Climate Change, Water and Public Health

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Climate, Water and Public Health Impacts

- Waterborne Disease
- Water Quality
- Water Quantity
- Drought
- Climate Variability
- Water Reuse
- Infrastructure
- Extremes
Spectrum of Waterborne Disease

- **Acute gastroenteritis**
  - *Cryptosporidium*, toxigenic *E. coli*, *Giardia*, *Shigella*, *Norovirus*, chemicals
- **Skin infections**
  - *Pseudomonas* dermatitis/folliculitis, fungal infections
- **Ear infections** – *Pseudomonas*
- **Eye infections and irritation**
  - *Acanthamoeba keratitis*, *Adenoviruses*
- **Respiratory infections**
  - *Legionella*, *Mycobacterium*, chemicals
- **Neurologic infections** – *Echovirus*, *Naegleria fowleri*
- **Wound infections** – *Vibrios*
- **Hepatitis** – *HAV*
- **Urinary tract infections** – *Pseudomonas*
Number of Outbreaks Associated with Drinking Water, by System Type and Month (N=762),* United States, 1971–2006

*Excludes outbreaks associated with commercially-bottled water (n=11), bulk water (n=1), mixed water systems (n=3), and unknown systems (n=3)

** P for seasonal trend <0.001

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Climate Sensitivity Pattern</th>
<th>Source</th>
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<tbody>
<tr>
<td><em>Salmonella spp.</em></td>
<td>↑ Temp, ↑ Incidence</td>
<td>Kovats et al. 2004; Fleury et al. 2006</td>
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<tr>
<td><em>Vibrio spp.</em></td>
<td>↑ Temp, ↑ environmental prevalence and disease</td>
<td>Lobitz et al. 2000; Pascaul et al. 2000; McLaughlin et al. 2005</td>
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<tr>
<td><em>Leptospira spp.</em></td>
<td>↑ Precip, ↑ Runoff, precedes outbreaks</td>
<td>Trevejo et al. 1998; Morgan et al. 2002</td>
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<tr>
<td>Norovirus</td>
<td>↑ Precip, ↑ Loading, ↑ Disease</td>
<td>Miossec et al. 2000</td>
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<tr>
<td><em>Cryptosporidium spp.</em></td>
<td>↑ Precip, ↑ Loading, ↑ Disease</td>
<td>MacKenzie et al. 1994</td>
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<tr>
<td><em>Giardia</em></td>
<td>↑ Precip, ↑ Loading, ↑ Disease</td>
<td>Atherholt et al. 1998</td>
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<tr>
<td><em>Naegleria fowleri</em></td>
<td>↑ Temp, ↑ environmental prevalence</td>
<td>Wellings et al., 1977; EPA 1979</td>
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<td></td>
<td>↑ Temp, ↑ range expansion</td>
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<td></td>
<td>↑ disease?</td>
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Waterborne Disease and Climate Change

• How will warming temperature and changing precipitation patterns impact waterborne disease?
  – Increased proliferation of pathogens in areas of existing activity?
  – New colonization/range expansions and infections in locations not previously documented?

• How can public health practitioners prepare? What is needed?
  – Research to better understand climate-sensitivity patterns of waterborne disease
  – Analytic and modeling approaches
    • Data (climatic and epidemiologic)
    • Analytic methods and models
    • Appropriate time scales
  – Goal: Development of predictive models and early warning systems for climate-sensitive diseases
Water Availability: Projected Changes in Runoff — 2041–2060

- Census projects 87% of U.S. population growth during 2005–2030 will occur in the West and Southwest
- Competing demands
  - Agricultural
  - Industrial
  - Municipal
  - Ecological
- Lower quality water sources
  - What are the public health, economic, engineering, and water treatment implications?

Sources: USGCRP 2009; Milly et al. 2008
U.S. Census Bureau, 2005
Water Quality

- Warmer ambient temperatures → warmer surface water temperatures → Interactions
  - Lower dissolved oxygen concentration in water → stress on aquatic species
  - Increased evapotranspiration, lower baseflows, increased salinity, concentration of pollutants
  - Increased THM formation, influenced by temperature, bromide, organic matter
  - Increased eutrophication and temperature → algal blooms and toxins
  - Water treatment and distribution system challenges (disinfection, byproducts, regrowth)

- Heavy precipitation events
  - Higher turbidity of source waters → challenges for treatment plants
  - CSOs in urban areas where storm water and wastewater infrastructure co-located
AWWA-CDC Project: Climate Adaptation Strategies

Interviews completed, data analyzed (n=14)

Alaska interviews completed (n=3)
CDC Climate and Water Resources

- CDC Healthy Water Website: [http://www.cdc.gov/healthywater/](http://www.cdc.gov/healthywater/)
- CDC Climate Change Program: [http://www.cdc.gov/climatechange/](http://www.cdc.gov/climatechange/)

Water-related work is conducted across multiple Centers at CDC. [http://www.cdc.gov/healthywater/at_cdc/](http://www.cdc.gov/healthywater/at_cdc/)

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Conceptual Model: Climate Change, Water and Public Health

- Climatic Factors
- Hydrology
- Land Use
- Ecologic Systems
- Political and Economic Systems
- Agent/Host Factors
- Human Behavior
- Disease Ecology

Public Health Impact

Source: Brunkard, 2010