

# CLIMATE & CHANGE:

## Mastering the Public Health Role



A PRACTICAL GUIDEBOOK  
APRIL 2011

**This guidebook is a translation of a six-part webinar series hosted by the American Public Health Association (APHA) and the Centers for Disease Control and Prevention (CDC) and is intended to be a useful tool to help prepare the public health community for the challenges of climate change.**

# CLIMATE CHANGE:

## Mastering the Public Health Role

### A PRACTICAL GUIDEBOOK

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# FOREWORD



**GEORGES C. BENJAMIN**, MD, FACP, FACEP (E)  
Executive Director  
American Public Health Association

**For several years now, those working in public health have been building the case that climate change is a major public health issue. National Public Health Week 2008, themed “Climate Change: Our Health in the Balance,” was the official start to APHA’s work to illuminate the connection between climate change and public health. Working with our diverse partners across the country, APHA is educating national policy-makers and practitioners about the vital role of public health agencies in addressing climate change and in preparing communities for related health impacts. Since then, much has been accomplished, but much remains to be done.**

**At the federal level, the Centers for Disease Control and Prevention (CDC) has been instrumental in the public health response to climate change. CDC published a series of articles on climate change and public health in the November 2008 issue of the American Journal of Preventive Medicine and has established a climate change**



**program to administer grants to help state and local health departments assess and build their capacity to address climate change.**

**Efforts to address climate change received a major boost in 2009 when the U.S. Environmental Protection Agency issued its official Endangerment Finding, which concluded that six key greenhouse gases pose a serious threat to the public health and welfare of current and future generations. The Endangerment Finding also reported that human activity and behavior, such as our dependence on motor vehicles, are the major contributors to climate change. At the global level, the international community has begun serious negotiations to curb the worldwide health and environmental threat as well as to reduce the greenhouse gas emissions that are the main contributors to climate change.**

**Much of the work to combat and prepare for climate change will happen at the community level, and public health workers**

**will be critical partners. State and local health officials should participate in climate planning processes, conduct local needs assessments, monitor and prepare for current and future climate-related health risks and educate the public about health risks associated with climate change. To assist in this work, APHA, with funding from and in collaboration with CDC, hosted a year-long, six-part webinar series titled “Climate Change: Mastering the Public Health Role” in 2009–2010. More than 2,600 public health practitioners from across the country tuned in. APHA and CDC are pleased to present this guidebook as a “translation” of that webinar series.\***

**APHA and CDC will continue to collaborate with our partner organizations to supply additional guidance and information as it develops in the future. This is only the beginning — there is much more work to do. We hope you find this guidebook useful in shaping your public health response to the challenges of climate change.**

\*This guidebook is a translation of each of the webinar presentations. Session presenters and their presentation titles are listed at the start of each webinar translation. Supplemental information is also provided within each chapter to help explain climate change as a public health issue and the role for public health practitioners. APHA staff translated the webinar presentations and are the primary authors of this guidebook.

# INTRODUCTION



**GEORGE LUBER**, PhD  
Associate Director for Global Climate Change  
National Center for Environmental Health at the  
Centers for Disease Control and Prevention

**Mounting evidence shows that the Earth's climate is changing. The United Nations Intergovernmental Panel on Climate Change (IPCC) concludes that "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising of global average sea level." And for the most part, the American public agrees. In a June 2010 U.S. poll,\* 61 percent of respondents reported that they believe that global warming is happening, and a majority reported that they worry about it. However, only a minority of those polled reported that they thought global warming would harm them personally. This highlights one of the principal challenges that the public health community faces: to communicate the health impacts of climate change and enhance public readiness to take actions that limit further warming. This guidebook, and the six-part webinar series it represents, takes a first step toward meeting that challenge by bringing a diverse set of experts together to bridge the gap between climate change science and the public health response. It is our hope that this series will not only inform and educate the**

\*Center for Climate Change Communication, George Mason University.  
Americans' Global Warming Beliefs & Attitudes: June 2010. Available at:  
[http://www.climatechangecommunication.org/images/files/ClimateBeliefsJune2010\(1\).pdf](http://www.climatechangecommunication.org/images/files/ClimateBeliefsJune2010(1).pdf).

public, policy-makers and the public health community, but will also serve to engage, empower and energize a generation to confront this “grand challenge.”


Preparing the public health community for the challenges of climate change requires:

- 1 Coordinated efforts at the local, state and federal levels among agencies responding to climate change and across various disciplines and sectors;**
- 2 Developing adaptation strategies and identifying a basic set of core competencies for public health professionals responding to and preparing for the effects of climate change; and**
- 3 Assembling a cadre of scientists with multidisciplinary and specialized skills in nontraditional fields that can support public health professionals working on the front lines in their own jurisdictions.**

Through this series, participants had a chance to hear from experts in the field of climate

change about topics such as climate science, communication, adaptation strategies and more. This practical guidebook is a translation of the series.

The webinar series and the first chapter of this guidebook begin with the basic science of climate change. Chapter 2 outlines the international and domestic human health impacts of climate change. The third chapter takes a look at how public health departments in California and Orange County, Florida, are addressing climate change. Chapter 4 highlights one of the principal challenges facing the public health community: providing evidence for and communicating to the public that climate change is a current threat to the health and welfare of Americans. Chapter 5 offers information about strategies employed to ensure that we can adapt to the changing climate and focuses on populations that are most vulnerable to the effects. In Chapter 6, the final webinar of the series, leaders from the Department of Health and Human Services and the Environmental Protection Agency discuss the future of climate change and how public health fits in.

A large, melting glacial iceberg floats in clear turquoise water. The iceberg is white on top with dark spots and has several large, circular holes. The water is a vibrant blue-green color. In the background, there are snow-covered mountains and other smaller icebergs.

The evidence is unequivocal;  
the Earth is warming and  
our climate is changing.

A melting glacial iceberg  
floating on the Iceberg Lagoon  
in Jokulsarlon, Iceland.  
Melting water can be seen  
coming off the iceberg.



CHAPTER  
I:Basic Climate  
Change ScienceWEBINAR  
TRANSLATION“Observed and  
Projected Changes  
in Climate”

October 4, 2009

## ▶ David Easterling, PhD

Chief of Scientific Services Division,  
National Oceanic and Atmospheric  
Administration’s National  
Climatic Data Center

**Global warming** is the gradual increase in the average temperatures of Earth’s near-surface air and oceans since the mid-20th century and its projected continuation.

**Climate change** is a change in the statistical distribution of weather over periods of time that range from decades to millions of years.

The evidence is unequivocal; the Earth is warming and our climate is changing.

In addition to the warming trend, changes in precipitation and an increase in extreme weather events are further warnings of climate change.

Trends in average annual global temperatures show an increase from 2001 – 2007 when compared to other periods in history. IMAGE #I:1 charts an increase of 0.74°C in global surface temperatures as measured from January through December in the years 1880 to 2000. These documented temperature changes are not globally uniform. However, higher latitude regions such as North America and Eurasia are experiencing greater warming (see IMAGE #I:2).

There are additional troubling signs of global warming: a decline in arctic sea ice; the retreat of alpine glaciers; a decline in Northern Hemisphere snow cover; and a rise in sea level.

Changes in precipitation are harder to measure than changes in global temperatures because precipitation varies greatly, both geographically and over time. This difficulty produces less confidence in measured and quantified precipitation levels. Nonetheless, changes in rainfall have been documented. In general, regions in higher latitudes have experienced increased precipitation, whereas lower-latitude land masses have experienced a decrease.

Another persuasive piece of evidence of global warming is the change in the location and incidence of extreme weather events — heat waves or cold snaps, severe storms and droughts. For example, IMAGE #I:3 shows that the southeastern

United States and parts of Russia have experienced unusually heavy rains and snowfalls in the first half of the 20th century to present.

## What Causes Climate Change?

“Climate forcings” — whether natural or manmade (anthropogenic) — are events that cause changes in the atmosphere and are a significant cause of global climate change. Ironically, volcanoes actually cool the planet. But a far greater number of factors, natural or manmade, and especially in the form of greenhouse gases and sulphate aerosols, do the opposite. Greenhouse gases trap heat in the atmosphere and warm the Earth. Without this effect, temperatures would plunge and render the planet uninhabitable. While some greenhouse gases occur naturally, human activities are amplifying the natural greenhouse effect and impacting the concentrations of gases in the atmosphere, thereby contributing to climate change.

Carbon dioxide is the second most abundant greenhouse gas after water vapor. With the onset of the Industrial Revolution, commercial growth and economic consumption spawned our reliance on fossil fuels and the subsequent deluge of CO<sub>2</sub> into the atmosphere. *IMAGE #I::4* shows increases in CO<sub>2</sub> emissions from the mid-1900s to today. These increasing — and clearly manmade — levels of CO<sub>2</sub> are increasing global warming and exacerbating climate change. Current levels of greenhouse gas emissions are disrupting the natural balance of the Earth’s temperature and warming the atmosphere at an alarming rate.

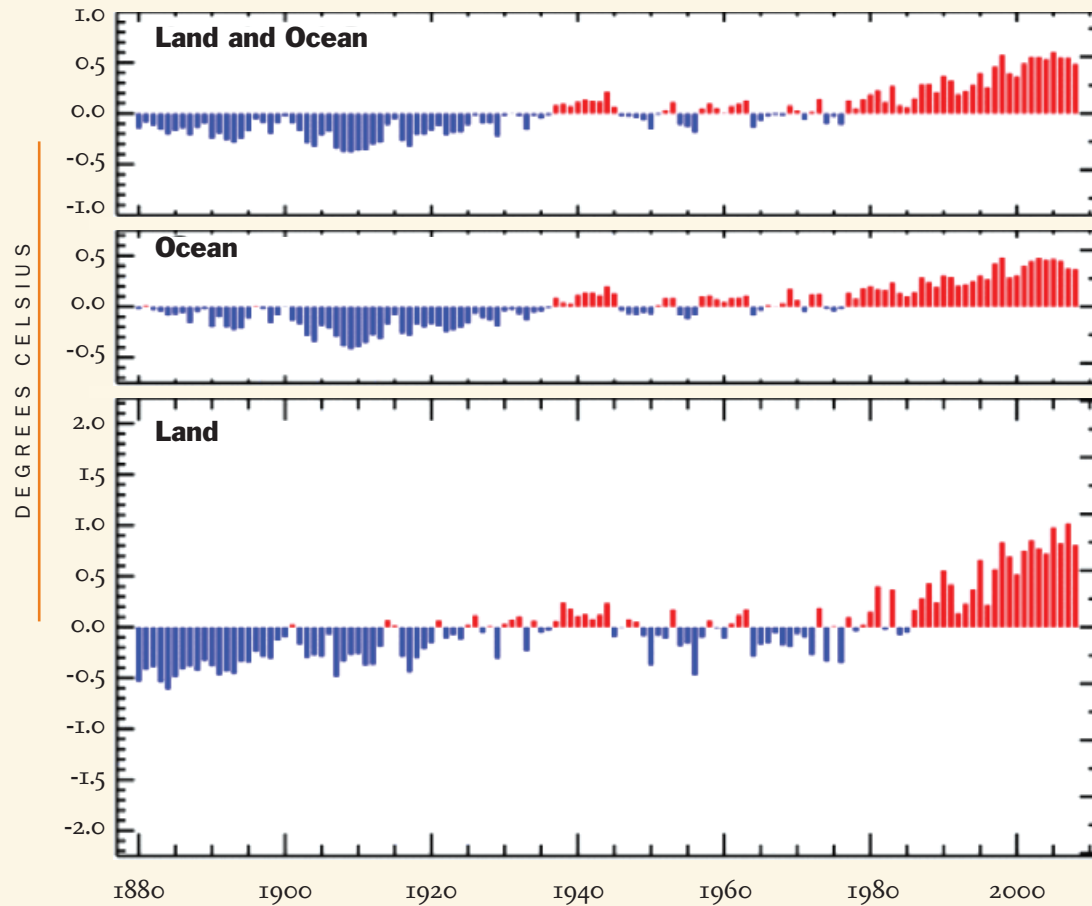
## Projecting the Future of Climate Change

Climate models developed by climatologists are used to project future climate change scenarios. They provide evidence about the need to decrease CO<sub>2</sub> emissions to reduce and eventually halt global warming. If nothing is done, within 100 years, unrestrained greenhouse gas emissions could cause the disappearance of the entire Arctic ice shelf. Still worse, the increased occurrence and intensity of extreme weather events, such as heat waves and hurricanes, would lead to more deaths and injuries throughout the world. The climate models in *IMAGE #I::5* show the projected impacts that extreme and even moderate increases in greenhouse gas emissions will have on global temperatures.

IMAGE #I::I

## January–December Global Surface Mean Temperature Anomalies

Source: Smith TM, Reynolds RW. A global merged land-air-sea surface temperature reconstruction based on historical observations (1880–1997). *J Climate*. 2005;18(12):2021–2036.



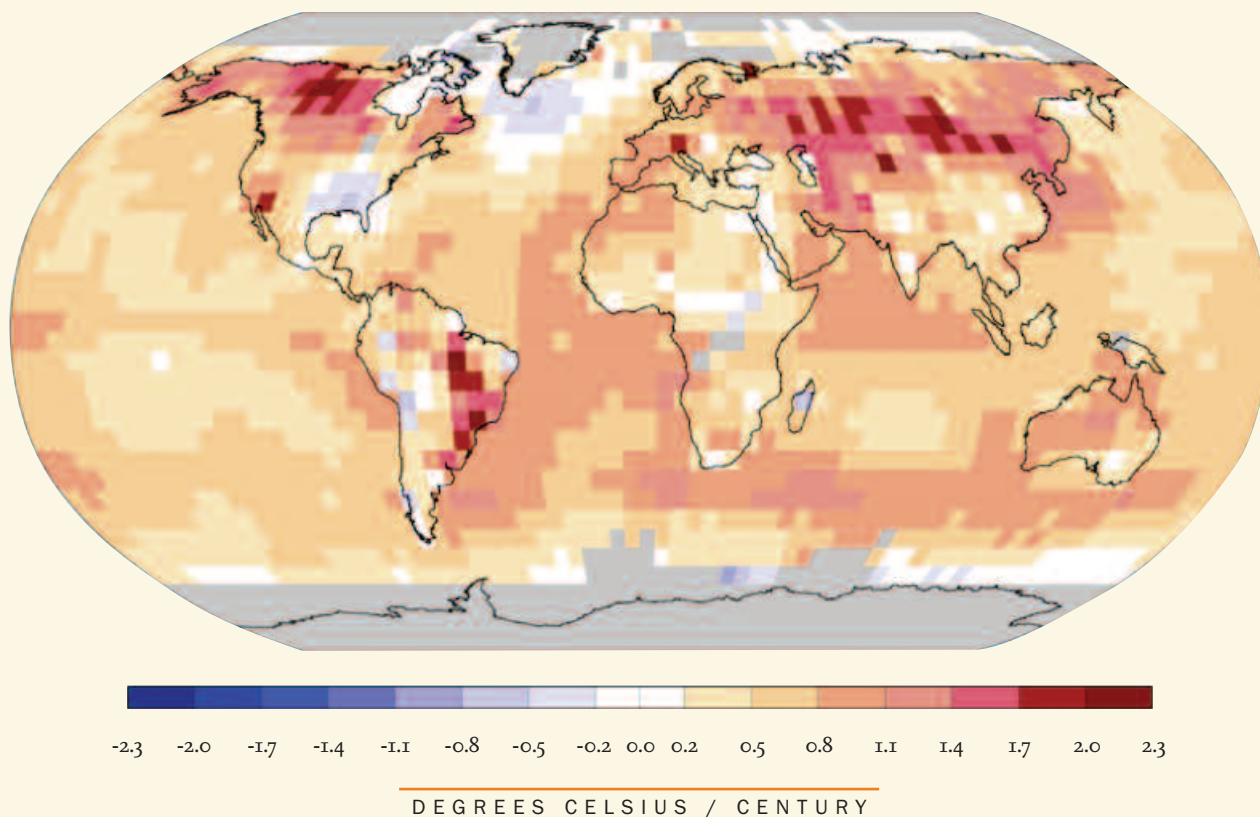
Trends in global temperature show an increase of 0.74°C in global surface temperature in January–December from 1880–2000.



IMAGE #I::2

## Change in Annual Average Temperature: 1901–2007

Source: Trenberth KE, Jones PD, Ambenje P, et al. Observations: Surface and Atmospheric Climate Change. In: Solomon S, Qin D, Manning M, Chen Z, Marquia M, Avery KB, Tignor M, Miller HL, eds. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK, and New York, NY: Cambridge University Press.

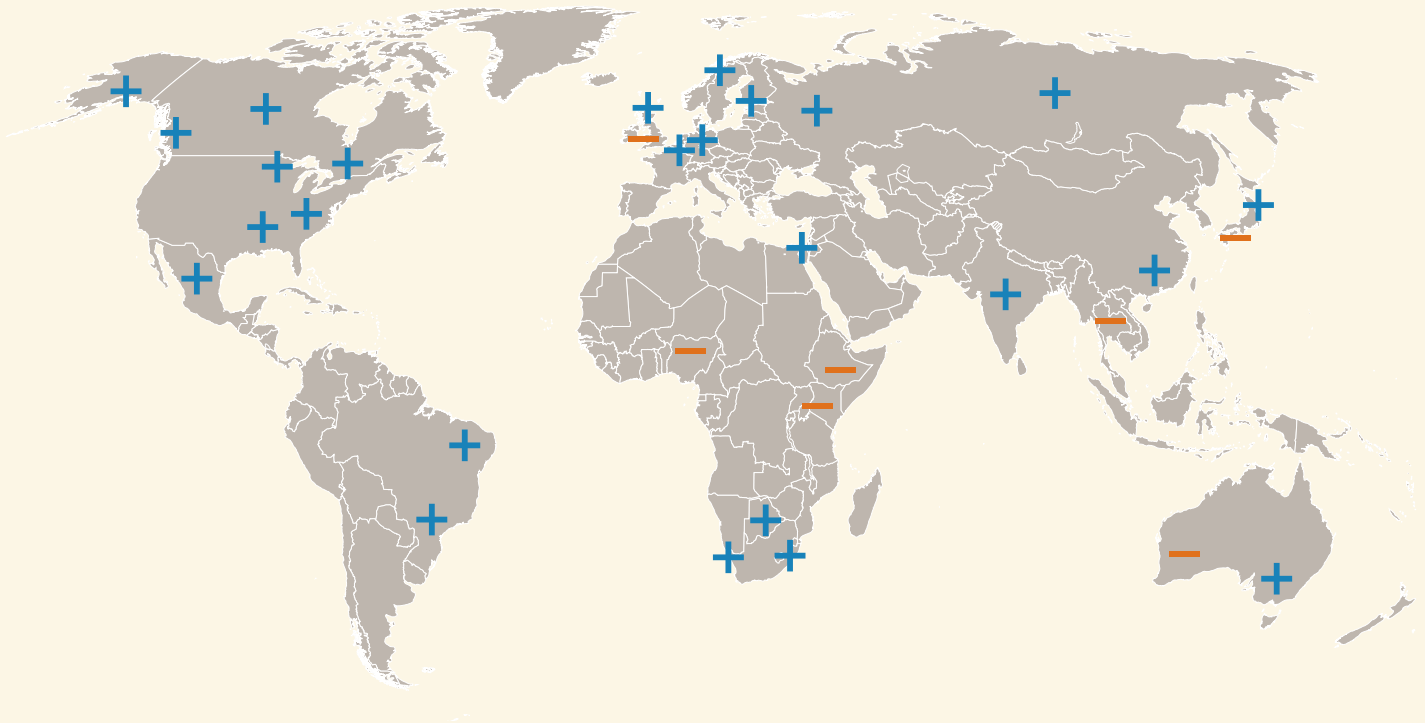


Higher latitude regions in North America and Eurasia are experiencing greater warming.

IMAGE #I:: 3

Regions Where Heavy Precipitation Events Have Increased (+) or Decreased (-)  
(first half of 20th century to present)

Source: Easterling D, Meehl G, Parmesan C, et al. Climate extremes: observations, modeling and impacts. *Science*. 2000;289(5487):2068-2074.

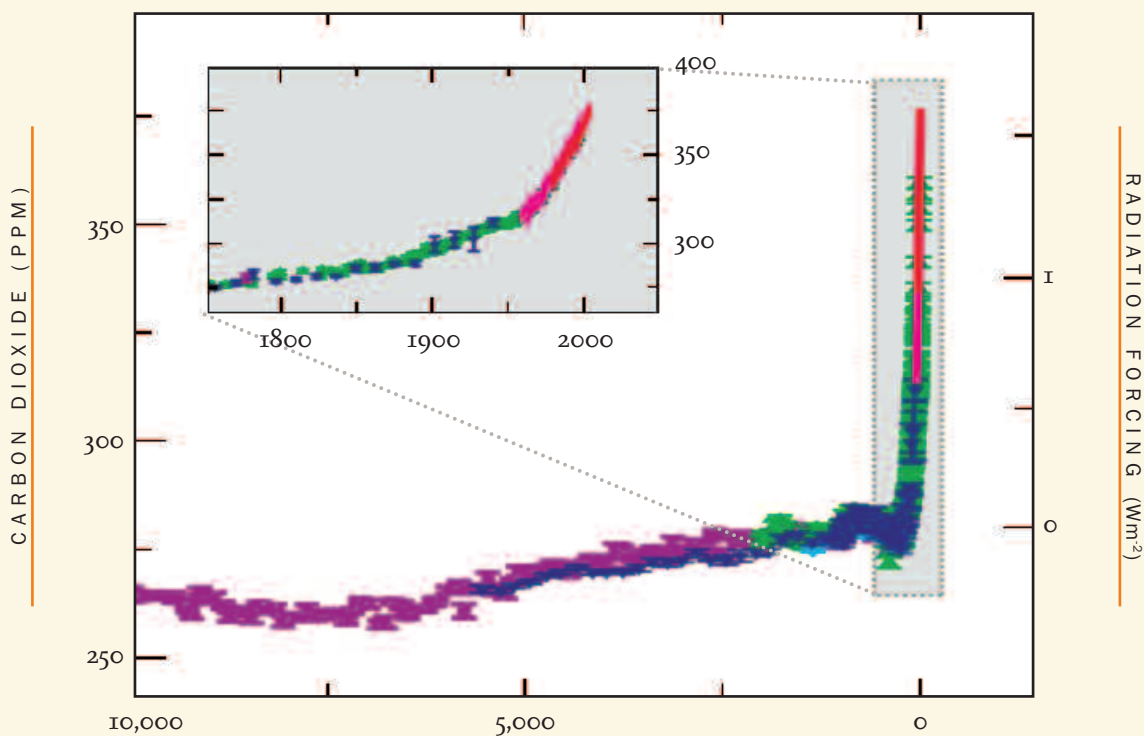


For example, the southeastern United States and Russia experienced unusually heavy rains and snowfalls in the first half of the 20th century.

IMAGE #I::4

## Climate Forcings: Anthropogenic (Human Induced)

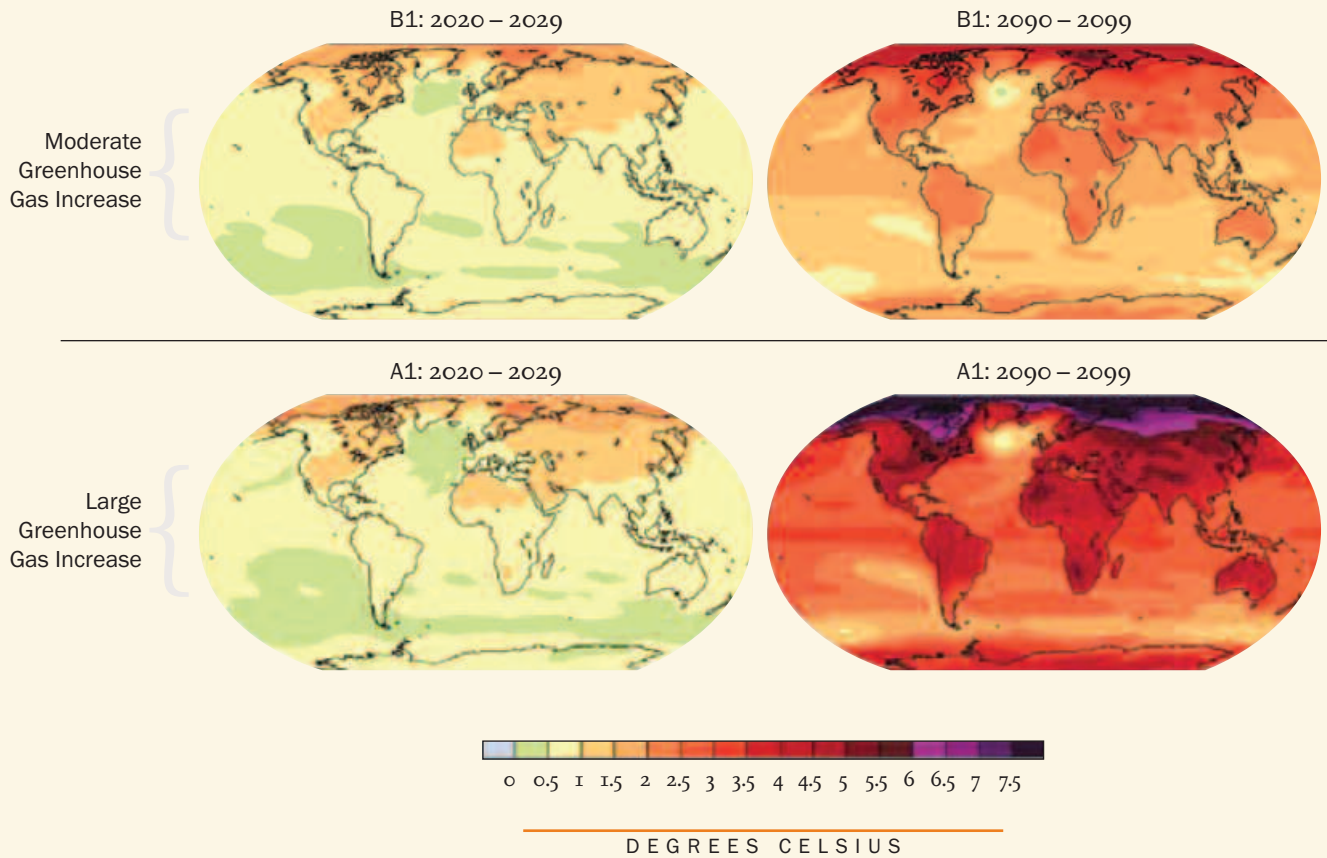
Source: Summary for Policymakers. In: Solomon S, Qin D, Manning M, et al. eds. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, and New York, NY: Cambridge University Press.



A significant increase in human-caused CO<sub>2</sub> emissions from the mid-1900s to today is increasing global warming and exacerbating climate change. Notice the sharp increase of CO<sub>2</sub> after 1950.

**IMAGE #I::5**  
**Projected Global Temperature Change**

Source: Summary for Policymakers. In: Solomon S, Qin D, Manning M, Chen Z, Marquia M, et al. eds. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK, and New York, NY: Cambridge University Press.



Models show that global temperatures will continue to rise with continued greenhouse gas emissions.





The poorest developing countries in Southeast Asia and southern Africa are suffering under the greatest climate change-related health burdens.



CHAPTER  
**2:**

# Health Implications

**WEBINAR**  
TRANSLATION**“Seven Degrees of Separation: The Public Health Implications of Climate Change”**

October 13, 2009

**▶ John M. Balbus, MD, MPH**

CURRENT: Senior Advisor for Public Health, National Institute of Environmental Health Sciences

FORMERLY: Department of Global Health, School of Public Health and Health Services, George Washington University

A small change in the Earth's temperature may translate into large modifications to the Earth's ecosystem. More simply, the weather conditions prevailing here on Earth could change substantially. Historical data have shown that slight increases in the Earth's surface temperature can have dramatic effects. For example, a slight 4 to 5 degree decrease in global temperature has been associated with the onset of the ice ages (see IMAGE #2::1). Climate models suggest that current greenhouse gas emissions may raise the Earth's temperature by as much as 7°C by 2020. An increase of that magnitude would exert significant impacts on the climate and produce extreme weather changes — both precipitation and temperature — as described in the climate science section of this guidebook (see Chapter 1).

Climate change impacts could lead to severe, adverse effects on health through both direct and indirect means, as illustrated in IMAGE #2::2. Potential, widespread adverse health effects could include:

- heat stress-induced illness and death;
- air pollution-related health effects;
- infectious disease, including water-, food-, vector- and rodent-borne diseases;
- malnutrition;
- extreme weather-related health effects;
- storm surge-related drownings and injuries; and
- health problems associated with displaced, refugee populations.

**Microbes & Temperature**

Microbes (*E. coli*, *Salmonella*, *Campylobacter*) favor and reproduce faster in warmer climates. Insects also favor warmer climates. Mosquito-transmitted malaria is predicted to increase significantly as global warming continues.

## Global Health Effects

The developing world will continue to experience the most pronounced health impacts from climate change. IMAGE #2::3 shows an estimate of deaths resulting from climate change. The poorest developing countries in Southeast Asia and southern Africa are suffering under the greatest climate change-related health burdens.

In addition, climate-induced changes become stress “multipliers” for many existing public health problems (see image #2::4). These include degradation of freshwater sources, a decline in food production and an increase in storm and flood disasters and subsequent migration. Water-borne illnesses already place huge health burdens on developing nations and are predicted to worsen due to climate change.



### WEBINAR TRANSLATION

#### “Climate Change: U.S. Regional Impacts and Opportunities for Health”

December 8, 2009

▶ **Jonathan Patz, MD, MPH**

Professor and Director, Nelson Institute for Environmental Studies, Department of Population Health Sciences, University of Wisconsin, Madison

## U.S. Health Effects

Regional differences will result in varying effects of climate change throughout the United States. The Global Climate Research Program has compiled a list of key climate change issues impacting each region (excerpts relating to human health impacts are from the program’s website at <http://www.globalchange.gov/>). A summary of these regional impacts is shown on pages 18 and 19.

### Water Supply and Water-Borne Diseases

Climate change is expected to increase precipitation in some areas throughout the world. In the United States, heavy rain and snowfall are anticipated in some areas, with the Northeast and Midwest expected to be particularly hard-hit. Heavier precipitation is likely, especially in the spring, when the ground is not thawed in many regions. This can lead to intense flooding because the soil cannot easily absorb rainfall. IMAGE #2::5 shows trends and future changes in seasonal precipitation across the United States.

Heavier rainfall may lead to a spike in water-borne diseases in communities using combined sewer overflow systems. Forty million Americans rely on this

**CSO** Combined sewer overflow is the discharge of stormwater and domestic waste during heavy rainfall that exceeds the capacity of sewer systems.



technology in more than 770 municipal systems mostly clustered in the Northeast and Midwest. For example, using models to downscale (or bringing climate change projections to a local or regional level), demonstrates the impact of increased rainfall on urban stormwater sewage overflow. The city of Milwaukee discovered that greater rainfall could cause *E. coli* contamination in the shoreline waters of Lake Michigan (see IMAGE #2::6). The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination, which poses a human health risk.

## Vulnerable Populations

Climate change will act as a stress multiplier for many existing public health problems that are impacting already burdened and vulnerable populations, such as people living in poverty, infants and children, among others. (For a complete list of vulnerable groups disproportionately impacted by climate change, see page 56.) Climate change is expected to affect both environmental and socioeconomic conditions for these groups (see IMAGE #2::7).

However, much is unknown about the impacts of climate change on vulnerable populations. To more fully understand these impacts:

- better surveillance systems are needed to track key indicators of climate-relevant exposures, vulnerabilities and health impacts; and
- expanded research is needed to better understand climate-health mechanisms, including vulnerability factors and the ability to project future health impacts under a range of climate change scenarios.

Identifying vulnerable populations and vulnerabilities is complex and requires information at the regional and local levels. Current climate change models make predictions at the global scale, and therefore downscaling to regional and local scales is necessary.

## Heat, Air Pollution and Pollen and Health Vulnerabilities

Heat is known to cause adverse health impacts. Death and injuries from excessive heat tend to occur more severely in urban areas from the “urban heat island effect.”

### WEBINAR TRANSLATION

#### “Regional Health Vulnerabilities to Climate Change: Air Pollution and Pollen”

December 8, 2009

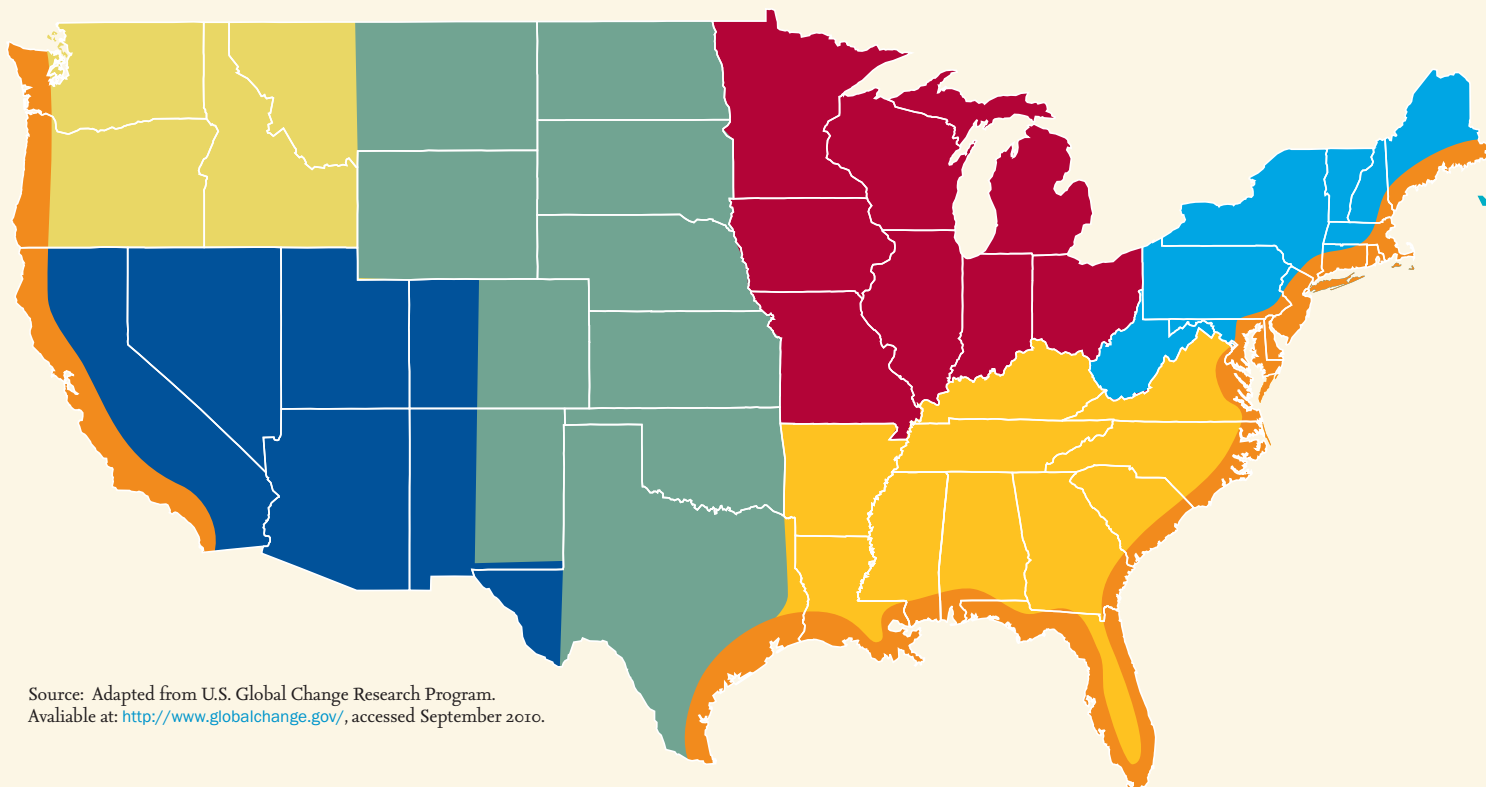
#### ► Patrick Kinney, PhD

Professor of Environmental Health Sciences and Director, Climate and Health Program, Mailman School of Public Health, Columbia University

#### Social Determinants of Health

The social determinants of health are a reflection of the conditions under which people are born, grow, live, work and age, including their access to health systems. Such basic life circumstances are, of course, shaped by the distribution of money, political power and available resources at the local, national and global levels. These social determinants of health are largely responsible for health inequities — the inequitable and not insurmountable differences in health status seen within and between nations.

## Regional Differences Due to Climate Change



Source: Adapted from U.S. Global Change Research Program.  
Available at: <http://www.globalchange.gov/>, accessed September 2010.

### NORTHEAST

- Extreme heat and declining air quality are likely to pose increasing problems for human health, especially in urban areas.
- Agricultural production, including dairy, fruit and maple syrup, is likely to be adversely affected as growing and harvesting conditions deteriorate.
- Severe flooding from a rise in sea level and heavy downpours is likely to occur more frequently.
- The projected reduction in snow cover will have adverse effects on winter recreation and related industries.
- The center of lobster fisheries is projected to continue its northward drift and the cod fishery on Georges Bank in the upper Northeast will likely diminish.

### MIDWEST

- During the summer, public health and quality of life, especially in cities, will see the negative effects of heat waves, reduced air quality and increased insect- and water-borne diseases. In the winter, warming will likely produce mixed results.
- The probable increase in winter and spring precipitation, heavy downpours and greater evaporation in summer will lead to extremes of both flooding and water deficits.
- While a longer growing season offers the potential for increased crop yields, increases in heat waves, floods, droughts, insects and weeds will present special challenges to the management of crops, livestock and forests.

### SOUTHEAST

- Projected increases in air and water temperatures will cause heat-related stress for people, animals and plants.
- Diminishing water resources will very likely affect the southeastern economy as well as its natural systems.
- Rising sea levels and the predicted increase in hurricane intensity and associated storm surge may rank as the most serious consequence of southeastern climate change.
- Ecological thresholds are likely to be crossed throughout the region, causing major disruptions to ecosystems and to the benefits they provide.
- Increasing heat stress, water scarcity, severe weather events and higher-cost or unobtainable insurance for at-risk properties will affect quality of life.



### GREAT PLAINS

- Projected increases in temperature, evaporation and drought frequency will exacerbate concerns about declining water resources.
- Agriculture, ranching and maintenance of natural lands — currently under pressure from limited water supplies — are very apt to be more stressed by rising temperatures.
- Climate change is expected to affect native plant and animal species by altering key habitats such as the Prairie Potholes or Playa Lakes wetland ecosystems.
- Shifts of population from rural areas to urban centers combined with climate change are expected to have significant, undetermined consequences.

### NORTHWEST

- Declining springtime snowpack will lead to reduced summer stream flows, straining water supplies.
- Increased insect infestations, wildfires and changing species composition in forests will pose challenges for ecosystems and the forest products industry.
- Salmon and other coldwater species will experience additional stress from rising water temperatures and declining summer stream flows.
- Rising sea levels along vulnerable coastlines will foster increased erosion and land loss.

### SOUTHWEST

- Water supplies will become increasingly scarce, calling for trade-offs among competing uses and leading to potential conflict.
- Increasing temperatures, drought, wildfire and invasive species will accelerate transformation of the landscape.
- Increased frequency and unpredictability of flooding will increase risks to people, ecosystems and infrastructure.
- Tourism and recreational opportunities are expected to suffer.
- Cities and agricultural areas will be subject to increasing risks from a changing climate.

### ALASKA

- Longer summers and higher temperatures will continue to produce drier conditions, even in the absence of strong trends in precipitation.
- Insect outbreaks and wildfires will increase with warming, while lakes are shrinking in area.
- Thawing permafrost results in damage to roads, runways, water, sewer systems and other infrastructure.
- Increasing coastal storms will threaten villages and fishing fleets.
- Displacement of marine species will affect key fisheries.

### ISLANDS

- The availability of freshwater is predicted to decline, with significant implications for island communities, economies and resources.
- Island communities, infrastructures and ecosystems are vulnerable to coastal inundation due to sea level rise and coastal storms.
- Climate change effects on coastal and marine ecosystems will have major implications for tourism and fisheries.

### COASTS

- Significant sea level rise and storm surge will adversely affect coastal cities, recreation areas and ecosystems around the nation's shoreline.
- Greater spring runoff and warmer coastal waters will add to a seasonal reduction in oxygen due to excess nitrogen from agriculture.
- Higher water temperatures and ocean acidification from increasing atmospheric carbon dioxide will present major additional stress to coral reefs, resulting in significant die-offs with limited recovery.
- Changing ocean currents will affect coastal ecosystems.

This is caused by the warming effect of densely populated and built-up cities. Heat islands increase summertime peak energy demand, air conditioning needs and costs, air pollution and greenhouse gas emissions and heat-related illness and mortality. Heat-related mortality and the urban heat island effect were seen in the 2003 Paris heat wave. A dramatic increase in deaths coincided with a spike in temperature during the month of August.

The impact of climate change on extreme weather events and the urban heat island effect will differ from city to city and is difficult to predict.

Factors that need to be considered when assessing health vulnerabilities include:

- 1 underlying medical conditions, such as heart or lung disease;
- 2 demographics such as race, age and education;
- 3 housing conditions;
- 4 local ecology and geography; and
- 5 water supply.

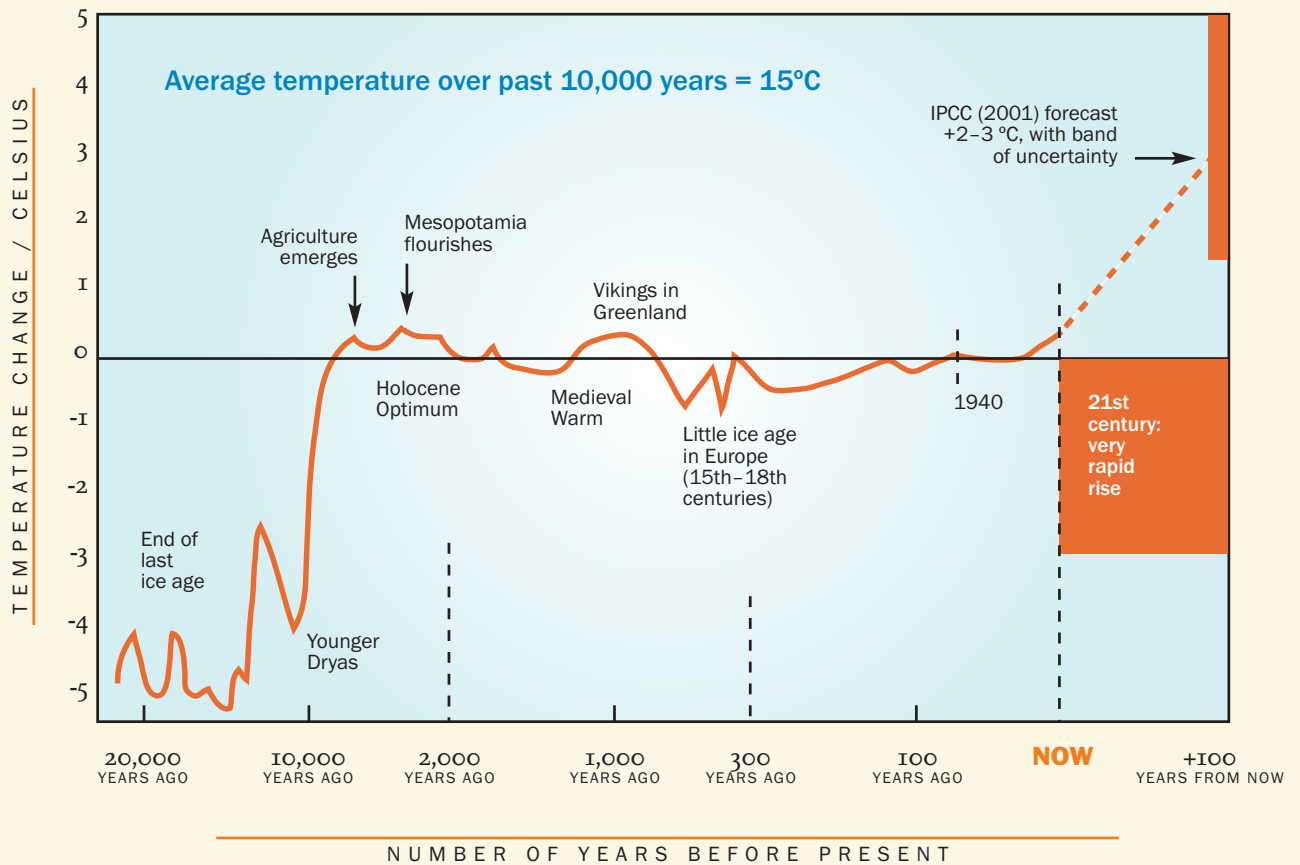
Downscaling global models to regional scenarios is necessary to identify key vulnerable areas and at-risk populations. Ground-level ozone is known to be a harmful air pollutant that is formed from fossil fuel emissions (e.g., vehicle exhaust), sunlight and higher temperatures (see IMAGE #2:8). Downscaling climate and air quality projections for air pollutants such as ozone show that in the future, climate change can lead to an increase in ozone levels and a potential increase in ozone-related deaths.

The potential for climate change to cause an increase in the intensity and length of the pollen season is also speculated. While the evidence is unclear and research is still ongoing, it is speculated that an increase in temperature could lead to an earlier and longer pollen season. At the same time, rising carbon dioxide levels may lead to greater pollen production by weeds and trees, which could cause increased allergies and respiratory-related illness.

IMAGE #2::1

## Variations in Earth's Average Surface Temperature Over the Past 20,000 Years

Source: Climate Change and Human Health — Risks and Responses. France: World Health Organization; 2003. WHO Publication.

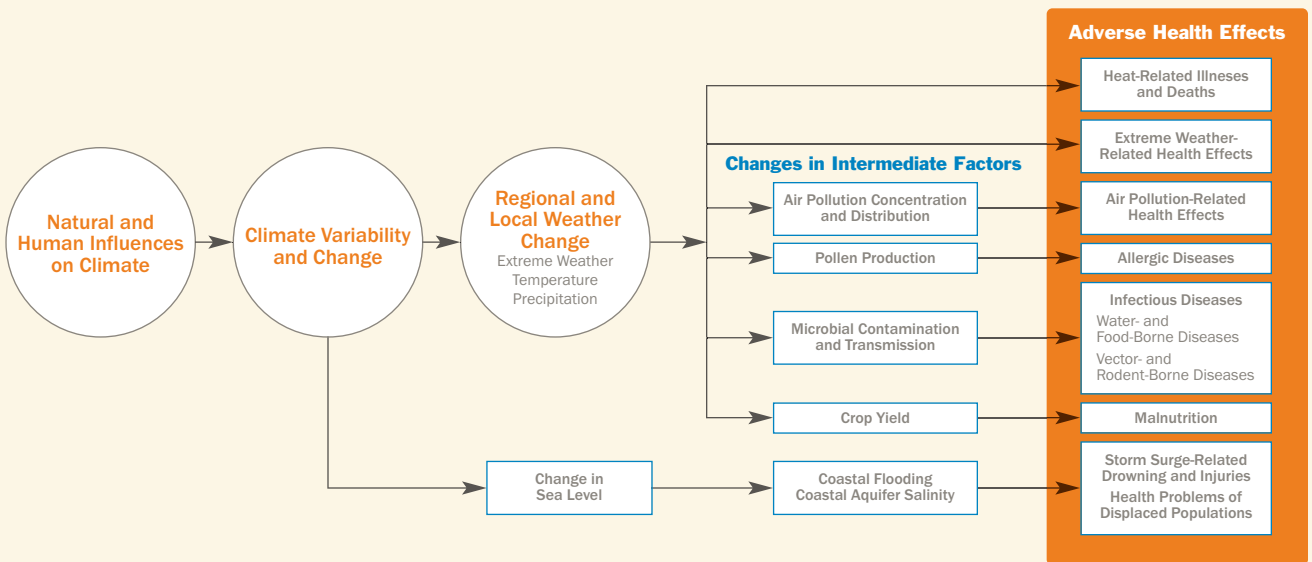


Slight changes in the Earth's temperature can lead to significant events, like the ice age.

IMAGE #2::2

## Potential Health Effects of Climate Change

Source: Haines A, Patz J. Health effects of climate change. JAMA. 2004;291(1):99-103.

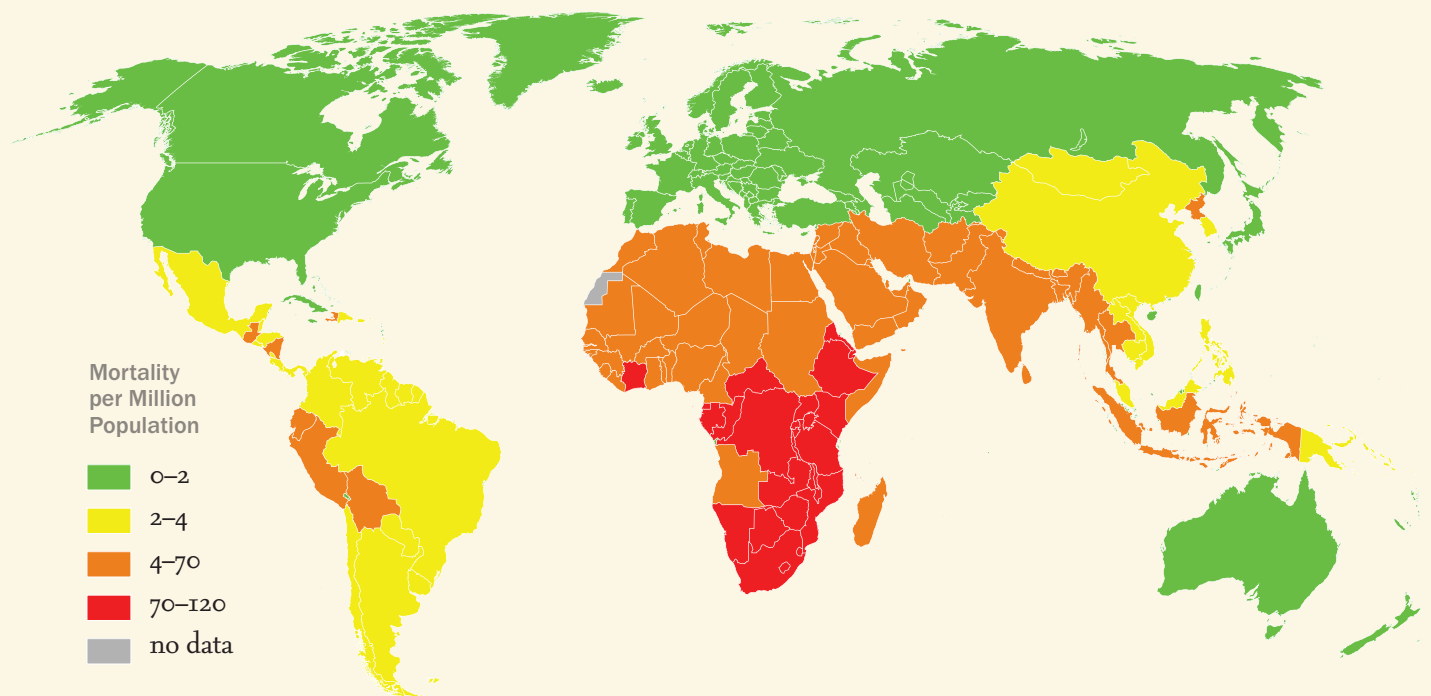


Climate change could have severe adverse impacts on health.

IMAGE #2::3

## Estimated Deaths Attributed to Climate Change in the Year 2000, by Subregion

Source: McMichael JJ, Campbell Lendrum D, Kovats RS, et al. In: Ezzati M, Lopez AD, Rodgers A, Murray CJL, eds. *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Due to Selected Major Risk Factors*. Geneva, Switzerland: World Health Organization; 2004.



CHANGE IN CLIMATE COMPARED TO BASELINE 1961-1990 CLIMATE

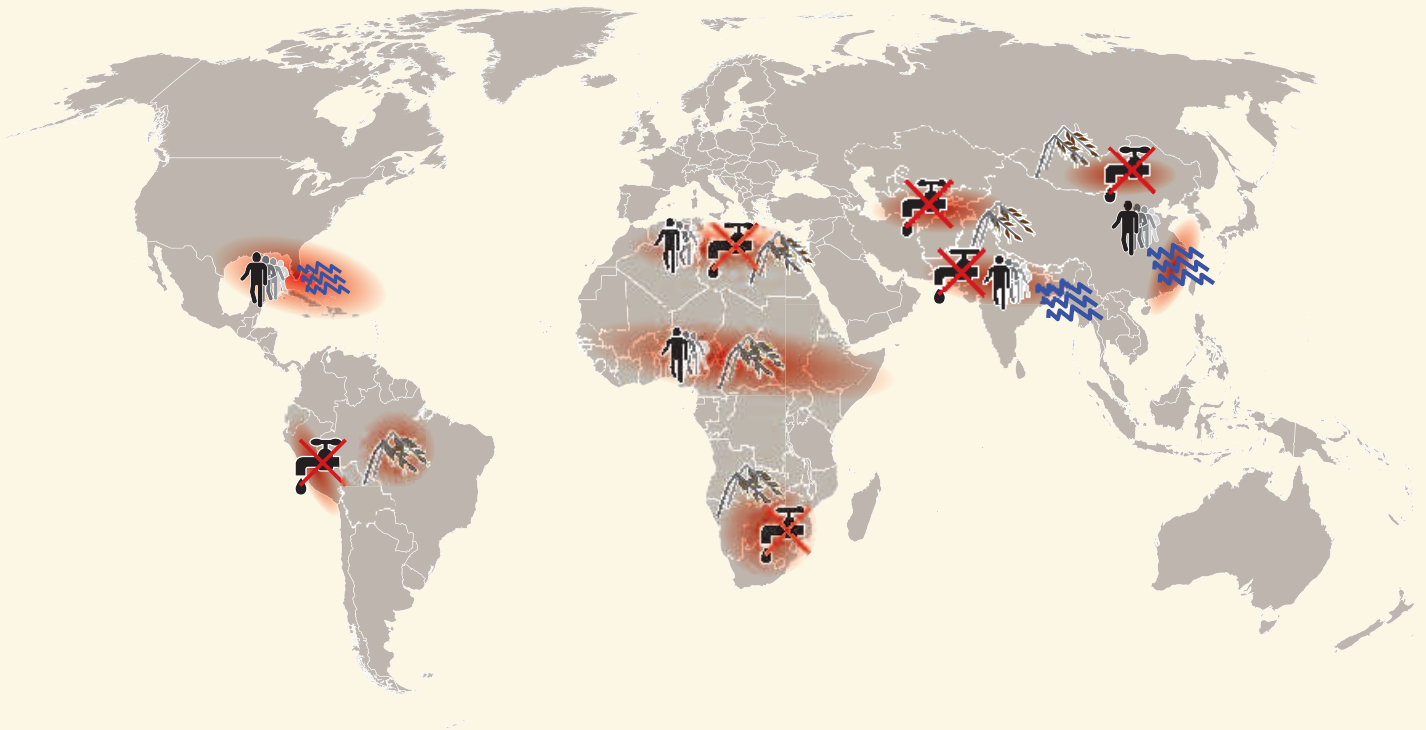
The World Health Organization estimates 160,000 additional deaths from malaria, malnutrition, diarrhea, flood and heat waves in 2000 as a result of climate change in the poorest developing countries in southwest Asia and southern Africa.



IMAGE #2::4

## Conflict Constellations in Selected Hotspots

Source: German Advisory Council on Global Change. World in Transition — Climate Change as a Security Risk. Berlin, Germany; 2007.



Climate-induced degradation of freshwater resources



Climate-induced decline in food production



Climate-induced increase in storm and flood disasters



Environmentally induced migration



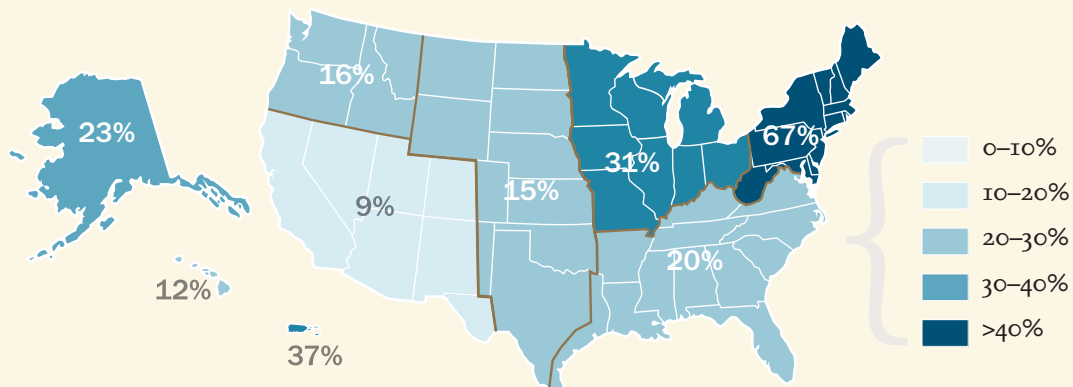
Hotspot

Climate change-induced stressors could lead to hotspots of conflict, especially in the poorest developing countries.

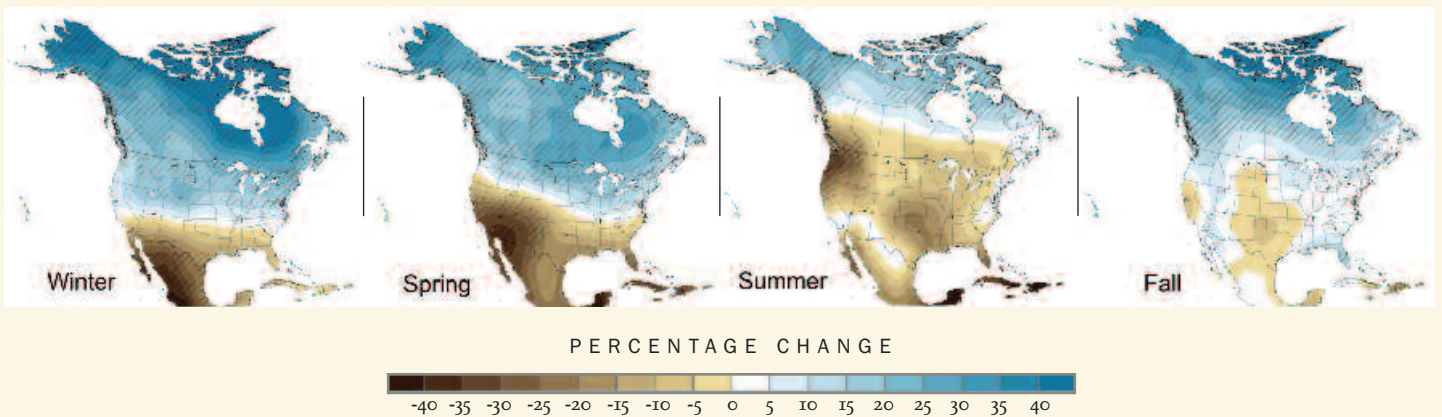
## IMAGE #2::5

## Precipitation: Past Trends and Future Projections

Source: United States Global Climate Change Research Program. *Global Climate Change Impacts in the United States*. Cambridge University Press; 2009.



The map shows the percentage increases in very heavy precipitation (defined as the heaviest 1 percent of all events) from 1958 to 2007 for each region. There are clear trends toward more very heavy precipitation for the nation as a whole and particularly in the Northeast and Midwest.

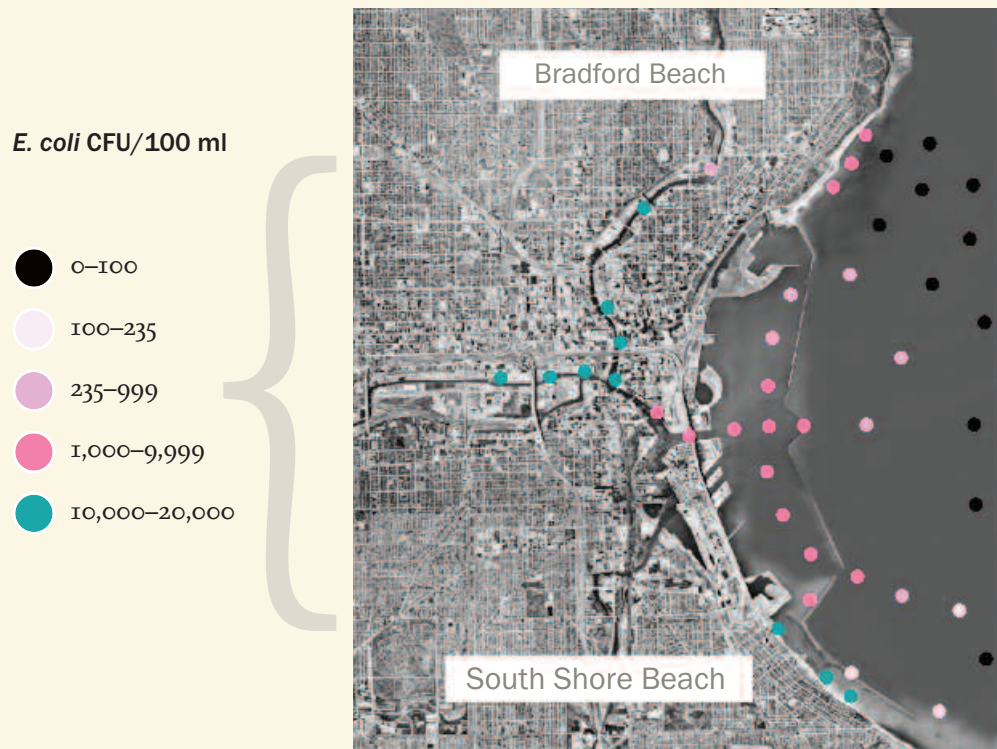


The maps show projected future changes in precipitation relative to the recent past as simulated by 15 climate models. The simulations are for late in the 21st century, under a higher emissions scenario. For example, in the spring, climate models agree that northern areas are likely to get wetter and southern areas drier. There is less confidence in exactly where the transition between wetter and drier areas will occur. Confidence in the projected changes is highest in the hatched areas.

IMAGE #2::6

## Impact of Rainfall on Urban Stormwater Sewage Overflow in Milwaukee and Contamination in Lake Michigan

Source: McLellan SL, Hollis ET, Depas MM, et al. Distribution and fate of *Escherichia coli* in Lake Michigan following contamination with urban stormwater and combined sewer overflows. *J Great Lakes Res.* 2007;33(3):566-580.

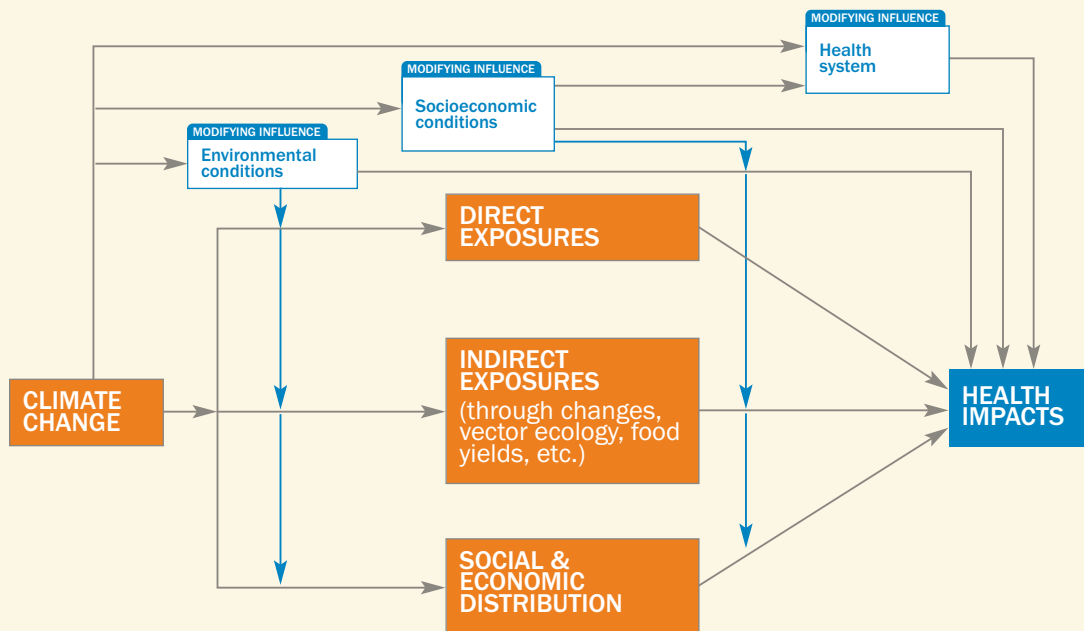


*E. coli* contamination is found on the shoreline of Lake Michigan after a heavy rainfall. *E. coli* in water is a strong indication of recent sewage or animal waste contamination, which poses a health risk.

## IMAGE #2::7

## Pathways by Which Climate Change May Affect Human Health

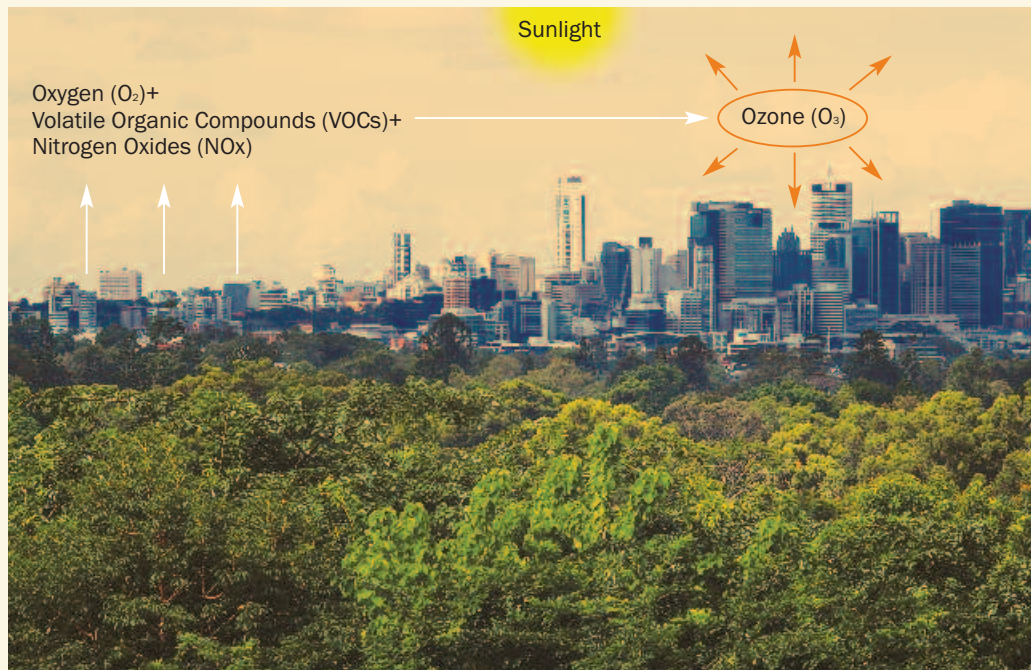
Source: Confalonieri U, Menne B, Akhtar R, et al. Climate Change 2007: Impacts, Adaptation and Vulnerability. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE, eds. Contributions of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press: 391-431.



Climate change is expected to affect both environmental and socioeconomic conditions, both of which also impact health.

IMAGE #2::8  
Ground-level Ozone Formation


Source: State of Queensland Department of Environment and Resource Management, 2006. Available at: [www.epa.qld.gov.au](http://www.epa.qld.gov.au).



Ground-level ozone formation is sensitive to temperature, sunlight and other climate factors as well as local pollution precursor emissions.





An aerial photograph of a complex multi-level highway interchange in Los Angeles. The roads are filled with cars, and the surrounding area includes greenery and residential buildings. In the background, the Los Angeles city skyline is visible under a hazy, golden sky. The text is overlaid on the upper left portion of the image.

Climate change action  
planning is a necessary  
first step in disease prevention  
and preparedness.



CHAPTER  
3:Climate Change Action Planning  
and Public Health:  
State and Local  
Perspectives

Climate change action planning is a necessary first step in disease prevention and preparedness. According to a 2009 report by Trust for America's Health (TFAH),\* more than 30 states have produced climate change action plans. Among these, only California, Maryland, New Hampshire, Virginia and Washington have a public health component in their plans.

Further, as part of climate change action planning, several states have formed climate change commissions or advisory committees. However, TFAH reports that of the 26 states with a climate change action commission, just 12 include a representative from state or local public health departments.

Climate change planning varies from state to state, but usually includes the following: an assessment of potential impacts; recommendations for ways to reduce or prevent greenhouse gases; and plans for adaptation (or preparedness). The development of a climate change action plan requires the involvement of multiple sectors and agency collaboration.

**Co-benefits of Reduced**

**Carbon Emissions:** While the primary goal of carbon offsets is to reduce climate-changing carbon emissions, many offset projects or policies may also lead to a healthier populace. These potential co-benefits should be kept in mind when developing or evaluating measures to reduce carbon emissions.

To ensure that public health is included in climate change action plans, state and local health professionals should be part of the planning process. In particular, public health plays an important role in educating policy-makers and the public about the effects of greenhouse gas emissions on health as well as in monitoring and preparing for conditions that may impact public health. Health professionals can also help explain the health co-benefits of climate change policies to policy-makers and to the public.

\*Levi J, Vinter S, Gratale D, et al. Health Problems Heat Up: Climate Change and the Public's Health. Trust for America's Health. 2009.

With the need for state and local health departments to move to the forefront of efforts to deal with the public health challenges of climate change, CDC and national nonprofit partners, including the Association of State and Territorial Health Officials (ASTHO) and the National Association of County and City Health Officials (NACCHO), are working with health departments on key priorities to address the health consequences of climate change. Included in those efforts is work to develop and deploy systems and tools needed to conduct climate change needs assessments that account for local health vulnerabilities.

In addition, local health departments selected as part of a one-year NACCHO demonstration project received assistance in coordinating efforts to respond to the public health consequences of climate change. Some of these processes included conducting a local health department internal needs assessment, using existing data to describe local public health impacts of climate change, developing messaging and communicating to internal health department staff and community partners. For updates on these demonstration projects and details about the objectives for individual health departments, visit <http://www.naccho.org/topics/environmental/climatechange/ccdemosites.cfm>.

The climate change program recently launched by CDC, in conjunction with national association partners, provides funding to state and local health departments to conduct assessments of their capabilities to address climate change. The intent of this funding is to help state and city health departments investigate, prepare for and respond to the health effects that climate change may have on people.

The five states receiving CDC funding include California, Florida, Michigan, Minnesota and New Hampshire, and the six local public health departments receiving funding are the 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).

In October 2010, CDC announced awards totaling \$5.25 million for a three-year funding period to support health departments' needs in responding to the public health challenges of climate change. The eight states and two cities that received awards are Arizona, Maine, Massachusetts, Michigan, Minnesota, New York, North Carolina, Oregon, San Francisco and New York City. These awards will support

health department programs in addressing health impacts, including heat-related illness, animal- and insect-related illness, food- and water-borne diseases, conditions that worsen allergies and respiratory problems and health effects linked to intense weather events. Updates on these efforts will be shared in 2011 and featured in the continuation of this year's webinar series. To learn more about CDC's Climate-Ready States and Cities Initiative, visit [http://www.cdc.gov/climatechange/climate\\_ready.htm](http://www.cdc.gov/climatechange/climate_ready.htm).

## California Climate and Public Health Action Plan

### WEBINAR TRANSLATION

#### “Climate Change & Health”

January 25, 2010

#### ▶ Linda Rudolph, MD, MPH

Deputy Director, Center for Chronic Disease Prevention and Health Promotion, California Department of Public Health

#### Climate Change Vulnerability

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability to climate change as “the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.”

**Cap and Trade** is an environmental policy tool that delivers results with a mandatory cap on emissions while providing emitting sources flexibility in how they comply. Also known as emissions trading, it is a market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants.

California is a leader in climate change action planning, with its Department of Public Health playing an important role. The California Climate Action Team (CAT) is a multi-agency group that provides coordination and oversight for climate mitigation and adaptation. The CAT Public Health Work Group is comprised of the state health department, other state agencies such as the Air Resources Board, local health departments and multiple stakeholders.

California's CAT Public Health Work Group identified the following key components in its work plan:

- **Vulnerability Assessment:** The California Department of Public Health has prepared an initial vulnerability assessment for heat as well as an overview of state climate and health vulnerabilities. The team plans to develop downscale assessments at the local level. For example, a Heat Vulnerability Index can identify specific neighborhoods that are more likely at risk during an acute heat event (see IMAGE #3::1).
- **Adaptation:** California released a Climate Adaptation Strategy in 2009, including a public health chapter that emphasizes promotion of community resilience and prioritization of both mitigation and adaptation strategies that maximize health co-benefits. (To download a copy, go to <http://www.climatechange.ca.gov/adaptation/>.)
- **Health Impact Assessment:** HIA is a “combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population.”\* California is developing a guide for health impact assessments and is undertaking a health impact assessment of cap and trade.

\*World Health Organization. 2011. Available at: <http://www.euro.who.int/en/what-we-do/health-topics/environmental-health/health-impact-assessment>.

- **Surveillance:** California is working to integrate climate change health indicators into its Environmental Public Health Tracking Program and other surveillance systems. Indicators should include climate change-related morbidity and mortality, vulnerable populations, adaptive capacity, real-time incidence in emergencies and more. Health departments should identify opportunities to build on and enhance existing surveillance systems.
- **Communication and Outreach:** Through grants to local agencies, California's Strategic Growth Council provides opportunities for local public health departments to participate in local and regional planning for sustainable communities. There is an urgent need for general and vulnerable population risk communication and messaging on climate mitigation and adaptation using multiple modalities.
- **Preparedness and Response:** Health agencies need to increase existing capacity for emergency response to climate change-related incidents. The CAT Public Health Work Group plan proposes to focus on heat, including urban heat island mitigation, heat warning systems, heat buddy systems and more robust heat vulnerability and heat impacts surveillance.
- **Training and Technical Assistance:** California's Department of Public Health provides training and technical assistance to local health departments and other agencies related to climate and health. For example, CDPH developed an advisory for local public health officials on wildfire smoke.
- **Research:** State and local climate action planning must include research on climate and health.
- **Policy Development:** Public health can play an important role in prioritizing climate policies with health co-benefits. Policies that address vulnerable populations are vital. For example, the California Division of Occupational Safety and Health mandated shade and rest stations for agricultural workers to help prevent heat-related illness.

## California-Specific Vulnerabilities

Downscaling climate risk models to identify local vulnerabilities is key in climate action planning. For example, in California, the Pacific Institute identified populations and counties most at risk of sea level rise (see IMAGE #3::2) and used mapping to show the relationships of sea level rise to critical infrastructure, such as hospitals (see IMAGE #3::3), nuclear power plants, drinking water supplies and water treatment plants, many of which are threatened by rising sea levels. Public health practitioners can play an important role in educating their own communities as well as the broader public about these and other health risks associated with climate change.

**WEBINAR**  
TRANSLATION**“Orange County,  
Florida’s Response  
to Climate Change  
Action Planning”**

January 25, 2010

**▶ Kevin Sherin, MD, MPH**Director, Orange County Health  
Department, Florida

## Preparing a Local Response to Climate Change in Orange County, Florida

A local response to climate change requires thoughtful planning that prepares for an increase in severity and frequency of common health risks and potentially some new health risks. Orange County identified a range of climate change-related health risks and is initiating programs to respond. Anticipated health risks include respiratory reactions for asthma sufferers and others caused by mold from weather events, increased pollen and declining air quality as well as threats from emerging diseases and increases in water-borne and heat-related illnesses.

Orange County, Florida’s Climate Action Team employs a proactive, anticipatory approach to planning for climate change. Its climate change action plan supports mitigation and adaptation strategies at the local level through education and outreach, collaboration with public and private organizations and interagency planning.

Orange County’s public health climate change initiatives include:

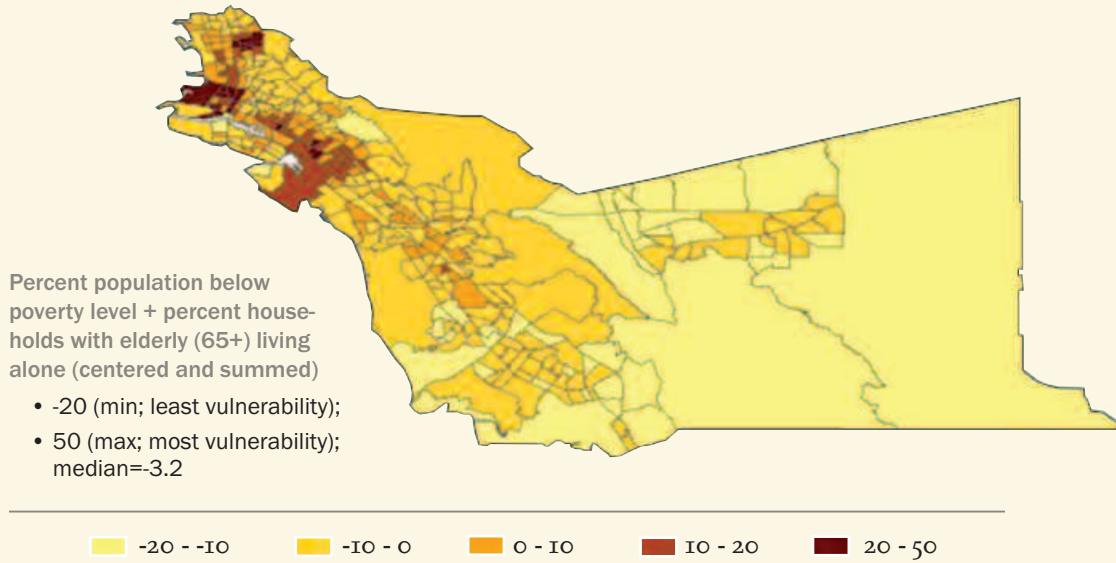
- working with the city of Orlando to alert vulnerable populations in advance of extreme weather events like hurricanes or heat waves;
- organizing community meetings to reach out to vulnerable populations;
- coordinating with the Florida Office of Minority Health to prepare an all-hazards approach to health threats that may be influenced by climate change at the county level; and
- coordinating local and statewide tracking programs to help monitor infectious disease incidence.



IMAGE #3::1

## Alameda County, California, Heat Vulnerability Index

Source: English P, Branch Science Advisor, California Department of Public Health. U.S. Census SF3 2000.

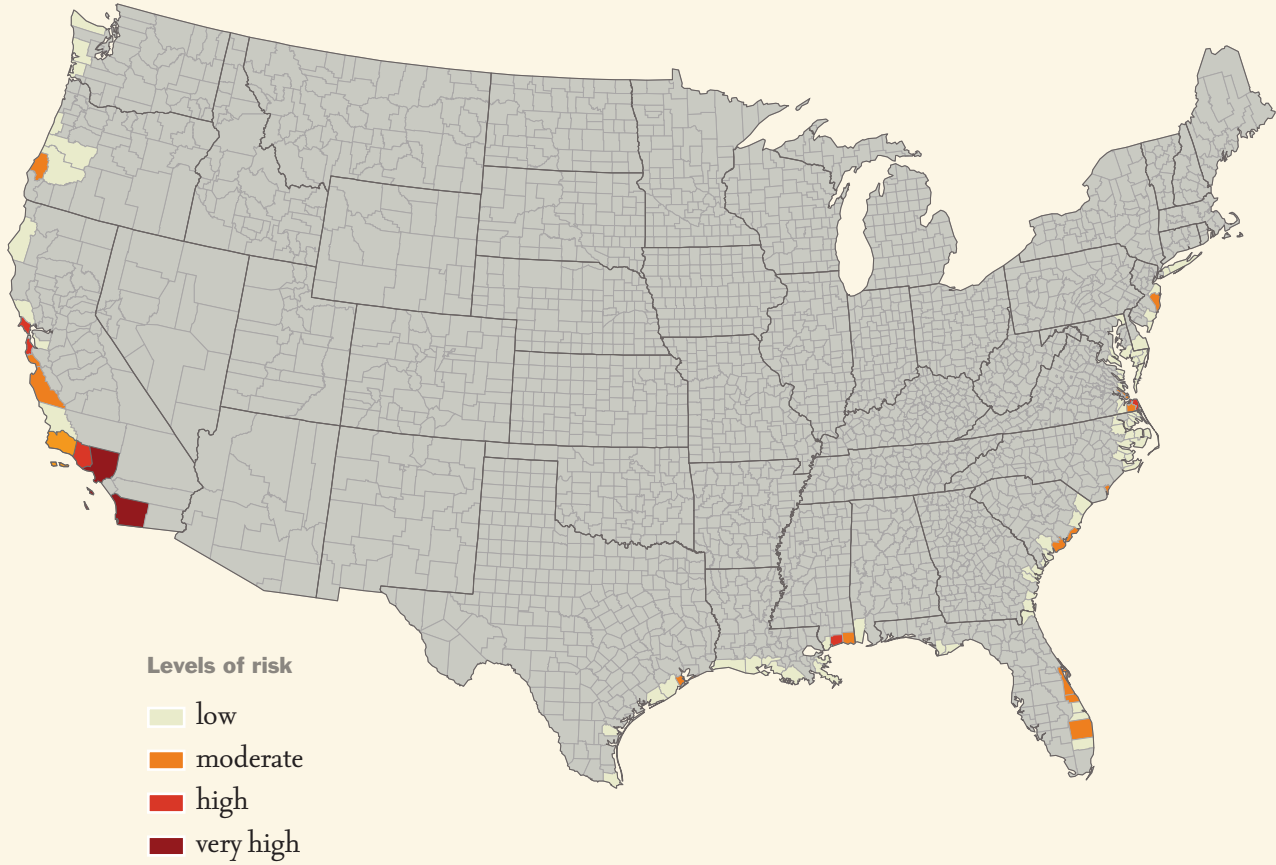


Populations most vulnerable to heat are identified in Alameda County through "vulnerability indexing"

IMAGE #3::2

## Populations at Risk for Sea Level Rise

Source: Pacific Institute, USGS and U.S. Census 2000. Available at: <http://ehp03.niehs.nih.gov/article/info:doi/10.1289/ehp.0900708>.



Some populations along the coast are at increased risk from sea level rise, as shown through downscaled modeling.

IMAGE #3::3

## Hospitals at Risk From Sea Level Rise

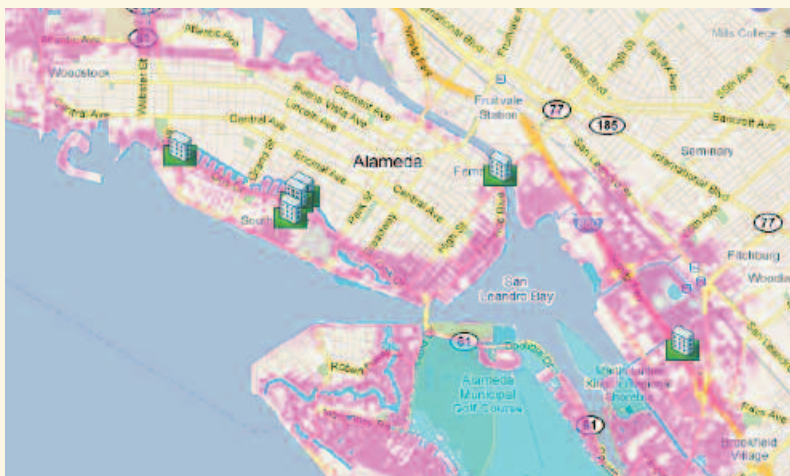
Source: Heberger M, Cooley H, Herrera P, et al. The Impacts of Sea-Level Rise on the California Coast. California Climate Change Center. 2009.

**HAZARD ZONES:**

Area at risk from a 100-year coastal flood event

- Current area at risk
- Area at risk with a 1.4-meter sea level rise

 Hospitals



Rises in sea level pose a risk to critical public health infrastructure on California's coast.







Chinese Flee  
Flood Threat  
From Quake

Climate  
change

quakes's to  
may reach 102°

could top 50K  
save the planet

wind, rain, fire  
Mudslides kill dozens

at least

Torrid temps plague Europe

Public health professionals have  
an opportunity to correct the  
common misperception that  
climate change is solely an  
environmental problem.

Thousands homeless, Storm  
Climate change  
Tsunami  
Snow means



CHAPTER  
4:Climate Change  
CommunicationWEBINAR  
TRANSLATION“Climate Change:  
Communicating the  
Public Health  
Imperative”

March 11, 2010

▶ **Edward Maibach, PhD, MPH**  
Director, Center for Climate  
Change Communication,  
George Mason University**Download** a PowerPoint presentation you can customize on “Global Warming: Why Public Health Professionals Care, and Why You Should Too” by visiting: <http://www.climatechangecommunication.org/publichealth.cfm>.

Despite its direct impact on human health, climate change is typically written about, discussed and reported as an environmental problem. As a result, most Americans think of the physical environment (such as glaciers and polar ice caps) and non-human species (such as plants, penguins and polar bears) as being the primary victims of the worst effects of climate change. They perceive its human impacts as being distant, experienced somewhere else, and at some time in the future (see IMAGE #4::1). However, there is a growing and compelling body of evidence that climate change is bad for humans — not just plants and animals. Moreover, Americans and others around the world are already being harmed. A 2008 survey of local public health directors in the United States found that a majority of the respondents have already identified existing public health impacts of climate change within their jurisdictions.\*

Public health professionals have an opportunity to correct the commonly held misperception that climate change is solely an environmental problem. Conveying the negative impacts of global climate change on human health and well-being and detailing the benefits associated with taking action against climate change will improve Americans’ understanding of the full significance of the issue. Communicating the ways in which public health practitioners are engaged in state and local climate change prevention and preparedness efforts (as detailed in Chapter 3), such as through the development of local needs assessments, identifying local vulnerabilities and other mitigation and adaptation planning processes, is equally important in demonstrating that climate change is not exclusively an environmental problem. These messages will likely enhance public engagement and readiness to enact policies that will limit further warming and help

\*Balbus J, Ebi K, Finzer L, et al. Are We Ready? Preparing for the Public Health Challenges of Climate Change. National Association of County and City Health Officials, Environmental Defense Fund, George Mason University. 2008.

communities adapt to climate change. Research demonstrates that ensuring the opportunity to live healthfully is a deeply held American value. Public health professionals are well positioned to explain the connections between the rapidly emerging threats associated with climate change and our personal and collective health and well-being.

## Communicating About Climate Change

Climate change is a complex topic, and communicating about it can be a challenging task. Developing a clear understanding of what the public currently believes about climate change and how those perceptions interact with personal values is an important way to improve the outcome of climate change communication.

Regarding the issue of climate change, recent research has shown there are six distinct groups of Americans. Each group has their own perceptions of climate change, has (or has not) taken different actions to respond to the issue and holds different opinions about the best climate change and energy use policies for America. These “Six Americas” range from the “Alarmed” segment, who hold the strongest beliefs in and concerns about global warming as a threat to humans and other living things, to the “Dismissive” segment, who are equally certain that global warming isn’t happening or isn’t human caused. In late 2008, when these groups were first identified, 18 percent of American adults were “Alarmed” and 7 percent were “Dismissive” — the remainder fell into one of the other four audiences, the large majority of whom believed in climate change but were less certain in their beliefs and in the best course of action (see IMAGE #4::2).

Public opinion about climate change is shaped by personal experiences and reflects other social, economic and environmental factors in the world around us. During the past two years, a number of events took place that influenced how Americans think about climate change; some of these events were directly related to climate change, others were not. These events include the global economic crisis and the rapidly escalating unemployment and mortgage default rates as well as the bitterness of the national debate around health care reform. Most recently, there were allegations that leading climate change researchers at the University of East

Anglia had suppressed dissenting findings from other climate change researchers, and significant errors were uncovered in the 2007 Intergovernmental Panel on Climate Change (IPCC) report.

## The “Six Americas” of Today and the Public Health Role

By January 2010, a dramatic shift had occurred: The proportion of Americans who believed that global warming is happening dropped from 71 percent to 57 percent; those who believed global warming is primarily human-caused dropped from 57 percent to 47 percent; and those who believe that “most scientists think that global warming is happening” dropped from 47 percent to 34 percent. The sharp economic downturn and the spike in global warming denial activity that occurred during the latter half of 2008 and 2009 caused a significant number of Americans to revise their opinions about climate change. Not surprisingly, these large shifts in public perception also influenced the proportion of U.S. adults who fall into each of the “Six Americas” (see IMAGE #4::2 and IMAGE #4::3).

Now more than ever, the public health community has a critical role to play in communicating the health impacts of climate change. Prior research shows people who understand that climate change is bad for humans are more likely to support policy responses to deal with the threat. Recently published research demonstrates that people in four of the “Six Americas” found information about the health threats associated with climate change to be useful in understanding the relevance of climate change. Moreover, people in all six of the audience segments found information about the health benefits associated with taking action against climate change to be compelling and useful.

These findings are important because they suggest how public health professionals should explain the relevance of climate change within the context of human health. People who believe that climate change is happening — that is, the majority of Americans — find value in learning about the health threats associated with climate change. This is information public health professionals can provide. More importantly, both those who don’t believe that climate change is happening

and those who do believe that it is happening support taking many of the same actions that have been proposed to limit climate change because they understand that these actions will lead to better health for all Americans. Such actions include moving away from fossil fuels and improving the design of our communities so that we can rely more on public transportation, walking and cycling in an effort to limit car use. In addition to decreasing pollution, these types of changes would have multiple health co-benefits, such as encouraging physical activity, preventing obesity and promoting community interaction. Public health professionals have the opportunity to tell the story of how America's response to climate change can improve our health and recreate our communities so that they better sustain us.

Some public health professionals may feel uncomfortable making the case that human-caused climate change is happening; climate change is a complex topic and making that case involves areas of science that are beyond the experience of many in our field. Public health professionals need not become experts in climate science to communicate the public health imperative of climate change. However, they can use the overwhelming opinion of scientists to influence public thinking.

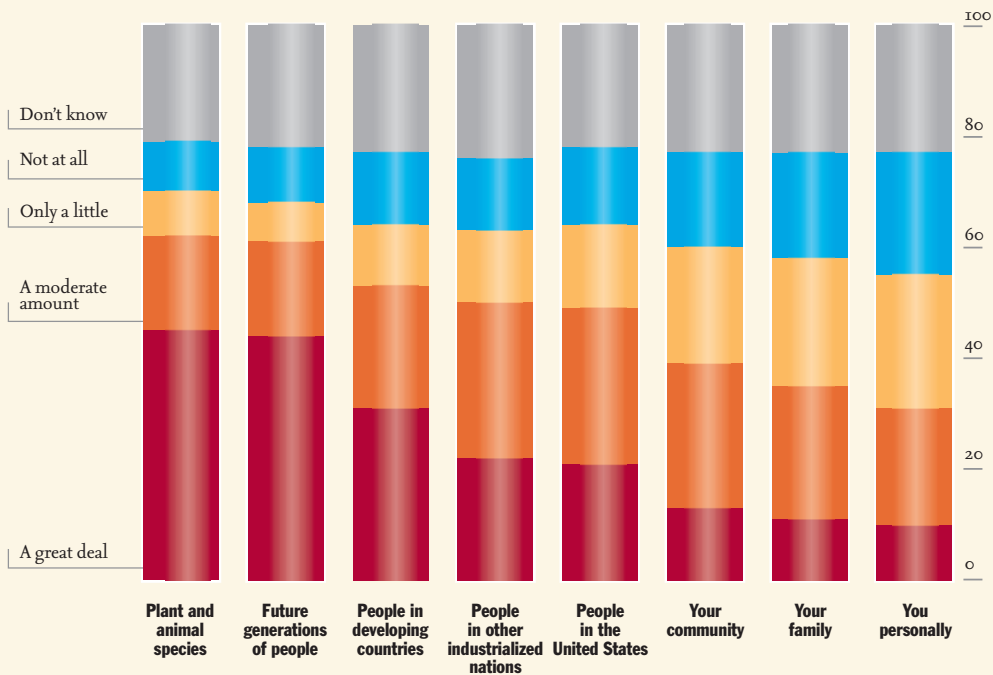
Expert climate scientists have reached a consensus that climate change is happening and that it is caused by human behavior. A recently published survey of earth scientists worldwide showed that 90 percent of all earth scientists who actively publish climate change research and over 96 percent of climatologists agree that the mean global temperature has been rising since the 18th century and that human activity is a significant contributing factor (see IMAGE #4::4). By relaying the consensus among expert climate scientists to others — that climate change is real and caused by humans — public health professionals can focus on aspects of this issue that the public health community is uniquely qualified to deal with.

The public health community has an opportunity to reframe the discussion around climate change and to advance solutions that are both good for the Earth's climate and good for people's health. Doing so will help regain public interest in and attention to this issue, catalyze action among members of the public who are already concerned about the issue and engage some members of the public who otherwise would be resistant to supporting public action.

**IMAGE #4::I**  
**Who Will Be Harmed by Global Warming?**

How much do you think global warming will harm...

Source: Leiserowitz A, Maibach E, Roser-Renouf C. *Climate Change in the American Mind*. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. 2009.



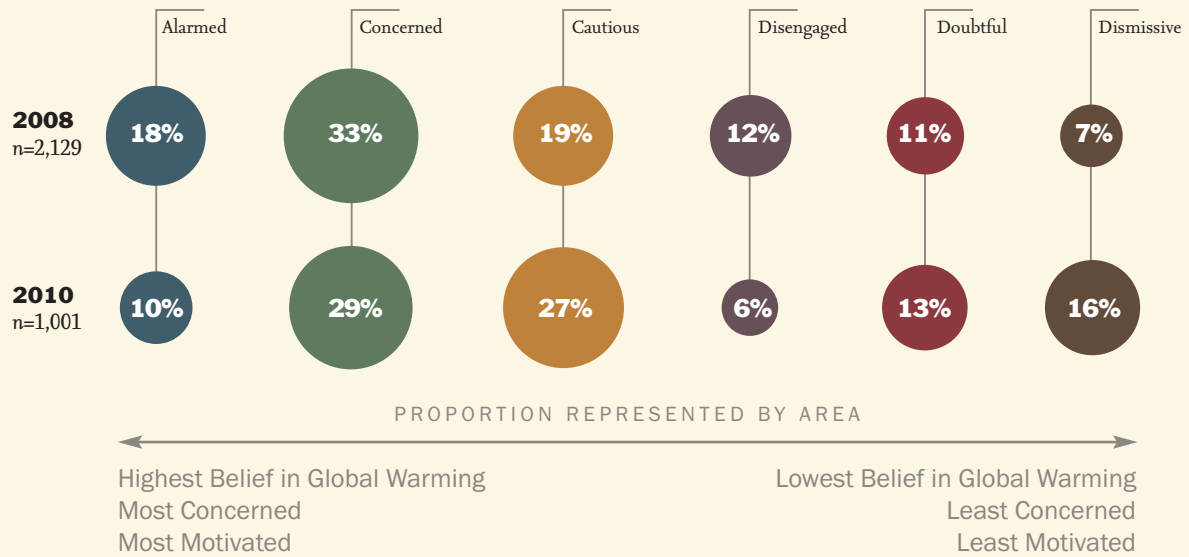
Most Americans think of the physical environment and plants and animals, not humans, as being the primary victims of the worst effects of climate change and perceive its human impact as being distant, somewhere else and in the future.



**IMAGE #4::2**  
**Global Warming's "Six Americas"**

Proportions of the U.S. adult population in the Six Americas, 2008 and 2010

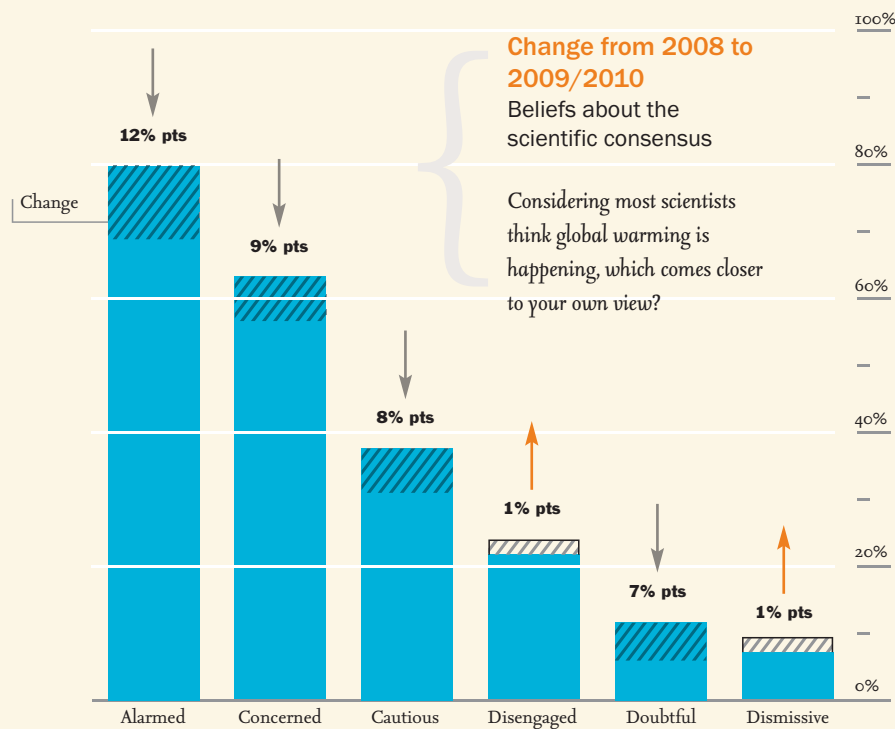
Source: Leiserowitz A, Maibach E, Roser-Renouf C. Global Warming's Six Americas. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. 2010. Available at: [http://www.climatechangecommunication.org/resources\\_reports.cfm](http://www.climatechangecommunication.org/resources_reports.cfm).



Research has found that there are six distinct groups of Americans — each group has a distinct perception of climate change.

**IMAGE #4::3**  
**Shifts in Public Perception of the Six Americas from 2008 to 2010**

Source: Leiserowitz A, Maibach E, Roser-Renouf C. Global Warming's Six Americas. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. 2010. Available at: [http://www.climatechangecommunication.org/resources\\_reports.cfm](http://www.climatechangecommunication.org/resources_reports.cfm).



A dramatic shift in the public perception about climate change within the six Americas occurred from 2008 to 2010 due to the economic downturn and spike in global warming denial activity.

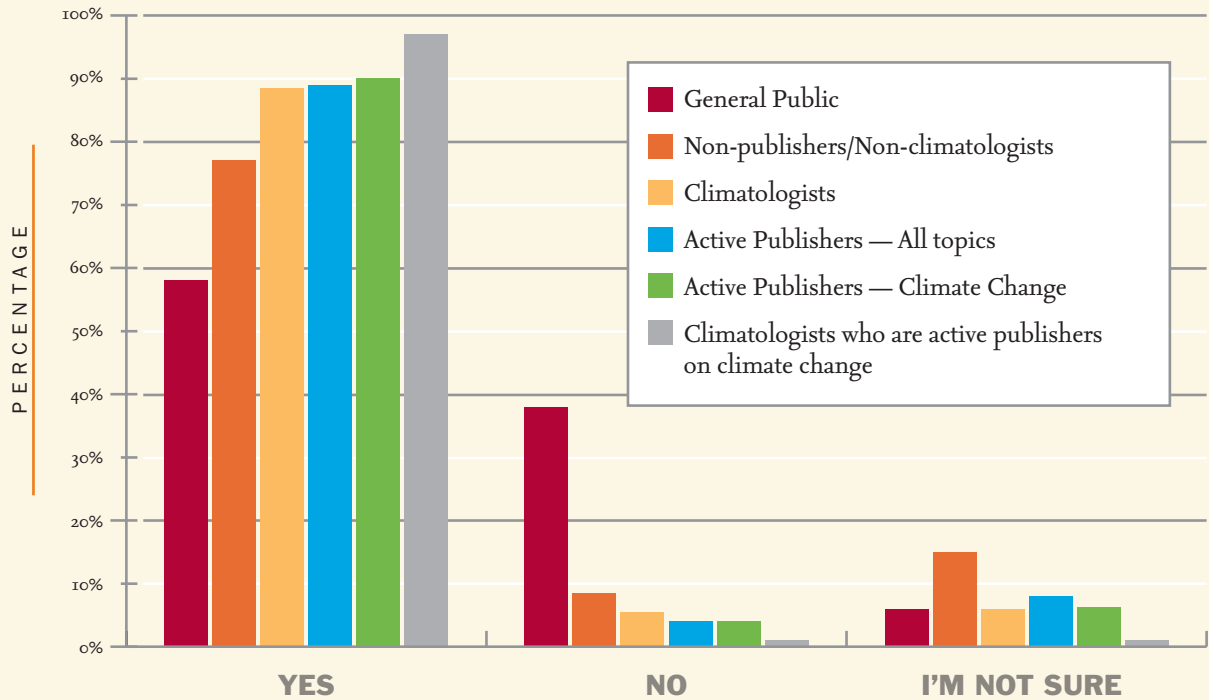
IMAGE #4::4

## A Survey of Earth Scientists (n=3,146) as compared to a Gallup Poll of the General Public\*

Has the mean global temperature risen since pre-1800? Is human activity a significant contributing factor?

Source: Doran P, Zimmerman M. Examining the scientific consensus on climate change. *Eos*. 2009;90(3):22.

\*Available at: <http://www.gallup.com/poll/1615/Environment.aspx>



The majority of scientists who publish research agree that the mean global temperature has risen since the 18th century and that human activity is a significant contributing factor.





A photograph showing two people standing under a shower of water. The water is falling from above, creating a misty and refreshing atmosphere. The people are silhouetted against the bright background of the water spray. The text is overlaid on the lower left portion of the image.

An increase in disease and death from climate change is almost certain without proper and effective climate change adaptation.



CHAPTER  
5:Climate Adaptation:  
Ensuring  
Public Health  
Preparedness

**Adaptation:** The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as the “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.”

The first four chapters have set the foundation that climate change is happening, it is real and there are health risks — around the globe as well as in the United States. These impacts will vary by region and local area and will likely have the most significant adverse effect on groups that are particularly vulnerable. (See list of groups disproportionately impacted by climate change on page 56.) Focusing on the United States, assessments need to be done at the regional and local levels to help inform public health practitioners in their adaptation planning. Assessments should address:

- 1 the short-term and long-term health impacts;
- 2 who is at greatest risk; and
- 3 what is needed to prevent harm and to prepare for these impacts.

Adaptation is not new. Nations, states, municipalities and communities have been developing preparedness plans to safeguard residents and prevent harm from a host of environmental and manmade threats throughout history. Weather events and health risks from climate change pose new and unique challenges for preparedness and adaptation. Public health practitioners have a key role to play in preparing and adapting to these climate challenges. They can help to identify and predict changes that are specific and unique to climate change as well as identify the health risks to the public as part of the overall framework of preparedness. The focus and scope of public health practitioners’ efforts — whether international, regional or local — will depend on where they work within the public health system. This chapter describes elements of successful adaptation strategies, which


**WEBINAR**  
TRANSLATION

**“Adaptation to the Health Risks of Climate Change”**

April 13, 2010

**► Kristie L. Ebi, PhD, MPH**  
Carnegie Institution for Science

include steps such as identifying vulnerabilities, tracking disease and environmental conditions, developing smart building design and educating the public on the ways they can prepare themselves and their communities for climate change.

Climate adaptation involves several steps and many stakeholders. Steps of the climate change adaptation process include:

- 1 identify current and future climate changes relevant to ecological, economic and human systems;
- 2 assess vulnerabilities and risks;
- 3 develop an adaptation strategy that prioritizes interventions by risk;
- 4 identify opportunities for benefits across sectors;
- 5 implement adaptation options; and
- 6 monitor and evaluate adaptation options and strategies and adjust as needed.\*

The ultimate goal of climate change adaptation is to reduce climate-related impacts, including harmful health impacts.

Similar to the disease prevention model, adaptation can occur at three levels:

- **Primary prevention** is intended to prevent disease, harm or exposure from ever happening. A climate change adaptation example is the protection of drinking water from contamination in the event of extreme precipitation and flooding or the development of an early warning system (see side box on page 53).
- **Secondary prevention** is a response (or intervention) that aims to prevent disease from occurring once someone is exposed. A good climate change adaptation example is enhancing a surveillance system to track and monitor a potential climate change-related disease.
- **Tertiary prevention** is the implementation of a series of measures to prevent a disease from worsening and reduce suffering caused by the disease. A climate change adaptation may improve diagnosis and treatment of a disease, thereby reducing morbidity or mortality.

For health protection, a crucial focus of adaptation should be ensuring the community has the ability to deal with variations in weather, such as extreme heat or increased precipitation from climate change, in order to prevent harm from

\*Taken from the National Research Council's America's Climate Choices: Adapting to the Impacts of Climate Change 2010.

### Adaptation Measures to Reduce Heat-Related Health Outcomes:

The following list shows examples of possible adaptations to heat-related health outcomes.

#### Legislative Policies

Alter building design and infrastructure codes to reduce urban heat islands (i.e., green roofs, etc.)

#### Decision Support Tools

Early warning systems

#### Technology Development

Improve building design to reduce heat loads during summer months

#### Surveillance and Monitoring

Alter health data collection systems to monitor for increased morbidity and mortality during a heat wave

#### Infrastructure Development

Improve urban design to reduce urban heat islands by planting trees, increasing green spaces, etc.

#### Other Measures

Conduct research on effective approaches to encourage appropriate behavior during a heat wave

### Adaptation and Early Warning

**Systems:** Early warning systems use environmental and health data to forecast regional health risks and are important for adaptation planning. **IMAGE #5::1** shows how researchers were able to develop an early warning system for malaria in Botswana by using environmental variables to predict outbreaks. Public health practitioners and climate experts should work together to develop early warning systems for heat waves and precipitation extremes.

ever happening. Public health practitioners have a key role to play in the adaptation process, especially in the early stages when health considerations must be part of the initial planning process. Failure to include health considerations early in the adaptation process will make adaptation planning much more challenging in the future and is likely to result in adverse health impacts.

In general, preparedness and adaptation target two types of risk: existing, such as an existing disease, pollutant or event, and new, such as an increase or first occurrence of a disease, pollutant or event. Climate change may add to existing risks and result in new risks. Integration of climate change risks, including new risks into existing preparedness planning, will help to facilitate an efficient and coordinated approach across all stakeholders and ensure that communities are ready and resilient.

## Adaptation—Important Considerations

Adaptation will vary depending on the time, scale and scope of the system or place for which adaptation is being developed. For example, some adaptation efforts may focus on a specific location or time, whereas others may be global in scale. Availability and sufficiency of resources may also affect adaptation options as decision-makers will have to weigh relative costs of adaptation against the risks of impacts. In all instances, important factors and questions to consider throughout the adaptation process are:

- 1 the current state of community preparedness for combating disease;
- 2 recent climate trends;
- 3 uncertainties associated with climate variability and change;
- 4 projected impact of climate change, including health impacts;
- 5 immediate local and regional actions to prepare for the effects of climate change;
- 6 timing and location of implemented adaptation activities; and
- 7 barriers, constraints and limitations to implementing adaptation strategies.

Given the growing number of issues facing public health practitioners today, the greatest challenge for the public health workforce will be to adapt to risks from

climate change while also confronting many other existing environmental and health stressors.

However, regardless of the effectiveness of climate change adaptation planning and implementation, adverse health impacts from climate change are likely to occur. Therefore, mitigating climate change is also very important.

Given the complexity of climate change and its potential impact on a system, an interdisciplinary approach — involving many sectors and professions, such as public health, agriculture, transportation and water resource management — in both climate change adaptation and mitigation is necessary. Many choices and activities within non-health sectors can and will have an impact, both adverse and beneficial, on public health. For example, wise land-use planning and transportation decisions can help to mitigate climate change and be beneficial for health. Conversely, poor decisions in these sectors can further contribute to greenhouse gas emissions and have a detrimental impact on health.

## Adaptation and Climate Variability

As shown in Chapter 2, climate change impacts vary geographically. In addition, recent climate research suggests a greater likelihood of repeated small events and disasters as well as increased frequency and intensity of large-scale events and disasters. In Europe, for example, a recent five-year period produced eight “one-in-500 years” extreme weather events that included heat waves, blizzards and heavy rains with associated flooding.

To successfully protect health and reduce health risks, adaptation strategies must account for these variations in climate. Two key criteria of any successful adaptation strategy are resiliency under a range of scenarios and the ability to make adjustments with little cost.

Those involved in adaptation, including public health practitioners, need to consider how current systems and measures, such as surveillance and monitoring systems or early warning systems, can be adapted to meet changes in climate and subsequent impacts in the future.

In particular, adapting surveillance and monitoring systems to account for climate change is a key health protection measure. IMAGE #5::2 illustrates the need to manage current climate health risks while preparing a response to a future health threat — in this case, the prevention of malaria.

A sustained commitment, one that is flexible and accounts for potential changes in climate impacts over time, is necessary for successful adaptation planning and implementation. An unfortunate case where a sustained commitment was lacking is in the case of *Aedes Aegypti*, a mosquito known to carry dengue fever and other diseases. IMAGE #5::3 shows the impacts of efforts to control the spread of *Aedes Aegypti* and its subsequent proliferation through the Americas due to a lack of funding for vector-control programs (the necessary intervention strategy). Sustained commitment to adaptation through monitoring adaptation decisions and continually updating the planning process is critical. An increase in disease and death from climate change is almost certain without proper and effective climate change adaptation.

## WEBINAR

TRANSLATION

### “Protecting the Most Vulnerable: A Framework for U.S. Climate-Health Preparedness”

April 13, 2010

#### ► Kim Knowlton, DrPH

Senior Scientist, Natural Resources Defense Council, and Assistant Clinical Professor, Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University

All Americans are facing increased risks from climate change, especially those with impaired health or greater susceptibility, such as asthma sufferers. Identifying climate health vulnerabilities and those individuals most likely to be affected is a first step in adaptation planning and a critical role for public health practitioners.

Research documents current impacts from climate change on the environment and on health which includes the national impacts and health outcomes (see IMAGE #5::4). Examples of harmful health outcomes that can be worsened by climate change include allergies, the spread of infectious disease, and heat or cold stress. (See Chapter 2 for information on health effects.)

## Adaptation and Climate Vulnerability Factors

Some populations have greater underlying susceptibility to harmful health outcomes of climate change. Vulnerability to climate change includes many factors, such as geography, local housing and infrastructure, public health resources, social



circumstance, age and health status, and must be considered in adaptation planning. Take the example below:

Community A is suffering from high exposures to late summer ozone smog. This particular community also has a high prevalence of pediatric asthma. Emissions from local vehicles and industry worsen smog and particulate air pollution and contribute to rising carbon dioxide (CO<sub>2</sub>) concentrations. Higher CO<sub>2</sub> levels also increase ragweed pollen production. Greater levels of pollen and air pollution exposure, combined with a population with increased susceptibility to adverse respiratory effects, lead to adverse impacts for this vulnerable segment of the community. Even worse, if Community A lacks an alert system for high smog or high pollen days, residents do not have needed information to take action and adopt countermeasures that limit the harmful effects of climate change on their community — that is, reduce daily exposures, change their behaviors and adapt to changing conditions.

Everyone is vulnerable to climate change, as described in Chapter 2. However, some groups are particularly vulnerable based on social, economic, environmental and biological factors. Vulnerable groups disproportionately impacted by climate change include:

- people living in poverty
- people without air conditioning
- outdoor workers
- children, as they are more susceptible to dehydration and have faster breathing rates. On average, children also spend more time outdoors than adults, increasing their chances for allergies and infectious disease.
- the elderly, who have increased susceptibility to heat due to decreased mobility and limited ability to thermo-regulate
- pregnant women
- people with chronic illness
- people with acute illness
- people who are disabled

The resources and infrastructure needed to adapt to many of the impacts of climate change exist, but efforts must be made to identify and target the most vulnerable communities to be successful. Those at greatest risk are often the least prepared. A community that is unprepared may face significant and costly effects resulting from climate change.

### Heat Warning Systems

Philadelphia is taking a progressive approach toward managing heat crises through early warning systems. Research shows that between 1995 and 1998, the city saved an estimated 117 lives by instituting an early warning system for heat. Some 20 cities in the United States currently have an early warning system for heat.

## Recommendations for adaptation planning for heat emergencies include:

### Identifying Vulnerable Communities

- Determine what ZIP codes are most at risk
- Determine where there are concentrations of elderly individuals living alone, those without air conditioning and those living in poverty

### Tracking

- Develop heat wave alert systems for early warning

### Climate-Smart Design

- Design to create sustainable communities; use alternative energy and energy efficiency to reduce urban heat island effects

### Public Education

- Promote cooling centers to those without air conditioning and provide transportation to these locations
- Develop and disseminate health care provider education tools that help clinicians encourage healthy choices for people experiencing a heat wave
- Develop employer education tools for workers who are vulnerable to heat stress

## California Case Study: Adaptation to Heat Emergencies

Heat waves are expected to increase in frequency as a result of climate change, and the 2006 California heat wave demonstrates the tragic consequences of being unprepared. Heat emergency preparedness is critical — virtually all heat wave-related deaths can be prevented through adaptation strategies. California's heat wave was responsible for 655 excess heat deaths, 140 coroner-confirmed heat deaths, more than 16,000 emergency room visits and about 1,200 hospitalizations (see IMAGE #5::5). Many of California's heat wave victims were from the most vulnerable groups.

To identify California's heat-related vulnerabilities, the California Department of Public Health participated in a study that mapped out factors attributed to heat illness. The study looked at contributing factors and mapped populations ages 65 or older living alone and those without air conditioning, among other factors. These data can be found in the summary report on California's Heat Vulnerability Assessment at: [http://www.ehib.org/papers/Heat\\_Vulnerability\\_2007.pdf](http://www.ehib.org/papers/Heat_Vulnerability_2007.pdf).

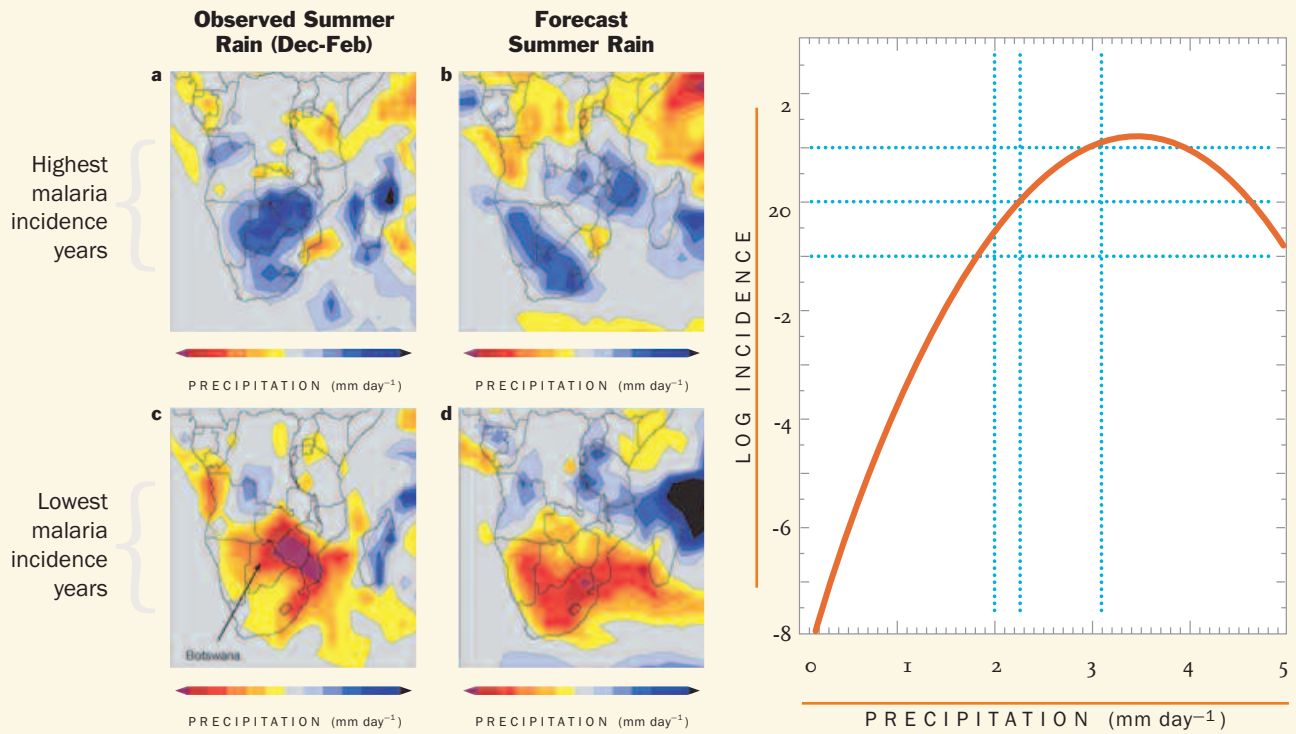
The 2009 study on California's 2006 heat wave produced aggregated data for six regions of the state assessing county-level statistics on hospitalizations and emergency room visits during the crisis. This data-mapping shows where the relative risk of heat-related emergency room visits was greatest. Findings also show the highest risk was on the central coast of California, where fewer residents have air conditioning and the population is not used to extreme heat.

The effects of climate change are clearly local, and adaptation planning should address specific health outcomes that can be expected. Along with federal adaptation programs now under way, state and local governments are helping to lead the way in framing adaptation policy. Public health practitioners must get involved in adaptation planning to provide expertise to committees assigned to developing long-term strategies for dealing with climate change and its effects on vulnerable populations. There are many ways states can adopt more comprehensive adaptation policies. Adaptation, combined with efforts to reduce greenhouse gas emissions, will ensure healthier communities today and greater resiliency to future climate change impacts.

IMAGE #5::I

## Using Climate-Health Data for a Malaria Early Warning System in Botswana

Source: Thomson MC, Mason SJ, Phindela T, Connor SJ. Use of rainfall and sea surface temperature monitoring for malaria early warning in Botswana. *Am J Trop Med Hyg.* 2005;73(1):214-221.

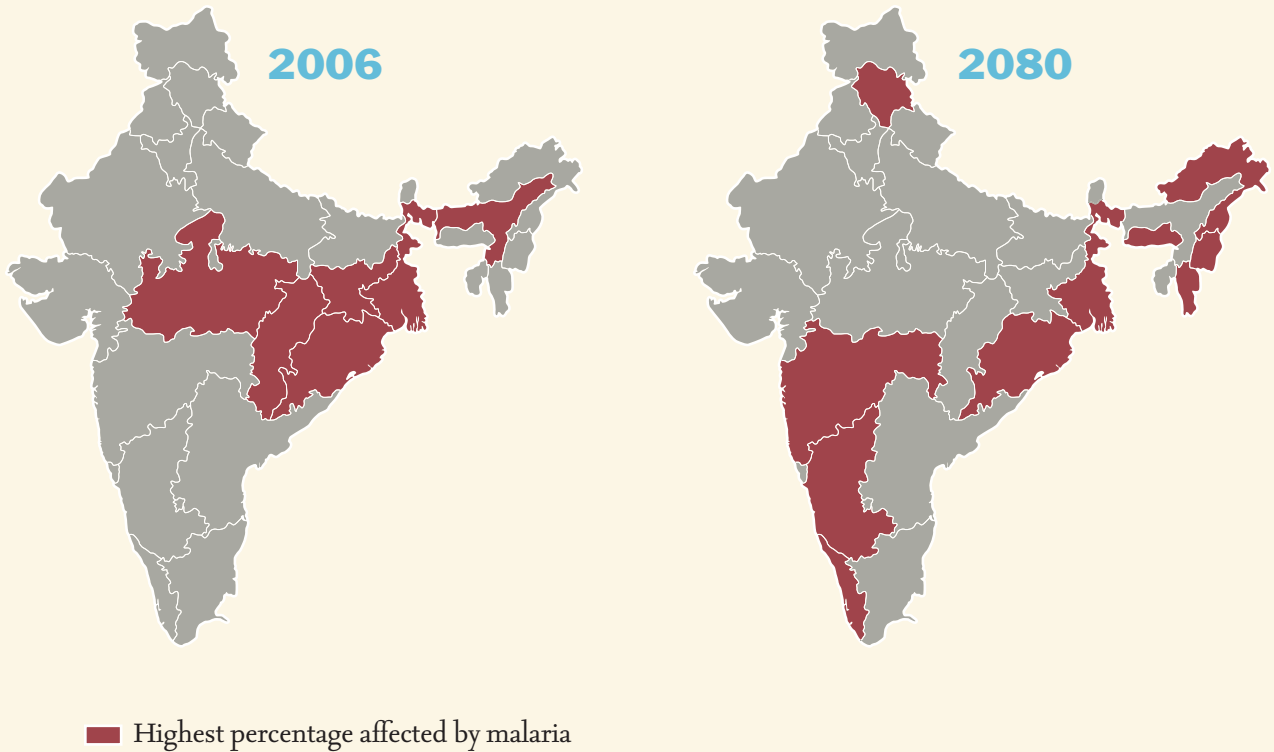


Environmental health data in Botswana were analyzed to develop an early warning system. This research helped public health professionals prepare for and predict malaria outbreaks and anticipate seasonal fluctuations.

IMAGE #5::2

## Malaria in India: Current and Projected Climate Health Risks

Source: Bhattacharya S, Sharma C, Dhiman R, Mitra A. Climate change and malaria in India. *Current Science*. 2006;90(3):369-375.

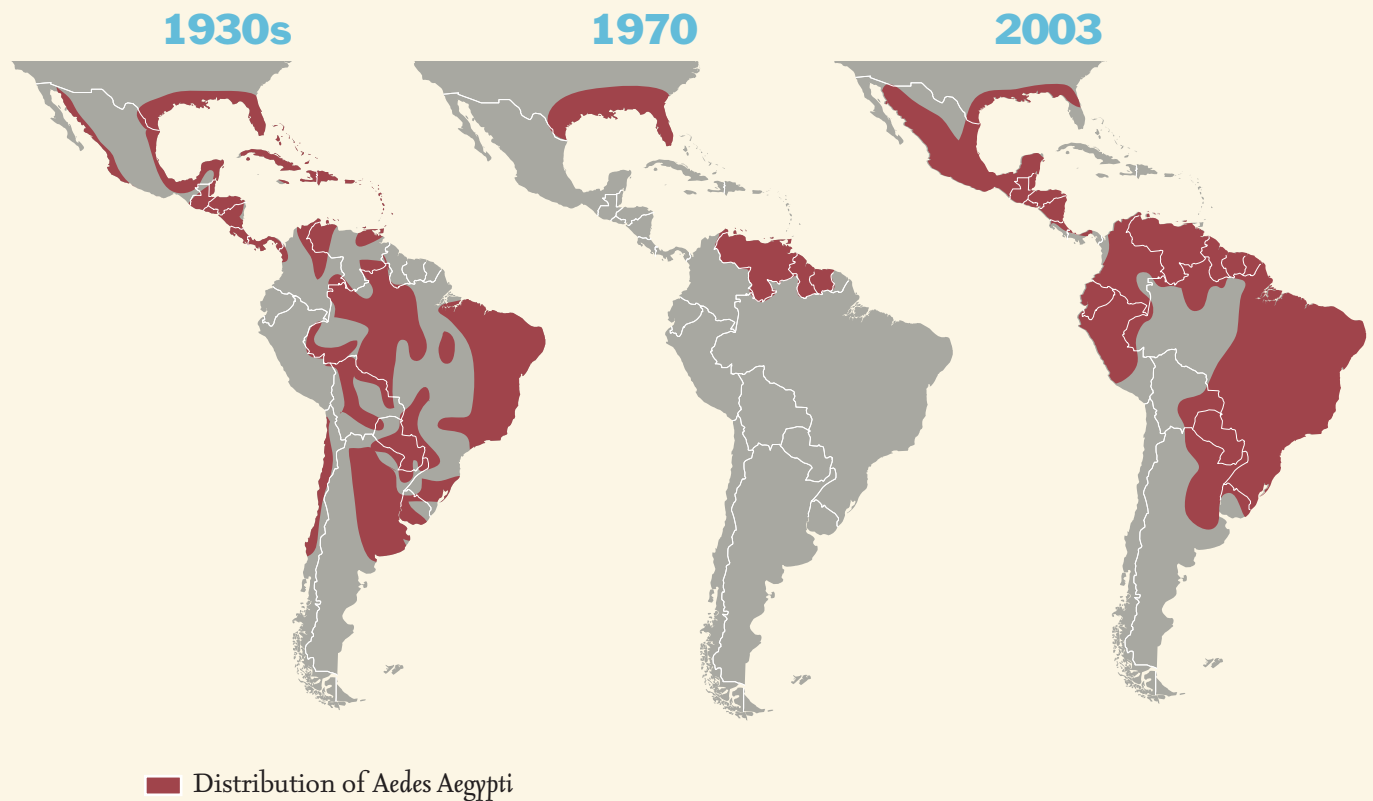


The projected distribution of malaria by states within India in 2006, as shown on the map on the left, is vastly different than the projected distribution of malaria in 2080, as shown on the map on the right. Public health practitioners need to plan for current environmental health challenges, but be adaptive to future climate health risks.

IMAGE #5::3

## The Distribution of *Aedes Aegypti* in the Americas

Source: Gibler DJ. The changing epidemiology of yellow fever and dengue, 1900 to 2003: full circle? *Comparative Immunology, Microbiology and Infectious Diseases*. 2004;27(5):319-330.



*Aedes Aegypti* is a mosquito that can spread dengue fever and yellow fever viruses. The maps display the resurgence of *Aedes Aegypti* in 2003 following the dissolution of disease control efforts in 1970. Public health efforts dramatically reduced the presence of *Aedes Aegypti* in the Americas, as shown in the center map, before these programs dissolved.

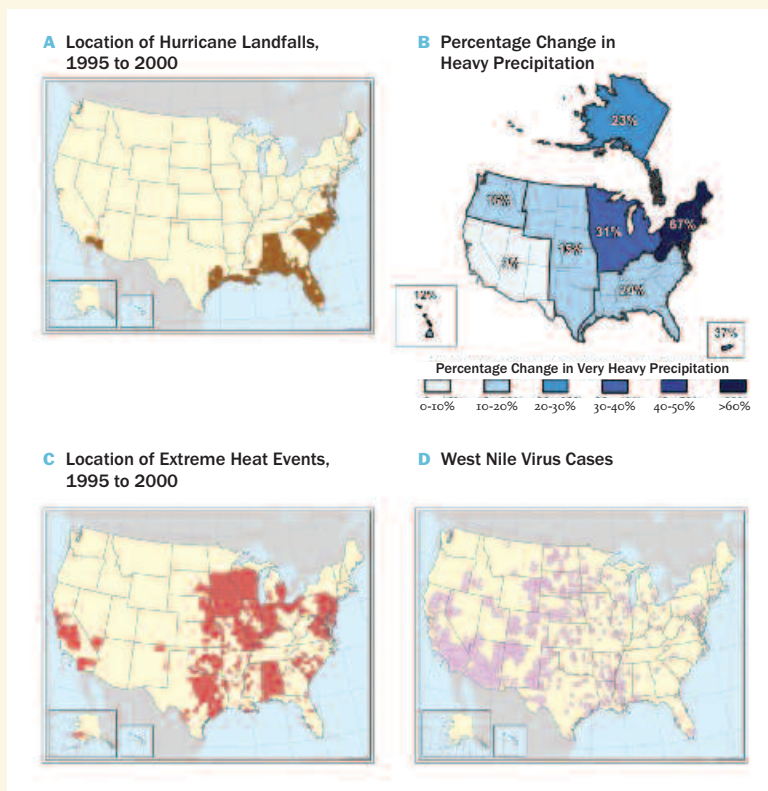


## IMAGE #5::4

## U.S. Impacts of Climate Change

Source: United States Global Climate Change Research Program. Global Climate Change Impacts in the United States. Cambridge University Press; 2009.

Ebi KL, Balbus J, Kinney PL, et al. Effects of Global Change on Human Health. In: Gamble JL, ed; Ebi KL, Sussman FG, Wilbanks TJ, authors. 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. Washington, DC: U.S. Environmental Protection Agency. 2008: 2-1 to 2-78.



2°F (1.1° C) higher average temperature in past 50 yrs

Sea level rise >8 inches in past 50 years in parts of Atlantic & Gulf Coasts

Increase in heavy downpours, as much as 67% in Northeast

Rapidly retreating glaciers, thawing permafrost

Earlier snowmelt, changes in river flows contribute to flooding

Pollen season longer, production double since 1900

4-fold increase in large western wildfires in recent years

158 million Americans live with unhealthy air pollution

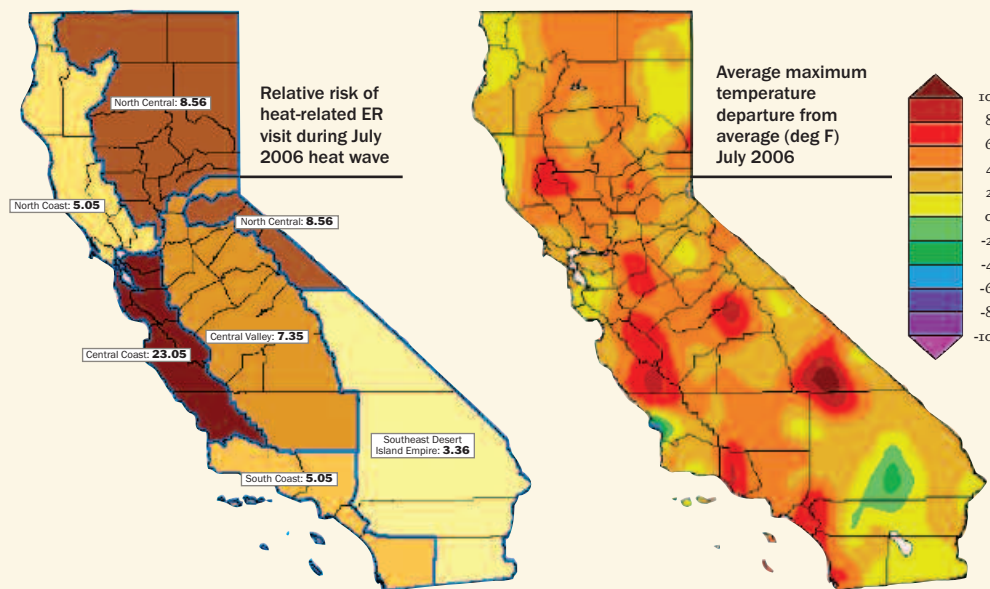
These maps demonstrate the current impacts of climate change on the United States. Research documents increases in temperature, rising sea level, increased intensity of storms and greater frequency of wildfires resulting from global warming.

## IMAGE #5::5 Tracking & Surveillance

### Relative risk of heat-related emergency room visits in California during July 2006 heat wave

Source: Knowlton K, Rotkin Ellman M, King, G, et al. The 2006 California heat wave-impacts on hospitalizations and emergency department visits. *Environ Health Perspect.* 2009;117(1):61-67.

Edwards L. Monthly weather summary. California Climate Watch. 2006;3(7):1-2. Available at: <http://www.calclim.dri.edu/climatewatch/CalClim200607-2.pdf>.



Generated August 1, 2006 at WRCC using provisional data.  
NOAA Regional Climate Centers

The 2006 California heat wave had a substantial effect on morbidity. This suggests that population acclimatization and adaptive capacity influenced risk. By better understanding these impacts and population vulnerabilities, local communities can improve heat wave preparedness to cope with climate change.



Climate change is a  
public health issue...with  
environmental consequences.



CHAPTER  
6:Public Health and Climate Change:  
EPA and HHS  
Perspectives

To close the webinar series, APHA and CDC invited two leaders from federal agencies that play key roles in the public health response to climate change: Dr. Howard Koh, assistant secretary for health with the U.S. Department of Health and Human Services, and Ms. Gina McCarthy, assistant administrator for the Office of Air and Radiation with the U.S. Environmental Protection Agency.

Both presenters echoed much of what was discussed in previous webinars — that climate change is real and that it is happening now (Chapter 1); climate change is a public health issue (Chapter 2); and public health practitioners at all levels have a key role to play in responding to and preparing for climate change (Chapters 3–5).

Both leaders shared what their agencies are doing to respond to the challenges of climate change and how these efforts relate to the goals and missions of their respective departments. They stressed the need for collaboration across sectors and between the growing number of federal agencies responding to climate change.

Presenters also described recent HHS and EPA collaboration on climate change work. Representatives from the agencies participate in an Interagency Working Group on Climate Change and Health, which was established as a collaborative effort to develop a strategic plan for basic and applied research on the human health effects of climate change. The two agencies held a 2009 White House stakeholder briefing on the health benefits of clean energy reform, and representatives from HHS and EPA comprise the Subcommittee on Global Change Research within the National Science and Technology Council. These and other HHS and EPA climate change activities are detailed in this chapter.





## WEBINAR

TRANSLATION

### “Looking Ahead: Advancing the Public Health Response to Climate Change”

June 30, 2010

► **Howard K. Koh, MD, MPH**  
Assistant Secretary for Health,  
U.S. Department of Health and  
Human Services

The science is clear that climate change is real and that it presents significant and costly health challenges. In fact, the World Health Organization estimates that climate change is already linked to more than 150,000 deaths each year. However, the public health effects of climate change remain largely unaddressed — at home and abroad.

The prevention approach — a model that public health practitioners are uniquely qualified to implement — is key to ensuring that climate change has a limited effect on the public's health and safety and makes certain that preparedness will remain central in assuring community resiliency in the face of climate change. Public health practitioners at all levels of government will — and do — have key roles in responding to climate change.

## Overview of HHS

HHS is the principal agency charged with protecting the health of all Americans and providing essential health services, especially for those who are least able to help themselves. HHS consists of the Office of the Secretary and 11 operating divisions with more than 65,000 employees.

### Health Impact Assessment

A health impact assessment is a combination of procedures, methods and tools that assess the impact of a policy or decision on health. HIAs can be used during the development of transportation, energy and land-design policies to ensure that health impacts are considered in decisions that are interrelated with climate change.

HHS upholds the social determinants approach in its work. Its Healthy People initiative aims to create social and physical environments through its “health in all policies” framework. This framework builds on the belief that all policies — whether transportation, affordable housing or access to nutritious foods — affect people's ability to attain good health. Such a framework can be sustained with the use of health impact assessments — a tool that helps measure the health impact of diverse policy decisions.

## Climate Change — The Public Health Approach

Taking action on climate change is often presented as two types of activities: primary prevention which often translates to mitigation, and adaptation or preparedness.

Mitigation is not only central to public health's climate change approach, but offers significant health co-benefits. For example, increasing safe and viable opportunities to walk and bike not only curbs the emissions that cause climate change, but promotes physical activity, combats obesity and reduces respiratory and cardiovascular illness rates.

Adaptation was covered in detail in Chapter 5. To recap, key elements of successful adaptation strategies include identifying vulnerabilities, tracking disease and environmental conditions and educating the public on the individual ways they can prepare themselves and their families for climate change.

Primary prevention often results in mitigation and includes efforts to slow, stabilize or reverse climate change by reducing greenhouse gas emissions. Primary prevention strategies include increasing energy efficiency in buildings and vehicles via smarter land-use and community design decisions as well as increasing opportunities for alternative transportation, i.e., walking, biking and public transit.

Secondary prevention, often referred to as adaptation, includes efforts to anticipate and prepare for the effects of climate change and reduce the associated health burden. Such activities can be integrated into existing public health preparedness plans.

Tertiary is a third form of prevention that aims to halt any additional increase in the burden of illness and injury through various public health interventions. The public health practitioner plays an important and unique role through these interventions.

## HHS Activities

Leading agencies within HHS on climate change include the National Institutes of Health (NIH), which supports research on the environmental and human health effects of climate change, and the Centers for Disease Control and Prevention (CDC), which identifies the health impacts of climate change and the populations most vulnerable to its effects, anticipates future trends and oversees and develops the systems needed to detect and respond to emerging health threats.

At the federal level, HHS has been involved in several significant collaborations. Specifically, HHS is collaborating with the U.S. Global Change Research Program, the Intergovernmental Panel on Climate Change, the Interagency Climate Change Adaptation Task Force, the Interagency Working Group on Climate Change and Health and the National Ocean Council.

During the past several years, HHS has also been involved in several notable events and publications regarding climate change and health. In 2008, CDC authored “Climate Change and the Health of the Public,” which was published in the *American Journal of Preventive Medicine*. As mentioned earlier, in the fall of 2009, HHS and EPA held a White House stakeholder briefing on the “Public Health Benefits of Clean Energy.” In addition, NIH’s National Institute of Environmental Health Sciences (NIEHS) co-funded *The Lancet* Health and Climate Change series, which addressed the public health impacts of climate change: <http://www.niehs.nih.gov/news/releases/2009/climatechange.cfm>.

NIEHS was also the coordinating author of the landmark report “A Human Health Perspective on Climate Change,” which was released in April 2010 through the Interagency Working Group on Climate Change and Health. The report identified the research needed to better understand and reduce the health effects of climate change. It also highlighted the health consequences of climate change and provided a starting point for the coordination of federal research and response activities.

#### Partner Spotlight

CDC is partnering with Texas’ Travis County Health Department to include health indicators in Austin’s climate protection planning process. The agency is developing vulnerability mapping tools that will allow the county health department to identify vulnerable areas that can benefit from better urban planning and climate mitigation efforts.

## CDC and State and Local Health Partners

CDC plays a key role in supporting state and local health partners in their climate change activities. The CDC Climate Change Program provides technical guidance and support for adaptation planning, maps vulnerabilities at the regional, state and local levels and is in the process of enhancing surveillance tools, such as CDC’s National Environmental Public Health Tracking Network, to include climate change indicators.

**Based on a survey** of local health directors conducted by the National Association of County and City Health Officials and George Mason University (discussed in Chapter 4), nearly 70 percent of those surveyed believed that their jurisdiction had experienced climate change in the past 20 years and 77 percent felt they lacked the resources needed to address climate-related health threats. Report available at: [http://www.edf.org/documents/7846\\_AreWeReady\\_April2008.pdf](http://www.edf.org/documents/7846_AreWeReady_April2008.pdf).

CDC also helps translate emerging climate science information and reports into information that is easily accessible to its diverse public health partners.

## A Call to Action and a Vision for the Future for Public Health and Front-Line Defenders

Public health practitioners are often the first line of defense against the health impacts of climate change. The 10 essential services are the tenets of public health practice. The public health practitioner's role in climate change can be aligned with these essential services (see IMAGE #6::I).

Public health practitioners, especially those at the state and local levels, have an important role in promoting policies that simultaneously confront climate change and benefit health through collaboration with nontraditional health partners, including those in transportation, energy, agricultural and environmental sectors. Public health practitioners also play an important role in educating decision-makers about these policies, especially through the use of localized and regional data.

Looking to the future, a public health response to climate change must include:

- 1 a well-prepared front line of defense: Local health providers and health departments should be prepared for any adverse impacts of climate change and know which populations are at greatest risk for negative health impacts;
- 2 reliable tracking systems to monitor diseases related to climate change and to identify trends;
- 3 investigation of disease outbreaks potentially associated with climate change;
- 4 health care providers who are well trained on the health aspects of climate change; and
- 5 effective communication and educational strategies to inform the public and policy-makers about the health impacts of climate change.

Confronting climate change means public health practitioners at all levels must get involved. Working together, our vision for the future is shaped by science-



## WEBINAR TRANSLATION

### “Climate Change: Connecting Public Health with Environmental Policy”

June 30, 2010

▶ **Gina McCarthy**

Assistant Administrator, Office of Air  
and Radiation, U.S. Environmental  
Protection Agency

based efforts that promote health, protect people, engage communities and prepare for a healthier future.

The federal government’s and EPA’s position on climate change is now clear: It is real, it is endangering public health and welfare, and now is the time to take action.

Cooperation is key to the federal response and work addressing the challenges of climate change. Such collaboration is astutely illustrated in the work between HHS and EPA.

## EPA Overview

EPA’s mission is to protect human health and the environment — the 2011–2015 strategic plan identifies five goals that guide the agency’s work:

- 1 taking action on climate change and improving air quality;
- 2 protecting America’s waters;
- 3 cleaning up communities and advancing sustainable development;
- 4 ensuring safety of chemicals and preventing pollution; and
- 5 enforcing environmental laws.

EPA also aims to protect those most vulnerable to environmental hazards.

## EPA and Climate Change

As stated above, taking action on climate change is among the top five strategic goals of EPA. The agency is at the forefront of the climate change discussion and is charged with researching and responding to its impact on health and the environment. Along with other federal agencies, EPA supports evidence that shows that climate change poses a threat to human health and welfare via temperature effects (e.g., severe heat waves), extreme weather events and an increase in climate-sensitive diseases. The science supports the agency’s stance that climate change is a real threat to human health and welfare.



## Climate Change and Air Quality

EPA continues to address air quality through the federal Clean Air Act, as climate change impacts air quality. For example, higher temperatures can interact with ozone and particle air pollution to increase negative health effects; hotter temperatures stimulate the growth of allergens that may increase sensitivity to air pollution and irritate asthma; and disruptions in social systems can increase overall vulnerability to a variety of stressors, including air pollution.

**EPA estimates** that clean energy and pollution reduction in the United States can result in significant annual health benefits and cost savings. For example:

- A reduction of 1,000 tons of SO<sub>x</sub> (a greenhouse gas) from power plants will save \$33 million to \$82 million per year.
- A reduction of 1,000 tons of direct particulate matter 2.5 (a harmful respiratory pollutant) from industrial sources will save \$190 million to \$460 million per year.
- A reduction of 1,000 tons of direct particulate matter 2.5 from mobile sources will save \$230 million to \$560 million per year, in part through 4,300 fewer missed days of work and 30 to 80 fewer cases of premature death.

A good example of the impact of climate change on air quality is ground-level ozone. Ground-level ozone is a harmful air pollutant — it can cause respiratory distress, exacerbate asthma and cause lung disease. It is a primary constituent of smog and is formed at ground level through a chemical reaction between oxides of nitrogen (NO<sub>x</sub>) and volatile organic compounds (VOCs) in the presence of sunlight. NO<sub>x</sub> and other VOCs come from vehicle exhaust, industrial emissions and other sources. Sunlight and increased temperatures can increase ground-level ozone. In a 2009 report (see IMAGE #6::2), EPA used modeling to project that by 2050 in particular areas of the country, climate change could cause an increase in ground-level ozone during the summer as well as lengthen the ozone season.

In line with its mission to protect air quality and employing the power of the Clean Air Act, EPA is striving to achieve climate and air quality “co-benefits,” i.e., reducing the harmful emissions that cause and exacerbate illness while also combating climate change.

Harmful emissions come from a variety of sources, such as power plants, heavy-duty diesel engines, cars, trucks, industrial manufacturers and wood-burning stoves. Currently, EPA is taking advantage of several opportunities to promote better health and confront climate change, particularly in the area of clean energy and energy efficiency. For example, the agency is working to develop and implement comprehensive energy strategies at industrial facilities that will reduce energy demand and pollution as well as promote new and efficient clean energy technologies.

## Climate Change and Water

EPA also understands and is managing climate change as a significant and challenging water quality issue. (Climate change and its impact on water and health, including the overtaxing of combined sewage overflow systems due to increased precipitation and resulting surface water contamination, are discussed in Chapter 2.)

In addition to the impact on combined sewer overflows, changes in the amount, frequency and type of precipitation from climate change could have various effects on water in different regions of the country (see the Chapter 2 map of U.S. regional impacts). For example, an increase in the amount and frequency of precipitation could result in increased flooding and greater runoff and erosion, which could negatively impact water quality. Conversely, a decrease in the amount and frequency of precipitation could constrain water resources and affect water quality in drier areas of the country. Rising temperatures may also diminish snow packs, for example in the Northwest, by increasing evaporation and affecting seasonal availability of water.

## Climate Change Adaptation

EPA recognizes and supports climate change adaptation strategies that benefit health, protect water sources and contend with climate change-induced energy needs and issues. (Adaptation is covered in detail in Chapter 5.)

Climate change adaptation strategies that can protect health and prevent harm will require adequate support from the public health system. Funding and support is needed to ensure proper training of public health practitioners, and to ensure that surveillance, emergency response and other prevention-focused programs are in place.

Other adaptation strategies that may benefit health include urban tree planting to help moderate temperature changes; strengthened weather advisories to alert the public to harmful and dangerous heat conditions; and methods to counter what

is known as the urban heat island effect, such as employing green roofing, planting trees and vegetation and increasing the use of cool roofs and pavements to lower temperatures in cities.

To protect the nation's water resources, adaptation strategies include changing water use and demand through common-sense community restrictions; improving water use efficiency; planning for alternative water resources, such as desalinization; and making changes to water allocation.

Adaptation strategies that address climate change-induced energy needs, such as higher energy demands during heat waves, include promoting energy efficiency to offset energy demand and consumption; protecting energy facilities; and diversifying the power supply to ensure full coverage in case a facility is unable to meet demand.

## Climate Change Mitigation and Regulation

A key and significant role that EPA plays in combating climate change and protecting public health is in the realm of mitigation and regulation.

On December 7, 2009, EPA Administrator Lisa Jackson signed the Greenhouse Gas Endangerment Finding,\* which confirmed that greenhouse gases pose a danger to human health and welfare, and that mobile sources contribute to that endangerment. This significant and pioneering finding lays the groundwork for future control and regulation of harmful greenhouse gas emissions.

EPA is now using its regulatory authority to reduce greenhouse gas emissions from mobile and large industrial sources.

Two significant mitigation rules are:

- **The Light-Duty Vehicle Greenhouse Gas Emissions Standards:** EPA and the National Highway Traffic Safety Administration have been working together on developing a national program of harmonized regulations to reduce greenhouse gas emissions and improve fuel economy of light-duty vehicles. The agencies issued

\*APHA supports EPA's endangerment finding as well as other efforts to reduce harmful air emissions and protect health.

final rules establishing standards for 2012–2016 model year passenger cars, light-duty trucks and medium-duty passenger vehicles on April 1, 2010. They require these vehicles to meet an estimated combined average emissions level of 250 grams of carbon dioxide per mile or the equivalent to 35.5 miles per gallon (MPG) if the automobile industry were to meet this carbon dioxide level solely through fuel economy improvements. Together, these standards will cut greenhouse gas emissions by an estimated 960 million metric tons and save 1.8 billion barrels of oil over the lifetime of the vehicles sold under the program. The agencies are now in the process of developing a rulemaking process to set standards for model years 2017–2025.

- **The Mandatory Greenhouse Gas Reporting Rule:** This rule requires the largest emitting sources, or about 10,000 facilities, to report their greenhouse gas emissions. The rule covers about 85 percent of such emissions in the United States. Reports were due in March 2011.

## Providing Opportunities to Communities

EPA offers several grants to communities and governments to assist in the fight against climate change.

**Climate Showcase Communities Grants:** Launched in 2009, this grant program offers competitive funds to local and tribal governments to establish and implement climate change initiatives. Ten million dollars in grants were made available in fiscal years 2009 and 2010.

**National Clean Diesel Campaign and Grant Program:** This program distributes funding for clean diesel activities, such as engine retrofitting and other emerging clean technologies. A combined funding amount of \$120 million was available in fiscal years 2009 and 2010.

**Clean Water State Revolving Fund:** This fund provides low-interest, flexible loans to fund water quality protection projects, such as wastewater treatment, nonpoint source pollution control and watershed and estuary management. To date, more than \$68 billion, in the form of 22,700 low-interest loans, have been granted.

## The Important Role of Public Health

In line with HHS' perspective, public health practitioners and their unique skills are integral in the ongoing struggle against climate change. And these practitioners are a valued EPA partner.

In particular, public health agencies and practitioners have several important roles to play, as echoed in previous chapters.

- 1 They play a key role in helping communities adapt to and prepare for climate change-related events and impacts.
- 2 Because public health workers intimately understand the needs and issues within their communities, they can assist agencies such as EPA in crafting regulations, voluntary programs and grant initiatives that better protect and respond to the needs of a diverse population.
- 3 Public health organizations and practitioners are crucial in relaying important messages and education about climate change to those who need this information.

EPA is committed to the fight against climate change and the protection of human health and welfare. (Visit EPA's climate change website for more information — see IMAGE #6::3.)



## IMAGE #6:: I

## 10 Essential Services of Public Health

Sources: Frumkin H, Hess J, Luber G, Malilay J, McGeehin M. Climate change: the public health response. *Am J Public Health*. 2008;98(3):435-445.

	Service	Climate Change Example
1	Monitor health status to identify and solve community health problems	Tracking of diseases and trends related to climate change
2	Diagnose and investigate health problems and health hazards in the community	Investigation of infectious water-, food-, and vector-borne disease outbreaks
3	Inform, educate and empower people	Informing the public and policy-makers about health impacts of climate change
4	Mobilize community partnerships and action to identify and solve health problems	Public health partnerships with industry, other professional groups, faith communities and others to craft and implement solutions
5	Develop policies and plans that support individual and community health efforts	Municipal heat wave preparedness plans
6	Enforce laws and regulations that protect health and ensure safety	(Little role for public health)
7	Link people to needed personal health services and ensure the provision of health care when otherwise unavailable	Health care service provision following disasters
8	Ensure competent public and personal health care workforce	Training of health care providers on health aspects of climate change
9	Evaluate effectiveness, accessibility and quality of personal and population-based health services	Program assessment of preparedness efforts such as heat wave plans
10	Research for new insights and innovative solutions to health problems	Research on health effects of climate change, including innovative techniques such as modeling and research on optimal adaptation strategies

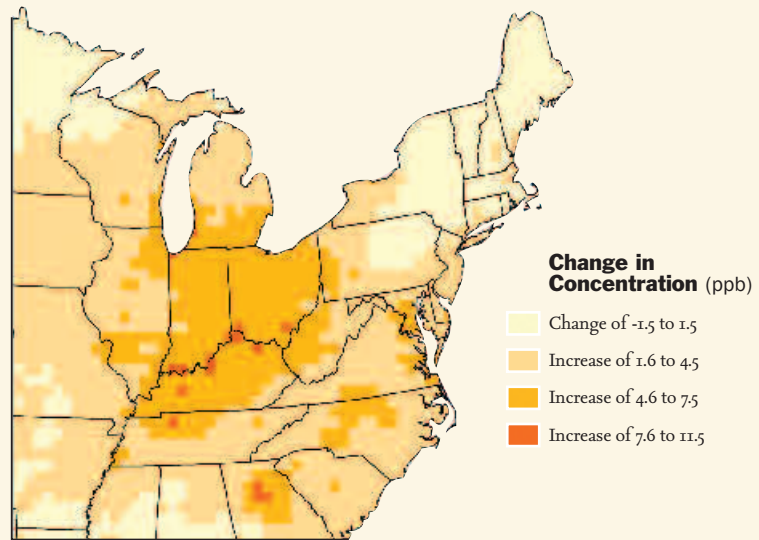
The 10 essential services are tenets of public health practice. The public health practitioners' role can be aligned with these services.

**IMAGE #6::2****Impacts of Climate Change on Air Quality: Ground-Level Ozone**

Source: Hogrefe C, et al. Figure 35. In: Our Nation's Air-Status and Trends Through 2008. U.S. Environmental Protection Agency, 2010. Available at: <http://www.epa.gov/airtrends/2010/report/climatechange.pdf>.

**An April 2009 EPA report found that by 2050, climate change could:**

- Increase summertime average ground-level ozone concentrations in many regions by 2 to 8 parts per billion
- Exacerbate peak ozone concentrations on days where weather is already conducive to high ozone concentrations
- Lengthen the ozone season
- Increase emissions of ozone precursors from natural sources



Increases in temperature and weaker circulation patterns lead to increased ozone, partly by accelerating photochemical oxidation rates.

## IMAGE #6::3 EPA's Climate Change Website

Source: EPA Climate Change Program. Available at: <http://www.epa.gov/climatechange>.

The screenshot shows the EPA's Climate Change website homepage. At the top, the EPA logo is on the left, and the text "U.S. ENVIRONMENTAL PROTECTION AGENCY" is on the right. Below the logo is the "Climate Change" title and a search bar. A navigation menu on the left lists various sections like "Climate Change Home", "Basic Information", "Frequent Questions", "Science", "Greenhouse Gas Emissions", "Health and Environmental Effects", "Regulatory Initiatives", "U.S. Climate Policy", "What You Can Do", "Climate Economics", "Where You Live", "Newsroom", "Related Links Directory", "About the Site", and "Glossary". The main content area features a banner with the text "Hurricanes in the Atlantic are likely to become more intense as ocean temperatures rise." Below this is a "Quick Finder" section with links to "Non-CO2 Voluntary Programs", "CO2 Pricing and Other Findings", and "GHG Transportation Programs". A "Climate Change Indicators" section is also visible, with sub-sections for "Science", "Greenhouse Gas Emissions", "Climate Economics", "Regulatory Initiatives for Greenhouse Gas (GHG) Emissions", and "U.S. Climate Policy". A "News" sidebar on the right highlights recent updates, including "New! (02/16/2011) EPA is seeking public comment on the annual 'Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009' draft report" and "11/21/2011 EPA Grants E15 Fuel Waiver for Model Years 2001-2006 Cars and Light Trucks".

EPA's website is a comprehensive source for information on science, impacts, emissions, policy and how the public can get involved.



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The American Public Health Association is the oldest and most diverse organization of public health professionals in the world and has been working to improve public health since 1872. The Association aims to protect all Americans and their communities from preventable, serious health threats and strives to assure community-based health promotion and disease prevention activities and preventive health services are universally accessible in the United States. APHA is committed to health equity and a healthy global society. The Association's broad array of public health professionals are champions of and advocate for healthy people and communities.

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