Exploring children's environmental health impacts using PRTR data

Osnat Wine

ChEHC (Children's Environmental Health Clinic), University of Alberta

2014 National Training Conference on the Toxics Release Inventory (TRI) and Environmental Conditions in Communities

Arlington, VA, May 2014

Who we are

- ChEHC- the Children's Environmental Health Clinic
- Dr. Irena Buka, Director
- Dr. Alvaro Osornio-Vargas, Research Director
- In our interdisciplinary work we collaborate with researchers from different disciplines , knowledge users and students

Our Children's Environmental Health research group objectives

Our current interdisciplinary research aims to identify associations between:

- Health outcomes and,
- Environmental variables (social, biological, environmental pollutants)

We explore innovative methods to estimate exposures and possible impacts by investigating different health outcomes, to support new **research towards cause-effect relationships.**

PRTR data, why use it?

- PRTR- Pollutant Release and Transfer Registries
- Currently, more than 50 countries have implemented a PRTR.
- USA(TRI),Canada(NPRI)
- PRTR data, in conjunction with additional information (e.g. pollutant characteristics, census data), can provide starting points in the determination of potential impacts of these releases on human health.

Using PRTR data in the scientific literature

Wine O, Hackett C, Campbell S, Cabrera-Rivera O,
Buka I, Zaiane O, DeVito S., Osornio-Vargas AR

REVIEW

Using pollutant release and transfer register data in human health research: a scoping review

Osnat Wine, Cian Hackett, Sandy Campbell, Orlando Cabrera-Rivera, Irena Buka, Osmar Zaiane, Stephen C. DeVito, and Alvaro Osornio-Vargas

Abstract: Pollutant release and transfer registers (PRTRs) collect and provide information on chemicals released to the environment or otherwise managed as waste. They support the public's right-to-know and provide useful information in gauging performance of facilities, sectors, and governments. The extent to which these data have been used in research, particularly in relation to human health, has not been documented. In this scoping review our objective was to learn from scholarly literature the extent and nature of the use of PRTR data in human health research. We performed literature searches (1994–2011) using various search engines and (or) key words. Articles selected for review were chosen following predefined criteria, to extract and analyze data. One hundred and eighty four papers were identified. Forty investigated possible relations with health outcomes: 33 of them identified positive associations. The rest explored other uses of PRTR data. Papers identified challenges, some imputable to the PRTR. We conclude that PRTR data are useful for research, including health-related studies, and have significant potential for prioritizing research needs that can influence policy, management, and ultimately human health. In spite of their inherent limitations, PRTRs represent a perfectible, unique useful source, whose application to human health research appears to be underutilized. Developing strategies to overcome these limitations could improve data quality and increase its utility in future environmental health research and policy applications.

Wine et al. Environmental Reviews, 2014, 22(1): 41-50

Using PRTR data in the scientific literature

- **Our objective:** Identify and examine the range and nature of the scholarly literature in which the scientific community has used PRTR data (particularly in association with human health outcomes), and evaluate its potential use in environmental health research.

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Using PRTR data in the scientific literature: Results

184 references fit the inclusion criteria were sorted into two groups:

1. Peer-reviewed studies that investigated PRTR data and human health outcomes data.
2. Peer-reviewed studies that investigated PRTR data and any other outcomes, or described other uses of the data.

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Using PRTR data in the scientific literature: Health outcomes publications

- 40 publications were identified between 1997-2011
- Most studies (85%) used the TRI (US) as the PRTR data source.
- Investigated health outcomes were mostly cancer related, exploring both adults and children.
- Most papers (33) identified positive associations between pollutants and negative health outcomes.

Wine et al. Environmental Reviews, 2014

Using PRTR data in the scientific literature: Other Uses

Studies evaluated:

- **Potential risk for human health** (e.g. cancer), and impact on housing market, corporate values, etc.
- **Environmental performance** in response to different policies, public pressure, or changes in management.
- **Accuracy of the data** presented, **trends**, and chemicals' measurements and characteristics (i.e. flow, exposures, risk impact).
- Possible **relationships between emissions** and **socio economical** variables.
- **Awareness** of the public about PRTRs and possible uses by communities.

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Using PRTR data in the scientific literature: Conclusions

- PRTR data are useful for research, including health-related studies.
- The data have significant potential for prioritizing research that can influence public policy, environmental management practices and ultimately human health.
- Although PRTR data have limitations, PRTRs are a unique and useful information source.
- The application to human health and environmental research has not been fully explored.

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PRTR and health outcomes publications 2011-2014(update)

- Several researchers have recently published research using PRTR data to explore health outcomes
- Different PRTRs used (e.g. Spain, USA and Canada)
- Health outcomes include: cancer, autism, mortality, congenital heart disease

Our research group projects:

Current projects link emissions to:

- Cancer
- Heart anomalies
- Gastrointestinal tract conditions
- Socio economic status
- Adverse birth outcomes (data mining)

The use of the NPRI by our Children's Environmental Health research group

- To know **which** hazardous chemicals have been reported as released to air, water and land by industry
- To know **how much** of those chemicals have been released by industry
- To know **where** those chemicals have been released

Which chemicals pose health hazards?

tonnes

HAZARD	Nitrogen oxides	Carbon monoxide	Sulphur dioxide	PM	Volatile Organic Compounds (VOCs)
Carcinogen				1	1
Developmental Toxicity		**1**	**1**	**1**	**1**
Neurotoxicity		1	1		
Reproductive Toxicity		1		1	1
Respiratory Toxicity	**1**	**1**	**1**	**1**	

1 = recognized health hazard

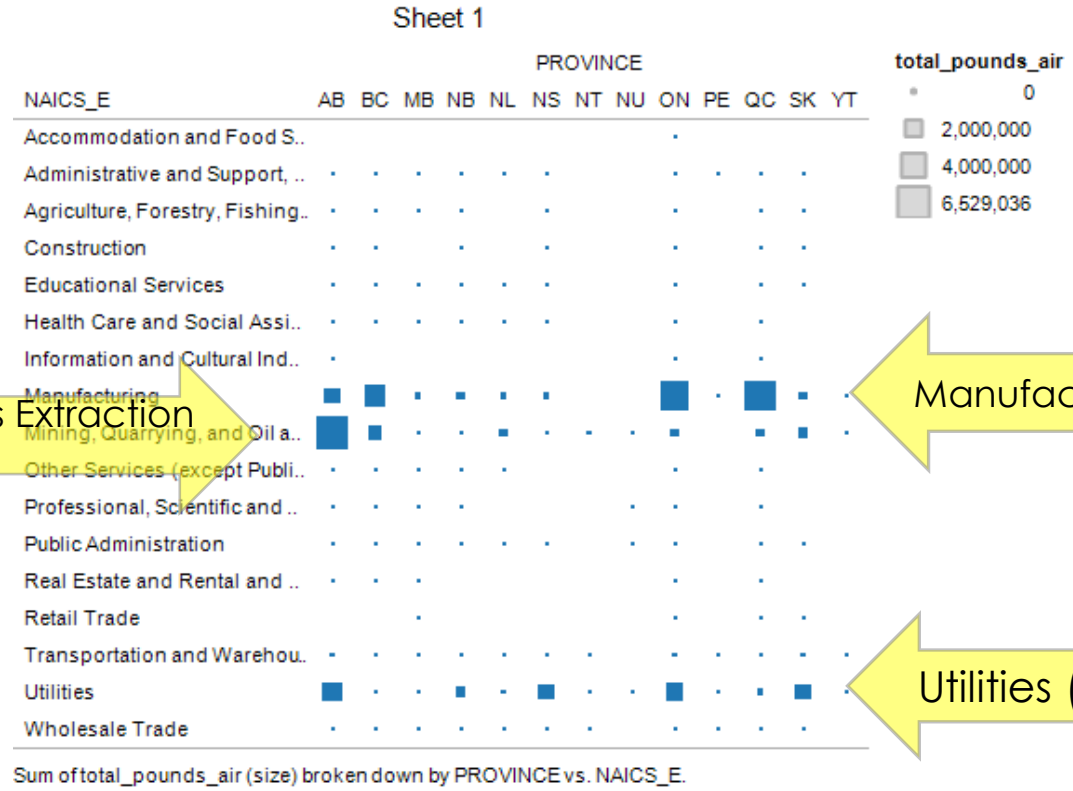
toxicity

HAZARD	Sulphur dioxide	Arsenic (and its compounds)	Cadmium (and its compounds)	Copper (and its compounds)	Lead (and its compounds)	Mercury (and its compounds)
Carcinogen		**1**	**1**		**1**	**1**
Developmental Toxicity	**1**	**1**	**1**		**1**	**1**
Neurotoxicity	**1**	**1**	**1**		**1**	**1**
Reproductive Toxicity		1	1		1	
Respiratory Toxicity	**1**	**1**	**1**	**1**		

1 = recognized effect

Data sources: NPRI , Scorecard
Unpublished results
Prepared by Jesus Serrano

How much chemicals are released? Profiling industrial chemical emissions by industrial sector per province



Mining, and Oil and Gas Extraction (29%)

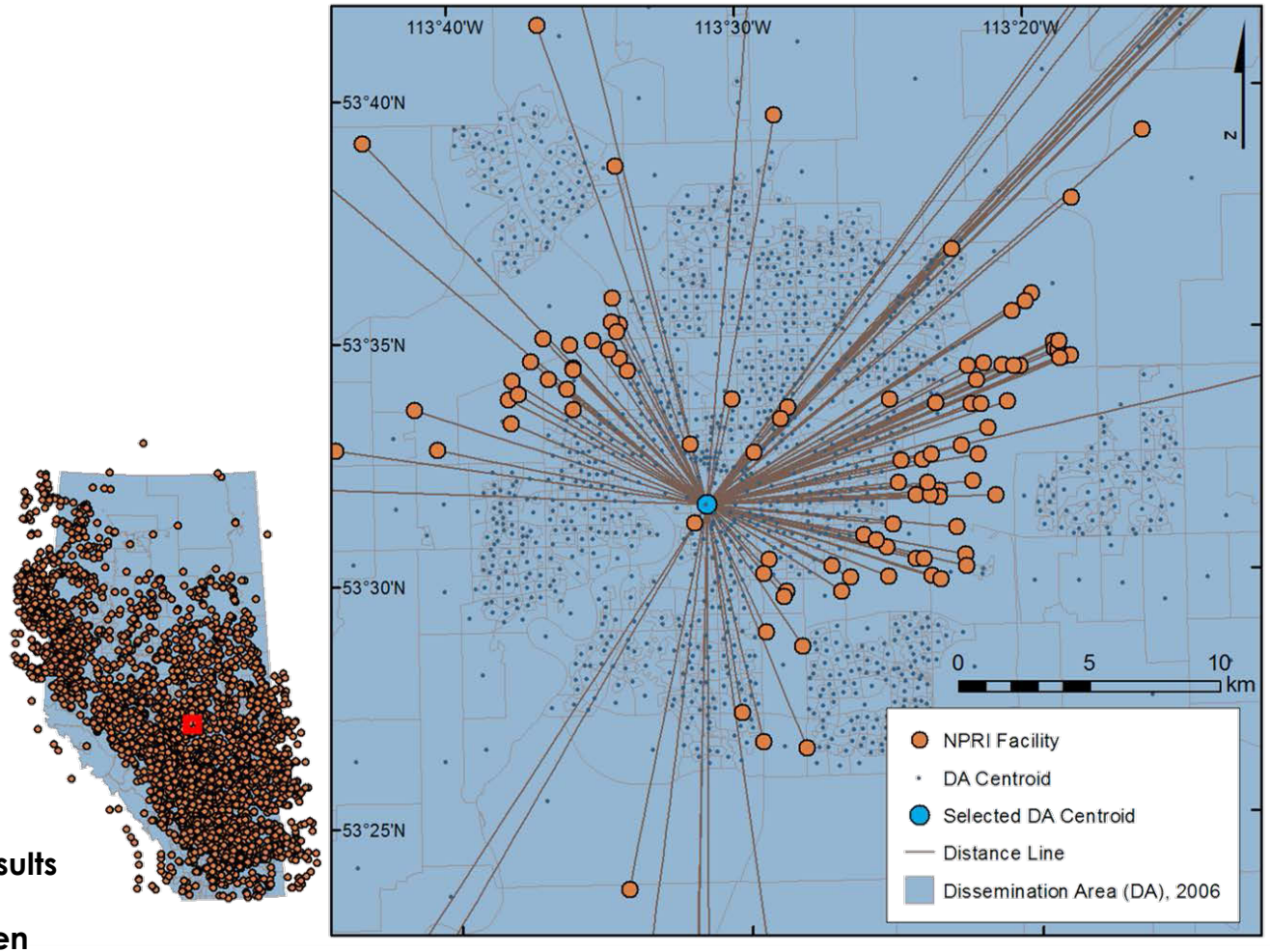
Manufacturing (47%)

Utilities (22%)

Chemicals released to the environment (2002 – 2010)

Unpublished results
Prepared by Jesus Serrano

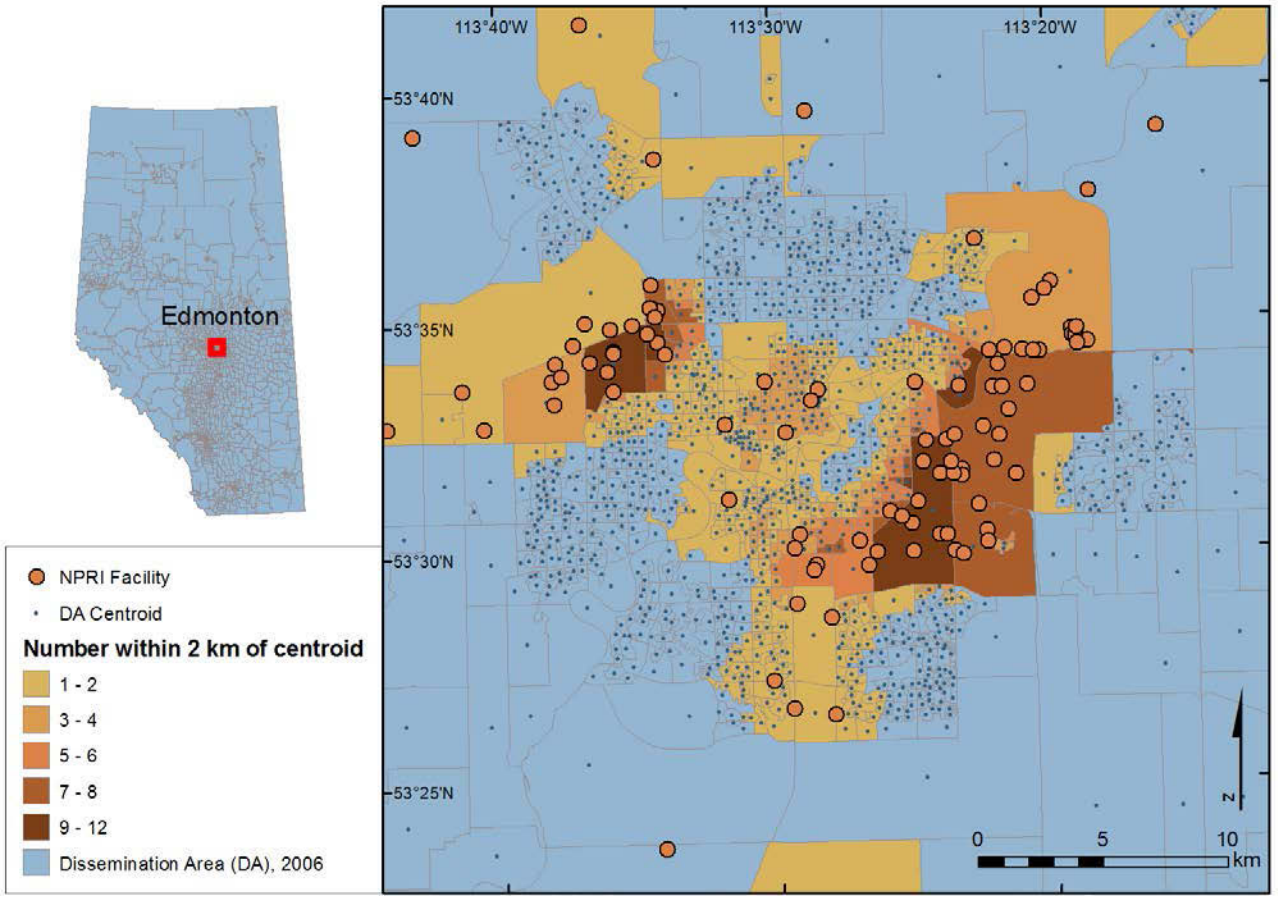
Distance Between DAs and Facilities, Edmonton, Alberta



Unpublished results
Prepared by
Charlene Nielsen

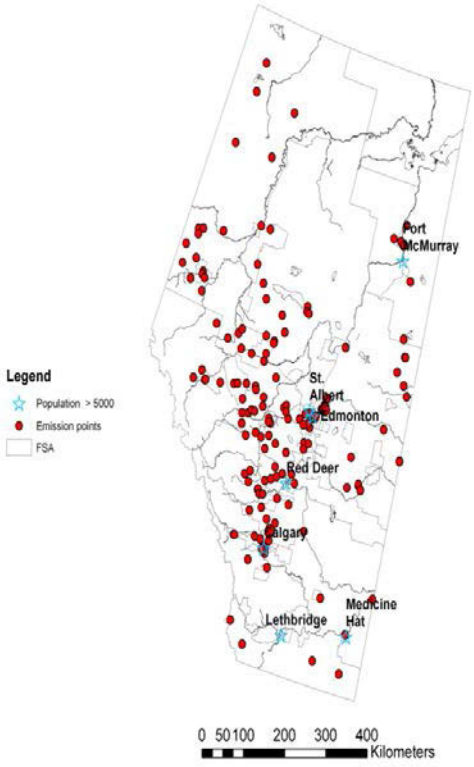
Where chemicals are being released?

Facilities Within 2 km of DA Centroids. Edmonton, Alberta



Unpublished results
Prepared by
Charlene Nielsen

Mapping carcinogens released to the environment

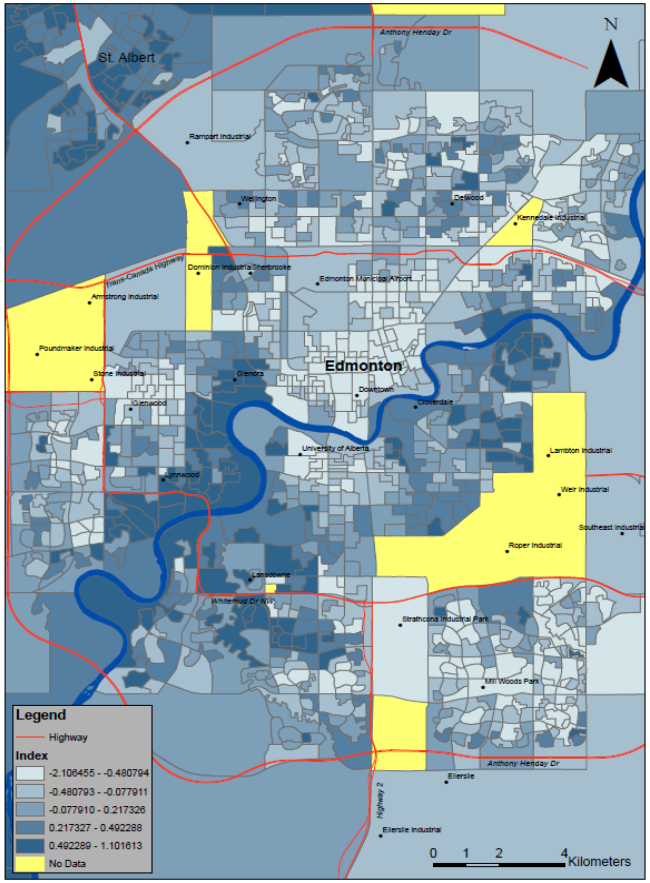


Carcinogen emissions across Alberta (1994-2005)

"Mapping environmental carcinogenic emissions in Canada: a GIS-based framework for supporting multidisciplinary research and surveillance."

Unpublished results
Prepared by Jesus Serrano

Development of Socioeconomic Index for Canada based on Census 2006



Distribution of the socioeconomic index in Edmonton, Alberta

Chan E., Serrano J., Osornio-Vargas A. Development of a Socioeconomic Index for Canada, 2013 (Unpublished results)

DoMiNO: Data Mining and Newborn outcomes Project

Spatial data mining exploring colocation of adverse birth(ABO) outcomes and environmental variables

- Current research identifies associations between ABO and various determinants of health and air pollution.
- This a complex problem:
  - multiple sources of pollution
  - chemical interactions and dispersion
  - interactions between biological, social, chemical and physical factors
  - etc.

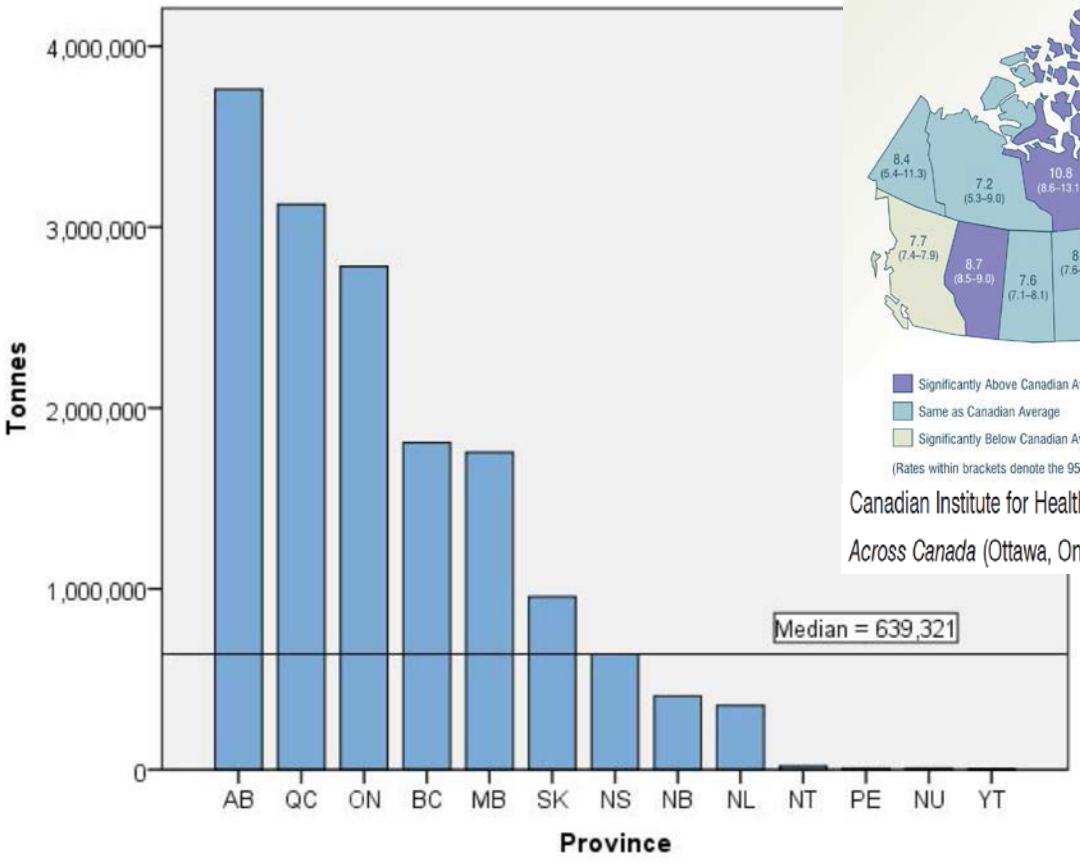
Total amounts of developmental toxicants reported to NPRI 2006-2010 in Canada

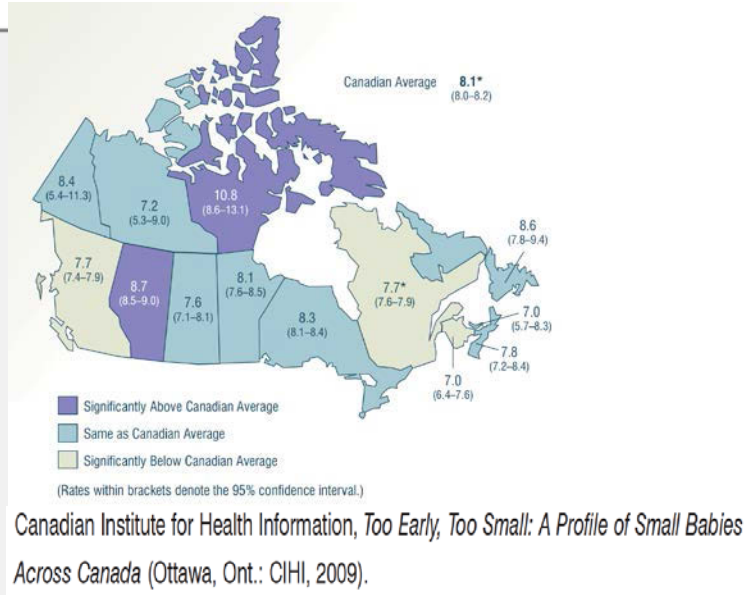
	Chemical name	Tonnes
1	Sulphur dioxide	7,614,400
2	Carbon monoxide	4,744,224
3	Volatile Organic Compounds (VOCs)	1,279,186
4	PM Total Particulate Matter	962,176
5	PM_{10} Particulate Matter ≤ 10 µm	520,352
6	$PM_{2.5}$ Particulate Matter ≤ 2.5 µm	277,572
7	Methanol	69,679
8	n-Hexane	26,108
9	Xylene (all isomers)	25,897
10	Toluene	21,220
11	Hydrogen fluoride	16,984
12	Carbon disulphide	16,377
13	Styrene	9,522
14	Methyl ethyl ketone	8,653
15	Isopropyl alcohol	6,947
16	Acetaldehyde	5,117
17	Ethylbenzene	4,055
18	Benzene	3,257
19	Phenol (and its salts)	3,031
20	2-Butoxyethanol	2,747
21	Chloromethane	2,242
22	Chlorine dioxide	2,118
23	Methyl isobutyl ketone	1,412
24	Trichloroethylene	1,270
25	Lead (and its compounds)	1,144
26	Nickel (and its compounds)	1,131
27	Ethylene glycol	830
28	Acrolein	715
29	N-Methyl-2-pyrrolidone	673
	Total	15,629,039

	Chemical name	Tonnes
30	HCFC-22	487
31	Chloroform	475
32	Naphthalene	449
33	Arsenic (and its compounds)	353
34	Methyl methacrylate	302
35	Acetonitrile	197
36	Tetrachloroethylene	196
37	1,3-Butadiene	193
38	tert-Butyl alcohol	126
39	Cadmium (and its compounds)	121
40	Acrylonitrile	69
41	Butyl benzyl phthalate	47
42	N,N-Dimethylformamide	46
43	Sodium nitrite	45
44	Benzo(a)pyrene - PAH	42
45	Bis(2-ethylhexyl) phthalate	37
46	1,2,4-Trichlorobenzene	27
47	p-Dichlorobenzene	27
48	Ethylene oxide	22
49	Mercury (and its compounds)	22
50	Biphenyl	19
51	Vinyl chloride	10
52	Dibutyl phthalate	7
53	1,2-Dichloroethane	6
54	2-Ethoxyethyl acetate	6
55	Ethylene thiourea	4
56	Bromomethane	1
57	Chlorobenzene	1
58	Ethyl acrylate	1
	Total	3,338
	GRAND TOTAL	15,632,377

Spatial data mining exploring colocation of adverse birth outcomes and environmental variables.
Osornio-Vargas, A.R.

Developmental toxicants emissions (2006-2010) and ABO in Canada

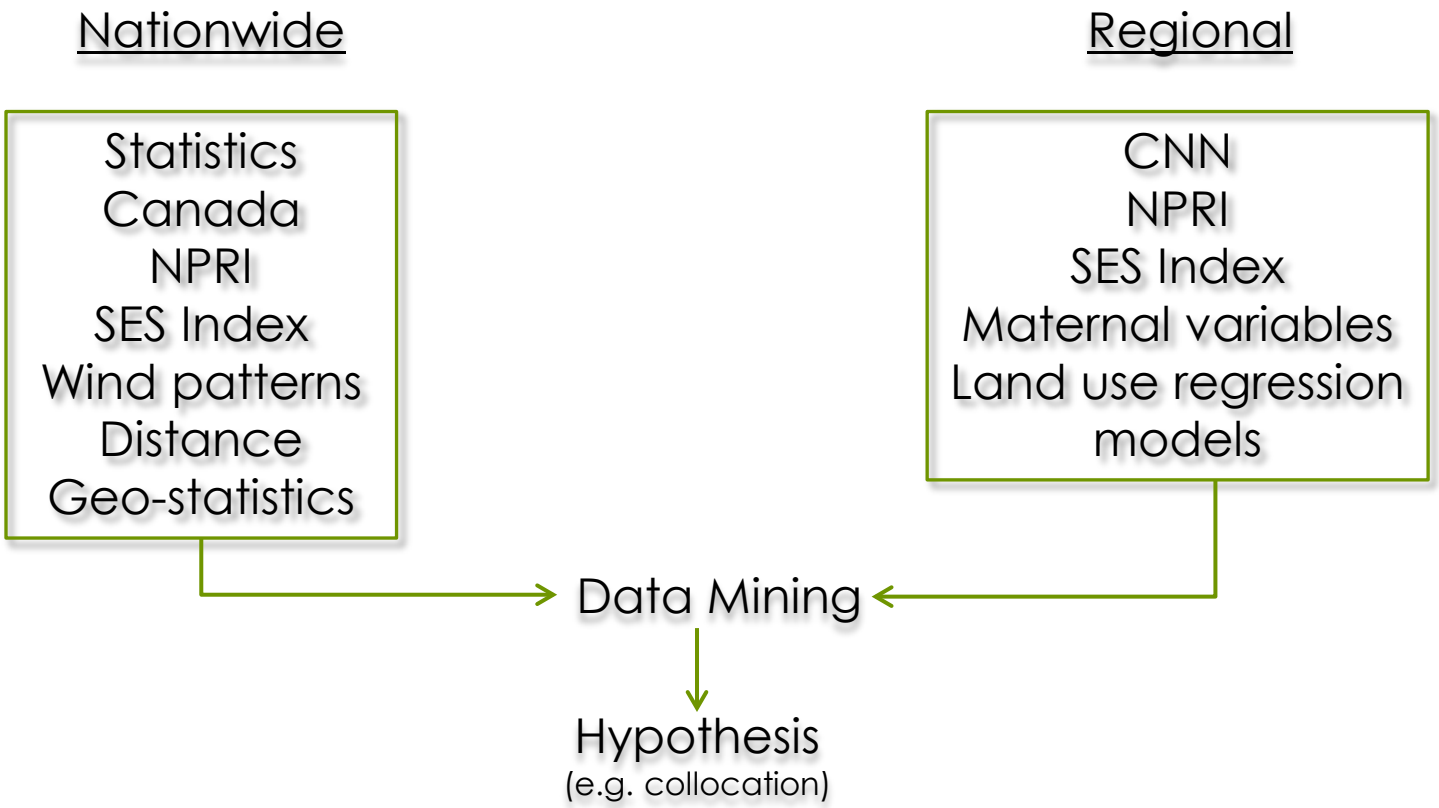




Canadian Institute for Health Information, *Too Early, Too Small: A Profile of Small Babies Across Canada* (Ottawa, Ont.: CIHI, 2009).

Spatial data mining exploring colocation of adverse birth outcomes and environmental variables. *Osornio-Vargas, A.R.*

DoMiNO: Spatial data mining exploring colocation of adverse birth outcomes and environmental variables



Interdisciplinary Research Design

DoMiNO: an Interdisciplinary Team

University of Alberta

Faculty of medicine

- Dr. Osornio-Vargas — Principal Investigator
- Dr. Irena Buka — Children's Environmental Health
- Dr. Khalid Aziz — Neonatology
- Dr. Manoj Kumar — Neonatology
- Dr. Sue Chandra — Perinatology
- Emily Chan — Socio Economic variables
- Osnat Wine — Knowledge Translation

Computing sciences

- Dr. Osmar Zaiane — Principal Investigator
- Jundong Li — Data mining

School of Public Health

- Dr. Sarah Bowen — Knowledge Translation
- Dr. Yan Yuan — Biostatistics
- Jesus Serrano — Data management

Faculty of sciences

- Charlene Nielsen — Geo-statistics

University of Victoria

Interdisciplinary Studies

- Dr. Laura Arbour — Paediatrics and Genetics
- Anders Erickson — Interdisciplinary PhD Student
- Dr. Eleanor Setton Lab/CAREX — Spatial Sciences Research

CAREX

- Dr. Paul Demers — Exposure Assessment

Oregon State University

College of Public Health and Human Sciences

- Dr. Perry Hystad — Land regression

CIHR Maternal –Infant Care (MiCare) Program

- Dr. Prakeshkumar Shah — Neonatology

Carlton University

Health Sciences

- Dr. Paul Villeneuve — Epidemiology

Knowledge Users

Health Canada

- Dr. Dave Stieb — Epidemiology

Alberta Perinatal Health Program

- Nancy Aelicks

Canadian Partnership for Children's Health & Environment

- Erica Phipps

DoMiNO: Integrated Knowledge Translation approach

- Stakeholders or knowledge users are engaged in the entire research project
- Collaborative research
- Action oriented research
- Evaluation of Knowledge translation processes in an interdisciplinary team collaborating with knowledge users in the field of environmental health

Limitations working with PRTR data, identified by the scoping review

- Type, quality and accuracy of the data (the lack of no threshold data, estimation errors, limited number of chemicals, incorrect addresses)
- Change in reporting requirements over time
- Lack of mobile and/or other area specific sources
- Data requires expert interpretation
- Incomparability in reporting requirements among PRTR systems

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Working with the NPRI and other databases

- Identified the year from which the NPRI data has become more stable 2002
- Dealing with confidential data, when using health outcomes databases
- Identified DA as the optimal geographic unit to work with , because of variability in databases
- Calculate distance from cases DA centroid to emitting facilities as a proxy for exposure

Acknowledgments

- Dr. Alvaro Osornio-Vargas
- Funding:
  - Emerging Research Team Grant from the Faculty of Medicine and Dentistry, University of Alberta –Alberta Health Services
  - WCHRI Women and Children Health research Institute, University of Alberta
  - CIHR/ NSERC Collaborative Health Research Program