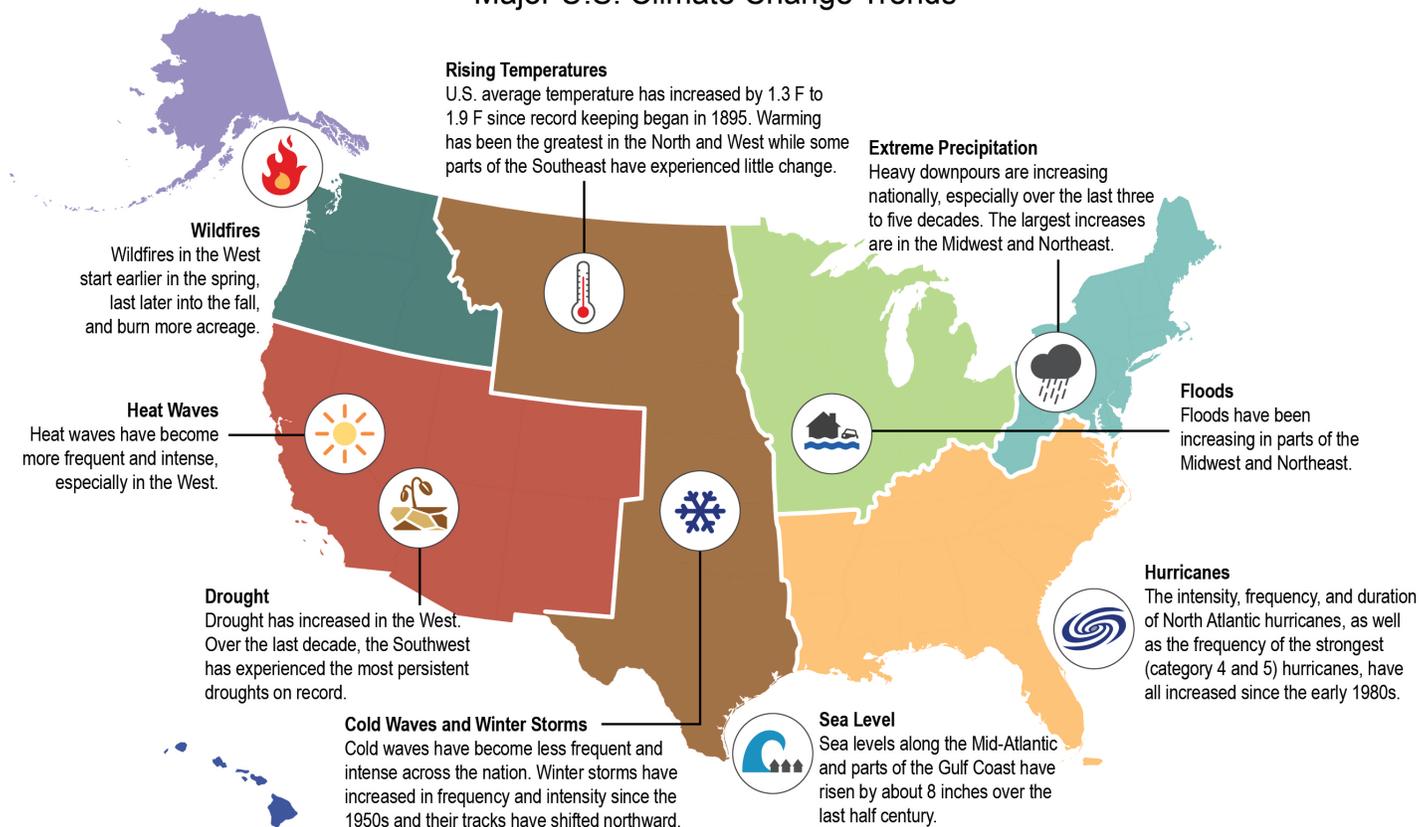


Climate Change and Human Health

Climate is significant to our health. Temperatures and the frequency of heavy rain and snow are increasing in the United States (see map). These and other changes, such as more intense severe weather and rising sea levels, may affect people's environments in ways that may, in turn, harm their health and well-being. The NIEHS Climate Change and Human Health Program leads and coordinates institute and NIH efforts to better understand how climate may affect people's health.

Major U.S. Climate Change Trends



Source: USGCRP (2016). The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC.

How Does Climate Change Affect Human Health?

While climate change is a global process, it has both local and regional impacts that may affect communities. Some of these effects are relatively direct, as when heat waves or intense hurricanes cause injury and illness, and even death. Some health effects of climate change are less direct and involve shifts in our environment that, in turn, can affect human health and diseases. For example, changes in temperatures and rainfall can have a strong effect on the lifecycles of insects and other species that transmit disease, such as Lyme disease and West Nile virus, leading to new outbreaks or variations in places where these diseases occur. Rising sea levels can worsen the flooding from hurricanes in coastal areas, leading to human exposures to water and areas contaminated by pollutants and hazardous wastes. Climate fluctuations often occur in combination with other well-known health stressors, such as poverty, social disadvantage, impaired language ability, and others. These factors make certain people more vulnerable by increasing the chance they may be exposed to climate-related risks. Examples of the varied ways that climate change may affect people's health are shown in the table on the following page.

Examples of Climate Change Impacts on Health

	Climate Driver	Exposure	Health Outcome	Impact
 Extreme Heat	More frequent, severe, prolonged heat events	Elevated temperatures	Heat-related death and illness	Rising temperatures may lead to an increase in heat-related deaths and illnesses.
 Outdoor Air Quality	Increasing temperatures and changing precipitation patterns	Worsened air quality (ozone, particulate matter, and higher pollen counts)	Premature death, acute and chronic cardiovascular and respiratory illnesses	Rising temperatures and wildfires and decreasing precipitation may lead to increases in ozone and particulate matter, elevating the risks of cardiovascular and respiratory illnesses and death.
 Flooding	Rising sea level and more frequent or intense extreme precipitation, hurricanes, and storm surge events	Contaminated water, debris, and disruptions to essential infrastructure	Drowning, injuries, mental health consequences, gastrointestinal and other illness	Increased coastal and inland flooding exposes populations to a range of negative health impacts before, during, and after events.
 Vector-Borne Infection (Lyme disease)	Changes in temperature extremes and seasonal weather patterns	Earlier and geographically expanded tick activity	Lyme disease	Ticks may show earlier seasonal activity and a generally northward range expansion, increasing risk of human exposure to Lyme disease-causing bacteria.
 Water-Related Infection (Vibrio vulnificus)	Rising sea surface temperature, changes in precipitation, and runoff affecting coastal salinity	Recreational water or shellfish contaminated with Vibrio vulnificus	Vibrio vulnificus-induced diarrhea and intestinal illness, wound and bloodstream infections, death	Increases in water temperatures may alter timing and location of Vibrio vulnificus growth, increasing exposure and risk of waterborne illness.
 Food-Related Infection (Salmonella)	Increases in temperature, humidity, and season length	Increased growth of pathogens, seasonal shifts in incidence of Salmonella exposure	Salmonella infection, gastrointestinal outbreaks	Rising temperatures increase Salmonella prevalence in food; longer seasons and warming winters increase risk of exposure and infection.
 Mental Health and Well-Being	Climate impacts, especially extreme weather	Level of exposure to traumatic events, like disasters	Distress, grief, behavioral health disorders, social impacts, resilience	Changes in exposure to climate- or weather-related disasters may cause or exacerbate stress and mental health consequences.

Who is Most at Risk From Climate Change?

Although the U.S. has a well-developed public health and medical system, every American may be vulnerable to the impacts of climate change at some point in their lives, no matter where they live. Certain U.S. populations are more vulnerable to climate-related health threats as a result of specific physical, environmental, and sociodemographic factors, as well as age and life stage. Some of these groups and the challenges they face follow.

Low-Income Groups



People with low incomes live with many factors that increase their vulnerability to the health effects of climate. They are more likely to live in risk-prone areas, such as urban heat islands, isolated rural areas, or coastal and other flood-prone areas, or where there is older or poorly maintained infrastructure. Low-income groups often face an added burden of air or other toxic pollution that may be increased or mobilized by climate events like severe storms. They experience relatively greater incidence of chronic medical conditions, such as cardiovascular and kidney disease, diabetes, asthma, and COPD, all of which may be worsened by climate. Also, limited transportation and access to health education can impede their ability to prepare for, respond to, and cope with climate-related health risks.

Indigenous Peoples



A number of health risks are higher among indigenous populations, such as poor mental health related to historical or personal trauma, environmental exposures from pollutants or toxic substances, and diabetes. Because of existing vulnerabilities, indigenous people, especially those who are dependent on the

environment for sustenance or who live in geographically isolated or impoverished communities, are likely to experience greater exposure and lower resilience to climate-related health effects. Indigenous communities already face threats to their homes, food sources, and cultural traditions from climate impacts on the environment, such as reductions in sea ice, increases in flooding and landslides, damage to wildlife habitats, loss of medicinal plants, and effects on the abundance and nutrition of certain traditional foods.

Children and Pregnant Women



Children have a proportionately higher intake of air, food, and water relative to their body weight compared to adults. They also share unique behaviors and interactions with their environment, such as more time spent outdoors and placing hands in their mouths. These factors, combined with climate fluctuations, may increase

their exposure to environmental contaminants. Extreme heat threatens student athletes who practice outdoors, as well as children in homes or schools without air conditioning. Children may be vulnerable to injury during extreme weather events, as they depend on adults to escape harm, and can suffer emotional trauma from displacement, loss of home or school, and exposure to the event itself. Climate-related exposures may lead to adverse pregnancy outcomes, including spontaneous abortion, low birth weight, preterm birth, and risks to newborns and infants, including increased neonatal death, dehydration, malnutrition, diarrhea, and respiratory diseases.

Older Adults



The number of people age 65 and older is growing substantially in the U.S. Older adults make up a population of concern for climate change impacts from extreme heat and weather events, degraded air quality, vector-borne diseases, and others. Older adults may be further challenged by climate events due to factors such as social

isolation and living in older structures that make them vulnerable to heat and extreme events, such as hurricanes and floods; preexisting health conditions, such as respiratory conditions that may be worsened by extreme climate; and mental health challenges, such as depression, dementia, and other cognitive impairments. Older adults are also more likely to take medications to treat chronic medical conditions, including antidepressants and antipsychotic drugs and diuretics, which make them more vulnerable to complications from heat exposure.

Occupational Groups



Outdoor workers are often among the first to be exposed to the effects of climate. Severe climate change may affect the health of outdoor workers through increases in ambient temperature, degraded air quality, extreme weather, vector-borne diseases, industrial exposures, and altered built environment. Workers affected by

climate change include farmers, ranchers, and other agricultural workers; commercial fishermen; construction workers; paramedics, firefighters, and other first responders; and transportation workers. Also, laborers exposed to hot indoor work environments, such as steel mills, dry cleaners, manufacturing facilities, warehouses, and other areas that lack air conditioning, may be at risk for extreme heat exposure. Military personnel who train and conduct operations in hot field environments may be at risk for heat-related illness, and may also be at increased risk for certain vector-borne diseases.

Persons With Disabilities or Chronic Medical Conditions



The term disability covers a variety of functional limitations related to hearing, speech, vision, cognition, and mobility. An increase in climate change can be expected to disproportionately affect populations with disabilities. Preexisting medical conditions present risk factors for increased illness and death associated with

climate-related stressors, especially exposure to extreme heat. Chronic medical conditions, including cardiovascular disease, respiratory disease, diabetes, asthma, and obesity, are likely to increase over the coming decades, resulting in larger populations at risk of medical complications from climate-related exposures. Communities that are both medically underserved and have a high prevalence of chronic medical conditions can be especially at risk.

What Are the Co-Benefits of Addressing Climate Change?

NIEHS is working to understand how addressing climate change can benefit health. Some responses to severe climate may lead to substantial reductions in harmful exposures to people, so-called co-benefits, or additional benefits to people's health beyond reducing the severity of climate itself. For example, measures to reduce emissions of carbon dioxide from burning fossil fuels may greatly reduce toxic air pollution that causes thousands of deaths in the U.S. each year. Another example of co-benefits may include healthy changes in food production and consumption that reduce methane emissions from agricultural sources, and improved housing insulation that helps people use less energy while adapting to more extreme temperatures.

What Is NIEHS Doing to Help People Prepare?

Working closely with researchers, communities, and decision-makers, NIEHS is supporting research and developing strategies to help people and communities prepare for potential health impacts of climate change, while also protecting health and the environment for future generations. Examples include the following:

- Developing models to define and predict high-risk days to determine when those with heart disease are most vulnerable.
- Investigating the impact of climate on the spread of disease in food and water.
- Researching the effects of extreme weather events on pregnant women and fetuses.
- Developing toolkits for sustainable and climate-resilient health care facilities.
- Assisting with public development of informational resources and tools.
- Partnering with other federal agencies through the U.S. Global Change Research Program, and internationally with the Intergovernmental Panel on Climate Change and the World Health Organization, to identify research gaps and develop tools for decision-making.
- Developing climate change and health learning materials for a wide range of student audiences.

NIEHS Climate Change and Human Health Lesson Plans

<https://niehs.nih.gov/health/scied/teachers/cchh>

The NIEHS Climate Change and Human Health Literature Portal

This comprehensive knowledge-management tool offers access to curated scientific literature on the health implications of climate change. Search the database: <https://tools.niehs.nih.gov/cchhl>

Where Can I Get More Information?

NIEHS Climate Change and Human Health Program
<https://niehs.nih.gov/research/programs/geh/climatechange>

National Oceanic and Atmospheric Administration (NOAA)
Climate - <https://cpo.noaa.gov>

Sustainable and Climate Resilient Health Care Facilities Toolkit

<https://toolkit.climate.gov/tool/sustainable-and-climate-resilient-health-care-facilities-toolkit>

U.S. Centers for Disease Control and Prevention
<https://cdc.gov/climateandhealth>

U.S. Climate Resilience Toolkit
Climate and Health Program - <https://toolkit.climate.gov>

U.S. Department of Health and Human Services

- **Climate Change and Human Health**
<https://hhs.gov/climate>
- **Climate Change and Children's Health Policy Roundup**
<https://hhs.gov/climate/childrenshealth>

U.S. Department of Homeland Security
Ready Program - <https://ready.gov>

Climate Change Affects the Health of All Americans

Building on previous reports, the Fourth National Climate Assessment draws a direct connection between the warming atmosphere and resulting changes that affect our physical, social, and economic well-being. It concludes the evidence of climate change is overwhelming and climate-related threats to Americans' health will increase without additional action.

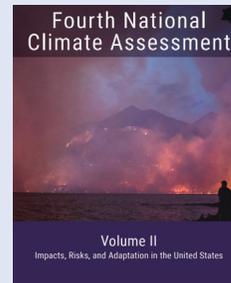
Extreme events, such as heat waves, floods, and droughts, can become more frequent, worsen, and lead to:

- Increased physical and mental health effects, especially among vulnerable, at-risk, and socially neglected populations.
- Damaged crops and livestock, with increases in pests and toxins, increasing threats to food security and quality.
- Diminished air and water quality.

Warming and other changes in climate may shift the distribution of certain diseases, including waterborne and vector-borne infections.

Mitigation and adaptation strategies are needed for coping with climate change. Reducing greenhouse gases will save many lives and avoid billions of dollars in economic costs. Helping health systems become more resilient will make it easier to manage climate-related health risks. Improving weather forecasting, developing and advancing more sustainable urban design and infrastructure, increasing education at all levels, and developing improved disaster response plans will also reduce health risks.

Mandated by the Global Change Research Act of 1990, the U.S. Global Change Research Program delivers a National Assessment Report to Congress and the president every four years. The reports provide scientific updates on climate change-related impacts, risks, and adaptation. They inform decision-making but do not recommend specific policies. Read more at <https://www.globalchange.gov>.



For more information on the National Institute of Environmental Health Sciences, go to <https://niehs.nih.gov>

Additional References

1. Reidmiller DR, Avery CW, Easterling DR, Kunkel KE, Lewis KLM, Maycock TK, Stewart BC, eds. 2018. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. U.S. Global Change Research Program, doi: 10.7930/NCA4.2018.
2. USGCRP (U.S. Global Change Research Program). 2016. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. (Crimmins A, Balbus J, et al., eds.). Washington, DC.
3. Melillo JM, Richmond TC, Yohe GW, eds. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program. doi:10.7930/J0Z31WJ2.