THE IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN THE UNITED STATES: A SCIENTIFIC ASSESSMENT

Allison Crimmins
U.S. Environmental Protection Agency
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What is the USGCRP Climate and Health Assessment?

• An Interagency product of the US Global Change Research Program (USGCRP)

• Part of the National Climate Assessment (NCA) sustained assessment process and called for under the President’s Climate Action Plan

What is the purpose of the Climate and Health Assessment?

• Enhance understanding about the growing threat climate change poses to the health and well-being of Americans

• Inform decisions made by public health officials, planners, decision makers, and stakeholders
What was the process for development?

- Driven by the USGCRP Interagency Crosscutting Group on Climate Change and Human Health (CCHHG)
- Coordinated by the EPA
- Written by a team of ~100 Federal employees, contractors, and grantees from eight U.S. Federal agencies: HHS (NIH, CDC, NIOSH, ASPR, FDA, SAMHSA), NOAA, EPA, USDA, NASA, USGS, DOD (USUHS), VA
- Extensively reviewed by the public and experts, including a committee of the National Academies of Sciences and the 13 Federal agencies of the USGCRP; draws from a large body of scientific peer-reviewed research
The Climate and Health Assessment is a Highly Influential Scientific Assessment (HISA):

• Synthesizes literature, assesses peer-reviewed science, weighs evidence, and provides confidence levels for key findings
• Advances the science: four chapters highlight new peer-reviewed quantitative analyses of projected health impacts
• Focuses on quantifying, where possible, observed and projected impacts.

The Climate and Health Assessment does not address:

• Mitigation, adaptation, economic valuation, or any policy recommendations.
• Indirect non-climate factors or other compounding, secondary, or cumulative effects of climate change.
• Research needs: though briefly summarized research needs are not described comprehensively.

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Top Line Messages of the Report

• Climate change is a significant threat to the health of the American people.
• Climate change exacerbates some existing health threats and creates new public health challenges.
• This assessment significantly advances what we know about the impacts of climate change on public health, and the confidence with which we know it.
• Every American is vulnerable to the health impacts associated with climate change.
Chapter 1: Introduction: Climate Change and Health

**CLIMATE DRIVERS**
- Increased temperatures
- Precipitation extremes
- Extreme weather events
- Sea level rise

**ENVIRONMENTAL & INSTITUTIONAL CONTEXT**
- Land-use change
- Ecosystem change
- Infrastructure condition
- Geography
- Agricultural production & livestock use

**EXPOSURE PATHWAYS**
- Extreme heat
- Poor air quality
- Reduced food & water quality
- Changes in infectious agents
- Population displacement

**SOCIAL & BEHAVIORAL CONTEXT**
- Age & gender
- Race & ethnicity
- Poverty
- Housing & infrastructure
- Education
- Discrimination
- Access to care & community health infrastructure

**HEALTH OUTCOMES**
- Heat-related illness
- Cardiopulmonary illness
- Food-, water-, & vectorborne disease
- Mental health consequences & stress
Chapter 2: Temperature-Related Death and Illness

Key Finding 1: Future Increases in Temperature-Related Deaths

Based on present-day sensitivity to heat, an increase of thousands to tens of thousands of premature heat-related deaths in the summer are projected each year as a result of climate change by the end of the century.

**KF2:** Even Small Differences from Seasonal Average Temperatures Result in Illness and Death

**KF3:** Changing Tolerance to Extreme Heat

**KF4:** Some Populations at Greater Risk
Chapter 2: Temperature-Related Death and Illness

Research Highlight: Heat and Cold Mortality (Schwartz et al., 2015)

- **Objective**: A quantitative projection of future deaths from heat and cold for 209 U.S. cities with a total population of over 160 million inhabitants.

- **Methods**:
  - RCP6.0; GFDL–CM3, MIROC5
  - 209 Cities (189 million residents, ~60% of US pop)
  - National Center for Health Statistics, all-cause mortality by county based on temperature, minus external causes (same day mortality for warm season, lag 1-5 for cold)

- **Results**: Future warming, without adjustments for adaptation, will lead to an increase in deaths during hotter months and a decrease in deaths during colder months with a total net increase of about 2,000 to 10,000 deaths per year by the end of the century compared to a 1990 baseline.
Key Finding 1: Exacerbated Ozone Health Impacts

Climate change will make it harder to reduce ground-level ozone pollution in the future as air and weather conditions support more ozone formation across most of the US. Unless offset by additional emissions reductions of ozone-producing chemicals, these climate-driven increases in ozone will cause premature deaths, hospital visits, lost school days, and acute respiratory symptoms.

KF2: Increased Health Impacts from Wildfires

KF3: Worsened Allergy and Asthma Conditions
Chapter 3: Air Quality Impacts

Research Highlight: Ozone-Related Health Effects (Fann et al., 2015)

- **Objective**: Project number and distribution of additional ozone-related illnesses and premature deaths in the U.S. due to climate change between 2000 and 2030 under projected air quality policies.

- **Methods**:
  - RCP6.0 and 8.5; GISS-E2, CESM, dynamic downscale
  - ICLUS population data, BenMAP, SES, air condition prevalence, baseline health status data
  - Emissions projections for 2030 and regional chemical transport model simulate changes in ozone used to compute regional health effects

- **Results**: 1°C to 4°C (1.8°F to 7.2°F) increases in average daily maximum temperatures and 1 to 5 parts per billion increases in daily 8-hour maximum ozone in 2030 resulting in tens to thousands of additional ozone-related illnesses and premature deaths per year.

Research Highlight II: Residential Infiltration and Indoor Air (Ilacqua et al., 2015)

Infiltration projected to decrease by ~5%, averaged across cities, seasons, and climate models in 2040-2070. Exposure to indoor pollutants would correspondingly increase, while exposure to outdoor air pollutants would decrease to some extent.
Chapter 4: Extreme Events

**KF1: Increased Exposure to Extreme Events**

**Key Finding 2: Disruption of Essential Infrastructure**

Many types of extreme events related to climate change cause disruption of infrastructure, including power, water, transportation, and communication systems, that are essential to maintaining access to health care and emergency response services and safeguarding human health.

**KF3: Vulnerability to Coastal Flooding**
Chapter 5: Vector-borne Diseases

**KF1:** Changing Distributions of Vectors and Vector-borne Diseases

**Key Finding 2: Earlier Tick Activity and Northward Range Expansion**

*Ticks capable of carrying the bacteria that cause Lyme disease and other pathogens will show earlier seasonal activity and a generally northward expansion in response to increasing temperatures associated with climate change. Longer seasonal activity and expanding geographic range of these ticks will increase the risk of human exposure to ticks.*

**KF3:** Changing Mosquito-borne Disease Dynamics

**KF4:** Emergence of New Vectorborne Pathogens
Objective: Examine impacts of climate change on the timing of the beginning of the annual Lyme disease season (annual onset week) in eastern U.S.

Methods:
- RCP2.6, 4.5, 6.0, 8.5; 5 models
- 12 states where Lyme is prevalent

Results: On average, the start of the Lyme disease season is projected to arrive a few days earlier for 2025–2040 (0.4–0.5 weeks), and approximately one to two weeks earlier for 2065–2080 (0.7–1.9 weeks)

Note: conclusions about the duration of the transmission season or changes in the annual number of new Lyme disease cases cannot be drawn from this study.
Key Finding 1: Seasonal and Geographic Changes in Waterborne Illness Risk

*Increases in water temperatures associated with climate change will change the seasonal windows of growth and the habitat range for freshwater and marine toxin-producing algae as well as certain naturally occurring Vibrio bacteria. These changes will increase the risk of exposure to waterborne pathogens and toxins that can cause a variety of illnesses.*

**KF2:** Runoff from Extreme Precipitation Increases Exposure Risk

**KF3:** Water Infrastructure Failure
Chapter 6: Water-Related Illnesses

Research Highlight: Seasonal Vibrio Abundance and Distribution (Jacobs et al., 2015)

- **Objective:** Projection future shifts in Vibrio seasonal abundance and geographic range.
- **Methods:**
  - RCP6.0; 21 CMIP5 models
  - Chesapeake Bay and Alaskan coast (also Alexandrium bacteria in Puget Sound)
  - GIS mapping of Alaskan coastal waters used to project distribution of monthly average water temperatures exceeding 15°C (minimum temperature favorable for growth)
- **Results:** Habitat availability for Vibrio growth will increase to nearly 60% of the Alaskan shoreline in August by the 2090s.

In Chesapeake Bay, probability of occurrence of V. vulnificus is projected to increase by nearly 16% in the shoulder months of the growing season (May and September), with a similar increase in abundance of V. parahaemolyticus in oysters.

Research Highlight II: Increased Risk of Ciguatera Fish Poisoning (Kibler et al., 2015)

Lower thermal tolerances of some Gambierdiscus species may result in range shifts to more northern latitudes, particularly from the Yucatan and eastern Caribbean Sea, meaning increases of CFP toxins in new areas where waters are warming and potential decreases in existing areas with less rapid warming.
Chapter 7: Food Safety, Nutrition, and Distribution

**KF1:** Increased Risk of Foodborne Illness

**KF2:** Chemical Contaminants in the Food Chain

**Key Finding 3: Rising Carbon Dioxide Lowers Nutritional Value of Food**

The nutritional value of agriculturally important food crops, such as wheat and rice, will decrease as rising levels of atmospheric carbon dioxide continue to reduce the concentrations of protein and essential minerals in most plant species.

**KF4:** Extreme Weather Limits Access to Safe Foods
Chapter 8: Mental Health and Well-Being

**KF1:** Exposure to Disasters Results in Mental Health Consequences

**KF2:** Specific Groups of People Are at Higher Risk

**KF3:** Climate Change Threats Result in Mental Health Consequences and Social Impacts

**Key Finding 4: Extreme Heat Increases Risks for People with Mental Illness**

*People with mental illness are at higher risk for poor physical and mental health due to extreme heat. Increases in extreme heat will increase the risk of disease and death for people with mental illness, including elderly populations and those taking prescription medications that impair the body’s ability to regulate temperature.*
Chapter 9: Populations of Concern

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KF1: Vulnerability Varies Over Time and is Place-Specific

KF2: Health Impacts Vary with Age and Life Stage

Key Finding 3: Social Determinants of Health Interact with Climate Factors to Affect Health Risk

Climate change threatens the health of people and communities by affecting exposure, sensitivity, and adaptive capacity. Social determinants of health, such as those related to socioeconomic factors and health disparities, may amplify, or otherwise influence climate-related health effects, particularly when these factors occur simultaneously or close in time or space.

KF4: Mapping Tools and Vulnerability Indices Identify Climate Health Risks
Allison Crimmins

crimmins.allison@epa.gov

USGCRP resources: health2016.globalchange.gov
EPA resources: www3.epa.gov/climatechange/impacts/health.html