YALE CENTER on CLIMATE CHANGE and HEALTH

Climate Change and Health in Connecticut 2020 Report Executive Summary

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EXECUTIVE SUMMARY

This report tracks 19 indicators related to climate change and health in Connecticut. Its purpose is to inform policymakers, health professionals, advocates, and residents about the impact of climate change, now and in the future, on human health in Connecticut. The indicators have been developed using publicly available data from state and federal agencies, peer-reviewed literature, and medical associations. Where possible, we directly track trends in health impacts (e.g., West Nile virus infections; emergency department visits and hospitalizations for heat stress). However, because of the relative paucity of Connecticut-specific data on health impacts associated with climate change, we also track environmental and climate conditions (e.g., drought; outdoor allergens) that can lead to adverse health outcomes.

We note trends when they are statistically significant, and wherever possible we report indicator results for each county. Some of our indicators demonstrate a trend over time consistent with what is expected under climate change, such as increasing average temperatures and heavy rainfall events. Other indicators do not yet show a trend, but scientific studies project changes as the planet continues to warm (see PANEL). The number of heat waves, for example, is projected to increase, in turn causing more heat-related illness.

There is overwhelming evidence that the dominant cause of warming temperatures is human activities, particularly from the emissions of greenhouse gases through the burning of fossil fuels (i.e., coal, oil, and natural gas), as well as from other activities including livestock production and deforestation.[1] Greenhouse gases warm the planet by acting like a blanket that traps heat from the Earth that would otherwise escape into space; the more greenhouse gases in the atmosphere, the more heat is trapped. In this report, we track indicators related not only to the impacts of climate change, but also to impacts caused by the drivers of climate change (specifically, air quality impacts largely driven by fossil fuel combustion).

While climate change affects everyone, it does not affect everyone equally. Climate change is sometimes called a "risk amplifier," meaning that many existing

PROJECTED CLIMATE CHANGE PHYSICAL IMPACTS

University of Connecticut researchers projected climate change impacts in Connecticut employing a high greenhouse gas emissions scenario (RCP 8.5, or "business as usual," in which no efforts are made to reduce emissions). Under this scenario, the following impacts are projected for mid-century (2040–69), compared with 1970–99:

- 5 ºF increase in annual mean temperature
- 8.5% increase in annual precipitation, due primarily to increases in winter and spring
- Greater flood risk due to the increase in heavy rainfall events
- Extreme summer droughts that occur three times as often[4]

The Connecticut Institute for Resilience and Climate Adaptation recommends planning for 20 inches (0.5 meters) of sea level rise by 2050, with continued sea level rise to occur after 2050.[5,6] Higher sea levels lead to more severe storm surges associated with coastal storms. In addition, as climate change progresses, Atlantic hurricanes are expected to become more intense (higher sustained wind speeds), with greater amounts of precipitation.[7]

risks to health—derived from environmental, economic, demographic, social, or genetic factors—are intensified by climate change impacts.[2, 3] Populations disproportionately vulnerable to the effects of climate change include those with low income, communities of color, immigrant groups (including those with limited English proficiency), Indigenous people, children and pregnant women, older adults, vulnerable occupational groups, people with disabilities, and people with preexisting or chronic medical conditions.[3]

KEY FINDINGS

The following section presents the report's key findings for each of the 19 indicators, along with a brief explanation about the indicator's relationship to climate change and health. A complete description of each indicator, including data figures, is found in the full report.

TEMPERATURE

INDICATOR 1: AVERAGE ANNUAL TEMPERATURE. Average annual temperature increased by 3.0–3.5 ºF in each county from 1895 to 2019. The increase in average temperature has wide-ranging effects, including for human health. For instance, warmer nighttime temperatures can be especially dangerous, particularly for people living in urban areas and for those without access to air conditioning. This is because cool nights are typically an opportunity for the body to cool down; without this cooling-off time, heat waves can be even more perilous.

INDICATOR 2: EXTREME HEAT DAYS. From 1950 to 2018, the number of extreme heat days (days with maximum temperature over 90 ºF) did not change significantly in any county. However, under climate change, such extreme heat days can be expected to increase, which is a significant concern for human health. Extreme heat days can be especially dangerous in cities because of the urban heat island effect, a phenomenon in which urban areas are hotter than surrounding areas because of the density of buildings and roads and the lack of trees, other greenery, and streams, rivers, ponds, and lakes.

INDICATOR 3: FROST DAYS. The number of frost days (days with minimum temperature at or below 32 ºF) decreased from 1950 to 2018 in four of the eight counties: Middlesex, New London, Tolland, and Windham. Fewer frost days, an earlier winter-spring transition, and a later fall-winter transition transform the natural environment in ways that can negatively affect human health, including by creating conditions for larger tick and mosquito populations that are active over a greater proportion of the year; a longer season for ragweed pollen,[8] which causes hay fever and exacerbates asthma; and a greater abundance of and longer seasons for plant pests, adversely affecting both forests and agriculture.[9]

INDICATOR 4: EMERGENCY DEPARTMENT VISITS AND HOSPITALIZATIONS FOR HEAT STRESS. From 2007 to 2016, there were on average 422 emergency department visits and 45 hospitalizations per year for heat stress in Connecticut. It is important to note, however, that the numbers of emergency department visits and hospitalizations are likely underreported; medical personnel often mistakenly fail to attribute the cause of illness to extreme heat, especially in a state like Connecticut where heat-related illness may not be as common as in some other parts of the country. Heat-related illnesses, such as heat exhaustion or heat stroke, happen when the body is not able to properly cool itself. Heat stroke can cause damage to the brain and other vital organs, or even death.

INDICATOR 5: POPULATIONS VULNERABLE TO HEAT-RELATED ILLNESS. This indicator tracked the following groups that are especially vulnerable to heat-related illness: outdoor workers (farm laborers; workers in the landscape and construction industries), people experiencing homelessness, and people age 65 and older. **The number and proportion of people over 65 in Connecticut is increasing, while the number of**

people experiencing homelessness is decreasing. The number of people in the other groups shows no trend over time. Together, these populations represent a substantial number of people at risk for heat-related illness.

EXTREME EVENTS

INDICATOR 6: HEAVY RAINFALL EVENTS. From 1960 to 2019, the annual number of heavy rainfall events (three consecutive days with cumulative precipitation of 3 inches or more) increased in New Haven, Hartford, Litchfield, Tolland, and Windham counties. Heavy rainfall can overwhelm the natural and human-made systems that normally process rainwater, leading to flooding along river systems and in urban areas. Flooding can cause injury and death due to drowning; can lead to indirect health impacts from disruption to medical care and critical infrastructure; and can result in human exposure to pathogens or toxic chemicals through their release into floodwaters or drinking water sources.[10] Heavy rain and flooding also can adversely affect indoor air quality by causing mold growth, chemical off-gassing from damaged building materials, and formation of other air contaminants.[11, 12] Exposure to extreme events, including flooding, is associated with a range of mental health impacts, such as post-traumatic stress disorder.[12]

INDICATOR 7: HIGH TIDE FLOODING. The annual number of days with high tide flooding has increased at the New London and the Bridgeport tide gauges, a trend consistent with the 8–9 inches of global sea level rise since 1880. High tide flooding occurs when seawater temporarily inundates low-lying areas until the tide recedes. As the flooding becomes more common or greater in magnitude or both, it can have an adverse effect on health. Flooding can transmit pathogens such as *Vibrio* bacteria, which can cause wound infections among people walking through the water. Saltwater can contaminate drinking water sources near the coast, as well as coastal agricultural fields. With a highly developed coastline, Connecticut also is at risk for high tide flooding affecting a large number of roads, homes, businesses, and other infrastructure.[13]

INDICATOR 8: DROUGHT. While there is no significant trend toward increased drought in any county, Connecticut has recently experienced disturbing droughts, including a 46-week statewide drought in 2016–2017. Expected impacts of moderate drought include increased wildfires, stressed trees and landscaping, and lake and reservoir levels below normal capacity. As a drought worsens, impacts expand, with particular concerns about agriculture, wildlife, and wildfires. Drought strains drinking water systems by lowering surface water reserves and contributing to saltwater intrusion into freshwater aquifers along the coast. The prolonged 2016–2017 drought raised awareness in Connecticut that river basins can become depleted, even though water scarcity has not typically been a problem for the state in the past.[14]

INDICATOR 9: DRINKING WATER RESERVOIR CAPACITY. We found no indication of a trend toward lower reservoir levels. Climate change may affect drinking water availability by increasing the intensity or frequency of droughts, storms, and other system shocks. Droughts, especially if prolonged, lower water levels in reservoirs (and wells), an impact we investigated through this indicator. Hurricanes may damage drinking water system infrastructure, as occurred during Hurricane Irene in 2011.[15, 16] Wells near the coast may be at risk for contamination from saltwater intrusion due to sea level rise and drought. Blue-green algae blooms—and more dangerously, harmful algal blooms—are more likely as surface water sources warm with rising temperatures.[17]

INDICATOR 10: WEATHER DISASTERS. From 2010 to 2019, nine federal disaster declarations for weather events were issued for Connecticut, compared with only 13 in the previous 56 years. Following those nine disaster declarations, the Federal Emergency Management Agency provided a total of $304.6 million in combined individual and public assistance grants to support recovery efforts. Nationally, weather disaster events are rising, with significant economic and social cost: 2019 was the fifth consecutive year in which the country endured 10 or more billion-dollar weather disaster events.[18] Over the past five years, the total cost of these disaster events nationally was approximately $500 billion.[18]

INDICATOR 11: SUPERFUND SITES. Seven of Connecticut's 16 Superfund sites are vulnerable to climate change impacts, including flooding and hurricane storm surge. Under the U.S. Environmental Protection Agency's Superfund program, the federal government identifies and cleans up contaminated sites to protect human health and the environment. In Connecticut, these sites range from old industrial sites to waste lagoons, quarries, and landfills. Climate change is making coastal storms more intense and extreme precipitation events and coastal and inland flooding more frequent, which may further damage Superfund sites and potentially release contaminants into ground or surface water, the air, or the soil.[19]

INFECTIOUS DISEASES

INDICATOR 12: MOSQUITOS. During 2001–2019, of 28 mosquito species found in Connecticut to carry viruses that cause human disease, 10 show trends of increasing abundance and three show trends of decreasing abundance. Mosquito abundance is a key factor that influences the capacity of a mosquito to transmit a virus and the rate at which infections spread. A high abundance is often a prelude to an epidemic.[20] Each of the mosquito species we tracked has been found in Connecticut to carry one or more of the following viruses: Cache Valley, Eastern equine encephalitis, Jamestown Canyon, Trivittatus, or West Nile.[21] Mosquitos, which are ectothermic (i.e., cold-blooded), can thrive in a warmer world.[22] As Connecticut becomes warmer, disease-carrying mosquitos may become even more abundant.

INDICATOR 13: WEST NILE VIRUS INFECTIONS. During 2000–2018, the number of reported symptomatic cases per year of West Nile virus infection, the leading mosquito-borne disease in the United States,[23] varied from 0 (2004 and 2009) to over 20 (2012 and 2018). Only about one in five people infected with West Nile virus show symptoms, which can include fever, headache, muscle pains, and rash. In very rare cases (1%), the infection can cause serious illness affecting the central nervous system, which can be fatal.[24] West Nile virus is transmitted by *Culex* mosquitos. Under INDICATOR 12, we found that one *Culex* species (*Culex salinarius*) has exhibited an increasing trend, which may be influenced by warmer weather or changes in precipitation patterns caused by climate change.

INDICATOR 14: EASTERN EQUINE ENCEPHALITIS. Connecticut's first reported human case of Eastern equine encephalitis, a rare mosquito-borne disease, occurred in 2013. In 2019, four cases were reported, of which three were fatal. Most people infected with this virus have no symptoms. Only in rare cases does an infected person develop a central nervous system infection; in these cases, Eastern equine encephalitis can be fatal. It is transmitted by *Aedes*, *Coquillettidia*, and *Culex* mosquitos. INDICATOR 12 shows that *Aedes albopictus*, *Culex salinarius*, and *Coquillettidia perturbans* are increasingly abundant in Connecticut, which may be influenced by warmer weather or changes in precipitation patterns caused by climate change.

INDICATOR 15: LYME DISEASE. Reported cases of Lyme disease declined from about 3,700 per year in 2008–2010 to about 1,900 per year in 2016–2018. Lyme disease, a bacterial disease transmitted to humans by the blacklegged tick, is generally cured with treatment; without treatment, symptoms can progress to severe joint pain and swelling, facial palsy, heart palpitations, inflammation of the brain and spinal cord, and nerve pain or numbness.[25] Transmission of Lyme disease occurs seasonally, with the most cases in Connecticut reported in June and July.[26] Cases may have declined because people are taking protective measures such as applying tick repellant and wearing long pants and sleeves when outdoors. Shorter and milder winters and earlier springs projected under climate change may lead to earlier tick activity and larger tick populations.[27] But extreme heat and drought increase tick mortality, so climate change also may lead to a countervailing force on tick abundance.[28]

INDICATOR 16: FOODBORNE *VIBRIO* INFECTIONS. The annual number of confirmed cases of foodborne *Vibrio* infections has increased. *Vibrio* bacteria live naturally in warm coastal waters, especially in lower-salinity estuaries. Humans can become infected by eating contaminated seafood that is raw or under-cooked. Symptoms include abdominal cramps, nausea, headaches, diarrhea, fever, and chills. As sea surface temperature rises, the abundance of *Vibrio* increases.[29] In Connecticut, summer near-surface water temperature is increasing at a significant rate on Long Island Sound,[30] consistent with the increase in *Vibrio* food-borne infections.

AIR QUALITY

INDICATOR 17: GROUND-LEVEL OZONE. Since 1990, the annual number of days on which ground-level ozone exceeded safe levels decreased in all counties, but more improvements are needed to fully protect human health. In fact, the American Lung Association gave all eight Connecticut counties an F grade for ozone pollution in its 2019 *State of the Air Report*.[31] The decreasing ground-level ozone trend in Connecticut (and nationally) is due to national and state environmental regulations, including those that limit emissions of precursor pollutants from the burning of fossil fuels in vehicles, power plants, and industry. Ground-level ozone is a strong lung irritant that can cause respiratory symptoms, asthma exacerbation, and premature death. In the Northeast's urban areas, the hottest days are associated with the highest concentrations of ground-level ozone.[9] This combination of extreme heat and poor urban air quality poses a major health risk to vulnerable groups, especially those with asthma and other preexisting respiratory conditions.[9]

INDICATOR 18: FINE PARTICULATE MATTER ($PM_{2.5}$). Since 1999, the annual number of days on which fine particulate matter exceeded safe levels decreased in Fairfield, Hartford, New Haven, and New London counties. No days meeting $PM_{2.5}$ Air Quality Index categories of unhealthy, very unhealthy, or hazardous have been reported in any of the five monitored counties in at least the past eight years. (There are no $PM_{2.5}$ monitoring stations in Middlesex, Tolland, and Windham counties.) As with ground-level ozone, this improvement in $PM_{2.5}$ pollution can be attributed to national and state environmental regulations that limit $PM_{2.5}$ emissions produced by the burning of fossil fuels in power plants, vehicles, and industrial sources. Exposure to $PM_{2.5}$ causes or aggravates heart and lung conditions and can cause premature death. Communities of color often live near power plants, major roads, and industrial facilities, increasing their exposure to $PM_{2.5}$ (as well as to ground-level ozone and other pollutants).

INDICATOR 19: OUTDOOR ALLERGENS (MOLD AND POLLEN). Since 2007, the percent of measured days with "high" or "very high" outdoor mold concentrations has increased. Concentrations of tree, grass, or weed pollen did not have increasing or decreasing trends. Nevertheless, increased carbon dioxide emissions and higher temperatures are expected to worsen allergies by lengthening the pollen season, raising the amount of pollen produced by plants, and possibly increasing the allergenic potency of the produced pollen, which would cause more intense allergic reactions.[32–34] Higher temperature and humidity have been found to promote the growth of mold outdoors.[35–37]

CONCLUSION

To protect human health now and in the future, Connecticut decision makers and residents alike must undertake strong action to confront the challenges identified in this report. First, this means swift action to mitigate climate change by reducing greenhouse gas emissions. Under its *2008 Global Warming Solutions*

Act and *2018 Act Concerning Climate Change Planning and Resiliency*, Connecticut has committed to reducing greenhouse gas emissions below 2001 levels by 45% by 2030 and 80% by 2050. Other states have committed to even more significant cuts, suggesting that Connecticut has further to go: New York, for instance, set a target of net-zero greenhouse gas emissions by 2050. Second, Connecticut must expand its work to prepare for and adapt to the climate change impacts that have begun and will worsen in the future. The Governor's Council on Climate Change now guides both efforts, with policy recommendations anticipated in early 2021 as part of the updated *Adaptation and Resilience Plan* for Connecticut and the council's annual report on the state's climate mitigation progress.

With this in mind, we offer seven crosscutting recommendations to support equitable, science-based, and holistic mitigation and adaptation actions to protect human health.

1 Monitor current conditions and project trends for Connecticut

To make rapid and effective responses based on data, decision makers need systems in place that monitor environmental and climatic changes and that track climate-sensitive health outcomes. Also needed is more research that projects Connecticut-specific impacts of climate change on human health in the future and identifies vulnerable populations. The state should pursue funding opportunities and partnerships to support the collection, monitoring, analysis, and dissemination of these critical data.

2 Invest in the social determinants of health

Social factors, including housing, education, employment, income, and access to medical care, are major drivers of population health. Climate change makes the imperative of addressing these social determinants to improve health and reduce health disparities even more urgent.[38] Actions to address climate change mitigation or adaptation that also invest in the social determinants of health produce synergistic benefits and should be prioritized.

3 Tackle the upstream drivers of climate change and health disparities

It has been aptly stated that "the root causes and upstream drivers of climate change and health inequities are often the same: Our energy, transportation, land use, housing, planning, food and agriculture, and socioeconomic systems are at once key contributors to climate pollution and key shapers of community living conditions."[39] Furthermore, these systems are "shaped by current and historical forces that include structural racism and the persistent lack of social, political, and economic power of low-income communities and communities of color."[39] Addressing climate change and health inequities requires confronting these upstream drivers by challenging historic and systemic burdens, including environmental pollution, income inequality, racism, and inequitable access to power and resources.

4 Pursue actions that integrate mitigation, adaptation, and immediate health benefits

Measures that combine climate change mitigation and adaptation with immediate health benefits should be prioritized. For example, increasing forested green space in coastal urban areas accomplishes mitigation because trees absorb carbon dioxide from the atmosphere; accomplishes adaptation because trees reduce the urban heat island effect through evapotranspiration and shade provision and because green space reduces flood risk; and provides immediate health benefits of space for physical activity, improved mental health, and healthier shellfish in Long Island Sound.

5 Build the capacity of health professionals and decision makers in other sectors to address climate and health

Most health professionals did not learn about climate change and its health effects in their formal training, and many other decision makers lack specific knowledge about how their issue area relates to climate change and health. Incorporating this material into health and other higher education curricula, as well as continuing education courses, would help close this key knowledge gap and prepare the workforce to make informed decisions under a changing climate.

This challenge should be addressed through combined efforts of colleges and universities, public health agencies, and professional associations.

6 Incorporate climate change into decision making across sectors

For both adaptation and mitigation efforts to be effective, climate change needs to be considered and incorporated into planning and investment at all levels of government. To do so requires that climate change not be treated as a siloed issue that can be addressed in isolation by personnel and policies focused only on climate change. Rather, inter-sectoral collaboration is essential.

7 Incorporate public health into climate change decision making

A “health in all policies approach” calls for public health representatives to be at the table when making policy decisions ranging from urban planning to transportation to voter registration.[40] Public health considerations should be incorporated into all climate change policymaking. An encouraging sign in Connecticut is that the Department of Public Health now has a seat on the Governor’s Council on Climate Change. Its role on the council should fully cover both adaptation and mitigation workstreams, particularly given the opportunities for immediate health benefits from mitigation.

REFERENCES

1
Blanco G, Gerlagh R, Suh S, Barrett J, de Coninck HC, Diaz Morejon CF, et al. Drivers, trends and mitigation. In: Edenhofer O, Pichs-Madruga R, Sokona Y, Farahani E, Kadner S, Seyboth K, et al., editors. Climate Change 2014: Mitigation of Climate Change Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press; 2014.

2
Ebi KL, Balbus JM, Luber G, Bole A, Crimmins A, Glass G, et al. Human health. In: Reidmiller DR, Avery CW, Easterling DR, Kunkel KE, Lewis KLM, Maycock TK, et al., editors. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. Washington, DC: US Global Change Research Program; 2018.

3
Gamble JL, Balbus J, Berger M, Bouye K, Campbell V, Chief K, et al. Populations of concern. In: Crimmins A, Balbus J, Gamble J, Beard C, Bell J, Dodgen D, et al., editors. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Washington, DC: US Global Change Research Program; 2016.

4
Seth A, Wang G, Kirchhoff C, Lombardo K, Stephenson S, Anyah R, et al. Connecticut Physical Climate Science Assessment Report (PCSAR): Observed Trends and Projections of Temperature and Precipitation. Connecticut Institute for Resilience and Climate Adaptation; 2019.

5
Sweet WV, Kopp RE, Weaver CP, Obeysekera J, Horton RM, Thieler ER, et al. Global and Regional Sea Level Rise Scenarios for the United States. NOAA Technical Report NOS CO-OPS 083. Silver Spring, MD: National Oceanic and Atmospheric Administration; 2017.

6
O'Donnell JO. Sea Level Rise in Connecticut, Final Report February 2019. Connecticut Institute for Resilience and Climate Adaptation; 2019; online at https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/10/Sea-Level-Rise-Connecticut-Final-Report-Feb-2019.pdf.

7
Hayhoe K, Wuebbles D, Easterling D, Fahey D, Doherty S, Kossin J, et al. Our changing climate. In: Reidmiller DR, Avery CW, Easterling DR, Kunkel KE, Lewis KLM, Maycock TK, et al., editors. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. Washington, DC: US Global Change Research Program; 2018.

8
Ziska L, Knowlton K, Rogers C, Dalan D, Tierney N, Elder MA, et al. Recent warming by latitude associated with increased length of ragweed pollen season in central North America. Proceedings of the National Academy of Sciences. 2011;108(10):4248-51.

9
Dupigny-Giroux LA, Mecray EL, Lemcke-Stampone MD, Hodgkins GA, Lentz EE, Mills KE, et al. Northeast. In: Reidmiller DR, Avery CW, Easterling DR, Kunkel KE, Lewis KLM, Maycock TK, et al., editors. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. Washington, DC: US Global Change Research Program; 2018.

10
Bell JE, Herring SC, Jantarasami L, Adrianopoli C, Benedict K, Conlon K, et al. Impacts of extreme events on human health. In: Crimmins A, Balbus J, Gamble J, Beard C, Bell J, Dodgen D, et al., editors. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Washington, DC: US Global Change Research Program; 2016.

11
Institute of Medicine. Climate Change, the Indoor Environment, and Health. Washington, DC: The National Academies Press; 2011.

12
Dodgen D, Donato D, Kelly N, La Greca A, Morganstein J, Reser J, et al. Mental health and well-being. In: Crimmins A, Balbus J, Gamble J, Beard C, Bell J, Dodgen D, et al., editors. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Washington, DC: US Global Change Research Program; 2016.

13
Dahl K, Cleetus R, Spanger-Siegfried E, Udvardy S, Caldas A, Worth P. Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate. Cambridge, MA: Union of Concerned Scientists; 2018.

14
Connecticut Water Planning Council. Connecticut State Water Plan, Final Report. 2018; online at https://portal.ct.gov/Water/Water-Planning-Council/State-Water-Plan.

15
The Cadmus Group. Report on the Operational and Economic Impacts of Hurricane Irene on Drinking Water Systems. Denver, CO: Water Research Foundation; 2012.

16
No Author. Drinking Water Vulnerability Assessment and Resilience Plan, Fairfield, New Haven, Middlesex, and New London Counties. Prepared for: Connecticut Department of Public Health; 2018.

17
Connecticut Department of Public Health. Fact Sheet: Blue–Green Algae Blooms in Connecticut Lakes and Ponds. 2013; online at https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/environmental_health/BEACH/Fact-sheet_Blue-Green-Algae-Blooms_102918.pdf.

18
NOAA National Centers for Environmental Information. U.S. Billion-Dollar Weather and Climate Disasters. 2020; online at https://www.ncdc.noaa.gov/billions/.

19
US Government Accountability Office. SUPERFUND: EPA Should Take Additional Actions to Manage Risks from Climate Change. 2019; online at https://www.gao.gov/products/GAO-20-73.

20
Roiz D, Ruiz S, Soriguer R, Figuerola J. Climatic effects on mosquito abundance in Mediterranean wetlands. Parasites & Vectors. 2014;7(1):333.

21
Andreadis TG, Thomas MC, Shepard JJ. Identification Guide to the Mosquitoes of Connecticut. New Haven, CT: The Connecticut Agricultural Experiment Station; 2005.

22
Rocklöv J, Dubrow R. Climate change: an enduring challenge for vector-borne disease prevention and control. Nature Immunology. 2020;21(5):479-83.

23
Beard CB, Eisen RJ, Barker CM, Garofalo JF, Hahn M, Hayden M, et al. Vectorborne diseases. In: Crimmins A, Balbus J, Gamble J, Beard C, Bell J, Dodgen D, et al., editors. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Washington, DC: US Global Change Research Program; 2016.

24
Centers for Disease Control and Prevention. West Nile Virus: Symptoms, Diagnosis, & Treatment. 2018; online at https://www.cdc.gov/westnile/symptoms/index.html.

25
Centers for Disease Control and Prevention. Tickborne Illnesses of the United States: A Reference Manual for Healthcare Providers. 5th Edition. 2018; online at https://www.cdc.gov/ticks/tickbornediseases/TickborneDiseases-P.pdf.

26
Connecticut Department of Public Health. Lyme Disease Annual Statistics. 2019; online at: https://portal.ct.gov/DPH/Epidemiology-and-Emerging-Infections/Lyme-Disease-Statistics.

27
Centers for Disease Control and Prevention, American Public Health Association. Insects and Ticks. n.d.; online at https://www.cdc.gov/climateandhealth/pubs/vector-borne-disease-final_508.pdf.

28
Ogden NH, Lindsay LR. Effects of climate and climate change on vectors and vector-borne diseases: ticks are different. Trends in Parasitology. 2016;32(8):646-56.

29
Vezzulli L, Grande C, Reid PC, Hélaouët P, Edwards M, Höfle MG, et al. Climate influence on Vibrio and associated human diseases during the past half-century in the coastal North Atlantic. Proceedings of the National Academy of Sciences. 2016;113(34):E5062-E71.

30
O'Donnell JO. Water Temperature. Dataset published in Long Island Sound Study. n.d.; online at https://longislandsoundstudy.net/ecosystem-target-indicators/water-temperature/.

31
American Lung Association. State of the Air 2019. 2019; online at http://www.stateoftheair.org/assets/sota-2019-full.pdf.

32
Singer BD, Ziska LH, Frenz DA, Gebhard DE, Straka JG. Increasing Amb a 1 content in common ragweed (Ambrosia artemisiifolia) pollen as a function of rising atmospheric CO_2 concentration. Functional Plant Biology. 2005;32(7):667-70.

33
Ziska LH. An overview of rising CO_2 and climatic change on aeroallergens and allergic diseases. Allergy, Asthma & Immunology Research. 2020;12(5):771-82.

34
Ziska LH, Makra L, Harry SK, Bruffaerts N, Hendrickx M, Coates F, et al. Temperature-related changes in airborne allergenic pollen abundance and seasonality across the northern hemisphere: a retrospective data analysis. The Lancet Planetary Health. 2019;3(3):e124-e31.

35
Katial RK, Zhang Y, Jones RH, Dyer PD. Atmospheric mold spore counts in relation to meteorological parameters. International Journal of Biometeorology. 1997;41(1):17-22.

36
Corden JM, Millington WM. The long-term trends and seasonal variation of the aeroallergen Alternaria in Derby, UK. Aerobiologia. 2001;17(2):127-36.

37
Kinney PL. Climate change, air quality, and human health. American Journal of Preventive Medicine. 2008;35(5):459-67.

38
Artiga S, Hinton E. Beyond health care: the role of social determinants in promoting health and health equity. Kaiser Health News. 2018.

39
Rudolph L, Harrison C, Buckley L, North S. Climate Change, Health, and Equity: A Guide for Local Health Departments. Oakland, CA and Washington D.C.: Public Health Institute and American Public Health Association; 2018.

40
Rudolph L, Caplan J, Ben-Moshe K, Dillon L. Health in All Policies: A Guide for State and Local Governments. Washington, DC and Oakland, CA: American Public Health Association and Public Health Institute; 2013.

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