Climate Change in the PNW and Implications for Public Health

Children's Environmental Health Working Group
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The Climate Impacts Group

An interdisciplinary team based at UW studying climate impacts in the Pacific Northwest since 1995

Areas of study:
- Water resources
- Salmon
- Forests
- Coasts
- (Agriculture, Human Health)

Objectives
- Increase regional resilience to climate variability and change
- Produce science accessible to (and useful for!) the decision making community
Projected Increases in PNW Temp

Data source: Abatzoglou (2013)
Extreme Temperature Projections

Increase in number of heat waves (3+ days of HUMIDEX > 32°C) from historical levels to mid 21st century.

Number of days > 95°F increases from less than 3 days to upwards of 10 days by mid century.*

Increase in nighttime heat waves (Tmin > 90th percentile) from historical levels to mid 21st century.

Salatthe 2010, *Kunkel 2013
Projected Changes Annual Precipitation

Small changes in annual precipitation (-5% to +10 %)

Data source: Abatzoglou (2013)
Some models show large seasonal changes

Most indicate drier summers and wetter winters, springs and autumns

Data source: Abatzoglou (2013)
Extreme Precipitation Projections

Increases in the maximum daily precipitation event averaged over 30-year periods: historical (1970 – 1999) vs. future (2030 – 2069)

Salathé et al. 2014
Schematic of a Cool Climate Flood

- Snow
- Snowpack
- Runoff
- Freezing Level
Schematic of a Warm Climate Flood

- Snowfall
- Rainfall
- Freezing Level
- Runoff
- Snowpack
Increased Drought Risk

Ratio of Low Flow (7Q10) Statistics
(21st Century ÷ 20th Century)

A1B

2020s

2040s

2080s

Tohver et al. 2014
Increased Wildfire Frequency

Littell et al. 2010
Projected Global Sea Level Rise

Key contributors to Global SLR

- Ocean has absorbed ~80% of warming associated with rising GHGs in last 50 years
- Thermal expansion – Water expands when warmed
- Melting of glaciers and land-based ice sheets – particularly Greenland and Antarctica since 1990s

Image source: IPCC 2013
WA/OR Sea Level Rise Estimates

Key contributors to regional SLR:

- Local tectonic processes (*subsidence and uplift*)
- Atmospheric dynamics, i.e., wind-driven “pile-up” of waves along the coast

National Research Council, 2012
Implications for Public Health

Vulnerable populations:

- Young children & infants
- Elderly people
- People with compromised immune systems
- Mentally ill populations
- Urban poor, racial/ethnic minorities, the socially-isolated
- Subsistence farmers
- Coastal populations
Impact Pathways for Public Health

Extreme Events (Flood, Storm Surge, Drought)
Warmer Temperatures (Heat stress)
Air Quality (Increased ground-level ozone)
Water Quality
Infectious Diseases
Societal Disruptions
Impact Pathways: Extreme Events

More Frequent Floods
- Injuries and death
- Exposure to hazardous and toxic substances released and spread by flooding,
- Respiratory illness from mold and microbial growth in flood-impacted structures

More Frequent Dry Spells
- More intense/frequent forest fires
- Reduced agricultural production
- Reduced energy and water supplies in summer

Sea Level Rise and Storm Surge
- Flooding of coastal areas
- Saltwater intrusion in aquifers
- Landslides
- Inundation of hazardous sites/sewage systems
Impact Pathways: Warmer Temperatures

Heat and Thermal Stress

- Worsening of existing problems with respiratory illness, cardiovascular disease, and kidney failure
- More heat exhaustion, heart attacks, strokes
- More heat related deaths, although the projected numbers vary widely.

One study for the greater Seattle area projected an additional 157 annual heat-related deaths by 2045 under a moderate (A1B) greenhouse gas emissions scenario.*

Another study projected only an additional 14 annual heat-related deaths in Seattle for approximately the same time period under a very high (A1FI) emissions scenario.#

*Jackson et al. 2010, #Greene et al. 2011
Smoke from the 2012 wildfires in Chelan and Kittitas Counties contributed to an additional 350 hospitalizations for respiratory conditions and 3,400 student absences from school.

*Glen Patrick, Manager of the Environmental Epidemiology, Washington State Dept. of Health

Increased forest fires
- Greater incidence of asthma, bronchitis, and pneumonia hospital admissions
- Missed school/work days

Increased allergen/pollen production
- More severe and longer-lasting allergy symptoms
- More asthma attacks
- Missed school/work days

Greater ground-level ozone production
- Under a high emissions scenario (A2), projections of annual number of additional May-September deaths due to ozone increase from 69 in 1997-2006 to 132 by mid-century in King County, and from 37 (1997-2006) to 74 in Spokane

*Jackson et al. 2010
Impact Pathways: Water Quality

- Increased winter flooding
  - Increased exposure to contaminants spread by flood water
  - Contaminated/disrupted public water supply

- Increased summer drought
  - Decreased water supply
  - Inconsistent groundwater supply

- Increased marine water temperature
  - Models project increased occurrence of Harmful Algal Blooms in the Puget Sound: A. catenella, which paralytic shellfish poisoning, projected to increase by about 13 days by the end of the century under a moderate (A1B) scenario

- Sea level rise
  - Increased salt water intrusion in freshwater supplies and agricultural floodplains
Impact Pathways: Infectious Diseases

Vector-borne diseases

West Nile appeared in WA State in 2006 with 3 reported cases (2005 was an El Niño year)

Water-borne diseases

Diarrhetic Shellfish Poisoning (DSP) and *Vibrio parahaemolyticus* cases concurrent with toxic algal blooms during episodes of warmer ocean temperatures (also linked to increased run-off)

Cases of Campylobacteriosis (*Campylobacter jejuni*) and E. coli (*Escherichia coli*) poisoning frequently reported after flood waters contaminated drinking water

The impact of climate change on Lyme disease, hantavirus, malaria, and dengue in the PNW is unknown.
Impact Pathways: Social Disruptions

Climate-induced migrations

- Higher demand for social services
- Greater energy demand/production
- Overwhelmed emergency management systems
- Lower access to health care
- Poor hit harder
- WA industries at risk: agriculture, energy and forestry
Methods

- Heat day vs. Non-heat day
  - Relative Risk – Poisson regression analysis
  - Top 1% of all days - 99th percentile
- Heat Intensity Effect
  - Time Series Poisson analysis; piece-wise linear fit summary
- Data
  - Mortality: 1980-2010, death certificate data
  - Hospitalizations: 1990-2010, CHARS data
  - Emergency Medical Service Calls: 2007-2012, King County data
- Exposure
  - Humidex: effect of temperature + humidity
King County Heat-Health Risks
All Ages above 99th percentile heat day

KC average 99th percentile day; with humidity = feels-like temp of ~36°C or 97°F humidex
King County Heat-Health Risks

• Mortality effects:
  – All ages for Circulatory (9%), Cerebrovascular (40%), & Accidents (19%)
  – Chronic Renal (900%) 0-4 year age group *very small #s

• Hospitalization effects:
  – All ages for Acute Renal (68%), Chronic Renal (57%) and Natural Heat (244%)
  – Mental Health (318%) 0-4 year age group *very small #s
  – Natural Heat Exposure (399%) 15-44 year age group *small numbers
  – TSA: 15-44 yr age group ↑ 10 & 12% for COPD & Asthma
**EMS – BLS Relative Risk Results – 95th percentile (29.7 °C )**

<table>
<thead>
<tr>
<th>Medical Issue</th>
<th>All Ages</th>
<th>0-4</th>
<th>5-14</th>
<th>15-44</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Causes</td>
<td>1.08 (1.06, 1.09)</td>
<td>1.14 (1.07, 1.21)</td>
<td>1.07 (1, 1.14)</td>
<td>1.11 (1.08, 1.13)</td>
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<tr>
<td>Trauma</td>
<td>1.13 (1.07, 1.18)</td>
<td>1.35 (1.18, 1.54)</td>
<td>1.11 (0.98, 1.25)</td>
<td>1.16 (1.09, 1.23)</td>
</tr>
<tr>
<td>Non-Trauma</td>
<td>1.06 (1.04, 1.08)</td>
<td>1.09 (1, 1.18)</td>
<td>1.04 (0.95, 1.14)</td>
<td>1.09 (1.06, 1.12)</td>
</tr>
<tr>
<td>Neurological</td>
<td>1.03 (1, 1.06)</td>
<td>1 (0.87, 1.15)</td>
<td>0.99 (0.83, 1.17)</td>
<td>1.06 (1, 1.12)</td>
</tr>
<tr>
<td>Heat Illness &amp; Dehydration</td>
<td>3.43 (3.07, 3.84)</td>
<td>3.89 (2.08, 7.29)</td>
<td>4.22 (2.67, 6.69)</td>
<td>4.41 (3.65, 5.32)</td>
</tr>
<tr>
<td>Psychological</td>
<td>1.03 (0.98, 1.08)</td>
<td>1.68 (0.78, 3.6)</td>
<td>0.99 (0.72, 1.34)</td>
<td><strong>1.07 (1.01, 1.14)</strong></td>
</tr>
</tbody>
</table>

Bolded relative risk values are significantly greater than 1 ($p < 0.05$)
Discussion

• Co-health benefits of reducing carbon pollution

• Youth-related research needs:
  – Seasonal allergies
  – Extreme heat - are we ready?
  – Mental health impacts
  – Others???