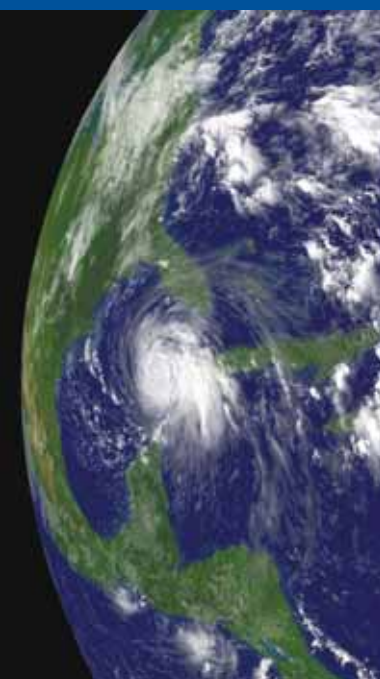


ISSUE REPORT

Health Problems Heat Up:

CLIMATE CHANGE AND THE PUBLIC'S HEALTH



OCTOBER 2009

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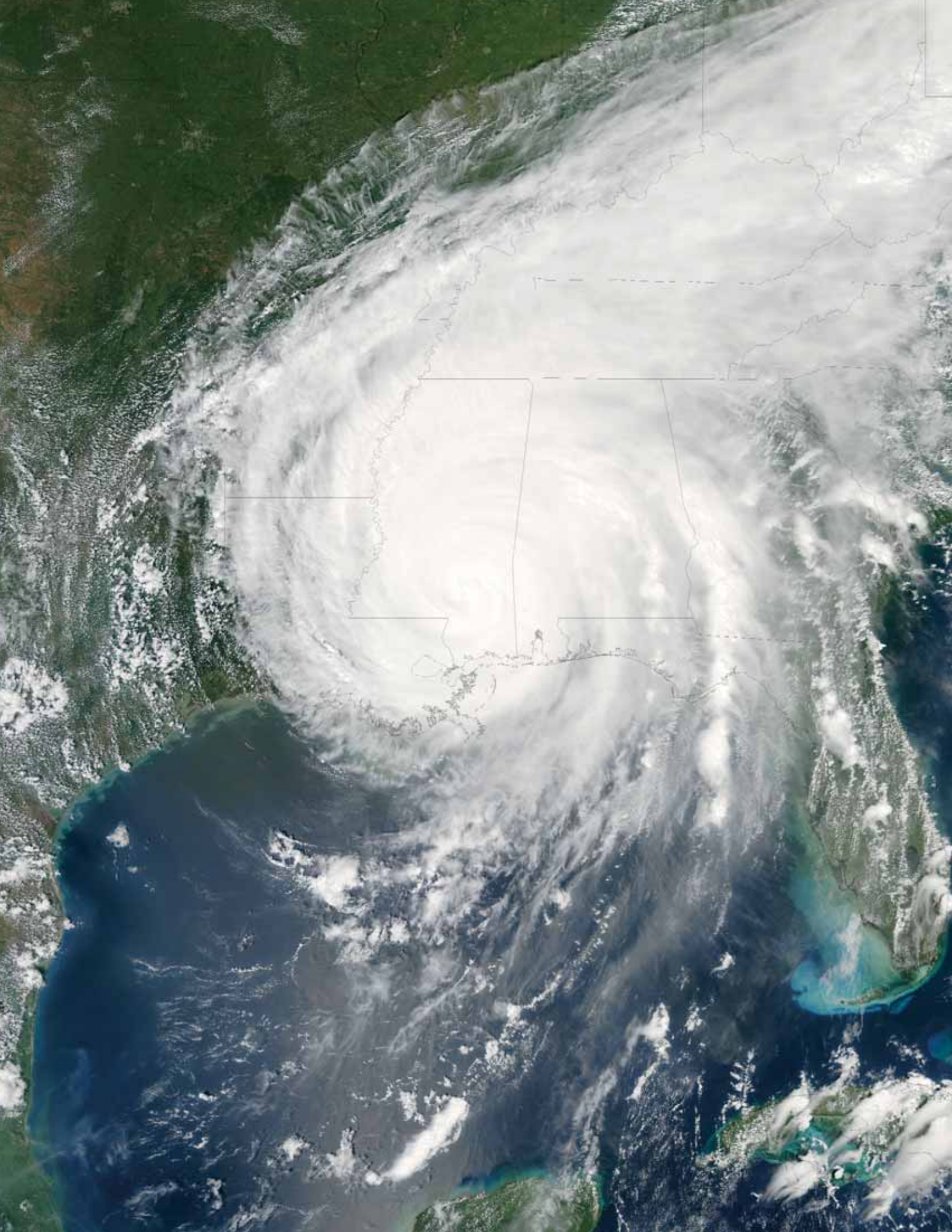
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Executive Summary

In this issue brief, Trust for America's Health (TFAH) examines the human health effects of climate change and the role public health authorities must play in preventing and preparing for further climate-related damage. We also explore the needs of state and local health departments as they set out to conduct climate change needs assessments and develop strategic plans to prevent and prepare for climate change. Finally, TFAH recommends increased action from federal, state, and local government to protect the nation from the harmful effects of climate change.

OVERVIEW

Climate change is expected to affect the health of all Americans. As temperatures and sea levels rise, many of the health challenges the United States currently contends with – such as natural disasters and infectious diseases that favor warmer climates – are expected to increase and become more severe. According to the U.S. Environmental Protection Agency (EPA), as the environment changes, people will be at a higher risk for a range of threats to our health, including:¹

- **Temperature Effects:** Severe heat waves are projected to intensify, which can increase heat-related deaths and sickness.
- **Air Quality Changes:** Worsening regional ozone pollution, with associated risks of respiratory infections, aggravation of asthma, increased allergens, and premature death.
- **More Extreme Weather Events:** Storm impacts, particularly hurricanes and tropical storms, are likely to be more severe. Heavy rainfall associated with these storms can increase the risk of flooding and lead to greater runoff and erosion, which can have adverse water quality effects. These can lead to an increase in the

number of people at risk from disease and injury related to floods and storms. Other areas will be afflicted by declines in annual precipitation, leading to an increase in the number of people at risk from disease and injury related to droughts and wildfires.

- **Climate-Sensitive Diseases:** Certain vector-, food-, and water-borne diseases are expected to occur more often and affect new populations, as a result of changes in temperature and precipitation, which allow these pathogens to expand into new geographic regions.

To combat climate change, Congress is considering energy legislation to impose a limit, or cap, on greenhouse emissions starting in 2012, along with a system for trading allowances and permitting offsets. However, more needs to be done to ensure that we are protecting Americans and people around the world from the varying threats that climate change poses to human health. Traditionally in the United States, public health departments are responsible for protecting the health of Americans. This includes preparing for existing health threats and planning for likely emerging threats.

Why Climate Change Requires a Public Health Response

Communities across the United States will experience the negative health effects associated with climate change. For instance:

- **Urban Communities:** Urban neighborhoods, particularly low-income areas, are vulnerable to natural disasters, such as floods and heat waves.
- **Rural Communities:** Rural communities may be threatened by increased food insecurity due to geographical shifts in crop-growing conditions and yield changes in those crops; reduced water resources; flood and storm damage; and increased rates of climate-sensitive health outcomes.²

- **Coastal and Low-Lying Areas:** Residents of coastal or low-lying areas are at risk, given that climate change could lead to a rise in sea levels, a rise in surface-sea temperatures, and an intensification of hurricanes and tropical storms.
- **Mountain Regions:** Residents of mountain communities are at increased risk, due to the melting of mountain glaciers and changes in snowpack and seasonal timing of snow melt, which can affect freshwater runoff. If the temperature warms at higher altitudes, some vector-borne pathogens could take advantage of new habitats.³

■ **Polar Regions (Alaska):** While Alaskan communities could see a reduction in cold-weather-related injuries and death, melting polar ice also puts indigenous communities at risk, as they have to travel further for food hunting into treacherous, shifting ice and waters. This warming could be accompanied by the spread of disease into warmer climates.⁴

Public health departments are uniquely prepared to help communities prepare for the adverse effects of climate change given their role in building

healthy communities. Public health workers are trained to develop communication campaigns that both inform and educate the public about health threats, and can use these skills to educate the public about climate change prevention and preparedness. Public health departments are also on the frontlines when there is an emergency, whether it's a natural disaster or an infectious disease outbreak. These types of emergency preparedness and response skills will be invaluable as extreme weather events become more common.

Special Concerns for Communities at High Risk for Health Consequences of Climate Change

Some Americans are particularly vulnerable to the negative consequences of climate change on health, including increasing heat stress, air pollution, extreme weather events, and diseases carried by food, water, and insects. These vulnerable populations include:⁵

- Infants and children;
- Pregnant women;
- The elderly;

- The poor;
- Racial and ethnic minorities;
- People with disabilities; and
- People with chronic medical conditions, including the obese.

Public health departments have well-established relationships with community- and faith-based organizations that can assist in reaching out to many of these underserved, vulnerable communities.

State Indicators of Climate Change

All Americans have the right to expect fundamental health protections no matter where they live, which includes protection from climate change-related events. Given the central role that states and localities play in protecting the public's health, whether in response to routine threats or climate change-related disasters and emergencies, many experts in the public health

community have proposed that federal, state, and local health departments develop a set of metrics by which authorities and the public can evaluate each jurisdiction's preparedness and response to climate change.

For this issue brief, TFAH has selected five state climate change-related indicators which are presented below.

Key Findings: 2009 State Climate Change-Related Indicators

Indicator	Finding
1. State climate change plan details public health's role in preventing and preparing for climate change.	Only five states have published a strategic climate change plan that includes the public health response. Meanwhile, 28 states have a strategic climate change plan that does NOT include a public health response and 17 states and D.C. have NOT published a strategic climate change plan at all.
2. State Climate Change Commission or Advisory Panel includes a representative from a public health department.	Only 12 states have established climate change commissions that include a representative from a public health department. Fourteen states have established climate change commissions that do NOT include a representative from a public health department, while 24 states and D.C. have NOT established climate change commissions at all.
3. State received a CDC Environmental Health Tracking Program grant (FY09).	Twenty-two states and New York City received grants to develop state surveillance programs as part of CDC's Environmental Public Health Tracking Network, the first national resource providing standardized environmental and public health data in one, searchable database.
4. State received a CDC Asthma Control Program grant (FY09).	Thirty-three states received CDC funding for state asthma control programs, which help state health departments build their asthma programs, bolster surveillance, implement interventions, and foster partnerships.
5. State received CDC-funding in FY 2008 to participate in ArboNET, CDC's internet-based national arboviral surveillance system.	Alaska is the only state that did not receive CDC funding to participate in ArboNET, an internet-based national arboviral surveillance system developed by state health departments and CDC in 2000 to provide public health officials and health care providers with information about disease activity in their states.

Policy Recommendations

In order to mount an effective response, public health officials at the federal, state, and local level need to be involved in climate change policy decisions. Currently, however, public health officials are not playing a central role in climate change policy and action. At the federal level, public health is not a central consideration of the current research agenda, nor is there substantial funding to help state and local health departments build capacity to prevent and prepare for climate change. At the state level, public health officials often are absent from climate change commissions and have not contributed to state climate change

planning. These gaps must be addressed in order for the United States to develop a comprehensive climate change agenda that seeks to both prevent and prepare for climate change.

To further strengthen public health's role in climate change policy and planning, Trust for America's Health (TFAH) recommends that the federal government – including the Obama administration, the U.S. Congress, and federal departments – and state and local governments take the following actions:

Federal Government -- The White House	<ul style="list-style-type: none"> ■ The White House should ensure that the existing high-level interagency working group on climate change considers the impact of all policies and programs on health.
Federal Government -- The U.S. Congress	<ul style="list-style-type: none"> ■ The U.S. Congress should provide increased funding for climate change activities, including comprehensive needs assessment and strategic planning, to state and local health departments. ■ The U.S. Congress should increase funding for research on the health effects of climate change and the translation of said research into practice. ■ The U.S. Congress should track federal tax dollars spent on climate change. ■ The U.S. Congress should increase funding for integrated biosurveillance systems that link to environmental and ecological surveillance systems. ■ The U.S. Congress should ensure that health information technology is developed to account for public health surveillance needs, not just clinical care. ■ The U.S. Congress should fund the development of enhanced modeling of climate change. ■ The U.S. Congress should enact and fund public health workforce scholarship initiatives to develop the workforce of the future.
Federal Government -- Departments and Agencies	<ul style="list-style-type: none"> ■ The U.S. Centers for Disease Control and Prevention (CDC) should establish national guidelines and measures for core public health functions related to climate change and require states and localities to report the findings to the public and federal government. ■ The U.S. Centers for Disease Control and Prevention and the National Institutes of Health should establish joint centers to study the health effects of climate change at research universities. ■ The U.S. Centers for Disease Control and Prevention should develop a clearinghouse for information regarding the health effects of climate change. ■ The U.S. Global Change Research Program (USGCRP) should elevate the Interagency Working Group on Climate Change and Human Health to a formal working group.
State and Local Governments	<ul style="list-style-type: none"> ■ State and local health departments should conduct climate change needs assessments. ■ State and local health departments should develop strategic climate change plans. ■ State and local health departments should develop public education campaigns regarding climate change and health. These communication campaigns must effectively target at-risk populations and vulnerable communities, including children. ■ State and local health departments must engage communities in climate change planning and preparedness. ■ State and local public health departments need to develop the knowledge base about climate change among their workforce.



Introduction

1 SECTION

“CLIMATE CHANGE IS POTENTIALLY THE BIGGEST GLOBAL HEALTH THREAT IN THE 21ST CENTURY. OUR RESPONSE REQUIRES A NEW PUBLIC HEALTH MOVEMENT THAT IS MULTIDISCIPLINARY AND MULTISECTORAL, AND THAT LEADS TO COORDINATED THINKING AND ACTION ACROSS GOVERNMENTS, INTERNATIONAL AGENCIES, NGOs, AND ACADEMIC INSTITUTIONS.”⁶

-- LANCET AND UNIVERSITY COLLEGE LONDON INSTITUTE FOR GLOBAL HEALTH COMMISSION

“CLIMATE CHANGE IS ONE OF THE MOST SERIOUS PUBLIC HEALTH THREATS FACING OUR NATION. YET FEW AMERICANS ARE AWARE OF THE VERY REAL CONSEQUENCES OF CLIMATE CHANGE ON THE HEALTH OF OUR COMMUNITIES, OUR FAMILIES, AND OUR CHILDREN.”⁷

-- GEORGES BENJAMIN, MD, EXECUTIVE DIRECTOR AMERICAN PUBLIC HEALTH ASSOCIATION

Climate change is expected to affect the health of all Americans. As temperatures and sea levels rise, many health challenges the United States currently contends with – such as natural disasters and infectious diseases that favor warmer climates – are expected to increase and become more severe. According to the U.S. Environmental Protection Agency (EPA), as the environment changes, people will be at a higher risk for a range of threats to our health, including:⁸

- **Temperature Effects:** Severe heat waves are projected to intensify, which can increase heat-related deaths and sickness. The EPA’s Excessive Heat Events Guidebook estimates there are 1,700 to 1,800 heat-attributable deaths each summer in the United States.⁹ It notes that excessive heat events have the greatest impact in the Northeast and Midwest, where populations “are not as acclimatized to elevated temperatures,” and that “structures in less susceptible areas [such as the South and Southwest] are better designed to accommodate elevated temperatures.”¹⁰
- **Air Quality Changes:** Worsening regional ozone pollution, has associated risks of respiratory infections, aggravation of asthma, increased allergens, and premature death.
- **More Extreme Weather Events:** Storm impacts, particularly hurricanes and tropical storms, are likely to be more severe. Heavy rainfall associated with these storms can increase the risk of flooding and lead to greater runoff and erosion, which can have adverse water quality effects. These events can lead to an increase in the number of people at risk of disease and injury, related to floods and storms. Other areas will be afflicted by declines in annual precipitation, leading to an increase in the number of people at risk from disease and injury related to droughts and wildfires.
- **Climate-Sensitive Diseases:** Certain vector-, food-, and water-borne diseases are expected to occur more often and affect new populations as a result of changes in temperature and precipitation, which allow these pathogens to expand into new geographic regions. For example, populations living in mountain states may become more susceptible to certain vector-borne diseases as a result of warming temperatures, which allow these vectors, such as mosquitoes, to live and reproduce at higher elevations.

WHAT IS CLIMATE CHANGE?

Climate change, also referred to as global warming, is the result of the decades-long buildup of greenhouse gases (carbon dioxide, methane, and nitrous oxide) in the atmosphere. According to climatologists, greenhouse gases are accumulating in the atmosphere at unprecedented rates due to our reliance on fossil fuels. As a result, the earth is warming. Over the past 100 years, global surface temperature has increased by about 1.5°F. Over the next 100 years, it is projected to rise another 2°F to 11.5°F.¹¹

The rise in temperature has led to the warming of the oceans, which in turn, has led to a rise in sea levels. The rise in sea levels is due to the thermal expansion of the oceans and increased melting of glaciers and polar ice caps. The change in climate and sea levels in turn has led to changes in precipitation.¹² Increases in extreme weather patterns can also be attributed to the changing climate.¹³

To date, many of the policies around climate change focus on preventing further warming of the planet or rolling back the global warming that has already occurred, which are often called mitigation strategies. In April 2009, the EPA issued the *Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Clean Air Act*, which stated that current and projected concentrations of six key greenhouse gases – carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆) – in the atmosphere threaten the public health and welfare of current and future generations. EPA also stated that greenhouse gas emissions from motor vehicles contribute to the atmospheric concentrations of these key greenhouse gases, and hence contribute to the threat of climate change. Under the Clean Air Act, EPA has the power to regulate these greenhouse gas emissions, although President Barack Obama and EPA Administrator Lisa Jackson have said they prefer that Congress address global warming through legislation.¹⁴ In fact, Congress is considering energy legislation to impose a limit, or cap, on greenhouse emissions starting in 2012, along with a system for trading allowances and permitting offsets. The House passed the legislation on June 26, and the Senate is expected to consider climate legislation this year, as well.

While these important efforts to address climate change are underway, it is also essential to ensure that we are protecting Americans and people around the world from the varying threats that climate change poses to human health. Traditionally in the United States, public health departments are responsible for protecting the health of Americans. This includes preparing for existing health threats and planning for likely emerging threats.

According to the U.S. Centers for Disease Control and Prevention (CDC) improving the overall health of communities is important for responding to extreme weather events and disease outbreaks, because:¹⁵

- Healthy people are less likely to suffer disaster-related sickness or death;
- Healthy homes are disaster-resilient, meaning they stay safe during an extreme weather event; and
- Healthy communities not only protect people from disasters, but when disaster strikes, they are better able to respond.

As of now, public health planning around the health effects of climate change and how best to protect the health of Americans has been limited. In fiscal year (FY) 2009, CDC received a relatively modest amount – \$7.5 million – for a new Climate Change initiative to develop and enhance programs to help the nation prepare for and adapt to the potential health effects of global climate change. And currently, the majority of state and local public health departments are not actively engaged in climate change planning and/or developing prevention strategies. Although CDC has received numerous requests for assistance in addressing climate change from state and local health departments, fewer than 20 percent of local health departments report that climate change is a top priority, according to a 2008 survey released by the Environmental Defense Fund, the National Association of County and City Health Officials (NACCHO), and George Mason University.¹⁶ Meanwhile, only 13 of 43 state health officials surveyed believe their agency currently has sufficient planning capacity to address climate change, while only 11 survey takers think their health department has sufficient response expertise.¹⁷

This issue brief examines the current status of health departments' abilities to respond to climate change-related health threats, and examines policies aimed at improving how federal, state, and local health agencies can prepare to respond to climate-associated events, ranging from an increase in heat waves and extreme weather events, such as hurricanes and flooding, to a rise in vector-borne diseases, such as West Nile Virus and Lyme disease. Many communities around the

country already face health emergencies related to natural disasters, heat waves, and infectious diseases, so enhanced preparation for these threats will have immediate benefits for the crisis at hand. In addition, public health preparedness has important ramifications for long-range planning for the impact of climate change on human health.

Trust for America's Health (TFAH) recommends that a national action plan be developed to improve U.S. readiness for the health consequences of climate change. This paper outlines the role for the public health community in responding to climate change, including:

1. Examining how climate change is a public health issue, including exploring the capacities health departments need to prepare, respond, and recover from the health impact of climate change-associated events;
2. Highlighting special concerns for communities at high risk for the health consequences of climate change;
3. A review of state-specific capacities; and
4. Policy recommendations for strengthening the ability of federal, state, and local public health departments to respond to climate change-associated events.

Table 1: Health Effects of Climate Change in the United States

Weather Event	Health Effects	Populations Most Affected
Heat waves	<ul style="list-style-type: none"> Premature death Heat-related illnesses such as heat stroke, heat exhaustion, and kidney stones 	<ul style="list-style-type: none"> The elderly Children Diabetics Poor, urban residents People with respiratory diseases Those active outdoors (workers, athletes, etc.)
Poor air quality	<ul style="list-style-type: none"> Increased asthma¹⁸ Increased chronic obstructive pulmonary disease (COPD) and other respiratory diseases^{19,20} 	<ul style="list-style-type: none"> Children Those active outdoors (workers, athletes, etc.) The elderly People with respiratory diseases The poor
Hurricanes	<ul style="list-style-type: none"> Death from drowning Injuries Mental health impacts such as depression and post-traumatic stress disorder Increased carbon monoxide poisoning Increased gastrointestinal illness Population displacement/homelessness 	<ul style="list-style-type: none"> Coastal residents The poor The elderly Children
Extreme rainfall and floods	<ul style="list-style-type: none"> Death from drowning Injuries Increased water-borne diseases from pathogens and water contamination from sewage overflows Increased food-borne disease²¹ 	<ul style="list-style-type: none"> Residents in low-lying areas The elderly Children The poor Residents in the Southwestern U.S.
Wildfires	<ul style="list-style-type: none"> Death from burns and smoke inhalation Injuries Eye and respiratory illness due to fire-related air pollution 	<ul style="list-style-type: none"> People with respiratory diseases
Droughts	<ul style="list-style-type: none"> Disruption in food supply Changing patterns of crops, pests and weed species Water shortages Malnutrition²² Food- and water-borne disease Emergence of new vector-borne and zoonotic disease 	<ul style="list-style-type: none"> The poor The elderly Children
Increased average temperature	<ul style="list-style-type: none"> Increased food-borne disease, such as Salmonella poisoning Increased vector-borne disease such as West Nile virus, equine encephalitis, Lyme disease, Rocky Mountain spotted fever, and hantavirus Increased strain on regional drinking water supplies Increased vulnerability to wildfires and associated air pollution 	<ul style="list-style-type: none"> Children Those active outdoors (workers, athletes, etc.)
Increased temperature and rising carbon dioxide levels	<ul style="list-style-type: none"> Increased allergies caused by pollen Increased cases of rashes and allergic reactions from toxic plants such as poison ivy, stinging nettle, and other weeds 	<ul style="list-style-type: none"> People with respiratory disease People with acute allergies Children Those active outdoors (workers, athletes, etc.)

Source: Except where noted, the information above is from Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009, p. 89-98.

For more details on the human health effects of climate change and what public health departments can do to prevent these adverse out-

comes, please see *Appendix A: The Influence of Climate Change on Health and the Role for Public Health*.

EXTREME WEATHER THREATS WITH HEALTH CONSEQUENCES IN THE UNITED STATES

The United States is vulnerable to many extreme weather events.²³ The 2009 report from the U.S. Global Change Research Project (USGCRP), *Global Climate Change Impacts in the United States*, devotes an entire section to regional climate impacts in the United States. The Gulf and Southeast Atlantic Coastal regions routinely experience hurricanes and tropical storms, although not all are as severe as Hurricanes Katrina and Rita in 2005 or Hurricane Ike in 2008. The Northeast increasingly suffers from extreme temperatures and poor air quality, as do the Midwest and the Great Plains, which are also prone to severe flooding in the spring. In the Southwest, increasing temperatures and decreased rainfall have strained the region's water supply increasing the vulnerability to wildfires and air pollution, as evidenced nearly yearly in California. The Northwest is likely to experience increased insect-borne outbreaks and wildfires due to warming temperatures, while sea-level rise will impact coastal communities.

Communities around the country are susceptible to climate change-related events. For instance:

■ **Urban Communities:** Urban neighborhoods, particularly low-income areas, are vulnerable to natural disasters, such as floods and heat waves. Researchers predict that "populations in high-density urban areas with poor housing will be at increased risk with increases in the frequency and intensity of heat waves, partly due to the interaction between increasing temperatures and urban heat-island effects."²⁴ The urban heat-island effect is due to large amounts of concrete and asphalt in cities that absorb and hold heat. Tall buildings reduce air flow and prevent heat from dissipating, while a lack of shade trees and other vegetation means there is little to no shade. As a result, parts of cities can be up to 10°F warmer than surrounding rural areas.²⁵

■ **Rural Communities:** Rural communities may be threatened by increased food insecurity due to geographical shifts in crop-growing conditions and yield changes in those crops; reduced water resources, flood and storm damage, and increased rates of climate-sensitive health outcomes.²⁶

■ **Coastal and Low-Lying Areas:** In the United States, more than 50 percent of Americans live in 772 coastal counties, and that number is expected to grow to 75 percent by 2025, with population density doubling in some areas such as Florida and California.²⁷ Residents of coastal or low-lying areas are at risk given that climate change could lead to a rise in sea levels, a rise in surface-sea temperatures, and an intensification of hurricanes and tropical storms. These changes could affect human health through flooding and damage to infrastructure; saltwater intrusion into freshwater resources; and an increase in vector- and water-borne diseases.²⁸

■ **Mountain Regions:** Residents of mountain communities are at increased risk due to the melting of mountain glaciers and changes in snowpack and seasonal timing of snow melt, which can affect freshwater runoff. This could lead to water scarcity during critical growing seasons and food insecurity. If the temperature warms at higher altitudes, some vector-borne pathogens could take advantage of new habitats.²⁹

■ **Polar Regions (Alaska):** While Alaskan communities could see a reduction in cold-weather-related injuries and death, melting polar ice also puts indigenous communities at risk as they have to travel further for food hunting into treacherous, shifting ice and waters. This warming could be accompanied by the spread of disease into warmer climates.³⁰

EXAMPLES OF EXTREME U.S. WEATHER EVENTS IN 2008 AND 2009

■ **March and June 2008:** Heavy rains caused severe flooding in the Midwest. In March, 17 people died as a result of the flooding, and by the end of June storms and flooding across six states caused 24 deaths, 148 injuries and more than \$1.5 billion in damages to Iowa alone.

■ **June 2008:** Lightning sparked thousands of wildfires across northern California. Over 2,700 individual fires were recorded causing mandatory evacuations and damaging thousands of acres.

■ **September 2008:** In early September, Hurricane Gustav made landfall in Louisiana and caused widespread destruction statewide, amounting to billions of dollars in damages.

■ **September 2008:** Just weeks after Hurricane Gustav battered the United States, Hurricane Ike hit Texas as a category two storm, causing extreme damage in Texas. Twenty-seven deaths were attributed to the storm that forced hundreds of thousands of residents to evacuate.

■ **March 2009:** Severe flooding in the upper Great Plains forced thousands from their homes in Minnesota, North Dakota, and South Dakota. Preliminary estimates suggested economic losses upwards of tens of millions of dollars in damage to roads, bridges, wastewater treatment plants and other public assets, in addition to damage to some homes and businesses.³¹

■ **May 2009:** Wildfires in southern California burned across nearly 9,000 acres and destroyed or damaged about 80 homes and businesses. Nearly 50,000 people were evacuated from their homes and 13 people, all of them firefighters, were injured.³²

■ **August 2009:** More than 75,000 acres in Southern California were burned by out of control wildfires forcing more than 2,400 residents from their homes. Eleven fires were burning across California, killing two firefighters.³³

Why Climate Change Requires a Public Health Response

“HEALTH SERVICES PROVIDE A BUFFER AGAINST THE HAZARDS OF CLIMATE VARIABILITY AND CHANGE.”³⁴

-- 2007 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, FOURTH ASSESSMENT REPORT

According to CDC’s National Center for Environmental Health, public health professionals are uniquely positioned to address the health impacts of climate change. “Community public health and medical institutions can play an active part in reducing human vulnerability to climate-related disasters through promotion of healthy people, healthy homes, and healthy communities.”³⁵ However, experts point out that, “Preparing for and effectively responding to climate change will be a process, not a one-time assessment of risks and likely effective interventions. ...failing to address adaptation will leave communities poorly prepared for the climatic changes expected over the next few decades.”³⁶

Public health departments regularly train to respond to health emergencies associated with extreme weather events and to infectious disease outbreaks. Most experts predict that extreme weather events and some infectious disease outbreaks are likely to occur more often due to climate change, and it is unclear how well prepared health departments are to respond to an increase in emergencies. According to a 2008 survey of local health departments, the majority of respondents believe that their jurisdiction already has experienced climate change in the past 20 years (70 percent) or will experience climate change in the next 20 years (78 percent); yet fewer than one-fifth (19 percent) indicated that climate change was among their department’s top 10 current priorities.³⁷ Only six percent indicated that climate change was one of their health department’s current top

five priorities. Meanwhile, a 2009 survey of state and territorial health officials found that 73 percent believe their state or territory will experience one or more serious public health problems in the next 20 years because of climate change.³⁸ Yet, 77 percent of respondents did not consider climate change to be one of their agencies’ top ten priorities.

To ensure the health and safety of Americans, federal, state, and local governments must take action now to address gaps in the public health infrastructure that undermine efforts to prevent and prepare for climate change-related events. Federal health agencies should work with state and local governments to develop and strengthen the capacities that are critical to prevent and prepare for the negative health consequences of climate change.

Developing Strategic Public Health Plans for Responding to Health Threats from Climate Change

In order to effectively prepare for and respond to climate change-driven threats, state and local public health departments need to:

- Conduct needs assessments; and
- Develop strategic plans.

State and local health departments should conduct these activities with technical support, capacity building, and translatable research from federal government agencies such as EPA, CDC, the National Oceanic and Atmospheric Administration (NOAA), and the National Institute of Environmental Health Sciences (NIEHS).

Public health planners need to be able to monitor key environmental factors. While some states have created public health and environmental health departments that function as one, other states have divided these responsibilities across multiple agencies. Therefore, it is essential that public health officials coordinate with their counterparts in environmental quality and environmental protection agencies to set up programs that efficiently monitor:

- Water quantity and quality;
- Air quality;
- Extreme temperatures; and
- Insect control programs.

According to research conducted by TFAH, as of July 2009, only 33 states have developed plans in response to climate change and/or green-

house gas emissions. Of those, only five plans detail the role of public health in preventing and preparing for climate change.

A 2009 Association of State and Territorial Health Officials (ASTHO) survey of its members found that only 42 percent of respondents thought their health department had sufficient assessment expertise to address climate change, while only 30 percent reported having sufficient planning expertise.³⁹ Meanwhile, a 2008 NACCHO survey of local health directors found that 83 percent felt they lacked the expertise to craft strategic climate change response plans.⁴⁰ Nor did local officials feel as though their federal or state counterparts could assist, with only 26 percent reporting that their state had the necessary expertise to assist with adaptation plans, and 34 percent reporting that CDC had such expertise.⁴¹

The House version of the so-called cap-and-trade climate bill – the American Clean Energy and Security Act of 2009 (H.R. 2454) – includes funding for the Climate Change Health Protection and Promotion Fund and directs the Health and Human Services (HHS) Secretary to develop a plan on climate and health. The bill would provide an estimated \$90 million for activities related to climate change and human health.

However, at the present time and absent enactment of H.R. 2454 or similar legislation, only limited technical advice and resources are available from federal officials.

A. NEEDS ASSESSMENTS

“A GREATER APPRECIATION OF THE HUMAN HEALTH DIMENSIONS OF CLIMATE CHANGE IS NECESSARY FOR BOTH THE DEVELOPMENT OF EFFECTIVE POLICY AND THE MOBILIZATION OF PUBLIC ENGAGEMENT.”⁴²

-- DIARMID CAMPBELL-LENDRUM, FROM A PAPER PRESENTED AT THE IOM WORKSHOP ON GLOBAL CLIMATE CHANGE AND EXTREME WEATHER EVENTS, DECEMBER 4-5, 2007.

Public health preparedness for climate change should begin with a needs assessment using a standardized methodology to determine the critical health needs and vulnerabilities of the population. According to an article in *Nature*, localized assessments are needed to design “interventions that are geographically and temporally targeted on highly susceptible populations.”⁴³

Few states and localities in the United States have conducted climate change vulnerability needs as-

sessments. Many in the public health workforce attribute this to a lack of resources and competing priorities, although a lack of expertise is also to blame. According to a NACCHO survey of local health departments, 77 percent of local health directors felt they lacked the expertise to assess local health impacts of climate change.⁴⁴ While 18 of 43 state and territorial health officials said their health agency did not possess ample expertise to assess the threats from climate change.⁴⁵

State and local health departments conducting climate change needs assessment should:

- Examine staff readiness to engage with partners on the issue of climate change and highlight the co-benefits of climate change prevention, preparedness, and response;
- Identify opportunities for public health to act in the legal and regulatory fields to address climate change;
- Include an examination of what additional capacities are needed, including:
 - ▲ Workforce needs;
 - ▲ Surveillance capacities: what data is currently being collected; whether there are shifting disease vectors in the state/community;
 - ▲ Assessment of the built environment; and

▲ Analysis of what segments of the population are most at risk for health impacts; and

- Identify ongoing public health activities that affect climate change prevention, planning, and response, while also examining the cost of not taking action both in terms of dollars and human health.

State and local comprehensive climate change needs assessments must also include a community risk assessment/vulnerability assessment to evaluate the jurisdictions' vulnerability to climate change, keeping in mind that climate change effects will vary by both geography and by individual and community characteristics. In addition, the ability to prepare and respond to climate change will vary by individual and community.

NATIONAL HEALTH IMPACT ASSESSMENTS OF CLIMATE CHANGE

Sixteen countries around the world have carried out national climate change health impact assessments since 2001: Australia, Bolivia, Bhutan, Canada, Finland, Germany, India, Japan, The Netherlands, New Zealand, Panama, Portugal, Spain, Tajikistan, Switzerland, and the United Kingdom.⁴⁶ Of these, 11 countries included recommendations aimed at preparing for the health consequences of climate change, ranging from raising awareness of the problem of climate change to developing early warning systems for heat waves and enhanced surveillance and monitoring of infectious diseases.

B. DEVELOPMENT OF A STRATEGIC RESPONSE PLAN

After a needs assessment is carried out in a state or community, the next step is the development of a strategic climate change plan. This plan must address bolstering the core public health capabilities needed to prepare for and respond to climate change related health threats, including:

- 1) Surveillance;
- 2) Communication;
- 3) Workforce;
- 4) Core Emergency Response and Long-Range Capabilities; and
- 5) Research and Accountability

Public health officials should engage all stakeholders in the development of the strategic plan, including government agencies and non-governmental organizations, such as faith- and community-based organizations. The strategic plan should lay out goals and objectives for how best to protect the health of communities. This should include finding ways to help prevent climate change in communities, such as addressing issues of the built environment and pollution, as well as acquiring the capabilities needed to respond to a potential rise in health problems related to extreme weather events and infectious diseases.

ENVIRONMENTAL VS. PUBLIC HEALTH CLIMATE CHANGE TERMINOLOGY

Environmentalists refer to efforts to curtail greenhouse gas emissions as mitigation strategies and those that lessen the harm of climate change as adaptation strategies. In public health, the terms prevention and public health preparedness are used instead. Prevention or mitigation efforts mainly occur in other sectors, such as energy, transportation, housing and urban planning, and agriculture, although the public health sector can and should contribute to these efforts.⁴⁷ Preparedness or adaptation strategies, however, especially those concerned with human health effects, are logically the domain of the public health and medical sector.

In addition to strategies for managing the response to health problems, public health departments may also develop strategies aimed at preventing or mitigating climate change that involve community design and the built environment. According to an article published in the *American Journal of Preventive Medicine*, “The built environment, climate change, and public health are closely connected. Built environment strategies that promote climate change mitigation through transportation infrastructure, building construction, and land-use planning provide opportunities both to improve health and reduce climate change. By combining various built environment strategies through complimentary policies and programs, multiple co-benefits emerge.”⁴⁸

I. SURVEILLANCE

Measuring the effect of climate change on human health is difficult. Health departments cannot protect people from existing or emerging climate change-related health threats, such as heat waves or vector-borne diseases, including West Nile virus, Lyme disease, and other tick-borne and mosquito-borne diseases, without correct and pertinent information. The lack of timely and comprehensive data can delay the identification of and response to serious health problems. In addition, federal, state and local health departments and private health care providers must all work together to effectively track information about and respond to health threats.

To help researchers and practitioners, public health departments need improved human health surveillance that is integrated with environmental quality and protection monitoring. Both health and environmental surveillance data needs to be collected on a regular basis and from a similar set of monitoring station locations. Data that is collected at the state and local level and shared with CDC should be rapidly analyzed and disseminated so that individuals responsible for decision-making have the best information possible.

In addition to disease surveillance, public health practitioners need access to “early-warning systems forecasting extreme weather [which] can help to reduce casualties and curtail the spread of disease.”⁵⁰ These systems should be integrated with all-hazards emergency response programs.

At the federal level, CDC runs the majority of national human disease surveillance networks, including the Arboviral Surveillance System (ArboNet), BioSense, Early Warning Infectious Disease Surveillance (EWIDS), Electronic Food-Borne Disease Outbreak Reporting System

Public health departments may also choose to address local-source air pollution, given that climate change and increasing air temperatures can affect exposure to air pollution in several ways. With air pollution directly linked to mortality, cardiovascular disease, and respiratory illnesses, including asthma among young children, health departments can promote active transportation – walking, running, or bicycling to school and work – instead of driving. According to an unpublished May 2007 analysis by the New York City Department of Health and Mental Hygiene’s Bureau of Environmental Surveillance and Policy, a modest 10 percent reduction in particulate matter pollution, a by-product of fossil-fuel combustion, would result in 400 to 500 fewer deaths each year.⁴⁹

(eFORS), Emerging Infection Program (EIP), Environmental Public Health Tracking Network, Epidemic Information Exchange (Epi-X), GeoSentinel, Global Disease Detection (GDD), National Outbreak Reporting System (NORS), and many others. Meanwhile, within each state there may be a dozen surveillance systems that work independently and voluntarily feed data to the corresponding national network at CDC. In addition, other federal agencies and departments have their own biosurveillance systems, including EPA, the Department of Homeland Security (DHS), the Department of Agriculture (USDA), the Food and Drug Administration (FDA), the Department of Veterans Affairs (VA), the Department of Defense (DOD), and the Office of the Director of National Intelligence (ODNI).

States and local jurisdictions will need to reinforce their existing surveillance systems to ensure they are able to gather real-time information on health conditions related to climate change, including those pertaining to extreme temperatures, poor air quality, and “notice” weather events, such as hurricanes and flooding. State and local health departments also need the ability to access modeling and forecasting data for planning, although currently such data generally are not accurate below a regional level. However, modeling and surveillance data are essential to evaluating individual communities’ risk of climate change. Ideally, there should be one central source for the most current climate information and future modeling simulations, for each region in the United States. Finally, state and local health departments need to address current gaps in data collection in order to ensure they are getting the most complete picture.

The 2009 American Recovery and Reinvestment Act (ARRA) included \$20 billion for health information technology (HIT). Ultimately, the national system of electronic health records affords an opportunity for health departments to better monitor the impact of climate change and to use

HIT as an early warning system of health effects of specific climate change-related incidents (e.g., heat waves or infectious disease outbreaks). If properly designed, the HIT system could reduce the need for separate, unlinked – so-called stove piped – surveillance systems.

2. COMMUNICATION

A core function of public health departments is information, education, and communication with diverse communities. State and local public health departments have an infrastructure, culture, and environment that support the development and delivery of effective and scientifically-rigorous public education initiatives.

In many cases, distinct, carefully crafted messages and respected messengers will be used to reach out to each community. Often, public health departments form partnerships with community-

and faith-based organization who may be more credible messengers. As such, public health is uniquely positioned to deliver climate change messages about prevention and preparedness.

However, effective public education and engagement campaigns are not cheap. In a time of limited resources, state and local public health departments need to build new partnerships to reach various communities, particularly those communities with racial and ethnic minorities and limited-English proficiency.

“IN TERMS OF RAISING AWARENESS, THERE IS GROWING APPRECIATION THAT CLIMATE CHANGE CAN NO LONGER BE CONSIDERED SIMPLY AN ENVIRONMENTAL OR DEVELOPMENTAL ISSUE.”⁵¹

-- DIARMID CAMPBELL-LENDRUM, FROM A PAPER PRESENTED AT THE IOM WORKSHOP ON GLOBAL CLIMATE CHANGE AND EXTREME WEATHER EVENTS, DECEMBER 4-5, 2007.

In order for Americans to prevent, prepare for, and respond to climate change, they must be educated and informed about the associated health risks. Educating people about the health impacts of climate change can persuade them to take steps to prepare themselves and their families for dangerous climate-related weather events, such as heat waves or hurricanes. It can also motivate them to take steps to reduce their household's environmental footprint, for example, by choosing to commute on foot or by bike instead of driving a car.

So that health departments can effectively communicate with the public, they must educate

people about the ways they can prepare their families and communities for climate change-related events. Campaigns that simply highlight the potential dangers without providing a solution could lead to increased levels of stress, fear, and despair among the population.

As part of their information and education campaigns, public health departments need to communicate the important role public health departments play in preparing for and responding to climate change-related events.

Inter-Agency Coordination

Climate change is a cross-cutting issue that requires input from many government agencies and public health professionals. However, although a majority of state and local public health officials view climate change as a public health issue, too often other agencies and elected officials do not.

For instance, a review by TFAH of state climate change plans found that of the 33 states with a plan, only eight states included state or local public health officials in the drafting of the report.

Meanwhile, a 2008 NACCHO survey of local health directors reported less than one-third of respondents felt that other pertinent stakeholders in their community, including appointed and elected officials, had knowledge of the potential public health impacts of climate change.⁵²

As part of their information and education campaign, public health departments need to communicate the important role public health departments play in preparing for and responding to climate change-related events. This communi-

cation needs to occur across agencies and with elected officials in the state legislature or county council and with the state's governor or senior local executive. Public health departments also need to be involved with the regulatory process and ensure that public health leadership is active in preventing climate change. Without input from public health officials it will be difficult to ascertain or anticipate the public health consequences that may occur with any decisions or policies. Public health practitioners are uniquely positioned to make

those assessments and observations. By effectively communicating with other state agencies and elected officials, public health professionals will help to ensure that they are involved in all climate change policy decisions from the beginning.

In addition to general community outreach and political / regulatory outreach, public health departments should make a special effort to engage vulnerable communities and at-risk populations, health care professionals, and businesses.

Vulnerable Communities and At-Risk Populations

Vulnerability to climate change-related events has two facets, according to Mark Keim at CDC's National Center for Environmental Health: "The degree of exposure to dangerous hazards (susceptibility) and the capacity to cope with or recover from the consequences of disaster (resilience)."⁵³ As part of the needs assessment process, state and local public health departments should identify vulnerable communities and at-risk populations. Public health departments must engage these com-

munities in planning and preparing for a robust response to climate change-related events. By engaging the most vulnerable sectors, public health departments can strengthen and build community resiliency.

As part of this engagement, public health departments should involve the environmental justice movement to determine the priorities of vulnerable communities.

Health Care Professionals

Public health departments need to conduct outreach campaigns to health care professionals – especially those who treat at-risk populations or who are located in vulnerable communities – in order to educate them about the risks their patients face. Patients view health care providers as trusted sources of information. By educating clinicians about the health risks associated with

climate change, these clinicians will be better positioned to counsel their patients about opportunities to prepare for and respond to climate change-related events. Health care professionals who have greater awareness of the impact of climate change on their patients' health may also serve as better early warning systems of new public health problems posed by climate change.

Businesses

Public health departments need to engage the local business community to inform them of the risks climate change poses to their employees'

health and what steps can be taken to prevent and prepare for climate change.

3. WORKFORCE

From first responders to scientists researching the health effects of climate change, the public health workforce is vital to protecting Americans' health. The public health workforce, however, is in crisis. There is a serious deficit of public health workers with the expertise needed to meet the depth and breadth of the responsibilities they are expected to carry out.

The problem is expected to get worse. As baby boomers retire, there is not a sufficient new generation of workers being trained to fill the void of expertly-trained public health workers our country needs. If the crisis is not addressed now, these vacancies leave the public at unnecessary risk for preventable health problems.

■ The United States has an estimated 50,000 fewer public health workers than it did 20 years ago.⁵⁴

■ One-third of the public health workforce in states will be eligible to retire within five years,⁵⁵ and 20 percent of local health department workers will be eligible to retire within just two years.⁵⁶

■ Eleven percent of state public health positions are currently vacant,⁵⁷ and four out of five current public health workers have not had formal training for their specific job functions.⁵⁸

■ The economic downturn has made the workforce shortage even worse. The Center on Budget and Policy Priorities reports that 48 states face shortfalls in their budgets for the upcoming year totaling \$166 billion, or 24 percent

of state budgets.⁵⁹ As a result, health departments have been forced to furlough and in some cases lay off trained staff. According to NACCHO, approximately 7,000 local public health workers were laid off nationwide in 2008 and this number is likely to increase in 2009.⁶⁰

The federal government must take the lead in developing incentives to help recruit, train, and retain the next generation of professionals into public health. Existing efforts to recruit and retain the public health workforce are insufficient. New policies and incentives must be created to make public service careers in public health an attractive professional path, especially for the emerging workforce and those changing careers.

For those entering the workforce – and those currently in the workforce – it will be critical that there is sufficient training in the public health response to climate change. This may require a broader set of skills or knowledge and health departments and schools or programs of public health should be developing appropriate training programs for their staffs and students. The

public health workforce will need to draw from a variety of skill sets to effectively address climate change prevention and preparedness, including epidemiology, health information technology, environmental health, infectious disease, chronic disease, emergency preparedness, mental health, nutrition, food safety, health communication, and injury prevention, among others. Clearly not every public health practitioner will be trained in all of these areas, but health departments should ensure they employ a range of staff so these competencies are addressed. And when possible, staff should be cross-trained.

When it comes to climate change, the public health response must be broadened to include all who should be aware of and responding to the public health implications of climate change. Thus everyone from meteorologists (who can educate the public about the health threats of weather events) to architects and city planners (who can adjust the built environment to mitigate the impact of climate change) must be part of the public health response.

4. EMERGENCY RESPONSE AND LONG-TERM PUBLIC HEALTH CAPACITY

Climate change will bring new challenges to public health departments, while exacerbating existing

ones. As such, public health departments must develop new capacities while bolstering current ones.

Emergency Response Capacity

Public health departments must develop the emergency response capacity to respond to severe weather events and other adverse effects of climate change. Already, public health departments are tasked with all-hazards and pandemic preparedness. Climate change-related events – and the increased likelihood of such events – must be incorporated into that planning. However, developing systems and plans is not enough.

This response capacity must also be tested in the form of table-top exercises, drills, and large-scale simulations. When gaps in planning are identified, they must be addressed and rectified.

As seen in Table 2 below, regions in the United States will experience climate change differently; as such, the types of response capacity will vary among the regions.

Table 2: Regional Effects of Climate Change

	Heat waves	Poor air quality	Extreme weather: hurricanes	Extreme weather: floods	Extreme weather: wildfires	Extreme weather: droughts	Increased average temperatures	Rising CO2 levels
Northeast	✓	✓		✓			✓	✓
Southeast	✓		✓	✓	✓	✓	✓	✓
Midwest	✓	✓		✓		✓	✓	✓
Great Plains	✓					✓	✓	✓
Southwest	✓	✓		✓	✓	✓	✓	✓
Northwest				✓	✓	✓	✓	✓
Alaska					✓	✓	✓	✓
Islands*			✓	✓			✓	✓

Source: U.S. Global Climate Research Project, Global Climate Change Impacts in the United States, 2009.⁶¹

* Note: This includes the state of Hawaii and U.S. territories Puerto Rico, the U.S. Virgin Islands, Guam, and other Pacific island territories.

Northeast

Residents of the northeastern United States, from West Virginia to Maine, will face more extreme heat and worsening air quality as a result of climate change. Heat waves are expected to threaten human health, especially in large urban cities where the so-called urban heat-island effect is most prominent.⁶² As such, cities in the Northeast must have appropriate systems and planning in place to respond to heat waves. However, a 2004 review of 18 at-risk cities found one-third lacked any written heat planning, including heat-

specific measures in all-hazards preparedness plans. Of the 10 cities that did have stand-alone heat plans, researchers determined “almost one third of these were cursory.”⁶³

Rising sea levels are expected to contribute to more frequent coastal flooding, displacement, and even injuries and death.⁶⁴ Public health departments will need to update their evacuation plans and ensure enough shelters to house the displaced.

Southeast

The Southeast region includes states along the Atlantic seaboard, from Virginia to Florida and the Gulf Coast, including part of Texas, in addition to Arkansas, Tennessee and Kentucky. Increases in the average temperature across this region will lead to more illness and death from heat stress in the summer.⁶⁵ Effective heat response plans are needed to prevent additional illness and death. The increase in temperature will also lead to more frequent food-borne disease outbreaks, more cases of allergic reactions to toxic plants, and more frequent and intense wildfires.

Along the Atlantic and Gulf Coasts, health departments need to be prepared to respond to hurricanes of increasing frequency and severity.⁶⁶ As we saw with Hurricanes Katrina and Rita in 2005 when 1,800 people died, the elderly and the poor are particularly vulnerable. States and localities vulnerable to hurricanes need to adopt risk communication strategies for at-risk populations in order to educate and inform them about evacuation plans.

The Southeast will also be more susceptible to flooding from increased precipitation unrelated to hurricanes or tropical storms.

Midwest

The U.S. Global Change Research Program predicts the Midwest – the Great Lakes states plus Iowa and Missouri – will suffer from “Heat waves that are more frequent, more severe, and longer lasting.”⁶⁷ While cities like Chicago and St. Louis have developed heat wave response plans, all major cities in this region should have one in place.

The warmer temperatures are expected to affect air quality and lead to more respiratory problems.⁶⁸ States and local health departments have to increase disease surveillance, develop interventions, and build partnerships to target areas with high rates of respiratory disease. Warmer winters mean that vectors, including ticks and

mosquitoes, will be more likely to survive and reproduce in greater numbers exposing more of the population to diseases such as West Nile virus.⁶⁹ States, in collaboration with localities, must develop enhanced vector-borne disease monitoring and surveillance systems to measure the impact.

With increased rainfall projected for the region, frequent flooding – and its impact on human health – will be a major problem.⁷⁰ Flooding can increase the risk of water-borne diseases, so enhanced environmental monitoring and surveillance is needed. Evacuation plans that account for at-risk populations, particularly the elderly and people with disabilities, must be drawn up.

Great Plains

Rising temperatures and decreasing precipitation will stress the communities of the Great Plains, from Texas to North Dakota.⁷¹ Economic changes in rural communities mean that “towns are increasingly populated by a vulnerable demographic of very old and very young people,

placing them more at risk for health issues than urban communities.”⁷² The elderly and children are both more susceptible to extreme temperatures so heat response plans should be devised with these groups in mind.

Southwest

The Southwest region encompasses the southern Rocky Mountain States – Arizona, Colorado, New Mexico Nevada, Utah, and southern California. Wildfires are likely to be more frequent and more severe in this region.⁷³ Public health departments should implement early warning systems and emergency response plans. Some of this planning may involve communication

campaigns to encourage wildfire preparedness measures, including smarter community design that incorporates fire-resistant building materials and proper landscaping. In addition, health departments will have to monitor fire-related air pollution, which can lead to an increase in respiratory disease.

Northwest

Residents of the Northwest – from western Montana and Idaho over to the Pacific Coast and northern California – will suffer from higher temperatures resulting in increased vector-borne diseases.⁷⁴ To prepare for this, state and local health departments will need enhanced surveillance systems to track the spread of vector-borne disease like West Nile virus. They will also need

to develop communication campaigns to educate the population about the increased risk and steps that can be taken to reduce exposure.

Rising sea levels along the Pacific coast could lead to increased flooding, which health departments will have to prepare for by developing evacuation plans and stepping up water-borne disease monitoring.

Alaska

Climate change impacts are much more pronounced in Alaska than in other regions as the state has warmed at more than twice the rate of the lower 48 states' average.⁷⁵ Vectors such as rodents, mosquitoes, and ticks are more likely to survive the milder weather leaving Alaskans at an increased risk of vector-borne disease. The Alaska State Health Department, together with

local health departments, will have to enhance vector surveillance and control programs and develop early warning systems for disease outbreaks, such as West Nile Virus. In addition, public health officials will have to develop and disseminate information on appropriate individual behavior to avoid exposure to vectors.

Islands

Hawaii, Puerto Rico, the U.S. Virgin Islands, and other U.S. territories in the Pacific will face more extreme weather events such as hurricanes as a result of climate change.⁷⁶ Public health officials should develop robust hurricane preparedness plans that include early warning systems. They should also undertake education

and outreach to vulnerable populations, including the poor, the elderly, and children. Public health departments must also be prepared to respond to environmental refugees who may be fleeing severe weather events, such as was the case during Hurricanes Katrina and Rita.

Long-Term Public Health Capacity

Public health departments should be prepared to address longer term public health implications, such as increases in vector-, water-, and food-borne diseases as a result of the changing climate. With warmer temperatures and changes in rainfall patterns, pathogens are expected to be introduced to regions that previously were inhospitable to their survival. As these pathogens become endemic to the new regions, state and local health departments will have to shift resources to address the new threats. Health departments will have to engage in public education campaigns to inform citizens of the

new threat and steps that can be taken to avoid contracting these diseases. In addition, mass vaccination campaigns may be necessary depending on the type of infectious disease threat.

Another long-term challenge will be dealing with changing migration and immigration patterns in the United States. Climate change is likely to affect residents of coastal areas where rising sea-levels will force people inland. Public health and health care professionals must be ready to address the added stress on the public health and health care infrastructure.

5. RESEARCH AND ACCOUNTABILITY

While there is a growing body of research on climate change and the related health effects, there are still major gaps in how health will be impacted. According to John Balbus, a public health leader in climate change, “Limited information is available to describe current exposure-response relationships for many climate-sensitive health outcomes in the United States or to determine the degree to which current programs and measures could be effective in addressing changes in the incidence, severity, and/or geographic range of health outcomes.”⁷⁷

A major barrier has been the limited federal investment in research on the health impacts of climate change. A 2009 analysis on federal funding for climate change deemed current levels to be “inadequate to address the real risks that climate change poses for U.S. populations.”⁷⁸

In 2008, the U.S. Global Change Research Program (formerly the U.S. Climate Change Science Program) identified gaps in human health research and made specific suggestions for research on climate change and human health, including the following:⁷⁹

- The ability to identify exposure thresholds for climate-sensitive health outcomes, such as heat stress, particularly for at-risk populations;
- The development of modeling that looks at the health impacts of climate change and gives researchers estimates on the number of people affected by certain events;
- Tools to monitor and evaluate current climate change preparedness measures, including the costs and benefits of interventions. For example, the effectiveness of heat warning systems or air quality alert programs;
- The development of modeling that gives state and local planners the ability to look at their

vulnerability at the micro level, including the ability to project when these climate change-related events might arise; and

- Research on the built environment and community design, particularly on how to strengthen infrastructure to provide protection against extreme weather events, reduce the effect of urban heat-islands, and maintain drinking and wastewater standards amid rising sea levels and changing precipitation patterns.

Other examples of research topics include: the way in which decreasing precipitation leads to reduced freshwater availability, thus increasing the potential for food- and water-borne disease; or, how changes in temperature and precipitation affect land use, which could affect the geographic spread and intensity of transmission of a range of vector-borne disease.

The authors of the 2009 review of U.S. funding for climate change research would also like to see more research on the possible mental health impacts of climate change, nutritional issues related to food scarcity, and population displacement. In addition, they note that public health officials would benefit from research on “how to communicate most effectively the health risks of climate change, and the possible health harms and benefits of adaptation and mitigation options to address these risks, in order to motivate appropriate responses across all sectors of society.”⁸⁰

Finally, all research analyzing the potential health effects of climate change should also include a discussion on the capacities that are needed to manage the impacts of new and changing climatic conditions. Essentially, the research needs to be translated so that public health departments can use the findings and apply them in the real world.

ENVIRONMENTAL HEALTH INDICATORS OF CLIMATE CHANGE

In May 2009 the State Environmental Health Indicator Collaborative (SEHIC) published a report, *Environmental Health Indicators of Climate Change*, outlining a series of indicators that could be used for climate change, including surveillance data on climate change-related health outcomes.⁸¹ The 28 indicators are intended to assess vulnerability to climate change-related events and preparedness for these events. They are categorized into four groups: Environmental; Morbidity and Mortality; Vulnerability; and Mitigation, Adaptation, and Policy.

The indicators listed under the first three categories (Environmental, Morbidity and Mortality, and Vulnerability) would be especially useful to state and local public health workers responsible for the needs assessment and the development of a strategic climate change response plan. In addition, once a baseline is established, many of the morbidity and mortality indicators could be used to measure the outcomes of various state and local responses to climate change-related events. A brief list of some of the proposed indicators and the relevant data source is presented below.

Indicator	Data Source
Greenhouse gas emissions	U.S. Environmental Protection Agency
Maximum and minimum temperatures	National Climatic Data Center, National Oceanic and Atmospheric Administration
Number of heat alerts/warnings	National Weather Service, National Oceanic and Atmospheric Administration
Frequency, severity, distribution, and duration of wildfires	National Interagency Fire Center
Excess mortality due to extreme heat	National Center for Health Statistics
Mortality from extreme weather events	National Climatic Data Center Storm Data Reports
Elderly living alone	U.S. Census Bureau
Poverty status	U.S. Census Bureau
Flooding vulnerability	Federal Emergency Management Agency
Sea-level rise vulnerability	U.S. Geographic Service

The adaptation indicators proposed by SEHIC can also serve as a jumping off point for developing metrics to measure and evaluate the public health response to climate change. Presently, the only way to obtain this information would be via surveys of state and local health departments. These adaptation indicators are presented below.

Indicator	Data Source
Does the state/local health department provide cooling centers during heat waves?	Survey of state/local health officials
Does the state/local health department provide transportation to those individuals in need of cooling centers?	Survey of state/local health officials
Does the state/local health department have a heat wave early warning system in place?	Survey of state/local health officials
Does the state/local health department have heat island mitigation plans in place?	Survey of state/local health officials
Does the state/local health department have surveillance systems in place to collect data related to human health effects of climate change?	Survey of state/local health officials
Does the state/local health department train its workforce in climate change research, surveillance, and/or adaptation?	Survey of state/local health officials
Does the state/county/city have a climate change task force and, if so, is there representation from the public health department on the task force?	Survey of state/local health officials

FEDERAL RESEARCH ON THE HUMAN HEALTH EFFECTS FROM CLIMATE CHANGE

The Obama administration is working to ensure there is coordination among the various federal departments and agencies. The Office of Science and Technology Policy (OSTP) and the Council on Environmental Quality (CEQ), both located within the White House, are leading an effort to look at climate change **preparedness capabilities and responses**. This is a high-level (Deputy Director and above) interagency committee.

A mid-level working group, the Interagency Working Group on Climate Change and Human Health, brings together staff from across the federal government to coordinate and collaborate on **health** research needs for climate change prevention and preparedness strategies. The group is developing a white paper it plans to release in October 2009 that identifies 11 areas for researchers interested in studying the human health effects of climate change:

- asthma, allergies, and airway diseases;
- vascular disease and stroke;
- nutrition and food-borne illness;
- heat-related morbidity and mortality;
- mental health and stress-related disorders;
- vector-borne and zoonotic diseases;
- water-borne disease;
- cancer;
- alterations in normal human development;
- neurological disease; and
- weather-related morbidity and mortality.

Finally, the U.S. Global Change Research Program (USGCRP) coordinates and integrates **all** federal research on changes in the global environment and their implications for society. Congress mandated the USGCRP when it passed the Global Change Research Act of 1990 (P.L. 101-606). Thirteen departments and agencies participate in the USGCRP, which was known as the U.S. Climate Change Science Program (CCSP) from 2002 through 2008.⁸² The 13 include: DOD, EPA, HHS, USDA, the Departments of Commerce, Energy, Interior, State, Transportation, National Aeronautics and Space Administration (NASA), National Sciences Foundation (NSF), Smithsonian Institution, and the Agency for International Development (USAID). The White House National Science and Technology Council oversees the program through the Committee on Environment and Natural Resources' Subcommittee on Global Change Research.

Every four to five years, the USGCRP issues a strategic research plan to help guide the program's research agenda. In the most recent plan, the key research components for 2008-2011 include the following:⁸³

- Provide the basic physical science required to understand Earth's past and present climate, including its natural variability, and to improve understanding of the causes of and uncertainties in observed variability and change at global, continental, regional, and local scales;

- Address the emerging need for research on the impacts of climate change on ecosystems, human health, and infrastructure, economic, and other human systems;
- Research adaptive management and mitigation efforts, with an emphasis on the regional and local level; and
- Communicate findings with users and stakeholders, including state and local governments, academia, industry, public utilities, and nongovernmental organizations.

The 13 participating agencies coordinate their research through 10 interagency working groups. Currently, there is no working group dedicated to the impact of climate change on human health. Instead, the Human Contributions and Responses working group lists human health as a significant research topic. However, there is talk that USGCRP may formally designate the Interagency Working Group on Climate Change and Human Health as the 11th official working group.

The following federal agencies have extensive climate change research portfolios.

U.S. Environmental Protection Agency (EPA)

The EPA's mission is to protect human health and the environment. As such, climate change programs and research are a central component of the agency's portfolio. EPA's climate change assessment program has four areas of emphasis: human health; air quality; water quality; and ecosystem health.⁸⁴

Among EPA's contributions to climate change research are the following:⁸⁵

- The first Health Sector Assessment was conducted through a public-private partnership with the Johns Hopkins School of Hygiene and Public Health and published in April 2000 issue of *Environmental Health Perspectives*;
- The development of a series of economic models and analytical tools to help researchers conduct climate change economic analyses. These tools include economy-wide models, mitigation models, integrated assessment models, and detailed sector models.
- A series of workshops on changing weather patterns. Researchers studied the effects warmer winters will have if they bring less snow storms but more ice storms. They concluded there will be more slips and falls, especially among elderly, and more automobile accidents as a result;
- Research on what an increase in vectors, such as mosquitoes and ticks, will mean for quality of life;
- An ozone air quality assessment;
- An aero-allergens report examining how climate change and warmer weather affect pollen count and allergies; and
- Investigating the effect climate change has on water-borne diseases.

In addition to internal research projects, EPA's National Center for Environmental Research runs that Science to Achieve Research (STAR) Grant Program for extramural research. Since 1995, EPA has issued 18 global climate change requests for applications (RFAs) from the scientific community. Of these, only two RFAs dealt specifically with climate change and health: Decision Support Systems Involving Climate Change and Public Health and The Impact of Climate Change & Variability on Human Health, both issued in 2005. These RFAs generated five research projects, which were funded for a total of nearly \$2.5 million over several years.⁸⁶

EPA also produced the *Excessive Heat Events Guidebook* with assistance from the National Oceanic and Atmospheric Administration (NOAA), the Centers for Disease Control and Prevention (CDC), and the Department of Homeland Security (DHS), in addition to state and local and academic partners.⁸⁷ EPA designed the guidebook to help community officials, emergency managers, meteorologists, and others plan for and respond to excessive heat events. The guidebook highlights best practices that have been employed to save lives during excessive heat events in different urban areas and provides a menu of options that officials can use to respond to these events in their communities.

The National Institute of Environmental Health Sciences (NIEHS)

NIEHS does not have a targeted climate change program. "Instead," according to a report on the NIEHS climate change research agenda, "NIEHS has a body of research investment that demonstrates state-of-the-art expertise in the range of health endpoints that are likely to be affected by climate change, and that could be deployed to understand those changes as necessary."⁸⁸

Currently, climate change research at NIEHS is coordinated by the Office of the Director. The goals of NIEHS's climate change research portfolio are to:⁸⁹

- Provide information on human health research related to climate change and to the use of a range of energy sources;
- Raise awareness and create new partnerships to advance key areas of health research and knowledge development; and
- Serve as an authoritative source of information on climate change, energy and health, and to assist scientists, health professionals and others who wish to engage in this arena.

NIEHS has funded work on the human health effects of the environmental changes resulting from rising greenhouse gas emissions, including:

- Vector-borne diseases;
- Changes in the agricultural growing season;
- Changes in water levels;
- Changes in low-level ozone; and
- More extreme weather events and their aftermath.

According to NIEHS Associate Director Sharon Hrynkow, NIEHS funds approximately \$100 million annually in research

related to climate change. However, it is hard to pin down how much of that is spent studying the human health effects of climate change.^{90,91}

NIEHS is also investing in research related to climate change prevention. One project they are funding through the World Health Organization is a pilot grant to determine the breadth of a study that would look at coal-fired power plants in order to determine how much they contribute to worldwide mortality and how much they prevent worldwide mortality.

Another climate change prevention project NIEHS is funding is the Project on Climate Change Mitigation and Public Health, which examines the health effects of climate change prevention strategies. The aim of this project is to quantify the population health consequences (both positive and negative) of key policy choices aimed at climate change prevention in each of four sectors: energy, housing/built environment, transportation, and food/agriculture. The London School of Hygiene & Tropical Medicine is leading a consortium of international climate change experts to study this issue.

The group will produce a report to guide policy makers in deciding the most appropriate mix of climate change mitigation strategies for different socioeconomic settings and expects to release the report in November 2009 ahead of the United Nations Climate Change Conference in Copenhagen in December 2009.

Other institutes at the National Institutes of Health (NIH), including the National Institute of Child Health and Development (NICHD), the National Institute of Allergies and Infectious Diseases (NIAID), and the National Cancer Institute (NCI), have also funded climate change-related research. For instance, NICHD's *National Children's Study* is a longitudinal study that examines the effects of environmental influences on the health and development of 100,000 children across the United States, following them from before birth until the age of 21. Most recently, the NIH Fogarty International Center for Advanced Study in the Health Sciences announced the NIH Challenge Awards in Health and Science Research, funded through the 2009 American Recovery and Reinvestment Act, or stimulus package. NIH is using \$200 million in stimulus dollars to fund research on topic areas that address specific scientific and health research challenges in biomedical and behavioral research that would benefit from significant two-year jumpstart funds, including work on models to predict the human health effects of climate change.⁹² NIH anticipates funding 200 or more grants, each of up to \$1 million in total costs, pending the number and quality of applications and availability of funds. According to NIH, interest in the climate change modeling topic was strong with 60 grant applications submitted by the May 1, 2009 deadline. However, given the overwhelming response for the Challenge grants as a whole -- over 20,000 applications submitted for 125 topics -- it is likely that only a handful of the climate change modeling proposals will be funded.⁹³

The Fogarty International Center is also responsible for coordinating climate change research across all NIH institutes.

U.S. Centers for Disease Control and Prevention (CDC)

CDC's National Center for Environmental Health leads the agency's climate change and public health program. CDC's role in climate change research is to investigate how federal, state, and local public health agencies can prepare for the health effects related to climate change, much as the agency funds research and capacity building to prepare for bioterrorism and pandemic influenza.

Among CDC's accomplishments to date are the following:

- Has longstanding programs that respond to natural disasters and heat waves; study, track, and work to control vector-borne, zoonotic, soil-associated, and water-borne infectious diseases; monitor respiratory disease; and provide technical assistance to states with harmful algal blooms;
- Has funded university researchers to develop mathematical models to identify urban areas and populations at increased risk for heat wave associated death and illness;
- Conducted a series of six scientific workshops with stakeholders to clarify the public health priorities, impact, and future research needs for the public health response to the effects of climate change;
- Convened thought leaders and subject matter experts in the areas of public health, climate change, communication, and marketing to begin development of a health communication and marketing framework;
- Established partnerships to identify health and injury issues associated with climate change with other federal agencies (EPA, NASA, NIH, NOAA, NWS, USGS), professional organizations (APHA, AWWA, PSR, National Hispanic Environmental Council), state and local organizations (ASTHO, NACCHO), and other non-traditional public health partners affected by the impacts of climate change; and
- Educated the public and professionals by presenting to community groups, professional organizations, scientific review panels, and academic institutions.

In FY2009, Congress appropriated \$7.5 million for CDC to formally establish its Climate Change and Health Program. The Program addresses five broad areas pertaining to climate change:

1. Expanding the climate change research foundation:

- Seventeen intramural research awards have been awarded competitively, amounting to nearly \$3 million. These projects relate to epidemiologic and laboratory sciences, infectious disease ecology, modeling and forecasting,

climatology and earth science, and communication and behavioral-change science. Additionally, approximately 10 extramural research grants will be awarded.

2. Developing partnerships:

- CDC is developing innovative partnerships to better understand predicted health outcomes and to ensure cooperation between diverse stakeholders. Collaborations have been established with the Association of Schools of Public Health (ASPH), the American Public Health Association (APHA), the National Network of Public Health Institutes (NNPHI), the USGCRP, ASTHO, and NACCHO, among other organizations.

3. Enhance capacity at state and local health departments:

- CDC is committed to building climate change capacity at state and local health departments through competitive grant awards. These pilot grants will be distributed through ASTHO and NACCHO. Five states will receive between \$75,000 and \$90,000 each, and six local jurisdictions will receive \$50,000 each to conduct needs assessments and develop strategic plans to address weaknesses and bolster climate change capacity.
 - ▲ According to both ASTHO and NACCHO, interest in applying for these funds has been high. Eleven state health departments and 31 local health departments submitted complete applications.⁹⁴
 - ▲ The five states that received grants from ASTHO are California, Florida, Michigan, Minnesota, and New Hampshire.
 - ▲ The six local jurisdictions that received grants from NACCHO are Austin/Travis County Health Department, TX; Hennepin County Human Services and Public Health Department, MN; Imperial County Public Health Department, CA; Mercer County Health Department, IL; Orange County Health Department, FL; and Thurston County Public Health and Social Services Department, WA.

4. Promoting workforce development:

- CDC is funding post-doctoral work and dissertation awards in climate change and health, developing web-based training for coaches to identify and prevent heat-related illness in student athletes, and holding a global workshop on climate change.

5. Communicating health-related aspects of climate change:

- This aspect supports evidence-based communication strategies such as the development of comprehensive communications campaigns for coordinated public health response to extreme heat events.

Special Concerns for Communities at High Risk for Health Consequences of Climate Change

Some Americans are particularly vulnerable to the negative consequences of climate change on health, including increasing heat stress, air pollution, extreme weather events, and diseases carried by food, water, and insects. These vulnerable populations include:⁹⁵

- Infants and children;
- Pregnant women;
- The elderly;
- The poor;
- Racial and ethnic minorities;
- People with disabilities;
- People with chronic medical conditions, including the obese; and
- Outdoor workers.

According to the Intergovernmental Panel on Climate Change, vulnerable populations are more likely to suffer from the health effects of climate change, including:⁹⁶

- Increases in malnutrition and consequent disorders, with implications for child growth and development;
- Increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts;
- The increased burden of diarrheal disease;
- The increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone related to climate changes; and
- Increased exposure to infectious disease vectors as rising temperatures and increased rainfall extend the natural habitat of insects, rodents, and other vectors.

While climate change is projected to bring some benefits, such as fewer deaths from cold exposure, the IPCC notes that, “Overall it is expected that these benefits will be outweighed by the negative health effects of rising temperatures worldwide, especially in developing countries.”⁹⁷

Populations that have access to education, health care, and public health initiatives and infrastructure, such as strong disease surveillance systems and emergency response plans, will be better positioned to face the consequences of climate change.⁹⁸ However, a 2007 IPCC report notes that, “Adaptive capacity needs to be improved everywhere; impacts of recent hurricanes and heat waves show that even high-income countries are not well prepared to cope with extreme weather events.”⁹⁹ Public health departments must tailor information to each group focusing on the specific risks these at-risk populations may face.

Public health departments create strategies to work with at-risk communities on a range of ongoing health concerns, and often have existing relationships with community- and faith-based organizations with ties to at-risk populations. By coordinating with these organizations, public health departments can get their targeted messages out in an effective manner and via a trusted, reliable source.

Public health departments can also build relationships with local universities which can assist with designing and disseminating information, education and communication campaigns to target these at-risk individuals.

A. THE POOR AND RACIAL AND ETHNIC MINORITIES

There is growing recognition that African Americans and other racial/ethnic minorities will suffer disproportionately from climate change, particularly those with low socio-economic status. In July 2008, the Joint Center for Political and Economic Studies, a public policy research organization focusing exclusively on issues of particular concern to African Americans and other people of color, launched the Commission to Engage African Americans on Climate Change (CEAC).

The CEAC “will work with African Americans and others to understand the impacts that climate change will have on their communities, and work to reduce greenhouse gas emissions and ensure that energy policies are fair to all Americans.”¹⁰⁰

The CEAC cited the following findings from its paper, *Global Warming and African Americans*, in describing the disproportionate impacts of climate change on African Americans:¹⁰¹

- **Urban dwelling:** Because of the “heat island effect,” temperature increases are expected to be more extreme in urban areas, where blacks are more than twice as likely to live than whites;
- **Energy consumption:** More African Americans will be “fuel-poor” as the demand for energy rises due to higher air-conditioning loads, population growth, and urbanization. African Americans already spend an estimated 25 percent greater share of their income on energy than the national average, and total spending is rising in the face of increasing gasoline and resource prices;
- **Population displacement:** Hurricane Katrina displaced more than 700,000 Americans, and poor African Americans represent a disproportionate percentage of the displaced. New Orleans’ African American population has fallen to less than 60 percent of its pre-hurricane levels; and
- **Heat-related deaths:** During the 1995 Chicago heat wave, the African American death rate was 1.5 times the rate for non-Hispanic whites. The correlation between lower air conditioning prevalence in African American households and higher heat-related mortality was noted in a study of heat-related deaths in four major U.S. cities. African Americans in the cities had half the rate of air conditioning penetration as whites and almost three times the percent increase in deaths.

A separate 2009 report, *The Climate Gap: Inequalities in How Climate Change Hurts Americans and How to Close the Gap*, from researchers at the University of Southern California also calls attention to the disproportionate and unequal impact climate change has on people of color and the poor.¹⁰² The report

uses currently available scientific and social science research on the health effects of climate change and related prevention policies to examine the disparate impact on low-income Americans. The authors focus on California, which serves as a microcosm of the entire United States.

The report echoes many of the findings of the CEAC and finds that racial and ethnic minority communities and the poor will suffer a series of adverse events at higher rates than white communities and the middle and upper classes, including:

- Higher rates of death and heat-related illnesses during extreme heat waves;
- Greater health impacts from breathing dirtier air, in part because the cities that suffer from high levels of air pollution also have the highest densities of minorities and low-income residents;
- Larger proportion of their incomes will be spent for basic necessities like food, electricity, and water; and
- Fewer job opportunities as sectors that predominately employ low-income people of color, including agriculture and tourism, are negatively affected by climate change.

The authors recommend several policy actions to close the “climate gap.” Among the recommendations are the following:

- Efforts should be made to reduce the economic impact climate change prevention policies, such as cap and trade, will have on minority and low-income communities. Revenues from emission control programs could be distributed to these at-risk populations through tax cuts, investments in clean energy and public transportation, or even via direct payments;
- Efforts to reduce greenhouse gas emissions should focus on the worst polluters, many of which are located in low-income, minority neighborhoods;
- Climate change planning and preparedness should focus on poor and minority neighborhoods. Interventions to enhance the built environment, such as planting trees and increasing green spaces to ameliorate heat island effects, and increasing access to public transportation to reduce greenhouse gas emissions, should also target at-risk communities; and
- Evaluation on the effectiveness of climate change policies, including both prevention and preparedness strategies, should examine whether or not they protect all Americans, including our most vulnerable citizens.

THE DISPARATE IMPACT OF HEAT WAVES ON LOW-INCOME, URBAN RESIDENTS

The July 1995 Chicago heat wave had a disproportionate impact on the low-income elderly and African-American population of Chicago.¹⁰³ That year the city experienced a heat wave with temperatures ranging from 93°F to 104°F. On July 13, the heat index peaked at 119, a record high for the city. After two days of the extreme heat, thousands of Chicagoans had developed severe heat-related illnesses. Paramedics were unable to keep up with all the emergency calls, and 23 hospitals went on “bypass status” meaning that they closed the doors of their emergency rooms to new patients.¹⁰⁴ With no city-wide monitoring system, 18 of those 23 hospitals simultaneously refused new patients.¹⁰⁵ Ambulance crews drove for hours looking for open beds. The city waited until the morgue had been filled with hundreds of new bodies to declare an official emergency.¹⁰⁶

According to the Cook County Medical Examiner’s Office, 465 deaths were certified as heat-related. Of the 465, almost half were among African-Americans (229) and more than 50 percent of deaths were among adults age 75 years or older.¹⁰⁷ An article in the *American Journal of Public Health* identified important risk factors -- other than race and age -- including living alone, living on higher floors, living in poverty, living without air conditioning, and using special and excessive medications.¹⁰⁸

A separate study in *The New England Journal of Medicine* found that those at greatest risk of dying from the heat were people with medical illnesses who were socially isolated and did not have access to air conditioning.¹⁰⁹ Those at-risk individuals who had social-service workers sent to visit them and explain the dangers of hot weather had a decreased risk of death associated with the heat wave. The study concluded that home

health care workers, friends, and the media are effective ways to prevent heat-wave related deaths for at-risk populations.¹¹⁰

To reduce the adverse health effects of extreme heat on at-risk populations, the study’s authors recommend the following:

- Open cooling centers for people who do not have access to air conditioning and provide transportation to those centers;
- For people who are house bound and normally have some form of social-services worker visit them, these visits should occur with more frequency during heat waves. Programs like Meals on Wheels or visiting nurses should be sent to their patients to warn about the risks and dangers of heat waves when the temperature hits a certain point;
- Use the media to spread information about the risks and dangers associated with heat waves, and how to stay healthy during heat waves;
- Cities/states need to have emergency plans in place in order to have a monitoring system so that people are not refused from emergency rooms; and
- Have city emergency workers go door to door in the especially at-risk neighborhoods.

Chicago did learn from its mistakes, and in 1999 during another heat wave the city issued warnings and news releases, opened cooling centers and provided free transportation to them, and went door to door to check on the elderly living alone, which significantly reduced the number of deaths to 110.¹¹¹

B. CLIMATE CHANGE PUTS CHILDREN AT RISK

Scientists and public health officials expect climate change to place an undue burden on children; though very few studies have focused specifically on the effect climate change will have on them. This is troubling, according to Harvard Medical School fellow Dr. Supinda Bunyavanich, who notes, “Children aren’t just little adults. They have a different physiology and different exposures.”¹¹²

In 2003, Bunyavanich and colleagues published a review of the available research on the health impacts of climate change and analyzed its relevance to children. Climate change-related events and the negative health consequences for children include the following:¹¹³

■ **Air pollution:** Climate change will lead to worsening regional ozone pollution, with associated risks of respiratory infections, aggravation of asthma, and premature death. Children, compared with adults, breathe more rapidly and spend more time outdoors playing leading to greater exposure to pollutants. Because chil-

dren’s respiratory systems are still developing, this damage can have long-term consequences.

- **Extreme temperatures:** Climate change will lead to intensifying severe heat waves. Children are less able to control whether or not they have access to air conditioning or cooling centers than adults. They also are less able to recognize the signs of heat stress, especially if a heat wave is sudden and severe.
- **Weather disasters:** Climate change will increase the number and intensity of extreme weather events such as heavy rainfall, floods, droughts, hurricanes, and tornadoes. The potential health impacts for children include drowning, water-borne diseases, and post-traumatic stress symptoms.
- ▲ **Drowning:** Children are less skilled swimmers than adults. With the number of people affected by flooding expected to double by 2100, many children could die from drowning.

▲ **Water-borne diseases:** Floods and severe storms can contaminate drinking water reservoirs and lead to water-borne diseases such as cholera. Children not only drink more water than adults per body mass, but their immune systems are less developed which puts them at greater risk of disease and death.

▲ **Mental health:** A 2006 study from Columbia University found children displaced by Hurricane Katrina were particularly vulnerable to mental health issues.¹¹⁴ An increase in severe storms would lead to more internal displacement and the resulting emotional trauma for children.

■ **Greater exposure to infectious diseases:** Certain vector-, food-, and water-borne diseases are expected to occur more often and affect new populations as a result of changes in temperature and precipitation that allow these pathogens to expand into new geographic regions. For example, populations living in mountain states may become more susceptible to certain vector-borne diseases as a result of warming temperatures, which allow these vectors, such as mosquitoes, to live and re-

produce at higher elevations. Those most at risk from dying from diseases such as malaria, West Nile virus, Lyme diseases, and encephalitis are young children, in part because children's immune systems are not as fully developed as those of adults. In addition, children spend more time outside playing than adults which puts them at increased risk of contracting an insect-borne disease.

Given children's increased vulnerability to the health effects of climate change, in 2007 the American Academy of Pediatrics (AAP) urged pediatric health care providers to educate themselves about these risks, plan for the impact climate change will have on children's health, and advocate for stronger prevention and preparedness activities.¹¹⁵

AAP also advocated for government at all levels to pay specific attention to the needs of children in emergency management and response, support information and education campaigns to raise awareness of the threats from climate change for children's health, and fund more research on the health effects of climate change on children's health.

CHILDREN AND HURRICANES

A 2008 Newsweek article published after Hurricane Ike's landfall in Texas called attention to the issue of disaster preparedness and children. Shortly after Hurricane Ike hit Texas, San Antonio officials compiled a list of statistics about evacuees in their city. City officials counted a total of 5,303 persons who had been forced to leave their homes, including 561 individuals with special medical needs, but there was no separate tally for children.¹¹⁶ According to disaster-relief experts this is not uncommon as kids are rarely counted in evacuations. Like hospitals, emergency shelters are often unprepared to handle children in emergencies, with essentials such as baby wipes and diapers nowhere to be found.¹¹⁷

Public health officials developing emergency response plans for hurricanes or other extreme weather events should consider the following general recommendations for children and disasters:

- There must be dedicated personnel, equipment, and care venues specifically for the size and needs of children;
- Pediatricians should urge families to put together disaster kits;
- Pediatricians should advocate that disaster planning drills include planning for children; and
- Emergency health departments should practice exercise scenarios, as well as use a standardized evaluation system to fine tune their pediatric disaster plan.¹¹⁸

C. SPECIAL NEEDS OF THE ELDERLY AND OBESE INDIVIDUALS

Two socio-demographic trends – the aging of the U.S. population and the growing numbers of obese Americans – make the United States particularly vulnerable to weather-related disasters.¹¹⁹

The percentage of the U.S. population over the age of 65 is projected to be 13 percent by 2010 and 20 percent by 2030, almost a 50 percent increase as the Baby Boomers join the ranks of the elderly.¹²⁰ According to the IPCC, “This is relevant to climate change because the elderly are more vulnerable than younger age groups to injury resulting from weather extremes such as heat waves, storms, and floods.”¹²¹

While the U.S. population is aging, it is also growing heavier. Rates of obesity and diabetes continue to rise in the United States. In 2008, adult obesity rates grew in 23 states and did not decrease in a single state.¹²² The number of obese adults now exceeds 25 percent in nearly two-thirds of states. In 1991, no state had an obesity rate above 20 percent. Meanwhile, adult diabetes rates increased in 19 states in the past year. In seven states, more than 10 percent of adults now have type 2 diabetes. This is particularly troubling because diabetics are at greater risk of heat-related death.

THE ELDERLY AND HURRICANES

Disasters disproportionately affect the elderly and infirm. Although adults ages 60 and older made up only 15 percent of the population of New Orleans before Hurricanes Katrina and Rita hit in 2005, 71 percent of those who died as a result of these storms were over the age 65.¹²³ Nursing home residents are particularly vulnerable. During Hurricane Katrina, 70 nursing home residents died in 13 different nursing homes following the storm.¹²⁴

In order to evaluate how nursing homes fared in the wake of Katrina, researchers studied 14 nursing homes affected by the storm. Their results showed many shortcomings, including the following:¹²⁵

- Nursing homes were not a part of community planning or listed as community health resources;
- Supplies and medications were inadequate;
- Evacuating nursing homes did not communicate well with sheltering nursing homes, or provide adequate information about evacuees; and
- Nursing homes lacked adequate relations with community leaders and local preparedness systems.

Given that some two million Americans live in an estimated 18,000 nursing homes across the country, it is crucial the public health preparedness plans take their needs into consideration.¹²⁶ To ensure elderly nursing home residents do not suffer disproportionately during future extreme weather events, the study made the following recommendations:¹²⁷

- Incorporate the needs of nursing home residents into disaster plans;
- Use nursing homes as a community resource during a disaster;
- Ensure that core functions are maintained during a disaster;
- Develop geriatric-specific protocols for managing across the continuum of care;
- Develop strategies to maintain mental health;
- Coordinate and plan for transportation; and
- Ensure communications.

D. COMMUNITIES IN ACTION: PLANS TO COMBAT THE HEALTH EFFECTS OF CLIMATE CHANGE

PHILADELPHIA -- HOT WEATHER-HEALTH WATCH/WARNING SYSTEM (PWWS)

After a severe heat wave in July 1993 resulted in at least 118 heat-related deaths, Philadelphia developed the Philadelphia Hot Weather-Health Watch/Warning System (PWWS) in 1995 to alert the city's population when weather conditions pose health risks. There are two types of air mass that are associated with increased risk of death in Philadelphia: maritime tropical and dry tropical. The PWWS forecasts air mass type for the current day and the coming two days during the summer season, which runs from May 15 through September 30. The PWWS factors in several variables to its forecasts including: the number of consecutive days that the air mass was present, the maximum temperature, and the time of season. The local branch of the National Weather Service determines whether or not to issue its own warning based on the PWWS forecasts, the heat index, and other information. More often than not, the NWS will issue a heat warning on days recommended by the PWWS.

When the National Weather Service issues a warning, the local health department and other agencies roll out a series of interventions.

1. Local media are asked to publicize the warning and include information on steps that residents can take to avoid heat-related illnesses.
2. Media announcements encourage friends, relatives, neighbors, and other volunteers to make daily visits to elderly persons during the heat wave to make sure these at-risk individuals have sufficient fluids, proper ventilation, and other tools to cope with the weather.
3. A "heatline" is operated together with the Philadelphia Corporation for the Aging to provide information and counseling to the general public on how to avoid heat stress.
4. The Philadelphia Department of Public Health contacts nursing homes and other elder care and child care facilities to inform them of the high-risk heat situation and offer advice on how best to protect their clients from the heat.
5. Local utilities halt service suspension during warning periods.
6. Local fire and rescue units call up more personnel during warnings in anticipation of increased demand.
7. Local homeless service agency activates increased daytime outreach activities to help those people living on the streets.
8. Senior centers extend their hours of operation of air-conditioned facilities during warming periods.

An analysis of the PWWS found that issuing a heat warning lowered daily mortality by about 2.6 lives on average, and that the costs of running such a system were negligible while the net benefits were around \$468 million over the three-year period of 1995-1998.¹²⁸

CHICAGO, ILLINOIS -- EXTREME WEATHER NOTIFICATION SYSTEMS

In mid-July 1995, Chicago experienced a heat wave with temperatures ranging from 93°F to 104°F. On July 13, the heat index peaked at 119, a record high for the city. In response to the deadly heat wave, Chicago developed a heat wave response program. One component of the program is the Extreme Weather Notification System that places automatic telephone calls to warn at-risk individuals of an impending heat or cold wave.¹²⁹ The calls consist of a recorded message of weather forecasts, safety tips and information on City services. Residents must register themselves or their friends and relatives online, over the phone, or by completing a form available at various city offices, library branches, and police stations.

The Extreme Weather Notification System is activated when the National Weather Service declares a Heat Warning or Wind Chill Warning. A Heat Warning occurs when forecasts indicate three consecutive days with a heat index of 100 to 105 F; or two consecutive days with a maximum heat index of 105 to 110 F; or one day with a maximum heat index of 110 F or greater. A Wind Chill Warning takes place when extreme low temperatures occur or if wind chills reach -30 F or colder, with wind speed greater than or equal to 10 mph.

ST. LOUIS, MISSOURI -- OPERATION WEATHER SURVIVAL

Operation Weather Survival (OWS) was created in 1981 to address the needs of the community during extreme weather conditions. It is comprised of public and private organizations working together to prevent illness or death from extreme heat, cold conditions, or ground level ozone. The program targets those most at-risk, including the homeless, the poor, the elderly, and chronically ill persons living alone. The St. Louis health department provides preventive education and also monitors temperatures in order to generate OWS alerts and warnings. OWS provides air conditioners to individuals who are medically at risk and helps to identify cooling sites that are open year-round. During severe heat, cooling center hours and services are extended.

ARIZONA -- HEAT EMERGENCY RESPONSE PLAN

Arizona is one of the hottest places on earth from June to September. Heat-related illnesses are common during the summer in Arizona. Year after year nearly 800 people are admitted to hospitals because of heat related illnesses.¹³⁰ As a result, the Arizona Department of Health Services, the Maricopa County Department of Emergency Management, and the City of Phoenix Emergency Management Office developed a Heat Emergency Response Plan.

The goals of the plan are to limit the adverse human health effects from extreme heat and to provide a framework for state and local health departments to provide services to at-risk populations, especially senior citizens and people with existing medical conditions.¹³¹ Depending on the type of heat-related warning the Phoenix office of the National Weather Service issues -- heat advisory, excessive heat watch, or excessive heat warning -- the Plan details the specific roles and responsibilities of various government agencies. The Plan includes a detailed public health education campaign to raise awareness among residents of the dangers of excessive heat and steps they can take to avoid harm. The communication campaign materials are available in both English and Spanish.

RHODE ISLAND -- AIR QUALITY ALERT PROGRAM

Ground level ozone, or smog, is a major air pollution problem in Rhode Island and other northeast states. The Rhode Island Department of Health warns that unhealthy levels of ozone can cause throat irritation, coughing, chest pain, shortness of breath, increased susceptibility to respiratory infection and aggravation of asthma and other respiratory ailments.¹³² These symptoms are worsened by exercise and heavy activity. The elderly, children, and people who have underlying lung diseases, such as asthma, are at particular risk of suffering from these effects. As ozone levels increase, the number of people affected and the severity of the health effects also increase. High levels of fine-particle matter are also a major health threat.

The Rhode Island Public Transit Authority implemented the Air Quality Alert Days Program, which is designed to help protect public health by issuing an alert on days when air quality is unhealthy due to a high level ozone or particle matter. The program is in effect all year round. When an Air Quality Alert is issued, residents are able to ride all public bus and trolley routes in the state for free. By encouraging people to leave their cars at home and take public transit, the state program aims to reduce air pollutant emissions. The program also encourages residents to limit their use of small engines, lawn mowers and charcoal lighter fluids.



State Indicators of Climate Change

4 SECTION

“ACCOUNTABILITY MECHANISMS ARE CRUCIAL...ACCOUNTABILITY INDICATORS SHOULD BE MONITORED BY THE ACADEMIC COMMUNITY AND CIVIL SOCIETY ORGANIZATIONS. IT SHOULD BE POSSIBLE TO AGREE UPON HEALTH AND CLIMATE CHANGE GOALS AND TARGETS FOR THE PROCESSES OF ENGAGEMENT AND EMPOWERMENT.”¹³³

--LANCET AND UNIVERSITY COLLEGE LONDON INSTITUTE FOR GLOBAL HEALTH COMMISSION

All Americans have the right to expect fundamental health protections no matter where they live, which includes protection from climate change-related events. Given the central role that states and localities play in protecting the public's health, whether in response to routine threats or climate change-related disasters and emergencies, many in the public health community have proposed that federal, state, and local health departments develop a set of metrics by which authorities and the public can evaluate each jurisdiction's preparedness and response to climate change. “The public health community should develop [its] own metrics for conveying the state of the environment and population health both globally and regionally,” say researchers at Johns Hopkins School of Public Health. “A carefully designed global environmental health index could be developed and adjudicated by a panel of independent scientists and public health experts.”¹³⁴

These metrics, or indicators, would be used to evaluate the outcomes of specific policies or programs undertaken by federal, state and local government to prepare for climate change. The indicators would identify where and how jurisdictions can improve or overcome obstacles to climate change preparedness. In addition, by providing information about which agencies have particular strengths, this allows others to know who to turn to for best practices and models to guide their own climate change preparedness efforts.

It also can be useful to track federal grant dollars for state and local climate change preparedness and response. Until there is a dedicated funding source for state and local climate change programs, TFAH proposes tracking related

CDC-grants, such as the Environmental Health Tracking Program, National Asthma Control Program, and Arbovirus Vector-Borne Disease Surveillance System grants.

For this report, TFAH has selected five state climate change-related indicators which are presented in the table below. We have relied on publicly available data from CDC and from individual states. By no means does this set of indicators entail a comprehensive assessment of a state's readiness to prevent, prepare, and respond to climate change. However, it does help identify gaps in current climate change preparedness and response. As such, TFAH believes it can serve as a useful tool for federal, state, and local officials as they seek to advance climate change readiness across the nation.

TABLE: STATE CLIMATE CHANGE-RELATED INDICATORS

	State climate change plan details public health's role in preventing and preparing for climate change	State Climate Commission or Advisory Panel includes representative from state department of public health	CDC Environmental Public Health Tracking Grant (FY09)	CDC Asthma Grant (FY09)	Arbovirus Vector-borne Disease Surveillance System (ArboNET) Funding (FY08)
Alabama					✓
Alaska					
Arizona					✓
Arkansas					✓
California†	✓	✓	✓	✓	✓
Colorado			✓	✓	✓
Connecticut		✓	✓	✓	✓
Delaware					✓
D.C.				✓	✓
Florida†			✓		✓
Georgia				✓	✓
Hawaii		✓		✓	✓
Idaho				✓	✓
Illinois				✓	✓
Indiana				✓	✓
Iowa				✓	✓
Kansas		✓	✓	✓	
Kentucky					✓
Louisiana			✓		✓
Maine		✓	✓	✓	✓
Maryland	✓	✓	✓	✓	✓
Massachusetts		✓	✓	✓	✓
Michigan†				✓	✓
Minnesota†			✓	✓	✓
Mississippi				✓	✓
Missouri			✓	✓	✓
Montana					✓
Nebraska					✓
Nevada		✓			✓
New Hampshire†	✓	✓	✓	✓	✓
New Jersey			✓	✓	✓
New Mexico			✓	✓	✓
New York*			✓	✓	✓
North Carolina				✓	✓
North Dakota					✓
Ohio				✓	✓
Oklahoma				✓	✓
Oregon		✓	✓	✓	✓
Pennsylvania			✓	✓	✓
Rhode Island				✓	✓
South Carolina		✓	✓		✓
South Dakota					✓
Tennessee					✓
Texas				✓	✓
Utah			✓	✓	✓
Vermont			✓	✓	✓
Virginia	✓			✓	✓
Washington	✓	✓	✓	✓	✓
West Virginia				✓	✓
Wisconsin			✓	✓	✓
Wyoming					✓
TOTAL	5	12	22 + NYC*	33 + D.C.	49 + D.C.

NOTES: *New York State and New York City both receive Environmental Public Health Tracking Grants.

† State is one of five states funded through a CDC pilot program to conduct a needs assessment and develop a strategic plan to address weaknesses and bolster climate change capacity.

A. PLANNING INDICATORS

Indicator 1: State Plan for Public Health Response to Climate Change

FINDING: Only five states have published state climate change plans that detail the public health department's role in preventing and preparing for climate change.

5 states have published a strategic climate change plan that includes the public health response		28 states have a strategic climate change plan that does NOT include a public health response		17 states and D.C. have NOT published a strategic climate change plan	
California Maryland New Hampshire	Virginia Washington	Alaska Arizona Arkansas Colorado Connecticut Delaware Florida Hawaii* Illinois Iowa Kentucky Maine Massachusetts* Michigan	Minnesota* Missouri Montana Nevada New Mexico New York North Carolina Oregon Pennsylvania Rhode Island South Carolina Utah Vermont Wisconsin	Alabama D.C. Georgia Idaho Indiana Kansas Louisiana Mississippi Nebraska	New Jersey North Dakota Ohio Oklahoma South Dakota Tennessee Texas West Virginia Wyoming

Notes: *Comprehensive climate change plan with a detailed section on public health is due out by the end of 2009.

Developing a strategic climate change plan is an important first step that states can take as they ready themselves to prevent and prepare for climate change.

A well-designed strategic plan will rely on a needs assessment, which both can help to identify gaps in a state's capacity to prevent and prepare for climate change and identify vulnerable communities within the state. The development of a state-wide strategic plan forces various government agencies to collaborate and break out of silos, which is essential in order to mount an effective response to climate change.

Seventeen states and D.C. have failed to publish a strategic climate change action plan, while 28 states have published state climate change plans that fail to consider the essential role their public health department plays. A review by TFAH of state climate change plans published online found only five states included a detailed vision of the role public health would play in preventing and preparing for climate change.

In 2009, CDC announced it would strengthen climate change capacity at state and local health departments through competitive grant awards. These pilot grants are being distributed through ASTHO and NACCHO. Five states will receive between \$75,000 and \$90,000 each, and six local jurisdictions will receive \$50,000 each to conduct needs assessments and develop strategic plans to address weaknesses and bolster climate change capacity.

The five states that received grants from ASTHO are California, Florida, Michigan, Minnesota, and New Hampshire. The six local jurisdictions that received grants from NACCHO are Austin/Travis County Health Department, TX; Hennepin County Human Services and Public Health Department, MN; Imperial County Public Health Department, CA; Mercer County Health Department, IL; Orange County Health Department, FL; and Thurston County Public Health and Social Services Department, WA.

Indicator 2: State Climate Change Commission with Public Health Participation

FINDING: Twelve states have established a climate change commission or advisory panel that includes a representative from state or local health departments.

12 states have established climate change commissions that includes a representative from a public health department		14 states have established climate change commissions that do NOT include a representative from a public health department		24 states and D.C. have NOT established climate change commissions	
California	Massachusetts	Alaska	Minnesota	Alabama	New Jersey
Connecticut	Nevada	Arizona	Montana	Colorado	New Mexico
Hawaii	New Hampshire	Arkansas	North Carolina	Delaware	New York
Kansas	Oregon	Florida	Utah	D.C.	North Dakota
Maine	South Carolina	Illinois	Vermont	Georgia	Ohio
Maryland	Washington	Iowa	Virginia	Idaho	Oklahoma
		Michigan	Wisconsin	Indiana	Pennsylvania
				Kentucky	Rhode Island
				Louisiana	South Dakota
				Mississippi	Tennessee
				Missouri	Texas
				Nebraska	West Virginia
					Wyoming

Another way states have sought to prepare for climate change is through the creation of climate change commissions or advisory panels that report to the governor or state legislature. Climate change is a cross-cutting issue that requires input from all government agencies, including public health. However, 24 states and D.C. have failed to establish a state-wide com-

mission on climate change, while 14 states have established climate change commissions or advisory panels that do not include a member from the state or local health departments. Only 12 states include a representative from state or local public health departments on their climate change commissions.

METHODOLOGY FOR PLANNING INDICATORS

For indicators 1 and 2, TFAH searched state government websites to determine whether or not a state had developed a comprehensive climate change plan, and whether or not the state had established a climate change commission or advisory panel. State climate change plans were then reviewed to determine whether the plan contained a detailed section on public health's role in preventing and preparing for climate change. Climate change commission membership rosters were searched to determine whether the body included a representative from a state or local public health department.

After compiling the results from this online review, TFAH coordinated with the Association of State and Territorial Health Officials (ASTHO) to confirm the findings with each state health official. ASTHO sent out emails on September 3, 2009 and state health officials were given until September 18, 2009 to confirm or correct the information. The states that did not reply by that date were assumed to be in accordance with the findings.

B. FUNDING INDICATORS

Indicator 3: Environmental Public Health Tracking Program Grant

FINDING: Twenty-two states and New York City receive CDC Environmental Public Health Tracking Program grants (FY09).

22 states and NYC received CDC Environmental Public Health Tracking Program grants in FY 2009		28 states and D.C. did NOT receive CDC Environmental Public Health Tracking Program grants in FY 2009	
California	New Jersey	Alabama	Mississippi
Colorado	New York City	Alaska	Montana
Connecticut	New Mexico	Arizona	Nebraska
Florida	New York	Arkansas	Nevada
Kansas	Oregon	Delaware	North Carolina
Louisiana	Pennsylvania	D.C.	North Dakota
Maine	South Carolina	Georgia	Ohio
Maryland	Utah	Hawaii	Oklahoma
Massachusetts	Vermont	Idaho	Rhode Island
Minnesota	Washington	Illinois	South Dakota
Missouri	Wisconsin	Indiana	Tennessee
New Hampshire		Iowa	Texas
		Kentucky	Virginia
		Michigan	West Virginia
			Wyoming

Source: U.S. Centers for Disease Control and Prevention

Public health agencies should play a leading role in measuring, anticipating, and preventing climate-change related effects on human populations. Monitoring climate-sensitive risk factors and related health outcomes is necessary to begin quantifying and predicting human health impacts and for informing public health actions to protect populations. Timely, high quality data will improve modeling of climate variables over the short-, medium-, and long-term, providing decision makers with evidenced based information for prioritization of efforts to address climate-related impacts on people.

One means for state health departments to enhance their understanding of the human health effects of climate change is CDC's National Environmental Public Health Tracking Network.

In 2002, Congress provided CDC with funding to develop an environmental health tracking program and network that would build our capacity to understand and respond to environmental health issues and explore links between environmental hazards and chronic disease. The Tracking Network is the first national resource providing standardized environmental and public health data in one, searchable database.

Currently, the Tracking Network's data and measures focus on:

- Health data that show the rates of certain non-infectious diseases or conditions like poisoning by carbon monoxide or lead, asthma, cancers, and birth defects;
- Exposure data that tell us about the concentrations of certain chemicals inside people's bodies. For example, childhood blood lead levels will be available on the Network; and
- Hazard data that tell us about contaminants and pollutants that may be found in air and water.

The Tracking Network offers states a unique opportunity to leverage existing public health information technology capabilities and data available through the network to incorporate climate change surveillance.

- The Tracking Network has already built an IT platform for bringing together health and environmental data, for example air, water, asthma and vital statistics;
- Adding new data, tools, and partners specific to climate change will maximize existing resources and prevent duplication of effort;

- Public and secure web interfaces (portals) which already exist could facilitate quicker access to information that can be utilized to drive public health action related to climate change;
- CDC has built a broad coalition of users, data providers, and champions with local, state, federal, and international public health and environmental agencies that can be leveraged to begin development of robust climate change tracking; and
- CDC and its state and local partners have been involved and will continue to work with the Council of State and Territorial Epidemiologists' State Environmental Health Indicators Collaborative to evaluate and pilot test possible climate change indicators.

In FY 2009, only 22 states and New York City received CDC Environmental Public Health Tracking Program grants. Not all states that apply for funds receive them because there are often insufficient funds appropriated to allow all states to receive grants.

CDC must expand the Network's capacity, update research into the system, and evaluate its progress. Plans for the network include monitoring new environmental hazards, more health effects, and additional state participation. To expand the network to all 50 states, at least \$120 million in annual appropriations will be needed. Only with a more robust system active in all 50 states can the Tracking Network effectively help public health officials plan and prepare for climate change.

Indicator 4: Asthma Control Program Grant

FINDING: Thirty-three states and D.C. receive CDC National Asthma Control Program grants (FY09).

33 states and D.C. received CDC funding for state asthma control programs in FY 2009		17 states did NOT receive funding for state asthma control programs in FY 2009	
California	New Hampshire	Alabama	Montana
Colorado	New Jersey	Alaska	Nebraska
Connecticut	New Mexico	Arizona	Nevada
D.C.	New York	Arkansas	North Dakota
Georgia	North Carolina	Delaware	South Carolina
Hawaii	Ohio	Florida	South Dakota
Idaho	Oklahoma	Kansas	Tennessee
Illinois	Oregon	Kentucky	Wyoming
Indiana	Pennsylvania	Louisiana	
Iowa	Rhode Island		
Maine	Texas		
Maryland	Utah		
Massachusetts	Vermont		
Michigan	Virginia		
Minnesota	Washington		
Mississippi	West Virginia		
Missouri	Wisconsin		

Source: U.S. Centers for Disease Control and Prevention

According to the EPA, climate change will affect air quality leading to worsening regional ozone pollution, with associated risks of respiratory infections, aggravation of asthma, and premature death. CDC's National Asthma Control Program grants help state health departments build their asthma programs, bolster surveillance, implement interventions, and foster partnerships.

Before 1998, cities and states did not collect asthma information uniformly. The National Asthma Control Program grants have helped state health departments standardize detailed data collection, which simplifies the comparison of disease rates across jurisdictions.

CDC-funded state asthma control programs now measure adult and child prevalence, indicators of asthma control, hospitalizations, and deaths. Some states also track asthma in the Medicaid population, costs attributable to asthma, or asthma management indicators – like asthma action plans, detailed medication use, school days or workdays missed due to asthma, or emergency department visits.¹³⁵

According to the most recent figures, in FY 2009 only 33 states and D.C. received CDC funding for state asthma control programs. Not all states that apply for funds receive them because there are often insufficient funds appropriated to allow all states to receive grants.

Indicator 5: Arbovirus Vector-Borne Disease Surveillance Funding

FINDING: Alaska is the only state that did not receive CDC-funding in FY 2008 to participate in ArboNET, CDC's internet-based national arboviral surveillance system.

49 states and D.C. received CDC funding to participate in ArboNET, a vector-borne disease surveillance system in FY 2008		1 state did NOT receive CDC funding to participate in ArboNET, a vector-borne disease surveillance system in FY 2008	
Alabama	Montana	Alaska	
Arizona	Nebraska		
Arkansas	Nevada		
California	New Hampshire		
Colorado	New Jersey		
Connecticut	New Mexico		
Delaware	New York		
D.C.	North Carolina		
Florida	North Dakota		
Georgia	Ohio		
Hawaii	Oklahoma		
Idaho	Oregon		
Illinois	Pennsylvania		
Indiana	Rhode Island		
Iowa	South Carolina		
Kansas	South Dakota		
Kentucky	Tennessee		
Louisiana	Texas		
Maine	Utah		
Maryland	Vermont		
Massachusetts	Virginia		
Michigan	Washington		
Minnesota	West Virginia		
Mississippi	Wisconsin		
Missouri	Wyoming		

Source: U.S. Centers for Disease Control and Prevention

According to the EPA, climate change will affect climate-sensitive diseases, including vector-borne diseases such as West Nile virus. Infectious disease surveillance systems, such as ArboNET, provide public health officials and health care providers with information about disease activity in their states. Having effective surveillance systems on the ground is essential as public health officials prepare for an increase in vector-borne diseases as a result of warming temperatures.

In FY 2008 CDC funded all states except Alaska to participate in ArboNET, an internet-based national arboviral surveillance system developed by state health departments and CDC in 2000. Arboviruses are transmitted by insects such as mos-

quitoes and ticks. States voluntarily submit data to ArboNET on West Nile virus, Colorado tick fever, dengue, Japanese encephalitis, yellow fever, and some dozen or so other domestic and imported arboviruses. In addition, states report results from environmental surveillance (e.g., testing mosquitoes, birds, and horses for evidence of arbovirus infection) to the degree it is conducted by local health departments and mosquito control agencies within the state. One of the major strengths of ArboNET is that it collects human, animal, and ecologic data, which provides users with a broad picture of arbovirus transmission activity by region. In addition, because it is internet-based, it offers the potential for real-time reporting.

OTHER VECTOR-BORNE DISEASE SURVEILLANCE SYSTEMS

Reporting of diseases on the nationally notifiable disease list is voluntary; the federal government has no legal mandate for requiring reporting.

Rocky Mountain spotted fever (RMSF) and Ehrlichiosis/Anaplasmosis

Rocky Mountain spotted fever (RMSF) and Ehrlichiosis/Anaplasmosis are nationally notifiable diseases, meaning that all states submit case reports to CDC using standard case definitions, and most or all states have regulations requiring reporting to the state by laboratories and/or physicians. States conduct this surveillance using their own authority and funding.

In FY 2009, CDC funded pilot surveillance efforts through the Emerging Infections Programs (EIP) funding mechanism for RMSF active surveillances. These one-time funds totaled \$60,000, and were awarded to Tennessee, a state that reports one of the highest U.S. incidence rates for RMSF and has a cluster of unusually severe infections with high case fatality.

Malaria

No funding to states for any surveillance activities.

Lyme Disease and Tularemia

Lyme disease and tularemia are both nationally notifiable diseases, meaning that all states submit case reports to CDC using standard case definitions, and most or all states have regulations requiring reporting to the state by laboratories and/or physicians. States conduct this surveillance using their own authority and funding.

In addition, CDC funds 12 States (which historically account for greater than 95 percent of reported Lyme disease cases) to help support surveillance for Lyme disease. These funds total just under \$500,000 and each state receives roughly \$40,000. The states that received CDC funding for Lyme disease surveillance in FY 2009 are: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Wisconsin.



Policy Recommendations

Climate change is expected to affect the health of all Americans; however, as with many public health threats, the most vulnerable members of the U.S. population will be the most affected by the health impacts. In order to mount an effective response, public health officials at the federal, state, and local level need to be involved in climate change policy decisions.

Currently, however, public health officials are not playing a central role in climate change policy and action. At the federal level, public health is not a central consideration of the current research agenda, nor is there substantial funding to help state and local health departments build capacity to prevent and prepare for climate change. At the state level, public health officials often are absent from climate change commissions and have not contributed to state climate change planning. These gaps must be addressed in order for the United States to develop a comprehensive climate change agenda that both seeks to prevent and to prepare for climate change.

To further strengthen public health's role in climate change policy and planning, TFAH recommends action across the following key areas:

- Funding;
- Interagency coordination;
- Transparency and accountability;
- Research;
- Communication and public engagement;
- Surveillance and modeling; and
- Workforce.

Recommendations are grouped by audience and focus on the role for public health in climate change prevention and preparedness, although other sectors – for example transportation, energy, and agriculture – have equally important roles to play, but they are not addressed in this issue brief.

A. FEDERAL GOVERNMENT

The federal government has the unique ability to set priorities and bring together state and local governments, the private sector, and communities to work towards solutions. The federal government has the leadership position to be able to de-

velop and set goals for implementing a comprehensive public health response to climate change, including preparedness for the adverse human health effects associated with global warming.

I. Presidential and White House Leadership

Although there is a growing recognition of the myriad of health effects related to climate change, health agencies too often do not have a seat at the table during policy discussions on climate change. Climate change is a problem that cannot be addressed by government agencies working in silos. Instead, all federal, state, and local agencies should consider the implications of their policies on climate change. At the federal level, the White House can foster interagency coordination.

The White House should ensure that the existing high-level interagency working group considers the impact of all policies and programs on the health implications of climate change.

Currently, the Office of Science and Technology Policy (OSTP) and the Council on Environmen-

tal Quality (CEQ), both located with the White House, are leading the effort to look at climate change preparedness capabilities and responses across all federal departments and agencies. The White House should ensure that this interagency working group assesses the multiple implications of climate change (research, planning, adaptation, and mitigation) on the public's health. Too often these efforts at coordination fail to substantially address the human health effects of climate change. The interagency working group should integrate the expertise from across government agencies into policy and research recommendations. The working group should also provide the necessary leadership to spur additional research, preparedness planning, and mapping at the state and local level.

2. U.S. Congress

The U.S. Congress is responsible for drafting and enacting legislation and distributing federal tax dollars. As such, the Congress has an important role to play in combating climate change.

Preventing climate change and preparing for the health effects of our changing climate require a well-trained public health workforce, a sustained effort at research, and enhanced surveillance and modeling systems. Public health, however, is chronically underfunded in the United States. A 2009 analysis by TFAH found states receive \$17.60 per person on average from CDC to spend on public health, while states spend an average of \$33 per person.¹³⁶ Without adequate funding, state and local health departments are unable to adequately carry out their core functions, and certainly are not in a position to develop new capacities to address climate change.

The U.S. Congress should provide increased funding for climate change activities to state and local health departments.

The U.S. Congress should fund state and local health agencies to conduct needs assessments, including the identification of vulnerable populations, and to draft climate-change specific plans and/or amend existing preparedness plans. Currently, only five states and six local health departments receive any sort of climate change funding from CDC as part of a pilot program initiated in 2009. Comprehensive needs assessment and planning are central to addressing climate change, whether it's related to creating new and specific global warming planning processes at the state and local levels or amending existing preparedness planning documents. Yet, few state and local public health agencies can undertake such planning without additional resources. Congress should direct the U.S. Centers for Disease Control and Prevention (CDC) to develop a grant program to provide state and local health departments with funding to conduct comprehensive needs assessments and strategic planning. Because expertise is lacking in some states and localities to carry out needs assessments and climate change-specific planning, Congress must give CDC sufficient funding to provide technical assistance regarding plan development. The grant guidelines should define core elements of such a plan, as well as core expectations of capacity prior to awarding any funding. Finally, after the initial planning phase, Congress should also make funding available for implementation.

The U.S. Congress should increase funding for research on the health effects of climate change and the translation of said research into practice.

Currently, federal funding directly assessing the health risks of climate change is “inadequate to address the real risks that climate change poses for U.S. populations.”¹³⁷ Given the real risks climate change poses for human health in the United States and beyond, federal agencies including EPA, CDC, NIH/NIEHS, and others need a substantial increase in funding and a mandate to investigate the human health effects of climate change, and develop concrete solutions to some of these problems. Longitudinal surveys, such as the National Children's Survey, that examine the effects of the environment on human health and development also should be funded.

The U.S. Congress should track federal tax dollars spent on climate change.

If the U.S. Congress is going to direct more resources to developing state and local capacity to respond to and prepare for climate change, Congress and the public deserve to know how those federal dollars are being spent. Congress should also provide a clear accounting of the dollars spent on climate change research, particularly, that spent on the human health effects of climate change. Currently, there is no systematic approach in the United States for ensuring state and local health agencies are adequately preventing and preparing for climate change, nor that government funding is being spent on public health programs in the most effective way. Establishing standards and fostering transparency and accountability are essential.

The U.S. Congress should increase funding for integrated biosurveillance systems that link to environmental and ecological surveillance systems.

Our nation's public health surveillance systems need to be modernized and upgraded to meet national standards to ensure interoperability between jurisdictions and rapid information sharing. While in many states, existing surveillance systems need to be improved – regardless of climate change issues – there is a need to systematically link environmental and ecological factors with more traditional disease surveillance. Such linkages can inform planning and responding to events related to climate change. Congress should increase funding to CDC for the design of integrated surveillance systems, including expansion of CDC's National Environmental Public Health Tracking Network.

The U.S. Congress should ensure that health information technology is developed to account for public health surveillance needs, not just clinical care.

The 2009 American Recovery and Reinvestment Act (ARRA) included \$20 billion for health information technology (HIT). Enhancements in HIT, particularly for electronic health records (EHRs), should be made with public health officials' need for near real-time data on disease surveillance factored into their design and implementation. Public health can use data from EHRs to monitor the health of the population and the demand for care, invaluable tools to help detect and mitigate climate change-related health events.

The U.S. Congress should fund the development of enhanced modeling of climate change.

Climate change modeling is one of the tools used to project the health risks of climate change. Currently, however, these modeling tools lack specificity below the regional level (for example, Gulf Coast, Southwest, Northeast, Midwest, Atlantic Coast, Pacific Northwest). Given that climate change implications and responses will occur at the local, and to a lesser degree, state level, developing such a tool is a high priority for state and local public health officials. Congress should fund federal agencies to partner with state and

local governments and/or academic institutions to develop a tool that can map trends at a micro level and then assess those findings. Such a tool is likely to cost between \$1 and \$2 million for the initial development and testing.¹³⁸

The U.S. Congress should enact and fund public health workforce scholarship initiatives to develop the workforce of the future.

Congress should institute a grant and/or loan repayment program for college juniors and seniors and graduate students in their final years of training who commit to entering the state or local public health workforce. Students would have to meet certain academic requirements, such as achieving a B average, to qualify for the program. The current health reform draft legislation up for consideration by the House and Senate includes these provisions.

The growing workforce shortage in public health threatens our country's health. America's response to climate change will be severely limited unless the workforce challenges the public health system currently faces are addressed. In addition, among the current public health workforce, knowledge, capacity, and expertise in climate change are limited.

3. Federal Departments and Agencies

The U.S. Centers for Disease Control and Prevention (CDC) should establish national guidelines and measures for core public health functions related to climate change and require states and localities to report the findings to the public and federal government.

In exchange for federal funding to support climate change planning and response, health departments should demonstrate they have met minimum accountability standards. For example, CDC, in collaboration with the states, should determine what elements make up a successful strategic climate change and health plan and routinely assess those plans. By evaluating state plans, the federal government can both highlight good examples for other states to study, and determine where there are gaps in a state's planning. The guidelines should eventually move beyond process measures to focus on outcome objectives. CDC would compile, analyze, and report on these measures to policymakers and the public on a regular basis.

The U.S. Centers for Disease Control and Prevention and the National Institutes of Health should establish joint centers to study the health effects of climate change at research universities.

As mentioned previously, there is a major knowledge and training deficit within the public health community when it comes to climate change.

CDC and NIH should draw upon expert faculty and researchers and fund joint centers to study the health effects of climate change at universities that are already thinking about these issues. These joint centers would have dedicated funding for faculty members who would teach appropriate classes and conduct research specific to the health implications of climate change. The joint centers should also serve as the host of graduate and doctoral students interested in conducting research on the health implications of climate change. The centers should contribute to the development of indicators to measure progress and accountability among state and local health departments. In addition, the joint centers should also assist with workforce development and capacity building in state and local public health agencies. In order to effectively and efficiently transfer knowledge to the public health workforce on the ground, CDC and NIH need to require that these joint centers are connected with state and local health departments so research is translated into practice.

The U.S. Centers for Disease Control and Prevention should develop a clearinghouse for information regarding the health effects of climate change.

CDC should develop a usable, practical, accessible bibliography or clearinghouse of published stud-

ies, white papers, and grey literature examining the health effects of climate change. This could be done through the climate change centers of excellence with appropriate funding and direction.

The U.S. Global Change Research Program (USGCRP) should elevate the Interagency Working Group on Climate Change and Human Health to a formal working group.

Currently, USGCRP coordinates its research through 10 interagency working groups, but there is no working group dedicated to studying the impact of climate change on human health. Instead, the Human Contributions and Responses working group lists human health as a significant research topic, and an informal Interagency

Working Group on Climate Change and Human Health meets. While USGCRP should continue to lead the federal government's overall climate change research agenda, human health should be given a higher priority by officially recognizing the existing Interagency Working Group on Climate Change and Human Health. This working group draws heavily on subject matter experts from CDC, EPA, NIH/NIEHS, and other federal departments and agencies and works to translate research into practice. Too often, evidence-based research fails to make the connection with public health officials working on the ground. We need more practice-based evidence to further climate change policy and planning.

B. STATE AND LOCAL HEALTH DEPARTMENTS

State and local health departments are on the frontlines everyday working with communities and individuals to prevent disease and illness from happening in the first place. When a public health emergency strikes – whether it is a natural disaster or an infectious disease outbreak – health departments are there to help communities and individuals prepare for, respond to, and recover from the adverse events.

Climate change is no different. Public health workers can be instrumental in spreading the word on the threat climate change poses to human health and what can be done to prevent further global warming. At the same time, public health departments are preparing for the expected increase in adverse effects associated with climate change, including extreme heat events, more frequent infectious disease outbreaks, and worsening air quality.

State and local health departments should conduct climate change needs assessments.

State and local health departments should conduct comprehensive needs assessments so they are better positioned to develop successful interventions. These needs assessments should examine staff readiness, include an examination of what additional capacities are needed, and identify vulnerable populations and communities.

State and local health departments should develop strategic climate change plans.

After carrying out a needs assessment, the next step is the development of a strategic climate change plan. This plan must address bolstering the core public health capabilities needed to

prepare for and respond to climate change related health threats, including: surveillance; communication; workforce; core emergency response and long-range capabilities; and research and accountability. State and local public health officials should engage all stakeholders in the development of the strategic plan, including government agencies and non-governmental organizations, such as faith- and community-based organizations. The strategic plan should lay out goals and objectives for how best to protect the health of communities. This should include finding ways to limit climate change in communities, such as by addressing issues of the built environment and pollution, as well as planning for the changing capabilities that will be needed to respond to a potential rise in health problems related to extreme weather events and infectious diseases.

State and local health departments should develop public education campaigns regarding climate change and health.

State and local health departments, with technical assistance from CDC, should develop messages to communicate the risks posed by climate change, particularly as they pertain to human health. The messages need to motivate Americans to engage in climate change policy debates and decision making and to take action at home, ranging from stewardship of the environment to dietary and transportation choices and energy use. These messages should not be fear-based, but rather offer citizens concrete actions they can take to improve their health and the health of the planet.

Communication campaigns must effectively target at-risk populations and vulnerable communities, including children.

State and local health departments, with technical assistance from CDC, should design communication campaigns that use respected, trusted, and culturally competent messengers. Current research and best-practices regarding climate change communication strategies for at-risk populations and vulnerable communities should direct the creation and dissemination of these messages.

Communication and engagement strategies should be developed for children and their caregivers. In particular, child advocates, such as teachers and pediatricians, should be consulted as plans are made. Children are also unique in that messages on climate change they learn in school are often brought back to their homes, whether those messages concern: 1) knowledge, for example on the health effects of climate change; 2) actions, such as turning off lights and reducing energy consumption; or 3) behaviors, for instance actively commuting to school and work to reduce greenhouse gas emissions.

State and local health departments must engage communities in climate change planning and preparedness.

Too often climate change policy decisions are made without the input of key stakeholders, such as community- and faith-based organizations, schools and universities, and professional societies, including health care workers. Planners must proactively approach these diverse groups and bring them to the table.

State and local public health departments need to develop the knowledge base about climate change among their workforce.

In order to enhance knowledge about climate change among state and local public health workers, agencies should cross-train their workforce. Epidemiologists, who specialize in infectious disease surveillance, can be trained to research heat-related morbidity and mortality. Emergency preparedness planners, who specialize in pandemic and all-hazards preparedness, can be educated about the increased risk of extreme weather events as a result of climate change. In addition to cross-training, health agencies should emphasize best practices and education.





The Influence of Climate Change on Health and the Role for Public Health

Weather Event	Health Effects	Populations Most Affected	Public Health Response
Heat waves	<ul style="list-style-type: none"> ■ Death ■ Heat-related illnesses such as heat stroke, heat exhaustion, and kidney stones 	<ul style="list-style-type: none"> ■ The elderly ■ Diabetics ■ Poor, urban residents ■ People with respiratory disease ■ Athletes 	<ul style="list-style-type: none"> ■ Develop scientific and technical guidance and decisions support tools for development of early warning systems and heat response plans, including appropriate individual behavior. ■ Implement early warning systems and heat response plans. ■ Conduct tests of early warning systems and heat response plans before events. ■ Conduct education and outreach on emergency preparedness for extreme heat events. ■ Ensure that extreme heat preparedness plans include medical services. ■ Improve surveillance programs to collect, analyze, and disseminate data on the health consequences of extreme heat. ■ Monitor and evaluate the effectiveness of systems. ■ Communicate that extreme heat waves are dangerous and conditions can be life-threatening. ■ Inform public of anticipated extreme heat event (EHE) conditions. ■ Assess locations with vulnerable populations such as nursing homes and public housing. ■ Staff additional emergency medical personnel to address the anticipated increase in demand. ■ Shift/expand homeless intervention services to cover daytime hours. ■ Open cooling centers to offer relief for people without air conditioning and urge the public to use them. ■ Provide access to additional sources of information: Toll-free numbers and web sites; Telephone hotlines; and Broadcast and print media.
Poor air quality	<ul style="list-style-type: none"> ■ Increased asthma¹³⁹ ■ Increased chronic obstructive pulmonary disease (COPD) and other respiratory diseases^{140,141} 	<ul style="list-style-type: none"> ■ Children ■ Outdoor workers ■ Athletes ■ The elderly ■ People with respiratory disease ■ The poor 	<ul style="list-style-type: none"> ■ Develop and enforce regulations of air pollutants. ■ Develop decision support tools for air quality early warning systems. ■ Conduct education and outreach on the risks of exposure to air pollutants. ■ Conduct research on treatment options.

Extreme Weather Event	Health Effects	Populations Most Affected	Public Health Response
Hurricanes	<ul style="list-style-type: none"> ■ Death from drowning ■ Injuries ■ Mental health impacts such as depression and post-traumatic stress disorder ■ Increased carbon monoxide poisoning ■ Increased gastrointestinal illness 	<ul style="list-style-type: none"> ■ Coastal residents ■ The poor ■ The elderly ■ Children 	<ul style="list-style-type: none"> ■ Develop scientific and technical guidance and decisions support tools for development of early warning systems and emergency response plans, including appropriate individual behavior. ■ Implement early warning systems and emergency response plans. ■ Conduct tests of early warning systems and response plans before events. ■ Conduct education and outreach on emergency preparedness. ■ Ensure that emergency preparedness plans include medical services. ■ Improve programs to monitor the air, water, and soil for hazardous exposures. ■ Improve surveillance programs to collect, analyze, and disseminate data on the health consequences of flooding and heavy rain. ■ Monitor and evaluate the effectiveness of systems.
Floods	<ul style="list-style-type: none"> ■ Death from drowning ■ Injuries ■ Increased water-borne diseases from pathogens and water contamination from sewage overflows ■ Increased food-borne disease¹⁴² 	<ul style="list-style-type: none"> ■ Residents in low-lying areas ■ The elderly ■ Children ■ The poor 	<ul style="list-style-type: none"> ■ Develop scientific and technical guidance and decisions support tools for development of early warning systems and emergency response plans, including appropriate individual behavior. ■ Implement early warning systems and emergency response plans. ■ Conduct tests of early warning systems and response plans before events. ■ Conduct education and outreach on emergency preparedness. ■ Ensure that emergency preparedness plans include medical services. ■ Improve programs to monitor the air, water, and soil for hazardous exposures. ■ Improve surveillance programs to collect, analyze, and disseminate data on the health consequences of flooding and heavy rain. ■ Monitor and evaluate the effectiveness of systems.
Wildfires	<ul style="list-style-type: none"> ■ Death from burns and smoke inhalation ■ Injuries ■ Eye and respiratory illness due to fire-related air pollution 	<ul style="list-style-type: none"> ■ Residents in the Southwestern U.S. ■ People with respiratory disease 	<ul style="list-style-type: none"> ■ Develop scientific and technical guidance and decisions support tools for development of early warning systems and wildfire response plans, including appropriate individual behavior. ■ Implement early warning systems and wildfire response plans. ■ Conduct tests of early warning systems and wildfire response plans before events. ■ Conduct education and outreach on wildfire preparedness. ■ Ensure that wildfire preparedness plans include medical services. ■ Improve programs to monitor the air, water, and soil for hazardous exposures. ■ Improve surveillance programs to collect, analyze, and disseminate data on the health consequences of wildfires, including air pollution. ■ Monitor and evaluate the effectiveness of systems.

Extreme Weather Event	Health Effects	Populations Most Affected	Public Health Response
Droughts	<ul style="list-style-type: none"> ■ Disruption in food supply ■ Water shortages ■ Food- and water-borne disease ■ Vector-borne disease ■ Malnutrition¹⁴³ 	<ul style="list-style-type: none"> ■ The poor ■ The elderly ■ Children 	<ul style="list-style-type: none"> ■ Develop scientific and technical guidance and decisions support tools for development of early warning systems and drought response plans, including appropriate individual behavior. ■ Implement early warning systems and drought response plans. ■ Conduct tests of early warning systems and drought response plans before events. ■ Conduct education and outreach on drought preparedness. ■ Improve programs to monitor the water for hazardous exposures. ■ Improve surveillance programs to collect, analyze, and disseminate data on the health consequences of droughts, including malnutrition and infectious diseases. ■ Monitor and evaluate the effectiveness of systems. ■ Improve surveillance and control programs for the detection of disease outbreaks. ■ Develop methods to ensure watershed protection and safe water and food handling. ■ Sponsor research and development on rapid diagnostic tools for food- and water-borne pathogens. ■ Sponsor research on treatment options. ■ Develop and disseminate information on signs and symptoms of disease to guide individuals on when to seek treatment.
Increased average temperature	<ul style="list-style-type: none"> ■ Increased food-borne disease, such as Salmonella poisoning ■ Increased vector-borne disease such as West Nile virus, equine encephalitis, Lyme disease, Rocky Mountain spotted fever, and hantavirus 	<ul style="list-style-type: none"> ■ Children ■ Outdoor workers and others engaging in outdoor recreation 	<ul style="list-style-type: none"> ■ Improve surveillance and control programs for early detection of disease outbreaks. ■ Sponsor research and development on rapid diagnostic tools for food- and water-borne pathogens. ■ Sponsor research and development on treatment options. ■ Develop and disseminate information on signs and symptoms of disease to guide individuals on when to seek treatment. ■ Provide scientific and technical guidance and decision support tools for development of early warning systems. ■ Conduct effective vector (and pathogen) surveillance and control programs (including consideration of land use policies that affect vector distribution and habitats.) ■ Develop early warning systems for disease outbreaks, such as West Nile Virus. ■ Develop and disseminate information on appropriate individual behavior to avoid exposure to vectors. ■ Conduct research on vaccines and other preventive measures. ■ Conduct research and development on rapid diagnostic tools. ■ Provide vaccinations to those likely to be exposed. ■ Conduct research on treatment options. ■ Develop and disseminate information on signs and symptoms of disease to guide individuals on when to seek treatment.

Extreme Weather Event	Health Effects	Populations Most Affected	Public Health Response
Increased temperature and rising carbon dioxide levels	<ul style="list-style-type: none"> ■ Increased allergies caused by pollen ■ Increased cases of rashes and allergic reactions from exposure to toxic plants such as poison ivy, stinging nettle, and other weeds 	<ul style="list-style-type: none"> ■ People with respiratory disease ■ Children ■ Outdoor workers and others engaging in outdoor recreation 	<ul style="list-style-type: none"> ■ Improve surveillance and control programs for early detection of disease outbreaks, such as asthma. ■ Sponsor research and development on treatment options for respiratory disease. ■ Develop and disseminate information on signs and symptoms of respiratory disease to guide individuals on when to seek treatment. ■ Provide scientific and technical guidance and decision support tools for development of early warning systems. ■ Conduct research and development on rapid diagnostic tools. ■ Conduct research on treatment options. ■ Develop and disseminate information on signs and symptoms of disease to guide individuals on when to seek treatment.

Source: The information presented in Appendix A -- except where noted -- is adapted from three primary sources. The information listed under "Health Effects" is from Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009, p. 89-98. The information listed under "Populations Most Affected" is from Frumkin, H., J. Hess, G. Luber, J. Malilay, and M. McGeehin. "Climate Change: The Public Health Response." *American Journal of Public Health* 98, no. 3 (2008): 435-45. Finally, the information listed under "Public Health Response" is from Ebi, K.L., J. Balbus, P.L. Kinney, et al. "Chapter 2: Effects of Global Change on Human Health" in *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. Washington, D.C.: U.S. CCSP Synthesis and Assessment Product 4.6, September 2008, p. 69-71.



References

- 1 U.S. Environmental Protection Agency. 2009. "Summary of the Science Supporting EPA's Finding that Greenhouse Gases Threaten Public Health and Welfare." Fact Sheet, April 17, 2009. <http://epa.gov/climatechange/endangerment/downloads/ScienceFactSheet.pdf> (accessed April 17, 2009).
- 2 Confalonieri, U., B. Menne, R. Akhtar, et al. "Human Health." Chapter 8 in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 391-431. Cambridge, UK: Cambridge University Press, 2007, p. 413.
- 3 Ibid.
- 4 Ibid.
- 5 Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson. 2008. Effects of global change on human health. In: *Synthesis and Assessment Product 4.6. Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. Ed. J.L. Gamble. Washington, D.C.: U.S. Environmental Protection Agency, 2-1 to 2-78.
- 6 Costello, A., M. Abbas, A. Allen, et al. "Managing the Health Effects of Climate Change." *The Lancet* 373, no. 9676 (2009): 1693-1733.
- 7 Maibach, E.W., A. Chadwick, D. McBride, et al. "Climate Change and Local Public Health in the United States: Preparedness, Programs and Perceptions of Local Public Health Department Directors." *PLoS ONE* 3, no. 7 (2008): e2838.
- 8 U.S. Environmental Protection Agency. 2009. "Summary of the Science Supporting EPA's Finding that Greenhouse Gases Threaten Public Health and Welfare." Fact Sheet, April 17, 2009. <http://epa.gov/climatechange/endangerment/downloads/ScienceFactSheet.pdf> (accessed April 17, 2009).
- 9 U.S. Environmental Protection Agency. *Excessive Heat Event Guidebook*. Washington, D.C.: EPA, 2008, p. 12. http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf (accessed August 13, 2009).
- 10 Ibid.
- 11 Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009.
- 12 Intergovernmental Panel on Climate Change. *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Eds: Pachauri, R.K and Reisinger, A. Geneva, Switzerland IPCC, 2007, p. 30. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf (accessed July 8, 2009).
- 13 Ibid.
- 14 Broder, J.M. "E.P.A. Clears Way for Greenhouse Gas Rules." *The New York Times*, April 17, 2009.
- 15 Keim, M.E. "Building Human Resilience: The Role of Public Health Preparedness and Response As an Adaptation to Climate Change." *American Journal of Preventive Medicine* 35, no. 5 (2008): 508-516.
- 16 Balbus, J., K. Ebi, L. Finzer, et al. *Are We Ready? Preparing for the Public Health Challenges of Climate Change*. Washington, D.C.: Environmental Defense Fund, 2008.
- 17 Association of State and Territorial Health Officials. *Climate Change: A Serious Threat to Public Health. Key Findings from ASTHO's 2009 Climate Change Needs Assessment*. Arlington, VA: ASTHO, 2009.
- 18 US CCSP January 2009 publication citing Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich, and A. Woodward, 2007: *Human health*. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, UK, and New York, pp. 391-431.
- 19 Bell ML, Goldberg R, Hogrefe C, Kinney PL, Knowlton K, Lynn B, Rosenthal J, Rosenzweig C, Patz J. "Climate Change, Ambient Ozone, and Health in 50 US Cities." *Climate Change*, 2007.
- 20 US CCSP January 2009 publication citing Shindell, D.T., H. Levy II, A. Gilliland, M.D. Schwarzkopf, and L.W. Horowitz, 2008: Climate change from short-lived emissions due to human activities. In: *Climate Projections Based on Emissions Scenarios for Long-Lived and Short-Lived Radiatively Active Gases and Aerosols*. [Levy II, H., D.T. Shindell, A. Gilliland, M.D. Schwarzkopf, and L.W. Horowitz, (eds.)]. Synthesis and Assessment Product 3.2. U.S. Climate Change Science Program, Washington, DC, pp. 27-60.
- 21 US CCSP January 2009 publication citing Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson, 2008: Effects of global change on human health. In: *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems* [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, and T.J. Wilbanks (authors)]. Synthesis and Assessment Product 4.6. U.S. Environmental Protection Agency, Washington, DC, pp. 2-1 to 2-78.
- 22 Keim, Mark E. "Building Human Resistance The Role of Public Health Preparedness and Response As an Adaptation to Climate Change" *American Journal of Preventive Medicine* 2008; 35 (5) citing Center for Research on the Epidemiology of Disasters (CRED). EM-DAT: The International Disaster Database. Ecole se Sante Publique, University Catholique de Louvain. Brussels Belgium, 2005.

- 23 Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009, p. 107-152.
- 24 Confalonieri, U., B. Menne, R. Akhtar, et al. "Human Health." Chapter 8 in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson. Cambridge, UK: Cambridge University Press, 2007, p. 412-13.
- 25 Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009.
- 26 Confalonieri, U., B. Menne, R. Akhtar, et al. "Human Health." Chapter 8 in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 391-431. Cambridge, UK: Cambridge University Press, 2007, p. 413.
- 27 Lane, N. *Considering Sea Level Rise*. Houston, TX: James Baker III Institute for Public Policy, Rice University, April 2008. http://www.rice.edu/energy/publications/FAQs/WWT_scalelevelrise_040208.pdf (accessed June 24, 2009).
- 28 Confalonieri, U., B. Menne, R. Akhtar, et al. "Human Health." Chapter 8 in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 391-431. Cambridge, UK: Cambridge University Press, 2007, p. 414.
- 29 Ibid.
- 30 Ibid.
- 31 Associated Press. "After Red River Flood Battle, Recovery Debate Begins in Midwest." April 2, 2009. <http://www.foxnews.com/story/0,2933,512238,00.html> (accessed May 15, 2009).
- 32 CNN.com. "California Firefighters Making a Dent as Weather Improves." May 9, 2009. <http://www.cnn.com/2009/US/weather/05/09/california.wildfires/index.html> (accessed May 15, 2009).
- 33 Grad, S. and J.R. Chong. "Huge Santa Barbara County Wildfire Caused by Marijuana Farm; Suspects as Large in Forest." *Los Angeles Times*, August 16, 2009. <http://latimesblogs.latimes.com/lanow/2009/08/huge-santa-barbara-wildfire-caused-by-marijuana-farm-suspects-at-large-in-forest.html> (accessed August 21, 2009).
- 34 Confalonieri, U., B. Menne, R. Akhtar, et al. 2007. Human health. In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 391-431. Cambridge: Cambridge University Press.
- 35 Keim, M.E. "Building Human Resilience: The Role of Public Health Preparedness and Response As an Adaptation to Climate Change." *American Journal of Preventive Medicine* 35, no. 5 (2008): 508-516.
- 36 Ebi, Kristie L and Jan C. Semenza "Community-Based Adaptation to the Health Impacts of Climate Change" *American Journal of Preventive Medicine* 2008: 35(5), p. 501.
- 37 Balbus, J., K. Ebi, L. Finzer, et al. *Are We Ready? Preparing for the Public Health Challenges of Climate Change*. Washington, D.C.: National Association of County and City Health Officials, Environmental Defense Fund, and George Mason University, 2008.
- 38 Association of State and Territorial Health Officials. *Climate Change: A Serious Threat to Public Health. Key Findings from ASTHO's 2009 Climate Change Needs Assessment*. Arlington, VA: ASTHO, 2009.
- 39 Ibid.
- 40 Balbus, J., K. Ebi, L. Finzer, et al. *Are We Ready? Preparing for the Public Health Challenges of Climate Change*. Washington, D.C.: National Association of County and City Health Officials, Environmental Defense Fund, and George Mason University, 2008.
- 41 Ibid.
- 42 Campbell-Lendrum, D. "Climate Change, Infectious Disease, and International Public Health Policy." Paper presented at the Institute of Medicine's Forum on Microbial Threats Public Workshop Global Climate Change and Extreme Weather Events: Understanding the Contributions to Infectious Disease Emergence, December 4-5, 2007. Washington, D.C.: National Academy Press, 2008. <http://www.nap.edu/catalog/12435.html> (accessed April 14, 2009).
- 43 Patz, Jonathan A., Diarmid Campbell-Lendrum, Tracey Holloway, and Jonathan A. Foley "Impact of Regional Climate Change on Human Health" *Nature* 428:17, November 2005.
- 44 Balbus, J., K. Ebi, L. Finzer, et al. *Are We Ready? Preparing for the Public Health Challenges of Climate Change*. Washington, D.C.: National Association of County and City Health Officials, Environmental Defense Fund, and George Mason University, 2008.
- 45 Association of State and Territorial Health Officials. *Climate Change: A Serious Threat to Public Health. Key Findings from ASTHO's 2009 Climate Change Needs Assessment*. Arlington, VA: ASTHO, 2009.
- 46 Confalonieri, U., B. Menne, R. Akhtar, et al. 2007. Human health. In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 391-431. Cambridge: Cambridge University Press.
- 47 Frumkin, H., J. Hess, G. Luber, J. Malilay, and M. McGeehin. "Climate Change: The Public Health Response." *American Journal of Public Health* 98, no. 3 (2008): 435-45.

- 48 Younger, Margalit et al. "The Built Environment, Climate Change, and Health: Opportunities for Co-Benefits." *American Journal of Preventive Medicine* 2008; 35 (5).
- 49 Bloomberg, Michael R. and Rohit T. Aggarwala, "Think Locally, Act Globally How Curbing Global Warming Emissions Can Improve Local Public Health." *American Journal of Preventive Medicine* 2008; 35 (5).
- 50 Epstein, P.R. "Climate Change and Human Health." *New England Journal of Medicine* 353, no. 14 (2005): 1433-1436.
- 51 Campbell-Lendrum, D. "Climate Change, Infectious Disease, and International Public Health Policy." Paper presented at the Institute of Medicine's Forum on Microbial Threats Public Workshop Global Climate Change and Extreme Weather Events: Understanding the Contributions to Infectious Disease Emergence, December 4-5, 2007. Washington, D.C.: National Academy Press, 2008. <http://www.nap.edu/catalog/12435.html> (accessed April 14, 2009).
- 52 Balbus, J., K. Ebi, L. Finzer, et al. *Are We Ready? Preparing for the Public Health Challenges of Climate Change*. Washington, D.C.: National Association of County and City Health Officials, Environmental Defense Fund, and George Mason University, 2008.
- 53 Keim, M.E. "Building Human Resilience: The Role of Public Health Preparedness and Response As an Adaptation to Climate Change." *American Journal of Preventive Medicine* 35, no. 5 (2008): 508-516.
- 54 Association of the Schools of Public Health. "Confronting the Public Health Workforce Crisis: ASPH Statement on the Public Health Workforce." Association of Schools of Public Health, 2008. <http://www.asph.org/document.cfm?page=1038> (accessed October 1, 2008).
- 55 Association of State and Territorial Health Officers. *2007 State Public Health Workforce Survey Results*. Arlington, VA: Association of State and Territorial Health Officers, 2007. <http://www.astho.org/pubs/WorkforceReport.pdf> (accessed October 1, 2007).
- 56 Leep, C.J. *2005 National Profile of Local Departments*, Washington, DC: National Association of City and County Health Officials, 2005. http://www.naccho.org/topics/infrastructure/profile/upload/NACCHO_report_final_000.pdf (accessed October 1, 2008).
- 57 Association of State and Territorial Health Officers. *2007 State Public Health Workforce Survey Results*. Arlington, VA: Association of State and Territorial Health Officers, 2007. <http://www.astho.org/pubs/WorkforceReport.pdf> (accessed October 1, 2007).
- 58 U.S. Centers for Disease Control and Prevention. *Public Health Infrastructure: A Status Report*. Atlanta: U.S. Centers for Disease Control and Prevention, March 2001. <http://www.uic.edu/sph/prepare/courses/ph410/resources/phinfrastructure.pdf> (accessed June 30, 2008).
- 59 Lav, I.J., and E. McNichol. "State Budget Troubles Worsen." Center on Budget and Policy Priorities. <http://www.cbpp.org/cms/?fa=view&id=711> (accessed July 13, 2009).
- 60 National Association of County and City Health Officials. *NACCHO Survey of Local Health Departments' Budget Cuts and Workforce Reductions*. Washington, D.C.: NACCHO, 2009. http://www.naccho.org/advocacy/upload/report_lhdbudgets.pdf (accessed July 13, 2009).
- 61 Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009, p. 107-52.
- 62 Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson. "Effects of Global Change on Human Health" Chapter in *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. Eds. Gamble, J.L., K.L. Ebi, F.G. Sussman, and T.J. Wilbanks. Synthesis and Assessment Product 4.6. Washington, D.C.: U.S. Environmental Protection Agency, 2008: pp. 39-87.
- 63 Bernard, S.M. and M.A. McGeehin. "Municipal Heat Wave Response Plans." *American Journal of Public Health* 94, no. 9 (2004): 1520-22.
- 64 Kirshen, P., C. Watson, E. Douglas, A. Gontz, J. Lee, and Y. Tian. "Coast Flooding in the Northeastern United States Due to Climate Change." *Mitigation and Adaptation Strategies for Global Change* 13, no. 5-6 (2008): 437-451.
- 65 Field, C.B., L.D. Mortsch, M. Brklacich, et al. "North America" Chapter in: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. New York, NY: Cambridge University Press, 2007, p.617-652.
- 66 Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009, p. 94.
- 67 Ibid.
- 68 Hayhoe, K., K. Cherkauer, N. Schlegal, J. VanDorn, S. Vavrus, and D. Wuebbles. "Regional Climate Change Projections for Chicago and the Great Lakes." *Journal of Great Lakes Research*. In press, 2009.
- 69 Kling, G.W., K. Hayhoe, L.B. Johnson, et al. *Confronting Climate Change in the Great Lakes Region: Impacts on Our Communities and Ecosystems*. Washington, D.C.: Union of Concerned Scientists and Ecological Society of America, 2003, p. 92. <http://www.ucsusa.org/greatlakes/> (accessed July 8, 2009).
- 70 Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009, p. 120.
- 71 Ibid.
- 72 Ibid.
- 73 Fried, J.S., J.K. Gilles, W.J. Riley, et al. "Predicting the Effect of Climate Change on Wildfire Behavior and Initial Attack Success." *Climatic Change* 87, Supplemental 1 (2008): S251-64.

- 74 Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. *Global Climate Change Impacts in the United States*. New York, NY: Cambridge University Press, 2009, p. 136.
- 75 Ibid.
- 76 Ibid.
- 77 Balbus, John. Memorandum to U.S. Climate Change Science Program on Strengthening Public Health Research and Science-based Practice with the U.S. Climate Change Science Program, January 2009.
- 78 Ebi, Kristie L., John Balbus, Patrick L. Kinney, Erin Lipp, David Mills, Marie S. O'Neill, and Mark L. Wilson, "U.S. Funding is Insufficient to Address the Human health Impacts of and Public Health Responses to Climate Variability and Change." Pre-publication draft for *Environmental Health Perspectives*
- 79 Gamble, J.L., K.L. Ebi, F.G. Sussman, T.J. Wilbanks, C. Reid, J.V. Thomas, and C.P. Weaver. "Common Themes and Research Recommendations." Chapter 5 in: *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems. A Report by the U.S. Climate Change Science Program and The Subcommittee On Global Change Research*. [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, T.J. Wilbanks, (Authors)]. Washington, D.C.: U.S. Environmental Protection Agency, 2008, p. 174–175.
- 80 Ebi, Kristie L., John Balbus, Patrick L. Kinney, Erin Lipp, David Mills, Marie S. O'Neill, and Mark L. Wilson, "U.S. Funding is Insufficient to Address the Human health Impacts of and Public Health Responses to Climate Variability and Change." Pre-publication draft for *Environmental Health Perspectives*
- 81 English, P.B., A.H. Sinclair, Z. Ross, et al. "Environmental Health Indicators of Climate Change for the United States: Findings from the State Environmental Health Indicator Collaborative." *Environmental Health Perspectives* (E-pub ahead of print): May 18, 2009. <http://www.ehponline.org/docs/2009/0900708/abstract.html> (accessed June 4, 2009).
- 82 U.S. Global Change Research Program. "Program Structure." <http://www.globalchange.gov/about/program-structure> (accessed June 25, 2009).
- 83 U.S. Global Change Research Program. Revised Research Plan for the U.S. Climate Change Science Program. Washington, D.C.: Climate Change Science Program and the Subcommittee on Global Change Research, 2008. <http://www.climatechange.gov/Library/stratplan2008/CCSP-RRP-FINAL.pdf> (accessed June 25, 2009).
- 84 U.S. Environmental Protection Agency, Global Change Research Program. "Program Overview." http://cfpub.epa.gov/gcrp/about_ov.cfm (accessed June 25, 2009).
- 85 Private communication from EPA, Conference Call on June 10, 2009.
- 86 U.S. Environmental Protection Agency, National Center for Environmental Research. "Research Project Search." http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/searchControlled.main (accessed June 25, 2009).
- 87 U.S. Environmental Protection Agency. *Excessive Heat Events Guidebook*. Washington, D.C.: EPA, 2006. http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf (accessed July 10, 2009).
- 88 National Institute of Environmental Health Sciences. *Framing the NIEHS Agenda on Climate Change: Meeting Report, April 16, 2008*. Washington, D.C.: NIEHS, 2008. <http://www.niehs.nih.gov/about/od/associate/docs/framingreport.pdf> (accessed June 25, 2009).
- 89 National Institute of Environmental Health Sciences. "Climate Change & Energy Project." <http://www.niehs.nih.gov/about/od/programs/climatechange/index.cfm> (accessed June 25, 2009).
- 90 Ebi, K.L., J. Balbus, P.L. Kinney, et al. "U.S. Funding is Insufficient to Address the Human Health Impacts of and Public Health Responses to Climate Variability and Change." *Environmental Health Perspectives* 117, no. 6 (June 2009): 857-62. <http://www.ehponline.org/members/2009/0800088/0800088.pdf> (accessed June 29, 2009).
- 91 In a private communication with TFAH NIEHS staff estimated that \$10 million is spent annually on research focused specifically and exclusively on the human health effects of climate change.
- 92 National Institutes of Health, Fogarty International Center. "NIH Challenge Grants in Health and Science Research American Recovery and Reinvestment Act of 2009 Fogarty International Center Activities." <http://www.fic.nih.gov/recovery/index.htm> (accessed August 20, 2009).
- 93 Private communication with Dr. Joshua Rosenthal, Division of International Training and Research, Fogarty International Center, National Institutes of Health, August 21, 2009.
- 94 Private communication from ASTHO and NACCHO.
- 95 Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson. 2008. Effects of global change on human health. In: *Synthesis and Assessment Product 4.6. Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. Ed. J.L. Gamble. Washington, D.C.: U.S. Environmental Protection Agency, 2-1 to 2-78.
- 96 IPCC. 2007. Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 7-22. Cambridge: Cambridge University Press.
- 97 Ibid.
- 98 Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson. 2008. Effects of global change on human health. In: *Synthesis and Assessment Product 4.6. Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. Ed. J.L. Gamble. Washington, D.C.: U.S. Environmental Protection Agency, 2-1 to 2-78.

- 99 Confalonieri, U., B. Menne, R. Akhtar, et al. 2007. Human health. In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 391-431. Cambridge: Cambridge University Press.
- 100 Joint Center for Political and Economic Studies. "Leaders Kick-Off Commission to Engage African Americans on Climate Change." News Release, July 29, 2008. <http://www.jointcenter.org/climate/pdf/Climate-PR%20072908.pdf> (accessed August 14, 2009).
- 101 Ibid.
- 102 Morello-Frosch, R., M. Pastor, J. Sadd, and S.B. Shonkoff. *The Climate Gap: Inequalities in How Climate Change Hurts Americans and How to Close the Gap*. Los Angeles, CA: University of Southern California, 2009. http://college.usc.edu/geography/ESPE/documents/The_Climate_Gap_Full_Report_FINAL.pdf (accessed June 30, 2009).
- 103 Whitman S., Good G., Donoghue E., Benbow N., Shou W., and S. Mou. "Mortality in Chicago Attributed to the July 1995 Heat Wave". *Am J Public Health* 1997;87:1515-1518.
- 104 An Interview with Eric Klinenberg author of *Heat Wave: A Social Autopsy of Disaster in Chicago*. <http://www.press.uchicago.edu/Misc/Chicago/443213in.html> (accessed July 10, 2009).
- 105 Ibid.
- 106 Ibid.
- 107 Center's for Disease Control and Prevention. "Heat-Related Mortality – Chicago, July 1995". *MMWR Weekly* August 11, 1995, 44(31):577-579.
- 108 Whitman S., Good G., Donoghue E., Benbow N., Shou W., and S. Mou. "Mortality in Chicago Attributed to the July 1995 Heat Wave". *Am J Public Health* 1997;87:1515-1518.
- 109 Semenza J., Rubin C., Falter K., Selanikio J., Flanders D., Howe H., and J. Wilhelm. "Heat-Related Deaths During the July 1995 Heat Wave in Chicago." *N Engl J Med* 1996;335:84-90.
- 110 Ibid.
- 111 An Interview with Eric Klinenberg author of *Heat Wave: A Social Autopsy of Disaster in Chicago*. <http://www.press.uchicago.edu/Misc/Chicago/443213in.html> (accessed July 10, 2009).
- 112 Voelker, R. "Climate Change Puts Children in Jeopardy." *Journal of the American Medical Association* 301, no. 21 (2009): 2197-99.
- 113 Bunyavanich, S., C.P. Landrigan, A.J. McMichael, and P.R. Epstein. "The Impact of Climate Change on Human Health." *Ambulatory Pediatrics* 3, no. 1 (2003): 44-52.
- 114 Abramson, D., et al. *On the Edge: Children and Families Displaced by Hurricanes Katrina and Rita Face a Looming Medical and Mental Health Crisis*. New York, NY: Columbia University National Center for Disaster Preparedness, April 2006.
- 115 American Academy of Pediatrics, Committee on Environmental Health. "Global Climate Change and Children's Health." *Pediatrics* 120, no. 5 (2007): 1149-52.
- 116 Kliff S, Skipp C. "Overlooked: The Littlest Evacuees." *Newsweek* October 6, 2008.
- 117 Ibid.
- 118 Cicero M., Baum C. "Pediatric Disaster Preparedness: Best Planning for the Worst-Case Scenario". *Pediatric Emergency Care* July 2008;24(7):478-484.
- 119 Confalonieri, U., B. Menne, R. Akhtar, et al. 2007. Human health. In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 391-431. Cambridge: Cambridge University Press.
- 120 Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson. 2008. Effects of global change on human health. In: *Synthesis and Assessment Product 4.6. Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. Ed. J.L. Gamble. Washington, D.C.: U.S. Environmental Protection Agency, 2-1 to 2-78.
- 121 Confalonieri, U., B. Menne, R. Akhtar, et al. 2007. Human health. In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, 391-431. Cambridge: Cambridge University Press.
- 122 Trust for America's Health. *F as in Fat 2009: How Obesity Policies Are Failing in America*. Washington, D.C.: TFAH, 2009.
- 123 U.S. Homeland Security Council. *The Federal Response to Hurricane Katrina: Lessons Learned*. Washington, D.C.: The White House, 2006.
- 124 King R. "Flood-ravaged Hospitals Are Diagnosing Their Needs This Hurricane Season". *New Orleans Times-Picayune*. May 27, 2006.
- 125 Laditka S., Laditka J., Xirasagar S., Cornman C., Davis C., Richter J. "Providing Shelter to Nursing Home Evacuees in Disasters: Lessons From Hurricane Katrina" *Am J Public Health*. 2008;98(7):1288-1293.
- 126 Jones A. "The National Nursing Home Survey: 1999 Summary". National Center for Health Statistics. *Vital Health Stat*. 2002;13(152):1-116.
- 127 Laditka S., Laditka J., Xirasagar S., Cornman C., Davis C., Richter J. "Providing Shelter to Nursing Home Evacuees in Disasters: Lessons From Hurricane Katrina" *Am J Public Health*. 2008;98(7):1288-1293.

- 128 Ebi, K.L., T.J. Teisberg, L.S. Kalkstein, L. Robinson, and R.F. Weiher. "Heat Watch/Warning Systems Save Lives: Estimated Costs and Benefits for Philadelphia 1995-98." *American Meteorological Society* 85, no. 8 (2004):1067-1073.
- 129 Chicago Department of Family and Support Services. "Extreme Weather Notification System." Press Release, May 25, 2004.
- 130 Arizona Department of Health Services. "Protecting Yourself from Arizona's Heat." http://www.azdhs.gov/phs/oeh/protect_from_heat.htm (accessed July 10, 2009).
- 131 Arizona Department of Health Services. *Heat Emergency Response Plan*. Phoenix, AZ: Arizona Department of Health Services, May 2006.
- 132 Rhode Island Public Transit Authority. "Air Quality Alert Days." <http://www.ripta.com/content/259.html> (accessed July 10, 2009).
- 133 Costello, A., M. Abbas, A. Allen, et al. "Managing the Health Effects of Climate Change." *The Lancet* 373, no. 9676 (2009): 1693-1733.
- 134 Schwartz Brian S., Cindy Parker, Thomas Glass, and Howard Hu. "Global Environmental Change: What Can health Care Providers and the Environmental Health Community Do About It Now?" *Environmental Health Perspectives*, December 2006. Vol 114, number 12
- 135 U.S. Centers for Disease Control and Prevention, National Asthma Control Program. *America Breathing Easier*. Atlanta, GA: CDC, 2007, p. 19. http://www.cdc.gov/asthma/pdfs/breathing_easier_brochure.pdf (accessed June 4, 2009).
- 136 Trust for America's Health. *Shortchanging America's Health*. Washington, D.C.: TFAH, 2009.
- 137 Ebi, K.L., J. Balbus, P.L. Kinney, et al. "U.S. Funding is Insufficient to Address the Human Health Impacts of and Public Health Responses to Climate Variability and Change." *Environmental Health Perspectives* 117, no. 6 (June 2009): 857-62. <http://www.ehponline.org/members/2009/0800088/0800088.pdf> (accessed June 29, 2009).
- 138 Ibid.
- 139 US CCSP January 2009 publication citing Con-falonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich, and A. Woodward, 2007: Human health. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, UK, and New York, pp. 391-431.
- 140 Bell ML, Goldberg R, Hogrefe C, Kinney PL, Knowlton K, Lynn B, Rosenthal J, Rosenzweig C, Patz J. "Climate Change, Ambient Ozone, and Health in 50 US Cities." *Climate Change*, 2007.
- 141 US CCSP January 2009 publication citing Shindell, D.T., H. Levy II, A. Gilliland, M.D. Schwarzkopf, and L.W. Horowitz, 2008: Climate change from short-lived emissions due to human activities. In: *Climate Projections Based on Emissions Scenarios for Long-Lived and Short-Lived Radiatively Active Gases and Aerosols*. [Levy II, H., D.T. Shindell, A. Gilliland, M.D. Schwarzkopf, and L.W. Horowitz, (eds.)]. Synthesis and Assessment Product 3.2. U.S. Climate Change Science Program, Washington, DC, pp. 27-60.
- 142 US CCSP January 2009 publication citing Ebi, K.L., J. Balbus, P.L. Kinney, E. Lipp, D. Mills, M.S. O'Neill, and M. Wilson, 2008: Effects of global change on human health. In: *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems* [Gamble, J.L. (ed.), K.L. Ebi, F.G. Sussman, and T.J. Wilbanks (authors)]. Synthesis and Assessment Product 4.6. U.S. Environmental Protection Agency, Washington, DC, pp. 2-1 to 2-78.
- 143 Keim, Mark E. "Building Human Resistance The Role of Public Health Preparedness and Response As an Adaptation to Climate Change" *American Journal of Preventive Medicine* 2008; 35 (5) citing Center for Research on the Epidemiology of Disasters (CRED). EM-DAT: The International Disaster Database. Ecole se Sante Publique, University Catholique de Louvain. Brussels Belgium, 2005.





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