

# Preparing for the Health Impacts of a Changing Climate

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Over the past century, anthropogenic activities have resulted in high levels of greenhouse gases in our environment, creating a warming effect on the Earth. As a result, global temperatures have risen, shifting climatic zones, influencing weather patterns, and intensifying storms. These changes include heavy precipitation, drought, wildfires, hurricanes, heat waves, and coastal flooding. The impacts from this climatic activity continue to contribute negatively to our environment while influencing human health.

In this special issue of the *North Carolina Medical Journal*, authors from universities, governmental agencies, and not-for-profit organizations address how the global impacts of climate change are affecting the health of communities across our beautiful state. This issue offers our readers research and real-life stories that underscore the need for keeping the issue of climate change at the forefront of public health for North Carolina. The information provided in these articles gives policymakers and health care providers a deeper understanding of the public health implications and challenges of climate change while highlighting the health risks to our most susceptible populations.

Because there are no direct clinical symptoms or signs, the effects of climate change are difficult to assess at the individual level. However, an abundance of peer-reviewed climate health research studies provides overwhelming scientific evidence that climate change is impacting population health with generalizable results. Mitigation and adaptability strategies are necessary for reducing carbon emissions and building climate-resilient communities. Policymakers and health care providers are in key positions for educating others, helping protect our planet, improving health outcomes, and moving North Carolina toward more sustainable solutions.

## Introduction

The Intergovernmental Panel on Climate Change (IPCC) reports that the carbon dioxide and other greenhouse gases (GHGs) released from human activity are at the highest levels in history and are contributing to widespread impacts on human health and natural systems [1]. Just over the past century, GHG emissions have contributed to increases in land and ocean surface temperatures by more

than 1.5°F (0.85°C) and those temperatures are expected to continue to increase another 0.5° to 8.6° over the next 100 years (Figure 1) [1, 2].

As a result of increasing temperatures, significant climatic changes have been reported in atmospheric pollution, acidity of oceans, diminished ice and snow cover, and rising sea level [1, 3, 4]. Worldwide, anthropogenic, or human-originated, pollution continues to influence and alter changes in global weather patterns resulting in more intense, widespread, and variable climate events. These changes have the ability to influence regional weather patterns, contributing to extreme temperatures, shifts of climatic zones, heavy precipitation, drought, wildfires, hurricanes, heat waves, and coastal flooding [1, 5].

As the planet continues to warm, experts predict significant changes in the natural environment will intensify and create new human health concerns [1]. While the influences of weather and climate on human health are complex, there is high agreement among scientists that climatic effects will negatively impact human health through the following: heat-related morbidity and mortality from extreme high temperatures [6-8]; cardiovascular [9] and respiratory diseases from poor air quality, aeroallergens [10, 11], and increased wildfires [12]; variable and seasonal distribution of vectors, increased vector-borne and infectious diseases from flooding, and introduction of new pests and pathogens into new regions [13]; degraded food and water quality; injuries and illnesses; mental health and stress disorders; and nutritional impacts of lessening crop yields [14, 15]. While some regions of the globe may experience health benefits from climate change, such as fewer winter deaths, other regions may experience devastating human health impacts such as starvation and malnutrition due to food and crop shortages [1, 16].

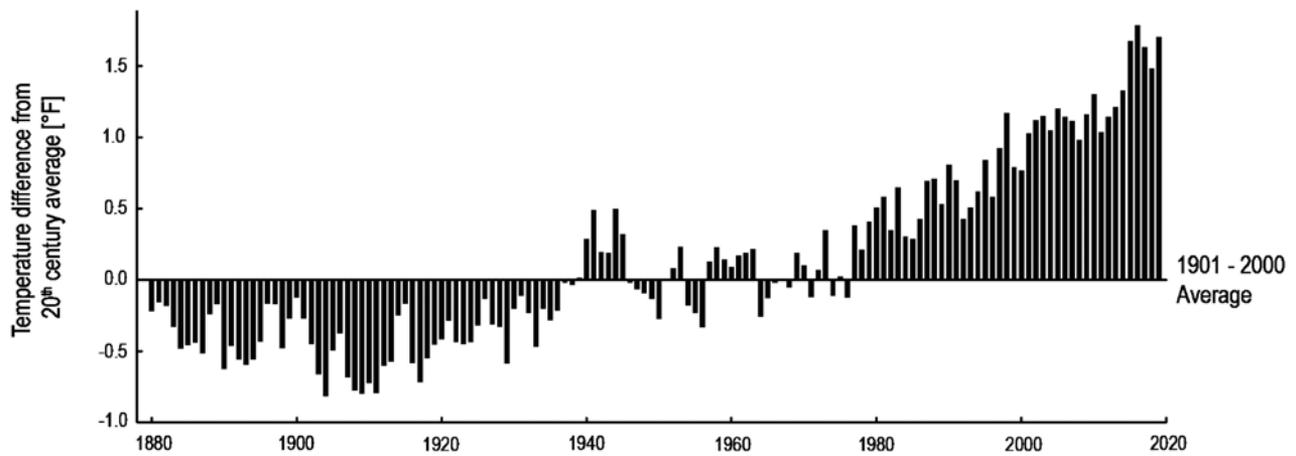
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**FIGURE 1.**  
Annual Global Surface Temperature Change for Land and Oceans



Source. Intergovernmental Panel on Climate Change, AR5 Assessment Report, 2014.

## Health Impacts

There is broad consensus among leading health authorities that climate change is affecting human health in a variety of ways [1, 3]. However, because there are no distinguishing characteristics or clinical signs describing the health effects of climate change, identifying and quantifying exposure is often complex [4, 17]. Therefore, many studies use predictive models based on existing relationships between climatic conditions and health outcomes [4]. As shown in Figure 1, climate change can impact human health through a combination of mediated causal pathways [16].

Direct human health impacts include those that are principally from increased extreme events, such as injuries and fatalities related to severe weather and heat waves, or respiratory and cardiovascular disease from degrading air quality [18]. Other effects of exposure involve changes in intermediate factors, or include multiple pathways (Figure 2). These pathways are referred to as indirect, moderating, and adaptive pathways and are more difficult to assess. Examples of indirect exposures can include community mental health consequences and increased exposure to waterborne diseases from contaminated water or from heavy precipitation in stormwater runoff. Moderating influences include factors that are non-climate-related, but still influence health, such as socioeconomic status, public health infrastructure, or access to health care. Adaptive measures are those that take actions to reduce risks, such as preparedness planning programs, monitoring for diseases, having access to air conditioning when it is hot outside, or having water filtration available [17].

## Climate-sensitive Populations

To a large extent, the direct and indirect effects of climate change will be felt most strongly among the poorest populations [1]. Those with limited resources will be especially

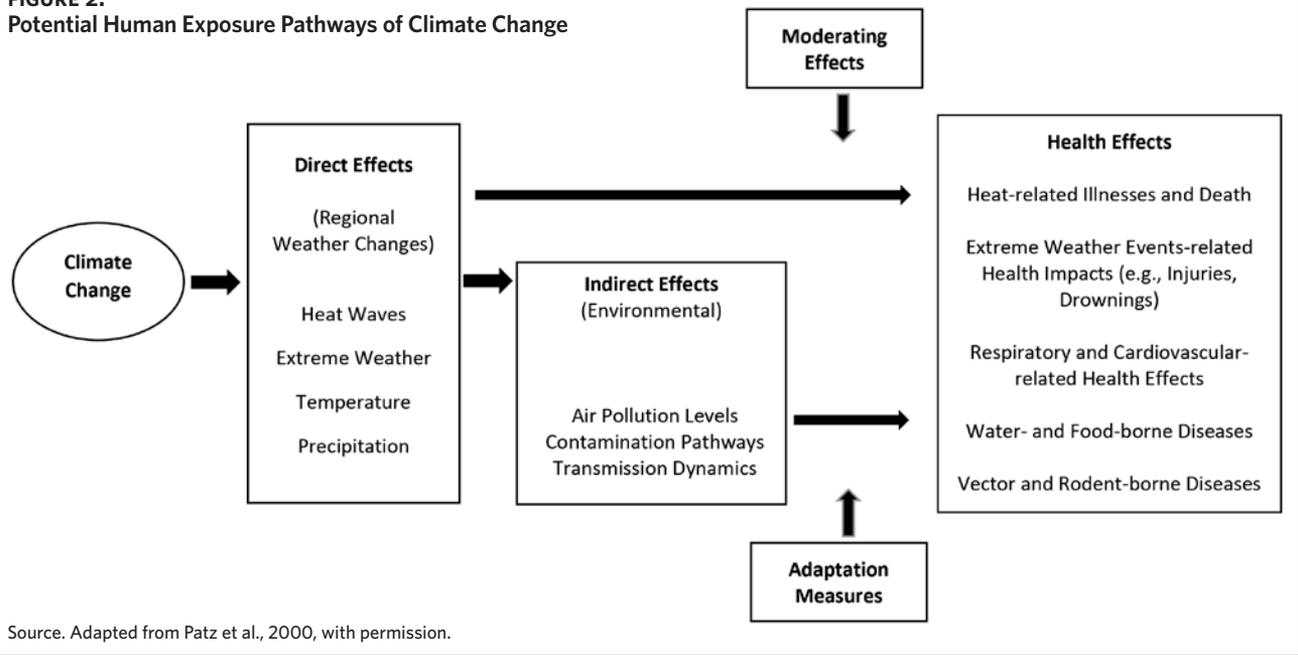
challenged because of higher energy costs to keep cool in summer and warm in winter; and increased food prices, food insecurity, and shortages related to agricultural damage from extreme weather [1]. Because of the complexity of these various factors, health impacts will also vary by geographic region [19]. Globally, populations that have existing health problems, the fewest resources, and live in lower latitudes, will be disproportionately impacted [20]. For example, developing countries, such as parts of Africa where basic public health services are lacking, water is unsafe, food nutrients have poor quality, and existing health problems are common, will experience the heaviest burden [4, 21].

In North America, the US Global Change Research Program (USGCRP) describes the climate-sensitive populations as low-income groups, pregnant women, communities of color, children, older adults, immigrants, outdoor workers, people with disabilities, and those who already suffer disproportionately from poor health [22]. Populations living in rural areas are also considered climate vulnerable because of smaller labor markets, lower income levels, social isolation, and reduced access and longer travel time to essential public services [1, 23].

## Climate Health: North Carolina

North Carolinians are experiencing the global effects of a changing climate, which are projected to continue into the future [5, 24]. In just the past four decades alone, North Carolina has experienced increasingly rising temperatures during summer months, heat waves, intense severe weather systems including tropical storms and hurricanes, severe flooding, and sea level rise [24]. These effects have added tremendous economic, infrastructure, and social burdens to our state, costing billions of dollars [25, 26]. Published studies have documented increased impacts on North Carolina populations, including injuries, heat-related illnesses and heat-related deaths, drownings, and behavioral

**FIGURE 2.**  
Potential Human Exposure Pathways of Climate Change



problems [27-31]. However, more research is needed at the regional level on climate and health effects in North Carolina populations.

In this special issue of the *NCMJ*, we have collated articles from authors across North Carolina to enlighten readers using evidence-based stories of how the devastating effects of hurricanes, coastal flooding, and extreme heat are contributing to heat-related deaths and illness, food insecurity, and mental health concerns. Listed below are examples of climate and key health indicators as noted by our authors, recognizing vulnerabilities and actions needed to move us toward achieving sustainability across our state. We hope this information will present health care providers and public health professionals with a better perspective on how climate influences health and what it means for communities that are confronted with this complex yet important issue.

### **Heat Waves and Heat-related Illness and Deaths**

Temperatures across North Carolina have increased about 1°F since record-keeping began, with the most recent decade being the warmest on record [24]. This warming trend is projected to continue and will pose significant health challenges for vulnerable populations. Exposure to extreme heat can lead to heat stroke, heat cramps, heat exhaustion, dehydration, and death [32]. Last year, more than 2,000 people went to emergency rooms across North Carolina for heat-related illness [33]. In this issue, Dr. Greg Kearney and Lariza Garzon describe in their article, “Calor Extremo: On the Frontlines of Climate Change With North Carolina Farmworkers,” the significant challenges and threats of rising temperatures for immigrant agricultural workers, while offering policy suggestions for protecting this vulnerable group [34].

### **Outdoor Air Quality and Respiratory Health**

Rising temperatures and drier soils are influencing the frequency and intensity of wildfires [35]. When a wildfire occurs, variable shifts in weather and wind patterns have the ability to impact air quality in a way that can increase respiratory concerns for communities, such as breathing problems, asthma attacks, and increased emergency department visits [3]. As North Carolina continues to experience frequent wildfires, Gail Robarge, Stacey Katz, and Dr. Wayne E. Cascio discuss in their article, “Wildfire Smoke: Opportunities for Cooperation Among Health Care, Public Health, and Land Management to Protect Patient Health,” current health assessment gaps while offering strategic insight for protecting patients through public health surveillance [36].

### **Extreme Weather and Mental Health**

North Carolina’s location along the Atlantic Coast makes it especially vulnerable to hurricanes and tropical storms [24]. Warmer ocean temperatures and sea level rise are increasing the intensity and strength of hurricanes, storms, and their impacts to our coast and inland areas. These extreme weather events can not only disrupt ecosystems and destroy property and infrastructure, they also contribute to ill health including, injuries, drownings, and even death. Although hurricanes and flooding are relatively short-term events, the recovery period can be long, leaving communities to reckon with both physical and emotional damages. As described by Drs Lea, Littleton, Allen, and Beasley in “Resilience, Self-compassion, and Mental Health Outcomes: Rebuilding Eastern North Carolina After Natural Disasters,” mental health issues following a natural disaster are a major concern [37]. Unfortunately, many people in North Carolina,

especially our poor, disabled, and other vulnerable populations, have nowhere to turn for mental health assistance in the time following a crisis. This point is further emphasized in a sidebar article by Pastor Dawn Gibson at Peletah Ministries, "Storm Recovery is Possible: 'From the Inside Out,'" which describes her experiences of working in post-disaster situations with people who have no insurance and rely on the emergency room for mental health services [38]. In another sidebar article, "Hurricanes and Public Health Preparedness: Meeting the Challenge," New Hanover Public Health Department Director Phil Tarte shares advice on how communities should prepare to meet climate change challenges by highlighting the importance of building resilience through community partnerships and strategic preparedness [39].

Following a catastrophic hurricane, flooding, or other natural disaster, where does a person go for food when there are no roads, electricity, or transportation? For people living in Eastern North Carolina, getting access to food becomes a dire issue as some rural communities are often isolated and detached from an essential service such as a grocery store. In their article, "The Food Bank's Role in Disaster Relief and Historic Response to Hurricane Florence," Jessica Slider-Whichard, Jennifer Caslin, and Lindsay Humbert describe how the Food Bank of Central & Eastern North Carolina's crisis team provides an essential service by finding and feeding our North Carolina friends and neighbors following extreme weather events [40].

### **Vectors and Infectious Diseases**

Changes in precipitation, temperatures, and seasonal variability have become increasingly more apparent in past decades and pose risks to natural ecosystems and human health [1, 41]. Infectious diseases, more specifically vector-borne diseases (VBDs) including Lyme disease and encephalitis, are increasingly becoming more common public health threats, particularly to the poor (i.e., those without window screens), and outdoor workers [3, 13]. In their article, "Vector-borne Diseases and Climate Change: North Carolina's Policy Should Promote Regional Resilience," Drs Byrd, Richards, Runkle, and Sugg provide an excellent overview of how warming temperatures and precipitation trends are changing seasonal activity and distribution of vectors, increasing the risk of infectious disease outbreaks in North Carolina [42]. These experts provide solid evidence for sustaining funding for vector programs while giving important key strategies to improve North Carolina's ability to respond to these threats.

### **Mitigation, Adaption, and Policy**

The move toward reaching equitable and sustainable solutions to combat climate change includes strategic ways to reduce carbon emissions. Drs Meiburg and Lazorick are right on track in their article, "Health Care in a Changing North Carolina Climate," when they discuss how concerted

efforts that focus on planning and risk reduction (prevention, mitigation, and preparedness) can lead to effective crisis management (response and recovery) [43]. In the article, "Health Benefits of North Carolina's Transition to Clean Energy," NC Department of Health and Human Services leaders Dr. Virginia Guidry, Lauren Thie, and Ben Money provide an excellent overview of North Carolina's roadmap to achieving a more sustainable future [44]. As described, Executive Order No. 80 will continue to keep North Carolina a leader in sustainability by accelerating clean energy innovation and economic opportunities and meeting reduced carbon emissions goals.

The North Carolina Climate Science Report (NCCSR, 2020) is the first-of-its-kind scientific document that provides unbiased, peer-reviewed evidence on the climate trends and future impacts of climate change in North Carolina. In their article, "A Hotter, Wetter, and More Humid North Carolina," Drs Dello, Robinson, Kunkel, Disson, and Maycock provide a brief summary of the report, highlighting past and projected effects of climbing temperatures, heat, flooding, sea level rise, droughts, and wildfires on our magnificent state [45].

Currently, we need a multidisciplinary approach to bridging the gap between science and social behavior and addressing the complexities of climate change. In the article, "Climate and Health in the Cities: A Challenge for the Built Environment," Dr. Rider, a professor of architecture at North Carolina State University, eloquently illustrates the important connection between public health and urban planning [46]. By designing better cities, striving to build greener buildings, and incorporating infrastructure and prioritizing nature, healthier lifestyles become more attainable.

### **Conclusions**

In 2009, The Lancet Commission on Health and Climate report stated that "climate change will impact the poorest in the world" and described it as the "biggest global health threat of the 21st century," [47]. For all of the above reasons, and more, one can begin to understand how these impacts would lead the Commission to reach this statement, but while it is certainly plausible and worthy of well-deserved attention, not all is doom and gloom. In 2015, the second Lancet report emphasized that climate change could be the "greatest global health opportunity of the 21st century" [48]. As highlighted here, sustainable development not only protects our environment, but when framed in a public health context offers many associated health co-benefits, such as using solar as an alternative to fossil fuels to improve air quality through reduction of airborne carbon emissions [48]. Other examples include designing walkable and bikeable cities with less dependency on automobiles, and moving toward plant-based diets, both of which benefit the environment as well as improving overall health and well-being [49].

Preparing to meet the challenges of climate change could have substantial health benefits to North Carolinians. To this

end, it is important that we work across political boundaries, agencies, businesses, and universities to engage in environmentally sustainable practices that promote and support efforts through policies like Executive Order No. 80. Cutting through the political noise to find that attainable balance remains a challenge, but through shared commitment, responsibility, leadership, and the right policy decisions, the desired results can be achieved.

A continued path for a more sustainable North Carolina ultimately rests on our willingness and desire to transform our current behaviors and culture, collectively recognizing and prioritizing what we feel is most important. Our ability to influence and transform cultural and behavioral beliefs can occur in a variety of forms. For example, in just the past 40 years we have witnessed major changes brought about by public concerns, including the removal of lead from gasoline to protect human health and the environment, the civil rights movement for social justice, and currently, society's demand to dismantle systemic racism. The decision to prioritize our environment and protect our health to address climate change will be reflected in our individual choices when purchasing products and services and making political decisions. It is important that we continue to stay involved on this topic and encourage policymakers to take action.

The COVID-19 pandemic has renewed interest in recognizing the importance of public health services and safety through primary prevention. Some researchers have taken this opportunity to study how COVID-19 has influenced climate change. In an article published in *Nature*, Le Quere and colleagues evaluated how "stay at home" restrictions and population confinement led to drastic changes in energy use and carbon emissions, reporting an estimated global 17% drop of CO<sub>2</sub> compared with mean levels in 2019 [50]. In the same article, it was reported that as countries have relaxed coronavirus policy lockdowns, emissions have begun to climb upward [50]. One of the ancillary impacts of COVID-19 is that our behavior has changed—we now think twice before taking a plane to a conference or a car trip to the grocery store. It's an interesting natural experiment that may provide lessons—and a needed boost in meeting sustainability goals—as we think about how to combat climate change and its effects on health in North Carolina and beyond.

Recognizing climate change in the context of health care is an important topic for North Carolina physicians, public health practitioners, health care providers, and policymakers. We hope that sharing this information with you will shed light on how these global impacts are being experienced by fellow North Carolinians across our state. **NCMJ**

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### References

1. Pachauri RK, Meyer LA, eds. Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland: IPCC; 2014. [http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5\\_SYR\\_FINAL\\_SPM.pdf](http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf). Published 2014. Accessed July 13, 2020.
2. National Academy of Sciences. Climate Change: Evidence and Causes: Update 2020. Washington, DC: The National Academies Press; 2020. <https://doi.org/10.17226/25733>
3. Crimmins A, Balbus J, Gamble JL, et al. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Washington, D.C.: U.S. Global Change Research Program; 2016. [https://health2016.globalchange.gov/low/Climate-Health2016\\_FullReport\\_small.pdf](https://health2016.globalchange.gov/low/Climate-Health2016_FullReport_small.pdf). Published 2016. Accessed July 13, 2020.
4. World Health Organization. Climate change. WHO website. <http://www.who.int/topics/climate/en/>. Updated 2015. Accessed May 7, 2016.
5. Melillo JM, Richmond TC, Yohe GW. Climate Change Impacts in the United States: The Third National Climate Assessment. Washington, D.C.: U.S. Global Change Research Program; 2014. [http://s3.amazonaws.com/nca2014/high/NCA3\\_Climate\\_Change\\_Impacts\\_in\\_the\\_United%20States\\_HighRes.pdf](http://s3.amazonaws.com/nca2014/high/NCA3_Climate_Change_Impacts_in_the_United%20States_HighRes.pdf). Published 2014. Accessed July 13, 2020.
6. Azhar GS, Mavalankar D, Nori-Sarma A, et al. Heat-related mortality in India: excess all-cause mortality associated with the 2010 Ahmedabad heat wave. *PLoS One*. 2014;9(3):e91831. doi: 10.1371/journal.pone.0091831
7. Madrigano J, Ito K, Johnson S, Kinney PL, Matte T. A case-only study of vulnerability to heat wave-related mortality in New York City (2000-2011). *Environ Health Perspect*. 2015;123(7):672-678. doi: 10.1289/ehp.1408178
8. Robine JM, Cheung SL, Le Roy S, et al. Death toll exceeded 70,000 in Europe during the summer of 2003. *C R Biol*. 2008;331(2):171-178. doi: 10.1016/j.crvi.2007.12.001
9. Thurston G, Lippmann M. Ambient particulate matter air pollution and cardiopulmonary diseases. *Semin Respir Crit Care Med*. 2015;36(3):422-432. doi: 10.1055/s-0035-1549455
10. D'Amato G, Holgate ST, Pawankar R, et al. Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders. A statement of the World Allergy Organization. *World Allergy Organ J*. 2015;8(1):25. doi: 10.1186/s40413-015-0073-0
11. D'Amato G, Pawankar R, Vitale C, et al. Climate change and air pollution: effects on respiratory allergy. *Allergy Asthma Immunol Res*. 2016;8(5):391-395. doi: 10.4168/aaair.2016.8.5.391
12. Johnston FH, Purdie S, Jalaludin B, Martin KL, Henderson SB, Morgan GG. Air pollution events from forest fires and emergency department attendances in Sydney, Australia 1996-2007: a case-crossover analysis. *Environ Health*. 2014;13:105. doi: 10.1186/1476-069X-13-105
13. Githeko AK, Lindsay SW, Confalonieri UE, Patz JA. Climate change and vector-borne diseases: a regional analysis. *Bull World Health Organ*. 2000;78(9):1136-1147
14. Rose JB, Epstein PR, Lipp EK, Sherman BH, Bernard SM, Patz JA. Climate variability and change in the United States: Potential impacts on water- and foodborne diseases caused by microbiologic agents. *Environ Health Perspect*. 2001;109(Suppl 2):211-221. doi: 10.1289/ehp.01109s2211
15. Patz JA, Engelberg D, Last J. The effects of changing weather on public health. *Annu Rev Public Health*. 2000;21:271-307. doi: 10.1146/annurev.publhealth.21.1.271
16. Patz JA, McGeehin MA, Bernard SM, et al. The potential health

- impacts of climate variability and change for the United States: executive summary of the report of the health sector of the U.S. National Assessment. *Environ Health Perspect*. 2000;108(4):367-376. doi: 10.1289/ehp.00108367
17. Patz JA, Frumkin H, Holloway T, Vimont DJ, Haines A. Climate change: challenges and opportunities for global health. *JAMA*. 2014;312(15):1565-1580. doi: 10.1001/jama.2014.13186
  18. Frumkin H, Hess J, Lubner G, Malilay J, McGeehin M. Climate change: the public health response. *Am J Public Health*. 2008;98(3):435-445. doi: 10.2105/AJPH.2007.119362
  19. Patz JA, Grabow ML, Limaye VS. When it rains, it pours: future climate extremes and health. *Ann Glob Health*. 2014;80(4):332-344. doi: 10.1016/j.aogh.2014.09.007
  20. Smith KR, Woodward A, Campbell-Lendrum D, et al. Ch. 11: Human Health: Impacts, Adaptation, and Co-Benefits. In: Field CB, Barros VR, Dokken DJ, eds. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* Cambridge, UK and New York, NY: IPCC; 2018. [https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap11\\_FINAL.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap11_FINAL.pdf). Published 2018. Accessed July 14, 2020.
  21. Wright CY, Garland RM, Norval M, Vogel C. Human health impacts in a changing South African climate. *S Afr Med J*. 2014;104(8):579-582. doi: 10.7196/samj.8603
  22. Gamble JL, Balbus J, Berger M, et al. Ch. 9: Populations of concern. In: Crimmins A, Balbus J, Gamble JL, et al. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. Washington, D.C.: U.S. Global Change Research Program; 2016. [https://health2016.globalchange.gov/low/Climate-Health2016\\_FullReport\\_small.pdf](https://health2016.globalchange.gov/low/Climate-Health2016_FullReport_small.pdf). Published 2016. Accessed July 13, 2020.
  23. Lal P, Alavalapati J, Mercer E. Socio-economic impacts of climate change on rural United States. *Mitig Adapt Strateg Glob Change*. 2011(16):819-844. doi: 10.1007/s11027-011-9295-9
  24. Frankson R, Kunkel K, Stevens L, et al. North Carolina State Climate Summary. NOAA Technical Report NESDIS 149-NC. <https://state-summaries.ncics.org/chapter/nc/>. Published May, 2019. Accessed July 14, 2020.
  25. Hsiang S, Kopp R, Jina A, et al. Estimating economic damage from climate change in the United States. *Science*. 2017;356(6345):1362-1369. doi: 10.1126/science.aal4369
  26. Alexander D, Currie J. Is it who you are or where you live? Residential segregation and racial gaps in childhood asthma. *J Health Econ*. 2017;55:186-200. doi: 10.1016/j.jhealeco.2017.07.003
  27. Curry MD, Mansfield CJ, Leonardo KD. Health and social problems of a primary care clinic population after a disaster. The Hurricane Floyd flood. *N C Med J*. 2001;62(2):99-102.
  28. Mirabelli MC, Richardson DB. Heat-related fatalities in North Carolina. *Am J Public Health*. 2005;95(4):635-637. doi: 10.2105/AJPH.2004.042630
  29. Yale JD, Cole TB, Garrison HG, Runyan CW, Riad Ruback JK. Motor vehicle-related drowning deaths associated with inland flooding after hurricane Floyd: a field investigation. *Traffic Inj Prev*. 2003;4(4):279-284. doi: 10.1080/714040485
  30. Harduar Morano L, Bunn TL, Lackovic M, et al. Occupational heat-related illness emergency department visits and inpatient hospitalizations in the southeast region, 2007-2011. *Am J Ind Med*. 2015;58(10):1114-1125. doi: 10.1002/ajim.22504
  31. Miller JA, Kearney GD, Proescholdbell SK. Surveillance of injuries in Eastern North Carolina following Hurricane Irene using emergency department data. *N C Med J*. 2013;74(4):272-278.
  32. Lugo-Amador NM, Rothenhaus T, Moyer P. Heat-related illness. *Emerg Med Clin North Am*. 2004;22(2):315-327. doi: 10.1016/j.emc.2004.01.004
  33. NC DETECT, North Carolina Department of Health and Human Services Division of Public Health, UNC School of Medicine. Emergency Department Visits for Heat-Related Illness. NC DETECT website. <https://ncdetect.org/2019/07/emergency-department-visits-for-heat-related-illness/>. Published July 18, 2019. Accessed July 7, 2020.
  34. Kearney GD, Garzon L. Calor extremo: on the frontlines of climate change with North Carolina farmworkers. *N C Med J*. 2020;81(5):311-314 (in this issue).
  35. Kinney PL. Climate change, air quality, and human health. *Am J Prev Med*. 2008;35(5):459-467. doi: 10.1016/j.amepre.2008.08.025
  36. Robarge G, Katz S, Cascio Wayne. Wildfire smoke: opportunities for cooperation among health care, public health, and land management to protect patient health. *N C Med J*. 2020;81(5):320-323 (in this issue).
  37. Lea CS, Littleton H, Atts Allen A, Beasley CM. Resilience, self-compassion, and mental health outcomes: rebuilding Eastern North Carolina after natural disasters. *N C Med J*. 2020;81(5):315-319 (in this issue).
  38. Gibson DB. Storm recovery is possible: 'from the inside out'. *N C Med J*. 2020;81(5):316-317 (in this issue).
  39. Tarte P. Hurricanes and public health preparedness: meeting the challenge. *N C Med J*. 2020;81(5):308-309 (in this issue).
  40. Slider-Whichard J, Caslin J, Humbert L. The food bank's role in disaster relief and historic response to Hurricane Florence. *N C Med J*. 2020;81(5):342-343 (in this issue).
  41. Caminade C, Kovats S, Rocklov J, et al. Impact of climate change on global malaria distribution. *Proc Natl Acad Sci U S A*. 2014;111(9):3286-3291. doi: 10.1073/pnas.1302089111
  42. Byrd B, Richards SL, Runkle JD, Sugg MM. Vector-borne diseases and climate change: North Carolina's policy should promote regional resilience. *N C Med J*. 2020;81(5):324-330 (in this issue).
  43. Meiburg S, Lazorick S. Health care in a changing North Carolina climate. *N C Med J*. 2020;81(5):338-341 (in this issue).
  44. Guidry VT, Thie L, Money EB. Health benefits of North Carolina's transition to clean energy. *N C Med J*. 2020;81(5):334-335 (in this issue).
  45. Dello K, Robinson W, Kunkel K, Disson J, Maycock T. A hotter, wetter, and more humid North Carolina. *N C Med J*. 2020;81(5):307-310 (in this issue).
  46. Rider TR. Climate and health in cities: a challenge for the built environment. *N C Med J*. 2020;81(5):331-337 (in this issue).
  47. A commission on climate change. *Lancet*. 2009;373(9676):1659. doi: 10.1016/S0140-6736(09)60922-3
  48. Watts N, Adger WN, Agnolucci P, et al. Health and climate change: policy responses to protect public health. *Lancet*. 2015;386(10006):1861-1914. doi: 10.1016/S0140-6736(15)60854-6
  49. Barrett B, Grabow M, Middlecamp C, et al. Mindful climate action: health and environmental co-benefits from mindfulness-based behavioral training. *Sustainability*. 2016;8(10):1040. doi: 10.3390/su8101040
  50. Le Quere C, Jackson RB, Jones MW, et al. Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. *Nat Clim Chang*. 2020;10:647-653. <https://doi.org/10.1038/s41558-020-0797-x>