Special challenges for public health with climate change and aging populations: Waterborne illness

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What I will talk about

Threats to drinking water resources with Climate Change

- Sea level rise
- Extreme weather events
- Snow, ice and storage capacity

Human health impacts

- What is needed for increased adaptive capacity?
- Who and where are our vulnerable populations?
Potential Health Effects of Climate Change in B.C.

- Increase in heat stress events
- Increase in ozone and other air pollutants
- Drying of woodlands and increase in forest and range fires
- Shifting infectious disease patterns
  - Vector borne: e.g. Lyme dz., West Nile and Hanta virus
- Water borne diseases
- Migration from warmer climes
Increased water stress due to climate change in B.C.

- Increase in extreme weather events
- Reduced glacial and snow-melt storage
  - Reduced drinking water storage
  - Reduced hydroelectric and irrigation water
  - Threats to river biology
- Sea-Level Rise
  - Salt water intrusion into freshwater supplies
  - Coastal land instability
  - Changes in shellfish and coastal food supplies
Expect Regional Precipitation Changes

Number of natural catastrophes 1980-2010

- Geophysical events: Earthquake, volcanic eruption
- Meteorological events: Tropical storm, winter storm, severe weather, hail, tornado, local storms
- Hydrological events: Flash flood, river flood, storm surge, mass movement (landslide)
- Climatological events: Heatwave, freeze, wildland fire, drought

Source: Munich Re - Topics Geo 2010
Reduction in glacial surface area in BC and Alberta from 1985 to 2005

Time Series of Mean Sea Level Rise from 1980-1999 mean

IPCC 2007
Waterborne gastro-intestinal illness, already a priority public health concern, is expected to increase under climate change conditions

- Currently 2.2 million annual deaths globally, mostly children in developing countries.
- In (over) developed nations, gastrointestinal illness leads to significant morbidity, days of worked missed, and health system burden with elderly particularly vulnerable, particularly with hospitalizations and mortality.
- In BC, annual economic burden is estimated at CAN$514.2 million (Henson, 2008)
Limited evidence base on risk of waterborne illness in elderly

percent increase in hospitalizations for diarrhea with an interquartile range increase in municipal water turbidity

Why a higher risk of serious diarrheal disease in ages 60 + ?

- Cryptosporidium, a major waterborne hazard has a shorter incubation period in older persons.
- Secondary, person-to-person transmission appears to be greater in elderly, particularly institutionalized elderly.
- Reduced immune response to infectious organisms.
- Reduced mobility, thirst response, likelihood to rehydrate and access needed medical care.
- Reduced response to boil water advisories.
Boil Water Advisories

In 2008, there were more than 1760 boil-water advisories in effect in communities across Canada.

"Advisories are intended to be a precautionary measure in the public health tool kit, but given that some have been in place for at least 5 years, they are apparently being used as a band-aid substitute for treatment" (Eggertson, 2008)
Waterborne illness in a BC township effected by water source 1996-2006


<table>
<thead>
<tr>
<th>Combined Average illness rate per 100,000</th>
<th>Municipal GW</th>
<th>Municipal GW + surface</th>
<th>Private well</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>16</td>
<td>37</td>
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</table>
Drinking water and Human Health With a Changing Climate

Water quantity  Water quality  Sustainable access

Safe drinking water  Climate change and variability

What will be the impacts on elder health and well-being?
Seasonality:

*Every disease occurs at any season of the year but some of them more frequently occur and are of greater severity at certain times.*

*(Hippocrates. Aphorisms, III, 19)*

- Changes in geographic distribution and seasonality of infectious disease is likely to be among the first identifiable associations between climate change and health (WHO, 2003)

- Numerous studies have documented seasonal variability in GI illness rates
  - Commonly see peak in warm summer months for bacterial and in early fall for protozoan (Naumova, 2007)
Precipitation:

- Considerable anecdotal evidence suggesting that precipitation plays a role in the risk of illness (e.g. Walkerton)
- Relationship between precipitation and GI illness has proven challenging to quantify
- Studies have shown that extreme precipitation events are associated with water-borne outbreaks
  - In the US, fifty-one percent of waterborne outbreaks between 1948 through 1998 were preceded by precipitation events above the 90th percentile and 68% by events above the 80th percentile (Curreiro, 2001).
Drinking water and Human Health With a Changing Climate in BC

Study Title: Water Quality and Human Health in a Changing Climate: Gastro-intestinal Illness in Small Communities in BC

Overarching Goal: Examine potential impacts of future climate change on the risk of waterborne GI illness in small BC communities

Specific aims include:
1. To describe the temporal and spatial distribution of GI illness;
2. To examine and quantify the association between weather events and the risk of GI illness;
3. To establish linkages between characteristics of the aquifer and the drinking water system and the vulnerability for pathogens in water supplies and;
4. To describe the links between water quality, human health, and expected climate change in the context of small BC communities
Drinking water and Human Health
With a Changing Climate in BC

[Diagram showing the relationship between heavy precipitation, dry period + heavy precipitation, temperature, snow melt, aquifer and water system vulnerability and water contamination, leading to increased risk of sporadic waterborne GI illness and waterborne GI outbreaks.]
Drinking water and Human Health
With a Changing Climate in BC

8 Study communities:
• Combination of water supply and rain regimes
• Geographic distribution across provinces
Drinking water and Human Health
With a Changing Climate in BC

**Outcome**

Sporadic GI illness
- Laboratory confirmed cases for 5 types GI illness
- 1998-2010 time series
- Relevant demographic variables linked to cases (i.e. gender, age)
- Source: data from iPHIS (integrated Public Health Information System) managed by the BCCDC.

**Predictors**

- *Weather variables*: Daily precipitation, snow depth, rain, snow, Temperature
- *Water source*: Groundwater, surface water
- *Water supply*: Municipal system/ private system
- *Water system characteristics*: Size, treatment, water shed protection and hydrogeology
Waterborne disease rates by age in eight BC study communities

Cumulative Incidence by Study Community
1999-2010
Waterborne disease rates by age in eight BC study communities

Cumulative Incidence Rate of GI Illness Across Age categories 1999-2010

11 year cumulative incidence rate (per 10,000)

- Male
- Female
Waterborne disease rates by age in eight BC study communities

Cumulative Incidence Rate by Community Water Source Across Age Categories 1999-2010

11-year cumulative incidence rate (per 10,000)

- Groundwater
- Mixed Water
- Surface Water
Drinking water and Human Health
With a Changing Climate in BC

Exploratory analyses: Seasonality…
Future research needs related to resilience in older populations

• What are characteristics of extreme weather events that increase drinking water hazards?
• What are water system characteristics that increase vulnerability to extreme events?
• When waterborne hazards increase, what interventions are effective at reducing health risk?
• Can such interventions be targeted to the vulnerable (isolated) elderly population?
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Our extended forecast includes global warming & the catastrophic end of the human race. But for the weekend, it's looking like sunny skies, mild temperatures, & a general apathy toward environmental concerns.

Back to you, Jim.
Absorbing capacity

- The ability to absorb the free energy of an event without sustaining damage
  - Levees
  - Building codes
  - Reforestation
  - Boarding windows
  - Bomb shelters
  - Bullet proof vests
  - Armor
  - Air bags

- *Mitigation* is anything done to increase absorbing capacity

Courtesy: Marvin Birnbaum
The Precautionary Principle

“When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.”

- The Wingspread Statement, Racine, WI 1998

“If you say nothing until you have high confidence and solid evidence, you’re failing society.”

-Stephen Schneider, Stanford Univ. 2009
Science Magazine Comments on US Position Following Rejection of Kyoto

“We are now undertaking a vast experiment with the earth’s climate. We’re not doing it to test a hypothesis or achieve a result, and it doesn’t have a design. We’re doing it because we can’t help it.”

-Donald Kennedy, Editor 2002
Climate Change and Human Health: The Limits of our Thinking

- Highly technical and complex
- Beyond anyone’s experience
- Misinformation actively disseminated
- Resistance to necessary behavioral changes.
Buffering Capacity

- The ability of a society to cope with damage and to function despite damage
- The ability to maintain essential functions for a change in available resources
  - Backup Generators
  - Alternate sources of fuel
  - Shelters
  - Cross-trained personnel
  - Wells / rain water

Courtesy: Marvin Birnbaum
WHO Assessment
Burden of Disease Due to Climate Change

• Global climate change since mid-1970s could be cause of over 150,000 deaths/yr.
• And 5 Million Disability Adjusted Life-yrs lost.

Due largely to:
  – Diarrheal disease (temp effects only)
  – Malaria
  – Malnutrition
  – Also, CVD, flooding, NOT direct heat related deaths

McMichael et al. in Comparative Quantification of Health Risks: WHO 2004