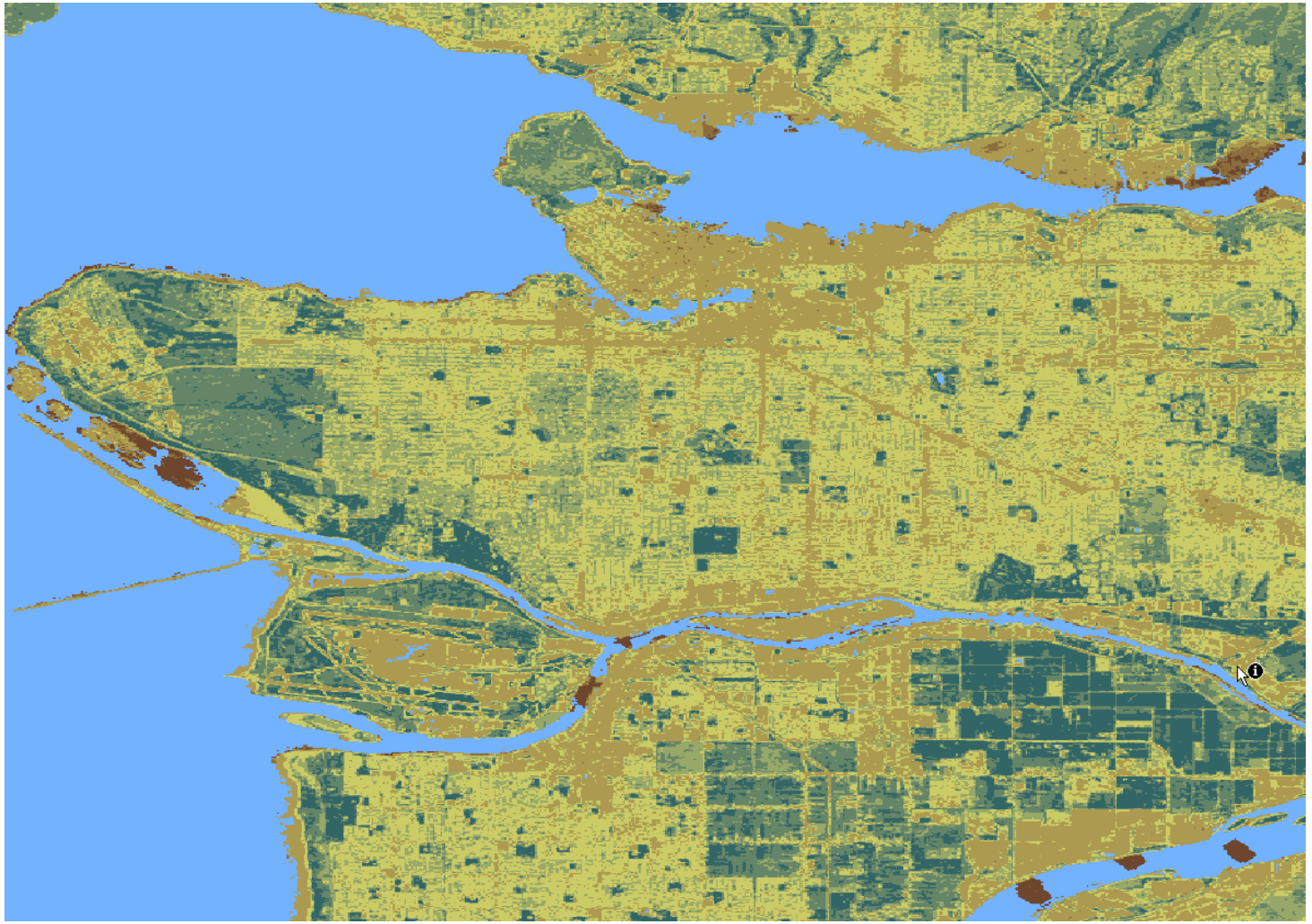
Standardized data are powerful!

Example: satellite-based ‘greenness’ measures (NDVI)

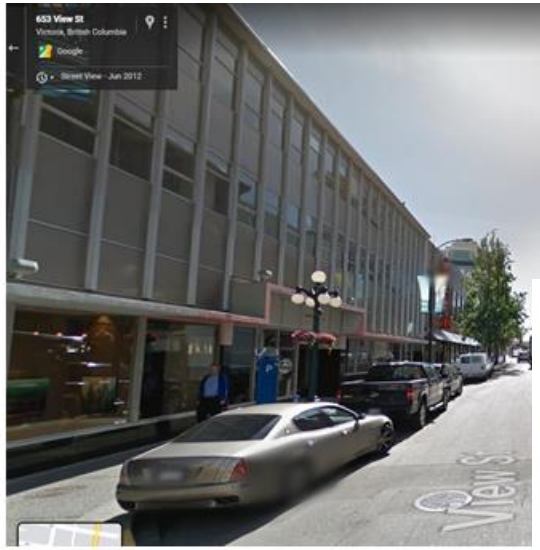
Globally available, consistent metric, high spatial resolution

10,000+ peer-reviewed journal articles related to ‘greenness’ + ‘health’ + ‘NDVI’ since 2010





New frontiers for urban data



[HTML] Developing and testing a street **audit** tool using **Google Street View** to measure environmental supportiveness for physical activity
P Griew, M Hillsdon, C Foster... - International ..., 2013 - ijbnpa.biomedcentral.com
... Download PDF. Research; Open Access; Published: 23 August 2013. Developing and testing a street **audit** tool using **Google Street View** to measure environmental supportiveness for physical activity ...
☆ 99 Cited by 134 Related articles All 24 versions 99

The promise, practicalities, and perils of virtually **auditing** neighborhoods usin **Google Street View**
MDM Bader, SJ Mooney, B Bennett... - The ANNALS of the ..., 2017 - journals.sagepub.com
... Format. Tips on citation download. Download Citation. Download article citation data for: The Promise, Practicalities, and Perils of Virtually **Auditing** Neighborhoods Using **Google Street View**. Michael DM Bader, Stephen J. Mooney, Blake Bennett, and Andrew G. Rundle ...
☆ 99 Cited by 43 Related articles All 4 versions

[HTML] Using **Google Street View** to **audit** neighborhood environments
AG Rundle, MDM Bader, CA Richards... - American journal of ..., 2011 - Elsevier
... Using **Google Street View**, researchers can conduct "**virtual**" field **audits** of neighborhoods .... 31 Street View **audits** can be implemented in multiple cities from one central location, eliminating travel costs as well as concerns about intrusiveness and research staff safety ...
☆ 99 Cited by 480 Related articles All 13 versions

[HTML] Assessing the micro-scale environment using **Google Street View**: the **virtual** systematic tool for evaluating pedestrian streetscapes (**virtual**-STEPS)
M Steinmetz-Wood... - BMC public ..., 2019 - bmcpublichealth.biomedcentral.com
... **audits** with the enviable properties of cost-efficiency from elimination of travel time and increased safety for **auditors**. This study examined the reliability of the **Virtual** Systematic Tool for Evaluating Pedestrian Streetscapes (**Virtual**-STEPS), a **Google Street View**-based **auditing** ...
☆ 99 Cited by 15 Related articles All 14 versions 99

[HTML] Built environment and violent crime: An environmental **audit** approach using **Google Street View**
L He, A Páez, D Liu - Computers, Environment and Urban Systems, 2017 - Elsevier
... we proceed to analyze the spatial filter to select sites for **virtual** environmental **audits** ... Built environment. Violent crime. Spatial filtering. Environmental **audit**. **Google Street View** ... Second, most conventional environmental **audits** involve on-site observations (Edwards et al., 2013) ...
☆ 99 Cited by 27 Related articles All 2 versions

Street level imagery from mobile cameras – Google Street View

Researchers/data developers can virtually visit locations and characterize kinds of green (trees, grass, etc) as well as vehicles, types of building, people, etc.

1000+ per-reviewed journal articles related to ‘Google Street View’ + ‘virtual’ + ‘audit’ since 2010

New frontiers for urban data

High resolution imagery + deep learning

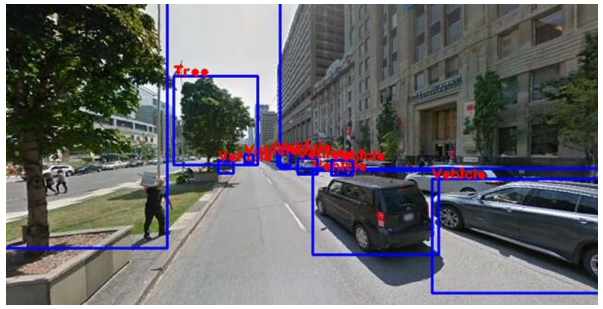


Image classification – images are grouped into classes, and then used for training a neural network to recognize each class.

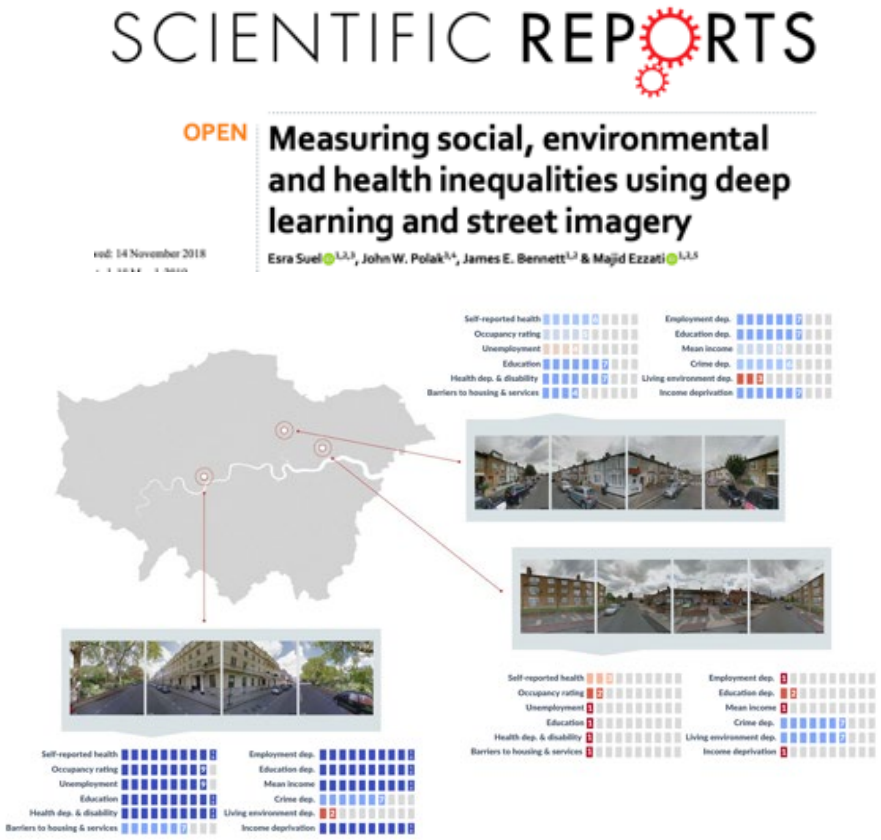
e.g. high/low quintiles of ambient air pollution, socio-economic factors

Object detection - the number of features in an image are identified

Image segmentation – the percent pixel coverage of a feature is calculated

e.g. road, sidewalk, building, wall, fence, pole, traffic light, traffic sign, vegetation, terrain, sky, person, rider, car, truck, bus, train, motorcycle, bicycle

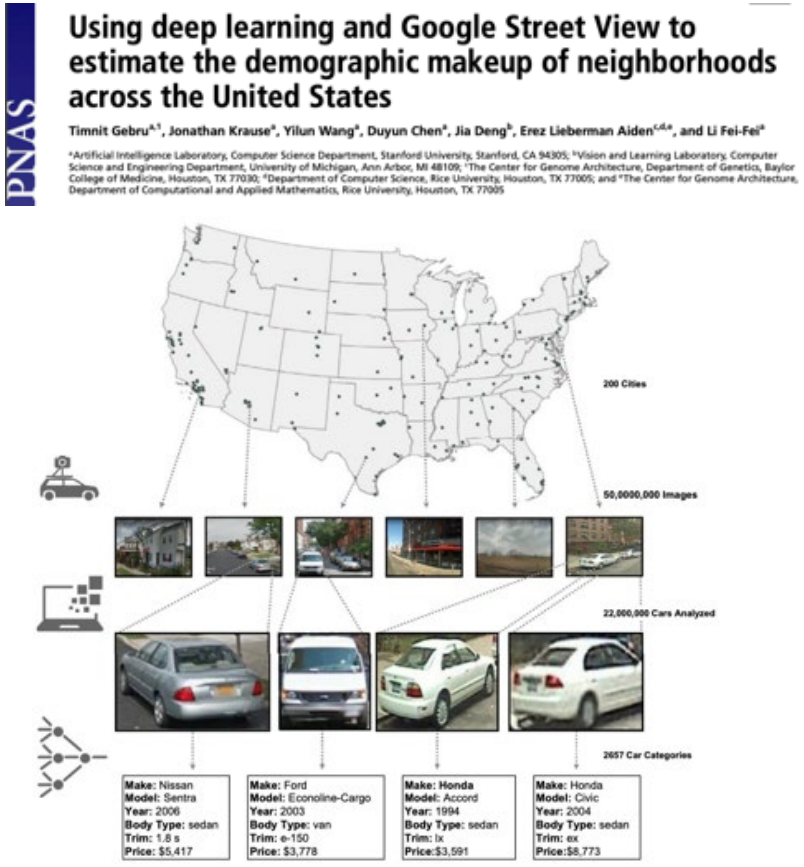
New frontiers for urban data


SCIENTIFIC REPORTS

OPEN

Measuring social, environmental and health inequalities using deep learning and street imagery

Esra Suel, John W. Polak, James E. Bennett & Majid Ezzati


PNAS

Using deep learning and Google Street View to estimate the demographic makeup of neighborhoods across the United States

Timnit Gebru, Jonathan Krause, Yilun Wang, Duyun Chen, Jia Deng, Erez Lieberman Aiden, and Li Fei-Fei

200 Cities

50,0000,000 Images

22,000,000 Cars Analyzed

2657 Car Categories

Make: Nissan Model: Sentra Year: 2006 Body Type: sedan Trim: 1.8 s Price: $5,417

Make: Ford Model: Econoline-Cargo Year: 2003 Body Type: van Trim: e-150 Price: $3,778

Make: Honda Model: Accord Year: 1994 Body Type: sedan Trim: lx Price:$3,591

Make: Honda Model: Civic Year: 2004 Body Type: sedan Trim: ex Price:$8,773

International Journal of Environmental Research and Public Health

MDPI

Article

The Association of Urban Greenness and Walking Behavior: Using Google Street View and Deep Learning Techniques to Estimate Residents' Exposure to Urban Greenness

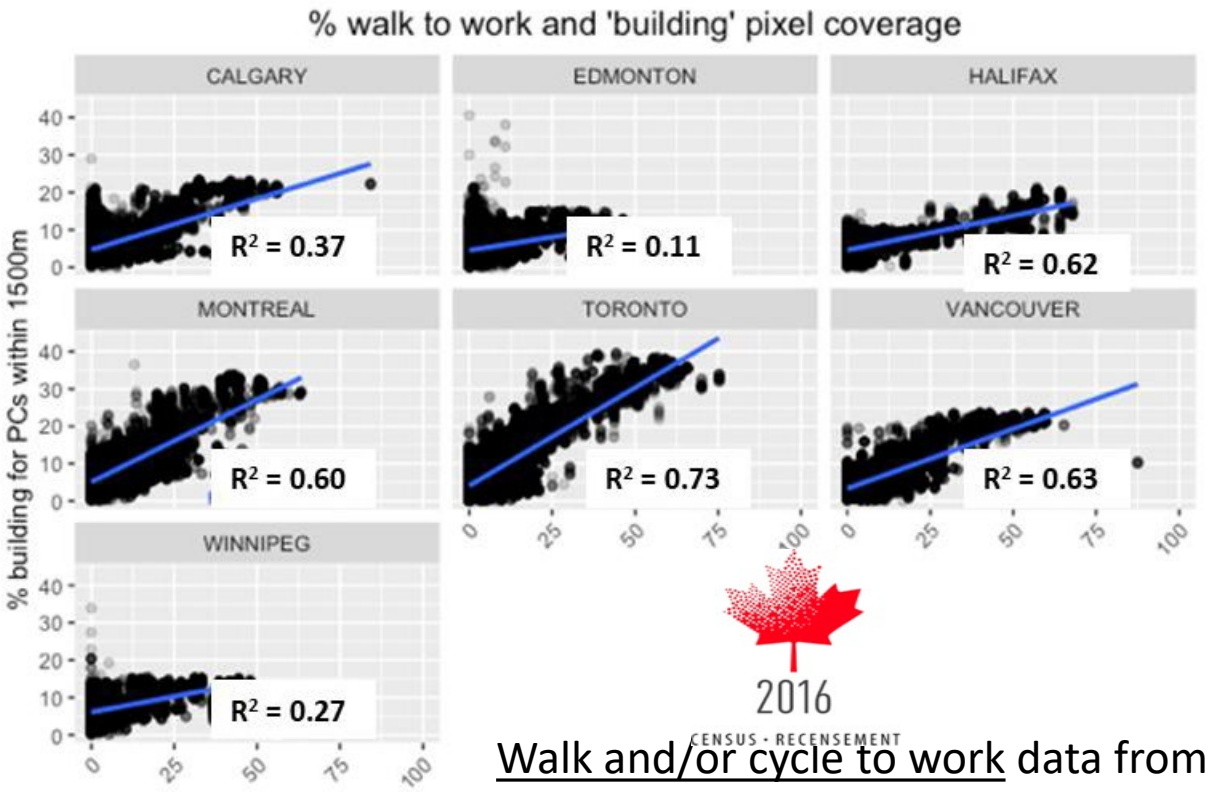
Yi Li

a)

b)

c)

New frontiers for urban data



Walk and/or cycle to work data from Canadian Census data **in 7 large Canadian cities**

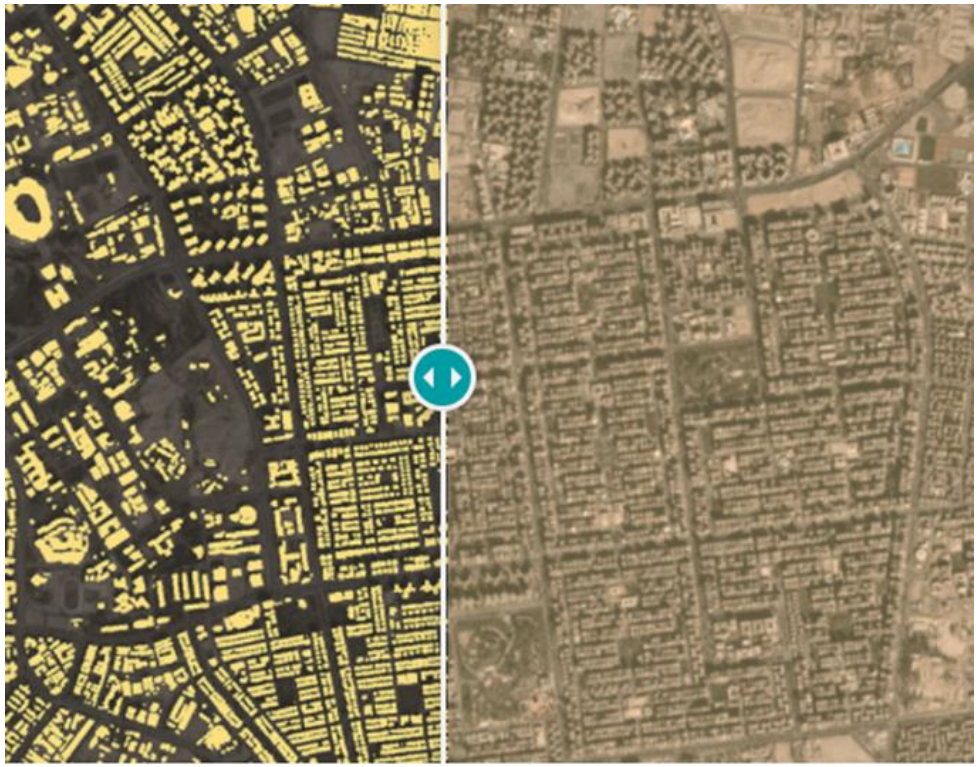
Based on 5 million GSV images

Ranking images in HealthyPlace.City

This place is….

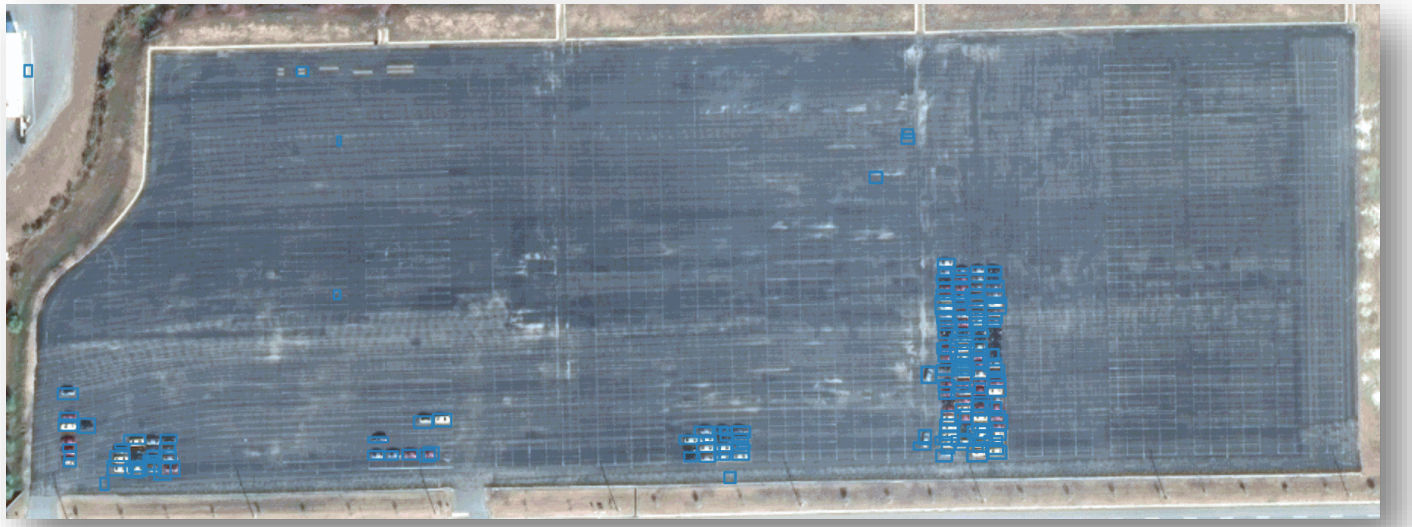
- Clean
- Safe
- Fun
- Relaxing
- …

New frontiers for urban data



Building footprints for North America freely available

Increasing resolution of satellite imagery and more frequent (but very expensive still)

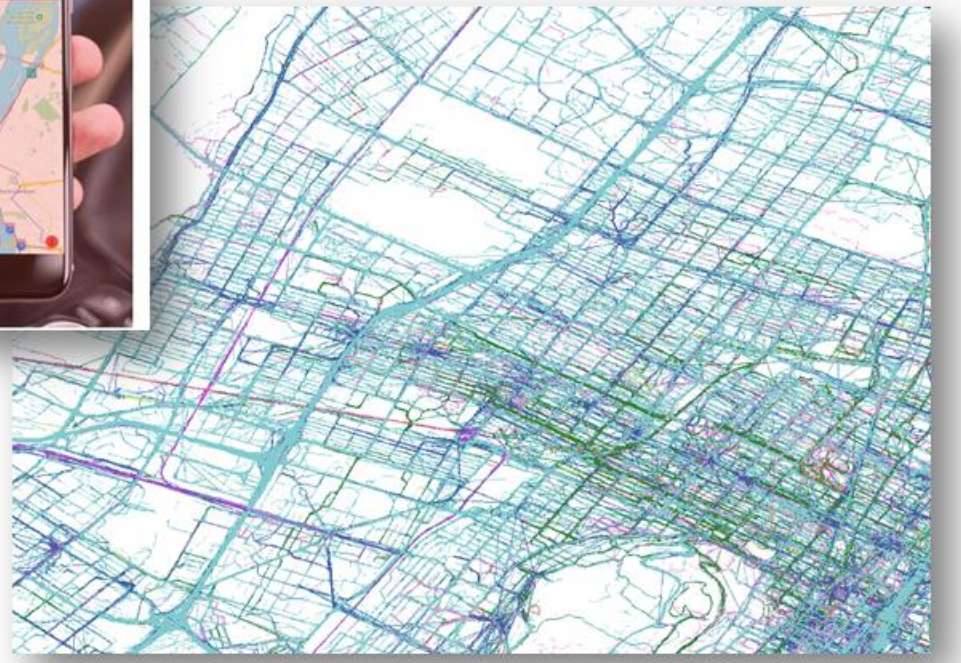


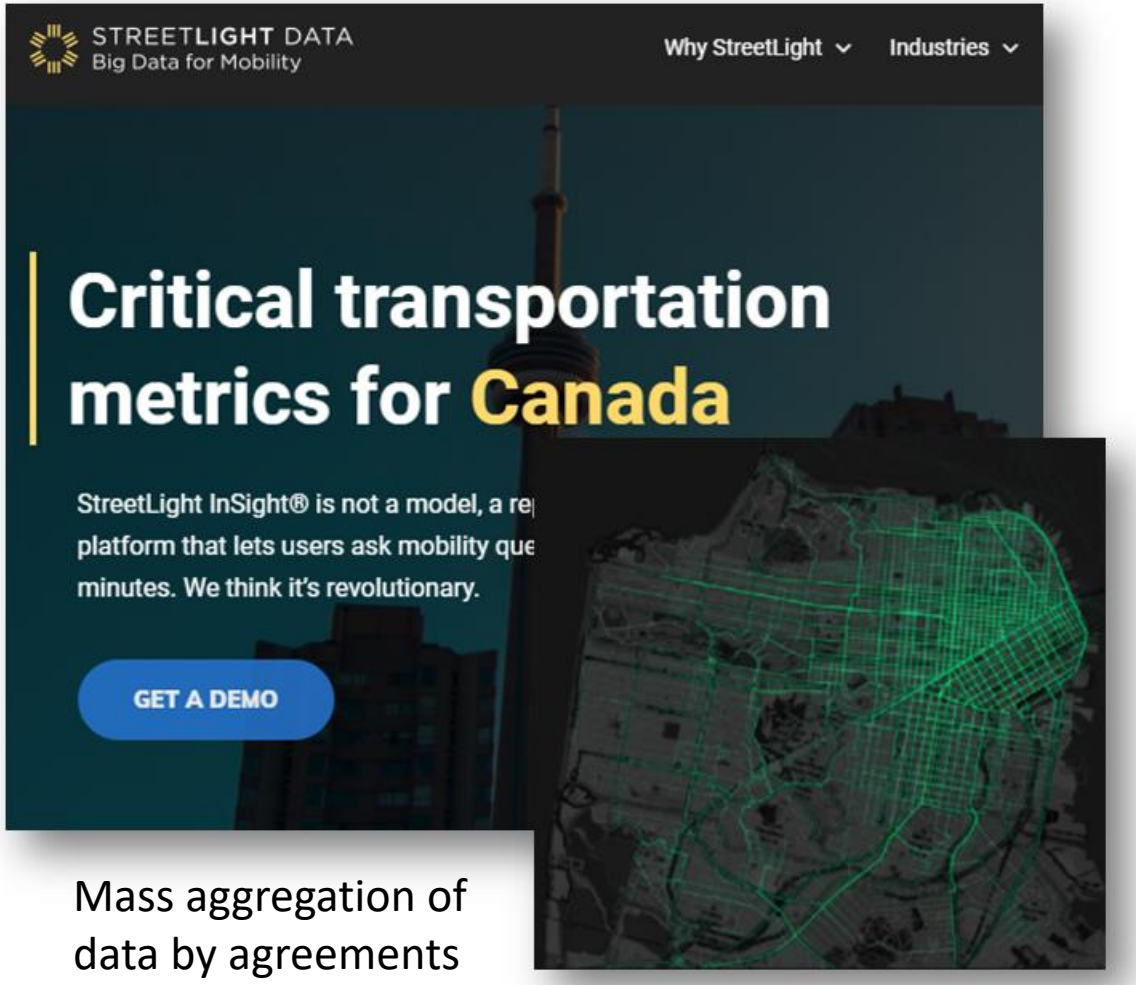
New frontiers for urban data

Mobile data!

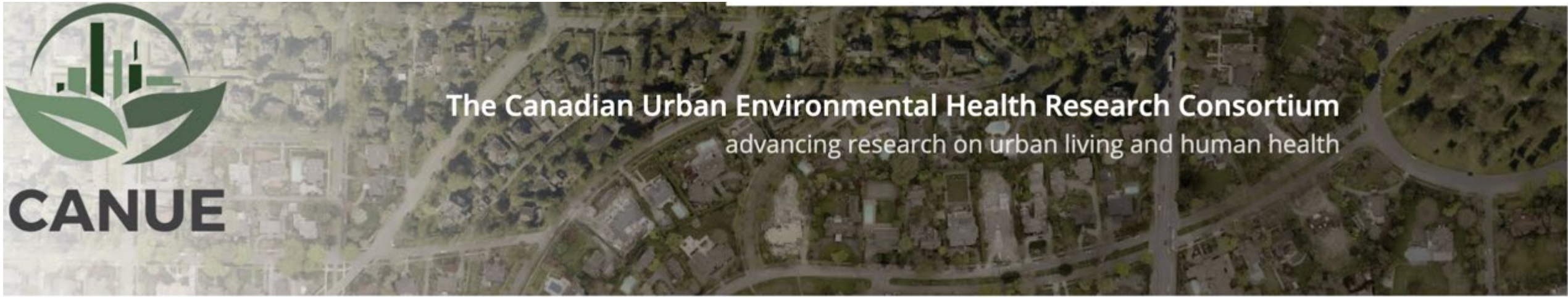
Special apps

By mode





Mass aggregation of data by agreements with cell companies

For more information visit:

CANUE website: www.canue.ca
CANUE data portal: www.canuedata.ca
HealthyDesign.City website: healthydesign.city