

SECTION 12

How Will Climate Change Affect Human Health in Washington?

Studies of climate change impacts on human health in the Pacific Northwest are limited. Research to date finds that climate change is likely to increase rates of heat related illnesses (including heat exhaustion and stroke); respiratory illness (e.g., allergies, asthma); vector-, water-, and food-borne diseases; and mental health stress. These impacts can lead to increased absences from schools and work, emergency room visits, hospitalizations, and deaths. Efforts to adapt Washington's public health systems are in the early stages due in part to the limited information available to agencies.

- 1. Climate change is expected to affect both the physical and mental health of Washington's residents by altering the frequency, duration, or intensity of climate-related hazards to which individuals and communities are exposed.**^{[A][1]} In some cases (e.g., disease vectors), climate change may also lead to the introduction of new risks.
 - *Health impacts are under-studied.* A small but growing number of local studies provide more regionally-specific information about the types and scale of human health impacts likely to be experienced in the Pacific Northwest as a result of climate change. However, the area remains under-studied and no studies on the individual and societal costs of climate change impacts on human health have been done to date in the Pacific Northwest region.
 - *Health impacts stem from a wide range of projected climate change impacts.* Human health in Washington State is likely to be affected by projected increases in extreme heat events, flooding, sea level rise, drought, and forest fires; increased allergen production and summer air pollution; and changes in the types, distribution, and transmission of infectious diseases (e.g., West Nile Virus) and fungal diseases (Table 12-1).
 - *Health impacts are diverse.* Anticipated health impacts include higher rates of heat related illnesses (including heat exhaustion and stroke); respiratory illness (e.g., allergies, asthma); vector-, water-, and food-borne diseases; and mental health impacts.^{[1][2]} These impacts can lead to increased absences from schools and work, emergency room visits, hospitalizations, and deaths.
 - *Some populations are more vulnerable to health impacts.* Vulnerable populations include those over age 65, children, poor and socially isolated individuals, the mentally ill, outdoor laborers, and those with cardiac or other underlying health problems (e.g., asthma or reduced immunity due to chemotherapy, illness, or disease).^{[1][2]}

^A Unless otherwise noted, material in this document is derived or directly quoted from Bethel et al. 2013,^[1] prepared as part of the U.S. National Climate Assessment.

2. Washington’s state and local governments are in the early stages of identifying how climate change may affect human health and public health infrastructure.

- *Washington State Dept. of Health.* The Washington State Department of Health is:
 - developing strategies to support enhanced emergency preparedness and response, specifically focused on heat waves;
 - looking at ways to enhance how the agency can track air quality and disease to detect and address public health threats; and
 - partnering with communities to build environments that manage growth, decrease urban sprawl, support efficient transportation modes, and offer protection from flooding and landslides.^[3]

The Department of Health has also developed the Washington Tracking Network (WTN), which is part of a national effort to develop better and more integrated ways of sharing environmental public health data that can be used to track and analyze climate-related health impacts over time.^[B]

- *King County.* Health-related adaptation activities at King County include the following:
 - *Climate change health indicators.* King County is tracking human health and economic impact indicators to help monitor how climate change may be affecting key issues in the County.^[C]
 - *Heat impacts assessment.* King County is partnering with the University of Washington to identify and plan for the impact of climate change on human health, including synthesizing data on the effects of changing temperature on illness and death in King County.^[4]

^B See <https://fortress.wa.gov/doh/wtn/WTNPortal/Help/AboutTracking.aspx> for more information.

^C More information available at: <http://www.kingcounty.gov/environment/climate/climate-change-resources/impacts-of-climate-change/health-economic-impacts.aspx>

Table 12-1. Summary of projected Pacific Northwest climate change impacts and related projected human health impacts, based on Bethel et al. 2013^[1] and other sources. More details, where available, on the projected climate change impacts listed here are included in other sections of this report. Few studies have been conducted to date on climate change impacts to human health in the Pacific Northwest. The health impacts listed here represent examples rather than an exhaustive list of potential impacts.

Projected Climate Change Impact		Related Human Health Impacts
General Trend	Specific Changes Projected	
More extreme heat events ^[D]	<ul style="list-style-type: none"> The number and duration of days above 90°F increases throughout the state.^[5] Increases in number of days in Washington above 95°F annually range from less than 3 days to up to 10 days by 2050s, compared to 1980-2000, depending on the greenhouse gas scenario and location.^{[E][5]} 	<p>Increased potential for:^[1]</p> <ul style="list-style-type: none"> worsening of existing problems with respiratory illness, cardiovascular disease, and kidney failure; more heat exhaustion, heart attacks, strokes, and drownings; and more heat related deaths, although the projected numbers vary widely. <p>Related information:</p> <ul style="list-style-type: none"> One study for the greater Seattle area projected an additional 157 annual heat-related deaths by 2045 under a moderate (A1B) greenhouse gas emissions scenario.^{[F][2]} Another study projected only an additional 14 annual heat-related deaths in Seattle for approximately the same time period under a very high (A1FI) emissions scenario.^{[G][6]}

^D The temperature thresholds used to define an extreme heat event will vary by location. The thresholds used for Seattle and Spokane in Jackson et al. 2010 were 92.5°F and 100.6°F, respectively. For more on projected changes in extreme events, see this report’s section on projected Pacific Northwest climate.

^E Greenhouse gas scenarios were developed by climate modeling centers for use in modeling global and regional climate impacts. These are described in the text as follows: "very low" refers to the RCP 2.6 scenario; "low" refers to RCP 4.5 or SRES B1; "medium" refers to RCP 6.0 or SRES A1B; and "high" refers to RCP 8.5, SRES A2, or SRES A1FI – descriptors are based on cumulative emissions by 2100 for each scenario. See Section 3 for more details.

^F Study inclusive of King, Pierce, and Snohomish Counties. Projected change in mortality for those over age 45, relative to a base period of 1980-2006. Projections based on the average of the climate change scenarios derived from two global climate models and two greenhouse gas emissions scenarios: the PCM model run with the B1 emissions scenario and the HADCM1 model run with the A1B emissions scenario. Population levels were held constant at year 2025.

^G Projected change in mortality relative to a base period of 1975-95. Projections cited here based on modeling of the A1FI greenhouse gas emissions scenario with the PCM global climate model.

Projected Climate Change Impact		Related Human Health Impacts
General Trend	Specific Changes Projected	
Increased winter flooding^[H]	<ul style="list-style-type: none"> • More winter flooding is expected west of the Cascades. The largest projected changes are found in mid-elevation mixed rain and snow basins, which are most sensitive to warming winter and spring temperatures.^{[I][7]} • Some higher elevation snow dominant watersheds will see increasing flooding, while others experience decreased flooding.^[7] 	Increased potential for: ^[1] <ul style="list-style-type: none"> • injuries and death, • exposure to hazardous and toxic substances released and spread by flooding, • respiratory illness from mold and microbial growth in flood-impacted structures, • contamination of, or disruption to, public water supplies,^[8] • mental health impacts^[J] associated with damage to homes, communities, places of employment.
Increased drought^[H]	<ul style="list-style-type: none"> • Lower summer streamflows, warmer summer temperatures, and earlier spring snowmelt contribute to increased risk of drought, particularly in eastern Washington. • Drought impacts can affect food production, the potential for wildfire in forests and rangeland, water supply, and water quality. 	Increased potential for: ^[1] <ul style="list-style-type: none"> • respiratory illness associated with increased forest fires (see next row), • reduced water supplies, including impacts to groundwater supplies used by private wells, and • mental health effects.

^H For more on projected impacts on Pacific Northwest hydrology, see Section 6.

^I Projections for specific Washington locations can be found here: <http://warm.atmos.washington.edu/2860/products/sites/>

^J Mental health impacts are common to most climate change impacts. Potential mental health impacts include: emotional and psychological stress associated with weather-related trauma, including loss of homes or places of employment, financial concerns, recovery and rebuilding, family pressure, loss of leisure and recreation, loss of security; physical impacts of stress, including post-traumatic stress disorder, high blood pressure, and unhealthy coping mechanisms (e.g., increased alcohol or tobacco use, poor dietary habits); non-trauma related anxiety and depression related to feelings of losing control over a situation, or uncertainty about the future; and grief and despair over the loss, or potential loss, of culturally important resources, traditions, or places.

Projected Climate Change Impact		Related Human Health Impacts
General Trend	Specific Changes Projected	
Increased forest fires^[K]	<ul style="list-style-type: none"> • Most models project increases in the amount of area burned in Washington by forest fires. The projected change is less than 100% to greater than 500% by mid-century.^[9] • Risk of fires is greatest east of the Cascades, but air quality around the state is affected. 	<p>Increased potential for:^[1]</p> <ul style="list-style-type: none"> • more asthma, bronchitis, and pneumonia hospital admissions; • missed school and work days; • mental health effects due to potential or actual loss of property and disruptions to communities. <p>Related information:</p> <ul style="list-style-type: none"> • Smoke from the 2012 wildfires in Chelan and Kittitas Counties contributed to an additional 350 hospitalizations for respiratory conditions and 3,400 student absences from school.^[L] • Studies in California found that fine particulate matter concentrations in the air were higher and more toxic during wildfires that occurred in 2003 and 2007.^[10]
Increased production of allergens	<ul style="list-style-type: none"> • The pollination season is projected to lengthen.^{[11][12]} • The amount of allergy-causing proteins in pollen is also projected to increase.^[12] 	<p>Increased potential for:^[1]</p> <ul style="list-style-type: none"> • more severe and longer-lasting allergy symptoms; • asthma attacks, and • missed school and work days.
Increased air pollution	<ul style="list-style-type: none"> • Warmer summer air temperatures are expected to lead to the production of more ground-level ozone, particularly in urban areas. This could slow air quality improvements made in recent decades in urban areas.^[2] 	<p>Increased potential for:^[1]</p> <ul style="list-style-type: none"> • Cardiovascular disease, respiratory disorders (e.g., asthma), and mortality. <p>Related information:</p> <ul style="list-style-type: none"> • Under a high emissions scenario (A2), the annual number of additional May-September deaths due to ozone is projected to increase from 69 in 1997-2006 to 132 by mid-century in

^K For more on projected impacts on Pacific Northwest forests and forest fire risk, see this report's section on forests.

^L Glen Patrick, Manager of the Environmental Epidemiology, Washington State Dept. of Health, personal communication

Projected Climate Change Impact		Related Human Health Impacts
General Trend	Specific Changes Projected	
		King County, and from 37 (1997-2006) to 74 in Spokane. ^[2]
Infectious, vector-borne, and fungal diseases	<ul style="list-style-type: none"> Higher temperatures may increase the incidence of West Nile virus. The impact of climate change on Lyme disease, hantavirus, malaria, and dengue in the PNW is unknown.^[1] Warmer ocean temperatures increase the risk of <i>Vibrio parahaemolyticus</i> outbreaks in oysters and shellfish, which can cause illness in humans.^[1] Projected increases in precipitation and flooding increase the potential for <i>Cryptosporidium</i> contamination in water supplies.^[1] 	<p>Increased potential for:^[1]</p> <ul style="list-style-type: none"> More illness and mortality associated with infectious diseases. <p>The emergence of new diseases and/or expansion of existing diseases is expected to exacerbate these impacts.</p>
Harmful Algal Blooms (HABs)	<ul style="list-style-type: none"> Models project the window of opportunity for <i>A. catenella</i>, which can cause illness or death via paralytic shellfish poisoning, in Puget Sound to increase by an average of 13 days by the end of the century under a moderate (A1B) greenhouse gas emissions scenario.^[13] 	<p>Increased potential for:^[1]</p> <ul style="list-style-type: none"> More illness and mortality associated with infectious diseases.
Sea Level Rise	<ul style="list-style-type: none"> Sea level is projected to increase +4 to +56 inches overall in Washington State by 2100, relative to 2000, although some locations may experience sea level fall because of uplift caused by plate tectonics.^{[M][14]} Associated impacts with the potential to impact human health include inundation of low-lying areas, increased coastal river flooding, increases in the frequency of today's extreme tidal/storm surge events, and changes in coastal habitats that may affect culturally and economically important species. 	<p>Increased potential for:^[1]</p> <ul style="list-style-type: none"> Mental health stress associated with storm surge damage and loss of culturally or economically important areas to inundation, erosion, or storm surge. Reduced drinking water quality due to saltwater intrusion into coastal aquifers and rivers.

^M Mean value: +24 inches (\pm 12 inches) for a moderate (A1B) greenhouse emissions scenario for 2100, relative to 2000. The range values reported in the table are for the lowest (B1) to the highest (A1FI) greenhouse gas emissions scenarios used prior to the release of the CMIP5 RCP scenarios. For more on sea level rise and coastal impacts, see this report's sections on projected Pacific Northwest climate and projected impacts on oceans and coasts.

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