



Testimony of Georges C. Benjamin, MD
Executive Director
American Public Health Association
The Costs of Climate Change: From Coasts to Heartland, Health to Security
Before the Committee on the Budget
United States House of Representatives
July 24, 2019

Chairman Yarmuth, Ranking Member Womack, and members of the committee, I thank you for inviting me to testify today on the serious public health threats we face from climate change, including those we are already facing today.

The American Public Health Association is a diverse community of public health professionals that champions the health of all people and all communities. We speak out on public health issues and policies backed by science. We are the only organization that combines a nearly 150-year perspective, a broad-based member community and the ability to influence policy to improve the public's health. APHA has been involved in advocating for climate change mitigation and adaptation strategies for more than two decades. Educating the public health community and the public about the serious health impacts of climate change and advocating for science-based solutions is a top priority for the association, and APHA declared 2017 the Year of Climate Change and Health, a yearlong initiative to raise awareness of the health impacts of climate change and to mobilize action to address this serious public health issue.

Climate change is here today, is threatening our health now, and, if left unchecked, will lead to increases in both illnesses and deaths. Immediate action can and must be taken to both mitigate the effects of climate change over time and adapt our communities in ways that reduce the health impacts now to protect our health. APHA strongly supports measures to reduce carbon pollution and other greenhouse gas emissions from all sectors, including energy production, transportation, health care, forestry, and agriculture.¹ In addition to mitigation efforts, APHA believes it is critical that the federal government provide technical assistance, tools and resources to help states, cities and rural communities, territories, and tribes prepare for and protect their communities from the health impacts of climate change.

The fourth National Climate Assessment, which was completed in 2018, details the health impacts of climate change in the United States and says “The health and well-being of Americans are already affected by climate change, with the adverse health consequences projected to worsen with additional climate change. Climate change affects human health by altering exposures to heat waves, floods, droughts, and other extreme events; vector-borne, food-borne and water-borne infectious diseases; changes in the quality and safety of air, food, and water; and stresses to mental health and well-being.”

In October 2018, the United Nations Intergovernmental Panel on Climate Change released their latest conclusions, underlining the impact of climate change on the world now and in the future.² The report confirms that actions underway now will not be enough to protect against the ongoing and growing risk to public health: more, stronger, faster steps must be taken to further limit warming to below 1.5° C. The Intergovernmental Panel on Climate Change provided strong recommendations of more aggressive actions needed to reduce greenhouse gas emissions and increase the use of clean, renewable energy

sources. According to the fifth assessment report from the IPCC, warming of the earth over the past century is “unequivocal” and is “unprecedented over decades to millennia.”³

The most recent National Climate Assessment conducted by the U.S. Global Change Research Program highlights the fact that recent years have seen “record-breaking, climate-related weather extremes, and the last three years have been the warmest years on record for the globe. These trends are expected to continue...”⁴ The long-term threat of climate change to health is both serious and urgent, and the IPCC special report, the IPCC fifth assessment, the fourth National Climate Assessment, and other scientific documents demonstrate convincingly that greenhouse gas emissions, due to human activity, are primarily responsible for this threat.

Climate change poses risks to human health^{i, 5}

Climate change poses many risks to human health. Some health impacts of climate change are already being felt in the United States, including those linked to:

Extreme heat⁶

Exposure to extreme heat kills more people in the U.S. than any other weather-related threat,^{7,8} and extreme heat events are on the rise. By 2050, one estimate predicts approximately 3,400 more premature deaths each year in the U.S. due to extreme heat.⁹ The burden of heat-related illness and death disproportionately affects climate-sensitive populations like pregnant women, the young and old, the chronically ill, minorities, low-income families, and outdoor workers.⁸ Just one heat wave event can cost \$179 million in hospitalizations, emergency department encounters, and outpatient visits.¹⁰

Extreme heat events can trigger a variety of other heat-related conditions, from severe dehydration, to heat syncope to heat stroke. High heat conditions can also exacerbate cardiovascular and respiratory disorders, resulting in hospitalization and even premature death. Also, extreme heat is linked to increased aggression, raising the number of assaults, murders, and suicides.^{11,12}

The built environment plays a role in the severity of heat-related events because of the urban heat island effect. Climate change can worsen heat effects due to less-reflective, impervious surfaces, which make urban settings more deadly than vegetative, rural communities.¹³ This issue of land use needs to be more actively addressed as the planet warms. Adaptation also requires considerable emergency planning and risk communications to inform the public, identify people most at risk, and respond with proactive measures to get people out of the heat. This requires a range of community tools such as cooling centers, water distribution, fan and air-conditioning unit distribution, and even relocation of at-risk people. Battling heat-related health threats requires considerable amounts of funding. As extreme heat events become more frequent and intense, health effects will worsen, and health care costs will rise. However, some public health interventions are well worth the investment because they are so cost-effective. For example, Ebi et al. reported that the cost of running a heat–health warning system for Philadelphia was relatively small (\$210,000) compared with the benefits of saving 117 lives (\$468 million) over the three-year period of 1995–1998.¹⁴

Vector-borne disease¹⁵

Greater rainfall and warmer temperatures influence the scope of diseases borne by vectors, such as pathogen-spreading ticks and mosquitoes. Dengue, malaria, yellow fever, West Nile, and Zika virus are

ⁱ **All APHA fact sheets on climate change and health available at: <https://www.apha.org/publications-and-periodicals/fact-sheets#climate>**

vector-borne diseases carried by mosquitoes. Ticks can carry the bacterium that causes Lyme disease. Warmer temperatures broaden the geographical ranges of vectors and introduce disease risks to new regions. Greater rainfall and warmer weather create conditions that are more hospitable for vector-borne disease carriers to multiply.

Addressing the spread of vector-borne diseases will require additional monitoring and surveillance, reinvestments in vector control programs, and strengthening of the infectious disease control capacity of state and local governmental public health agencies. Further, extensive education of local health care providers concerning these new and reemerging infectious disease threats is essential. Also, we must provide improved health education measures for individuals and families in the community concerning prevention and protection measures to reduce the risk of vector-borne diseases.

Air quality^{16,17}

Climate change affects human health by increasing ground-level ozone and particulate matter air pollution. Ground-level ozone, a key component of smog, is associated with many health problems, including reduced lung function. Air pollution increases the risk of health complications from cardiovascular disease and respiratory conditions like asthma and chronic obstructive pulmonary disease. Increased carbon dioxide also causes increased pollen potency, leading to a longer and more intense allergy season. Asthma attacks are a major cause of school absenteeism, and, therefore, climate change has an indirect impact on children's education. This is especially troubling considering the fact that educational attainment is strongly link to improved health.

The cheapest way to reduce the health impact from air pollution is to address the factors that cause it. Major causes of air pollution include the burning of fossil fuels, power plant emissions, and automobile exhausts. Minimizing damage from air pollution is an important step to reduce health impacts and health care costs. It is critical to engage with federal, state, and local officials, planners, and local organizations to better educate residents on air quality and develop community design solutions to improve air quality.

Flooding and water quality¹⁸

Marine bacteria that make humans sick are more likely to survive and thrive as oceans get warmer. Heavy downpours contribute to increases in severe flooding and combined sewer overflows. Local officials and planners must restrict development in flood-prone areas, incorporate design elements that better handle storm water runoff, and establish strong evacuation plans.¹⁹ Floodwaters can become contaminated with agricultural waste, chemicals, and raw sewage carrying disease-causing bacteria, parasites, and viruses. With flooding and poor water quality come injury and illness.

Public health has an important role to both monitor water quality and work with other agencies to ensure the public's health is protected from water-borne contaminants. Floods increase the burden on the public health system to monitor and test drinking and recreational water for harmful contaminants, track water contamination in agricultural waste that may lead to food-borne illness, and also to educate as well as notify the public about water-borne hazards or outbreaks. As climate change exacerbates water quality issues, it is critical that the public and environmental health workforce has the capability and capacity to conduct routine surveillance, monitoring, and risk communications to affected communities.

Drought and wildfires^{16,20}

Certain health hazards occur in drought conditions, including wildfires, dust storms, reduced air quality, extreme heat events, flash floods, and degraded water quality. Drought risk reduction is an immense

undertaking for a community. Concerted efforts must be made to identify vulnerable communities and strengthen community resilience to mitigate health consequences in the event of drought and wildfires.

Wildfires associated with drought conditions degrade air quality. Exposure to wildfire smoke and dust storms increases medical visits, hospitalizations, and emergency department visits for respiratory and cardiovascular symptoms of asthma, bronchitis, chest pain, chronic obstructive pulmonary disease, respiratory infections, and medical visits for lung illnesses.

Climate change increases the number and intensity of costly and destructive wildfires. The 2017 U.S. wildfire season caused historical damage, burning 9.8 million acres and killing at least 44 people. The wildfire health damages estimate for the U.S. in 2017 has yet to be fully calculated, but time periods with less active wildfires (2008-2012) still accounted for a staggering \$87-\$150 billion in damages per year.²¹

Severe storms: Hurricanes and tornadoes

Severe storms are also increasing in frequency and intensity due to climate change, and this is affecting children disproportionately.²² Infrastructure damage and compromised physical health undermine survivors' mental health. Severe storms impact the health of a community in several ways. For instance, acute traumatic injury from a storm can be caused by an injury during clean up, exposure to toxic chemicals, irritation or respiratory issues caused by fires and burning debris, and/or exposure to infectious disease from food and water contamination. Moderate and long-term health impacts occur due to loss of health care infrastructure, from closed primary care offices and clinics to reduced access to hospital services because of blocked roads, loss of power and supply chain disruptions. The health impacts of severe storms can be significant as we experienced with Hurricanes Katrina and Rita, Superstorm Sandy, and Hurricanes Wilma and Maria. Health impacts can be severe, prolonged, and result in numerous deaths. For example, Hurricane Maria caused an estimated \$90 billion in damage²³ and up to 5,740 deaths²⁴ when it made landfall in Puerto Rico in 2017.

Impacts on mental health

Natural disasters may cause post-traumatic stress disorder, anxiety, depression, and stress. Self-harm, including substance abuse and suicidal ideation, may also occur as people try to cope. After a climate event or resulting displacement, people may experience a diminished sense of self, difficulty relating to others, diminished social interaction and solastalgia (the loss of a sense of place, solace, and security tied to one's physical environment). Community impacts include domestic abuse, child abuse, and violence (e.g., assault and civil conflict). Economic insecurity and physical damage are other potential effects.²⁵

While public health programs focus on providing short-term assistance during and after major climate events, the public also needs long-term strategies to cope with the strain that increasing, ongoing climate change events have on mental health and psychosocial well-being. As public health departments develop climate adaptation plans, building adaptation measures to lessen the mental health burden will best serve their vulnerable populations, particularly in the long run.

The human health effects of climate change have a disproportionate impact

Vulnerable populations, such as communities of color, older adults, young children, the sick, and the poor, bear the greatest burden of disease and death risks related to climate change. The existing conditions that cause worse health among these populations – unhealthy air, water, and living conditions, heat, drought, flooding, and mental health stresses – are exacerbated by the adverse effects of climate change.⁶

The impacts of climate change on health are significantly moderated by individual and community vulnerability and resilience. Two critical components of climate vulnerability are pre-existing health status and living conditions. In the United States, these factors are shaped by economics and the distribution of money, power, social policies, and politics at the global, national, state, and local levels. They differ by place, race, and income, as a result of inequities in the distribution of money and power, historical disinvestment in some communities, discriminatory practices and policies over time, structural racism, higher pollution burdens, and lesser access to resources for health. Therefore, low-income communities and communities of color are two populations disproportionately affected by the health impacts of climate change.

Children and older adults

Also, children and older adults are more susceptible to heat stress, as they have a harder time regulating their body temperature. Infants have four times the rate of heat-related deaths when compared to people 1-44 years old.²⁶ Children tend to be outside more often and breathe in more air than adults, which increases their risk to the climate effects of air pollution, and may result in asthma and allergies.²⁶

Low-income populations

Low-income populations are at increased risk due to lack of resources such as owning and running air conditioning or the ability to relocate due to climate change events.²⁷

Communities of color

Communities of color are more vulnerable to climate change as well, due to factors such as historical and current systems of inequities. For example, black communities tend to have fewer trees and more heat-trapping pavement and “the rate of heat-related deaths in African Americans is 150–200% greater than that for non-Hispanic Whites.”²⁷ Climate change is negatively impacting our air quality, and this is particularly true for communities of color. Consider that “Nearly 1 in 2 Latinos live in counties with poor air quality. Latino children are twice as likely to die from asthma as non-Latino whites.”²⁷ Due to sea level rise, many coastal communities and those living in Hawaii and some Pacific Islands, are or will have to migrate. They are also greatly impacted by extreme weather events, which are becoming more and more frequent, and can cause disruptions to essential health services.²⁸

Rural communities

The fourth National Climate Assessment identified rural communities as vulnerable to the adverse health impacts of worsening climate change. And rural America is already experiencing the health impacts of climate change. Extreme storms damage local levees and roads, and fires and other weather-related disasters result in large-scale losses.^{29,30} These events further isolate and stress already strained communities and contribute to a greater reliance on federal aid in the event of disaster. Geographic and demographic obstacles like physical isolation, limited economic diversity, and higher poverty rates, combined with an aging population, increase the climate change vulnerability of rural communities.³¹

Climate change threatens the natural resources upon which rural communities are dependent for economic activities like agriculture, forestry, and recreation. Severe droughts and flooding decimate crops and livestock that many rural communities rely on for their livelihoods and sustenance. Warming temperatures further strain agricultural communities in unprecedented shifts in planting and harvesting times. Local officials in rural communities have limited institutional capacity to update transportation, health, and emergency response systems that would strengthen their climate resilience. Rural areas are

often characterized by higher unemployment and less diversified economies, making them particularly dependent on government transfer payments.

Northern Native American/Alaska Native communities

Alaska Native villagers are being forced to migrate, causing them to become some of the first climate refugees. Alaska is “among the fastest warming regions on Earth,”³² and 86% (184 out of 213) of Alaska Native villages are affected by flooding and erosion, partly due to rising temperatures.³³

Alaskan coastal villages are subject to increased flooding and erosion due to depleting ice shelf, and these warmer temperatures may introduce new disease carrying vectors. In just five years, the coast of Alaska’s Beaufort Sea has more than double in its erosion.³⁴ Some coastal villages have also been swamped, and plant, fish, and animal populations are adapting to the thawing tundra.³⁵ For example, harmful algal blooms tend to increase during warmer summer months, resulting in marine biotoxins that act as poisons. These biotoxins poison shellfish, which is a source of sustenance and used for ceremonial purposes and commercial harvest for the Lummi tribe of Washington state.³⁶

Outdoor workers

According to U.S. Bureau of Labor Statistics, the U.S. has upwards of 1,000 occupational heat-related illnesses each year. Additionally, there are over 350 civilian worker deaths cited over the past 10 years due to heat exposure.³⁷ Agricultural workers are especially at increased risk of being exposed to extreme heat, leading to dehydration, heat exhaustion, and heat stroke. Emerging research has shown exposure to heat on a regular basis, along with regular physical exertion, can result in chronic kidney disease.^{38, 39} Higher rainfall and temperatures have been shown to decrease worker productivity and an increase in sick leave.⁴⁰ “Studies have shown that the mental health of workers in susceptible occupations can be significantly affected by increasing weather fluctuations associated with changes in climate. A positive association has been found between suicide rates among farmers and the severity of drought conditions.”⁴¹

In-depth analysis of data observed between 2005 and 2010 from Los Angeles County, California, uncovered a notable correlation during the summer months between outdoor workers and heat-related hospitalizations and emergency department visits. The research cited: “each percentage increase in residents working in construction resulted in an 8.1 percent increase in heat-related ED visits and a 7.9 percent increase in heat-related hospitalizations during summer heat events, while each percentage increase in residents working in agriculture, forestry, fishing and hunting, and mining resulted in a 10.9 percent increase in heat-related ED visits.”⁴²

Fiscal Impacts

Emerging data indicate that health, social and economic costs of climate change are vast, with one study estimating health costs of six climate related events at approximately \$14-40 billion, which is consistent with costs from other weather and climate disasters.⁴³

The U.S. has increased the funds spent on adaptation and resilience to climate change by 5% from 2015-2016, spending a total of \$67.2 billion. Of this total spending, the U.S. spent 5% (\$3.5 billion) on health adaptation of climate change, which refers to formal health care sector adaptation only. Fourteen percent (\$9.4 billion) of these funds were spent on health-related adaptation for climate change, which includes the health care sector as well as agriculture and disaster preparedness.⁴⁴

A combined \$80 billion for insured losses and \$94 billion in uninsured losses were due to climate-related extreme events in 2017.⁴⁴ The costs to the federal budget from insurance programs such as Medicare, Medicaid, the Veterans Health Administration, and the Department of Defense health programs are unclear, however. One can anticipate that they will be substantial as the health impact from climate change grows. Billions of dollars have been lost due to climate and weather disasters in the United States. The year 2017 saw a record-tying 16 major events. This costs approximately \$313 billion, which includes damage calculations for insured and uninsured losses, such as structural and agricultural.²³ Notably, the health costs such as people's mental and physical health from these events were not accounted for.^{45, 46}

The highest risk for occupational heat-related deaths are agricultural and construction workers.⁴⁷ According to one estimate by the U.S. EPA, "there could be an annual loss of 880 million labor hours and \$44 billion in lost wages in 2050" compared to 2005.¹² Costs to the system for workers' compensation should also be recognized as an additional cost.

Recommendations

We believe the following are important steps Congress, the administration, and the private sector can and should take to address the threat of climate change from a public health perspective.

1. Reduce carbon and other greenhouse gas emissions.

Urgent action is needed to address climate change by cleaning up major sources of carbon pollution and other greenhouse gases, including power plants, cars, trucks, and other mobile sources. Any proposed policy must: adopt science-based targets to prevent climate change above 1.5 degrees Celsius; maximize benefits to health, reducing carbon and methane pollution at the same time that they reduce other dangerous air emissions from polluting sources; ensure pollution is cleaned up in all communities, including those near polluting sources that have historically borne a disproportionate burden from air pollution; and maintain EPA's authority under the Clean Air Act to reduce greenhouse gas emissions. Unfortunately, the current administration continues to roll back critical existing public health regulations to reduce greenhouse gas emissions. The administration has rolled back and replaced the Clean Power Plan, which was estimated by the U.S. Environmental Protection Agency to prevent 4,500 early deaths every year once fully implemented in 2030. The much weaker replacement will increase carbon pollution and will result in some fossil fuel plants running more often and delaying their retirement, which would mean increased emissions of dangerous pollution as compared to the Clean Power Plan, and even as compared to no rule at all.

Additionally, EPA is currently in the process of rolling back other important rules to reduce greenhouse gas emissions, including EPA and the National Highway Traffic Safety Administration's existing vehicle emission and efficiency standards to reduce carbon emissions from the transportation sector, EPA's existing standards for carbon pollution for New, Modified and Reconstructed Stationary Sources (new coal-fired power plants), and EPA's Emission Standards for New, Reconstructed, and Modified Sources within the Oil and Natural Gas Sector, which target leaks of methane and volatile organic compounds. APHA supports all of these existing standards and has opposed the proposed efforts to weaken or roll back these important public health protections.

2. Engage the health care delivery system to reduce its carbon footprint.

Recently APHA joined over 70 health organizations to sign the U.S. Call to Action on Climate, Health and Equity: A Policy Agenda.⁴⁸ One of the 10 policy areas focuses on incorporating climate solutions into all health care. The Call to Action highlights the need for hospitals and health care

systems to “implement climate-smart health care, build facility resilience, and leverage their economic power to decarbonize the supply chain and promote equitable local economic development.” Three ways to address this are:

1. Support policies to advance implementation of climate-smart energy, water, transportation, food, anesthetic gas and waste management practices in U.S. health care facilities, including clinics and provider offices.
 2. Develop incentives for use of low-carbon care pathways and models of care, including community-based interventions that reduce the need for acute and chronic clinical care.
 3. Support redesign of all health professional curricula to better prepare the health workforce to lead in climate change mitigation and adaptation.
- 3. Create and implement a plan of action that will strengthening the nation’s public health capacity to respond to and reduce the risks from climate change and enhance efforts to educate the public about climate change, the risks to their health, and what they can do about it both individually and collectively.**

Support H.R. 1243, the Climate Change Health Protection and Promotion Act. This important legislation would also help our nation address the serious health threats associated with climate change. The bill would require the U.S. Department of Health and Human Services to develop a national strategic action plan for addressing the public health impacts of climate change. Acting through the director of the Centers for Disease Control and Prevention and in coordination with other federal agencies, the bill would enhance forecasting and modeling, track environmental and disease data, and expand the science base to better understand the relationship between climate change and health outcomes. Importantly, the legislation would prioritize activities to address the health impacts of climate change, including preparedness planning, surveillance, education and training in order to ensure that our already overburdened state and local public health workforce can adequately address the health impacts of climate change while continuing to respond to other ongoing threats and challenges. The legislation would also provide for the development of tools to educate public health and health care professionals and the public about the health impacts of climate change.

According to surveys conducted by APHA,⁴⁹ the National Association of County and City Health Officials,⁵⁰ and the Association of State and Territorial Health Officials,⁵¹ many of the nation’s health departments and public health professionals continue to state they lacked the expertise or resources to address climate-related health threats. In addition, many health departments still do not have a strategic plan in place to deal with local health impacts of climate change. Since 2008, local health departments have lost more than 56,000 staff and many lack the resources to initiate new programs. Due in part to changes in funding or staffing resources, fewer local health departments reported addressing climate change-related issues in 2017 than in 2012.²⁷ This legislation would play a critical role in helping to ensure the nation’s public health workforce is prepared to protect their communities from the negative health impacts of climate change.

- 4. Support federal programs that strengthen the health system at the federal, state, and local level to both mitigate and adapt to climate change.**

We specifically support the Climate and Health Program at the Centers for Disease Control and Prevention, the only federal program that helps states, cities, territories and tribes prepare for and respond to the specific health impacts of climate change. The Climate and Health Program currently funds 16 states, two cities, three tribes and three territories (covering 50% of the U.S. population). Examples of the grantee activities supported by the program include: the development of a vulnerability mapping tool in Massachusetts; an extensive study to assess the impacts of Superstorm Sandy on public health infrastructure in New York; a climate change and healthy homes curriculum

for community health workers in Maryland; the identification of specific communities at greatest risk due to sea level rise in North Carolina; and educational programs for rural elders on heat stress and for day-camp counselors on tick exposures in New Hampshire.

APHA and other public health advocates are requesting that Congress increase funding for the program by \$5 million, bringing the total to \$15 million in FY 2020. An increase of \$5 million would allow CDC to fund additional health departments while also increasing funding to current grantees for demonstration projects and evaluation activities. Increased funding would also help CDC identify interventions that most effectively protect the public from the health effects of climate change. By building the evidence base for specific interventions through demonstration projects, evaluation activities, and additional research, CDC will be able to promote strategies that have proven effective at protecting communities from the health effects of climate change. We are extremely pleased that the House's FY 2020 Labor, Health and Human Services, Education, and Related Agencies bill includes our request of \$15 million for the program and we are hopeful the Senate Appropriations Committee will also meet our request for increased funding.

Conclusion

Climate change poses a grave threat to the health and well-being of all Americans and people worldwide. As a nation we must work to significantly reduce greenhouse gas emissions from all sectors and we must invest in our federal, state, local, and tribal health agencies to ensure they have the capacity and capability to protect the nation and our communities from the significant health threats posed by climate change. We look forward to working with Congress to best protect the public's health from these threats.

I thank you again for the opportunity to testify about the public health impacts of climate change and look forward to answering any questions you may have.

References

¹ APHA policy statement 20157: Public Health Opportunities to Address the Health Effects of Climate Change. Available at: <https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2015/12/03/15/34/public-health-opportunities-to-address-the-health-effects-of-climate-change>

² Intergovernmental Panel on Climate Change. 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press. Retrieved July 22, 2019, from: <https://www.ipcc.ch/sr15/>

³ Climate Change 2014 Synthesis Report Summary for Policymakers. 2014. Retrieved July 22, 2019, from Intergovernmental Panel on Climate Change website: https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf

⁴ U.S. Global Change Research Program, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp, doi: 10.7930/J0J964J6

⁵ American Public Health Association. (2018). *Adaptation in Action Part 2: Updated Grantee Success Stories from CDC's Climate and Health Program*. Retrieved July 22, 2019, from American Public Health Association website: https://www.apha.org/-/media/files/pdf/topics/climate/adaptation_in_action_part_2.ashx

⁶ American Public Health Association. *Extreme heat can impact our health in many ways*. 2016. Retrieved from APHA website: https://www.apha.org/-/media/files/pdf/factsheets/climate/extreme_heat.ashx

⁷ National Weather Service Office of Climate, Water, and Weather Services. 2018. *Weather Fatalities 2018*. Retrieved from <https://www.nws.noaa.gov/om/hazstats.shtml>

-
- ⁸ U.S. Global Change Research Program. Temperature-Related Death and Illness. In: *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. Washington DC; 2016. p.43–68. Retrieved from: <https://health2016.globalchange.gov/temperaturerelated-death-and-illness>
- ⁹ U.S. Environmental Protection Agency. 2017. *Multi-Model Framework for Quantitative Sectorial Impacts Analysis: A Technical Report for the Fourth National Climate Assessment*. Available from: https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=OAP&dirEntryId=335095
- ¹⁰ Knowlton K, Rotkin-Ellman M, Geballe L, Max W, Solomon GM. 2011 *Six Climate Change-Related Events In The United States Accounted For About \$14 Billion In Lost Lives And Health Costs*. *Health Aff.* 30(11):2167–76. Available from: <http://www.healthaffairs.org/doi/10.1377/hlthaff.2011.0229>
- ¹¹ Plante, C., & Anderson, C. A. (2017). *Global Warming and Violent Behavior*. Association for Psychological Science. Retrieved from <https://www.psychologicalscience.org/observer/global-warming-and-violent-behavior>
- ¹² Watts, N., Adger, W. N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., et al. 2015. *Health and climate change: policy responses to protect public health*. *The Lancet*, 386(10006), 1861–1914. [http://doi.org/10.1016/S0140-6736\(15\)60854-6](http://doi.org/10.1016/S0140-6736(15)60854-6)
- ¹³ Habeeb, D., Vargo, J. & Stone, B. *Natural Hazards* (2015) 76: 1651. <https://doi.org/10.1007/s11069-014-1563-z>
- ¹⁴ National Environmental Health Partnership Council. (2016). *The Value of Environmental Health Services: Exploring the Evidence*. Retrieved July 22, 2019, from American Public Health Association website: https://www.apha.org/~media/files/pdf/topics/environment/eh_values.ashx
- ¹⁵ American Public Health Association. *Climate change increases the number and geographic range of disease-carrying insects and ticks*. 2016. Retrieved from APHA website: https://www.apha.org/~media/files/pdf/factsheets/climate/vector_borne.ashx
- ¹⁶ American Public Health Association. *Climate Change Decreases the Quality of the Air We Breathe*. 2016. Retrieved from APHA website: https://www.apha.org/~media/files/pdf/factsheets/climate/air_quality.ashx
- ¹⁷ American Public Health Association and ecoAmerica. *Making the Connection: Climate Changes Allergies and Asthma*. 2016. Retrieved from APHA website: https://www.apha.org/~media/files/pdf/topics/climate/asthma_allergies.ashx?la=en&hash=3D185CE3CF0356230453313CBB88C5DC1E967E01
- ¹⁸ American Public Health Association. *Warmer Water and Flooding Increase the Risk of Illness and Injury*. 2016. Retrieved from APHA website: https://www.apha.org/~media/files/pdf/factsheets/climate/warmer_water.ashx
- ¹⁹ American Planning Association: Policy Guide on Planning & Climate Change. Available at: https://planning-org-uploaded-media.s3.amazonaws.com/legacy_resources/policy/guides/pdf/climatechange.pdf
- ²⁰ American Public Health Association. *Extreme Rainfall and Drought*. 2016. Retrieved from APHA website: <https://www.apha.org/~media/files/pdf/factsheets/climate/precipitation.ashx>
- ²¹ Fann, N., Alman, B., Broome, R. A., Morgan, G. G., Johnston, F. H., Pouliot, G., & Rappold, A. G. (2018). The health impacts and economic value of wildland fire episodes in the U.S.: 2008–2012. *Science of The Total Environment*, 610-611, 802-809. doi:10.1016/j.scitotenv.2017.08.024
- ²² National Commission on Children and Disasters. 2010 Report to the President and Congress. AHRQ Publication No. 10-M037. Rockville, MD: Agency for Healthcare Research and Quality. October 2010. Retrieved July 22, 2019 from: <https://archive.ahrq.gov/prep/nccdreport/nccdreport.pdf>
- ²³ National Oceanic and Atmospheric Administration. National Centers for Environmental Information. 2019. *U.S. Billion-Dollar Weather and Climate Disasters*. Retrieved July 22, 2019 from: <https://www.ncdc.noaa.gov/billions/>
- ²⁴ Kishore, Nishant, Domingo Marqués, Ayesha Mahmud, Mathew V. Kiang, Irmay Rodriguez, Arlan Fuller, Peggy Ebner, Cecilia Sorensen, Fabio Racy, Jay Lemery, Leslie Maas, Jennifer Leaning, et al. Mortality in Puerto Rico after Hurricane Maria. (2018). *New England Journal of Medicine*, 379(17). doi:10.1056/nejmc1810872
- ²⁵ Cunsolo, Ashlee, & Ellis, Neville R. (2018). Ecological grief as a mental health response to climate change-related loss. *Nature Climate Change*, 8(4), 275-281. doi: 10.1038/s41558-018-0092-2
- ²⁶ American Public Health Association, & EcoAmerica. 2016. *Making the Connection: Climate Changes Children's Health*. Retrieved July 22, 2019, from American Public Health Association website: https://www.apha.org/~media/files/pdf/topics/climate/childrens_health.ashx
- ²⁷ Public Health Institute and American Public Health Association. *Climate Change, Health, and Equity: A Guide for Local Health Departments*. Retrieved July 17, 2019, From American Public Health Association website: https://apha.org/~media/files/pdf/topics/climate/climate_health_equity.ashx
- ²⁸ Kim, R., Costello, A., & Campbell-Lendrum, D. (2015). Climate change and health in Pacific island states [Editorial]. *Bulletin of the World Health Organization*. Retrieved July 22, 2019, from <https://www.who.int/bulletin/volumes/93/12/15-166199/en/> doi: <http://dx.doi.org/10.2471/BLT.15.166199>

-
- ²⁹ U.S. Department of Transportation. 2010. Freight Analysis Framework (Version 3) Data Tabulation Tool, Total Flows. U.S. Department of Transportation.
- ³⁰ Westerling, A. L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam, 2006. Warming and earlier spring increase western U.S. forest wildfire activity. *Science*, 313, 940-943, doi:10.1126/science.1128834
- ³¹ U.S. Global Change Research Program. 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 186 pp.
- ³² Markon, C., S. Gray, M. Berman, L. Erkes-Medrano, T. Hennessy, H. Huntington, J. Littell, M. McCammon, R. Thoman, and S. Trainor, 2018: Alaska. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 1185–1241. doi: 10.7930/NCA4.2018.CH26
- ³³ U.S. General Accounting Office. 2003. *ALASKA NATIVE VILLAGES: Most Are Affected by Flooding and Erosion, but Few Qualify for Federal Assistance*. Retrieved July 22, 2019, from <https://www.gao.gov/products/GAO-04-142>
- ³⁴ Jones, B. M., Arp, C. D., Jorgenson, M. T., Hinkel, K. M., Schmutz, J. A., & Flint, P. L. 2009. *Increase in the rate and uniformity of coastline erosion in Arctic Alaska*. *Geophysical Research Letters*, 36(3). doi:10.1029/2008gl036205
- ³⁵ Weinhold B. 2010. *Climate change and health: a Native American perspective*. *Environmental health perspectives*, 118(2), A64–A65. doi:10.1289/ehp.118-a64
- ³⁶ Northwest Treaty Tribes. (2019, May 08). Lummi Nation tests for biotoxins in shellfish. Retrieved June 27, 2019, from <https://nwtreatytribes.org/lummi-nation-tests-for-biotoxins-in-shellfish/>
- ³⁷ Perkison, W. B., Kearney, G. D., Saberi, P., Guidotti, T., McCarthy, R., Cook-Shimanek, M., . . . ACOEM Task Force on Climate Change. 2018. *Responsibilities of the Occupational and Environmental Medicine Provider in the Treatment and Prevention of Climate Change-Related Health Problems*. *Journal of Occupational and Environmental Medicine*, 60(2), E76-E81. doi:DOI: 10.1097/JOM.0000000000001251
- ³⁸ Glaser, J., Lemery, J., Rajagopalan, B., Diaz, H. F., García-Trabanino, R., Taduri, G., . . . Johnson, R. J. 2016. *Climate Change and the Emergent Epidemic of CKD from Heat Stress in Rural Communities: The Case for Heat Stress Nephropathy*. *Clinical Journal of the American Society of Nephrology*, 11(8), 1472-1483. doi:10.2215/cjn.13841215
- ³⁹ Climate change, direct heat exposure, health and well-being in low and middle-income countries. (2009). *Global Health Action*, 2(1), 1958. doi:10.3402/gha.v2i0.1958
- ⁴⁰ Farnier, L., Lovatt, J., & Oger, C. 2018. *Climate Change and Health: The Business Case for Action*. Retrieved July 22, 2019, from Business for Social Responsibility website: https://www.bsr.org/reports/BSR_Climate_Nexus_Health.pdf
- ⁴¹ Perkison, W. B., Kearney, G. D., Saberi, P., Guidotti, T., McCarthy, R., Cook-Shimanek, M., . . . ACOEM Task Force on Climate Change. 2018) Responsibilities of the Occupational and Environmental Medicine Provider in the Treatment and Prevention of Climate Change-Related Health Problems. *Journal of Occupational and Environmental Medicine*, 60(2), E76-E81. doi:DOI: 10.1097/JOM.0000000000001251
- ⁴² Riley, K., Wilhalme, H., Delp, L., & Eisenman, D. (2018). Mortality and Morbidity during Extreme Heat Events and Prevalence of Outdoor Work: An Analysis of Community-Level Data from Los Angeles County, California. *International Journal of Environmental Research and Public Health*, 15(4), 580. doi:10.3390/ijerph15040580
- ⁴³ National Environmental Health Partnership Council. The Value for Environmental Health Services: Exploring the Evidence. 2016. Retrieved from: https://www.apha.org/~media/files/pdf/topics/environment/eh_values.ashx
- ⁴⁴ Watts N, Amann M, Ayeb-Karlsson S, Belesova K, Bouley T, Boykoff M...Costello, A. (2018) The 2018 report of the Lancet Countdown on health and climate change. *Lancet*. doi:[https://doi.org/10.1016/S0140-6736\(18\)32594-7](https://doi.org/10.1016/S0140-6736(18)32594-7)
- ⁴⁵ Nomura S, Parsons AJQ, Hirabayashi M, Kinoshita R, Liao Y, Hodgson S. 2016. *Social determinants of mid- to long-term disaster impacts on health: A systematic review*. *Int J Disaster Risk Reduct*. 16:53–67. Available from: <https://www.sciencedirect.com/science/article/pii/S221242091530087X>
- ⁴⁶ Howell J, Elliott JR. 2018 *Damages Done: The Longitudinal Impacts of Natural Hazards on Wealth Inequality in the United States*. *Soc Probl*. Available from: <https://academic.oup.com/socpro/advance-article/doi/10.1093/socpro/spy016/5074453>

⁴⁷ Gubernot DM, Anderson GB, Hunting KL. 2015. Characterizing occupational heat-related mortality in the United States, 2000-2010: An analysis using the census of fatal occupational injuries database. *Am J Ind Med.* 58(2):203–11. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25603942>

⁴⁸ U.S. Call to Action on Climate, Health and Equity. Retrieved July 19, 2019 from APHA website: https://climatehealthaction.org/media/cta_docs/US_Call_to_Action.pdf

⁴⁹ American Public Health Association. *Climate Change Needs Assessment*. 2019. Retrieved from: https://apha.org/-/media/files/pdf/topics/climate/needs_assessment.ashx

⁵⁰ National Association of County and City Health Officials. 2018. *Chapter 6: Environmental Health in 2018 Forces of Change survey*. Retrieved July 22, 2019, from National Association of County and City Health Officials website: <http://nacchoprofilestudy.org/wp-content/uploads/2018/12/2018-Forces-of-Change-Main-Report.pdf>

⁵¹ *State and Territorial Health Agency Needs for a Changing Climate: A Summary and Analysis of ASTHO's 2009 and 2012 Climate Health Needs Assessments*. 2012. Retrieved July 22, 2019, from Association of State and Territorial Health Officials website: <http://www.astho.org/Programs/Environmental-Health/Natural-Environment/Climate-Change/2012-Climate-and-Health-Survey-Report/>