



# Emerging Public Health Threats and the Role of Climate Change

A report on the March 11-12, 1998 conference sponsored by the EPA Office of Policy, Planning and Evaluation, Office of Economy and Environment

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## INSIDE

- Reflections on Kyoto ..... 2
- Emerging Public Health Threats ..... 3
- Protecting Children's Health ..... 4
- The Role of the Public Health Professional .. 11
- And more...

## HEALTH PROFESSIONALS DISCUSS RISKS OF CLIMATE CHANGE

Global warming could have significant consequences for human health, ranging from a higher incidence of heat stress and a worsening of air quality to an increase in potential risks of infectious diseases such as malaria and dengue fever. But many unanswered questions remain about how serious those impacts are likely to be, which people will be affected, and what should be done to reduce the vulnerability of our society and others to the health effects of climate change.

"We are just beginning to understand the potential risks," said Joel Scheraga, director of the U.S. Environmental Protection Agency's Global Change Research Program. Scheraga served as chief moderator of an EPA-sponsored conference on climate change and public health, held March 11-12, 1998, in Atlanta.

The goal of the conference was to foster a balanced dialogue on the potential health impacts. "It is imperative to convey not just what we know, but how well we know it and what we don't know," Scheraga said. He urged speakers to identify positive as well as negative effects.

Media coverage of the conference included a televised report by CNN and an article on CNN's website. The CNN article may be viewed online at <http://cnn.com/HEALTH/9803/12/ill.winds/index.html>.

Nine organizations and agencies co-sponsored or contributed to the conference, which was attended by close to 100 people from 27 states, Puerto Rico, and two Canadian provinces. Attendees included representatives from municipal, county, state, and federal health agencies; academic institutions; corporations; nonprofit environmental and health organizations; and others.

Avis Robinson, deputy director of EPA's Office of Economy and Environment, opened the meeting

with an update on international efforts to reduce greenhouse gas emissions. She told the audience that although the recently negotiated Kyoto Protocol is an unfinished agreement, it represents a "cost-effective, commonsense approach to a serious problem." She said the Clinton Administration is working to secure the meaningful participation of key developing countries before sending the treaty to Congress for ratification.



▲ The conference's 100 attendees learned about potential impacts of climate change on human health, such as heat stress, respiratory illness, and infectious diseases.

Richard J. Jackson, director of the National Center for Environmental Health, Centers for Disease Control and Prevention, raised concerns that climate change has the potential to lead to political instability and unrest. Water shortages, sea-level rise, and declines in agricultural productivity could lead to large population movements, which could have profound impacts on health, he said.

Children's environmental health was the focus of a luncheon address by Dr. Steven K. Galson, science director of EPA's Office of Children's Health Protection. Galson noted that environmentally related childhood diseases, such as asthma, cancer, and lead poisoning, are on the rise. He described a number of recent federal initiatives to promote children's environmental health, including the work of his own office at EPA.

Dr. Barry S. Levy, immediate past president of the American Public Health Association, discussed the role of public health professionals in addressing climate change. Levy described five areas—documentation, research, education and communication, advocacy, and prevention—in which public health officials can work to reduce our nation's vulnerability to climate change.

Continued on page 2

This report summarizes the results of a conference sponsored by the U.S. Environmental Protection Agency entitled "Emerging Public Health Threats and the Role of Climate Change." The conference took place on March 11-12 1998, in Atlanta, Georgia.

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EPA publishes a number of information sheets about global warming. Call EPA's Fax-On-Demand Service (202-260-2860) or access EPA's global warming Internet site at [www.epa.gov/globalwarming](http://www.epa.gov/globalwarming).

In breakout sessions on heat waves, infectious diseases, and food- and water-borne illnesses, conference participants identified research opportunities and recommended strategies to monitor, reduce, and prevent the health risks associated with climate change.

An interdisciplinary theme permeated the conference, as many speakers stressed the need for partnerships between health professionals and researchers in areas such as ecology and climatology. Several speakers also noted that the potential impacts of global warming must be considered within the context of other issues. Poverty, access to health care, public health infrastructure, and political stability are all important determinants of health.

The prospect of advances in medical science and technology, and the varying ability of societies to adapt to change, make it especially hard to predict our future vulnerability to the effects of global warming.

Several speakers and audience members noted, however, that not all countries have the resources or infrastructures to protect themselves.



▲ EPA's Joel Scheraga described a new national assessment process to determine the potential consequences of climate change and climate variability for the United States.

Developing countries are likely to be the most strongly affected by climate change, including its impacts on human health.

Still, as Avis Robinson pointed out, even Americans are vulnerable to disruptions in climate. While noting that the potential linkages between El Niño and global warming are unclear, Robinson said that the devastating impacts of the 1997-98 El Niño in California and Florida provide a "case study of vulnerability" and should serve as a warning of the possible consequences of climate change.

Closing the conference, EPA's Joel Scheraga described a new multidisciplinary process to assess the potential consequences of climate change and variability on the United States. The assessment, to be completed by January 2000, will be accomplished through a public-private partnership involving government agencies, research institutions, and

stakeholders throughout the nation. Scheraga invited all those attending the conference to participate in the process. ♦

## REFLECTIONS ON KYOTO

"The science is complex but the conclusions are clear," said Avis Robinson, deputy director of EPA's Office of Economy and Environment. "Human beings are changing the earth's climate by increasing concentrations of greenhouse gases in the atmosphere."

Because the impacts of global warming are potentially serious and costly, the United States agreed in December to the Kyoto Protocol on climate change. The treaty embodies two of the three major objectives established by President Clinton: sound targets and timetables for reducing emissions, and the use of flexible, market-based

mechanisms to achieve emissions targets.

Robinson said the administration is working to achieve the president's third goal: to secure the meaningful participation of key developing countries before signing the treaty and sending it to Congress for ratification.

Under the protocol, the United States must reduce its greenhouse gas emissions to 7 percent below 1990 levels by 2008-2012. This timeframe will help "cushion the transition" and minimize any impact on businesses and workers, Robinson said. Costs will be further reduced through market-based mechanisms such as emissions trading.



◀ Avis Robinson, deputy director of EPA's Office of Economy and Environment, described the implications of the recently negotiated Kyoto Protocol.

"Every dollar we invest to improve energy efficiency and limit climate change will control other pollutants besides greenhouse gases," Robinson noted. The combustion of fossil fuels produces pollutants that have been linked with serious illnesses such as heart disease and chronic bronchitis.

Robinson concluded that, with the Kyoto Protocol's multiple benefits to society and reliance on market mechanisms, it is a "cost-effective, commonsense approach to a serious problem." ♦

## THE EARTH'S CHANGING CLIMATE

We have finally come to recognize that human activities are changing the composition and behavior of the atmosphere, said Irving M. Mintzer, executive editor of *Global Change* magazine and co-author of the Intergovernmental Panel on Climate Change's Synthesis Panel Report. The earth has undergone many climatic shifts over the past two billion years and will continue to do so in the future. But the changes currently underway are different, Mintzer said, because they reflect the influence of human activity.



◀ Irving Mintzer, executive editor of *Global Change* magazine, said the impacts of climate change are likely to be unevenly distributed.

temperature will rise 1.8 to 6.3°F over the next century. To put this into perspective, a rise of 3.8°F would take the planet outside the range of anything experienced in the last 10,000 years. The rate of change would be “precipitous” for many species, Mintzer warned. Global warming would raise the earth's average temperature but also would lead to changes in the distribution of temperature and precipitation. These changes would affect human health, water availability and quality, crop fertility and yields, and forest composition. “The impacts of climate change are likely to be diverse, and their distribution is likely to be uneven, spotty, and discontinuous.”

The concentration of heat-trapping greenhouse gases in the atmosphere is increasing, Mintzer explained, in a process that resembles a bathtub with a big faucet and a small drain. The level in the tub rises as humans pour more gases into the atmosphere than natural cycles can remove.

Climate models predict that, if greenhouse gas emissions continue to increase, the earth's average

According to Mintzer, global warming is essentially a problem in risk management. “We need to think about strategies to reduce the rate of buildup of greenhouse gases, increase the resilience of society to the changes that this particular environmental process will produce, and plan now for the kinds of industrial development that can sustain economic development and growth.” ♦

## EMERGING PUBLIC HEALTH THREATS

Perhaps the greatest threat from global warming is its potential to lead to political instability and civil unrest, according to Richard J. Jackson, director of the National Center for Environmental Health, Centers for Disease Control and Prevention. “War is the ultimate environmental hazard,” he said.

Jackson warned that conflicts may occur in the future over access to water systems as climate change causes precipitation patterns to shift. Water shortages and declines in agricultural productivity, superimposed on other changes such as the growing potential for economic instability in world markets, could lead to political upheavals. Sea level rise could displace millions of people in developing countries such as Bangladesh. “What part of the world is ready to absorb 100 million Bangladeshi refugees?” Jackson asked.



◀ Richard Jackson, director of CDC's National Center for Environmental Health, said global warming could cause civil unrest.

The health impacts of global warming will fall most heavily on developing countries, Jackson said. Wealthy nations are better prepared to deal with health risks. For example, malaria was the leading cause of death in California in 1900, but it is extremely rare today due to investments in public health and environmental interventions.

Developing countries do not have the resources or infrastructure to eradicate malaria and other infectious diseases. “We've got to figure out ways to deal with global issues that free people from want,” said Jackson, “that get them out of grinding poverty, that are friendly to sensible development, and that free people from fear and the totalitarianism that comes with it.”

The design of urban environments can play an important role in reducing the health impacts of global warming, Jackson said. For example, better building design can reduce residents' vulnerability to heat waves. However, Jackson noted that while public health agencies spend a lot of money tracking pollutants in the air and water, “we spend next to nothing tracking the human health endpoints of who's getting sick and where they're getting sick.” Such data are critical in helping to design better urban environments, he said.

*Continued on page 4*

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***“The world is moving headlong into further industrialization, and there is no way of stopping the desire for economic development. We've got to figure out how to have smart economic development.”***

Richard Jackson  
Director  
National Center for Environmental Health  
Centers for Disease Control and Prevention

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***“Every dollar we invest to improve energy efficiency and limit climate change will control other pollutants besides greenhouse gases.”***

Avis Robinson  
Deputy Director  
Office of Economy and Environment  
U.S. Environmental Protection Agency

## EMERGING PUBLIC HEALTH THREATS *Continued from page 3*

Public health officials have effective tools to inform the public about heat waves and other health risks, but better risk assessment will require more data on levels of exposure in the field. "You can learn a huge amount by seeing what's going on in the actual population," Jackson said. "These data are very powerful when you plug them back into the public policy process." Information technologies can help officials better track disease rates in the population and plan interventions accordingly.

Efforts also must be taken to mitigate global warming. "We can do a lot in terms of the ways we use fossil fuels," Jackson said. "Improving the energy efficiency of our homes, our automobiles, and our communities are important steps that everyone can begin taking now."

Although the scientific evidence for global warming is not yet conclusive, that should not be a reason to delay action, according to Jackson. "In medicine, you often have to begin treatment before you are really sure what's wrong." ♦

## REVIEWING THE RISKS

Climate change can affect health in many different ways, according to Dr. Jonathan A. Patz, director of the Program on Health Effects of Global Environmental Change at Johns Hopkins School of Hygiene and Public Health. A number of diseases are sensitive to changes in temperature and weather.

Patz stressed that climate change involves more than just changes in temperature, noting that the term "global warming" is misleading. Climate is likely to become more variable, with greater extremes, and sea levels are expected to rise. The impacts of these changes, and the vulnerability of human populations, will vary from region to region.

Climate change is a problem that cuts across many sectors, Patz said. Interrelated impacts, such as effects on agriculture and the availability of fresh water, are likely to occur. He emphasized that we must evaluate the potential impacts of global warming in the context of other determinants of public health, such

as demographic shifts and changes in public health infrastructures. "Climate is not the be-all or end-all to determining disease," Patz said.

Patz noted that there are diseases, such as cyclospora and cryptosporidium, that exhibit seasonal variability.

Short-term seasonal or El-Niño-related fluctuations in climate provide an opportunity to understand the effect of climate and weather on health. For example, a recent study found that malaria cases in Colombia typically increase by 20 percent in the year after an El Niño event, Patz said. Hantavirus and cholera are two other diseases that researchers are studying.

Patz emphasized that the potential health effects of climate change often are intertwined with environmental and ecological problems. "We need to build a multidisciplinary effort to address climate change," he concluded, one that examines whole systems rather than taking a disease-by-disease approach. ♦

## PROTECTING CHILDREN'S HEALTH

Children's health is "inexorably linked" to the potential effects of global climate change, according to Dr. Steven K. Galson, science director of EPA's Office of Children's Health Protection. "When we talk about climate change," said Galson, "we're talking about our children, our grandchildren, and the environment they will live in."



Children are more susceptible than adults to environmental hazards. "They play close to the

◀ Steven Galson, science director of EPA's Office of Children's Health Protection, described federal initiatives to promote children's environmental health.

ground, they have intense hand-to-mouth activity at certain ages, and frequently are less able to metabolize and excrete toxic substances," Galson told the conference. Pound-for-pound, children breathe more, drink more water, and eat more food than adults. They also have rapidly developing organ systems and have more future years of life during which a latent health effect can express itself.

Following a series of federal studies and initiatives, President Clinton issued an executive order in 1997 requiring the creation of a multiagency federal task force to set priorities and focus on specific activities in children's environmental health. Led by EPA and the Department of Health and Human Services, this group has tentatively identified asthma, childhood cancer, unintentional injuries, and developmental effects as top priorities.

To ensure that key elements of the President's executive order are reflected in EPA activities,

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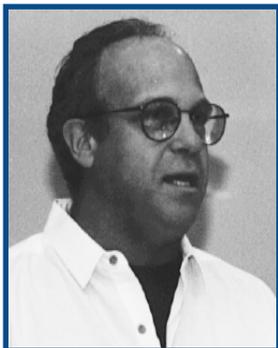
EPA Administrator Carol Browner created the Office of Children's Health Protection in 1997. The office, together with the National Institutes of Health, has launched a new \$10 million grant program to create three to five centers of academic excellence in children's environmental health. The office also is helping set priorities for EPA's research in this area and helps develop risk assessment and management policies, including cancer guidelines and pesticide policies.

For more information, visit the Office of Children's Health Protection's website at: [www.epa.gov/children](http://www.epa.gov/children). ♦

## HEAT STRESS

Heat-related mortality is a "very under-reported problem," according to Laurence S. Kalkstein, professor at the University of Delaware's Center for Climatic Research. Estimates suggest that over 1,000 heat-related deaths may occur in an average summer, but most aren't reported as such by medical examiners. "When you die of a heart attack on a hot day, you are not recorded as a heat-related death," Kalkstein said.

This under-reporting has contributed to a lack of awareness of how dangerous extreme heat can be, and as a result too little emphasis is placed on heat-related mortality. Kalkstein also noted that financial and political constraints hinder many municipalities from establishing comprehensive warning systems.



There are simple, effective steps that can

◀ *The University of Delaware's Laurence Kalkstein noted the need for a study of mortality in southern cities during the first heat waves in spring.*

### HEAT STRESS RECOMMENDATIONS

- Improve the transfer of information among climatologists, meteorologists, and public health officials.
- Work with the National Weather Service to base heat warnings on health outcomes.
- Evaluate warning systems and other interventions to determine their effectiveness in saving lives.
- Conduct research to separate impacts due to heat waves versus those from air pollution to learn whether they act synergistically.
- Determine whether interventions should be standardized for diverse urban areas.
- Begin collecting heat-related morbidity and rural mortality data.
- Involve social scientists, city planners, and architects—for example, to design inexpensive ways of keeping buildings cooler.

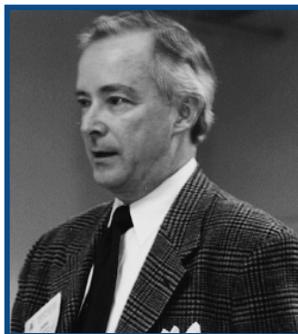
be taken to reduce vulnerability to heat stress, Kalkstein said, such as installing reflective surfaces on rooftops. He emphasized the need to involve non-governmental community groups in planning and mitigation efforts. The people most at risk from heat waves may be among the hardest to reach, such as isolated elderly people. ♦

## Lessons from Chicago

"It wasn't the science that failed us," said John Wilhelm, deputy health commissioner for Chicago. "It was the response." Wilhelm described the events of July 1995 when Chicago's temperature hovered at 104°F and the city went into shock as heat-related mortality mounted over a period of five days to a final count of 733 deaths.

Chicago's response had three phases. In the beginning, city agencies responded by alerting the media so that the public could be warned to take precautions. But this was not enough, given the unique weather of that July when the dew point rose to an unprecedented high.

Wilhelm listed the lessons learned from the Chicago tragedy: (1) the response that had worked for years failed during such an extreme heat wave; (2) the most vulnerable are the elderly



◀ *Chicago's heat wave of 1995 was so memorable that John Wilhelm believes that the city will maintain preparedness—even for heat waves that are rare in their intensity.*

who are isolated by medical conditions, changing neighborhoods, and fear of crime; (3) a concise simple message should be delivered by a single official; and (4) family, friends, neighbors, churches, visiting nurses, and Meals on Wheels volunteers need to check on the isolated and medically fragile. ♦

## St. Louis Prepares for Heat Waves

After a severe heat emergency in 1980 that took 295 lives in Missouri, the state and the municipalities of St. Louis, Kansas City, and Springfield took steps to plan for future heat waves. Dr. H. Denny Donnell, state epidemiologist at the Missouri Department of Health, described a study that identified 10 factors that put a person at risk during heat waves. Examples include the inability to care for oneself, living on the higher floors of a building, and using major tranquilizers.

In subsequent years, St. Louis officials showed a video on prevention of heat-related illness throughout the community. The city and social service agencies signed a formal contract to coordinate assistance. The Salvation Army and Red Cross would provide shelters, Union Electric Company would provide window air conditioners on loan, and senior centers would reach out to high-risk individuals.

### Components of a Weather Warning Plan

Coordination, planning, and the involvement of multiple organizations are essential components of heat plans, according to Dr. Michael McGeehin, chief of the Health Studies Program Branch of the National Center for Environmental Health, Centers for Disease Control and Prevention.

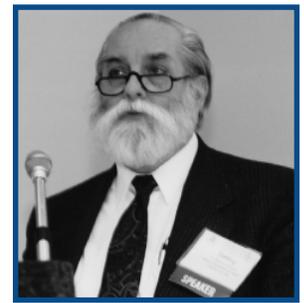
Public education is necessary before watch/warning systems are implemented, and all media must be used for early warnings, he said. McGeehin called for “focused outreach” to vulnerable populations by non-governmental organizations,



◀ The CDC's Michael McGeehin said that coordination and the involvement of multiple organizations are essential for a comprehensive heat emergency plan.

Finally, state and city officials agreed on a common language for heat warnings. A heat index of 105°F in a large portion of the state would trigger a heat *advisory*. When peak afternoon indices remain at 105°F for two days, a heat *warning* is issued. After three days and reports of heat-related illnesses and deaths, a heat *emergency* is declared.

“Some will be false alarms,” said Donnell, “but we generally err on the side of giving advisory information.” ♦



▲ H. Denny Donnell, state epidemiologist in Missouri, described the triggers for heat advisory, warning, and emergency.

governments, and private industry. “The most difficult part of the solution is getting to high-risk populations” such as isolated elderly people, McGeehin said. ♦

### CDC SURVEY OF WEATHER WARNING PLANS

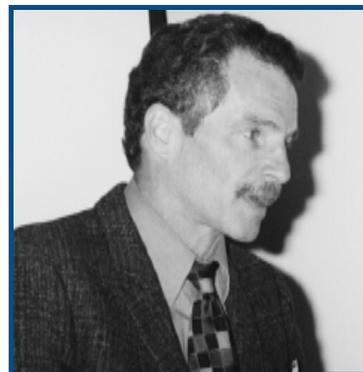
In 1997, the Centers for Disease Control and Prevention completed a survey of weather warning plans in large cities. Key findings include the following:

Number of cities surveyed	13
Cities with a weather warning plan	12
Plans that involve community organizations	11
Plans that include early warning systems	8
Plans focusing on elderly	8
Plans that educate medical community	2
Plans that work with media before warnings	8
Plans providing air-conditioned shelters	13
Plans providing transport to shelters	6
Plans that check on isolated individuals	11
Plans with phone “hot lines”	10
Plans providing risk information to the public	11
Plans providing information in Spanish	2

## INFECTIOUS DISEASES AND LESSONS FROM PAST OUTBREAKS

Over the past 100 years, temperatures during the day have increased 0.88°C. But more important, according to Dr. Paul Epstein, associate director of the Center for Health and the Global Environment at Harvard Medical School, is the rise in nighttime temperatures. Since 1950, these temperatures have increased 1.86°C. Precipitation also has increased during that period.

Vector-borne diseases, including dengue fever and St. Louis encephalitis, are sensitive to climate. There is concern that changes in



◀ Harvard Medical School's Paul Epstein noted that higher nighttime temperatures could promote the spread of vector-borne diseases.

Continued on page 7

climate could increase the potential for transmission. Human behavior and public health infrastructure are key factors determining disease outbreaks.

Disease surveillance plays a crucial role in monitoring, evaluating, and providing early warnings of outbreaks of vector-borne diseases. As the climate changes, it is critical that surveillance remains an integral component of all public health plans. Because surveillance is costly and time-consuming, it is hampered when resources are limited.

INFECTIOUS DISEASE RECOMMENDATIONS

- Obtain additional human disease data in order to determine the environmental influences on human health.
- Gain insights by studying variability in disease incidence and weather conditions.
- Establish a population-based assessment of disease patterns and correlate these with climate variables.
- Use data from existing studies or active surveillance systems already in place because of the cost of data acquisition.
- Conduct studies on the full economic impact of disease outbreaks on communities. ♦

### *The Risk of Dengue and Encephalitis*

“Dengue fever and St. Louis encephalitis (SLE) are examples of ecologically sensitive diseases,” said Robert Shope, professor of pathology at the Center for Tropical Diseases, University of Texas Medical Branch. “The ecology of these diseases could change with climate change.”

The pathogens that cause dengue fever and SLE are carried by mosquitoes. Both the pathogen and the host are significantly affected by warmer temperatures. With climatic changes, the mosquito’s geographic distribution, development, and reproduction rates are affected. In addition, heat quickens the incubation period of the infectious agent inside the mosquito.

The *Aedes aegypti* mosquito that carries the dengue virus lives with people, Shope said. It can breed in tires, clay pots, and other containers that are frequently found near people’s homes. In 1995, six cases of dengue were reported in Texas, while 4,000 cases were reported just across the border in Mexico. Shope suggested that the

discrepancy in numbers of cases might be a result of different housing, economies, and socioeconomic conditions.

In 1997, nine cases of SLE were reported in Florida, and one person died. SLE is normally passed back and forth from mosquitoes to birds during the late afternoon and early evening. People are accidental hosts. “This outbreak had an influence totally out of proportion to the risk,” said Shope, who mentioned that Disney World closed early during the outbreak. ♦

▶ Robert Shope, of the University of Texas, said that ecological changes could increase the risk of dengue fever and encephalitis in some areas.



### *Hantavirus and El Niño*

In 1993, an El Niño year, 63 people died from hantavirus pulmonary syndrome (HPS) in the southwestern United States. Dr. Jonathan Patz, of the Johns Hopkins School of Hygiene and Public Health, reported on a study by a colleague at Johns

by El Niño may lead to population explosions of these mice in parts of the Southwest.

Gurri Glass and his colleagues selected 27 cases of HPS and used the location of those households to define high-risk areas. When the remainder of the HPS cases were examined, a high percentage matched those areas defined as high risk. “This study is unique because it started from the human health end,” said Patz.

Based on the study’s results, the researchers are using satellite images to predict areas at risk in 1997-98, another El Niño period. High- and low-risk areas have been assigned based on landscape features. Researchers are catching mice, documenting their locations, and testing their blood for the virus. Preliminary results indicate that satellite images can predict areas of high risk nine months in advance of any outbreak. ♦



▶ Jonathan Patz, of the Johns Hopkins School of Hygiene and Public Health, described the potential relationship between El Niño and outbreaks of hantavirus.

Hopkins, Dr. Greg Gurri Glass, that used satellite images to evaluate landscape

features (vegetation and soil moisture) predictive of HPS risk. The goal of Gurri Glass’s study was to identify habitats that favor deer mice, which carry the HPS virus. Changes in weather patterns caused

## The Crucial Role of Disease Surveillance

"Surveillance is the first goal of the CDC plan to address emerging diseases," said Duane Gubler, director of vector-borne diseases, Centers for Disease Control and Prevention. Public health surveillance is used for advocacy, planning, implementation, and most important, monitoring and evaluation.

Gubler noted that there are two types of surveillance. Passive surveillance involves reporting diseases as they occur, and is used to standardize case definitions and reporting systems. Active surveillance provides early warnings of disease outbreaks and is laboratory-based. Both passive and active surveillance are critical components of public health plans, Gubler said.

Dissemination of data is an essential component of any surveillance system. The Internet has revolutionized disease surveillance, allowing for rapid delivery of information. But Gubler cautioned that not all online information is reliable, due to the lack of reliable oversight of Internet information. Other important information sources include the CDC's weekly morbidity and mortality reports. ♦

▶  
"Surveillance is the first goal of the CDC plan to address emerging diseases," said Duane Gubler of the Centers for Disease Control and Prevention.



## INCREASED RISK OF ILLNESSES FROM FOOD AND WATER

An estimated 10 million cases of food-borne and 1 million water-borne diseases occur in the United States each year, according to Joan B. Rose, professor in the University of South Florida's Department of Marine Science. These diseases appear to be on the increase due to emerging pathogens, antibiotic resistance, increases in sensitive populations, changing water supplies, and changes in the global food market.



◀ A complex mix of environmental, biological, and infrastructural factors typically interact in disease outbreaks. "We need to understand the dynamics in our communities

◀ Joan Rose, of the University of South Florida, said that food- and water-borne diseases appear to be increasing in the United States.

### FOOD- AND WATER-BORNE ILLNESSES RECOMMENDATIONS

- Evaluate seasonality, geographical distributions, and climate factors (direct and indirect) in cases of food-borne diseases identified in FoodNet.
- Use ecosystem-based cholera studies as a model for studies of other emerging concerns, such as *psittacosis*, and their impacts on coastal health.
- Promote communication among federal, state, and local community groups to make use of El Niño predictions.
- Maintain bridges with institutions and affected parties so that feedback on the production and use of El Niño data can be used to improve models.
- Build public outreach into global climate and health programs. ♦

that may lead to exposure and identify where risk management can make a difference in decreasing the exposure and the risk," Rose said. ♦

## Reducing the Risk of Contaminated Food

"We say we have the safest food supply in the world, but there are many threats," said Roger Kline, of the Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration. "The number of FDA-regulated products recalled for life-threatening microbial contamination increased fivefold from 1988 to 1995."

To reduce the incidence of food-borne diseases, President Clinton has launched the Food Safety Initiative, which focuses on improving food safety practices and policies. The initiative's key elements include enhanced surveillance of food-borne disease outbreaks, better coordination among government agencies, more food inspections, risk assessment,

▶  
FDA's Roger Kline described federal efforts to improve the safety of domestic and imported foods.



research on detection and prevention, and education for consumers and food workers.

Through the initiative, new sites are being added to the Foodborne Disease Activity Surveillance Network (FoodNet) established by FDA, the Centers for Disease Control and Prevention, and the U.S. Department of Agriculture. The initiative also will allow FDA to hire more food inspectors.

The food industry will assume more responsibility for safety through expansion of the Hazard Analysis and Critical Control Point (HACCP) program to new sectors such as the fruit and vegetable juice industries.

For more information, visit the Food Safety Initiative website at <http://vm.cfsan.fda.gov/~dms/fs-toc.html>. ♦



Rita Colwell, of the University of Maryland's Biotechnology Institute, said that 3,000 cholera cases were reported in Peru during the first week of January 1998, in the midst of the powerful 1997-98 El Niño.

The specter of cholera is still with us, warned Rita R. Colwell, president of the University of Maryland's Biotechnology Institute. It seems to be one of those diseases that re-emerges and catches us by surprise.

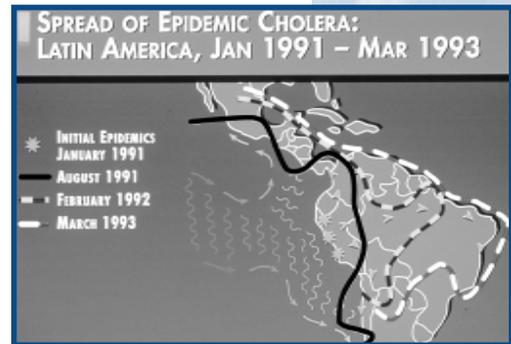
Colwell added, however, that it might be possible to predict conditions conducive to cholera outbreaks and prevent epidemics through public health measures.

Cholera outbreaks in riverine and coastal areas occur in conjunction with changes in sea surface temperature, sea surface height, nutrient loads, and salinity. The disease is associated with zooplankton

nutrient-rich water. People may catch the disease by eating fish or shellfish that consumed the zooplankton, or they may ingest the bacteria from drinking untreated, unfiltered water.

Cholera epidemics in Latin America have occurred in El Niño years, when sea temperatures rise and heavy rainfall and runoff bring nutrients into estuaries, triggering shifts in plankton populations.

Could global warming cause cholera epidemics in the United States? Not if water treatment is effective, Colwell said. "But if you have serious and dramatic climate events that cause a breakdown in water treatment, then all bets are off." ♦



R. Colwell, Science, Vol. 274, 20 December 1996.

### El Niño's Relationship to Health

"Next to the annual cycle of the seasons, El Niño has the largest impact on climate," said Juli Trtanj, of the Office of Global Programs at the National Oceanic and Atmospheric Administration. El Niño is a natural phenomenon, typically occurring every three to seven years, but it may change in intensity and frequency as the world becomes warmer.

NOAA's Juli Trtanj discussed the health impacts of El Niño.



In recent years, researchers have improved their ability to predict El Niño accurately and gauge its effect on weather around the world. Efforts are now underway to make those predictions

more useful and understandable to affected populations and communities. Early warning systems would include increased surveillance, education and outreach, and efforts to reduce vulnerability.

Public health researchers are now studying the effects of El Niño on encephalitis, dengue fever, malaria, water-borne diseases, and marine ecological disturbances, according to Trtanj. She called for an interdisciplinary dialogue to

identify future research and monitoring needs, and to discuss ways to distribute useful climate information and predictions. ♦

**"Bacteria don't carry passports."**

Rita Colwell  
Biotechnology Institute  
University of Maryland  
College Park, Maryland

### WHAT CAN THE INDIVIDUAL PHYSICIAN DO?



Frank Mitchell, former chief medical officer of the Agency for Toxic Substances and Disease Registry, called for more outreach to individual physicians.

Dr. Frank Mitchell, former chief medical officer of the Agency for Toxic Substances and Disease Registry, told the conference that family practice physicians are the "primary moving force" in generating public awareness and concern about public health risks. "We have to realize the incredible influence that individual practitioners can have," he said. "They have a built-in audience."

Patients view their physician as a source of knowledge on virtually any health-related topic, but doctors often are poorly informed about emerging issues such as climate change.

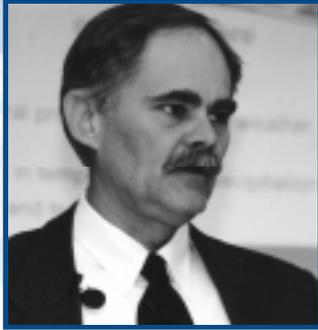
Information on the health effects of global warming simply isn't getting out to family physicians, Mitchell said.

He added that individual physicians are the front line for identifying and reporting disease outbreaks, so they should be aware of the specific types of infectious diseases and other public health risks that may be associated with climate change.

Mitchell noted that some organizations, such as the American Medical Association and the American College of Occupational and Environmental Medicine, have made efforts to raise their members' awareness of the potential health risks associated with global warming, but much more needs to be done. "We won't get anywhere until we figure out a way to show physicians why they should be interested," he said. ♦

## IMPLICATIONS FOR AGRICULTURE AND FOOD SUPPLIES

Will climate change increase the risk of hunger and malnutrition? "It depends," said Richard Adams, professor of agriculture and resource economics at Oregon State University. It depends on whether global warming is moderate or severe, the extent to which farmers can adapt to climate change, the deployment of new



technologies to increase yields, and other factors such as per capita income, population growth, and the efficiency of international trade.



*"Agricultural productivity is driven by weather events," said Richard Adams, professor of agriculture at Oregon State University.*

Changes in climate are likely to have at least some impact on agriculture. "Agricultural productivity is driven by weather events," Adams noted. Higher temperatures may either increase or decrease yields, depending on whether a region is initially warm or cool. Too much heat may harm livestock, Adams said, although he noted that animals would benefit from warmer winters. Adams stressed that agriculture is a managed system and that farmers will try to adapt.

Global warming may increase climatic variability, which implies a riskier environment for farmers to produce crops, Adams said. The projected increase in overall precipitation under global warming may not be enough to offset crops'

increased water requirements in a warmer world. Climate change also may increase pest and disease problems in crops and livestock.

According to Adams, modeling studies suggest there will be little change in total agricultural output under moderate temperature increases, especially when the fertilization effect of CO<sub>2</sub> is incorporated. "In the aggregate, if you allow for adaptation, CO<sub>2</sub> fertilization, and trade between countries, we can keep agricultural production at about the same level as it would be without climate change."

Nevertheless, Adams noted, there are likely to be regional winners and losers. In the United States, agricultural productivity may increase in northerly latitudes and decline in the Southeast and Southwest. On a global scale, the main losers would be developing countries in the tropics.

"Simply saying that agricultural production may go up or down does not necessarily translate into the amount of food that gets to the market," he said. According to Adams, some scenarios suggest that there will be slight to moderate increases in food prices under global warming. Without corresponding increases in per capita income, this could translate to more people at risk of hunger.

In the end, Adams said, climate change is likely to be an element that adds to the challenges that we already face with respect to providing an adequate, healthful supply of food to the world's population 100 years hence. ♦

## CLIMATE CHANGE AND HEAT STRESS

Large moist tropical air masses are associated with a high mortality rate, according to Laurence S. Kalkstein of the University of Delaware. "This is *today*, not a climate change prediction," he said. Southern cities have much lower numbers of heat-related deaths than northern cities, because southern people and their dwellings are better prepared to deal with heat.

Kalkstein has determined that these air masses are increasing in frequency over the United States. Under computer-simulated climate change scenarios, such air masses would become even more prevalent in the future. The projections suggest that heat-related mortality in Chicago could increase from 191 in today's average

summer to as high as 538 by 2020. "We found gross increases domestically and in foreign cities," said Kalkstein.

He went on to describe a number of uncertainties about the data, such as the possibility that a decrease in winter mortality will compensate for increases in summer deaths. "In the United States, however, winter mortality is mainly due to infectious agents," said Kalkstein, "and those will not decrease in a warmer world."

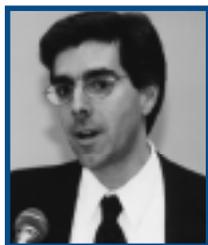
Will we simply acclimatize to the increased warmth? "We might," Kalkstein said, but he emphasized that better urban structures will be needed to reduce mortality in vulnerable populations. ♦

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**UPCOMING CONFERENCE:** The next regional conference sponsored by the U.S. EPA, "Climate Change: What Does It Mean for the Southwest?" will be held September 24, 1998, in Phoenix, AZ. For more information, contact Monica Duda, Waste Policy Institute, 703-247-2410.

## CLIMATE CHANGE AND RESPIRATORY HEALTH

Carbon dioxide should be listed as the seventh criteria air pollutant, said Dr. John M. Balbus, acting department chairman of environmental and occupational health at The George Washington University. "Levels of CO<sub>2</sub> in the atmosphere are inextricably linked to levels of particulate matter, sulfur dioxide, nitrogen oxides, and other air pollutants that are increasingly being shown to affect respiratory health and mortality."



▲ GWU's John Balbus described how global warming might affect respiratory health.

In fact, Balbus said, human respiratory health might benefit more from the reduction of conventional air pollutants—as a co-benefit of efforts to lower CO<sub>2</sub> emissions than from the mitigation of climate change itself. Still, climate and weather do have direct and indirect impacts on respiratory health. The formation of ground-level ozone increases with temperature, and

pollutant concentrations are affected by wind, precipitation, temperature, and the stability of air masses.

Climate and weather may affect the incidence of asthma, Balbus said. A significant increase in asthma cases often occurs in conjunction with the first cold snap in autumn, and bioallergens such as molds and pollens are linked with moist conditions. However, Balbus noted that no relationship seems to exist between global warming and the increase in asthma that has occurred since the 1960s. Air pollution cannot be responsible for the increase, because it has declined over the past several decades.

Ecological changes caused by global warming could result in changes in weed species. The resulting changes in pollen profiles could have either a positive or negative impact on respiratory health. Overall, however, Balbus said he does not see climate change as a "major driving force" for respiratory illnesses. ♦

## THE ROLE OF THE PUBLIC HEALTH PROFESSIONAL

"We need to engage the public now," said Barry S. Levy, immediate past president of the American Public Health Association. "We need to do it wisely, to build public understanding of complex issues, and we need to do it strategically in a way that builds public awareness and confidence in scientists and other health and environment professionals."

Levy identified five broad areas of action to reduce the public health risks associated with global climate change:

**Documentation.** "We need to facilitate new and creative ways of surveillance," Levy said, using as models such innovative programs as the federal SENSOR initiative for occupational disease reporting. Levy added that health officials must develop an understanding of potential climate-related health problems and how to diagnose them.

**Research.** Levy called for a unified, interdisciplinary national or international research agenda.

Research is needed to clarify the links between climate change and human health, and to develop and evaluate warning systems and interventions.

**Education and Communication.** Education and outreach efforts must be targeted to the public, policymakers, and the media, according to Levy. Vulnerable subsets of the population, such as the elderly and those who care for them, should receive special attention. The public health risks of climate change also should be incorporated into the mainstream curriculum in schools of public health, medical schools, and nursing schools.

**Advocacy.** Levy called on health officials to advocate on the local, national, and international levels for measures to slow global warming and reduce society's vulnerability to its impacts. He stressed that advocacy should be directed broadly toward policies that will lead to sustainable human development, not just those that focus on climate change.

**Prevention.** "We can't wait for things to happen before embarking on preventive measures," Levy said. He recommended that officials think in terms of the traditional public health framework of primary, secondary, and tertiary prevention—to prevent problems before they occur, detect problems at an early stage, and supply supportive and restorative care.

Levy stressed the importance of values and vision in achieving meaningful results under these five areas of action.

"Most of the successful public health interventions over time have resulted from people who have visions of what needed to happen," Levy said. The vision must be based on strong values such as a basic concern for human health and well being, concern for the global commons, and the precautionary principle, which dictates that action must sometimes be taken even when scientific proof is lacking.

Finally, Levy said, nothing can be accomplished without strong leadership. "We need the courage, conviction, and ability to translate visions and values into reality." ♦



▲ Barry Levy, immediate past president of the American Public Health Association, identified five areas of action to reduce the health risks of climate change.

*"We need to organize people around specific issues that might affect them or their families and communities."*

Barry Levy  
Immediate Past  
President  
American Public  
Health Association

## TAKING AN INTERDISCIPLINARY APPROACH

Health professionals must incorporate environmental management into the conceptual models they use, according to Dr. Samuel Myers, AAAS science and diplomacy fellow in the Environmental Health Division of the U.S. Agency for International Development. "We need to recognize that how we treat our land, our water, our oceans, and our atmosphere have direct consequences to our own health."



Samuel Myers, of the U.S. Agency for International Development, called for interdisciplinary partnerships to identify the relationships of climate to ecology and health.

Myers called for a new set of partnerships among health professionals, ecologists, agricultural experts, climatologists, and water resource managers "to tease out" the relationships of climate to ecology and health. He noted that efforts already are underway to incorporate health data into global observing systems.

An interdisciplinary approach is critical for disease surveillance, Myers said. For example, sea surface temperatures and nutrient loads in estuarine environments could be monitored as part of an early warning system to prevent cholera outbreaks.

Myers called for a "rational agenda" to reduce vulnerability and direct our research efforts in the most fruitful way. Activities such as improving access to potable water and sanitation, improving agricultural practices, and better surveillance and control of infectious diseases will help reduce developing countries' vulnerability to global warming, he concluded. ♦

## BRINGING THE DISCIPLINES TOGETHER

The disciplines of medicine, public health, sanitation, and the environmental sciences have drifted apart, said Karl W. Western, assistant director for international research at the National Institute of Allergy and Infectious Diseases. The fragmentation is partly due to the proliferation of government agencies and services, many of which are directed toward specific programs and goals.



Karl Western, of the National Institute of Allergy and Infectious Diseases, identified common themes from the conference and recommended strategic responses.

This fragmentation is unfortunate, Western said, because environmental health problems are complex and multi-sectoral. A multidisciplinary effort is

needed, but such efforts are difficult to organize, obtain support for, and sustain.

Western identified four strategic steps that interested parties and government agencies could take to promote multidisciplinary studies of the health impacts of climate change.

**1. Promote interagency cooperation.** Agencies and private foundations can pool their resources to support joint programs/announcements of research, establish interagency task forces, and cooperate in commissioning studies by independent groups such as the National Academy of Sciences and the Institute of Medicine.

**2. Form partnerships with successful existing initiatives.** Western noted that expanding existing research efforts is likely to be more fruitful than trying to create new programs. For example, the initiative on Emerging Infectious Diseases could expand its environmental and climate change components.

**3. Encourage the building of constituencies that can serve as advocates for multidisciplinary programs.** The National Institutes of Health, for example, has developed a strong constituency base in the academic community.

**4. Develop multidisciplinary teams at the community level.** Most large communities, Western said, have the essential ingredients for such teams, including universities, local governments, private organizations, and interested public figures. ♦

## THE NATIONAL ASSESSMENT PROCESS

A public-private process is underway to generate a comprehensive report on the potential impacts of climate change and climate variability for our nation. Several federal agencies are involved in this National Assessment process, EPA's Joel Scheraga said, and private stakeholders will play a key role. Scheraga emphasized that the process is designed to ensure those stakeholders' concerns and questions are addressed. He stressed that it is an "open and inclusive" interdisciplinary process that adheres to the highest standards of scientific credibility.

The assessment is being performed on a regional basis, with the country divided into 19 regions. It includes an education component to ensure that the findings are communicated effectively to the American people and relevant stakeholders.

The assessment will address three basic themes: (1) identifying current conditions and stressors in each region, independent of climate change; (2) determining how climate change and climate variability might exacerbate or ameliorate those stressors; and (3) identifying strategies to reduce risks or take advantage of positive effects. The assessment also will include five crosscutting sectoral reports on agriculture, forests, coastal zones, water resources, and human health.

Scheraga invited all attendees to participate in the process, saying that it poses a "golden opportunity" for researchers and stakeholders to help shape the report and ensure it is balanced, credible, and useful to the American people. ♦

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