The Medical and Public Health Impacts of Global Warming

A Warming World

As scientific evidence continues to mount that the earth's climate is rapidly changing, it is clear that global warming is no longer just a prediction.

Rising oceans, stronger hurricanes, prolonged droughts, and more intense heat waves are signs of the already discernable impacts that global warming is having worldwide. Global average surface temperatures have increased by about one degree Fahrenheit since the beginning of the 20th century,[1] and the five hottest years on record have all occurred within the last decade.[2] With the atmospheric concentration of carbon dioxide (CO_2) now higher than at any point in the last 420,000 years, widespread consensus within the scientific community points to the burning of fossil fuels as the primary cause of this warming of the planet.[3] Unless emissions of heat-trapping greenhouse gases are reduced, temperatures will increase by an additional 2.5 to 10.4 degrees Fahrenheit during the next 100 years—a rate likely to be without precedent in the last 10,000 years.[1]

Beyond the serious and potentially irreversible impacts on physical and biological systems,[4] a growing body of research also suggests that global warming will adversely affect public health in a number of important ways.

Heat-Related Illness

Climate models predict that North American heat waves will increase in intensity, frequency, and duration as global mean temperatures rise over the course of this century.[5] Under this scenario, the many health problems associated with exposure to extreme and prolonged heat—heat cramps, heat syncope (fainting), heat exhaustion, and heatstroke[6]—will become increasingly common. Heat acclimatization is possible, but in cases of extreme or chronic heat stress, the body's ability to shed heat through increased blood circulation and perspiration, and thus its ability to maintain temperature balance, is lost.[6] In such cases, death can result.

The 2003 European heat waves resulted in a surge of heat-related deaths. Across the United Kingdom, France, Italy, the Netherlands, Portugal, and Spain, the heat waves that occurred during the summer of 2003 are estimated to have caused at least 22,000 excess deaths, with some arguing that this figure could be revised upward by as much as an astounding 50–100 percent.[7]

In the United States, a seven-day (July14–20) heat wave in Chicago during the summer of 1995 resulted in 485 heat-related deaths.[8] In total, 739 excess deaths were reported during this period, representing a 147 percent increase above baseline levels.[8]

These figures demonstrate the potentially devastating impact that could result from an increase in heat wave frequency and intensity. Though heat waves normally affect broad geographic regions and resident populations, certain groups are particularly vulnerable. The very old and the very young tend to have reduced heat-regulating mechanisms and are at increased risk.[6] The poor, the socially isolated, and those already suffering from chronic illness also are likely to be disproportionately affected by an increase in heat wave frequency and severity.[6]

Air Pollution-Related Health Impacts

While both air pollutant emissions and ambient pollutant concentrations have generally fallen since passage of the 1970 Clean Air Act, as recently as 2002 approximately 146 million people in the United States lived in counties that did not meet air quality standards for at least one regulated pollutant.[9] Exposure to air pollution can aggravate chronic respiratory and cardiovascular disease, damage lung tissue, lead to premature

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death, and may even contribute to cancer.[10] Global warming may exacerbate these problems by affecting the concentration, distribution, and type of both manmade and natural air pollutants.[10] Ozone levels, for example, are likely to increase because higher temperatures accelerate the rate at which ground-level ozone (the main component of smog) is formed.[10] While long-term exposure to ozone is linked to the development and exacerbation of chronic lung diseases, even short-term exposure to relatively low ozone concentrations can cause lung inflammation, acutely decreased lung function, and respiratory impairment.[10] A 2004 study using global warming and air quality models in the 31-county New York metropolitan region projected a median increase of ozone-related acute mortality across the region of 4.5 percent by the 2050s.[11]

Although increasing atmospheric CO_2 concentrations have no known direct adverse health effects, other byproducts of fossil fuel combustion, including airborne particulate matter (PM), sulfur oxides (SO_x), and nitrogen oxides (NO_x), are associated with a number of well-established health risks.[12] Consequently, a continued rise in CO_2 emissions would be mirrored by a rise in the harmful effects of these combustion byproducts.

In recognizing the link between CO_2 emissions and PM pollution, Cifuentes et al. estimated that adoption of existing, readily acquirable greenhouse gas mitigation technologies would reduce PM concentrations by 10 percent, thus avoiding 64,000 premature deaths and 65,000 chronic bronchitis cases through 2020 in four cities alone—New York City, USA; Santiago, Chile; Mexico City, Mexico; and São Paulo, Brazil.[13] These studies demonstrate that actions aimed at mitigating the atmospheric accumulation of greenhouse gases would have the additional benefit of reducing the adverse health effects associated with a range of air pollutants.

There also is growing evidence that rising global mean temperatures are impacting both the timing and abundance of airborne allergens, especially pollen.[14]

In recent decades, spring flowering, and thus the allergenic pollen season, has advanced at a rate of nearly a day per year.[15] In Europe, spring events such as leaf unfolding advanced by six days, while autumn events such as leaf coloring have been delayed by nearly five days in the last 35 years.[16] Experimental studies have demonstrated significant increases in pollen production resulting from exposure to increased CO_2 concentrations, while examination of recent trends have linked elevated pollen levels to increases in temperature.[14] Additionally, some studies suggest stronger allergenicity of pollen from trees grown at increased temperatures.[17] Patz, et al. warn of the potential public health consequences of these changes: "climate change may adversely impact the occurrence and severity of asthma, the most common chronic disease of childhood, and affect the timing or duration of seasonal allergies such as hay fever."[14] Combined with the observed doubling of pediatric asthma prevalence within the past twenty years,[18] children's physiological and behavioral susceptibility to air pollution increases their risk of being adversely affected by changes in the concentration and distribution of pollutants.[19]

Infectious Disease

Since 1976 the world has witnessed not only the emergence of 30 diseases previously unknown to medicine, but also the resurgence of older diseases such as malaria and cholera, and

Forebodings from the Gulf Coast

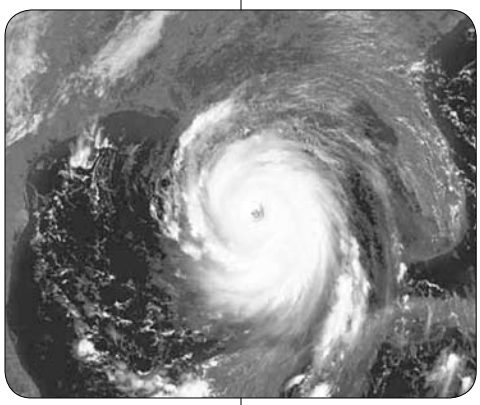
The devastation produced by Hurricanes Katrina and Rita along the Alabama, Mississippi, and Louisiana coasts has given new urgency to the threats posed by global warming. Although Hurricane Katrina cannot be specifically attributed to global warming, recent trends point to a shift toward more intense storms.

As tropical ocean sea surface temperatures (SSTs) continue to rise—SSTs increased 0.5 degrees Celsius during the last 35 years[40]—warmer ocean temperatures will increase the total energy available to amplify storm intensity. According to a study published in the journal *Science*, during the past 35 years the number of hurricanes reaching categories 4 and 5 has nearly doubled in both number and proportion.[40] Other investigators have concluded that "the potential destructiveness of hurricanes... has increased markedly since the mid-1970s," warning that "future warming may lead to an upward trend in tropical cyclone destructive potential."

Already, more than 1,200 deaths have been reported as a result of Katrina.[42] Public health and rescue workers also have documented numerous cases of respiratory and diarrheal disease among evacuees and rescue workers. The long-term public health effects of the storm, however, remain uncertain though considerable. Of particular concern are the health threats associated with exposure to molds in flood damaged structures and the risk posed by the toxic residues left behind from the flooding of chemical facilities and oil refineries along the 100 mile stretch between Baton Rouge and New Orleans known as "Cancer Alley."

the redistribution of others, including West Nile virus.[15] While not all of these changes in infectious disease transmission patterns are related to global warming, Paul Epstein, MD, of Harvard Medical School's Center for Health and the Global Environment has warned that "a warming and unstable climate is playing an ever-increasing role in driving this global emergence, resurgence, and redistribution of infectious diseases."[20] Furthermore, in a 2003 report on climate change and human health, the World Health Organization (WHO) concluded that "changes in infectious disease transmission patterns are a likely major consequence of climate change."[21]

Vector-borne diseases result from infections transmitted to humans primarily by blood feeding arthropods such as mosquitoes, ticks, and fleas.[22] Most vector-borne diseases exhibit a distinct seasonal pattern, with weather variables such as temperature and rainfall affecting both the vectors and the disease-causing pathogens they transmit.[23] Mosquitoes, for example, are very sensitive to temperature changes.[24] Higher temperature increases their rate of reproduction, the number of blood meals they take, prolongs their breeding season, and shortens the maturation period for the pathogens they carry.[24] Rising global temperatures could also result in the expansion of vector ranges into areas with previously unexposed populations.[14] The 1999 outbreak of West Nile virus (WNV) in New York in which seven people died,[20] and the subsequent expansion of the disease in the summer of 2002, when 230 animal species were infected and cases of human or animal WNV were reported in 44 states and the District of Columbia,[24] exemplify what may occur more regularly as global warming progresses.



Extreme Weather Events and Water-Related Health Impacts

Evidence indicates that extreme weather events such as heavy precipitation, floods, droughts, and hurricanes have increased in frequency, intensity, and duration over the past century[1,25,26,27] and climate models predict that this trend will continue as global warming continues.[4] Even if rain becomes less frequent, many areas throughout the United States will experience heavier downpours.[28] The annual number of days with precipitation exceeding two to four inches has already increased in the past 100 years.[25] While increasing global temperatures will create heavier precipitation events in some regions, acceleration of land-surface drying will also mean more frequent, more severe drought in others.[25]

Death and injury are the direct health impacts most commonly associated with extreme weather events. However, the environmental hazards left behind by natural disasters such as floods and hurricanes can also have a number of serious secondary health effects.

Water quality would be jeopardized by increased heavy rainfalls, especially if preceded by drought, as surface waters became polluted by runoff carrying human and animal wastes, pesticides, fertilizers, and other pollutants.[29] In the past, outbreaks of water-borne diseases, such as *Cryptosporidium* and *Escherichia coli*, have been linked to heavy rainfall events.[14,30] An analysis of 548 gastrointestinal outbreaks that occurred in the United States between 1948 and 1994 showed that 68 percent of cases were preceded by very heavy rainfall.[31] Threats to water quality from increased precipitation would be compounded by rising temperatures, which promote the growth of disease-causing bacteria.

In the ocean, the combination of rising surface water temperatures and increased nutrient loading from rivers carrying agricultural runoff may contribute to increased harmful blooms of algal species capable of producing biotoxins.[29] The consumption of fish and shellfish contaminated by these toxins can result in neurological damage, respiratory irritation, skin irritations, and gastrointestinal illness.[32]

Water quantity also may become an issue as a result of global warming. Droughts, decreased winter snow-packs, earlier snowmelt, and a shift to less frequent but more intense precipitation events could all put a strain on freshwater resources.[29] As water supplies decline, concentrations of human waste, animal waste, and other pollutants increase while stagnant waters provide breeding ground for disease vectors.[33,34] Poor, developing nations in southern and west Africa and in the Middle East are at particular risk to increased water stress and may experience a rise in the incidence of water-related diseases as people are forced to rely on increasingly contaminated sources of fresh water for all of their daily needs—drinking, cooking, bathing, and irrigation.[30]

Addressing Global Warming: A Public Health Imperative

The evidence base for global warming has grown stronger since the United Nations Intergovernmental Panel on Climate Change (IPCC) released its first scientific assessment of global warming. The World Health Organization (WHO) estimates more than 150,000 deaths and approximately 5 million 'disability-adjusted life years' (DALYs) annually as a result of increasing incidences of disease and malnutrition caused by global warming.[35] The public health impacts are expected to get worse, with climate models projecting a doubling of climate-linked disease burden by the year 2030 without regulatory action.[35]

With new data indicating that sea ice loss in the Arctic and Antarctic is accelerating and climate experts now warning that the Earth may be fast approaching a climate change tipping point, it is clear that we can no longer afford to delay action. To stabilize the earth's climate and avoid the most serious public health and environmental impacts, we must reduce our greenhouse gas emissions by 80 percent below 1990 levels.[36] This can be achieved by developing new, cleaner, and more efficient ways of producing energy, transportation, and goods.

The fastest and most affordable way to curb greenhouse gas emissions is to increase energy efficiency. Replacing older home appliances such as refrigerators and washing machines with more efficient models; improving heating and cooling systems; better insulating both commercial and residential buildings; and replacing old lighting systems with new advanced lighting systems that use compact fluorescent or LED bulbs—all these actions can drastically reduce energy use without having to sacrifice functionality or comfort. In fact, Amory Lovins of the Rocky Mountain Institute estimates that 75 percent of total electricity consumption in the U.S. could be displaced by more widespread use of the best electricity-saving technologies.[37]

Because the electric power industry is the single largest source of greenhouse gas emissions in the U.S.,[38] the generation of electricity using renewable energy technologies holds great potential for drastically reducing global warming pollution. Wind energy already is cost-competitive with new coal and gas-fired power plants, and the U.S. has tremendous potential for generating wind energy. In twelve states alone (North Dakota, Texas, Kansas, South Dakota, Montana, Nebraska, Wyoming, Oklahoma, Minnesota, Iowa, Colorado, and New Mexico), wind turbines could produce as much as 2.6 times the total electricity generation of the entire U.S.[39] Solar energy is another renewable energy source capable of making a significant contribution to meeting U.S. energy needs. While the current economics of solar energy are constrained, costs have steadily fallen in the past 20 years. Additionally, as the materials to construct solar panels become cheaper and more efficient, as production methods improve, and as installation becomes easier, solar energy is expected to become cost-competitive with conventional electricity production in the near future. Also holding enormous potential for renewable energy production is the harnessing of both geothermal heat energy and ocean tides and currents for electricity generation.

Automobiles are the second largest source of U.S. greenhouse gas emissions.[38] Thus, a significant increase in the fuel economy of cars and trucks is another essential component of any strategy to curb global warming. Fortunately, hybrid engines, flex-fuel vehicles capable of running on ethanol, and biodiesel engines are all gaining in popularity and commanding an increasing share of the automotive market. Increased automotive efficiency not only helps to slow global warming, but also reduces the emission of harmful air pollution, all while saving consumers money at the gas pump. As a result of increased purchases of minivans, pickup trucks, and SUVs, the current average fuel economy of America's passenger vehicle fleet is at its lowest point since the early 1980s and is far behind that of the European Union, Japan, and China. Existing technology is capable of nearly doubling the average fuel economy of America's cars, and even more significant improvements are possible in the near future as existing technologies mature and as new technologies such as fuel cells enter the market. By providing the appropriate incentives to both auto manufacturers and consumers, policymakers can ensure that these technologies continue to grow in market share and can lessen America's need for oil while drastically reducing the transportation fuel sector's contribution to global warming.

Though the task before us is formidable, we already possess the scientific, technical, and industrial know-how to greatly reduce global warming pollution. Scientists warn, however, that the window of opportunity is closing quickly and we must begin to curb global warming emissions within the next ten years to prevent the worst impacts from occurring. The time for action to stop global warming is NOW!

For all references, please visit the Publications and Resources page of the PSR website at http://www.psr.org/site/PageServer?pagename=enviro_resources.

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