Health Implications of Climate Change: Heat, Extreme Events, and Vector-Borne Diseases

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4\textsuperscript{th} National Climate Assessment

- The 4\textsuperscript{th} National Climate Assessment was released in November 2018
- The National Climate Assessment (NCA) assesses the science of climate change and variability and its impacts across the United States, now and throughout this century.
- The NCA is congressionally mandated and authored by the US Global Change Research Program
- www.nca2018.globalchange.gov
Health in NCA4

- 2 “Health Chapters”
  - Ch. 13: Air Quality
  - Ch. 14: Human Health

- Sectoral and Response chapters that have health content
  - Ch. 10: Agriculture and Rural Communities (KM3)
  - Ch. 11: Urban (KM 1)
  - Ch. 15: Tribes and Indigenous Peoples (KM2)
  - Ch. 16: International Interests (Box 16.1)
  - Ch. 17: Complex Systems (Boxes 17.1, 17.4, 17,5)
  - Ch. 28: Adaptation (KM4)
  - Ch. 29: Mitigation (KM3)

- Regional chapters that have significant health content
  - All of them!!
2016 Climate Health Assessment

Topics Include

1. Introduction to Climate Change and Human Health
2. Temperature-Related Death and Illness
3. Air Quality Impacts
4. Extreme Events
5. Vector-borne Disease
6. Water-Related Illnesses
7. Food Safety, Nutrition, and Distribution
8. Mental Health and Well-Being
9. Populations of Concern

• The 2016 Climate and Health Assessment does not address:
  – Mitigation, adaptation, economic valuation
  – Impacts on and roles of the health sector
  – Research needs

• health2016.globalchange.gov
1 Climate Change and Health

Major U.S. Climate Trends

- **Rising Temperatures**
  U.S. average temperature has increased by 1.3°F to 1.9°F since record keeping began in 1895. Warming has been the greatest in North and West while some parts of the Southeast have experienced little change.

- **Extreme Precipitation**
  Heavy downpours are increasing nationally, especially over the last three to five decades. The largest increases are in the Midwest and Northeast.

- **Wildfires**
  Wildfires in the West start earlier in the spring, last later into the fall, and burn more acreage.

- **Heat Waves**
  Heat waves have become more frequent and intense, especially in the West.

- **Drought**
  Drought has increased in the West. Over the last decade, the Southwest has experienced the most persistent droughts on record.

- **Cold Waves and Winter Storms**
  Cold waves have become less frequent and intense across the Nation. Winter storms have increased in frequency and intensity since the 1950s and their tracks have shifted northward.

- **Floods**
  Floods have been increasing in parts of the Midwest and Northeast.

- ** Hurricanes**
  The intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of the strongest (category 4 and 5) hurricanes, have all increased since the early 1980s.

- **Sea Level**
  Sea levels along the Mid-Atlantic and parts of the Gulf Coast have risen by about 8 inches over the last half century.
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
- Forced migration, civil conflict, mental health impacts
- Respiratory allergies, asthma
- Malnutrition, diarrheal disease
- Cholera, cryptosporidiosis, campylobacter, leptospirosis, harmful algal blooms

Rising Temperatures
- Severe Weather
- Extreme Heat
- Water and Food Supply Impacts
- Malnutrition, diarrheal disease

More Extreme Weather
- Air Pollution
- Changes in Vector Ecology
- Water Quality Impacts
- Cholera, cryptosporidiosis, campylobacter, leptospirosis, harmful algal blooms

Increasing CO2 Levels
- Environmental Degradation
- Increasing Allergens
- Malnutrition, diarrheal disease
- Respiratory allergies, asthma

Slide courtesy of Dr. George Luber, CDC
Key Health Message 1: Climate Change Affects the Health of All Americans

- The health and well-being of Americans are already affected by climate change, with the adverse health consequences projected to worsen with additional climate change.
Key Health Message 2: Exposure and resilience vary across populations and communities

- **Communities of Color**: Some communities of color living in risk-prone areas face cumulative exposure to multiple pollutants.
  - Adaptation plans that consider these communities and improve access to healthcare help address social inequities.
- **Children**: Children have higher risk of heat stroke and illness than adults.
  - Adults can lessen risk by monitoring exertion and hydration.
- **Low Income Communities**: Low income families are at risk of physical and mental illnesses during flooding and in crowded shelter conditions.
- **Older Adults**: Older adults are vulnerable to extreme events that cause power outages or require evacuation.
  - Checking on elderly neighbors and proper emergency communication can save lives.

Comprehensive disaster management can improve resiliency for people with limited resources.
Key Health Message 3: Adaptation reduces risks and improves health

- Proactive adaptation policies and programs reduce the risks and impacts from climate-sensitive health outcomes and from disruptions in healthcare services.
- Additional benefits to health arise from explicitly accounting for climate change risks in infrastructure planning and urban design.
Key Health Message 4: Reducing GHG Emissions Results in Health and Economic Benefits

Projected change in annual extreme temperature mortality 2080-2099
49 cities

Lower Scenario (RCP4.5)

Upper Scenario (RCP8.5)

Change in Mortality Rate
(deaths per 100,000 people)

- 10.1–12.0
- 8.1–10.0
- 6.1–8.0
- 4.1–6.0
- 2.1–4.0
- 0.0–2.0

3,900 additional deaths

9,300 additional deaths
Temperature-Related Death and Illness

- Increase premature heat-related deaths in the summer and decrease cold-related deaths during winter:
  - Decrease in cold-related deaths will not offset increase in heat-related deaths
  - Based on present-day sensitivity

- Small differences result in increased mortality and morbidity
- Population tolerance to extreme heat can increase (acclimatization)
- Some populations at greater risk (e.g., children, elderly, outdoor occupation)
Extreme Weather Events

• Increase in frequency and intensity of extreme events:
  – Death, injury, illness
  – Exacerbation of underlying conditions
  – Pregnancy outcomes
  – Mental health impacts
  – Pre/post health impacts

• Disruption of essential infrastructure impacts access to healthcare and emergency response

• Increase in exposure to coastal flooding

Smith and Katz, 2013
Projected increase in tropical cyclone intensity with accompanying decrease in frequency

Climate Drivers
- Increased sea surface temperatures
  - Higher wind speeds
  - Higher rates of precipitation
- Sea Level Rise
  - Increases storm surge
  - Coastal Flooding

Slide courtesy of Dr. Cecilia Sorensen, U Colorado
Estimating mortality after disasters:

**Direct Mortality** - is a direct result of the forces/energy of the disaster or by the immediate consequences of these forces, such as structural collapse, flying debris, or radiation exposure.

**Indirect Mortality** - death occurs when the unsafe or unhealthy conditions present during any disaster phase (i.e., pre-event, during, or post-event during recovery) contribute to a death.

**Death certificates generally greatly underestimate deaths (both direct and indirect) caused by a disaster event.**
Methods

Figure S1: Barrio Selection

- a) average travel time to population center of 50,000 people
- b) selected barrios

Slide courtesy of Dr. Cecilia Sorensen, U Colorado
Methods

• Composition of household
• Deaths in household
• Causes of death (verbal autopsy)
• Delays in medical care
  • Availability of medical care
  • Delays in transport
  • Lack of medications
• Loss of essential resources
  • Potable water
  • Electricity
  • Communication
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The New York Times | Source: Demographic Registry of Puerto Rico, Health Department of Puerto Rico (causes of death as of May 31) | Note: Percentage change is the number of deaths in September and October 2017 compared with the average of the number of deaths in the same months in 2015 and 2016.
Vector Borne Diseases

Where Zika Virus Is In The Americas

- Countries and territories with CDC travel alerts related to the Zika virus

Zika virus is transmitted:

- **By mosquitos of the Aedes genus**
  - The same mosquitos that spread dengue and chikungunya viruses.

- **From mother to child**
  - It's rare, but a woman infected with Zika can pass the virus to her child during birth, or possibly to the fetus during pregnancy.

- **Possibly through blood or sexual contact**

Source: WHO, CDC
Millions of visitors on ships....
...and by air
Zika risk mapping - importance of human travel
Vector-borne Diseases

- Changes in geographic and seasonal distributions of vectors and associated diseases:
  - Lyme Disease (earlier tick activity and northward range expansion)
  - West Nile Virus (geographic distribution of mosquito, abundance and infection prevalence)
- Emergence/re-emergence of new vector-borne pathogens
- Difficult to model:
  - Complex transmission cycles
  - Social and environmental drivers

Changes in Lyme Disease Case Report Distribution

CDC, 2015
Air Quality Impacts

- Increase in exposure to ozone and associated health impacts
- Increase in frequency and severity of wildfires
- Increase in exposure to aeroallergens
- Impacts on indoor air are not as well studied

Fann et al., 2015
Key Messages for Air Quality

1. Increasing Risks from Air Pollution
2. Increasing Impacts of Wildfires
3. Increases in Airborne Allergen Exposure
4. Co-Benefits of Greenhouse Gas Mitigation
This visualization tool generates interactive graphs and maps showing climate projections and observations for any county in the contiguous United States. You can also explore historical temperature and precipitation observations at hundreds of climate stations, and view observed and projected days of high-tide flooding at more than 90 coastal tide-gauge stations.
Health Case Studies from the Toolkit...

Where Do We Need Shade?
Mapping Urban Heat Islands in Richmond, Virginia

Hospital Plans Ahead for Power, Serves the Community Through Hurricane Sandy

Following a Devastating Tornado, Town and Hospital Rebuild to Harness Wind Energy

Keeping Toxins From Harmful Algal Blooms out of the Food Supply
Some US resources related to resilience

• NIEHS Climate Change Literature Portal
  – http://tools.niehs.nih.gov/climatehealthlit

• NIEHS Climate and Health Educational Materials
  – https://www.niehs.nih.gov/lessonsinclimatechange

• CDC’s BRACE framework and guidance documents
  – http://www.cdc.gov/climateandhealth/default.htm

• 4th National Climate Assessment

• Impacts of Climate Change on Human Health in the United States: A Scientific Assessment

• US Climate Resilience Toolkit
  – https://toolkit.climate.gov/
Thank you for your attention!

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