THE IMPACTS OF CLIMATE CHANGE ON

HUMAN HEALTH

IN THE UNITED STATES:

A SCIENTIFIC ASSESSMENT

Allison Crimmins

U.S. Environmental Protection Agency

HEI– 05/01/16

U.S. Global Change Research Program

Health2016.globalchange.gov

USGCRP Climate and Health Assessment

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

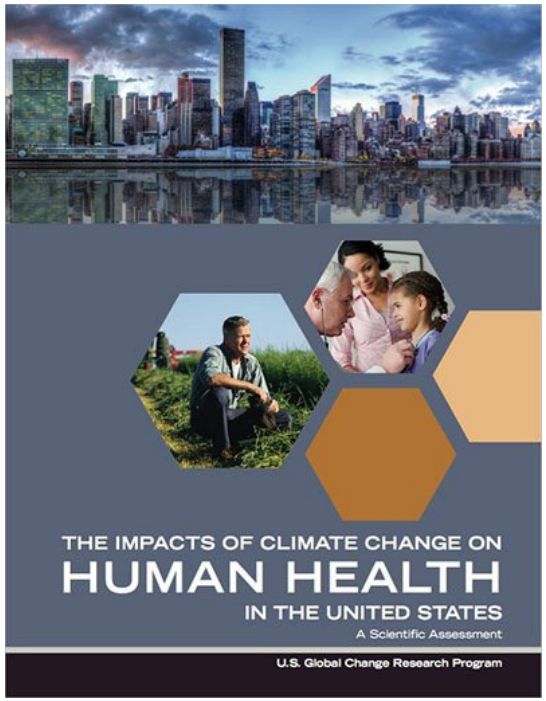
What is the purpose of the Climate and Health Assessment?

- 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

Process and People

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



Health2016.globalchange.gov

Scope

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 <u>does not address</u>:

- 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.

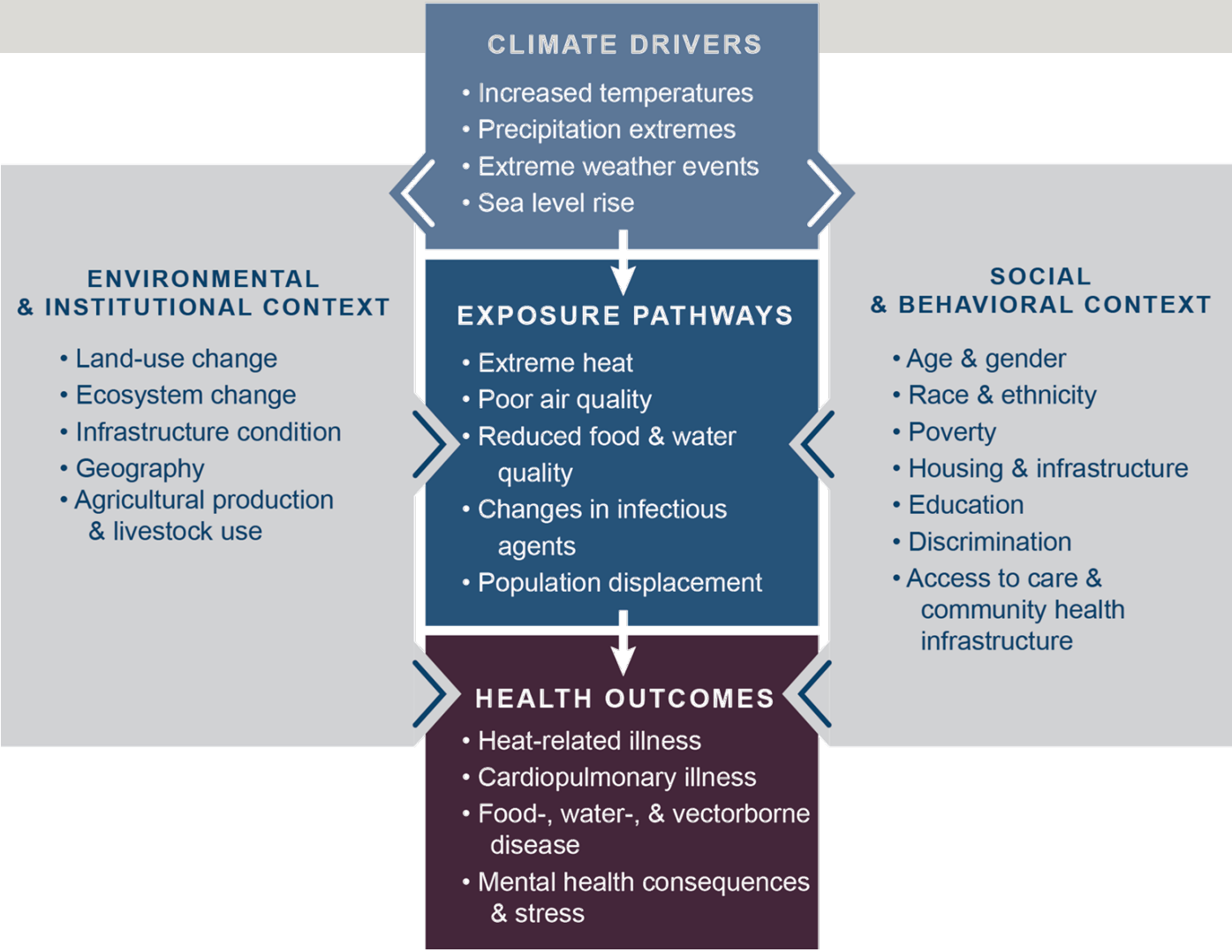
Table of Contents

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

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.

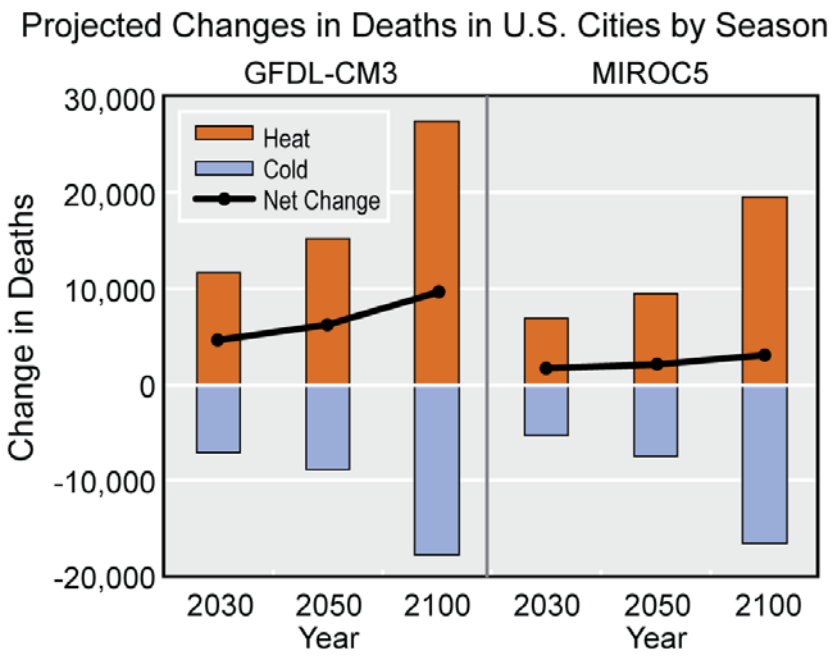
Chapter 1: Introduction: Climate Change and Health



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

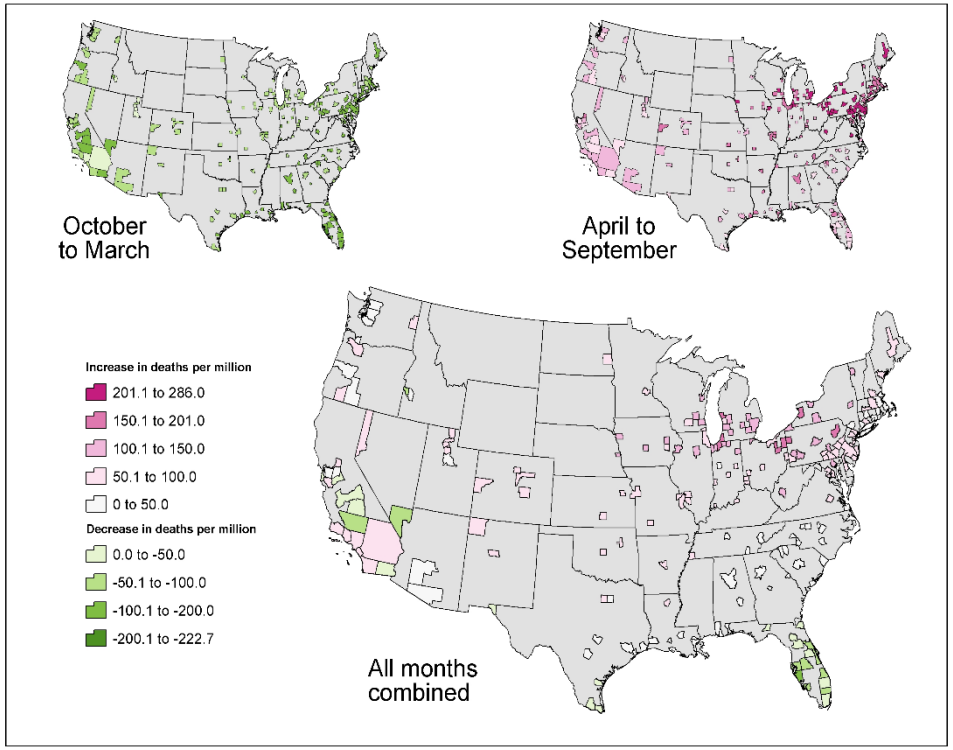
KF3: Changing Tolerance to Extreme Heat

KF4: Some Populations at Greater Risk

Chapter 2: Temperature- Related Death and Illness

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

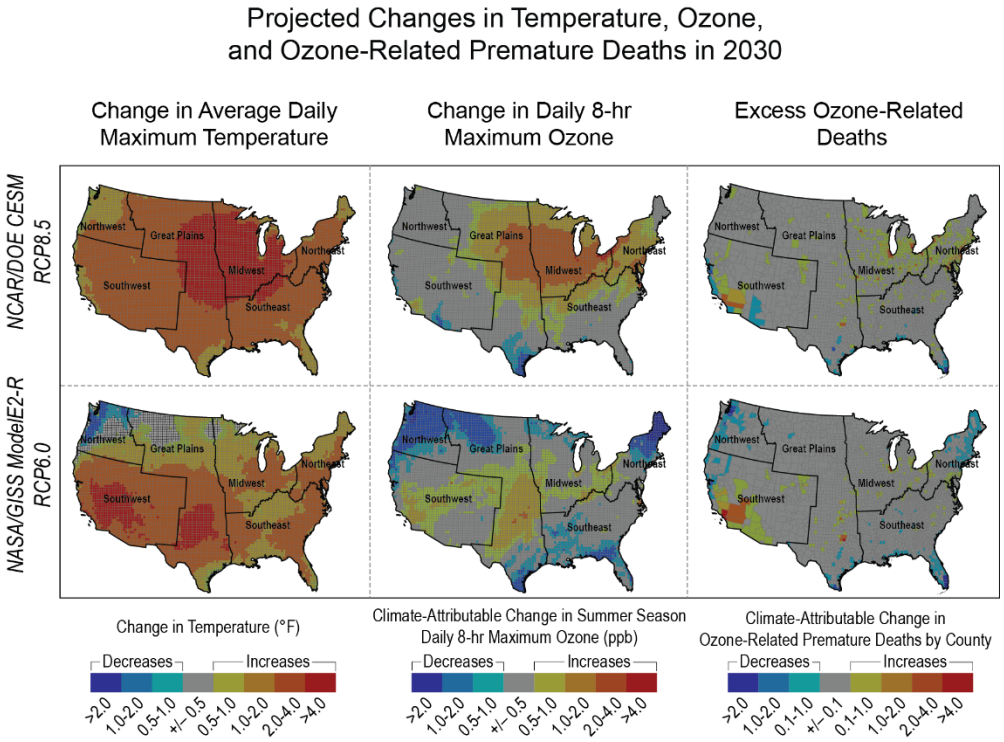
- **Objective**: A quantitative projection of future deaths from heat and cold for 209 U.S. cities with a total population of over 160 million inhabitants.
- **Methods**:
  - RCP6.0; GFDL–CM3, MIROC5
  - 209 Cities (189 million residents, ~60% of US pop)
  - National Center for Health Statistics, all-cause 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



Chapter 3: Air Quality Impacts

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.



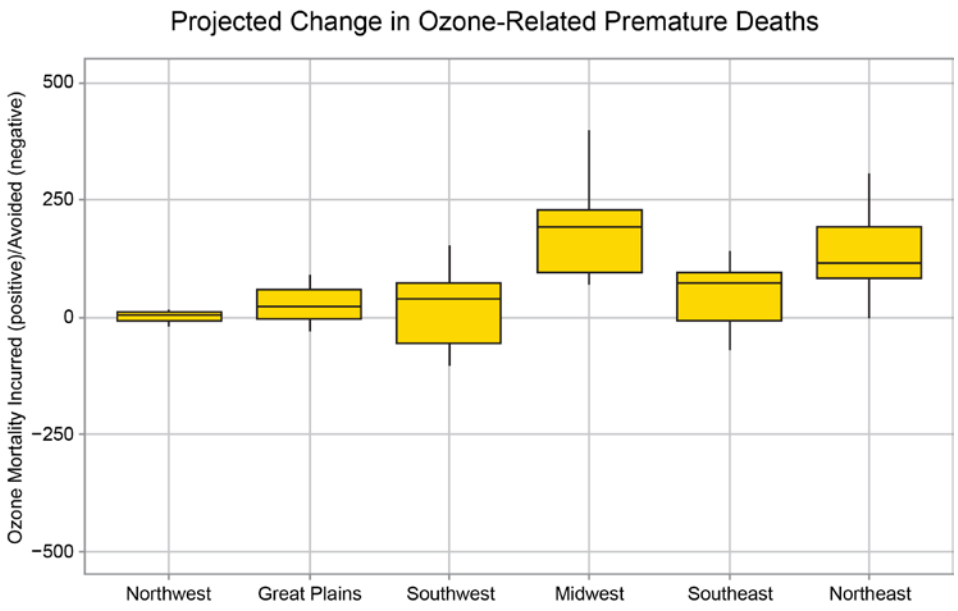
KF2: Increased Health Impacts from Wildfires

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)

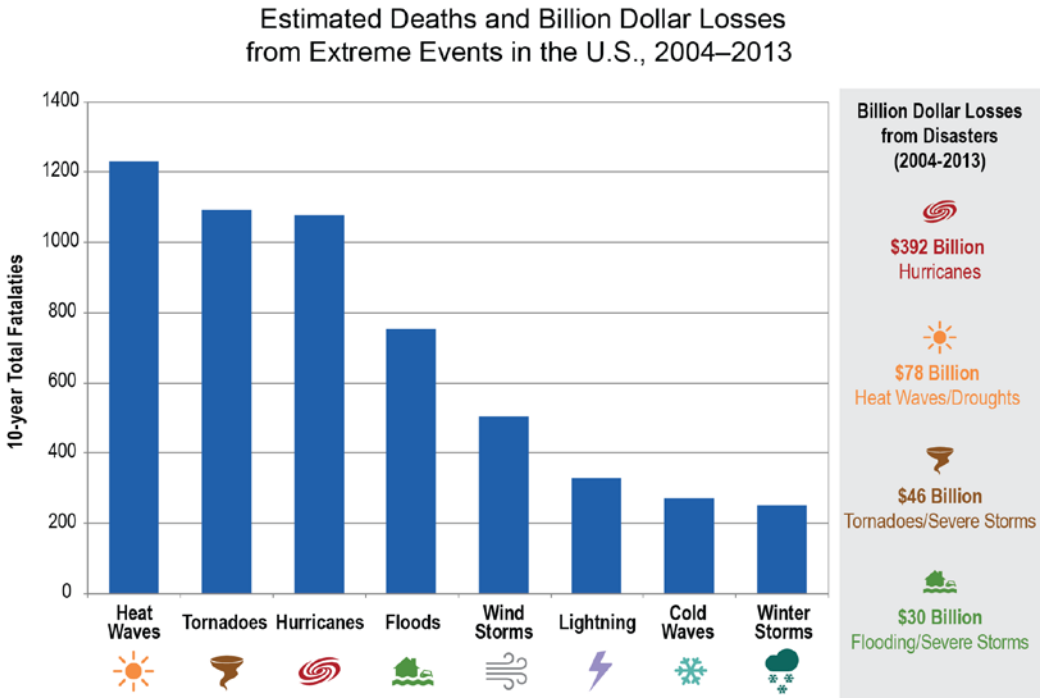
Infiltration projected to decrease by ~5%, averaged across cities, seasons, and climate models in 2040-2070. Exposure to indoor pollutants would correspondingly increase, while exposure to outdoor air pollutants would decrease to some extent.

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

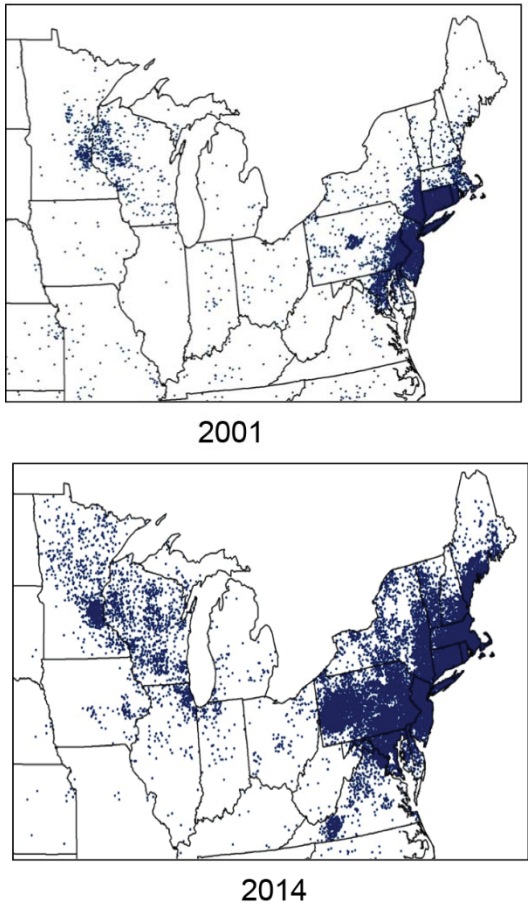
Key Finding 2: Earlier Tick Activity and Northward Range Expansion

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

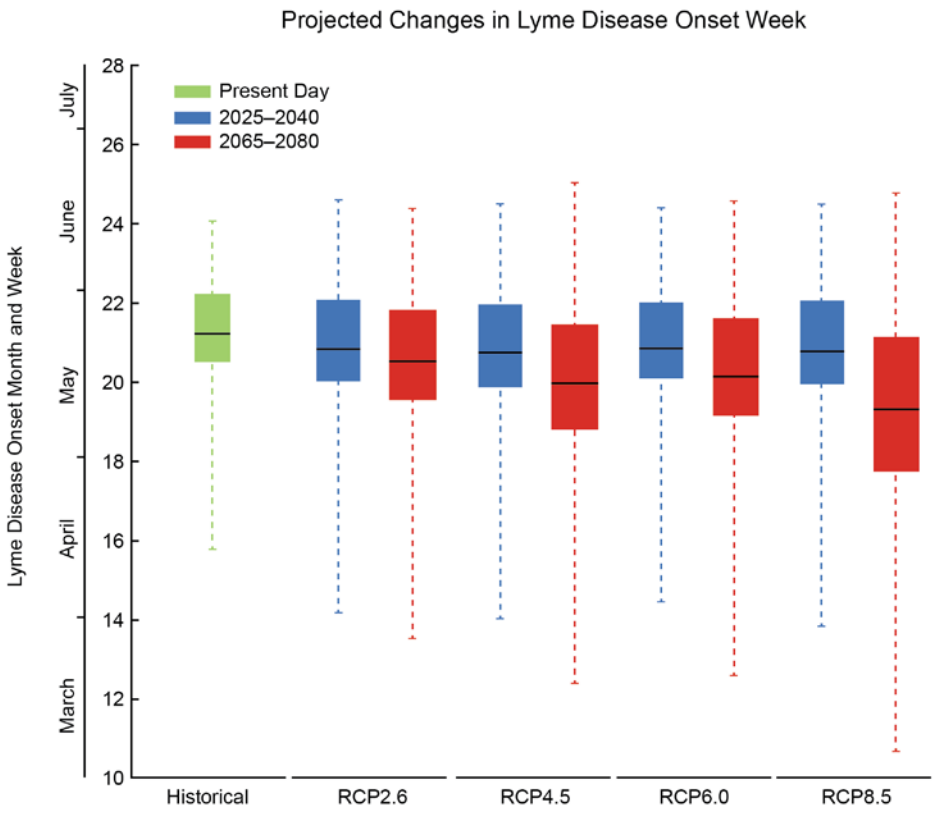
KF4: Emergence of New Vectorborne Pathogens

Changes in Lyme Disease Case Report Distribution



Research Highlight: Lyme Disease Onset Week (Monaghan et al., 2015)

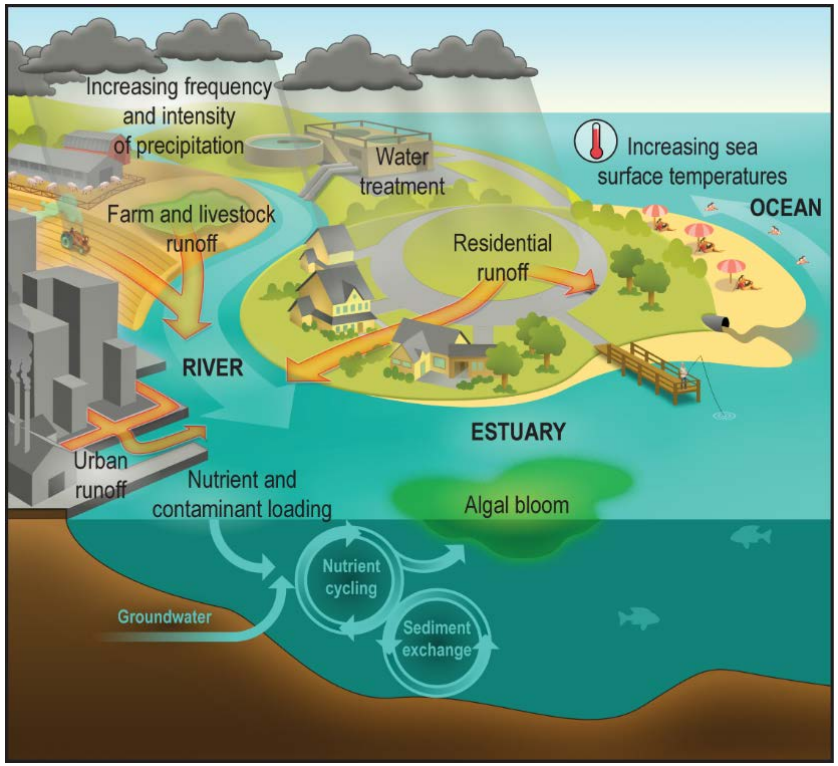
- **Objective**: Examine impacts of climate change on the timing of the beginning of the annual Lyme disease season (annual onset week) in eastern U.S.
- **Methods**:
  - RCP2.6, 4.5, 6.0, 8.5; 5 models
  - 12 states where Lyme is prevalent
- **Results:** On average, the start of the Lyme disease season 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.



Chapter 6: Water-Related Illnesses

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

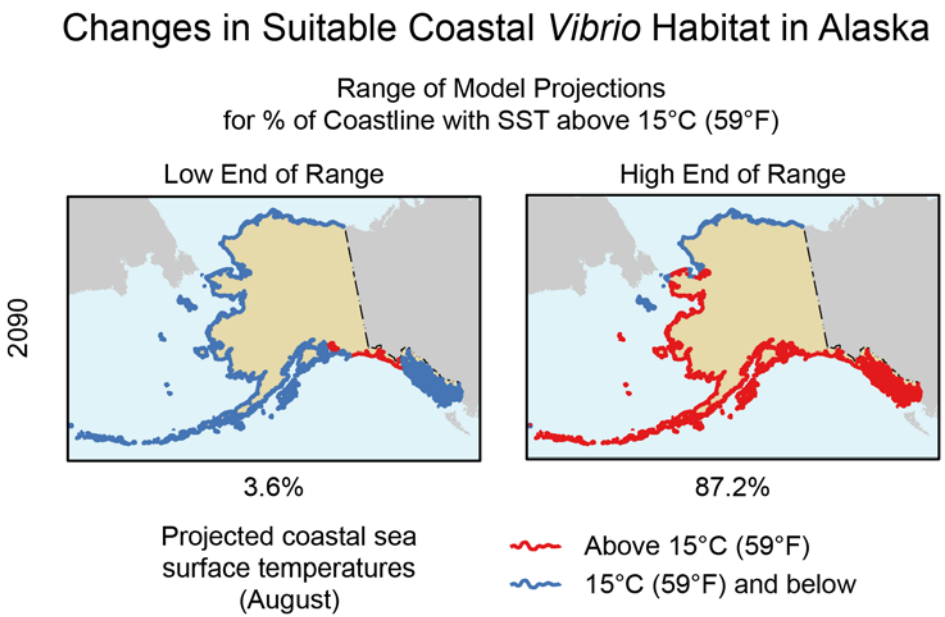
KF3: Water Infrastructure Failure

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

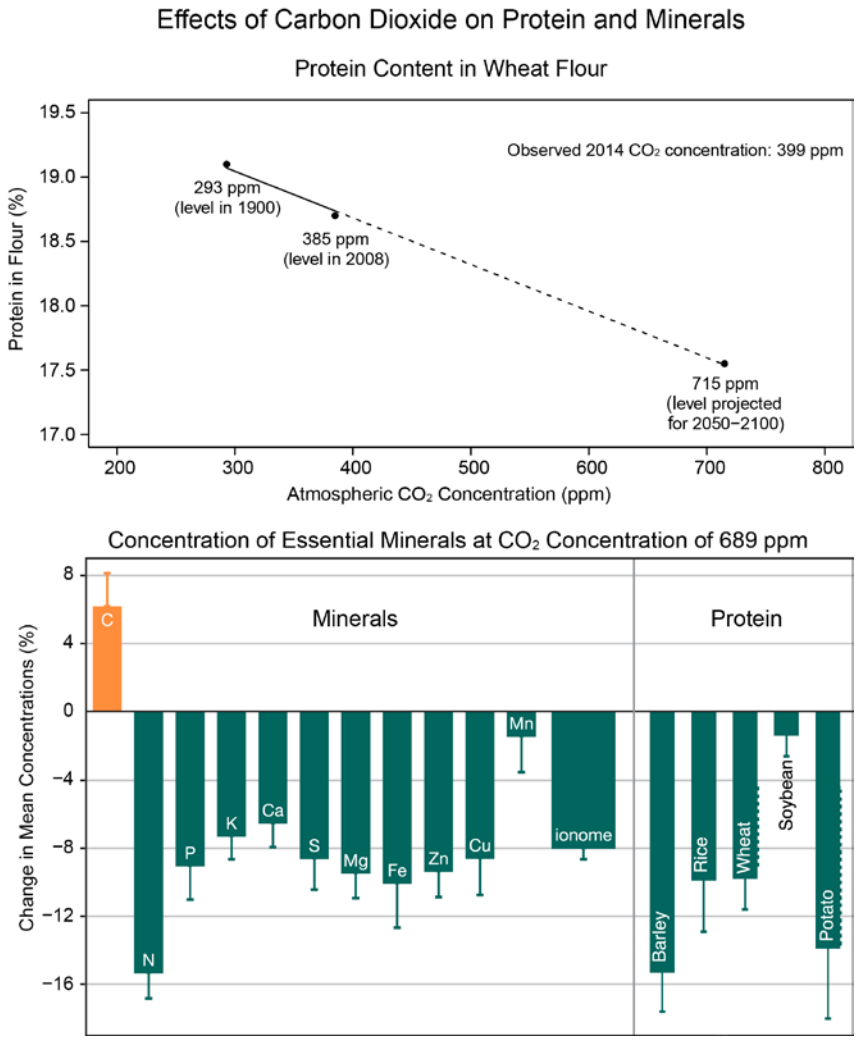
KF1: Increased Risk of Foodborne Illness

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

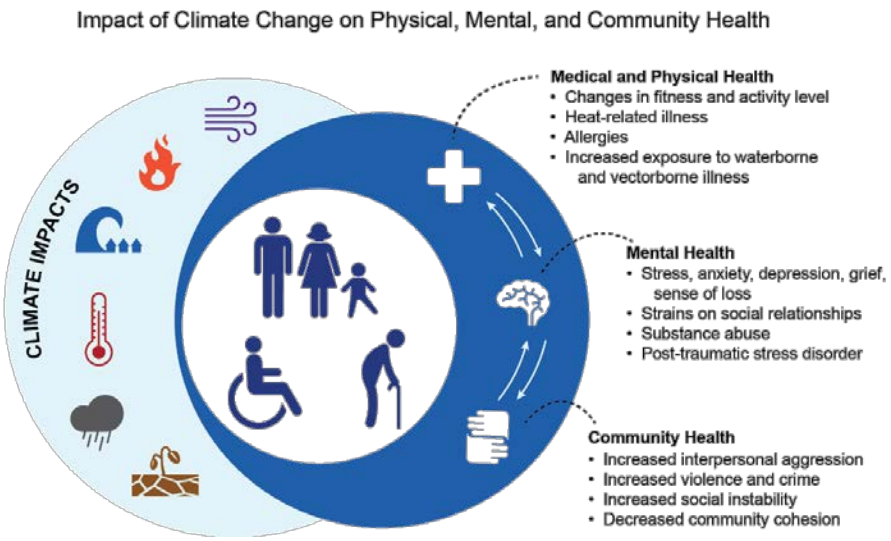


Chapter 8: Mental Health and Well-Being

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

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