# A HOW-TO GUIDE FOR CREATING A SEASONAL FORECAST FOR HEALTH

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# Introduction

A Seasonal Forecast for Health (SF4H) is a vital tool that can be used to inform health professionals and the public about the ways in which climate-related hazards can affect human health and provide resources to stay safe and healthy. A SF4H incorporates widely available short-term weather forecasts for climate-related hazards like heat, drought, wildfire, and hurricanes into a health context by identifying the potential health impacts of these hazards and populations most at-risk of adverse health impacts when exposed to these hazards. A SF4H can also be combined with stories of climate resilience, address prevalent community issues, and feature relevant local, state, and federal resources. The goal is to distill complex seasonal to sub-seasonal data into an accessible, actionable format to protect health.

The HHS Office of Climate Change and Health Equity (OCCHE) created the first U.S. SF4H, also known as the Climate and Health Outlook (CHO), to provide actionable resources to mitigate climate-related health impacts. OCCHE's CHO delivers monthly and seasonal climate-related forecasts alongside information about the health impacts of each hazard and actions and resources to stay safe. While there is value in having a resource like this at a national scale, state, local, Tribal, and territorial governments or other organizations may prefer to develop a more customized version of a SF4H by utilizing unique local datasets or incorporating priorities identified by local communities. This guide offers a framework for communities to create their own SF4Hs tailored to their communities' unique needs.

For additional resources, please email us at OCCHE@HHS.gov.

## A 3-Step Process

The process to create a SF4H can be distilled into three core steps. Each step ensures the final product is informative, actionable, and tailored to the intended audience.

### Step 1: Identifying and Assessing Seasonal and Sub-seasonal Forecasts

Data availability, quality, and relevance to the target audience can guide the inclusion of climate-related hazard forecasts in a SF4H. Once data sources for climate-related hazards have been identified, it is useful to meet with the data providers and build lasting partnerships to ensure that forecasts can consistently be featured in an accurate and usable format. It is good practice to accompany each forecast with an explanation of its threat to public health, recommendations on how to stay safe, and a list of available resources (see Appendix Table A1).

#### Climate-Related Hazard Forecasts

Leverage high-quality, reliable forecast data sources to support your SF4H. Organizations may want to consider using granular datasets for regional and state-level SF4Hs. The following is a non-comprehensive list of databases and forecast websites that provide climate-related hazard information at the national and state level:

| **Climate-Related Hazards** | **Forecasts and Databases** |
|---|---|
| Drought | • National Oceanic and Atmospheric Association's (NOAA) National Weather Service (NWS) Climate Prediction Center's U.S. Monthly Drought Outlook: Forecast and GIS Data Download |
| Wildfire | • National Interagency Fire Center's National Significant Wildland Fire Potential Outlook: Forecast and GIS Data Download<br>• EPA and the U.S. Forest Service's AirNow Fire and Smoke Map<br>• Minnesota Department of Natural Resources' Fire Danger and Burning Restrictions Map |
| Heat | • CDC's Heat & Health Tracker<br>• CDC-NWS HeatRisk Forecast Tool<br>• NOAA NWS Climate Prediction Center's Seasonal Temperature Outlook<br>• NWS CPC's North American Multi-Model Ensemble |
| Winter Weather | • NOAA's Monthly Precipitation and Temperature Outlooks<br>• FEMA's Winter Weather National Risk Index<br>• NOAA's El Niño & La Niña |
| Hurricanes | • NOAA's Hurricane Season Outlook |
| Flooding | • NOAA's Spring Flood Outlook<br>• California's Water Watch Forecast<br>• Minnesota's Enhanced Flood Forecast/Warning System<br>• North Carolina's Flood Inundation Mapping and Alert Network |
| Spring Pollen | • USA National Phenology Network's Status of Spring |

**Table 1: SF4H Forecasts and Databases**

## Step 2: Identifying and Accessing Datasets for Population Risk Factors/Vulnerability

To identify populations that may be at increased risk of negative health outcomes from climate-related hazards, OCCHE developed a nationwide dataset of county-level individual risk factors that may increase vulnerability to specific hazards. These social, environmental, and health indicators characterize an increased risk of negative health outcomes for individuals who have these risk factors and are exposed to relevant climate-related hazards. In early renditions of the CHO, OCCHE provided information on the number of counties that were in the top quartile of all U.S. counties (i.e., counties that have "a high number of people") for the risk factors relevant to each hazard. Individual states and counties can create their own datasets of vulnerability indicators and use this information to prioritize outreach and resources to vulnerable populations. Refer to Appendix Table A2 for a data table of individual risk factors at the county-level.

## Step 3: Developing Presentation Modes

Information from a SF4H can be presented multimodally to appeal to a broad audience and meet different needs. OCCHE publishes the information included in each monthly CHO through three mains modes: periodicals, website updates, and a geospatial portal.

It is generally best practice to use simple language catered to an 8th grade reading level alongside images and symbols to break up the text. OCCHE uses Federal plain language guidelines; a PDF of this resource can also be found in the accompanying supplemental materials folder.

### Periodicals

A PDF that condenses all forecasts, health impacts, and resources a SF4H into a <10-page document allows for easy distribution among healthcare providers and their patients and other audiences. The OCCHE periodical is loosely grouped into sections based on climate hazards, with the first page featuring an “all-hazards” map and descriptions of national-level forecasts by National Climate Assessment (NCA) region. Visit OCCHE’s CHO webpage to view examples of national SF4H periodicals throughout the years.

#### *Showcasing Health Impacts and Actionable Steps to Protect Health*

Every forecast included in a SF4H should be accompanied by an explanation of its potential health impacts, at-risk populations, and steps to protect health.

For example, a drought forecast may be accompanied by an explanation of the health impacts of drought on certain at-risk populations, such as farmers, who may face negative mental health outcomes during periods of drought due to impacts on their livelihoods. It should also include resources on how to mitigate these health impacts, such as information about the Substance Abuse and Mental Health Services Administration’s Disaster Distress Helpline, which provides 24/7 disaster crisis counseling.

#### *Writing and Preparing Feature Stories*

Feature stories have been incorporated into OCCHE’s periodicals to provide real-world examples and expand the reach of the publication through new partnerships. OCCHE selects stories that include timely, relevant, and impactful content for the audience on specific climate-related hazards and works with subject matter experts (SMEs) willing to write or review a

concise (~250 word) piece on the topic. Examples of feature story topics include stories to address climate-driven health threats for specific populations, such as pediatric “hot car deaths” that occur during warmer months, and provide tips for prevention, or stories that highlight diseases predicted to increase due to climate-related events, such as the spread of dengue after a hurricane.

For examples of feature stories created for previous CHOs, please refer to the attached folder of supplemental materials.

### Web Displays

A web version of the content featured in the periodical can provide easy access to hyperlinked resources and create a space to archive content from previous SF4Hs. The main page of OCCHE’s CHO website features a link to the most recent PDF, monthly seasonal forecast summaries for each NCA region, and links to other webpages with content on specific climate-related hazards featured in the publications, as well as links to previous editions.

### Geospatial Tools

Organizations can also develop an interactive geospatial version of monthly forecasts and county-level risk factors. OCCHE developed the Climate and Health Outlook Portal to accompany the monthly publication and make it easier to determine which counties across the country are at risk of specific hazards each month. The tool features interactive maps with county-level heat, wildfire, and drought forecasts for the current month along with county-level data on individual risk factors that may make people more vulnerable to negative health outcomes from these climate hazards.

When clicking on a county that is forecast to experience one or more climate-related hazards in the current month, risk factors will only show up for counties that are both in the top quartile of U.S. counties (i.e., have "a high number of people") for these risk factors **and** are experiencing one or more relevant hazard(s) in the current month. Information on risk factors will not show up for counties that are not forecast to experience heat, wildfire, and/or drought in the current month. See Appendix Table A2 for data sources and additional information on risk factors used in OCCHE’s Climate and Health Outlook Portal.

The forecasts showcased in OCCHE’s Climate and Health Outlook Portal have an Application Programming Interface (API), which allows for the Portal to be automatically updated when new forecasts are released each month. Other organizations may wish to create a geospatial tool that includes additional relevant hazard forecasts or includes forecasts at a different timescale, such as daily or weekly forecasts, for example.

# Appendix

**Table A1: Descriptions of the Public Health Impacts of Specific Climate-related Hazards and At-risk Populations**

| Climate-related Hazard | Description of Public Health Impacts and At-risk Populations |
|---|---|
| Drought | Drought increases the risk for a diverse range of health outcomes. For example:<br>• Low crop yields can result in rising food prices and shortages, potentially leading to **malnutrition**.<br>• Dry soil can increase the number of particulates such as **dust and pollen** that are suspended in the air, which can irritate the respiratory system.<br>• If there isn't enough water to flow, waterways may become stagnant breeding grounds for **disease vectors** such as mosquitoes.<br>• Drought's complex economic consequences can increase **mood**<br>• **disorders, domestic violence,** and **suicide**.<br><br>**People at Elevated Health Risk From Drought Exposure**<br>According to NOAA & CDC, include those who:<br><br>• Have increased exposure to dust (e.g., are experiencing homelessness, work outdoors, or live/work in agricultural communities);<br>• Rely on water from private wells or small or poorly maintained municipal systems, the quality of which is more susceptible to environmental changes; and/or<br>• Have increased biologic sensitivity (e.g., are under age 5, are age 65 or over, are pregnant, have chronic health conditions, and/or have special needs in the event of a public health emergency). |
| Wildfire | Wildland fire increases the risk for a diverse range of health outcomes from both the fire itself and smoke. For example:<br><br>• Due to the nature of their work, firefighters are at risk of developing severe heat-related illness (such as **heat stroke**) and rhabdomyolysis (**muscle breakdown**).<br>• Wildfire can cause **burns** through contact with flames and hot surfaces.<br>• Wildfire smoke can lead to disorders including **reduced lung function**, **bronchitis**, exacerbation of **asthma**, and cardiovascular effects like **heart failure**.<br>• For pregnant people, smoke exposure may increase the risk of **reduced birth weight** and **preterm birth**.<br>• Wildfire smoke may affect the immune system, potentially leading to increased vulnerability to **lung infections**.<br>• Smoke from wildfires can travel downwind and affect air quality hundreds of miles away from the fire. |

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| | **People at Elevated Health Risk From Wildfire Smoke Exposure**<br>According to the EPA include those who:<br>• Have increased biologic sensitivity (e.g., are under age 5, are age 65 or over, are pregnant, and/or have chronic health conditions such as asthma or another lung disease or a cardiovascular disease); and/or<br>• Face economic, social, environmental, and/or other burdens that may limit their ability to reduce exposure (e.g., identify as a racial or ethnic minority, have low-income, have one or more disabilities, and/or work outdoors). |
| Heat | Warmer temperatures increase the risk for a diverse range of health risks. For example:<br>• An increased risk of **heart disease hospitalization**.<br>• **Heat exhaustion**, which can lead to **heat stroke** that, if not treated, can cause critical illness, brain injury, and even death.<br>• Worsening **asthma** and **chronic obstructive pulmonary disease (COPD)** as heat increases the production of ground-level ozone.<br>• Dehydration, which can lead to **kidney injury** and blood pressure problems.<br>• Mental health and substance use risks, including **loss of sleep** and **slowing of brain cognition**, and heightened risk of **increased acute psychiatric and substance use symptoms** among people with chronic behavioral health conditions.<br><br>**People at Elevated Health Risk from Extreme Heat Exposure**<br>According to HEAT.gov and CDC include those who:<br>• Have increased exposure (e.g., are experiencing homelessness; are emergency responders; are athletes; and/or work outdoors, or indoors with insufficient cooling);<br>• Have increased biologic sensitivity (e.g., are under age 5; are age 65 or over; are pregnant; and/or have chronic health conditions such as a mental illness, diabetes, or a cardiovascular condition); and/or<br>• Face high socioeconomic burden and/or barriers to accessing cooling or healthcare (e.g., live in a low-income community and/or have one or more disabilities) |
| Winter Weather | Winter can bring extreme cold, freezing rain, snow, ice, and high winds which can last a few hours or several days.<br>• Those with inadequate indoor heating or clothing coverage, and those who work outdoors are at greater risk of **hypothermia** and **frostbite** with prolonged exposure to excessive cold.<br>• Winter storms can lead to **outages of power, heating, and communication systems**, which can pose safety hazards, especially for people who critically depend on electricity dependent medical equipment.<br>• Using space heaters, fireplaces, or appliances that are not meant for heating, such as ovens or stoves, can increase the **risk of fire** and **worsen indoor air quality**.<br>• Running a generator indoors or outdoors without adequate ventilation can cause carbon monoxide (CO) exposure, which can lead to **loss of** |

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| | **consciousness and death**. Over 400 people die each year from accidental CO poisoning.<br>• Walking or driving on slippery surfaces in the winter can lead to **injuries** and **vehicle accidents**.<br>• Extreme cold can cause pipes to freeze and burst. Standing water from burst pipes can lead to mold growth, which increases risk of respiratory issues, particularly for people with **asthma, allergies**, or **other breathing conditions**.<br>• The combination of cold temperatures, which can increase blood pressure, and potential overexertion while shoveling snow can increase the risk of **heart attack**.<br><br>**Populations at Elevated Health Risk From Winter Weather Extremes**<br>According to NOAA, the National Institutes of Health (NIH), and the Environmental Protection Agency (EPA), populations at elevated risk include:<br>• Infants and young children due to more skin surface area compared to the size of their bodies, which causes them to lose heat quicker than older children and adults;<br>• Older adults due to existing chronic medical conditions and susceptibility to injury with slippery winter surfaces;<br>• People experiencing homelessness, outdoor workers, and others who remain outside for prolonged periods, due to increased exposure;<br>• People with inadequate or wet clothing due to faster loss of body heat;<br>• Individuals with heart disease, high blood pressure, diabetes, asthma, thyroid issues, memory problems, and other conditions due to impacts to circulation, body temperature regulation, breathing in cold air, and/or remembering to take precautions;<br>• People taking medications that can interfere with the body's ability to regulate temperature;<br>• Low-income households who may struggle to afford adequate heating; and<br>• Individuals with disabilities or limited mobility who face increase difficulties in maintaining warmth, accessing essential resources, and/or navigating icy or snowy conditions. |
| Tornados, Flooding, Hurricanes | **Tornadoes**<br>• During a tornado, people face hazards from extremely high winds and risk being struck by flying objects. After a tornado, the damage left behind poses additional injury risks.<br>• It's normal for people to experience emotional distress regarding tornadoes, including due to their unpredictable nature and damage<br>**Flooding**<br>• Contaminated floodwaters pose risks of **injuries**, **infections**, and more. Floods are the second leading cause of weather-related **deaths** in the U.S. (after heat).<br>• Homes damaged by floodwaters may experience the growth of mold and other microbes that can harm respiratory health and worsen **allergies** and **asthma**.<br>• Extreme rain, along with compounding risks such as rising sea levels and more frequent wildfires, is also making landslides more likely. |

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| | Rapidly moving water and debris can lead to **injuries** and **disrupt access to health care**.<br>**Hurricanes**<br>• Hurricanes often cause flooding which poses drowning risks. Storm surge, one type of flooding hurricanes can cause via storm winds pushing coastal water inland, historically is the leading cause of hurricane-related deaths in the U.S.<br>• Winds can blow debris—like pieces of broken glass and other objects—at high speeds. Flying debris is the most common cause of injury during a hurricane.<br>• Loss of power is likely during hurricanes which leads many people to use generators. Using generators improperly can cause carbon monoxide exposure, which can lead to **loss of consciousness** and **death**.<br>• It is common to experience emotional distress in response to hurricanes, especially for people who have struggled with recovery from past storms, children and teens, older adults, and first responders and recovery workers. |
| Vector and Pathogen Ecology | **Tickborne Diseases and Conditions**<br>Tickborne diseases—when a person has been bitten by a tick and gets sick—are increasingly threatening the health of people in the U.S. Tickborne diseases include Lyme disease, anaplasmosis, babesiosis, ehrlichiosis, spotted fever rickettsiosis (Rocky Mountain spotted fever), and tularemia.<br><br>Lyme disease is the most common tickborne illness in the U.S., with an estimated 476,000 Americans diagnosed and treated for Lyme disease each year. Early localized symptoms can include a rash at the site of tick bite (occurring in 70–80% of infected persons), fever, chills, malaise, fatigue, headache, muscle aches, joint stiffness, and swelling of lymph nodes. Patients who have Lyme disease are often not even aware of a tick bite before getting sick. Untreated Lyme disease can progress to disseminated disease and produce a wide range of symptoms including additional rashes, facial paralysis, an irregular heartbeat, and arthritis.<br><br>Tick bites can also lead to conditions such as alpha-gal syndrome (AGS), a potentially life-threatening allergy to red meat and consumer products made from mammals. People with AGS have delayed allergic reactions to a sugar molecule called alpha-gal, which can be found in pork, beef, rabbit, lamb, venison, gelatin, and dairy. Patients with AGS have varying tolerance and sensitivity to products containing alpha-gal, and AGS reactions can vary, ranging from mild to life-threatening.<br><br>**Tickborne Disease Risk Factors**<br>Risk of tickborne disease varies based on time of year, time spent outdoors in tick habitat, and geographic region.<br>• *Time of year:* In areas of the eastern U.S. where Lyme disease is common, people are most likely to be bitten by blacklegged (deer) ticks during two times of the year: from April through July when nymphs are active, and again from September through November when adults are most active, though people can get bitten any time ticks are present. |

- *Time spent outdoors:* Outdoor workers are at increased risk of tickborne diseases if they work at sites where ticks are common. Worksites with woods, bushes, high grass, or leaf litter are likely to have more ticks. Children ages 5 to 15 years are also at increased risk of tickborne diseases, especially if they play in tick-prone areas.
- *Geographic region:* Different climates throughout the U.S. support different species of ticks, which spread different diseases. Overall, the geographic range of infected ticks is expanding, putting an increasing number of communities at risk for tickborne diseases. Although the reported nationwide incidence of Lyme disease remained fairly stable from 2008 to 2019 at approximately 11 cases per 100,000 people per year, Vermont, Maine, Rhode Island, Pennsylvania, and West Virginia saw marked increases in Lyme disease incidence over the 10-year period. Data show that the majority of patients with AGS are adults living in the southern, mid-Atlantic, and midwestern regions.

**Mosquito-Borne Diseases**
Mosquito-borne diseases—when a person has been bitten by a mosquito and gets sick—increasingly threaten the health of people in the U.S. Mosquito-borne diseases include West Nile Virus (West Nile), dengue, malaria, Cache Valley, chikungunya, eastern equine encephalitis, Jamestown Canyon, La Crosse encephalitis, Rift Valley fever, St. Louis encephalitis, and Zika.

West Nile virus is the most common mosquito-borne disease in the continental U.S. Many U.S. counties now report West Nile cases, but the Great Plains and western states are more likely to have high incidence. Approximately 80% of people infected with WNV will not have any symptoms, 20% will experience flu-like symptoms, and less than 1% will develop severe West Nile neuroinvasive disease (WNND), a condition that can lead to death or long-term disability. Older adults and those with compromised immune systems are at higher risk for WNND. Currently, no medicines or vaccines are available for West Nile.

***Vibrio***
*Vibrio vulnificus* (*V. vulnificus*) are bacteria that live in coastal waters. They can get into an open wound of any size through salt water or brackish water (i.e., a mixture of fresh and salt water often found where rivers meet the ocean), or through drippings from raw seafood.

*Vibrio vulnificus* wound infections are rare but serious. Treating these infections can require intensive care or limb amputations. About 1 in 5 people die from the infection. *V. vulnificus* bacteria thrive in warmer waters—especially during the summer months (May to October) —and in moderately salty environments like estuaries.

***Vibrio* Risk Factors**
Anyone can get a *Vibrio* infection, but some medical conditions and treatments can increase a person's risk for infection and severe complications. These include:
- Having liver disease, cancer, diabetes, HIV, or thalassemia
- Receiving immune-suppressing treatments

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| | • Taking medicine to decrease stomach acid levels<br>• Having had recent stomach surgery |
| Pollen | Pollen is an airborne allergen that can affect our health. Pollen exposure can trigger various allergic reactions, including:<br>• Sneezing, runny nose, and congestion.<br>• Red, watery, or itchy eyes.<br>• Asthma or other respiratory illness exacerbation.<br><br>These symptoms have been linked to negative impacts on sleep, daily activities, productivity, concentration, and quality of life. Allergic asthma and seasonal allergies affect approximately 40% of the U.S. population. |

**Table A2: Individual Risk Factor Dataset from OCCHE's Climate and Health Outlook Portal**

| Risk Factor | Relevant Hazard(s) | Justification for Inclusion | Data Source | Data Specifics |
|---|---|---|---|---|
| Number of county residents aged 65 years and over, living alone. | Heat, Wildfire, Drought | Older adults (aged 65 and over), and particularly those who live alone, are at increased risk of negative health impacts from climate-related hazards, including heat, wildfire, and drought. Physical aging processes can make it more difficult for older bodies to tolerate climate-related environmental stressors. For example, as people age, their ability to regulate body temperature decreases, making them more susceptible to extreme heat. Additionally, older adults are more likely to have mobility constraints, rely on electricity-dependent medical equipment, have chronic health conditions, and take medications that make them more vulnerable to climate-related hazards. Older adults living alone are more likely to be socially isolated, which may make it more difficult for them to move to safety or receive medical attention during extreme events. Social isolation may also increase their risk of negative mental health outcomes from climate-related hazards. | U.S. Census American Community Survey: 2021 5-Year Estimates | B11010_005E + B11010_012E |
| Number of county residents | Heat, Wildfire, Drought | Young children and infants (under 5) are at increased risk of negative health impacts from climate-related | U.S. Census American Community | DP05_0005E |

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| aged less than 5 years. | | hazards, including heat, wildfire, and drought. Their bodies and brains are still developing, putting them at increased risk of both physical and mental health impacts from climate-related hazards. They tend to breathe at a faster rate and spend more time outdoors than adults, making them more likely to be exposed climate-related hazards. They also depend on adults for their safety and well-being. | Survey: 2021 5-Year Estimates | |
| Percentage of county residents 18 years and older with current asthma. | Heat, Wildfire, Drought | People with asthma are at increased risk of negative health outcomes associated with climate-related hazards, including heat, wildfire, and drought. Air quality tends to worsen on hot, sunny days due to interactions between sunlight, warm temperatures, and air pollutants. This leads to increased ground-level ozone, which can exacerbate asthma symptoms. Wildfire smoke is harmful to everyone, but is particularly dangerous for people with asthma, leading to increased asthma symptoms and asthma attacks. Drought leads to increased dust and worsened air quality, exacerbating asthma symptoms. | CDC's PLACES | 2020 \| Current asthma among adults aged >=18 years \| Age-adjusted prevalence |
| Percentage of county residents 18 years and older diagnosed with diabetes. | Heat | People with diabetes are at increased risk of negative health outcomes from heat. Certain complications from diabetes, including damage to blood vessels and nerves, can affect sweat glands, preventing the body from cooling effectively. People with diabetes also become dehydrated more quickly; not drinking enough liquids can raise blood sugar, and high blood sugar can increase urination. People with diabetes also rely on insulin, which is less effective if stored in high temperatures. High temperatures can also change how your body uses insulin, so you may need to | CDC's PLACES | 2020 \| Diagnosed diabetes among adults aged >=18 years \| Age-adjusted prevalence |

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| | | test your blood sugar more often and adjust your dose and what you eat and drink when it's hot out. | | |
| Number of county residents 18 years and older reporting 14 or more days of poor mental health per month. | Heat, Wildfire, Drought | People experiencing frequent mental distress may be more at-risk of negative impacts from climate-related hazards, which can exacerbate underlying medical conditions, increase stress, and cause adverse mental health impacts. Climate-related hazards can also disrupt critical public health, healthcare, and related systems that can adversely affect mental health long after the event. People with preexisting mental health conditions are even more vulnerable to adverse mental health impacts leading up to, during, and after climate-related hazard events. | CDC's PLACES | 2020 \| Mental health not good for >=14 days among adults aged >=18 years \| Age-adjusted prevalence |
| Number of county residents with one or more disabilities. | Heat, Wildfire, Drought | People with disabilities are at increased risk of negative health outcomes associated with climate-related hazards, including heat, wildfire, and drought. People with physical disabilities may have compromised mobility that interferes with their ability to move to safety or access medical care during or after a heat or wildfire event. Additionally, risk communication is not always designed or delivered in an accessible format for individuals who are deaf or hard of hearing, who are blind or have low vision, or who have cognitive disabilities, which could prevent these individuals from taking precautions during hazard events. Cognitive disabilities, such as intellectual disabilities, Alzheimer's disease, and dementia, can also impact a person's ability to comprehend symptoms and/or communicate the effects they are experiencing from heat, wildfire, or drought. People who communicate using something other than spoken language, such as people whose | U.S. Census American Community Survey: 2021 5-Year Estimates | B18101_004E + B18101_007E + B18101_010E + B18101_013E + B18101_016E + B18101_019E + B18101_023E + B18101_026E + B18101_029E + B18101_032E + B18101_035E + B18101_038E |

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| | | primary language is ASL and people who use assistive communication devices that may not be available to them during events, may similarly have difficulty communicating effects they are experiencing. | | |
| Number of Medicare beneficiaries in county relying on electricity-dependent durable medical and assistive equipment (DME) and devices to live independently in their homes enrolled in the HHS emPOWER program. | Heat, Wildfire | People who rely on medical equipment that requires an uninterrupted source of electricity, such as portable oxygen, are at increased risk of negative health outcomes due to prolonged power outages during or after extreme heat and wildfire events. Additionally, these individuals may be more likely to have compromised mobility that makes it more difficult for them to seek shelter during these events. | HHS' emPOWER map | By State: Electricity Dependent DME ALL |
| Number of county residents without health insurance. | Heat, Wildfire, Drought | People without health insurance are less likely to receive preventive care for chronic health conditions, such as diabetes, asthma, and cardiovascular disease, which are exacerbated by climate-related hazard events, including heat, wildfire, and drought. Additionally, people without health insurance are less likely to have access to necessary health care during and after climate-related hazard events, putting them at increased risk of negative health outcomes from these hazards. | U.S. Census American Community Survey: 2021 5-Year Estimates | B27010_017E + B27010_033E + B27010_050E + B27010_066E |
| Number of county residents identifying as Not Hispanic or | Heat, Wildfire, Drought | People who identify as a racial or ethnic minority may be more likely to live in areas with social and environmental drivers of health that exacerbate the health impacts of climate-related hazards, such as | U.S. Census American Community Survey: 2021 5-Year | B03002_004E + B03002_005E + B03002_006E + |

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| Latino (Black or African American alone, American Indian and Alaska Native alone, Asian alone, Native Hawaiian and Other Pacific Islander alone, Some other race alone, or Two or more races) or Hispanic or Latino. | | poor air quality. They also may be more likely to live in areas that are exposed to climate-related hazards, such as heat. People who identify as a racial or ethnic minority may also be more likely to have underlying health conditions that increase their sensitivity to climate-related hazards due to systemic racism. | Estimates | B03002_007E + B03002_008E + B03002_010E + B03002_011E + B03002_012E |
| Number of county residents whose household income in the past twelve months was below 200% of the federal poverty level. | Heat, Wildfire, Drought | People living in poverty may be more likely to live in areas with social and environmental drivers of health that exacerbate the health impacts of climate-related hazards, such as poor air quality. They also may be more likely to live in areas that are exposed to climate-related hazards, such as heat. People living in poverty also may have less capacity to prepare for and respond to climate-related hazards and may be less able to access health care during and after climate-related hazard events. | U.S. Census American Community Survey: 2021 5-Year Estimates | S1701_C01_042E |
| Number of county residents living in mobile homes. | Heat, Wildfire, Drought | People who live in mobile homes are more likely to be older adults, households with small children, racial and/or ethnic minorities, households of lower socioeconomic status, and households where English is not the primary language, which are populations that are more at-risk of negative health outcomes from climate-related hazards. People living in mobile homes are more likely to be exposed to extreme | U.S. Census American Community Survey: 2021 5-Year Estimates | B25033_012E + B25033_006E |

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| | | temperatures during heat events due to high density and lack of green space in mobile home parks and substandard construction of older mobile homes. Mobile home parks are also more likely to be in areas of high future wildfire risk and are more likely to rely on groundwater, which can be unreliable during severe droughts. | | |
| Rate (per 100,000 population) of primary care physicians in county. | Heat, Wildfire, Drought | People living in areas without adequate access to health care and health care professionals may have increased risk of poor health outcomes due to difficulty receiving care. These health outcomes may be exacerbated by climate events, including heat, wildfire, and drought. People living in areas with low access to health care may also experience a delay in receiving care during and after a climate-related hazard event, putting them at increased risk of negative health outcomes from these hazards. | HRSA's Area Health Resources Files | By State: 2021-2022 Primary Care Physicians |
| Energy burden estimate for households 0-100% of the federal poverty level (inclusive of all building types, fuel types, and building ages) as percentage of income (0-3%, 3-4%, 4-5%, 5-6%, 6-8%, 8-15%) in county. | Heat, Wildfire | People who are energy burdened or spend a large proportion of their income on home energy costs may not have access to reliable and affordable energy when they need it most during climate-related events. They may not be able to afford electricity or air conditioning during heat waves or periods of poor air quality from wildfire smoke, which puts them at increased risk of exposure to these climate-related hazards. Low-income households are more likely to be energy burdened than those with higher incomes, and they may also live in housing without adequate insulation or outdated appliances, which increases their energy needs during climate-related hazard events. | DOE's Low-Income Energy Affordability Data Tool | Map regions: counties |
| Number of county residents in the civilian | Heat, Wildfire, Drought | People who work outdoors, such as those who work in construction, agriculture, transportation, emergency response, or other | U.S. Census American Community Survey: 2021 | S2401_C01_020E + S2401_C |

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| employed population 16 years of age or older working outdoors in: protective service occupations; building and grounds cleaning and maintenance occupations; farming, fishing, and forestry occupations; construction and extraction occupations; installation, maintenance, and repair occupations; transportation occupations; and material moving occupations. | | occupations, are more likely to be exposed to climate-related hazards. Therefore, outdoor workers are at increased risk of heat-related illness, as well as respiratory illnesses from exposure to air pollutants caused by heat, wildfire smoke, and drought. In addition to physical health impacts, those who work outdoors may also be at increased risk of adverse mental health impacts from climate-related hazards, such as agricultural workers during periods of drought or firefighters during wildfire events. | 5-Year Estimates | 01_024E + S2401_C01_030E + S2401_C01_031E + S2401_C01_032E + S2401_C01_035E + S2401_C01_036E |
| Average percent of county land that is covered by developed imperviousness. | Heat, Wildfire, Drought | People living in areas with high amounts of impervious surfaces are more likely to be exposed to extreme heat due to the heat-trapping nature of these surfaces. They are also more likely to be exposed to poor air quality due to the lack of vegetation in these areas, making them more at-risk of negative health impacts from climate-related hazards that decrease air quality, including heat, wildfire, and drought. | CDC's National Environmental Public Health Tracking Network | Community Characteristics > Land Cover > Average Percent of Developed Imperviousness \| National By County \| 2021 |
| Three-year average PM2.5 | Heat, Wildfire, Drought | People living in areas with high levels of PM2.5 have an increased risk of certain health conditions, | CDC's National Environmenta | Air Quality > National Ambient |

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| ambient air concentration in county. | | such as cardiovascular and respiratory diseases, that put them at increased risk of negative health impacts from climate-related hazards. People living in areas with high levels of PM2.5 are also more likely to be members of populations that are more at-risk of negative impacts from climate-related hazards, including racial and/or ethnic minorities and low-income populations. | l Public Health Tracking Network | Air Quality Standards > PM2.5: Percent of Days over Air Quality Standard (Monitor + Modeled Data) \| National By County \| 2019 |
| Percent of county population living in census tracts with EJI scores ≥ 0.75 & number of county residents living in census tracts with EJI scores ≥ 0.75. | Heat, Wildfire, Drought | Cumulative impacts are the total harm to human health that occurs from a combination of environmental burden, pre-existing health conditions, and social factors. People living in communities experiencing high cumulative impacts of environmental injustice may be more at-risk of exposure to climate-related hazards, more sensitive to the health impacts from climate-related hazards and may have less ability to adapt to the impacts of climate-related hazards. | CDC's Environmental Justice Index | Information on RPL_EJI (census tract-level Environmental Justice Index) available at https://www.atsdr.cdc.gov/placeandhealth/eji/technical_documentation.html |