Exploring children’s environmental health impacts using PRTR data

Osnat Wine

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

Wine et al. Environmental Reviews, 2014
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.

Wine et al. Environmental Reviews, 2014
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.

Wine et al. Environmental Reviews, 2014
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.

Wine et al. Environmental Reviews, 2014
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?

<table>
<thead>
<tr>
<th>HAZARD</th>
<th>Nitrogen oxides</th>
<th>Carbon monoxide</th>
<th>Sulphur dioxide</th>
<th>PM</th>
<th>Volatile Organic Compounds (VOCs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcinogen</td>
<td></td>
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<td>1</td>
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<tr>
<td>Developmental Toxicity</td>
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<td>Neurotoxicity</td>
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<tr>
<td>Reproductive Toxicity</td>
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<tr>
<td>Respiratory Toxicity</td>
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<td><strong>1</strong></td>
<td><strong>1</strong></td>
<td><strong>1</strong></td>
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</tr>
</tbody>
</table>

**toxins**

<table>
<thead>
<tr>
<th>HAZARD</th>
<th>Sulphur dioxide</th>
<th>Arsenic (and its compounds)</th>
<th>Cadmium (and its compounds)</th>
<th>Copper (and its compounds)</th>
<th>Lead (and its compounds)</th>
<th>Mercury (and its compounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcinogen</td>
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<td>1</td>
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<tr>
<td>Developmental Toxicity</td>
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<td>1</td>
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<tr>
<td>Neurotoxicity</td>
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<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>Reproductive Toxicity</td>
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<td>1</td>
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<td>1</td>
</tr>
<tr>
<td>Respiratory Toxicity</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

1 = recognized health hazard

Data sources: NPRI, Scorecard

Unpublished results

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

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

<table>
<thead>
<tr>
<th>Chemical name</th>
<th>Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Sulphur dioxide</td>
<td>7,814,403</td>
</tr>
<tr>
<td>2 Carbon monoxide</td>
<td>4,744,224</td>
</tr>
<tr>
<td>3 Volatile Organic Compounds (VOCs)</td>
<td>1,279,189</td>
</tr>
<tr>
<td>4 PM Total Particulate Matter</td>
<td>962,176</td>
</tr>
<tr>
<td>5 PM&lt;sub&gt;10&lt;/sub&gt; Particulate Matter ≤ 10 µm</td>
<td>520,352</td>
</tr>
<tr>
<td>6 PM&lt;sub&gt;2.5&lt;/sub&gt; Particulate Matter ≤ 2.5 µm</td>
<td>277,572</td>
</tr>
<tr>
<td>7 Methanol</td>
<td>69,879</td>
</tr>
<tr>
<td>8 n-Hexane</td>
<td>28,108</td>
</tr>
<tr>
<td>9 Xylene (all isomers)</td>
<td>25,897</td>
</tr>
<tr>
<td>10 Toluene</td>
<td>21,220</td>
</tr>
<tr>
<td>11 Hydrogen fluoride</td>
<td>16,964</td>
</tr>
<tr>
<td>12 Carbon disulphide</td>
<td>16,377</td>
</tr>
<tr>
<td>13 Styrene</td>
<td>9,522</td>
</tr>
<tr>
<td>14 Methyl ethyl ketone</td>
<td>8,663</td>
</tr>
<tr>
<td>15 Isopropyl alcohol</td>
<td>6,947</td>
</tr>
<tr>
<td>16 Acetaldehyde</td>
<td>5,117</td>
</tr>
<tr>
<td>17 Ethylbenzene</td>
<td>4,055</td>
</tr>
<tr>
<td>18 Benzene</td>
<td>3,257</td>
</tr>
<tr>
<td>19 Phenol (and its salts)</td>
<td>3,031</td>
</tr>
<tr>
<td>20 2-Butoxyethanol</td>
<td>2,747</td>
</tr>
<tr>
<td>21 Chloromethane</td>
<td>2,242</td>
</tr>
<tr>
<td>22 Chlorine dioxide</td>
<td>2,118</td>
</tr>
<tr>
<td>23 Methyl isobutyl ketone</td>
<td>1,412</td>
</tr>
<tr>
<td>24 Trichloroethylene</td>
<td>1,270</td>
</tr>
<tr>
<td>25 Lead (and its compounds)</td>
<td>1,144</td>
</tr>
<tr>
<td>26 Nickel (and its compounds)</td>
<td>1,131</td>
</tr>
<tr>
<td>27 Ethylene glycol</td>
<td>830</td>
</tr>
<tr>
<td>28 Acrolein</td>
<td>715</td>
</tr>
<tr>
<td>29 N-Methyl-2-pyrrolidone</td>
<td>673</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15,629,039</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical name</th>
<th>Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 HCFC-22</td>
<td>487</td>
</tr>
<tr>
<td>31 Chloroform</td>
<td>475</td>
</tr>
<tr>
<td>32 Naphthalene</td>
<td>449</td>
</tr>
<tr>
<td>33 Arsenic (and its compounds)</td>
<td>353</td>
</tr>
<tr>
<td>34 Methyl methacrylate</td>
<td>302</td>
</tr>
<tr>
<td>35 Acetonitrile</td>
<td>197</td>
</tr>
<tr>
<td>36 Tetrachloroethylene</td>
<td>198</td>
</tr>
<tr>
<td>37 1,3-Butadiene</td>
<td>193</td>
</tr>
<tr>
<td>38 tert-Butyl alcohol</td>
<td>126</td>
</tr>
<tr>
<td>39 Cadmium (and its compounds)</td>
<td>121</td>
</tr>
<tr>
<td>40 Acrylonitrile</td>
<td>69</td>
</tr>
<tr>
<td>41 Butyl benzyl phthalate</td>
<td>47</td>
</tr>
<tr>
<td>42 N,N-Dimethylformamide</td>
<td>45</td>
</tr>
<tr>
<td>43 Sodium nitrate</td>
<td>45</td>
</tr>
<tr>
<td>44 Benzol[alpyrene - PAH</td>
<td>42</td>
</tr>
<tr>
<td>45 Bis(2-ethylhexyl) phthalate</td>
<td>37</td>
</tr>
<tr>
<td>46 1,2,4-Trichlorobenzene</td>
<td>27</td>
</tr>
<tr>
<td>47 p-Dichlorobenzene</td>
<td>27</td>
</tr>
<tr>
<td>48 Ethylene oxide</td>
<td>22</td>
</tr>
<tr>
<td>49 Mercury (and its compounds)</td>
<td>22</td>
</tr>
<tr>
<td>50 Biphenyl</td>
<td>19</td>
</tr>
<tr>
<td>51 Vinyl chloride</td>
<td>10</td>
</tr>
<tr>
<td>52 Dibutyl phthalate</td>
<td>7</td>
</tr>
<tr>
<td>53 1,2-Dichloroethane</td>
<td>6</td>
</tr>
<tr>
<td>54 2-Ethoxyethyl acetate</td>
<td>6</td>
</tr>
<tr>
<td>55 Ethylene thiocurea</td>
<td>4</td>
</tr>
<tr>
<td>56 Bromomethane</td>
<td>1</td>
</tr>
<tr>
<td>57 Chlorobenzene</td>
<td>1</td>
</tr>
<tr>
<td>58 Ethyl acrylate</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,338</strong></td>
</tr>
</tbody>
</table>

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

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

Nationwide

- Statistics
- Canada
- NPRI
- SES Index
- Wind patterns
- Distance
- Geo-statistics

Regional

- CNN
- NPRI
- SES Index
- Maternal variables
- Land use regression models

Data Mining

Hypothesis
(e.g. collocation)

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, 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

Wine et al. Environmental Reviews, 2014
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