Climate Change and Health: Diverse Pathways of Impact

Mark L. Wilson, Sc.D.
Professor of Epidemiology and of Ecology and Evolutionary Biology
The University of Michigan
Ann Arbor, Michigan, USA
Outline

- Describe the major areas of environment and health impact
- Identify the most vulnerable populations
- Characterize climate-sensitive health outcomes
- Evaluate exacerbated burden of disease
Health Impacts of Climate Change

McMichael et al. 2003a
### Direction and Magnitude of Change of Selected Health Impacts of Climate Change

<table>
<thead>
<tr>
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<th>Negative Impact</th>
<th>Positive Impact</th>
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<tbody>
<tr>
<td><strong>Very High Confidence</strong></td>
<td><em>Malaria: Contraction and expansion, changes in transmission season</em></td>
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<tr>
<td><strong>High Confidence</strong></td>
<td><em>Increase in malnutrition</em></td>
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<td></td>
<td><em>Increase in the number of people suffering from deaths, disease and injuries</em></td>
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<td><em>from extreme weather events</em></td>
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<td><em>Increase in the frequency of cardio-respiratory diseases from changes in air quality</em></td>
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<td><em>Change in the range of infectious disease vectors</em></td>
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<td><em>Reduction of cold-related deaths</em></td>
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<td><strong>Medium Confidence</strong></td>
<td><em>Increase in the burden of diarrheal diseases</em></td>
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(IPCC, 2007a)
Pathways for Weather to Affect Health: Example of Diarrheal Disease

**Distal Causes**

- Temperature
- Humidity
- Precipitation

Living conditions
(water supply and sanitation)

Food sources and hygiene practices

WHO 2009
Multiple Factors Affect Climate-Sensitive Health Outcomes

- Biophysical factors
  - Baseline climate
  - Elevation
  - Natural resources (e.g., water bodies, soil moisture)
- Biological sensitivity
  - Concomitant diseases
  - Acquired immunity
  - Genetic factors
- Socioeconomic status
Intergovernmental Panel on Climate Change 4th Assessment

- Health impacts due to climate change are occurring
  - Impacts unevenly distributed
- Impacts will increase with increasing climate change
  - All regions will be affected
- Mitigation and adaptation needed now
  - Inertia in the climate system means change will continue for decades after successful control of greenhouse emissions
  - Extent of health impacts over next few decades will depend on the design and implementation of effective adaptation measures

WHO 2009
IPCC AR4 Health Impacts of Climate Change

- Emerging evidence of climate change impacts:
  - Altered **geographic distribution** of some vectors
  - Altered **seasonal distribution** of some pollen species
  - Increased risk of **heatwave deaths**
Consequences of Diarrheal Diseases, Malaria, and Malnutrition in Children in Developing Countries

- Diarrheal diseases cause ~2 million deaths annually, most attributable to contaminated water and inadequate sanitation and hygiene.
- Malaria causes 300–500 million infections every year, leading to approximately 1–3 million deaths.
- Malnutrition is an underlying cause of approximately half of the 10.5 million deaths every year in children under five years old.
Childhood Diarrhea (0–4 Years)
Childhood Mortality (0–4 Years)
Total CO₂ Emissions

The United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992, divides countries into Annex I (industrialized countries and countries with economies in transition) and Non-Annex I parties (mostly developing countries). Some of them committed to reduce their greenhouse gas emissions by adopting the Kyoto Protocol (1997).

Data source: Gregg Marland, Tom Boden, Bob Andres, Oak Ridge National Laboratory. Please note that data for Norway is inaccurate.

UNEP 2009

WHO 2009
Health Burden of Climate Change Impacts

Deaths from malaria and dengue fever, diarrhoea, malnutrition, flooding, and (in OECD countries) heatwaves

This map shows estimated mortality (per million people) attributable to climate change by the year 2000. Map is a density-equalizing cartogram in which the sizes of the 14 WHO regions are proportional to the increased mortality.
Economic Co-Benefits of GHG Mitigation on Health

Findings of IPCC AR4

• Health benefits make up between 50% and 400% of carbon mitigation costs

• Benefits range from $7/ton C (USA) to several $100/ton C (China)

WHO 2009
Climate Change is about Children

WHO 2009
And Other Vulnerable Groups
Sum of Years of Life Lost and Years of Life Lived with Disability by Cause and Latitude

Pitcher et al. 2008

WHO 2009
Impacts Depend on Local Context
Possible Impact Scenarios

- Single large-scale disasters
- Repeated smaller disasters
- Continuous temperature increase producing gradual, linear increase in climate-sensitive health outcomes
- Any combination of the above
- Adverse health impacts of mitigation and adaptation measures

WHO 2009
Climate Change
Is Adding More
Energy to the
Atmosphere

http://earthobservatory.nasa.gov

WHO 2009
Heatwave: August 2003

35,000 extra deaths over a two-week period

http://earthobservatory.nasa.gov

WHO 2009
Climate Change and Heatwave Impacts in California

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<tr>
<th>Scenario</th>
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<tbody>
<tr>
<td>Heatwave days (Los Angeles)</td>
<td>4X</td>
<td>6–8X</td>
</tr>
<tr>
<td>Length of heatwave season</td>
<td>5–7 weeks</td>
<td>9–13 weeks</td>
</tr>
<tr>
<td>Heat-related mortality (Los Angeles)</td>
<td>2–3X</td>
<td>5–7X</td>
</tr>
</tbody>
</table>

Hayhoe et al. 2004

WHO 2009
Floods in Europe

1992: 1,346 killed in Tajikistan
1993: 125 died in Yekaterinburg, Russia
1996: 86 died in the Biescas campsite, Spain
1998: 147 died in Sarno, Italy
2002: 120 died in Central Europe

Trends in Disasters over Time

Trends in number of reported events

Much of the increase in the number of hazardous events is probably due to significant improvements in information access and also to population growth, but the number of floods and cyclones being reported is still rising compared to earthquakes. How, we must ask, is global warming affecting the frequency of natural hazards?

All disasters include: drought, earthquake, extreme temperatures, famine, flood, insect infestation, slides, volcanic eruption, wave / surge, wild fires, wind storm.

Earthquakes versus climatic disasters

Floods
Cyclones

WHO 2009
Projected Changes in Ozone and Related Deaths, New York Metro Area

Kinney et al. 2006

WHO 2009
Climate Change Will Affect Flora & Fauna
RR of *Salmonella* increased by 1.2% per degree above - 10°C

RR of *Campylobacter* increased by 2.2% (4.5% in Newfoundland) per degree above - 10°C

RR of *E. coli* increased by 6.0% per degree above - 10°C

Fleury et al. 2006
Modeled geographic limits projected for the establishment of *I. scapularis* ticks, in degree-days above 0°C. Present modeled limits in blue or red (considering Great Lakes cooling effect). Triangles indicate endemic tick populations. Red dotted lines indicated projected change in the modeled geographic limits in three future time periods according to climate change scenarios (Ogden et al., 2005).
Malaria in India

1980 to 2000

2050’s

Bhattacharya et al. 2006

WHO 2009
IPCC AR4 Health Impacts of Climate Change

• Health **co-benefits** from reduced air pollution as a result of actions to reduce greenhouse gas emissions can be substantial and may offset a substantial fraction of mitigation costs

• Actions to reduce methane will decrease global concentrations of surface ozone
IPCC AR4 Health Impacts of Climate Change (cont.)

- **Adaptive capacity** needs to be improved everywhere
  - Even high-income countries not prepared for extreme weather events
- Adverse impacts will be **greatest in low-income countries**
  - Those at greatest risk include the urban poor, the elderly and children, traditional societies, subsistence farmers, and coastal populations
- Economic development is important, but is **insufficient** to protect the world’s population against the health impacts of climate change
  - Critical factors include the **manner in which growth occurs**, the **distribution** of benefits, **public health infrastructure**, and other factors that determine population health
Need for New Knowledge

- Understand **exposure-response relationships** between background climate variation and health outcomes
- Estimate current **health burden** (e.g., annual deaths) attributable to climate change
- Develop **scenario-based modeling** to project health risks
- Assess health harms and benefits of proposed **mitigation and adaptation policy** options
Mauritius and Region

- **Small Island Developing States (SIDS) are disaster prone**
- The most vulnerable people and places live in poverty and inadequate shelter
- Climate-sensitive health outcomes vary in type and degree among different SIDS
- Extreme events and climate variability are exacerbating current burden of disease
Mauritius and Region

http://www.grida.no/publications/other/aeo/?src=/aeo/047.htm
South East Asia Region (SEAR) Shares Similar Vulnerabilities

- 44% of all disasters, globally
- 1996-2005: 57% of people killed globally in natural disasters were from SEAR countries
- Indonesia, 2007: 3 flood events; 4 landslides; 2 tornadoes
- Maldives, May 2007: high tide floods
- Bangladesh November 2007: Super cyclone SIDR: 4,000 dead, millions affected
- Myanmar, May 2008: Cyclone Nargis, 135,000 perish

Photo: http://cache.daylife.com/imageserve/02fAd1d1tWeAW/340x.jpg

WHO 2009
“Adverse health impacts will be greatest in low-income countries. Those at greater risk include, in all countries, the urban poor, the elderly and children, traditional societies, subsistence farmers, and coastal populations (high confidence).” (IPCC AR4, 2007)
Global Warming Impacts on Climate and Risk Factors

- More extreme weather events: storms, cyclones
- Heat waves: more frequent, more intense, and longer
- Air pollution: increase in levels of ground ozone, more allergens
- Disturbed rainfall patterns: more droughts, more extreme precipitation events, floods, and disrupted water supply
- Warmer temperatures: warmer minima
- Sea-level rise: inundation, saltwater intrusion, loss of land

WHO 2009
Climate Change Impacts on Health: Increase in Climate-Sensitive Outcomes

- Injuries, disability, drowning
- Heat stress
- Water- and food-borne diseases
- Malnutrition
- Vector-borne diseases
- Psychological stress

Photo: http://southasia.oneworld.net/ImageCatalog/climate-picture.jpg

WHO 2009
More Injuries, Disabilities, and Drowning from Extreme Weather Events

Photo: ©Abir Abdullah/Still Pictures

Photo: ©Abir Abdullah/Still Pictures

WHO 2009
Adding to the Existing Burden

India: “Super-cyclone” 1999 shattered lives and livelihoods of 12 million people in Orissa

Bangladesh: Cyclone SIDR, 2007

Myanmar: Nargis 2008
Drowning: A Leading Cause of Child Death in Many Asian Countries

- More than 175,000 children and teenagers die from drowning each year.
- Children under the age of 5 years are most at risk.
- Most child drowning events happen in and around the home.

Fatal injury rates per 100,000 children aged 0–17 years in five Asian countries:

- Drowning
- Road traffic injuries
- Suffocation
- Falls
- Animal bites
- Suicide
- Electrocution
- Sharp objects
- Poisoning
- Blunt objects
- Burns
- Falling objects

WHO 2009

* Bangladesh, China (Beijing, Jiangxi), Philippines, Thailand, Viet Nam

World Health Organization, 2008c
More Heat Waves and Heat Strokes

- 2003 Andhra Pradesh, India heat wave, with temperatures of up to 54°C, took a toll of at least 3,000 lives
- The number of heat strokes was not recorded

Refugee Study Centre (RSC), http://www.rsc.ox.ac.uk

WHO 2009
More Respiratory Diseases

Air pollution: Meeting increasing energy demands by greater use of fossil fuels will increase in ground ozone levels and allergens

Photo: © Deb Kushal - UNEP / Still Pictures
More Water-Borne Diseases

• In 2005, diarrhoeal diseases accounted for 20.1% of deaths in children less than five years
Changes in Agriculture = Malnutrition
Malnutrition: First Cause of Childhood Mortality

Proportional mortality among children under five years of age – World 2002
Underweight and Stunting among Children in Bangladesh, 1990 to 2005

Prevalence of underweight and stunting (height-for-age <-2 Z-scores) among children under five years of age in rural Bangladesh, 1990 to 2005

WHO 2009
More and Widespread Vector-Borne Diseases

- Warmer temperatures and disturbed rain patterns could alter the distribution of important disease vectors.
- Combined with altered rainfall patterns, hotter conditions may increase the spread of disease, such as malaria, dengue, and chikungunya, to new areas.

*Aedes aegypti*
Sea Level Rise Risks in South East Asia Region

- IPCC, 2007: “Coastal areas, especially the heavily-populated mega deltas regions in South, East and South East Asia, will be at greatest risk due to increased flooding from the sea and, in some mega deltas, flooding from the rivers”
Sea Level Rise Enhances Cholera Outbreaks

Space.com, 2000

WHO 2009
Sea Level Rise: Bangladesh

Today
Total population: 112 Million
Total land area: 134,000 km²

1.5 m - Impact
Total population affected: 17 Million (15%)
Total land area affected: 22,000 km² (16%)

Source: UNEP/GRID Geneva; University of Dacca; JRC Munich; The World Bank; World Resources Institute, Washington D.C.

WHO 2009
Psychosocial Stress Will Affect the Health of Communities and Individuals
Urgent Action is Needed

Adaptation for health sector: strengthen prevention, surveillance and early warning systems pertaining to climate sensitive diseases

Mitigation for health sector: to promote and support initiatives that protect health by reducing greenhouse gas emissions

WHO 2009
World Health Assembly adopts Global Action Plan, May 2009

- Aim: to scale up WHO's technical assistance to countries to assess and address the implications of climate change for health and health systems. It has four objectives:
  - Encourage advocacy and awareness raising
  - Engage in partnerships with other UN organizations and sectors other than the health sector at national, regional and international levels
  - Promote and support the generation of scientific evidence
  - Strengthen health systems to cope with the health threat posed by climate change, including emergencies related to extreme weather events and sea-level rise.

WHO 2009
Conclusions

- The region has a population that is currently vulnerable to a number of climate sensitive health stressors.
- These stressors are already having a significant adverse health impacts.
- Climate change is likely to increase the risks linked to these stressors, and introduce new sources of risk going forward.
- Without adaptation and mitigation climate change could result in a dramatically increased health burden in the region.

WHO 2009
Discussion

Questions?

Thoughts?

Concerns?

Suggestions?
Acknowledgements

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