

CRS Report for Congress

Received through the CRS Web

Global Climate Change: Federal Research on Possible Human Health Effects

Updated February 10, 2006

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Summary

The average global temperature has risen approximately 0.6°C (0.9°F) over the past century. Global mean temperatures are projected by recent computer models to increase by 1.8°C to as much as 7.1°C (2.7°F to 10.7°F) over the next 100 years. It appears likely that global mean temperature increases will continue, and projections into the future predict a variety of possible related impacts in general, such as more volatile weather patterns, increased incidence of hot spells, and changing precipitation patterns that may include more intense rainfall patterns, as well as changing and intensified drought patterns. Extensive research is underway concerning the links between climate and human health; however, much of this research is being done for reasons unrelated to climate change per se. This report does not address the underlying question of climate change itself, details about which can be found in the CRS Issue Brief IB89005, *Global Climate Change*, by John R. Justus and Susan R. Fletcher. This report identifies the array of climate-relevant human health research and discusses the interconnections. Approximately \$57 million each year since FY2005 supports climate change research at the National Institutes of Health.

Health effects research topics are very wide-ranging, including studying skin and eye damage from increased ultraviolet radiation, effects of damaged water infrastructure, dynamics of recovering from disasters, and ways to strengthen the capacity in developing countries to deal with infectious diseases. Three conclusions are common to several studies on possible health effects of climate change: the infirm, the elderly, and the poor may be disproportionately impacted if climate change results in more severe and/or more frequent episodes of heat waves and air pollution; the risks of vector- and water-borne diseases may increase with global warming, but countries and regions with adequate sanitation, surveillance, and public health systems may not see significant increases in disease incidence or distribution; and further research is needed to better understand the complex linkages between climate and health.

Human health problems that may be linked to climate change are not created by changes in climate per se; rather, they are problems independent of climate change that may be exacerbated or intensified by changing weather patterns (climate, a longer-term phenomenon, can be considered to be the average of shorter-term weather patterns). Most health research is being conducted for reasons unrelated to climate change, but researchers are alert to ways in which environmental factors affecting health may be altered by climate change. In its oversight responsibilities, Congress may wish to consider the priorities and coordination of federally funded climate change health research. This report will be updated as events warrant.

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Global Climate Change: Federal Research on Possible Human Health Effects

Background

The average global temperature has risen approximately 0.6°C (0.9°F) over the past century. Global mean temperatures are projected by recent computer models to increase by 1.8°C to as much as 7.1°C (2.7°F to 10.7°F) over the next 100 years, with a variety of possible related impacts, such as more volatile weather patterns, increased incidence of hot spells, and changing precipitation patterns that may include more intense rainfall, and changing and intensified droughts.¹ At the same time, local climate conditions may result in other temperature effects and related impacts (the presence of sulfates from combusted sulfur-containing fossil fuels, for example, may limit warming in some areas²).

In 1988, the World Meteorological Organization and the United Nations Environment Program established the Intergovernmental Panel on Climate Change (IPCC). The task of the IPCC is to assess the scientific, technical, and socioeconomic information relevant to understanding the possible risk of human-induced climate change. Its First Assessment Report was distributed in 1990. The Third Assessment Report is titled “Climate Change 2001”; the finalized report was distributed on October 1, 2001. In it, the IPCC states that the link between climate and human activities is clearer than before, the resultant potential warming may be greater than previously thought, and “overall, climate change is projected to increase threats to human health, particularly in lower income populations, predominantly within tropical/subtropical countries.”³

For more detailed discussion, see CRS Issue Brief IB89005, *Global Climate Change*, by John R. Justus and Susan R. Fletcher, and the Environmental Protection Agency’s Global Warming site at: [<http://www.epa.gov/oar/globalwarming.nsf/content/index.html>].

Human health problems that may be linked to climate change are not created by changes in climate; rather, they are problems independent of climate change that may

¹ This report is about health issues related to climate change, and does not address the underlying question of climate change itself. On that latter issue, see the CRS Issue Brief IB89005, *Global Climate Change*, by John R. Justus and Susan R. Fletcher.

² From [<http://www.epa.gov/globalwarming/impacts/index.html>].

³ “Climate Change 2001: Synthesis Report” Intergovernmental Panel on Climate Change. [<http://www.ipcc.ch/pub/tar/syr/005.htm>].

be exacerbated or intensified by changing weather patterns.⁴ Most health research is being conducted for reasons unrelated to climate change, but researchers are alert to ways in which environmental factors affecting health may be altered by climate change.

This issue has drawn increasing attention during the past decade. On July 10, 1995 the United States Global Change Research Program (USGCRP, which coordinates federal climate change research discussed below) held a seminar on “Climate Change and Health”. This seminar included participation by the National Institute for Environmental Health Science, and examined the roles of climate and climate change in the emergence and re-emergence of infectious diseases in humans and animals.

Another major meeting on health and climate, the Conference on Human Health and Global Climate Change, was held at the National Academy of Sciences on September 11-12, 1995, was organized and conducted collaboratively by the Institute of Medicine, the National Academy of Sciences, and the National Science and Technology Council (NSTC), with support from several member agencies of the NSTC. Concerns about the potential risks to human health from changes in global climate raised at the conference led to several interagency discussions. Plans for a follow-up study were developed within the National Research Council’s Committee on Climate, Ecosystems, Infectious Diseases, and Human Health (CEIDH). The CEIDH released its report “Under the Weather: Climate, Ecosystems, and Infectious Disease” in April 2001. The report found that many infectious diseases may be influenced by weather fluctuations and seasonal-to-interannual climate variability, affecting their evolution and emergence through complex, sometimes causal, often not fully understood relationships. The report recommended further research to better understand and control the linkages among climate, diseases, epidemiological surveillance, and public health infrastructure and measures.

The Bush Administration commissioned the National Research Council (NRC) on May 11, 2001 to produce a report on climate change. “Climate Change Science: An Analysis of Some Key Questions” was released in June 2001 by a special Committee on the Science of Climate Change of the NRC. The report, prepared by eleven of the nation’s leading climate scientists, generally concurred with the latest conclusions of the IPCC and concluded that the climate changes observed in the past several decades likely were due to human activities, although a significant part of the climate changes could be from natural climate variability. It also summarized information relating to major kinds of possible human health effects of climate change, and identified related scientific research currently underway, in particular under federal government auspices.

⁴ Climate, a longer-term phenomenon, can be considered to be the average of shorter-term weather patterns.

Scope of This Report

The research identified in this report includes possible human health effects of atmospheric change generally, including health effects of stratospheric ozone depletion that allows greater exposure to ultraviolet (UV) radiation. However, ozone depletion is not per se usually included in climate change. While it is a major factor in atmospheric change, its effects are more direct and do not act through changes in climate. While the agents that deplete stratospheric ozone are themselves greenhouse gases, ozone depletion itself is regarded as a problem separate from climate change.

In many cases, air quality and water supply and quality may be affected by weather changes. Heavy or rapid rainfall, for example, can exceed the capacity of local physical infrastructure to handle such rain, overflow and equipment overloads can occur, and local water quality and supply may be adversely affected. Whether weather changes may or may not be related to global climate change, and the relationship of weather as mediated through these and other factors to health, is an issue involving a complex web of interactions.⁵

Human Health Effects Possibly Related to Climate Change

The range of human responses to temperature and other weather and climate conditions and changes is very broad. Age, general health status, and physiological resilience contribute to this breadth of responses. Given this breadth, predicting human responses for climate change policy relies heavily on past observations and on experience. The following observations are generally recognized from broad and general experience.

- Hot weather, often accompanied by air with higher concentrations of pollutants, tends to be associated with excess hospitalizations, i.e., more people than would be expected are admitted to hospitals when the weather is hot. These excess admissions are often because people are experiencing respiratory difficulties.⁶
- Hot weather also tends to be associated with excess mortality, i.e., more people than would be expected die during spells of hot weather.⁷

⁵ For a detailed discussion of both the direct and indirect relationships between health impacts of weather and climate, and the difficulty of establishing cause and effect, see *Human Health and Global Climate Change*, a report released in December 2000 by the Pew Center on Global Climate Change, available at [<http://www.pewclimate.org>].

⁶ [<http://www.epa.gov/globalwarming/impacts/health/index.html>].

⁷ Ibid.

- Warmer environmental conditions are associated with excess allergens and related substances (by enhancing the growth potential of allergen-producing plants), and with excess cases of people with allergic and asthmatic responses.⁸
- Warmer environmental conditions are associated with various excess illnesses resulting from the enhancement of the range and life cycle of disease-associated insects and microbial life forms and viruses; these illness vectors may have been water, air, contact, and/or food borne.⁹
- Warmer conditions tend to be associated with more extreme weather events, e.g., heavier precipitation which may result directly in health impacts from floods.¹⁰
- Warmer conditions with heavier precipitation may result in indirect health effects, e.g., public health may be threatened by overloaded wastewater infrastructure.¹¹

On the other hand, the following observations also can be based on general experience.

- While about 1,000 people die from the cold each year (in comparison, about 2,000 die from conditions related to heat¹²), warmer conditions may lead to a reduction of deaths from the cold. In general, cold-related deaths happen when relatively rare cold spells occur in areas where people are accustomed to mild winters, situations that may or may not be affected by global climate change. Cold-related deaths, however, are less sensitive to temperature changes than heat-related deaths (e.g., the mortality difference between -29°C and -26°C [-20° F and -15° F] is less than that observed between 35°C and 38°C [95° F and 100° F]).¹³
- Morbidity and mortality are not always observed to increase even if more extreme weather events occur. Appropriate infrastructure (including building codes, zoning, and sanitation systems), severe-weather warning systems, disease surveillance and prevention

⁸ United States Department of State, *U.S. Climate Action Report 2002*, Washington, D.C., May 2002, p. 107.

⁹ [<http://www.epa.gov/globalwarming/impacts/health/index.html>].

¹⁰ [<http://www.epa.gov/globalwarming/impacts/water/index.html>].

¹¹ The Water Environmental Research Foundation is studying ways to design water-handling infrastructure that will maintain desired levels of public health under varying environmental conditions. [http://www.werf.org/watersheds/stormwater_pressure.cfm].

¹² [<http://www.epa.gov/globalwarming/impacts/health/index.html>].

¹³ [<http://www.epa.gov/globalwarming/impacts/health/index.html>].

programs, and education of professionals and the public appear to prevent excess illnesses and deaths even in the face of more extreme weather events.¹⁴

- As a whole, agriculture in the United States is technically advanced, quick to adopt new technology, regionally diverse and adapted to a wide range of conditions, intensively managed, and market based. As such, as a whole, while the agricultural economy is argued by some to appear to be of low vulnerability to climate change, local monitoring of diverse local conditions has been recommended.¹⁵

Trends of Concern

Various trends, ranging in scale from local through national, may relate to the possible human health effects of climate change, potentially augmenting morbidity or mortality effects.

- The average age of Americans is going up. While 1 in 8 Americans was 65 years or older in 1990, 1 in 6 will be 65 or older in 2020.¹⁶ With this expected aging, it is projected, will come a loss of physiological resilience, on average. More of the population is expected to be more susceptible to possible health effects from all environmental stresses, including any related to climate change.¹⁷
- More Americans are and will be living in urban settings, which generally demonstrate urban heat-island effects (higher average temperatures than surrounding non-urban areas, owing to more heat-generating activities and more heat-retaining urban structures) and higher levels of air pollution. As such, more Americans are and will be exposed to potentially augmented climate change stresses and potential health effects.¹⁸
- Advancing therapies allow people with compromised immune systems to live longer. The increasing number of immunocompromised people means there may be more people with

¹⁴ United States Department of State, *U.S. Climate Action Report 2002*, Washington, D.C., May 2002, p. 109.

¹⁵ [<http://www.epa.gov/globalwarming/impacts/agriculture/index.html>].

¹⁶ United States Department of Commerce, *We the American Elderly*, Washington, D.C., September 2001, p. 2.

¹⁷ United States Global Change Research Program, *US National Assessment of the Potential Consequences of Climate Variability and Change/Sector: Human Health*, p. 441.

¹⁸ United States Department of State, *U.S. Climate Action Report 2002*, Washington, D.C., May 2002, p. 106.

greater vulnerability to possible climate-related health effects, including those caused by water and vector borne pathogens.¹⁹

- “Poverty is a risk factor for heat related illnesses and deaths because the poor are more likely to live in urban areas and are less likely to be able to afford air-conditioning systems.”²⁰ A recent rise in one measure of poverty in the United States is argued by some to suggest that there may be more poor people who may be more vulnerable to possible climate-related health effects by being less able to afford appropriate health care as well as air conditioning.²¹
- Using national data gathered on a regional level, one study hypothesized that some regions or states may be more greatly affected by possible health effects of climate change than others “not only because they are more prone to summer weather/climate-related diseases, but also because they contain a greater proportion of the sensitive subpopulations in the United States.”²² Recognizing the current shortages of dose-response data (linking climate to health effects) and reliable modeling of future regional climates, the report says that the current state of research is sufficient to generate the hypothesis but not test it, which constitutes part of the ongoing need for further research.

Human Health Effects Research Related to Climate Change

Research on human health effects of environmental conditions that may result from global climate change is being conducted domestically. While most of these efforts are not focused specifically on climate change, they are examining health conditions that could be affected by a change of climate, such as skin cancers caused by solar radiation, mediated through changes in weather patterns and variability. Some research may also relate to terrorism, e.g., use of a nuclear device by a terrorist could result in increased cancer risks. Some cancer research could be useful in countering radiation exposures whether from climate change or a nuclear device. The multiplicity of benefits from basic research makes difficult the task of categorizing basic research funding for climate change or other reasons.

¹⁹ United States Global Change Research Program, op. cit.

²⁰ Ibid.

²¹ Madrick, Jeff. *A Rise in Child Poverty Rates Is At Risk In U.S.*, the New York Times on the Web, June 13, 2002. Also, United States Global Change Research Program, op. cit.

²² Longstreth, Janice. *Public Health Consequences of Global Climate Change in the United States — Some Regions May Suffer Disproportionately*, Environmental Health Perspectives Volume 107, Supplement 1, February 1, 1999, pp. 169-179.

National Institutes of Health (NIH)

Following are descriptions of research areas that could be related to climate change and associated environmental conditions. Funding for the research is summarized by agency in **Table 1** below.

- **National Cancer Institute** is conducting research in two major areas: 1) increased health risks associated with excessive exposure to sunlight, including skin cancers and suppression of immune systems; and 2) possible interactions of environmental conditions (such as temperature and solar intensity) and pesticides and other environmental toxicants (such as polychlorinated biphenyls).
- **National Eye Institute** is studying exposure to ultraviolet (UV) radiation and cataracts, and the use of antioxidants to protect eyes from UV damage (regardless of the source or cause of the UV radiation).
- **National Institute of Environmental Health Sciences** is conducting research on the interactions of indoor and outdoor air pollutants and respiratory disease (including ozone, acid aerosols, particulate matter, and asthma), causes (including genetic) of differential susceptibility to air pollutants, health consequences of increased UV radiation, impacts on health of changes in the ranges of insect and parasitic disease vectors, and health effects of damage to the water supply.
- **National Institute of Arthritis and Musculoskeletal and Skin Diseases** is conducting research on the effects of UV radiation on skin and skin diseases, regardless of its source or cause.

Table 1. Climate Change Research at the National Institutes of Health
(\$ millions)

Institutes and Centers	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006 estimate	FY 2007 estimate
National Cancer Institute (NCI)	32.0	35.1	36.5	32.7	32.7	32.7
National Eye Institute (NEI)	13.6	11.4	11.7	10.7	10.7	10.7
National Institute of Environmental Health Sciences (NIEHS)	9.7	13.5	14.0	12.5	12.5	12.5
National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)	0.4	1.2	1.2	1.1	1.1	1.1
NIH total	72.5	61.2	63.4	57.0	57.0	57.0

Source: United States Department of Health and Human Services, National Institutes of Health, "Estimates of Funding for Various Diseases, Conditions, Research Areas," updated February 3, 2006, [<http://www.nih.gov/news/fundingresearchareas.htm>], and personal communication with NIH.

World Health Organization (WHO)²³

The World Health Organization, an agency of the United Nations, was founded in 1948 and currently has 191 Member States. The mission of WHO is "to give worldwide guidance in the field of health, to set global standards for health, to cooperate with governments in strengthening national health programmes, to develop and transfer appropriate health technology, information and standards."²⁴ The Project on Climate Change, Stratospheric Ozone Depletion, and Health was established within WHO in 1997. This project works to: bring together and make available scientific knowledge on the health effects of climate change/variability and stratospheric ozone depletion, facilitate and disseminate information on preventive policies, cooperate with countries to address specific climate-health problems and

²³ A very useful report is by A.J. McMichael, A. Haines, R. Slooff, and S. Kovats (editors), *Climate Change and Human Health*, World Health Organization, Geneva, Switzerland, 1996.

²⁴ World Health Organization. Rapid Overview. [<http://www.who.int/aboutwho/en/rapid.htm>].

increase local capacity, and facilitate the coordination of research to answer the key questions on climate and health.”²⁵

Some of WHO’s major areas of concern and effort include the establishment of an interagency network to effectively communicate among parties, development of a system for monitoring health effects and for conducting assessments of national health impacts, and development and implementation of methods for adaptation and mitigation.²⁶ These major areas of concern incorporate specific concerns, such as the growing threat of spreading antibiotic resistance (malaria, for example, has become immune to antibiotics in some countries), and funding that may be inadequate to the task.²⁷ Specific funding levels for United States support of WHO’s climate-associated human health effects research were unavailable but were characterized as “small.”²⁸

Conclusions

The changing global climate likely will impact the complicated interrelated web of plant and animal life, viruses, water, air, and land. The magnitude and beneficial or adverse direction of the impact will depend on specific locations and economic, political, social, and environmental conditions. Studies on the subject have produced myriad conclusions. Only very basic conclusions find wide agreement at present:²⁹

- The infirm, the elderly, and the poor may be disproportionately and negatively impacted should climate change result in more severe and/or more frequent episodes of heat waves and air pollution.
- The risks of vector- and water-borne diseases may increase with global warming, but countries and regions with adequate sanitation, surveillance, and public health systems may not see significant increases in disease incidence or distribution.
- Further research is needed to better understand the complex linkages among climate and health.

²⁵ World Health Organization. Climate Change. [http://www.who.it/london_conference/climate_change.htm].

²⁶ Personal communication with Bettina Menne MD, Associate Professional Officer Public Health, WHO-European Centre for Environment and Health. [bme@who.it] March 2000.

²⁷ Antibiotic resistance a growing threat, WHO reports. [http://www.cnn.com/2000/HEALTH/06/12/antibiotic.resistance/index.html].

²⁸ Personal communication with Bettina Menne MD, op.cit.

²⁹ Among others: Pew Center on Global Climate Change, *Human Health and Global Climate Change*, December 2000; Commission on Geosciences, Environment, and Resources, *Under the Weather: Climate, Ecosystems, and Infectious Disease*, National Academy Press 2001; A.J. McMichael, *Climate Change and Human Health*, op.cit.