Effects of Extreme Heat, Cold, Weather Events, and Older Adult Housing on Health

NRDC

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Seminar on Consequences of Climate Change for Health at Older Ages

NASEM Committee on Population

@vlimaye

Our Climate Emergency

Source: Intergovernmental Panel on Climate Change (2021)

Climate Change

Temperature rise

2-3°C by 2100

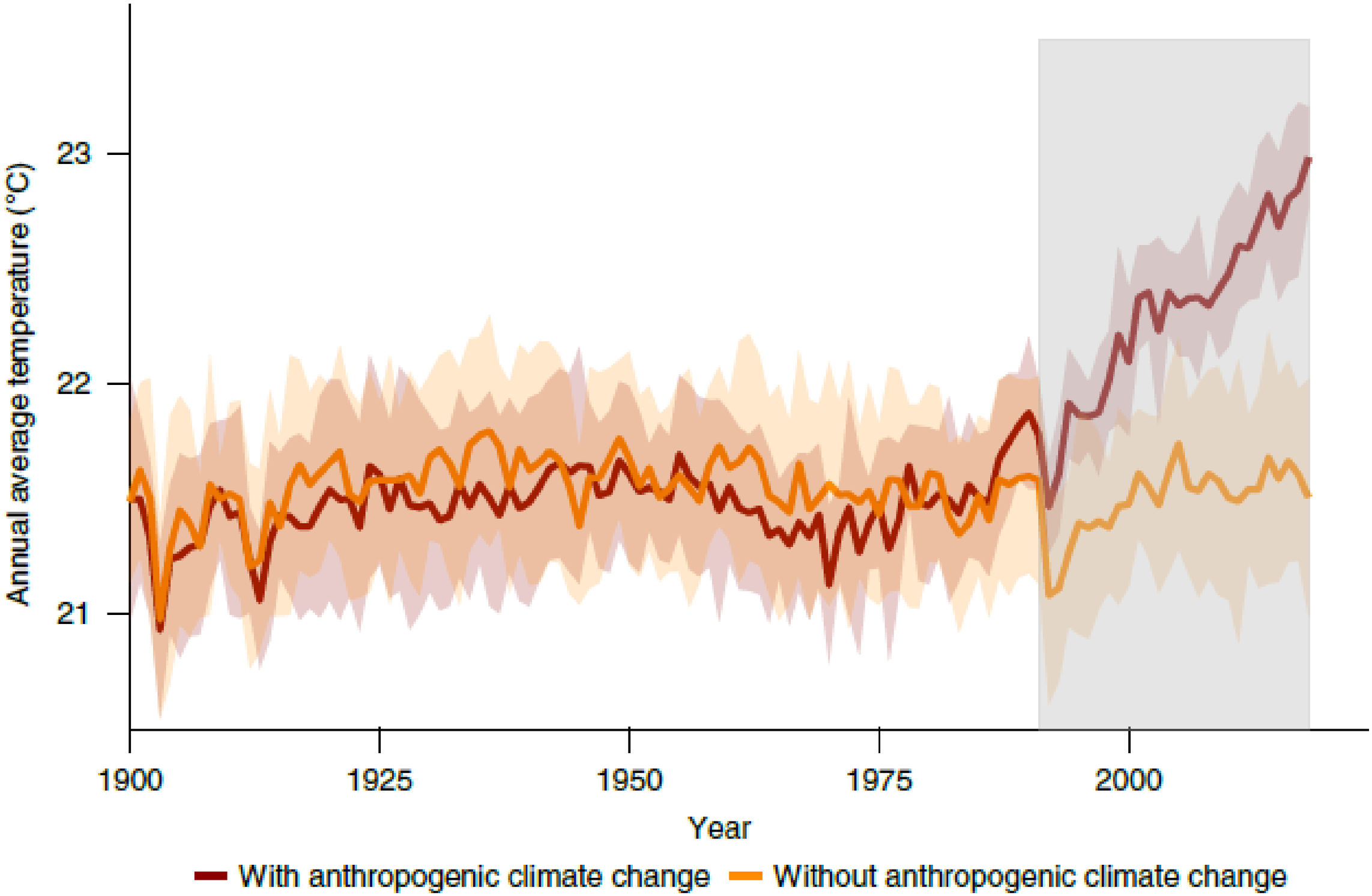
Sea level rise

Hydrologic and weather extremes

Urban Heat Island Effect	→	Heat stress Cardiorespiratory failure
Air Pollution	→	Respiratory diseases (e.g., COPD, Asthma)
Vector-borne Diseases	→	Malaria, Dengue Encephalitis Hantavirus Rift Valley Fever
Waterborne Diseases	→	Cholera Cyclospora Cryptosporidiosis Campylobacter Leptospirosis
Water Resources and Food Supply	→	Malnutrition Diarrhea
Environmental Refugees	→	Forced migration Overcrowding Infectious diseases Human conflicts

Source: Patz (1998)

Attributing Health Problems to Climate Change



Current Underestimation of Health Hazards from Heat

Excessive Heat and Respiratory Hospitalizations in New York State: Estimating Current and Future Public Health Burden Related to Climate Change

Shao Lin,[1,2] Wan-Hsiang Hsu,[1,2] Alissa R. Van Zutphen,[1,2] Shubhayu Saha,[3] George Luber,[3] and Syni-An Hwang[1,2]

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RESEARCH ARTICLE

Quantifying the impact of future extreme heat on the outdoor work sector in the United States

Rachel Licker[1,*], Kristina Dahl[1], and John T. Abatzoglou[2]

scientific reports

OPEN

The impact of heat on kidney stone presentations in South Carolina under two climate change scenarios

M. Vicedo-Cabrera[2,3], Vicky Tam[4], Lihai Song[4], Ethan Coffel[5] &

The 2021 Western North America Heat Dome Increased Climate Change Anxiety Among British Columbians: Results from A Natural Experiment

Andreea Bratu[1,2,*] andreea.brt@gmail.com, Kiffer G. Card[3], Kalysha Closson[1,2], Niloufar Aran[2,3], Carly Marshall[2], Susan Clayton[4], Maya Gislason[3], Hasina Samji[3], Gina Martin[5], Melissa Lem[6], Carmen Logie[7], Tim Takaro[3], Robert S. Hogg[2,3]

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Ontario, Canada

Research

A Section 508–conformant HTML version of this article is available at https://doi.org/10.1289/EHP8083.

Warm Season and Emergency Department Visits to U.S. Children's Hospitals

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Temperature Risks to Older Adults

- **Climate and demographic change are converging in ways that threaten older individuals**

- **Social isolation and limited income can function to heighten exposure risks and limit available adaptation responses**

- **Heat exposure increases the risk of illness and death in older people, but specific risks to people with dementia have been under-studied**

Heightened Exposure Risks

- Worsened thermal regulation in older adults, lack of clinician training in climate-specific health risks
- Interaction of heat with medications
- Heat exposure can exacerbate confusion, disorientation, mental stress and anguish
- Heat threatens organ systems throughout the body and is not merely an inconvenience

Limited Adaptive Responses

- Social isolation
- Mobility challenges
- Communicating discomfort and hydration needs
- Economic vulnerability and substandard housing

Compounding Inequities

- Temperature exposures and additional environmental stressors

- Chronic health conditions and other health-related vulnerability

- Economic insecurity and lack of access to affordable care

An Adaptation Agenda for Older Adults

We must better help older adults and informal caregivers properly plan and prepare for mounting climate risks:

- Providing older adults and informal caregivers with outreach and education
- Engaging appropriate agencies in the emergency planning processes
- Supporting older adults after acute hazard passes
- Support professionals who can help older adults and their informal caregivers prepare for climate hazards

Intervention Windows

Commentary

Reducing the inequitable health and financial burdens of climate change

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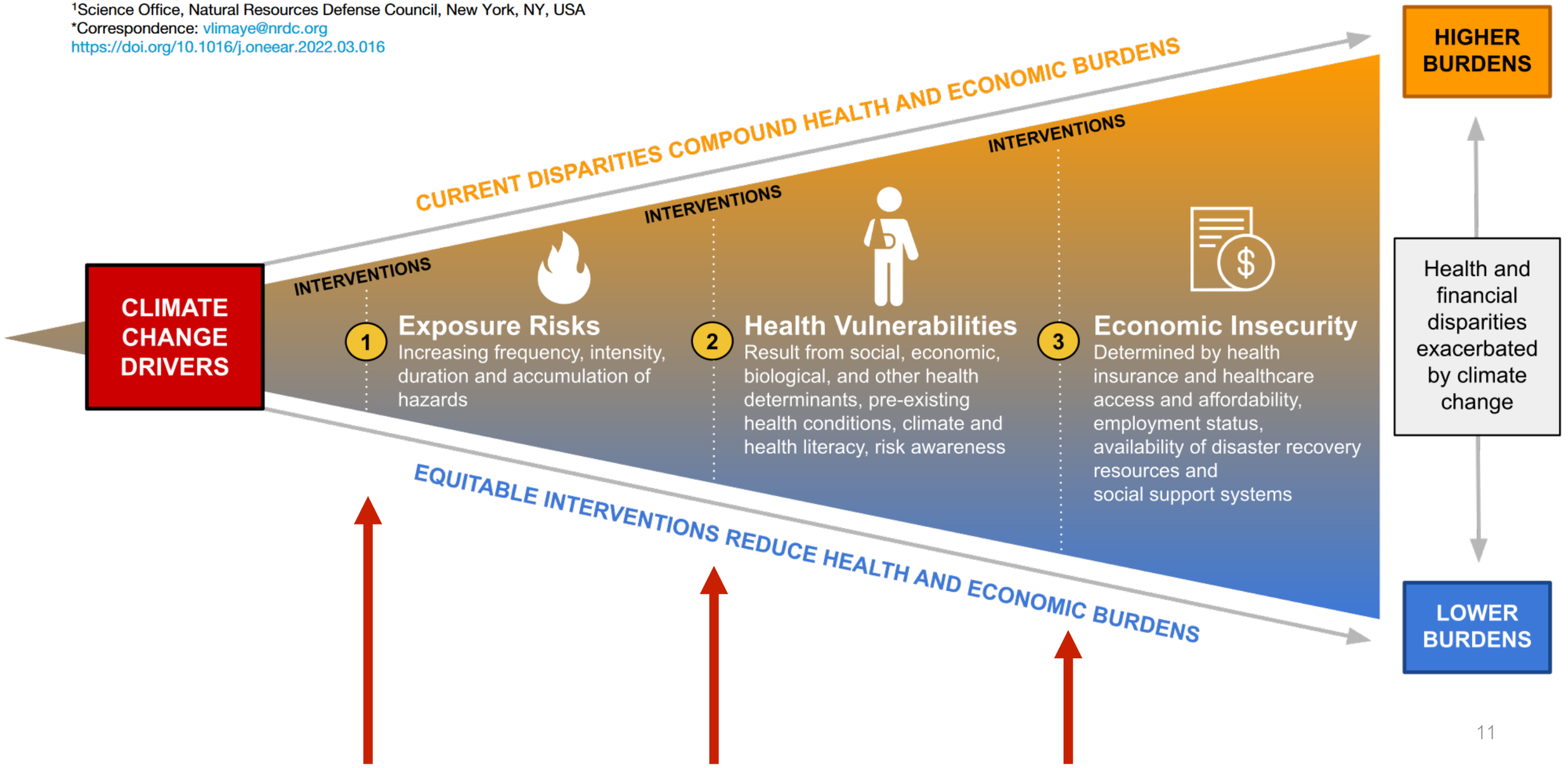

Research Needs

Global warming and neurological practice: systematic review

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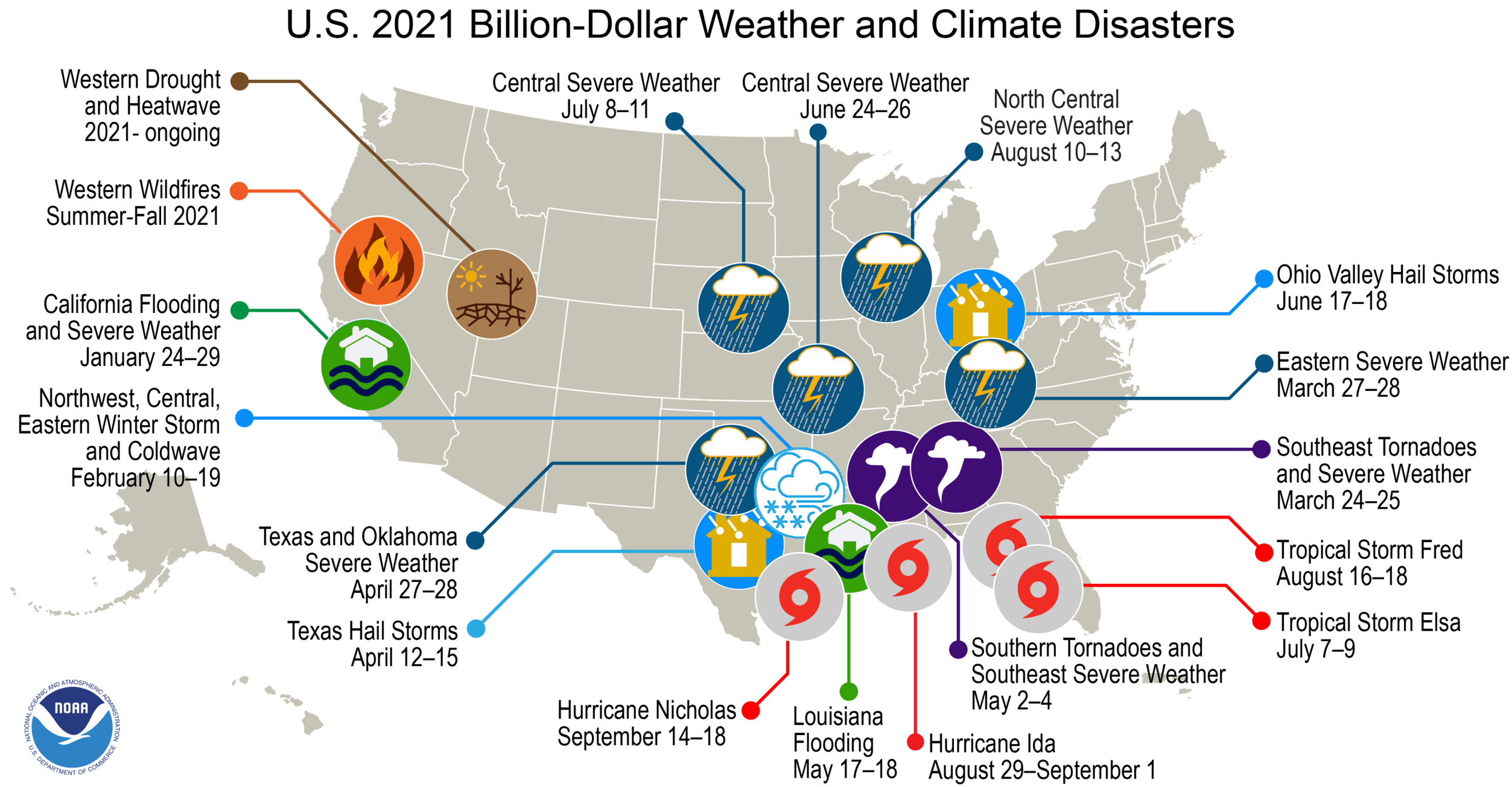
"We were unable to identify a single adequately designed study addressing how global warming and human migration will change neurological practice.

The evidence so far suggests that climate change will affect the practice of all major neurological disorders in the near future. Adequately designed studies to address this issue are urgently needed, requiring concerted efforts from the entire neurological community."

Costly Climate Impacts



*This map denotes the approximate location for each of the **18 separate billion-dollar weather and climate disasters that impacted the United States January–September 2021**.*

NRDC Study

- **Case Study approach:**
  - Select events spanning the range of climate-health harms
  - Events from a single year (2012), health outcomes quantified at the state level in scientific journals or other public data sources

- Estimated health costs using **combined valuation method:**
  - Health costs derived from federal statistics
    - Incidence-based cost of illness (including lost wages)
    - Value of a Statistical Life (as applied by federal agencies)

AGU100

GeoHealth

RESEARCH ARTICLE
10.1029/2019GH000202

Key Points:
- Climate change threatens human health, but there remains a lack of evidence on the economic toll of the adverse public health impacts of climate-sensitive events
- We estimate $10.0 billion (2018 dollars) in health-related costs from 10 climate-sensitive U.S. case study events during 2012
- This work helps to shed light on the high burden climate-sensitive events already place on U.S. public health each year

Supporting Information:
- Supporting Information S1

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(continued)

Estimating the Health-Related Costs of 10 Climate-Sensitive U.S. Events During 2012

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Abstract Climate change threatens human health, but there remains a lack of evidence on the economic toll of climate-sensitive public health impacts. We characterize human mortality and morbidity costs associated with 10 climate-sensitive case study events spanning 11 US states in 2012: wildfires in Colorado and Washington, ozone air pollution in Nevada, extreme heat in Wisconsin, infectious disease outbreaks of tick-borne Lyme disease in Michigan and mosquito-borne West Nile virus in Texas, extreme weather in Ohio, impacts of Hurricane Sandy in New Jersey and New York, allergenic oak pollen in North Carolina, and harmful algal blooms on the Florida coast. Applying a consistent economic valuation approach to published studies and state estimates, we estimate total health-related costs from 917 deaths, 20,568 hospitalizations, and 17,857 emergency department visits of $10.0 billion in 2018 dollars, with a sensitivity range of $2.7–24.6 billion. Our estimates indicate that the financial burden of deaths, hospitalizations, emergency department visits, and associated medical care is a key dimension of the overall economic impact of climate-sensitive events. We found that mortality costs (i.e., the value of a statistical life) of $8.4 billion exceeded morbidity costs and lost wages ($1.6 billion combined). By better characterizing health damages in economic terms, this work helps to shed light on the burden climate-sensitive events already place on U.S. public health each year. In doing so, we provide a conceptual framework for broader estimation of climate-sensitive health-related costs. The high health-related costs associated with climate-sensitive events highlight the importance of actions to mitigate climate change and adapt to its unavoidable impacts.

Plain Language Summary Global climate change is underway and accelerating, posing threats to human health. Despite growing evidence of the harmful health impacts of climate change, there remains a lack of evidence on the personal and societal economic cost of climate-sensitive events. We analyzed publicly available data sets, government databases, and published analyses in the peer-reviewed literature to estimate the human health-related costs of a subset of 10 climate-sensitive case studies that occurred in 11 U.S. states during 2012: wildfires in Colorado and Washington, ozone air pollution in Nevada, extreme heat in Wisconsin, infectious disease outbreaks of tick-borne Lyme disease in Michigan and mosquito-borne West Nile virus in Texas, extreme weather in Ohio, impacts of Hurricane Sandy in New Jersey and New York, allergenic oak pollen in North Carolina, and harmful algal blooms on the Florida coast. We estimated a total of $10.0 billion (2018 dollars) in health-related costs from these 10 events, with mortality costs ($8.4 billion) exceeding illness costs and lost wages ($1.6 billion combined). The high health-related costs of climate-sensitive events highlight the need to mitigate climate change and adapt to its unavoidable impacts.

1. Introduction

Global climate change is underway and accelerating, posing a vast array of direct and indirect threats to human health (Intergovernmental Panel on Climate Change, 2018; U.S. Global Change Research Program, 2016, 2018). Despite growing evidence of the harmful health impacts of climate change and its exacerbation of global inequality (Diffenbaugh & Burke, 2019), there remains a dearth of evidence on the personal and societal economic toll of climate-sensitive events; numerous studies have called for more investigation on this issue (Díaz & Moore, 2017; Government Accountability Office, 2017; Gropp, 2017; Hutton & Menne, 2014; U.S. Global Change Research Program, 2016).

Cost valuation of climate-sensitive health impacts is useful for several purposes. First, valuation estimates illuminate a tangible yet understudied impact of climate change and shed light on how this threat is affecting sectors far beyond infrastructure and agriculture (Revesz et al., 2014; Watts, Amann, Arnell, et al., 2018).

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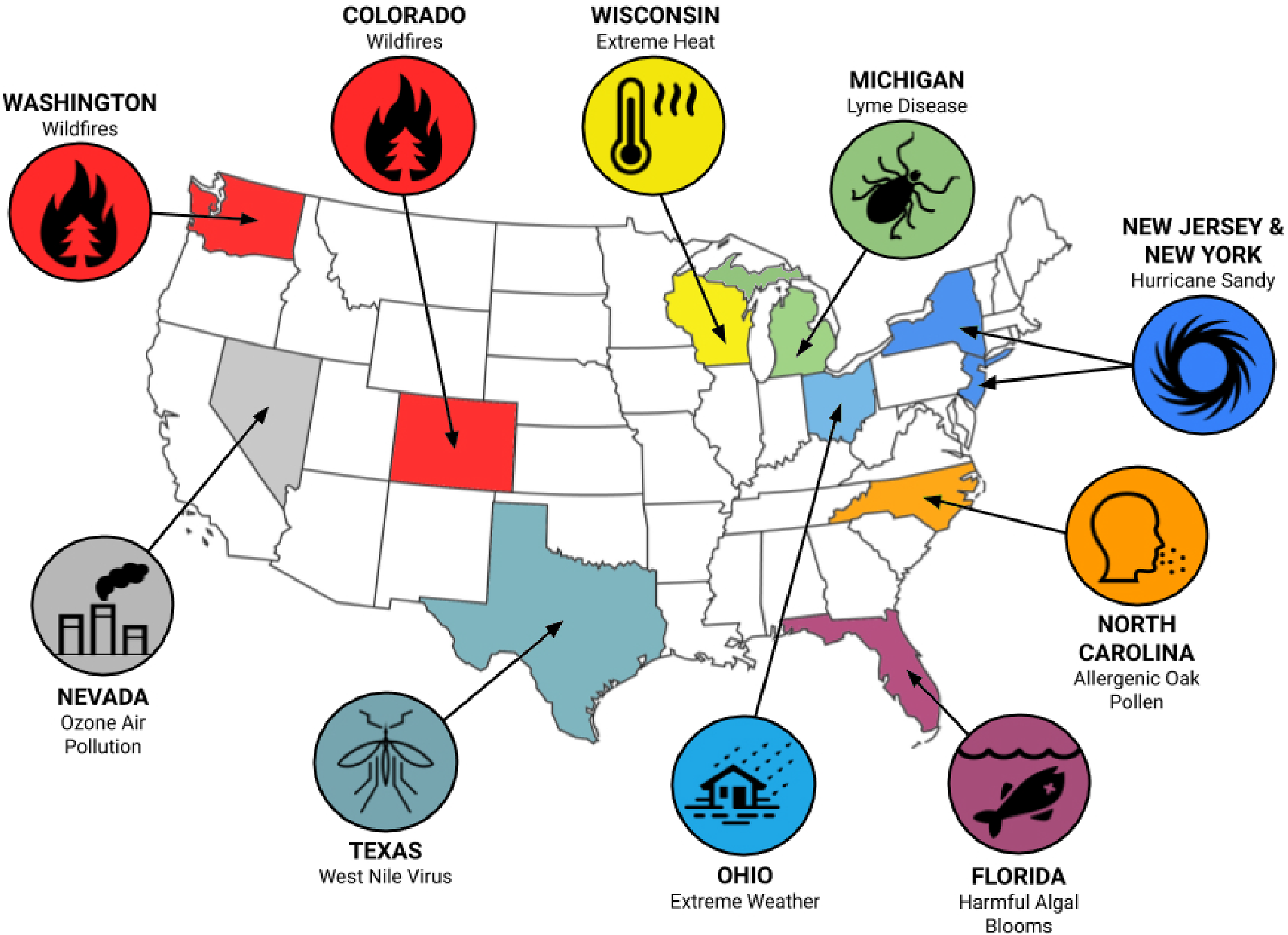
WASHINGTON
Wildfires
COLORADO
Wildfires
WISCONSIN
Extreme Heat
MICHIGAN
Lyme Disease
NEW JERSEY &
NEW YORK
Hurricane Sandy
NEVADA
Ozone Air
Pollution
TEXAS
West Nile Virus
OHIO
Extreme Weather
NORTH
CAROLINA
Allergenic Oak
Pollen
FLORIDA
Harmful Algal
Blooms

Methods: Estimating Health Costs

Deaths

Outpatient Care

Medical Care
(Emergency Room Visits & Hospitalizations)

Home Health Care

Lost Wages

Prescribed Medications

Integrating Fragmented Data

Case study	Peer-reviewed literature (number of studies)	State-collected health data	U.S. Centers for Disease Control and Prevention (CDC)	U.S. Environmental Protection Agency (EPA)	U.S. National Atmospheric and Oceanic Administration (NOAA)
Lyme disease	✓ (1)	✓	✓		
Extreme weather	✓ (2)	✓			✓
Extreme heat	✓ (1)	✓	✓		
Allergenic oak pollen	✓ (2)	✓		✓	
Ozone air pollution	✓ (2)			✓	
West Nile virus	✓ (1)	✓	✓		
Wildfires	✓ (2)	✓		✓	✓
Wildfires	✓ (2)	✓		✓	
Harmful algal blooms	✓ (1)	✓		✓	
Hurricane Sandy	✓ (9) ✓ (12)	✓ ✓	✓		

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Results: Wide Array of Health Problems

Table 2
Health Impacts Included in 2012 Climate-Sensitive Health Cost Valuation

State	Case study	Health effects included in valuation
Michigan	Lyme disease	Arthritis, carditis, erythema migrans rash, facial palsy, meningitis, radiculoneuropathy
North Carolina	Allergenic oak pollen	Mortality, asthma
Ohio	Extreme weather	Mortality, acute respiratory infection, asthma, gastrointestinal illness, skin and soft tissue infection
Wisconsin	Extreme heat	Mortality, exposure to excessive heat, heat cramps, heat edema, heat exhaustion, heat fatigue, stroke, heat syncope, sun stroke
Florida	Harmful algal blooms	Digestive system disease, respiratory disease
Nevada	Ozone air pollution	Mortality, asthma, chronic lung disease, respiratory problems
Texas	West Nile virus	Mortality, acute flaccid paralysis, cranial nerve palsy, encephalitis, fever, meningitis
Colorado	Wildfires	Mortality, acute myocardial infarction, asthma, bronchitis, chronic obstructive pulmonary disease, pneumonia, respiratory disease, upper respiratory infection
Washington	Wildfires	Mortality, acute myocardial infarction, asthma, bronchitis, cerebrovascular disease, chronic obstructive pulmonary disease, pneumonia, respiratory disease, upper respiratory infection
New Jersey	Hurricane Sandy	Mortality, acute upper respiratory illness, bronchitis, calculus of kidney and ureter, carbon monoxide exposure, contusion, cut/pierce injury, dehydration, dialysis, end-stage renal disease, falls, fracture, fluid imbalance, functional digestive issue, myocardial infarction, open wound, osteoarthritis, other injury, overexertion, mental illness, sprain, stroke, struck by/against object (unintentional contact) injury, tree-related injury, type II diabetes
New York	Hurricane Sandy	Mortality, anxiety, carbon monoxide exposure, dialysis, electrolyte abnormality, end-stage renal disease, external exposure, homelessness, hypertensive kidney disease, hypothermia, legionellosis, mental or mood disorder, myeloproliferative/neoplasm, nonfatal injury, psychosis, pulmonary fibrosis, respiratory problem, substance abuse, suicide counseling, threatened or spontaneous abortion, type II diabetes, ventilator needed

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Results: Wide Array of Health Problems

- **Shedding new light on climate-linked harms, including:**
  - **Hurricane Sandy:** mental health (anxiety, depression, substance abuse), homelessness, pregnancy complications, deaths from end-stage renal (kidney) disease

  - **Wildfires:** new science quantifying harms of deadly wildfire smoke-generated fine particles ($PM_{2.5}$), which travel hundreds of miles downwind

- Our understanding of climate-health impacts grows by the day--we're capturing just a subset of impacts within a confined time period

Results: Health Impacts

State	Case Study	Deaths	Hospital Admissions	Emergency Department Visits
MI	Lyme Disease	0	157	11
NC	Allergenic Oak Pollen	4	183	1,149
OH	Extreme Weather	8	37	343
WI	Extreme Heat	27	155	1,620
NV	Ozone Air Pollution	97	114	194
TX	West Nile Virus	89	1,628	2,680
CO	Wildfires	174	256	1,432
FL	Harmful Algal Blooms	0	11,066	3,857
WA	Wildfires	245	371	1,897
NJ	Hurricane Sandy	273*	5,795	2,247
NY			807	2,426
	TOTAL	**917**	**20,568**	**17,857**

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Results: Health Costs

State	Case Study	Cost of Premature Deaths	Cost Of Illness	Total Health Costs (including lost wages)
MI	Lyme Disease	-	$8 million	$8 million
NC	Allergenic Oak Pollen	$37 million	$6 million	$43 million
OH	Extreme Weather	$73 million	$10 million	$83 million
WI	Extreme Heat	$246 million	$5 million	$252 million
NV	Ozone Air Pollution	$887 million	$11 million	$898 million
TX	West Nile Virus	$812 million	$274 million	$1.1 billion
CO	Wildfires	$1.6 billion	$23 million	$1.6 billion
FL	Harmful Algal Blooms	-	$546 million	$557 million
WA	Wildfires	$2.2 billion	$55 million	$2.3 billion
NJ NY	Hurricane Sandy	$2.5 billion	$647 million	$3.1 billion
	TOTAL	**$8.4 billion**	**$1.6 billion**	**$10.0 billion**

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Results: An Inequitable Cost Burden

- **Who pays for these costs?**
  - A disproportionate share of the illness-related costs of the events (about 64%) were shouldered by Medicare and Medicaid patients.

- Older adults and the economically disadvantaged are among those most vulnerable to the health effects of climate-sensitive events.

- Health systems are not equipped to handle the climate crisis, but targeted interventions can benefit vulnerable communities.

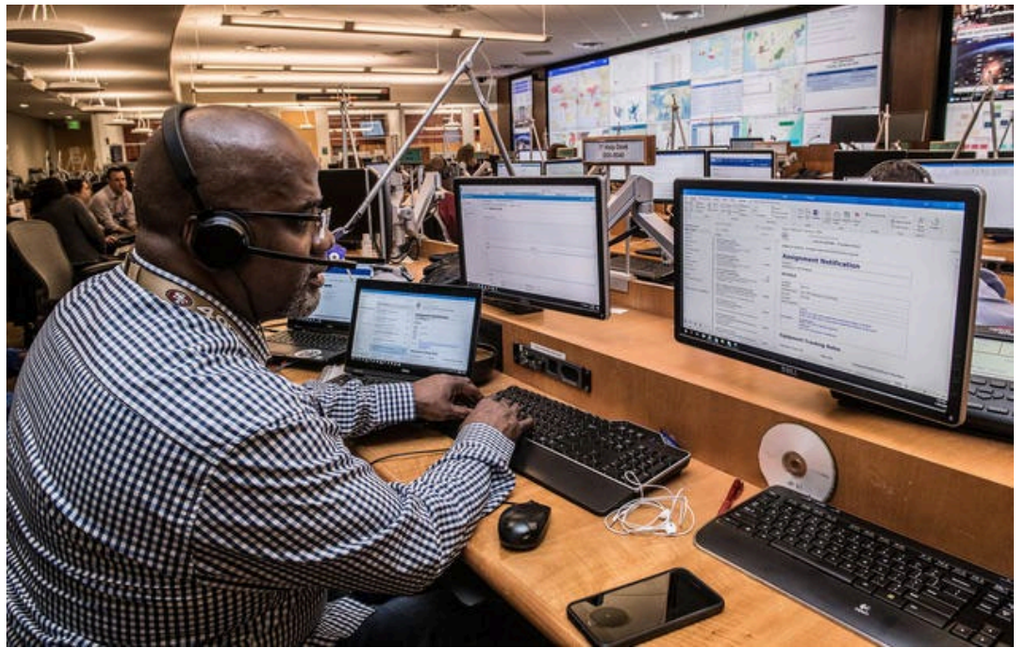
Climate & Health Data: Goals and Obstacles

- **Better understanding of climate-sensitive cost burden** on individuals, families, employers, insurers, governments

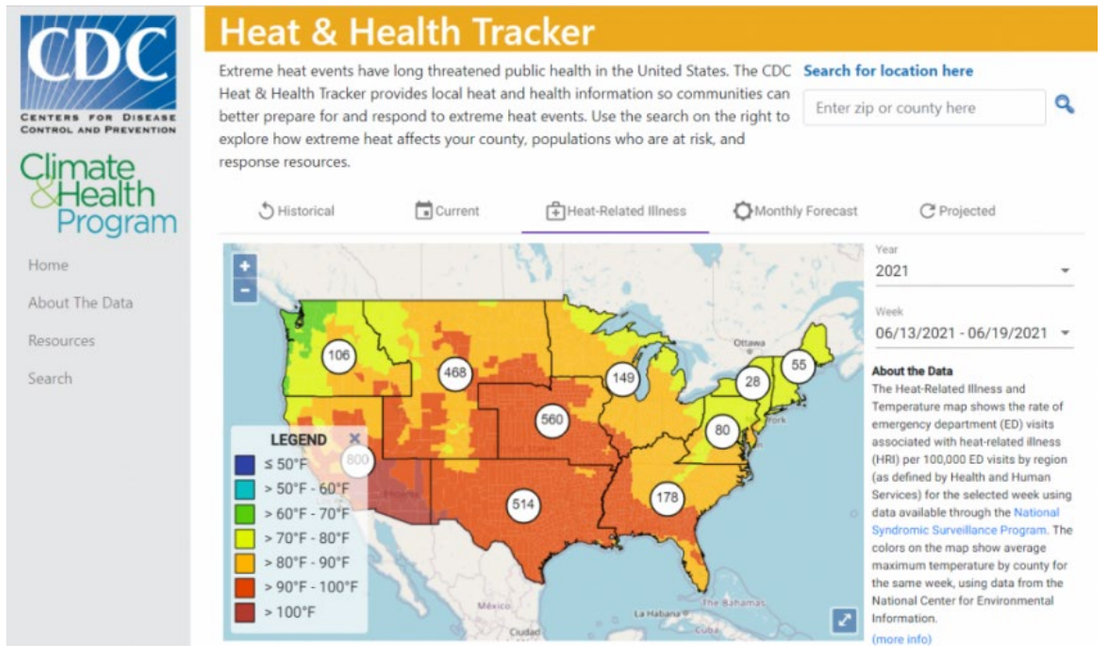
- Demonstrating the **health and financial benefits of a robust response** to the climate crisis

- **Investing in staff** and partnerships to further local understanding of climate-worsened health harms

- Improving **public health surveillance data systems** and deployment of adequate technology to track this growing threat



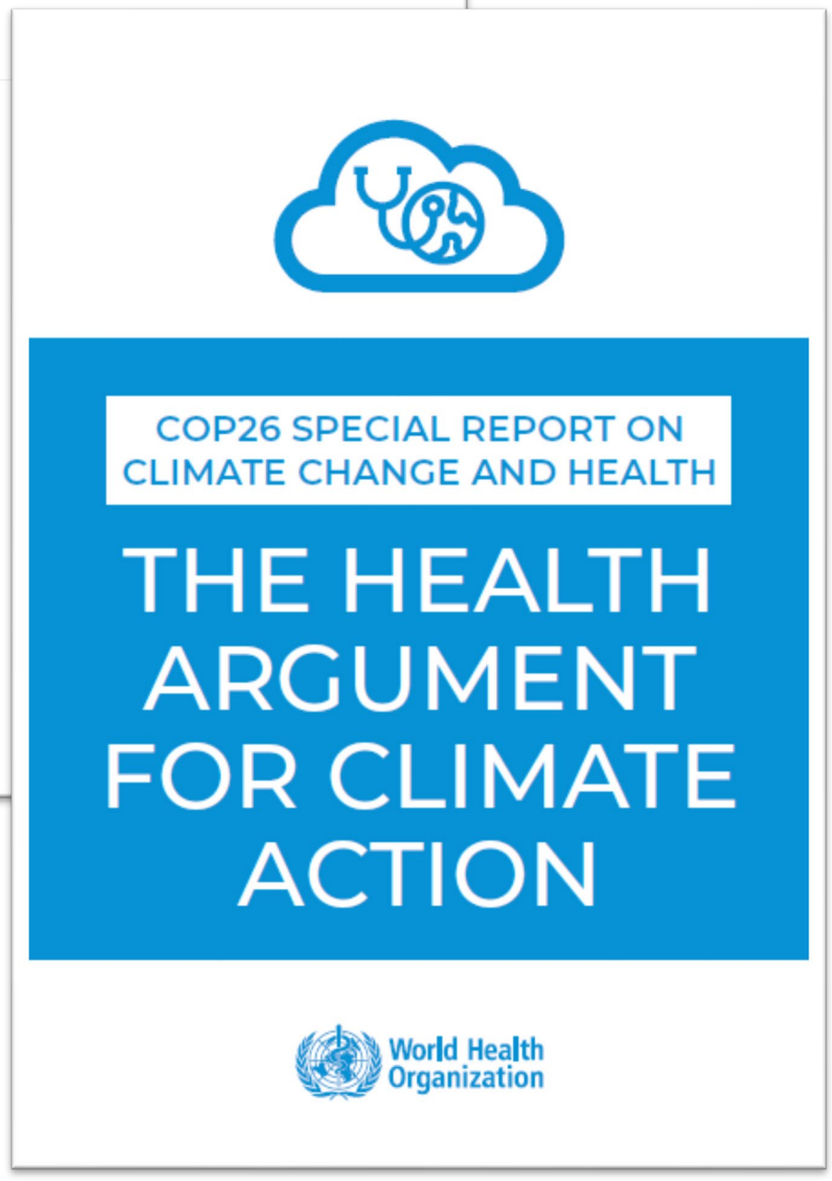
Emergency Operations Center staff responding to the coronavirus crisis at CDC Headquarters in Atlanta, Georgia, on February 3, 2020. (Credit: CDC)



ephtracking.cdc.gov/applications/heattracker/

Combatting “Climate Silence”

washingtonpost.com/opinions/2021/08/09/true-cost-climate-change-needs-include-health-toll



who.int/publications/i/item/cop26-special-report

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