

Climate Change: A Review of a Public Health Opportunity for the Northeast

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INTRODUCTION

The connection between climate change and health has been called the greatest public health threat of our time.¹ The Northeast (NE) is especially vulnerable. Average temperatures in the NE are expected to rise >3.6°F (2°C) higher than in the pre-industrial era and far more quickly than in the other contiguous states in North America. The region faces higher sea level rise and worse flooding than other regions of the United States (U.S.) with negative human health and economic impacts in the region. At present, the key mitigating mechanisms to ameliorate the health effects of climate change is through decreasing green house gas (GHG) emissions and developing evidence-based adaptation interventions.

STATE OF CLIMATE CHANGE IN 2018

The consensus among 97% of climate scientists is that climate change is occurring and is human caused.² Most contrarian research has significant methodological flaws.³ The planet is already 1.8°F (1°C) warmer than the pre-industrial baseline. Meanwhile, 2018 is on track to be the fourth hottest year on record, surpassed only by the preceding three years. The warmest 20 years have occurred in the past 22 years.⁴

Climate change leads to the following exposure pathways, among others: extreme heat, rising sea levels, extremes of precipitation, and more extreme weather (Figure 1).⁵⁻⁷ The U.S. had 16 billion-dollar weather and climate disasters in 2017 with an estimated total of \$313 billion dollars in damages.⁵ Worldwide, a number of catastrophic extreme weather events are related to climate change.⁸

During the 2016 Paris Agreement, 194 countries joined together to declare action on climate change. This body reconvened in December 2018 at the 24th Conference of the Parties (COP24)

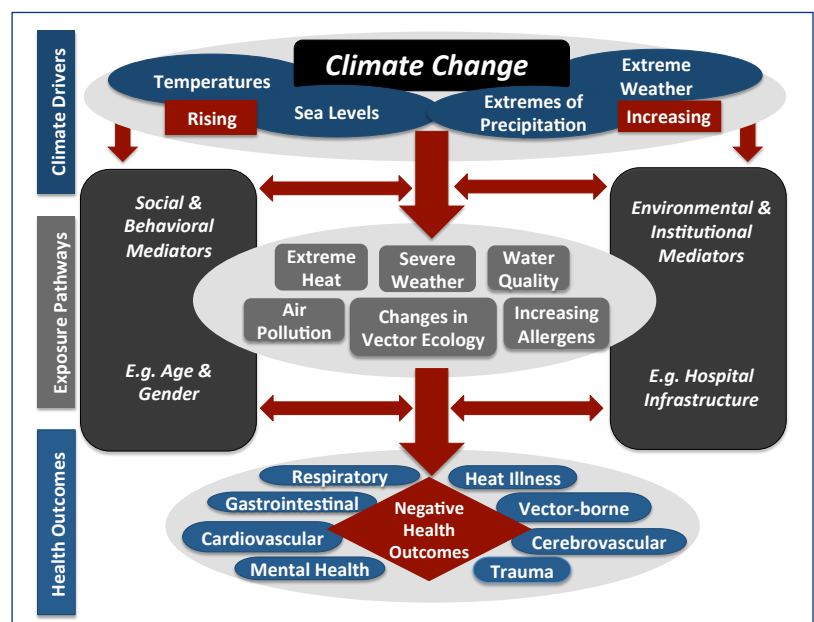
to outline the specifics of implementing the reduction of GHGs. While a consensus was reached, the current committed action will not be sufficient to reduce global GHG emissions to a level that will keep the planet below the necessary 2.7°F (1.5°C) as outlined by a special report in October 2018.⁹ This report by the Intergovernmental Panel on Climate Change (IPCC) gave an urgent call that global GHG emissions must be cut in half by 2030 to attempt the goal of 2.7°F (1.5°C). We are currently on track for 5.4°F (3°C).

The healthcare system is part of the problem given the energy intensity of immense 24-7-365 facilities. The U.S. health sector is responsible for approximately 10% of U.S. GHG emissions.¹⁰ It has been estimated that the mortality burden from the U.S. health sector's air pollution production is equal to the mortality burden of medical errors.¹¹

CLIMATE CHANGE AND HEALTH

Climate change leads to a broad range of negative health impacts (Figure 1).¹² Recent emerging health concerns, such as an association between increased heat and microbial

Figure 1. Sample Climate Change Exposure Pathways, Mediators, and Health Implications for the United States (figure created by R. Salas).



resistance to antibiotics, reveal that our understanding of these health risks is still in its infancy.⁵ Importantly, climate change disproportionately harms the health of the most vulnerable, including children, the elderly, and those with chronic medical conditions, as well as people of lower socioeconomic classes. Recent reports from key agencies, such as the *Lancet* Countdown, World Health Organization (WHO), and U.S. Global Change Research Program (USGCRP), outlined these health impacts globally and for the U.S.^{5-7,13}

The *Lancet* Countdown is an interdisciplinary research consortium tracking the impact of climate change on health in 41 indicators over five domains.⁶ It also stresses the potential for cascading disruptions to public health infrastructure that may overwhelm existing health services. The WHO report highlights that air pollution from the burning of fossil fuels leads to seven million deaths annually, suggesting that climate change is a public health emergency.¹³ Worldwide, the U.S. has the second highest carbon emission from the burning of fossil fuel, creating disproportionate health impacts in developing countries.^{14,15}

Two recent reports stress that the health impacts of climate change are not only occurring in distant lands, but also in the U.S. The companion 2018 *Lancet* Countdown Brief for the U.S. highlights that Americans have increased exposure to more frequent and longer heat waves, increasing extreme weather, and worsening climate-sensitive vector-borne diseases.⁵ In addition, the USGCRP's second volume of the National Climate Assessment, released in November 2018, also outlines that the health of every American is at risk and emphasizes the unique geographic vulnerabilities.⁷

THE NORTHEAST: UNIQUE CLIMATE CHANGE AND HEALTH CHALLENGES

Extreme Heat

The NE is predicted to have the largest temperature increase for the contiguous U.S. – nearly 3.6°F (2°C) warmer by 2035 and over 5°F (2.8°C) by 2050 compared to present day averages.⁷ This temperature rise will be nearly 20 years ahead of the predicted global rise to 3.6°F (2°C).¹⁶ therefore, benefit from understanding regional consequences of limiting the global mean temperature increase to well below 2°C above pre-industrial levels, a limit agreed upon at the United Nations Climate Summit in Paris in December 2015. Here, we analyze climate model simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5 Annual temperatures in New England have already increased by about 3°F (1.7°C) since the beginning of the 20th century.⁷ The seasons in the NE are also becoming less distinct as the winter months are warming three times faster than summers, while the health risks for heat appear to be most significant at the start of the summer. In addition, those residing in cities are especially at risk due to the phenomenon of urban heat islands – areas of increased temperatures

in urban areas in comparison to outlying suburban, exurban and rural locations.

The connection between extreme heat and health is well established, as elevated temperatures can lead to heat stroke, cardiovascular, renal, and respiratory disease, worsening mental health issues, and adverse birth outcomes.^{5,7,12} One study of Rhode Island (RI) found increased morbidity, mortality, and emergency department (ED) utilization with increased temperatures.¹⁷ The increase in ED visits occurs rather abruptly when maximum ambient temperature is > 80°F. Between 2005–2012, all cause ED visits increased by 1.3% with the strongest association at the extremes of age. Heat-related ED visits increased by 23.9% when the daily maximum temperatures increased by 10°F (from 75°F to 85°F), while all cause mortality increased by 4%. It is predicted that the NE will experience 650 excess deaths annually by 2050 and then upsurges from approximately 960 in a moderate climate model to 2,300 excess deaths in the extreme model per year by 2090 from heat.⁷

Ocean Warming

The ocean is warming three times faster along the Northeast Continental Shelf compared to the global rate, with the Gulf of Maine increasing 99% more than the global average the last decade.⁷ In 2012, the NE experienced the most intense warming event as the ocean rose to 3.6°F (2°C) above average. As ocean temperatures increase, conditions for harmful algae blooms are growing more favorable and have been increasing in both frequency and duration in the Gulf of Maine.⁷ Conditions for *Vibrio* are also more favorable and have expanded to the north. Both of these potentially leave more Americans exposed to toxins and bacteria through direct contact or ingestion of contaminated seafood.⁵⁻⁷

Sea Level Rise and Extreme Weather

Ocean levels are not rising equally due to a variety of factors, and the NE has experienced some of the highest rates of sea level rise.⁷ It is predicted that by the end of the century, sea levels could rise to more than 11 feet on average in this region. As sea levels rise, high tide flooding has increased by 100–200% in some areas with more nuisance flooding. Over the past 20 years, the NE has also experienced some of the largest increases in precipitation during the spring and fall seasons.¹⁸ Increased precipitation and flooding risks, coupled with more frequent power outages, create ideal mold conditions, which has implications for respiratory conditions.⁷

The NE experiences nearly year-round storms from Nor'easters, occurring September to April, and from Atlantic hurricanes, occurring June to September.⁷ This is especially concerning as Atlantic hurricanes are of higher intensity and produce increased precipitation.¹⁸ Extreme weather can result in healthcare issues related to direct trauma and disruptions in the healthcare system.¹² For instance, due to the aging infrastructure of NE urban centers, the region is

increasingly vulnerable to flood dynamics. It is predicted that climate-related hazards may cause upward of \$11–17 billion dollars per year of damage.⁷ Many northeast cities – Boston, New York, Philadelphia, Portland, Providence, and others – have begun to plan for climate change as they seek to upgrade aging infrastructure, including water systems. Many NE cities have combined sewer systems, which can lead to drinking water contamination and subsequent gastrointestinal illness during flood events. Massachusetts has seen an increase in gastrointestinal illness related to heavy rains and runoff and Maryland has noted increased cases of *Campylobacter* and *Salmonella* during heavy precipitation.^{19, 20} These vulnerabilities reinforce that healthcare systems must be prepared for contingencies and remain resilient during extreme weather.

Air Degradation

Air quality has improved in the NE over recent decades, yet climate change threatens to unravel this achievement. For example, as the NE experiences higher temperatures, it will worsen ground-level ozone concentrations and lead to hundreds of excess deaths by 2050 from the baseline estimate in 2000.⁷ While the NE is immune to wildfires, climate change is intensifying wildfires in the western U.S. and Canada, and smoke can travel thousands of miles. Worsening air quality in the NE from increased smoke particulate matter, worsening pollen levels due to higher CO2 levels, and increased ozone all pose significant health risks, especially for those with underlying lung pathology.

Climate-sensitive Vector Borne Diseases

As the conditions for vectors, especially arthropods, are altered by climate change, the risk of transmission to humans is heightened. The ticks and mosquitoes known to transmit two key climate-sensitive vector-borne diseases in the NE, Lyme disease and West Nile virus, are expected to continue moving further north.⁷ By 2065–2080, the transmission of Lyme in the NE could start nearly three weeks earlier in Maine and Pennsylvania (compared to baseline 1992–2007). Cases of neuro-invasive West Nile may increase by 210 to 490 cases per year.

OPPORTUNITIES TO MINIMIZE MORBIDITY AND MORTALITY IN THE NORTHEAST

Mitigation

The reduction of GHG emissions, notably through converting from fossil fuels to renewable energy sources like wind and solar, can positively impact healthcare by reducing air pollution and minimizing climate change. In a best-case scenario, mitigation can result in a moderate climate change model and could save \$21 billion and prevent nearly 1,400 premature deaths annually from heat alone. Given the current lack of federal commitment to this issue, action will likely reside on local and state levels. However, the current local and state commitments are only meeting half of the U.S. Paris Agreement commitments.⁵ While states in the NE are reducing the carbon intensity of the energy system (Figures 2 and 3)²¹, urgent and aggressive action is needed in order to maintain global temperature rise below 2.7°F (1.5°C).⁹

The health sector can assume leadership in the field by modeling the behavior needed to reduce morbidity and mortality. Healthcare systems can honor U.S. Paris Agreement commitments and reduce GHG emissions by reducing

Figure 2. Per Capita Energy-Related Carbon Dioxide Emissions for Northeast States for Years 2000–2015 (figure created from data from U.S. Energy Information Administration).

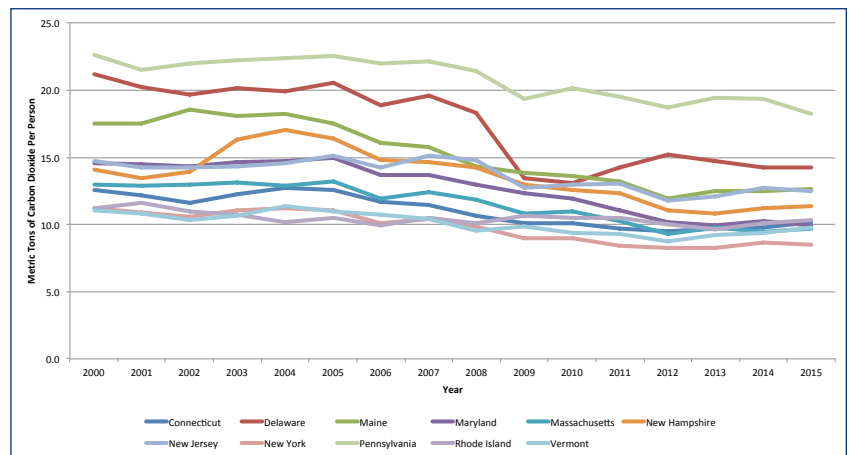
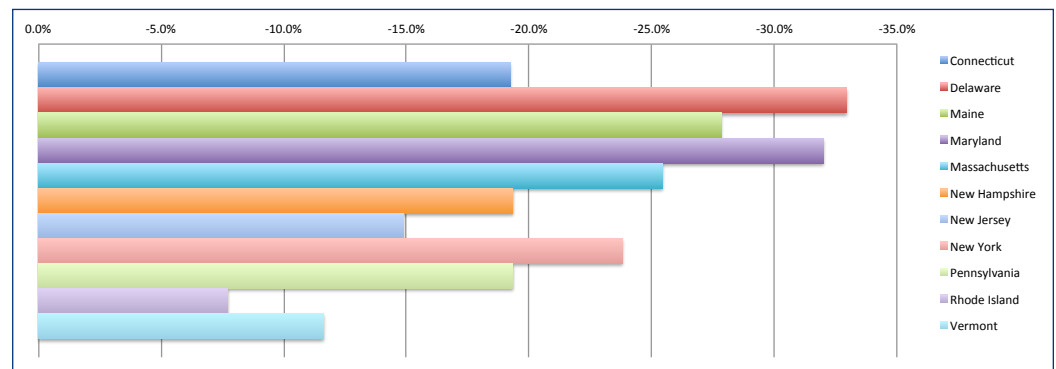


Figure 3. Percent Change Between 2000–2015 in Per Capita Energy-Related Carbon Dioxide Emissions by Northeast State (figure created from data from U.S. Energy Information Administration).



fossil fuel use. A physician messenger transmitting the key message that climate change is first and foremost a public health issue has been found to increase the engagement of the public and depoliticize it.¹⁰

Adaptation

Adaptation interventions can help minimize the harm climate change is causing to health. Philadelphia and New York City have implemented policies and alterations in its infrastructure, including opening cooling centers, protecting utility services from overload, and planting over one million trees to develop an urban canopy – that will reduce mortality from heat.²² In addition, health systems must focus on climate resiliency to ensure that these systems can face the numerous challenges of climate change as it threatens to disrupt efficiency, infrastructure, supply chains, and function.

CONCLUSION

Climate change is the greatest public health opportunity of this generation. Advocating for renewable energy and research into evidence-based adaptation interventions is in line with the Hippocratic oath. There is nothing political about protecting the health of patients.

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