Human health morbidity and mortality in high resolution

Kristie L. Ebi, Ph.D., MPH
Professor, Department of Global Health
Department of Environmental and Occupational Health Sciences

AGCI Workshop on
IMPACT RELEVANCE AND USABILITY OF HIGH RESOLUTION CLIMATE MODELING AND DATASETS
For exposed and vulnerable communities, even non-extreme weather and climate events can have extreme impacts

- Africa’s largest recorded cholera outbreak
- over 90,000 affected
- over 4,000 killed
- began following onset of seasonal rains
- vulnerability and exposure increased risk

Case Study: Zimbabwe 2008
Impact of Climate Change on Human Health

- Injuries, fatalities, mental health impacts
- Asthma, cardiovascular disease
- Heat-related illness and death, cardiovascular failure
- Malaria, dengue, encephalitis, hantavirus, Rift Valley fever, Lyme disease, chikungunya, West Nile virus

Extreme Heat
- Rising Temperatures
- More Extreme Weather

Severe Weather
- Air Pollution
- Changes in Vector Ecology

Sea Levels
- RISING CO2 Levels
- Increasing Allergens
- Respiratory allergies, asthma

Water and Food Supply Impacts
- Water Quality Impacts
- Cholera, cryptosporidiosis, campylobacter, leptospirosis, harmful algal blooms

Malnutrition, diarrheal disease
- Environmental Degradation
- Forced migration, civil conflict, mental health impacts

Slide courtesy of Dr. George Luber, CDC
Estimates of mortality due to climate change, 2030s: approximately 250,000 excess deaths/year

WHO 2014
The Midwest was in the midst of an intense and deadly heat wave on this date in 1995. The heat wave claimed nearly 600 lives in Chicago, where temperatures soared to 106 degrees on the 13th. High dew points made the air feel dangerously hotter.
5 July 2015

THE GREAT 2015 HEATWAVE

7 HASN'T HAPPENED SINCE JULY 2009

Consecutive 90°+ Days

- Will exceed all-time record Thursday (10 days)
- 2 weeks of 90°+ Weather!

NO SIMILAR EVENT IN PDX WEATHER HISTORY!

10 July – 12 of past 15 days above 90 degrees
29 June 2015

120-year records broken in multiple communities
Western Wildfires

Active Fires

- 0 to 100 ha
- 101 to 1000 ha
- > 1000 ha

(hectares)
1 ha = 10^4 m^2

Source: Natural Resources Canada
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28 June 2015
<table>
<thead>
<tr>
<th></th>
<th>Aedes aegypti</th>
<th>Aedes albopictus</th>
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<tbody>
<tr>
<td>Yellow fever mosquito</td>
<td>Asian tiger mosquito</td>
<td></td>
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<tr>
<td>Bright silvery lyre-shaped dorsal pattern and white banded legs</td>
<td>Single longitudinal silvery dorsal stripes and white banded legs</td>
<td></td>
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<tr>
<td>Occupies urban areas with or without vegetation</td>
<td>Associated with thickets and arboreal vegetation</td>
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<tr>
<td>Bites, rests, and lays eggs indoors and outdoors</td>
<td>Mostly an outdoor (garden) mosquito</td>
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<tr>
<td>Sneaky biter</td>
<td>Aggressive biter</td>
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<td>High preference for taking blood meals from humans and to a lesser extent from domestic mammals</td>
<td>Bites humans but also a variety of available domestic and wild vertebrates that do not carry the dengue virus, which lowers its capacity to transmit them</td>
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<td>Main dengue vector worldwide</td>
<td>Main dengue vector in some areas, but is mostly a secondary vector</td>
<td></td>
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<td>Major production places are mam-made containers, tree holes, and bamboo internodes holding water</td>
<td>Preference for tree holes and bamboo internodes with water but can also utilize human-made containers for its immature development</td>
<td></td>
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<tr>
<td>Most containers with water used for immature development are within or in close proximity to households</td>
<td>Utilizes water-filled containers around or further away from households</td>
<td></td>
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</tbody>
</table>
Cartogram of 2010 dengue infections

Bhatt et al. 2013
Biophysical influences on dengue ecology showing the interactions between climate variables, vectors, and the virus.
1. Habitat availability for mosquito larvae is influenced by temperature through evaporation and transpiration;
2. And incoming precipitation;
3. Temperature is a major regulator of mosquito development;
4. And of viral replication within infected mosquitoes;
5. And mosquito survival;
6. And the reproductive behavior of mosquitoes;
7. Habitat availability is required for immature mosquito survival;
8. And reproduction of adult mosquitoes;
9. Faster mosquito development will accelerate mosquito reproduction;
10. And increased survival will accelerate mosquito reproduction;
11. Increased mosquito reproduction enhances the likelihood of transmission by increasing the number of blood feedings;
12. Whereas faster viral replication increases transmission by shortening the time for the virus to develop in the mosquito; and
13. Increase survival of the adult mosquito increases the amount of viral replication.
Singapore Dengue Early Warning System

Based on weekly mean temperature and cumulative rainfall

Figure 3. Forecasted dengue cases versus reported dengue cases in 2011–2012. Weekly forecasted dengue cases compared with reported cases during the validation period from 2011 week 1 to 2012 week 16. Epidemic threshold was 191 cases for 2011 and 200 cases for 2012. doi:10.1371/journal.pntd.0001908.g003
Schematic diagram of key requirements for understanding the risks of dengue virus transmission
Airport final destination of international travelers from dengue affected areas

Semenza et al. 2014
Projected dengue distribution 2085
Comparative temperature suitability of Ae. aegypti and Ae. albopictus

Brady et al. 2014
Global hunger map: 2012

840 million undernourished from insufficient calories or protein
1-2 billion undernourished from inadequate micronutrients
• In 2012, 366 million people in 20 countries lived in protracted crisis
  – 129 million were undernourished or 19% of the global total of food-insecure people

• Prevalence of undernourishment in these countries was 39% compared with 15% for the rest of the world

Typology of crises shifted over the past 30 years to more structural, longer-term, and protracted situations resulting from a combination of factors, especially natural disasters and conflicts, with climate change increasingly among the exacerbating factors
Zinc deficiency risk

http://www.izincg.org/
% change in nutrients in elevated (~550 ppm) vs. ambient CO₂

Myers et al. 2014
Absolute % increase in risk of zinc deficiency in response to elevated CO2

Myers et al. 2015