

# Health Sector Contribution to the National Assessment on the Potential Consequences of Climate Variability and Change for the United States

The overall goal of the National Assessment is to analyze and evaluate what is known about the potential consequences of climate variability and change for the Nation in the context of other pressures on the public, the environment, and the Nation's resources. The National Assessment process has been broadly inclusive, drawing on inputs from academia, government, the public and private sectors, and interested citizens. Starting with broad public concerns about the environment, the Assessment is exploring the degree to which existing and future variations and changes in climate might affect issues that people care about.

The National Assessment has three major components:

1. National synthesis: The National Assessment Synthesis Team has responsibility for summarizing and integrating the findings of the regional and sectoral studies, with the broader literature, and then drawing conclusions about the importance of climate change and variability for the United States.
2. Sectoral analyses: Workshops and assessments are being carried out to characterize the potential consequences of climate variability and change for major sectors that cut across environmental, economic, and societal interests. The sectoral studies analyze how the consequences in each region affect the Nation, making these reports national in scope and of interest to everyone. The sectors being focused on in this first phase of the ongoing National Assessment include Agriculture, Forests, Human Health, Water, and Coastal Areas and Marine Resources.
3. Regional analyses: Workshops and assessments are characterizing the potential consequences of climate variability and change in selected regions spanning the US. The reports from these activities address the interests of those in the particular regions by focusing on the regional patterns and texture of changes where people live. Many workshop reports are already available (see <http://www.nacc.usgcrp.gov>) and regional assessment reports, of which this is the first, will become available over the next several months.

Each of the regional, sectoral, and national synthesis activities is being led by a team comprised of experts from both the public and private sectors, from universities and government, and from the spectrum of stakeholder communities.



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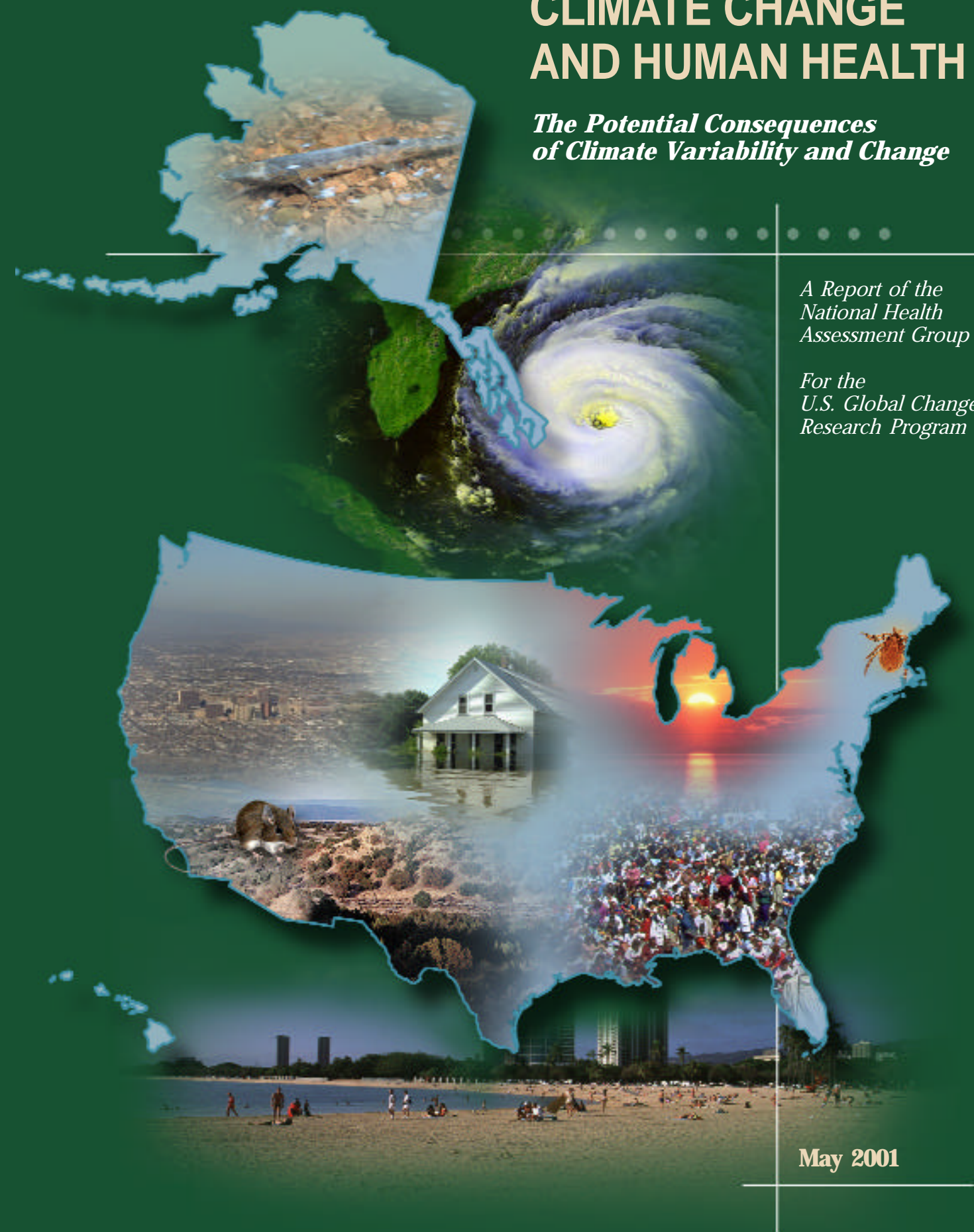
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# CLIMATE CHANGE AND HUMAN HEALTH

*The Potential Consequences of Climate Variability and Change*

*A Report of the National Health Assessment Group*

*For the U.S. Global Change Research Program*



**May 2001**

# Introduction

## Climate Change Has the Potential to Affect Human Health in the United States

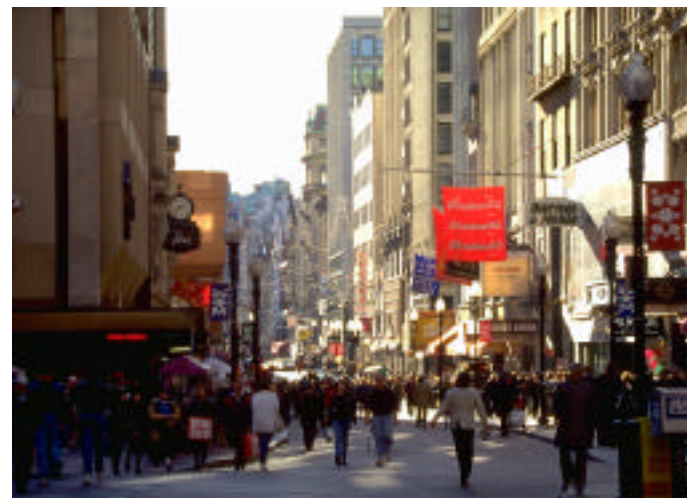
This brochure summarizes a recent scientific assessment of how current climate variability and future global warming may affect people in the United States. The assessment, sponsored by the U.S. Environmental Protection Agency's Global Change Research Program, makes clear that the potential health impacts are diverse and demand improved health infrastructure and enhanced, targeted research.

The study was conducted by a team of scientists from academia, government, and the private sector as part of the congressionally mandated U.S. National Assessment of the Potential Consequences of Climate Variability and Change. Leadership of the assessment was jointly shared between the Johns Hopkins School of Public Health and the Centers for Disease Control and Prevention (CDC).

### Five Critical Health Issues Identified

The study identifies and examines five key health issues

- Heat-related illness and death
- Health effects related to extreme weather events
- Health effects related to air pollution
- Water-borne and food-borne diseases
- Vector-borne and rodent-borne diseases



The report also identifies groups at risk, key research areas, and public health measures that, if properly addressed, could improve the nation's resilience to risks associated with current climate variability and future climate change.

### Maintenance and Improvements in Health Infrastructure are Essential

*"The future vulnerability of the U.S. population to the health impacts of climate change depends on our capacity to adapt to potential adverse changes through legislative, administrative, institutional, technological, educational, and research-related measures. Examples include building codes and zoning to prevent storm or flood damage, severe weather warning systems, improved disease surveillance and prevention programs, improved sanitation systems, education of health professionals and the public, and research addressing key knowledge gaps in climate/health relationships."*

From the Report to the President and Congress, National Assessment Synthesis Team, 2001

The United States has a solid public health infrastructure, but we are frequently reminded that human health is inextricably bound to weather and the many complex natural systems it affects. Weather-related deaths, such as fatalities in heat waves and floods, and illnesses, such as water-borne diseases, continue to occur. By improving the nation's public health infrastructure, focusing on groups at special risk, and addressing research gaps, we can reduce the potential health impacts of climate change and variability.

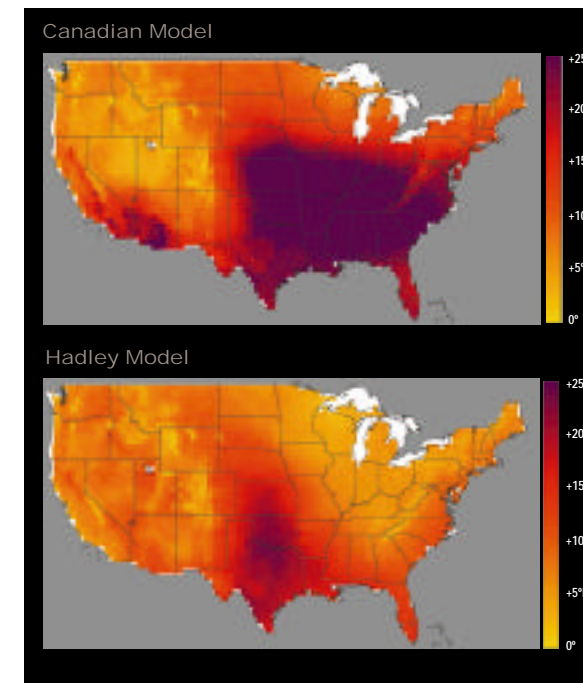
## Populations Most Vulnerable to Climate Change Health Threats in the United States

*"At present, much of the U.S. population is protected against adverse health outcomes associated with weather and/or climate, although certain demographic and geographic populations are at increased risk."*

From the Report to the President and Congress, National Assessment Synthesis Team, 2001

Within the United States, the elderly, children, and low-income and immunocompromised individuals already are at higher risk from a variety of environmental hazards, including air pollution, water pollution, heat stroke, and infectious diseases. These same individuals may be more vulnerable to health risks that can be intensified by climate change.

### July Heat Index Change - 21<sup>st</sup> Century



Heat and heat waves are projected to increase in severity and frequency with increasing global mean temperatures. Both of the above models project substantial increases in the July heat index over the 21st century. The largest increases are in the southeastern states, where the Canadian model projects increases of more than 25°F. (Map by Benjamin Felzer, UCAR, based on data from Canadian and Hadley modeling centers.)

### Low-Income Individuals

Poverty is a risk factor for heat-related illnesses and deaths because low-income individuals are more likely to live in urban areas (where summer temperatures are often highest), are less likely to be able to afford air-conditioning systems, and may have less access to health care. Because poverty is higher among African-Americans and Hispanics, these groups may be more susceptible to health risks related to extreme weather conditions.

### The Elderly

The proportion of elderly residents in the United States is expected to rise in the coming decades. Aging is often accompanied by chronic illnesses that may increase susceptibility to infectious disease or to extreme heat and other environmental conditions. Poverty, which increases with age among the elderly, may add to this group's risk from severe weather.

### Children

The factors that may affect children's special vulnerability to possible future climate change include poverty, access to medical care, and children's susceptibility to environmental hazards because of their size, behavior, and the fact that they are growing and developing.

### Immunocompromised Individuals

Many illnesses, such as cancer, AIDS, and diabetes, compromise human immune systems. Individuals affected in this manner may be more susceptible to water-borne and vector-borne infectious diseases and to physical stresses, such as those experienced during heat waves or floods. Adequate protection from those stresses is important and includes access to air conditioning, sanitation, and safe drinking water.

# Critical Health Issues

## Related to Climate Change in the United States

### Heat-Related Illnesses and Death

More frequent heat waves are projected to accompany climate change in the United States. Because the elderly are the most susceptible to dying from extreme heat, these heat waves pose particular risks to an aging U.S. population. Populations in northeastern and Midwestern U.S. cities, where high temperatures currently appear infrequently or irregularly, are likely to experience the greatest number of heat-related deaths and illnesses, which include heat cramps, fainting, heat exhaustion, and stroke.

Within heat-sensitive regions, urban areas are the most vulnerable and the threat is intensified by the absence of nighttime heat relief. For example, the 1995 Chicago heat wave caused more than 600 fatalities.

Milder winters could potentially reduce the current level of winter deaths. In general, however, more research is needed to understand the relationship between temperature and winter deaths.

### Strategies That Could Reduce Risk

- Individual behavioral changes, including increased fluid intake and increased use of air conditioning
- Development of community-wide heat emergency plans



### Health Effects Related to Extreme Weather Events

Changes in the frequency, timing, intensity, and duration of extreme weather events, such as floods and storms, could have negative health impacts in the United States. Potential effects from weather disasters range from acute trauma and drowning to conditions of unsafe water and post-traumatic stress disorder.

The health impacts of floods, storms, and other extreme weather events hinge on the vulnerabilities of the natural environment and the local population, as well as on their capacity to recover. The location of development in high-risk areas, such as coasts and floodplains, increases a community's vulnerability to extreme weather effects.

Adverse health outcomes in the United States are low compared with global figures, partly because of the many federal, state, and local government agencies and non-governmental organizations engaged in disaster planning, early warning, and response. Nonetheless, climate change and vulnerability will likely require increased vigilance.

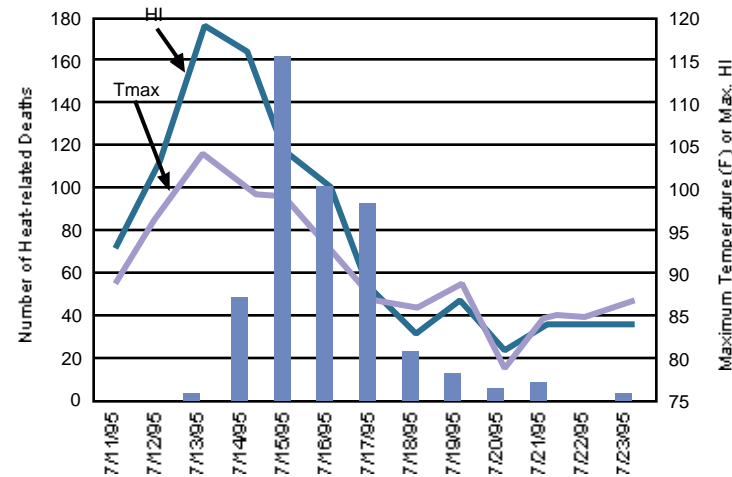
### Strategies That Could Reduce Risk

- Continued refinements to public early warning systems
- Improved engineering for flood control
- Enhanced zoning and building codes

### Air Pollution-Related Health Effects

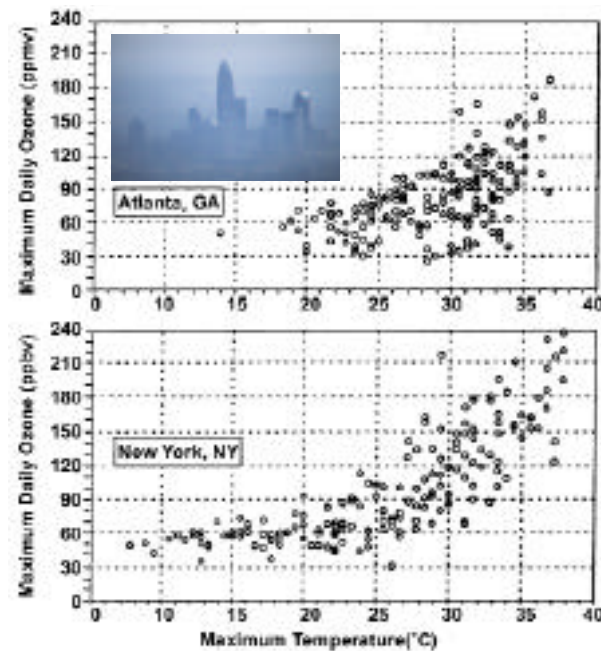
Climate change and variability may affect exposure to air pollutants in the United States by influencing local weather, changing the distribution

Heat Related Deaths in Chicago in July 1995



Studies of heat waves in urban areas show a link between increases in death and increases in heat. The above graph tracks the maximum temperature (Tmax), heat index (HI), and heat-related deaths during a 1995 Chicago heat wave that caused at least 600 deaths over five days. (Source: NOAA/NCDC).

**Maximum Daily Ozone Concentrations versus Maximum Daily Temperature in Atlanta and New York.**



Higher surface temperatures are conducive to the formation of ground-level ozone, particularly in urban areas such as Atlanta and New York City. Ground-level ozone can intensify respiratory diseases and cause short-term reduction in lung function. (Maximum daily ozone chart provided by U.S. EPA).

and types of airborne allergens, and increasing both human-driven and natural emissions.

Warmer and more variable weather may cause increases in ground-level ozone. These increases could intensify respiratory diseases by damaging lung tissue, reducing lung function, and sensitizing the respiratory tract to other irritants. More air conditioning use due to warmer temperatures could cause an increase in potentially harmful power plant emissions. Exposure to particulate matter from these and other combustion-related sources can aggravate chronic respiratory and cardiovascular diseases, alter host defenses, damage lung tissue, lead to premature death, and possibly contribute to cancer.

In addition, changes in green plant distribution or pollen production could affect the timing and/or duration of hay fever and other seasonal allergies.

**Strategies That Could Reduce Risk**

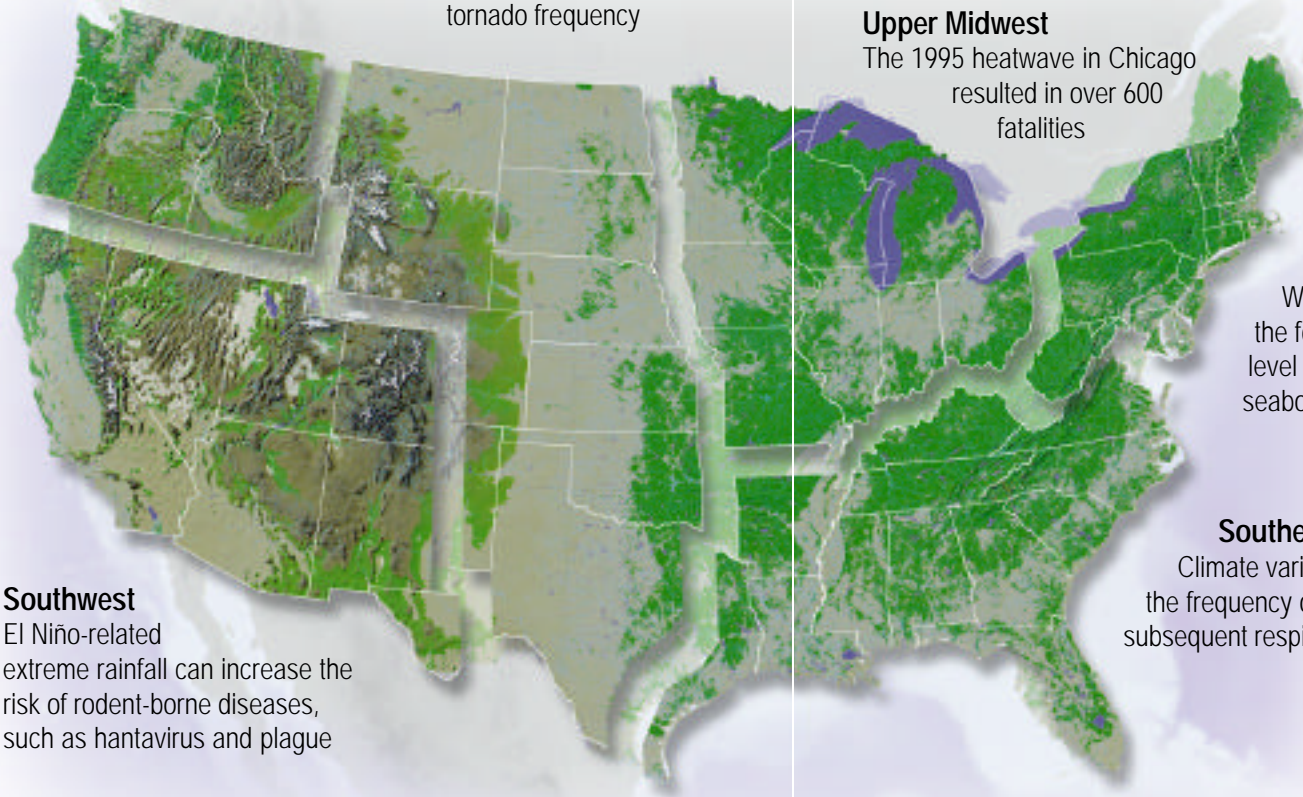
- Improved early warning systems for air quality
- Increased use of mass transit
- Better urban planning
- Improved pollution control policies

**Northwest**

Heavy runoff and flooding can lead to outbreaks of water-borne infectious diseases

**Plains**

Little is known how climate change might alter tornado frequency



**Southwest**

El Niño-related extreme rainfall can increase the risk of rodent-borne diseases, such as hantavirus and plague

**Water-Borne and Food-Borne Diseases**

Climate change and weather variability in the United States pose threats for water-borne diseases, some food-borne diseases, and marine and coastal issues, including harmful algal blooms and ecological disruption. Changes in precipitation, temperature, humidity, salinity, and wind have a measurable effect on the quality of water used for drinking, recreation, and commerce. Heavy rainfall has been associated with water-borne disease outbreaks throughout the United States.

Temperature also influences the occurrence of bacterial agents, toxic algal blooms (red tides), and survival of viral pathogens that cause shellfish poisoning. Although federal and state water regulations protect much of the U.S. population, current deficiencies in watershed protection and storm drainage systems can increase the risk of contamination events if rainfall increases as pro-

Wastewater systems that combine storm water drainage and sewage are still in use in about 950 communities. Increased storm events could lead to more combined sewage overflow (CSO) events, posing a risk to water safety. Source: USEPA, <http://www.epa.gov/owmitnet.cso.htm>

**Upper Midwest**

The 1995 heatwave in Chicago resulted in over 600 fatalities

**Northeast**

Weather conditions affect the formation of smog(ground-level ozone) along the eastern seaboard

**Southeast**

Climate variability influences the frequency of forest fires and subsequent respiratory illness

**Locations of Combined Wastewater Systems**



jected with climate change. For example, more than 950 communities in the United States have combined sewer overflow systems, which service both public wastewater and drinking water. During periods of heavy rainfall, these systems discharge excess waste-

water directly into surface water bodies that may be used to provide public drinking water.

**Strategies That Could Reduce Risk**

- Improved surveillance for infectious diseases
- Enhanced water systems and improved water systems engineering
- Watershed protection policies

**Vector-Borne and Rodent-Borne Diseases**

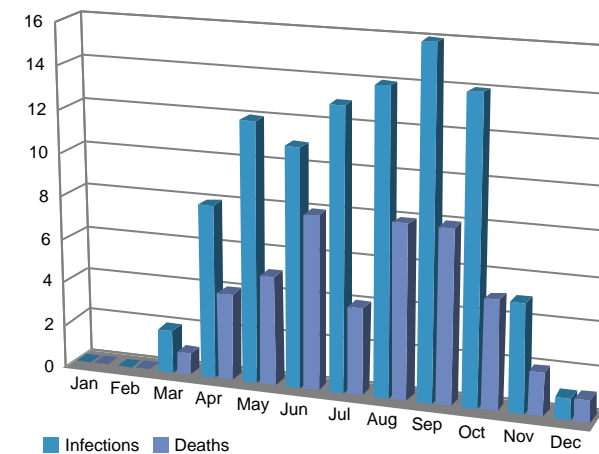


Vector-borne diseases result from infections transmitted to humans and other animals by blood-feeding insects, such as mosquitoes, ticks, and fleas. Most vector-borne diseases exhibit a distinct seasonal pattern, which clearly suggests that they are weather sensitive. For example, past St. Louis encephalitis outbreaks have been associated with a pattern of warm, wet winters, cool springs, and hot, dry summers.

Rodent-borne diseases are less directly affected by temperature. However, the impact of weather on disease-carrying rodent populations (for example, increased food supply or exposure during flooding) can affect transmission of diseases such as hantavirus and flea-borne plague.

In general, disease transmission by insects and rodents is a complex process and unique for each disease. Population characteristics, human behavior, and ecological factors play a critical role in determining when and where disease occurs, which makes it unlikely that increasing temperatures alone will have a major impact on tropical diseases spreading into the United States. There is even greater uncertainty regarding diseases that cycle through animals and can also infect humans, such as Lyme disease and mosquito-carried encephalitis viruses.

**Seasonality of Shellfish Poisoning in Florida 1981-1994**



Water-borne disease agents—such as *Vibrio* bacteria, which cause shellfish poisoning—are affected by weather. Over a 14-year period in Florida, a higher number of *Vibrio*-related illnesses and deaths occurred during summer, when water temperature is higher. (Adapted from Lipp and Rose, 1997).

### Strategies That Could Reduce Risk

- Improved disease surveillance
- Enhanced insect-control programs
- Vaccine development and improved protections for U.S. travelers to disease-endemic areas

### Need for Research About Climate and Health

*“Projections of the extent and direction of the potential health impacts of climate variability and change are extremely difficult to make because of the many confounding and poorly understood factors associated with potential health outcomes, population vulnerability, and adaptation. In fact, the relationship between weather and specific health outcomes is understood for a relatively small number of diseases, with few quantitative models available for analysis. The costs, benefits and availability of resources to address adaptation measures also require evaluation. Research aimed at filling the priority knowledge gaps identified in this assessment would allow for more quantitative assessments in the future.”*

From the Report to the President and Congress,  
National Assessment Synthesis Team, 2001

The following research areas were among those identified as priorities by the expert health assessment team:

#### *Research areas on heat-related illness and death*

- Improved prediction, warning, and response systems
- Relationship of weather to influenza and other causes of winter mortality
- Techniques to enhance urban design and energy systems

#### *Research areas on health impacts from extreme weather events*

- Improved surveillance for long-term health effects from storms
- Techniques to enhance prediction, warning, and response
- Investigation of past impacts and effectiveness of warnings

#### *Research areas on air pollution-related health effects*

- Relationship between weather and air pollution concentrations
- Relationships between exposure patterns and health effects
- Effect of weather on vegetative emissions and allergens (such as pollen)

#### *Research areas on water-borne and food-borne diseases*

- Improved monitoring of weather/ecological effects on marine-related disease
- Impacts of land use and agriculture on water quality
- Enhanced monitoring and mapping of the movement of contaminants in surface water and groundwater, combined with improved monitoring for human disease

#### *Research areas on vector-borne and rodent-borne diseases*

- Improved rapid diagnostic tests, especially in the field
- Enhanced disease surveillance strategies
- Linkages between climate, altered ecology, and infectious disease transmission

Expertise from many disciplines is required to solve these important questions.

### For More Information

The full assessment document was published in the May 2001 special supplement issue of the journal *Environmental Health Perspectives*. Also, visit the health assessment Web site at <http://jhsph.edu/nationalassessment-health> or call 410/614-6976.

To view the official report to Congress, or for information on the other sector and regional assessment reports of the U.S. National Assessment on the Potential Consequences of Climate Variability and Change, visit the U.S. Global Change Research Program Web site at <http://www.usgcrp.gov/usgcrp/library/nationalassessment>

This health assessment is sponsored by the U.S. Environmental Protection Agency, Global Change Research Program (<http://www.epa.gov/globalresearch>).