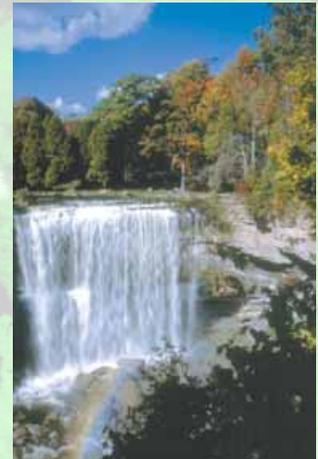


Great Lakes and Human Health

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Outline

- Introduction & Background
- Site-Specific Toxic Effects
- Example: The Aamjiwnaang First Nations Reserve
- Conclusions
 - Emerging Contaminant Issues
 - Other Sources and Pathways
 - Policy Issues



Background

- Increase in release of chemicals
- Ontario with large amounts of releases and transfers of chemicals (2002)
 - Other jurisdictions with large releases include Texas, Ohio, Michigan, Pennsylvania, Indiana
- Greatest volume of carcinogenic pollutants located in Ontario (CEC 2004)

Background (Cont'd)

- An integrated system
- Use of water resources for drinking and recreation
 - Many in Great Lakes basin draw drinking water from the basin; also ground-water for drinking
 - Other uses: sport-fishing & recreation: issue of justice – First Nations and recent immigrants as consumers of Great Lakes fish

Background (Cont'd)

- Surface & groundwater sources increasingly contaminated due to industrial and agricultural activities, including:
 - Direct releases into water
 - Airborne releases deposited to water (up to 90% of some persistent organic pollutants), i.e.:
 - Inorganics
 - heavy metals (cadmium, lead, mercury, chromium, arsenic)
 - PCBs
 - Polycyclic aromatic hydrocarbons (PAHs)

Background (Cont'd)

- Given industrial, energy, commercial, residential, agricultural, and transportation-related structures in the region, there is a significant and cumulative impact on the Basin's population and Great Lakes water quality
- Significant contribution from atmospheric deposition

Background (Cont'd)

- Nearshore areas suffer from particular and disproportionate environmental burden due to their unique and sensitive environments and proximity to development
- Ontario counties with higher pollution output tend to have higher per-capita healthcare expenditures (Jerrett *et al.*, 2001)
- Elliott *et al.*, (2001) – rates of mortality for stomach and esophageal cancers associated with living in Great Lakes border counties

Site-Specific Toxic Effects

❖ Carcinogenic

- ❖ **Recognized:** Aldrin, Chlordane, DDT, Dieldrin, Heptachlor, Mirex, Toxaphene, PCBs, HCB, Dioxins/Furans, Arsenic, Lead, Mercury, Vinyl Chloride, Benzene, Cadmium, Chloroform, Chromium, PBDEs, Benzo(a)pyrene, Uranium, Tritium
- ❖ **Suspected:** PAHs, THMs, Atrazine

Cancer Type	Exposure	Carcinogen	
		Known	Suspected
Lung	Somewhat raises risk	Arsenic Benzo(a)pyrene Bis(Chloromethyl)ether Chromium Nickel subsulfide Zinc Chromate Uranium	Acrylonitrile Beryllium Cadmium 1,2-Dibromo-d-chloropropane PAHs
Prostate	Might raise risk	Cadmium	
Stomach	Might raise risk	Zinc Chromate	Ethylene oxide
Oral/Pharynx	Might raise risk	Zinc Chromate	Tetrachloroethylene
Liver	Might raise risk	Vinyl Chloride	
Bladder	Somewhat raises risk	Benzidine Tetrachloroethylene Cyclophosphamide 4-Aminodiphenyl Chloraphazine	Tetrachloroethylene
Skin		Arsenic Benzo(a)pyrene	PAHs Tetrachloroethylene

Site-Specific Toxic Effects (Cont'd)

❖ Cardiovascular

❖ **Recognized:**

- ❖ **Suspected:** Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Toxaphene, PCBs, HCB, Dioxins/Furans, Arsenic, Lead, Mercury, Vinyl Chloride, Benzene, Cadmium, PAHs, Phosphorous, Chloroform, Uranium

Site-Specific Toxic Effects (Cont'd)

❖ Reproductive

- ❖ **Recognized:** DDT, Lead, Benzene, Cadmium,
- ❖ **Suspected:** Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Toxaphene, PCBs, HCB, Dioxins/Furans, Arsenic, Mercury, Vinyl Chloride, PAHs, Phosphorous, Chloroform, Chromium, Phthlates, Atrazine, Methoxychlor, Uranium

Site-Specific Toxic Effects (Cont'd)

- ❖ Neurotoxic

- ❖ **Recognized:**

- ❖ **Suspected:** Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Toxaphene, HCB, Dioxins/Furans, Arsenic, Lead, Mercury, Vinyl Chloride, Benzene, Cadmium, PAHs, Phosphorous, Chloroform, PBDEs, Atrazine, Methoxychlor, Uranium

Site-Specific Toxic Effects (Cont'd)

- ❖ Immunotoxic
 - ❖ **Recognized:**
 - ❖ **Suspected:** DDT, Dieldrin, HCB, Arsenic, Lead, Mercury, Benzene, Cadmium, PAHs, Chromium, Atrazine, Benzo(a)pyrene

Site-Specific Toxic Effects (Cont'd)

❖ Developmental

- ❖ **Recognized:** DDT, Endrin, Heptachlor, PCBs, HCB, Arsenic, Lead, Mercury, Benzene, Cadmium, PBDEs
- ❖ **Suspected:** Aldrin, Chlordane, Toxaphene, Dioxins/Furans, Vinyl Chloride, PAHs, Chloroform, Phthalates, Benzo(a)pyrene, Methoxychlor

Site-Specific Toxic Effects (Cont'd)

- ❖ Endocrine

- ❖ **Recognized:**

- ❖ **Suspected:** Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Mirex, Toxaphene, PCBs, HCB, Dioxins/Furans, Arsenic, Lead, Mercury, Benzene, Cadmium, PAHs, Chromium, Ethoxylates, PBDEs, Phthalates, Atrazine, Benzo(a)pyrene, Methoxychlor

Example:

The Aamjiwnaang First Nations Reserve

- Mackenzie *et al.* 2005. “Declining Sex Ratio in a First Nations Community”, *Environmental Health Perspectives*
 - Examined relationship between environmental pollutants and sex ratio of Aamjiwnaang First Nations community, adjacent to St. Clair river AoC and Sarnia-Lambton’s ‘Chemical Valley’
 - Decline in live-birth ratio over 20 years
 - Typical: males = 0.512 of live births
 - Reserve: males = 0.348 of live births

Total live births, proportion of live male births (male live births/total live births) for Aamjiwnaang First Nation 1984-2003.

PERIOD	TOTAL LIVE BIRTHS BIRTHS	PROPORTION MALE
5-YEAR		
1984-88	173	0.538
1989-93	185	0.551
1994-98	215	0.451
1999-2003	132	0.348
10-YEAR		
1984-1993	358	0.545
1994-2003	347	0.412

(MacKenzie *et al*, 2005, p.1296)

The Aamjiwnaang First Nations Reserve: (Cont'd)

- Posited connection to environmental pollutants:
 - Soil/sediment sampling revealed high concentrations of PCBs, HCBs, PAHs, Metals (including Mercury), Ethylene, Dioxins, and Vinyl Chloride;
 - Also evidence of changes in the reproductive and sexual development of wildlife in the area.

The Aamjiwnaang First Nations Reserve: (Cont'd)

- “.....although there are several potential factors that could be contributing to the observed decrease in sex ratio of the Aamjiwnaang First Nation, the close proximity of this community to a large aggregation of industries and potential exposures to compounds that may influence sex ratios warrants further assessment into the types of chemical exposures for this population.” (Mackenzie *et al*, 2005:1298)

The Aamjiwnaang First Nations Reserve: Limitations

- Sampling and control group design:
- Sex ratio deviations:
 - Martuzzi *et al.* (2001): Variations due to biologic and socio-economic controls (and not environmental or chemical variables)
 - Biological correction for high prevalence of male births earlier?

The Aamjiwnaang First Nations Reserve: Limitations

- ❑ Sex ratio as a reliable indicator/marker of the reproductive health of a population? (James 1998)
 - ATSDR supports the use of more 'reliable' indicators of environmental pollutants and reproductive health, such as congenital defects and developmental defects

The Aamjiwnaang First Nations Reserve: Limitations

- Causality:
 - Supportive:
 - Ryan *et al.* (2002): Russian pesticide workers: paternal exposure to dioxins
 - Rio Gomez *et al.* (2002): Taiwan oil disaster (1979): paternal exposure before age 20
 - Weisskopf *et al.* (2003): consumption of GLSCF: maternal exposure may reduce sex ratio

The Aamjiwnaang First Nations Reserve: Limitations

- Causality:
 - Unsupportive:
 - Yang *et al.* (2000): air pollution exposure near Taiwan refineries: no effect
 - Vartainen *et al.* (1999): 250 years of Finnish live birth data – chemicalization not responsible for observed trends, with variations in sex ratio before industrialization
 - Figa-Talamanca *et al.*, (2003): No relationship between environmental pollution and sex ratio
 - Biological pathways, assessment of causality, and multi-causality?

Conclusions

- Emergent Contaminant Issues
- Other Sources and Pathways
- Policy Context

1. Emergent Contaminant Issues



- “All things are poison and not without poison; only the dose makes a thing not a poison”
(Paracelsus, 1493-1541)

1. Emergent Contaminant Issues

- Progress in reduction of many persistent organic pollutants, although reduction leveled off in recent years (LaRoe 1995; US EPA 2002).
- Peak concentrations in GL sediments from the 1960s to 1970s.
- Concentrations have declined since these peaks.

1. Emergent Contaminant Issues

- However:

- What do we focus on and what is the process to identify emergent issues? How do we identify relevance (public and policy salience), distribution and persistence, and main health effects?
- Long-term sediment entrapment
- What is 'background' and a 'safe' level of exposure?
- How clean is 'clean'?
- Science of persistent pollutants still being defined (e.g. new PCB congeners)

1. Emergent Contaminant Issues (Cont'd)

- Remaining concerns over unmonitored chemicals including:
 - Pharmaceuticals & personal care products (PPCPs)
 - Flame-retardants (PBDEs)
 - Ethoxylates, phthalates, & disinfectant by-products (DBPs)
 - Synergistic effects
 - Endocrine disrupting
 - High volume chemicals (i.e., biodegradable pesticides)

Pharmaceuticals and Personal Care Products:

- ❑ Ubiquitous & widespread occurrence of low-level concentrations in water through agricultural runoff or domestic and industrial discharges
 - Ability to enter domestic water supply?
 - Health effects from short- and long-term exposure?

Pharmaceuticals and Personal Care Products:

Relevance/Risk	Distribution	Health Effects
<ul style="list-style-type: none">■ Low profile, but ubiquitous & continuous charging	<ul style="list-style-type: none">■ Released during disposal and waste	<ul style="list-style-type: none">■ Low levels■ No conclusive evidence of health links in humans

PDBEs

- Ubiquitous & widespread occurrence
 - Ability to enter domestic water supply?
 - Health effects from short- and long-term exposure?

PDBEs

Relevance/Risk	Distribution	Health Effects
<ul style="list-style-type: none">■ Low profile, but ubiquitous and present in bodies	<ul style="list-style-type: none">■ Not manufactured in Canada, but imported and released during manufacturing, production, and disposal	<ul style="list-style-type: none">■ Recognized carcinogen and thyroid disruptor in animals■ No conclusive evidence of health links in humans

Endocrine-Disrupting Chemicals:

- ❑ Growing list of chemicals (i.e., PCBs, DDT, dieldrin, toxaphene, mirex, HCB, furans, dioxins) & found in the Great Lakes, may interfere with the endocrine system
- ❑ Evidence of increase in some hormonally sensitive carcinomas, decreased sperm count and quality, increased obesity and earlier puberty in girls, and altered physical and mental development in children
- ❑ Increasing scientific evidence, but causal pathways of adverse outcomes unclear

PCBs

Relevance/Risk	Distribution	Health Effects
High	<ul style="list-style-type: none">■ Environmental and biological persistence remains concern■ Decreased consumption through food	<ul style="list-style-type: none">■ Include acne-like skin conditions, & neurobehavioral and immunological changes in children■ Carcinogen in animals

Dioxins/Furans

Relevance/Risk	Distribution	Health Effects
High	<ul style="list-style-type: none">■ Widespread - exposure in some groups exceeds guidelines	<ul style="list-style-type: none">■ Some members are carcinogens■ Suspected endocrine disruptors■ Suspected neurological, developmental, and reproductive toxicants

Synergistic Interactions:

- ❑ In general, there is limited understanding of health impacts due to chemical exposures
 - ATDSR – limited evaluation to 6 common chemicals – broader range?
- ❑ In addition, what has been delineated has been through research that examines exposure effects to single chemicals

1. Emergent Contaminant Issues (Cont'd)

- ❑ Reality is that body burden and exposure consists of many chemicals
- ❑ Little known about interaction effects or cumulative toxicity of chemicals acting together
- ❑ Mixtures could have additive, antagonistic, or synergistic effects
 - Special concern of synergistic effects, where mixtures toxicity is greater than sum of individual toxicities, i.e., asbestos exposure (5x greater risk of lung cancer) and smoking (10x greater risk of lung cancer), but synergistic effect is 80x greater!

2. Other Sources & Pathways

- Tend to focus on water - the water we drink, the food we eat, or the water we swim in can affect our health
- However, needs cannot be prioritized in terms of water quality issues alone – water only one part of equation and can not be seen in isolation from air, land, food pathways, etc. (cross-media transfer).

3. Policy Context

- Research is complex and costly
- Interjurisdictional issues – Federal/Provincial, Canada/US
- Politicization of pollution

3. Policy Context

- What are the emerging and important of chemicals of concern?
 - How do we identify relevance (public and policy salience), distribution and persistence, and main health effects?