



# The Canadian Urban Environmental Health Research Consortium

➔ building a national environmental exposure data platform for  
integrated analyses of urban form and health

**Jeff Brook**  
Scientific Director



UNIVERSITY OF TORONTO  
DALLA LANA SCHOOL OF PUBLIC HEALTH



UNIVERSITY OF TORONTO  
FACULTY OF APPLIED SCIENCE & ENGINEERING



Environnement et  
Changement climatique Canada

Environment and  
Climate Change Canada



# Learning Objectives for today

- Become aware of the environmental exposure data CANUE is and plans to hold and share freely for research on urban form and health.
- To better appreciate the challenges that exist in quantifying exposures consistently for all Canadians for multiple years in the past as well as into the future and how CANUE is addressing them.
- To become familiar with some of the health research studies CANUE members are undertaking and with some of the exciting research directions that may be possible given the critical mass of researchers brought together under CANUE.

# Origin of CANUE



**MEASURING  
ENVIRONMENTAL  
EXPOSURES  
WORKSHOP**

**2011**

**ENVIRONMENT,  
GENES AND  
CHRONIC DISEASE  
NATIONAL  
WORKSHOP**

**2012**

**ENVIRONMENTS  
AND HEALTH  
NATIONAL  
FORUM**

**2013**

- Break down some of the existing silos of research in the environment and health field.
- Tackle the real-world complexity of interacting and ubiquitous environmental influences.
- Build research capacity and supporting data platforms.

# Increasing proportion of urban dwellers

Population (as count and as share of total population) and growth rate of metropolitan and non-metropolitan Canada, 2006 and 2011

Statistical Area Classification	2006		2011		Growth rate	
	Population	%	Population	%	2001 to 2006	2006 to 2011
					%	
Canada	31,612,897	100.0	33,476,688	100.0	5.4	5.9
Census metropolitan areas (CMAs)	21,534,063	68.1	23,123,441	69.1	6.9	7.4
Census agglomerations (CAs)	4,136,342	13.1	4,311,524	12.9	4.0	4.2
Outside of CMAs and CAs	5,942,492	18.8	6,041,723	18.0	1.0	1.7
Close to CMAs or CAs <sup>1</sup>	1,521,507	4.8	1,586,681	4.7	4.7	4.3
Remote from CMAs and CAs <sup>2</sup>	4,361,273	13.8	4,393,039	13.1	-0.1	0.7
Territories <sup>3</sup>	59,712	0.2	62,003	0.2	8.9	3.8

>80% of Canadians live in urban areas

35% live in:  
Toronto  
Montreal  
Vancouver

Notes:

1. Refers to census subdivisions (CSD) outside CMAs and CAs classified as strong metropolitan influenced zone (strong MIZ). See <http://www12.statcan.gc.ca/census-recensement/2011/ref/dict/geo010-eng.cfm>.
2. Refers to census subdivisions (CSD) outside CMAs and CAs classified as either moderate, weak or no metropolitan influenced zone (moderate MIZ, weak MIZ or no MIZ). See <http://www12.statcan.gc.ca/census-recensement/2011/ref/dict/geo010-eng.cfm>.
3. Excludes CAs of Yellowknife and Whitehorse.

Sources: Statistics Canada, censuses of population, 2001, 2006 and 2011.

<http://www12.statcan.gc.ca/census-recensement/2011/as-sa/98-310-x/98-310-x2011001-eng.pdf>

ARTICLE

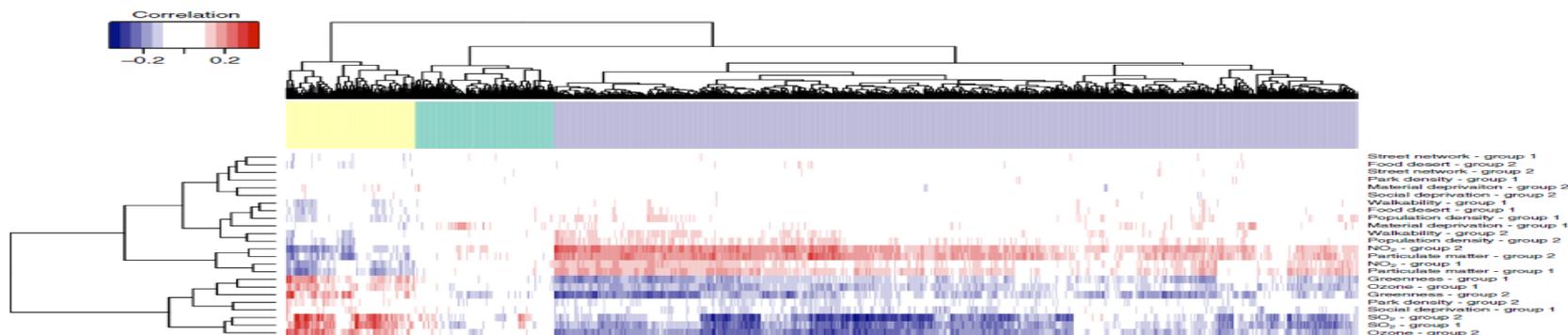
DOI: 10.1038/s41467-018-03202-2

OPEN

# Gene-by-environment interactions in urban populations modulate risk phenotypes

Marie-Julie Favé<sup>1,2</sup>, Fabien C. Lamaze<sup>1</sup>, David Soave<sup>1</sup>, Alan Hodgkinson<sup>2,3</sup>, Héloïse Gauvin<sup>2,4</sup>, Vanessa Bruat<sup>1,2</sup>, Jean-Christophe Grenier <sup>1,2</sup>, Elias Gbeha<sup>1</sup>, Kimberly Skead<sup>1</sup>, Audrey Smargiassi<sup>5</sup>, Markey Johnson<sup>6</sup>, Youssef Idaghdour<sup>7</sup> & Philip Awadalla<sup>1,2,8,9</sup>

Our findings demonstrate how the local environment directly affects disease risk phenotypes and that genetic variation, including less common variants, can modulate individual's response to environmental challenges



Individual  
Factors &  
Responses



SOCIOECONOMIC STATUS      LIFESTAGE

TIMES SPENT AT HOME, WORK, SCHOOL AND INDOOR/OUTDOOR      COMMUTE TIME      TRANSPORTATION MODE

POPULATION DISTRIBUTION OVER GEOGRAPHY AND TIME

AIR QUALITY      FOOD      GREEN /BLUE SPACE  
 +/- EXPOSURES  
 PHYSICAL ACTIVITY      NOISE      HEAT/COLD WET/DRY

+/- IMPACTS ON HUMAN HEALTH

Urban form



PARKS AND WATERWAYS  
 TRANSPORTATION OPTIONS  
 HOME, WORK, SCHOOL AND SERVICES

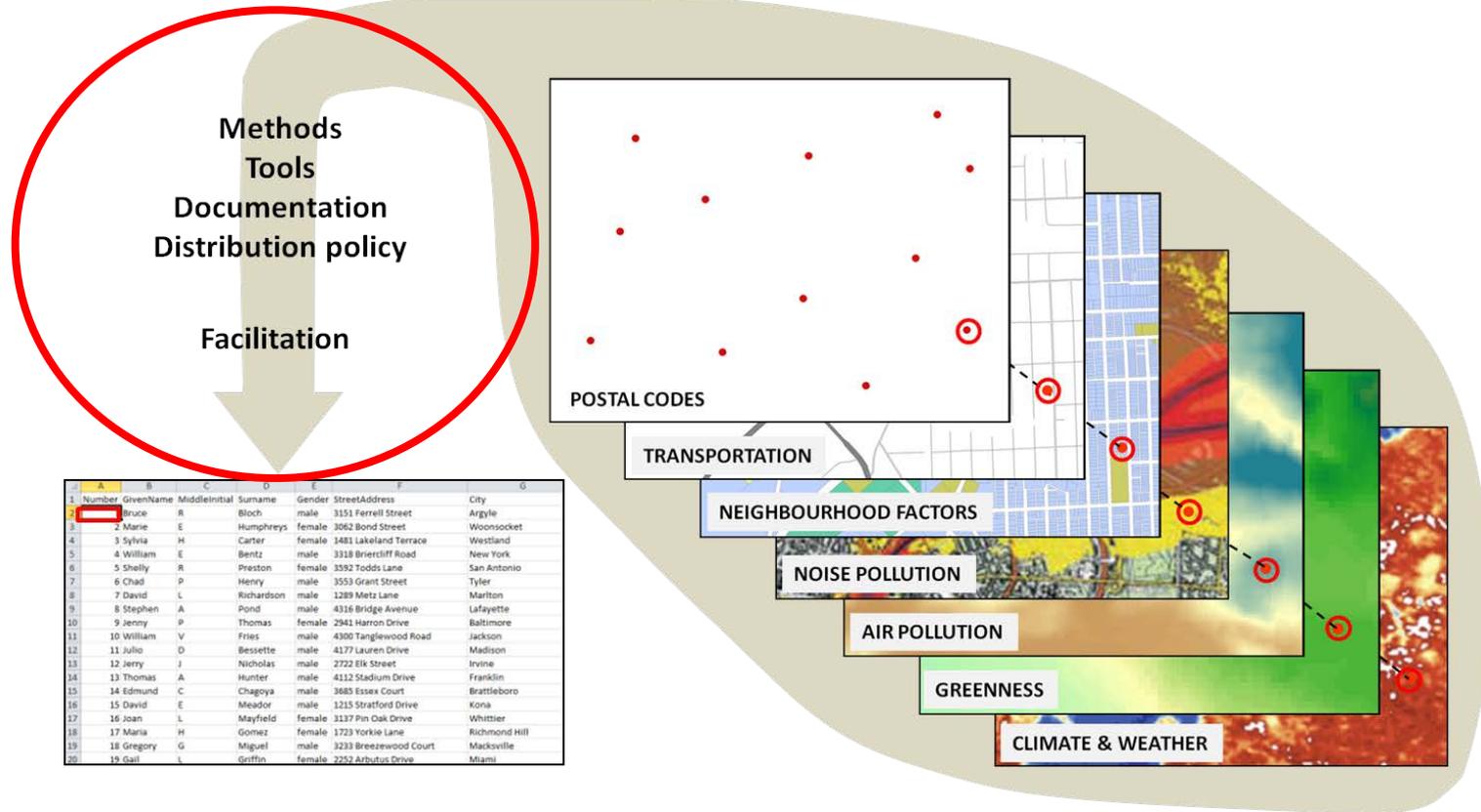
Policy responses

PLANNING: LAND USE & TRANSPORTATION

External forces

POPULATION GROWTH      ECONOMIC GROWTH      WEATHER & CLIMATE

# CANUE Key Mandate: Build a Data and Methods Platform

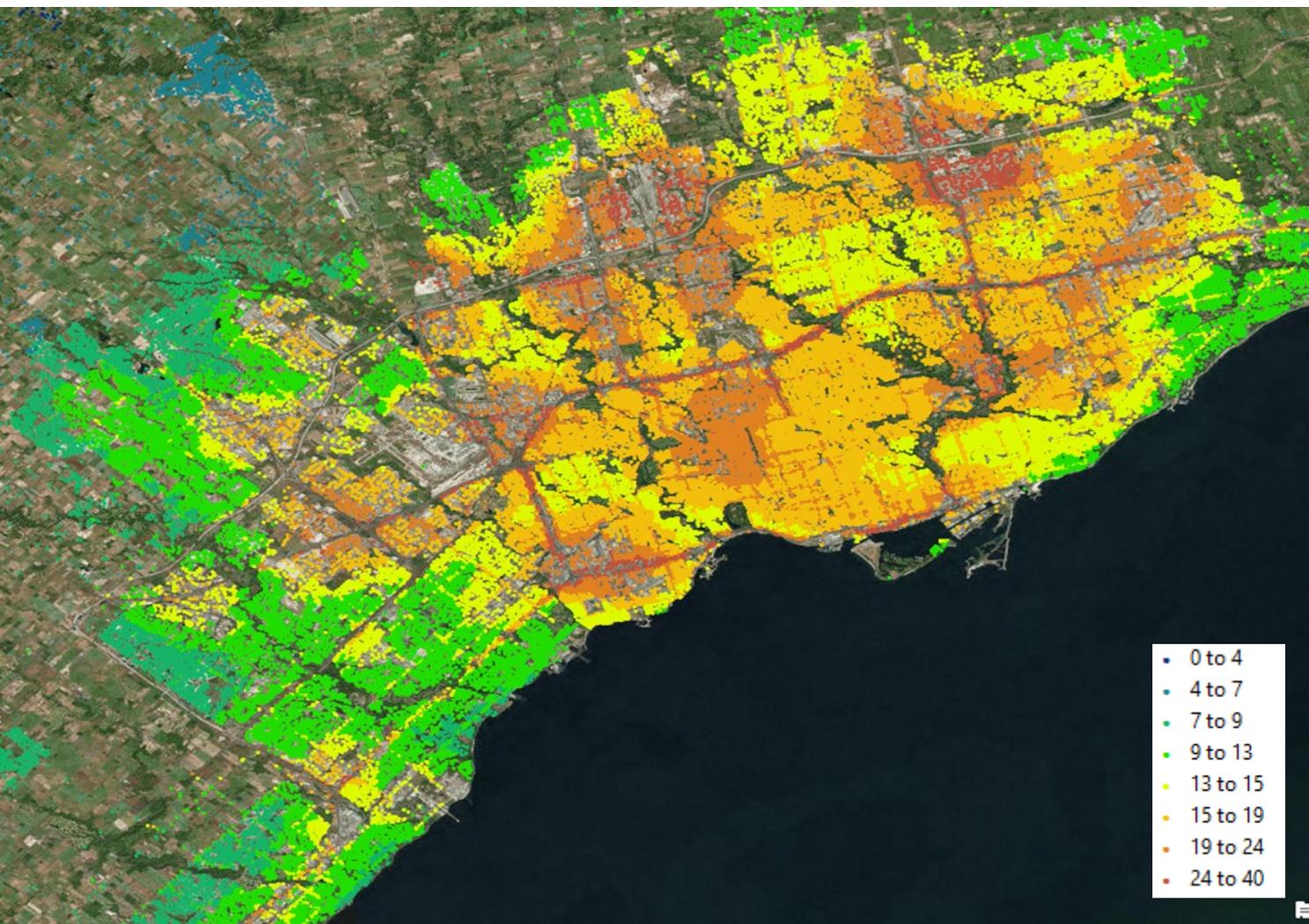


Number	GivenName	MiddleInitial	Surname	Gender	StreetAddress	City
1	Bruce	R	Bloch	male	3151 Ferrell Street	Argyle
2	Marie	E	Humphreys	female	3062 Bond Street	Woonsocket
3	Sylvia	H	Carter	female	1481 Lakeland Terrace	Westland
4	William	E	Bentz	male	3132 Briercroft Road	New York
5	Shelly	R	Preston	female	3592 Todds Lane	San Antonio
6	Chad	P	Henry	male	3553 Grant Street	Tyler
7	David	L	Richardson	male	1289 Metz Lane	Marlton
8	Stephen	A	Pond	male	4316 Bridge Avenue	Lafayette
9	Jenny	P	Thomas	female	2941 Harron Drive	Baltimore
10	William	V	Fries	male	4300 Tanglewood Road	Jackson
11	Julio	D	Besette	male	4177 Lauren Drive	Madison
12	Jerry	J	Nicholas	male	2722 Elk Street	Irvine
13	Thomas	A	Hunter	male	4112 Stadium Drive	Franklin
14	Edmund	C	Chagoya	male	3685 Essex Court	Brattleboro
15	David	E	Meador	male	1215 Stratford Drive	Kona
16	Joan	L	Mayfield	female	3137 Pin Oak Drive	Whittier
17	Maria	H	Gomez	female	1723 Yorkie Lane	Richmond Hill
18	Gregory	G	Miguel	male	3233 Breezewood Court	Macksville
19	Paul	L	Griffin	female	2252 Arbutus Drive	Miami

1980's

2050?

CANUE DATA

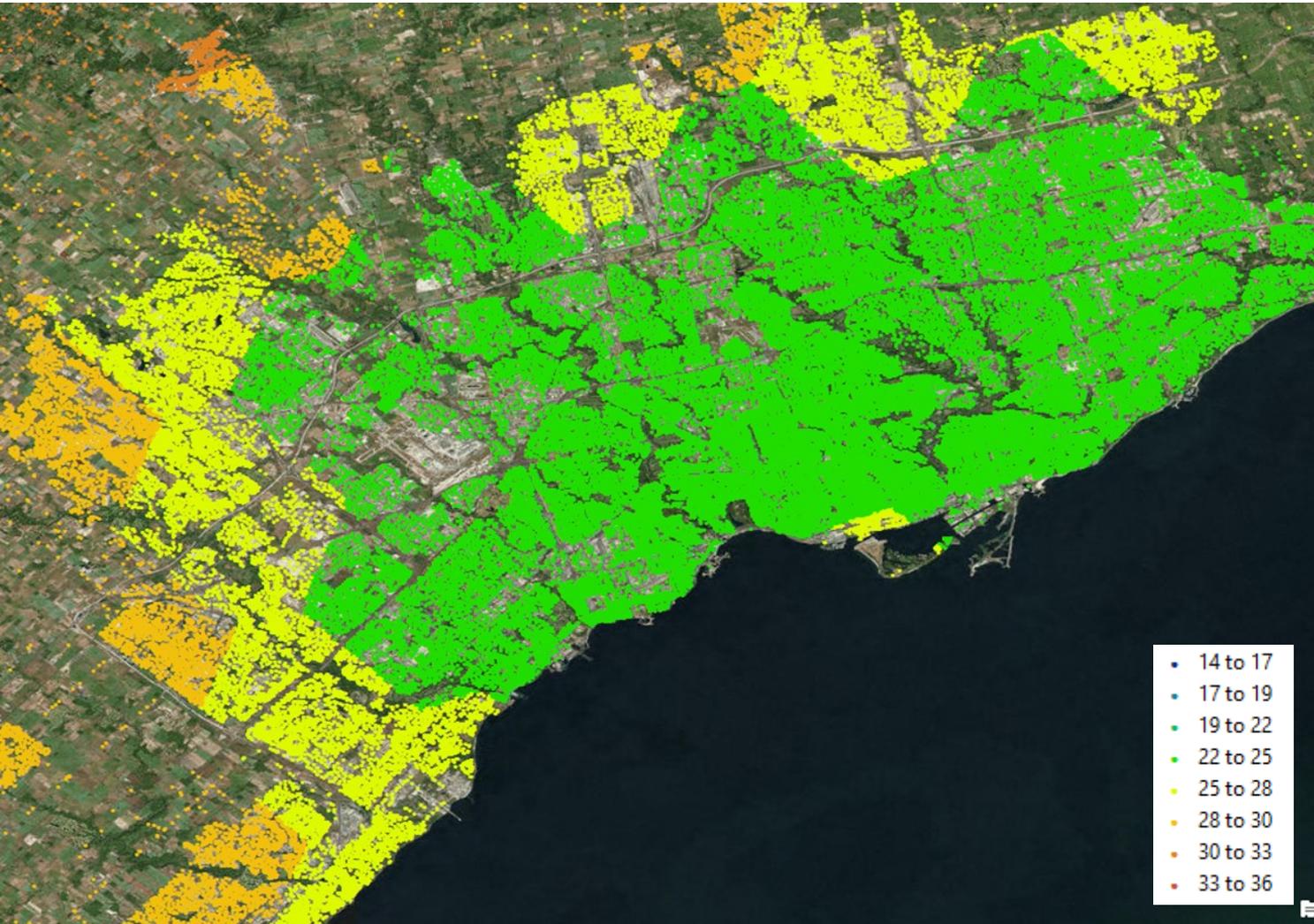


Hystad et al.  
Land Use  
Regression

Annual Average  
Nitrogen Dioxide

Postal code

1984 - 2012



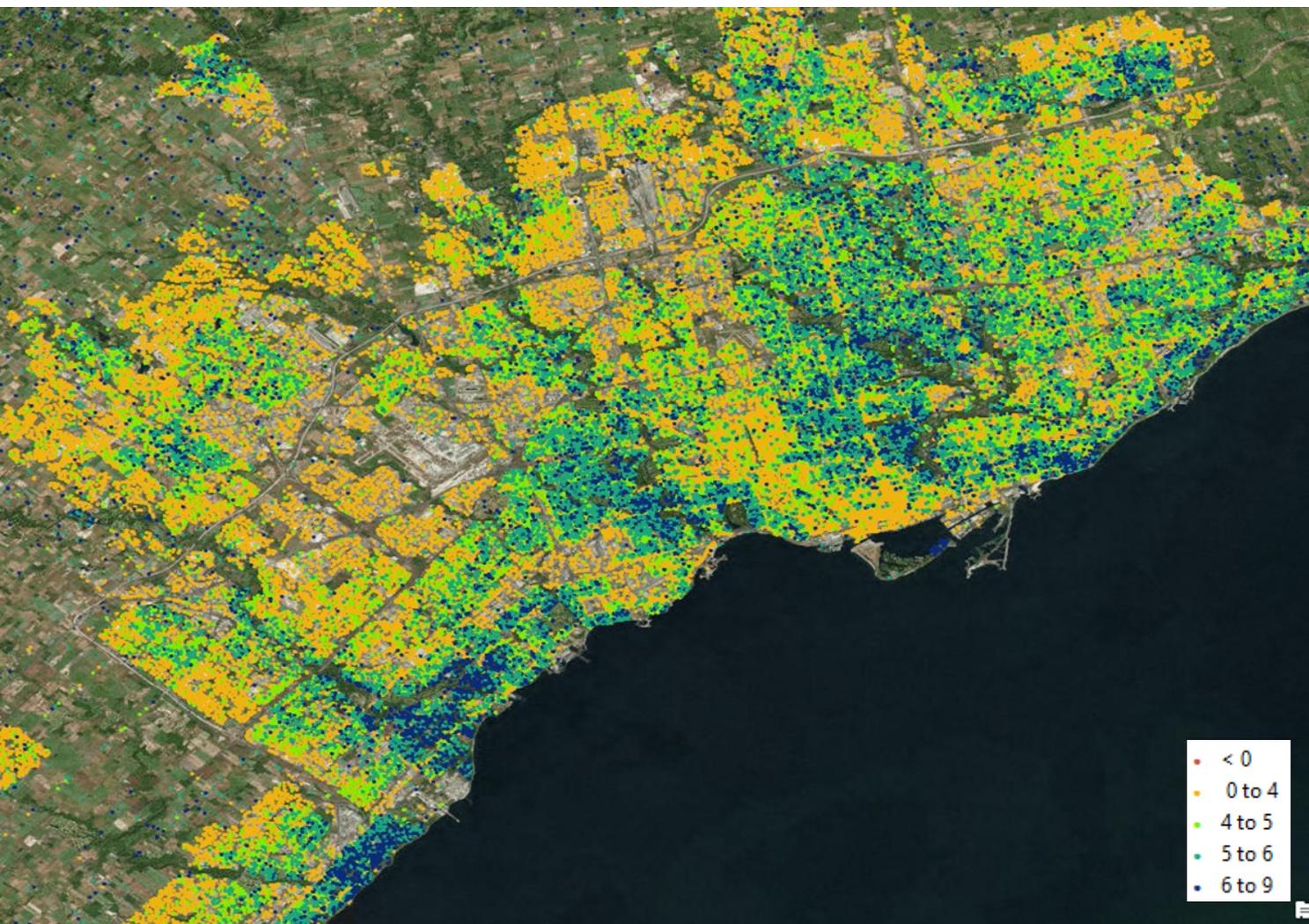
ECCC Modelled  
(CHRONOS GEM-  
MACH)

Annual Average  
Ozone

2000 – 2009  
(~20km)

2010 – 2015 →  
(~10 km)

# CANUE Overview

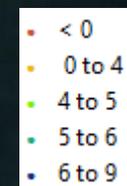


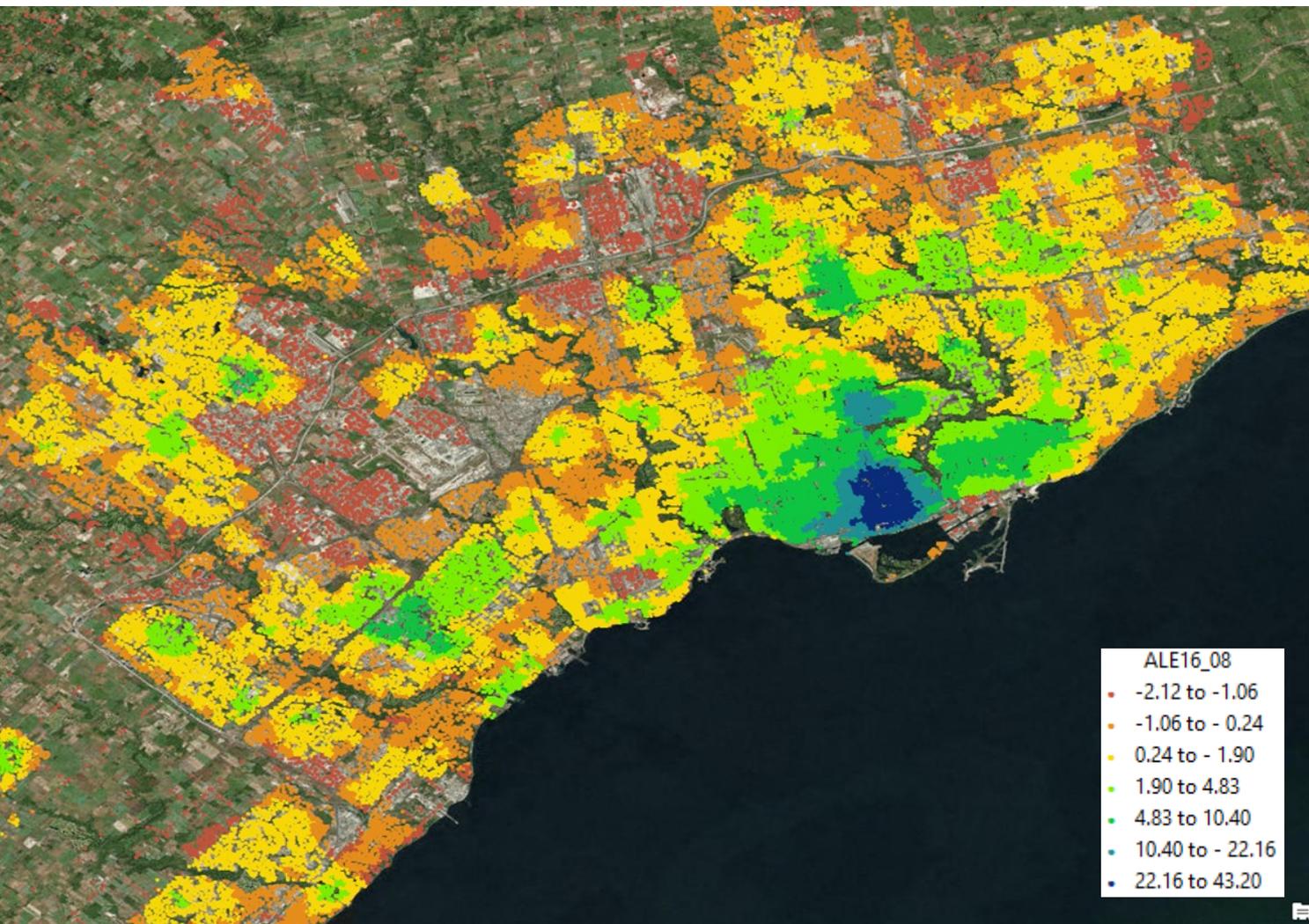
CANUE staff  
Landsat 5/8

Annual highest  
NDVI

30m

1984 – 2015 →





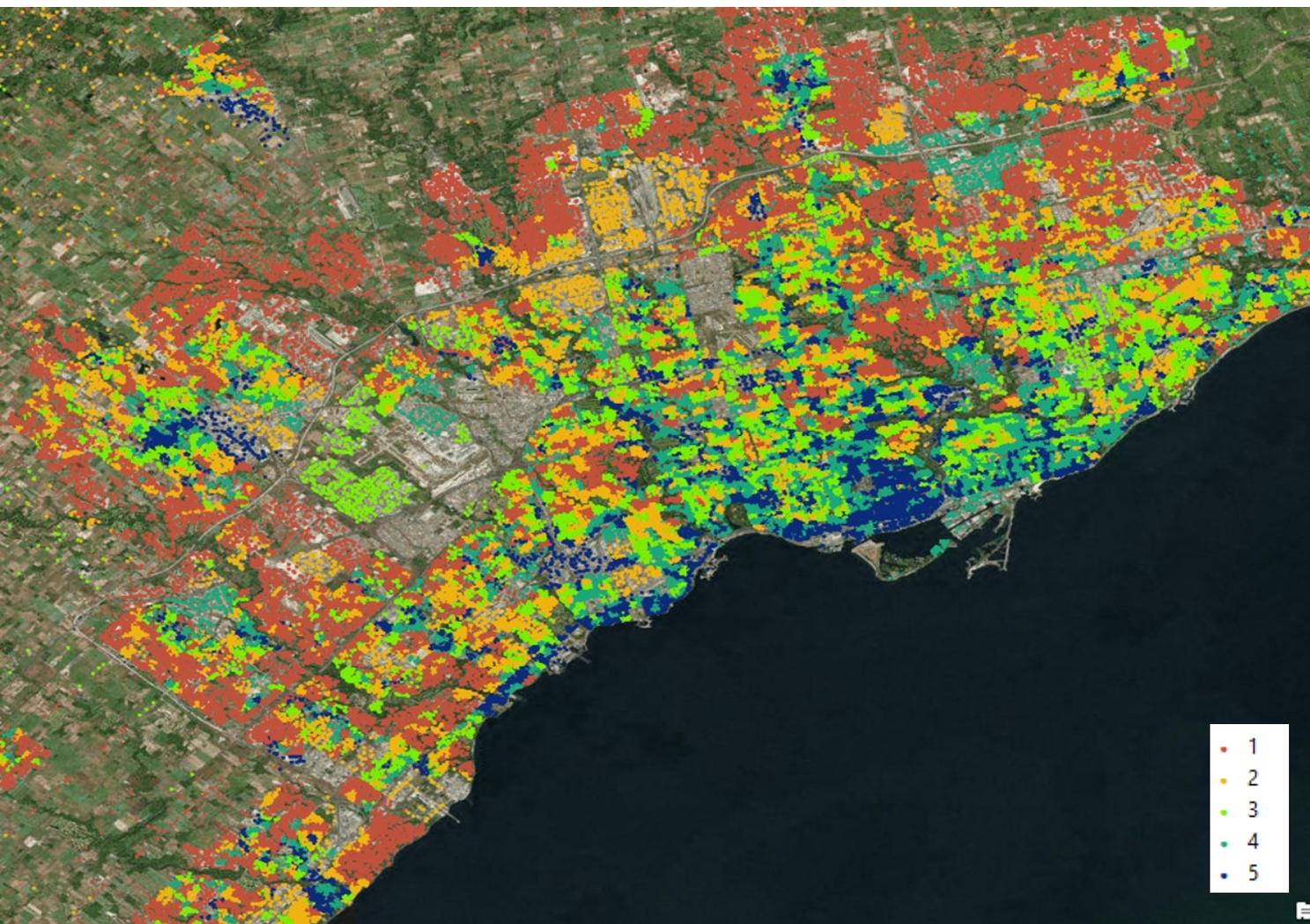
Ross, Hermann et al.

Active Living Environment Index

Dissemination areas

2006

2016

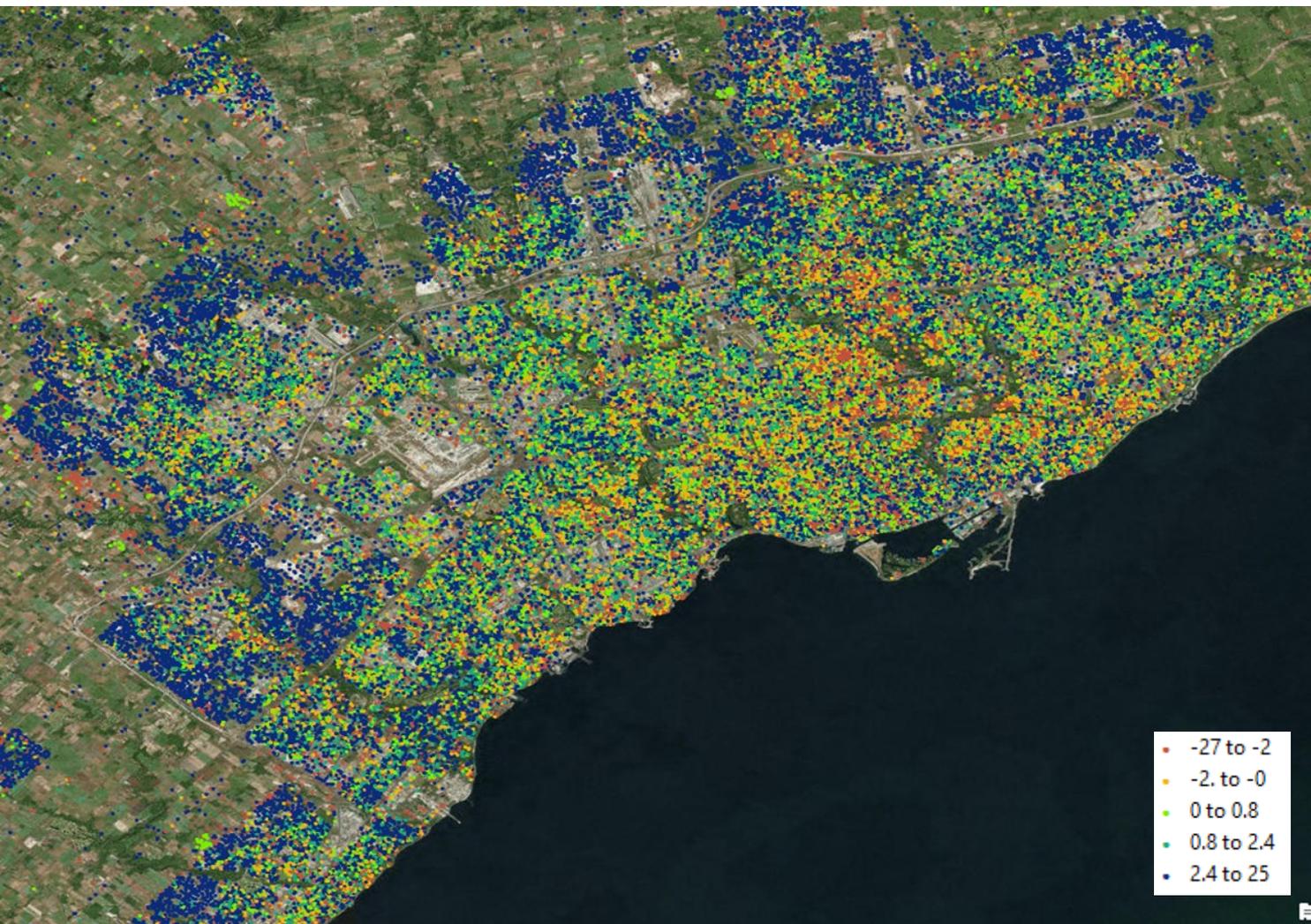


INSPQ  
Material and  
Social Deprivation  
(Pampalon)

Social Deprivation  
Score (quintiles)

Dissemination  
Areas

1991, 1996, 2001,  
2006, 2011 →



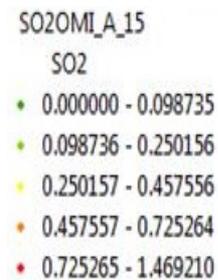
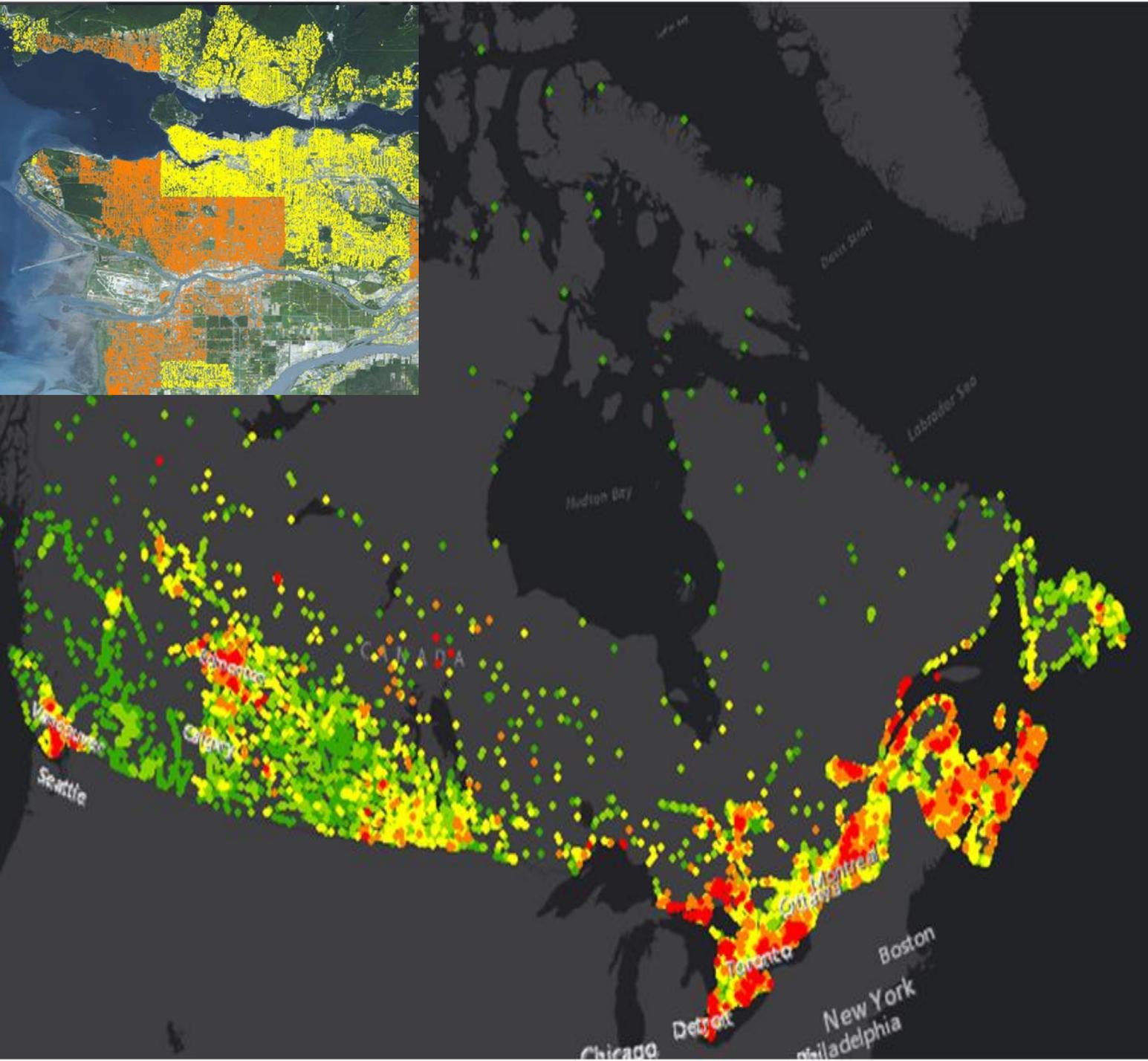
CANUE staff  
Landsat 5/8

Trend in annual  
mean NDVI (slope)

30m

Slope of values at  
each postal code  
(1984 to 2015)

Industrially-Related  
Air Pollution  
Sulfur Dioxide  
(20 km)



*Environ Health Perspect*; DOI:10.1289/EHP935

## Outdoor Light at Night and Breast Cancer Incidence in the Nurses' Health Study II

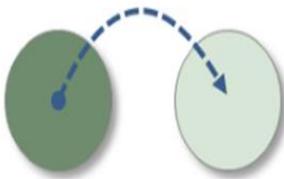
Peter James,<sup>1,2,3</sup> Kimberly A. Bertrand,<sup>4</sup> Jaime E. Hart,<sup>2,3</sup> Eva S. Schemhammer,<sup>1,3,5,6</sup> Rulla M. Tamimi,<sup>1,3</sup> and Francine Laden<sup>1,2,3</sup>

**CONCLUSIONS:** Although further work is required to confirm our results and to clarify potential mechanisms, our findings suggest that exposure to residential outdoor light at night may contribute to invasive breast cancer risk. <https://doi.org/10.1289/EHP935>

Annual Average  
Nighttime Light

## Data

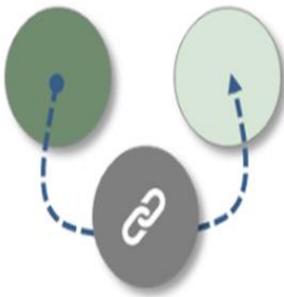
You are here: Home / Data



Get data directly from CANUE:

Fill in the [CANUE Data Use and Sharing Agreement V1.1](#) and email to [info@canue.ca](mailto:info@canue.ca). We will contact you shortly to arrange a data transfer.

Let us know if we don't have what you are looking for. We are happy to take your [special requests](#).



Work with CANUE data pre-linked to major health databases:

Watch here for a list of cohorts, cross-sectional surveys and provincial health datasets that have already linked CANUE data.

When these are complete, you can download and fill out the required CANUE Use and Sharing Agreement here to include with your data access request to the health data manager.

### QUICK PICK DOCUMENTS

- ✦ [Data Use and Sharing Agreement V1.1](#)
- ✦ [CANUE Data Dictionary V1.0](#)
- ✦ [Postal Code User Guide V1.0](#)
- ✦ [Metadata: Postal Codes](#)
- ✦ [Metadata: National LUR Nitrogen Dioxide](#)
- ✦ [Metadata: National Modelled Ozone](#)
- ✦ [Metadata: National Satellite-based Fine Particulates](#)
- ✦ [Metadata: National Satellite-based Sulfur Dioxide](#)
- ✦ [Metadata: National Landsat NDVI \(greenness\)](#)
- ✦ [Metadata: National MODIS NDVI \(greenness\)](#)
- ✦ [Metadata: National AVHRR NDVI \(greenness\)](#)
- ✦ [Metadata: National Pampalon Deprivation Indices](#)
- ✦ [Metadata: National Satellite-based Nighttime Light](#)
- ✦ [Metadata: National Interpolated Weather Indices](#)

### ONLINE DATA CATALOGUE

# CANUE Overview



**CanCHEC (Canadian Census Health and Environment Cohort)**



Statistics  
Canada

Statistique  
Canada

CHMS



Population Data BC



populationdata<sup>BC</sup>

Population Data BC (PopData) is a multi-university, data and education resource facilitating interdisciplinary research on the determinants of human health, well-being and development.

We offer researchers access to one of the world's largest collections of health care, health services and population health data, and a comprehensive education and training service on how to best use those data.



**ReACH**

Research Advancement through  
Cohort Cataloguing and Harmonization



...and more

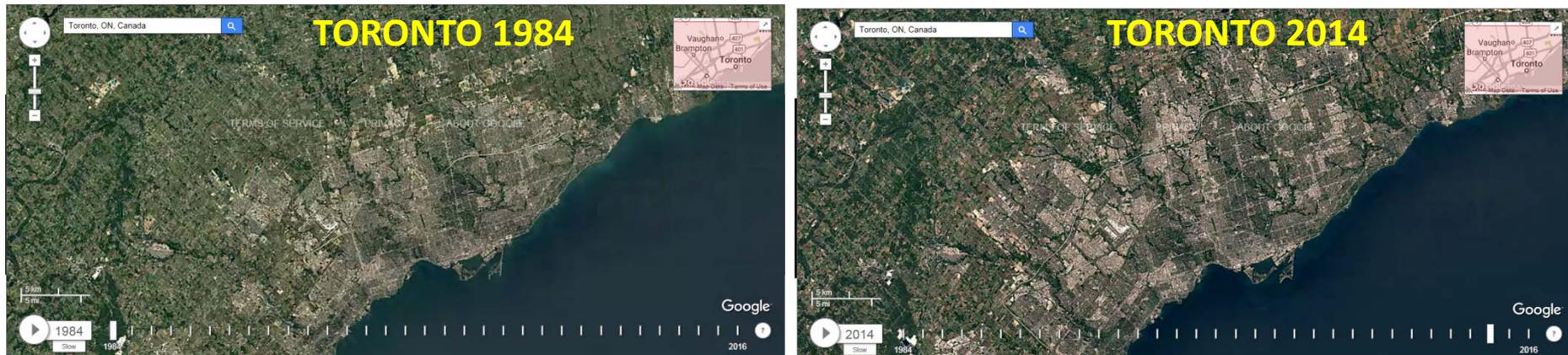


- One of Canada's largest long-term health studies
  - ~230,000 participants from across the province
- A platform for researchers to use now and decades into the future
- Investigations of the complex interplay between genetics, lifestyle, environment and health

# Historical Environmental Exposures

## CPTP

- 35 year old in 2015 – born in 1980
- 69 years old in 2015 – born in 1946



Google Earth Engine tools

Residential History can be determined annually to 1981  
from data housed in Statistics Canada's Social Data Linkage  
Environment

# CANUE's Aim to Provide Residential History



Health  
Canada

Santé  
Canada



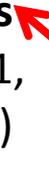
Statistics  
Canada

Statistique  
Canada



**Canadian Health  
Measures Surveys**

(2007-09, 2009-11,  
2012-13, 2014-15)



**Reconstruct residential history using federal records**

**Five datasets over five years:**

**2016-17**

**2017-18**

**2018-19**

**2019-20**

**2020-21**

# Canadian Partnership for Tomorrow Project: SDLE residential history construction

Cohort	Participant consent/REB status (as of March 7, 2018)	SDLE participation status	# of participants
Ontario Health Study (Ontario)	Obtained ethics approval	Moving ahead	150,000
Alberta's Tomorrow Project (Alberta)	Submitted REB proposal	Under consideration	55,000
BC Generations Project (British Columbia)	Submitted REB proposal	Under consideration	30,000
Atlantic PATH (Atlantic Provinces)	Preparing REB proposal	Under consideration	35,471
CARTaGENE (Quebec)	Lengthy approval process/would be difficult to obtain approval	Will not participate	43,068

# Build it and they shall come !

- Rural population health and environmental quality (all data)
  - Spatial patterns of adverse birth outcomes (air quality, SES, nighttime light)
    - Spatial patterns in urban exposures and lung function (air pollution, weather, SES, Landsat, MODIS)



OUR FIRST DATA DELIVERY IS READY TO GO!

- Greenness and health outcomes of long-term care home residents (SES, weather, Landsat, MODIS, AVVHR)
- Residential greenness and breast cancer (Landsat))
- Air pollution and multiple sclerosis risk/prognosis (air quality, weather)
- Air pollution, dementia and other degenerative diseases (Alzheimer's, Parkinson's) (air pollution, Landsat)
- Social participation and aging (nighttime light, weather, Landsat)

# Build it and they shall come !

- Canadian exposure profile trends (all data, all years)
- Information dissemination/KT via interactive mapping application (air quality, weather, Landsat)
- Graduate course in spatial analysis looking at environmental equity (air quality, SES, nighttime light)
- Student group project: air quality index at residence vs closest observation station (air quality, weather)
- Neighbourhood disadvantage and psychological stress in pregnant women (SES index, nighttime light)
- Greenness metrics and public health outcomes via ecosystem services (air quality, SES index, Landsat)
- Evaluating changes in greenspace or CHILD cohort (air quality, weather, Landsat, MODIS)
- Air pollution exposure and systemic autoimmune rheumatic diseases (ozone)
- Residential greenness, air pollution and mortality (Landsat)
- Residential noise and pre-natal health (air quality)

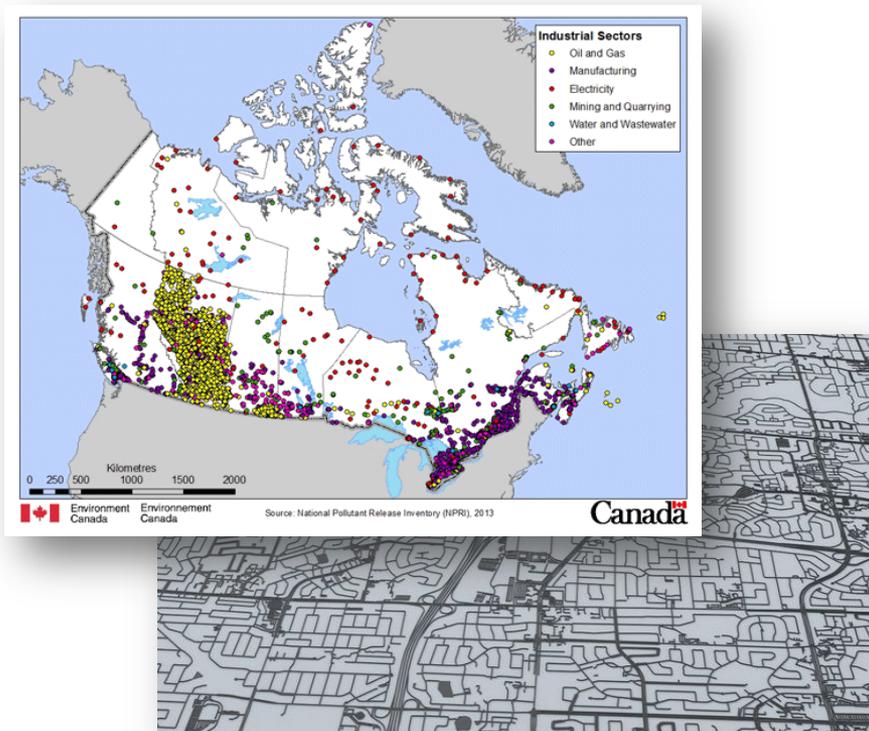


OUR FIRST DATA DELIVERY IS READY TO GO!

# Next for CANUE...

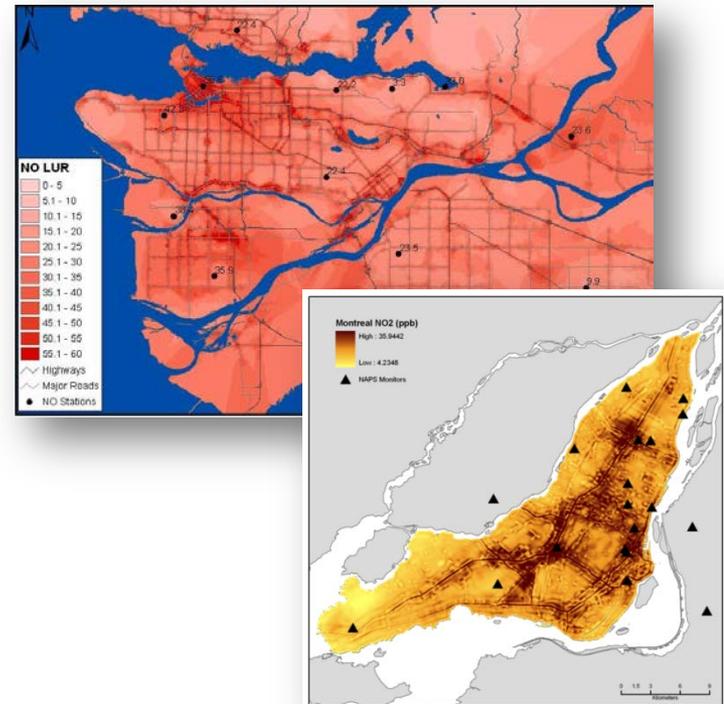
Increase temporal resolution → monthly metrics  
Bring in more existing data:

## National Pollutant Release Inventory



Proximity to roads

## Regional data/models – air quality, noise, transportation



# Next for CANUE...

## Looking ahead – hourly air pollution from North America's geostationary satellite

In 2019 the world's first geostationary satellite (TEMPO) for measuring air pollution will produce high resolution (~5km) maps every daytime hour of tropospheric NO<sub>2</sub>, SO<sub>2</sub>, and aerosols. These maps can be used to estimate exposure to air pollution. For more information, see the presentation by Dr. Chris McLinden and Chris McLinden at the 2018 CANUE meeting.



## Estimating gas and diesel emissions

In close collaboration with the Transportation Data Team, we will – for the first time – produce independent exposure surfaces for gasoline and diesel traffic-related air pollution at the urban to suburban scale. Isolating health effects of these two sources will have significant policy implications.

# Next for CANUE...

## Capturing different greenness qualities

Data from the NDVI only indicate the causal pathways between green space and health. We need a suite of measures to investigate the space, type of vegetation, tree canopy cover, and other green services. Building on current work with NDVI with measures of green space and applying quality appraisal with

CANUE Neighbourhood Factors  
The Future of Walkability  
November

### SUMMARY

The CANUE Neighbourhood Factors team met to discuss the next steps for the Neighbourhood Factors team in the coming years.

- We are developing measures that are good for health and equity*
- Equity focus makes our work uniquely Canadian*
- Once everything is said and done, more green space is needed*
- Focus on creating quality measures and not just quantity*

### SUMMARY OF PRIORITIES FOR NEIGHBOURHOOD FACTORS

1. Focus on microscale feature measurement
  - a. Image Recognition: Work with NRC
  - b. Develop a citizen science platform for microscale features
2. Tap researchers who would be willing to become members of the neighbourhood factors team with different expertise
3. Conduct rapid reviews for measures of:
  - a. Gentrification
  - b. Microscale features
4. Conduct some qualitative research with developers, engineers, and planners to find out what they might want in a new measure



shop

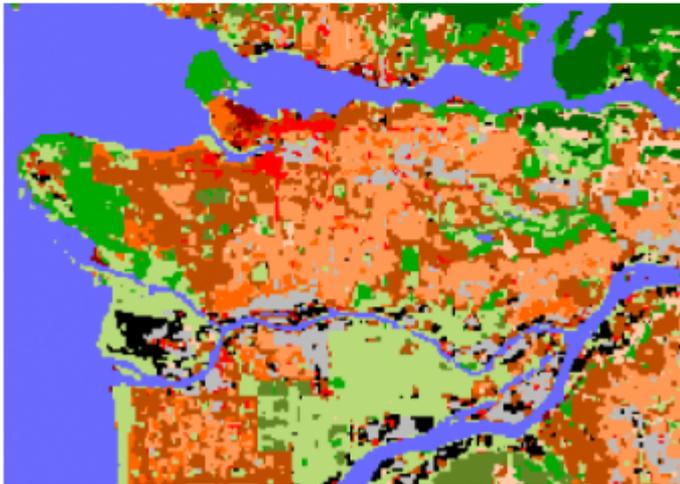
ex (Statistics Canada)

Food Environment Workshop

# Next for CANUE...

## Mapping local climate zones

We are investigating the Local Climate Zones (LCZ) concept, which uses urban characteristics to estimate the magnitude of urban heat islands and other hazards. It is possible to define multiple LCZ classes at the neighborhood scale and link them to air quality, pollen exposure, urban flooding, and other hazards.



## Assessing physical activity



Children in several of the birth cohorts that CANUE members represent are now reaching school age and puberty – critical ages for evaluating physical activity. CANUE members are designing a study in which parents and children report their physical activity by standardized questionnaire as well as using accelerometers, the gold standard for measuring physical activity. Key neighbourhood metrics for studying physical activity will be provided by our Neighbourhood Factors Data Team (e.g., walkability).

# Neighbourhood environment

## *Influences physical activity*

Ability to engage in active transportation

- Parks
- Playgrounds
- Recreational facilities
- Commercial areas
- Friends
- Social activities

## *Walkability*

Ability to walk/bike to desirable/necessary places

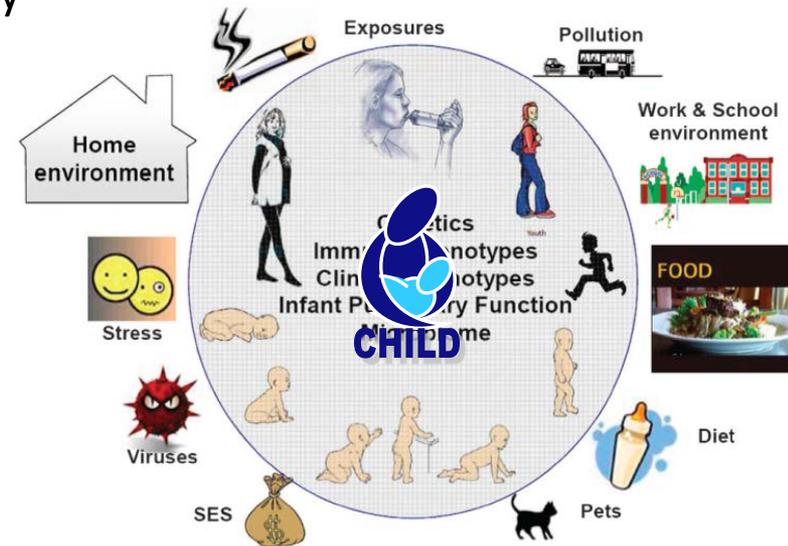
- Sidewalks
- Bike paths
- Safety
- Cleanliness
- Efficient routes
- Access to regular needs

Not expected to be the same for young children, teens, adults and seniors

# CANUE: A detailed focus on children

## Canadian Health Infant Longitudinal Development Study

- **3624** families have been enrolled from **Toronto, Winnipeg, Edmonton and Vancouver**, plus two rural areas in Manitoba
- Health and environment questions repeated at 11 time points from mid-pregnancy, including a home visit, complete to AGE 5
- Clinic visits at age 1, 3 and 5



## AGE 8 and 11

How much physical activity?

How much sedentary behaviour?

Who and/or what is influencing them?

## Questionnaires

1 week of personal

GPS

Accelerometer



# CANUE: A detailed focus on children



A rich new national dataset to explore relationships between neighbourhood and social environment and children's physical activity in Canada – by season – by age

## AGE 8 and 11

How much physical activity?

How much sedentary behaviour?

Who and/or what is influencing them?

Questionnaires

1 week of personal

GPS

Accelerometer



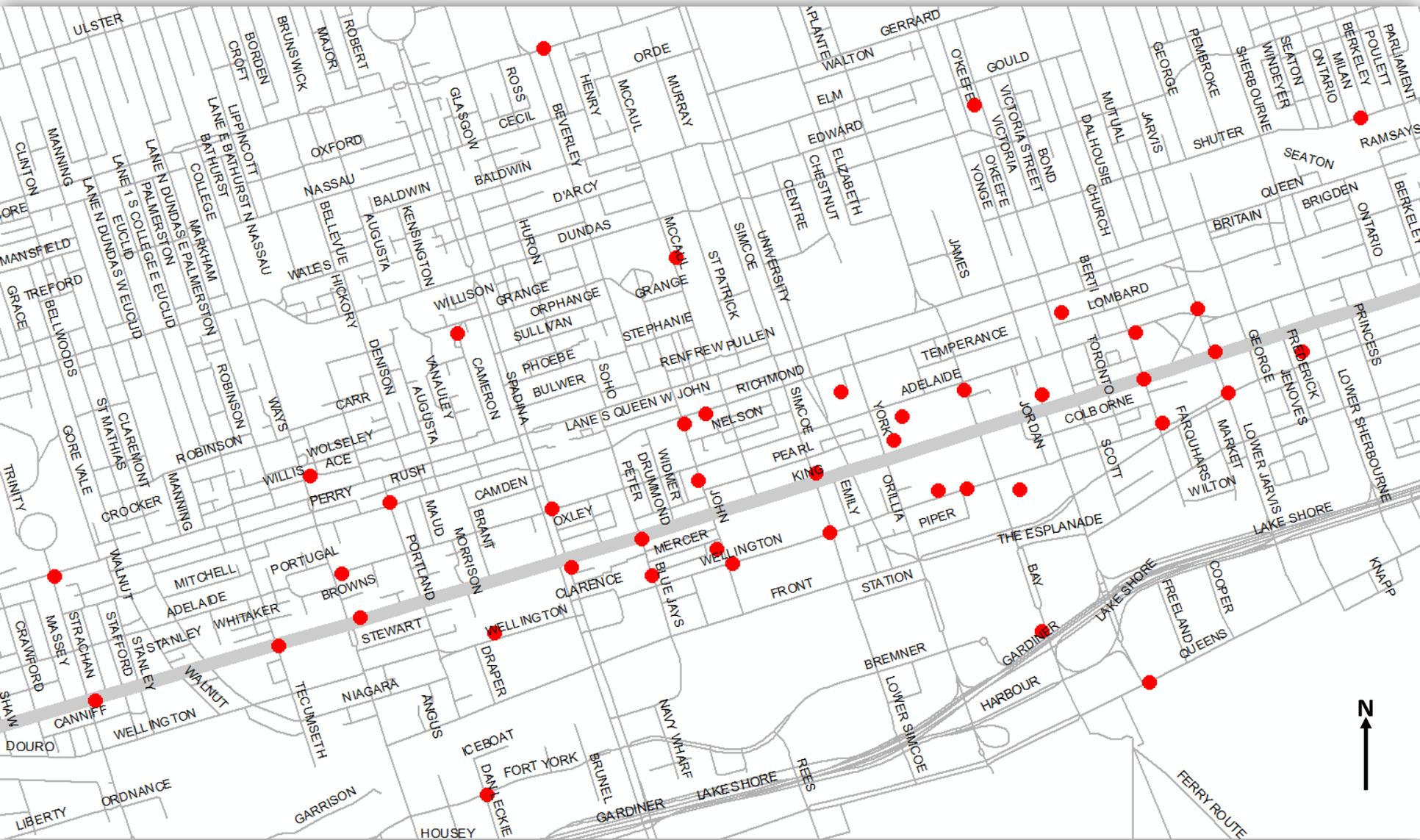
# Ripple Effects of Planning Decisions: KING STREET



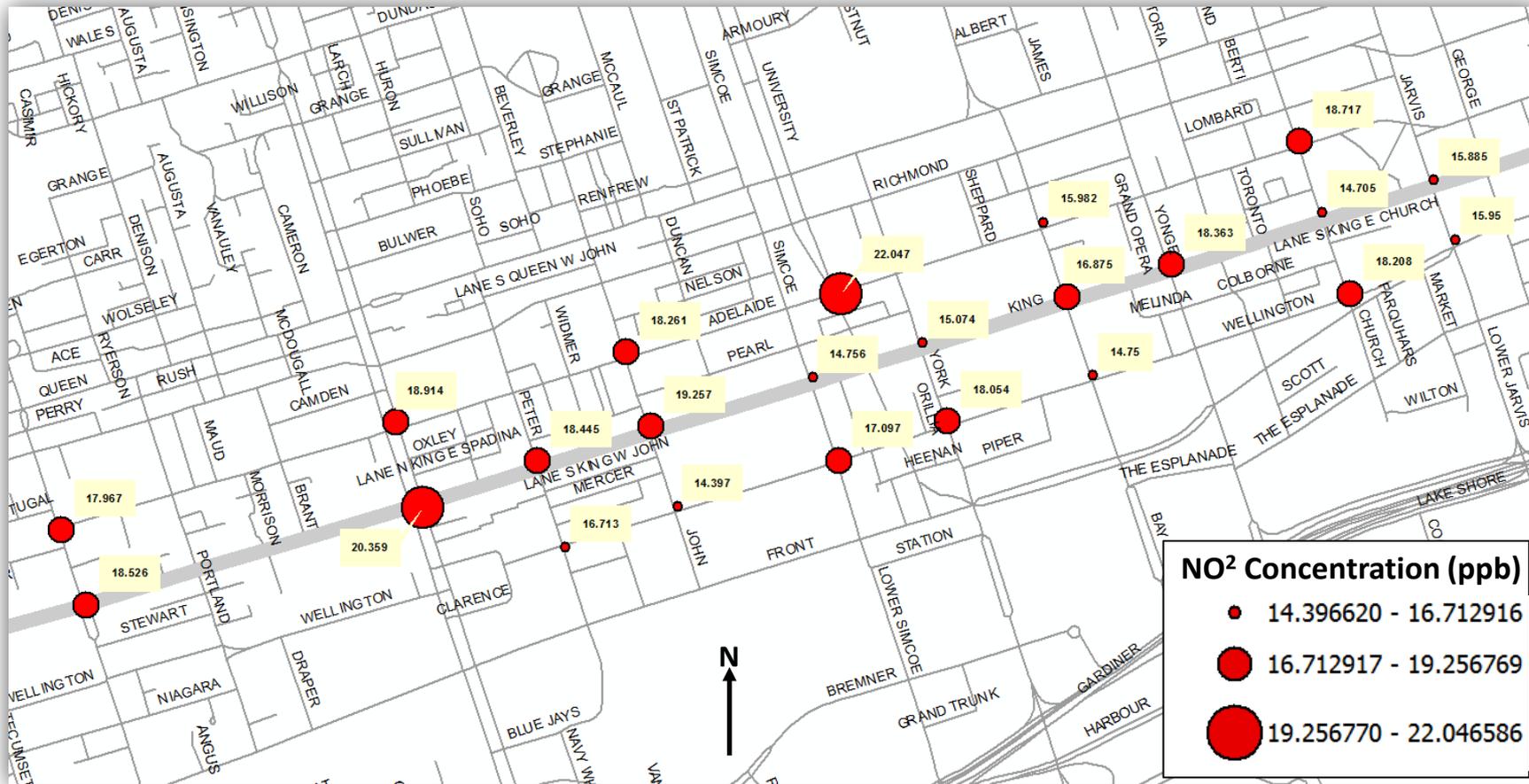
A rich local dataset to explore relationships between transportation planning and multiple health-relevant factors



King Street Pilot Study Pre-Intervention Sample Locations, Toronto, Ontario

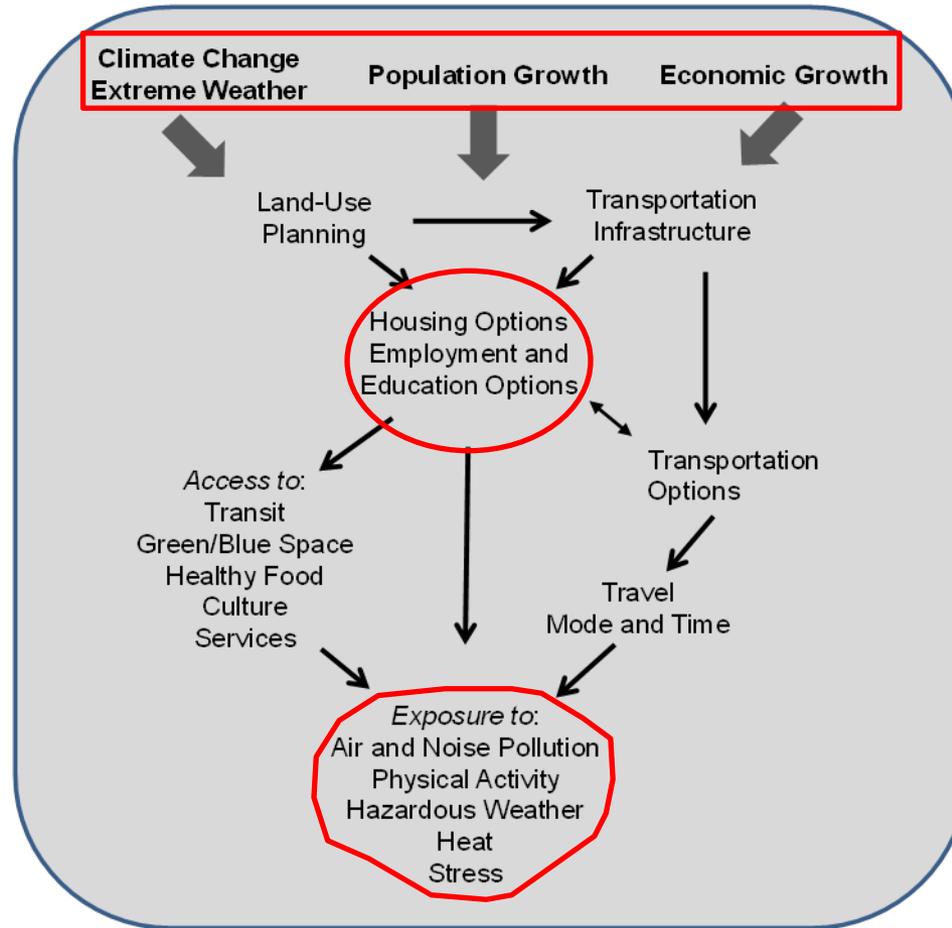


King Street Pilot Study Post-Intervention Sample Locations, Toronto, Ontario



King Street Pilot Study Pre-Intervention NO<sub>2</sub> Concentrations, Toronto, Ontario

# Interactions - Over-Arching Forces



**Over 850,000 Canadians spend more than an hour — each way — getting to work in their cars**



## Average Commute Times



# Can we do something really novel in OHS?

## Transit time/mode and health



- Increased stress
- Increased air pollution exposure
- Less time for physical activity
- Less time for family/social interaction
- Traffic accidents

# ***BIG* Motivating Scientific Questions**

*A career's worth of learning objects*

- **Totality of beneficial and detrimental environmental factors**
  - How much of disease X can be attributed to environment?
- **Individual susceptibility to environmental factors and how the latter influences the former**
  - Is personalized environmental health feasible?
- **Early life or even ancestor environmental exposure importance to lifelong disease trajectories relative to other exposures**
  - How does one's exposome evolve and can it inform early intervention?

# ***BIG* Motivating Scientific Questions**

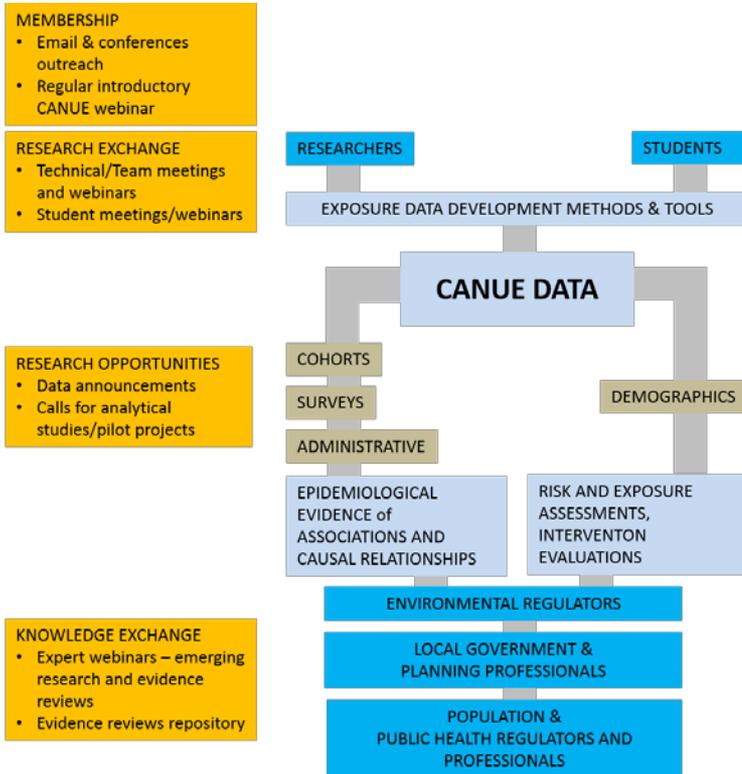
- **How important are urban planning decisions to our health and to public health?**
  - Can this be quantified in a more-integrated manner?
  - Which decisions will have the greatest benefit?
  - Are there plans being developed today and tomorrow that could be modified?



# *BIG* Underlying Hypotheses

- A concerted effort to generate and disseminate environmental exposure data linkable to health data platforms will create research opportunities and the potential for new environmental health discoveries
- These discoveries will lead to new knowledge on human health risks and benefits that will inform future decisions related to urban planning and climate adaptation strategies
- Healthier, more-resilient cities will result in economic benefits for Canadians
- **CANUE has engaged researchers and knowledge-users from across Canada and has now created a platform for access to standard, national-level environmental exposure data**

# KT from CANUE...



## Knowledge Transfer and Exchange now gaining momentum

- Expert webinar series now live
- CANUE members attending conferences
  - Canadian Public Health Association (one symposium)
  - ISES/ISEE (two symposia)

# CANUE's GREAT Staff



Jeff Brook  
Scientific Director



Eleanor Setton  
Managing Director



Evan Seed  
Geospatial Data Lead



Dany Doiron  
Data Linkage Specialist



Mahdi Shooshtari  
Data Scientist/Developer



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[BMC Public Health](#). 2018; 18: 114.  
Published online 2018 Jan 8. doi: [10.1186/s12889-017-5001-5](https://doi.org/10.1186/s12889-017-5001-5)

PMCID: PMC5759244

## The Canadian Urban Environmental Health Research Consortium – a protocol for building a national environmental exposure data platform for integrated analyses of urban form and health

Jeffrey R. Brook,<sup>1,2</sup> Eleanor M. Setton,<sup>3</sup> Evan Seed,<sup>2</sup> Mahdi Shooshtari,<sup>3</sup> Dany Doiron,<sup>4</sup> and CANUE – The Canadian Urban Environmental Health Research Consortium

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