Health in the Hot Zone

How would global warming affect humans?

By RICHARD MONASTERSKY

Paul R. Epstein, a specialist in tropical public health, knows too well the kinds of diseases plaguing the tropical latitudes of this planet. While working in Mozambique during the late 1970s, the physician endured a withering bout of cholera that he caught by eating infected shellfish. During the same trip, his wife and two children came down with malaria, even though they were taking prophylactic drugs.

What concerns Epstein, a researcher and clinician at the Harvard School of Public Health in Boston, is that many millions of uninitiated people will endure similar lessons, as cholera, malaria, and other scourges spread in the coming decades. The unwanted education would come courtesy of global warming, which could allow diseases to reach into previously unscathed areas.

"I think climate change is a very big threat," says Epstein. "It's a major wake-up call. Climate change is already a factor in terms of the distributions of malaria, dengue fever, and cholera. They are changing their distributions right now."

Epstein is not alone. In a soon-to-be-released report, the United Nation's World Health Organization examines the health effects of global warming—the predicted planetary fever caused by emissions of carbon dioxide and other heat-trapping gases. The report calls climate change one of the largest public health challenges for the upcoming century. Last year, the Intergovernmental Panel on Climate Change (IPCC) reached a similar conclusion, finding that "climate change is likely to have wide-ranging and mostly adverse impacts on human health, with significant loss of life."

The issue extends beyond tropical illnesses. Deaths caused directly by heat would increase during the ever more oppressive summers. Dwindling agricultural yields in the tropics could leave tens of millions more people facing hunger and starvation.

Armed with such alarming forecasts, Epstein and his colleagues have taken their information on the road. They have sounded the alert at dozens of conferences in the last 2 years.

The new focus on health could bolster the message of climatologists, whose warnings have received a cool reception from the public recently. Global warming predictions have tended to be abstract and easily ignored. Scientists speak of globally averaged temperature and worldwide sea level rise, factors removed from everyday life. The concern about health threats may put a human face on climate change.

Temperature and mortality

For evidence that heat can kill, one need look no farther than Chicago. When a summer heat wave hit the eastern and midwestern United States last year, it left more than 500 dead in that city alone.

By matching daily summertime temperatures with mortality records in different cities, Laurence S. Kalkstein of the University of Delaware in Newark has shown that heat waves raise death rates. Although people may cope with gradually climbing summer temperatures, most climate models also predict increased intensity and frequency of heat waves. Kalkstein therefore anticipates an upward spiral in the number of heat-related deaths.

The problem is expected to strike most severely in large urban centers located in the midlatitudes. By the middle of the next century, giant cities like Shanghai and New York could face several thousand extra heat casualties each year, he wrote in the Sept. 30, 1995 LANCET.

During winter, however, warming could have the opposite effect in some regions. One British study, cited in the IPCC report, concluded that by 2050, warming of 2° to 2.5°C will save 9,000 lives each year in England and Wales. Most of these people would otherwise have died from heart disease and stroke, problems exacerbated by blood's tendency to clot in colder temperatures. The lives saved would more than balance the increase in deaths from Britain's relatively mild heat waves, says Anthony J. McMichael, lead author of the IPCC chapter on human health and a researcher at the London School of Hygiene and Tropical Medicine.

The United States, though, should not bank on comparable benefits from global warming. The country's large size—with most regions situated far from any coastline—makes it more susceptible to extreme hot spells. "Scientists in the United States expect that there will be more losses in the summer than gains in the winter," says McMichael.

Tropical trouble

Though heat can kill directly, global warming is expected to claim even more of its victims through an indirect influence on disease, particularly on vector-borne microbes, which hitch a ride inside insects and other organisms.

"Many diseases are extremely sensitive to climate," says Jonathan Patz of the Johns Hopkins School of Hygiene and Public Health in Baltimore. "Now that the climatology community says

Adapted from IPCC

Major Vectorborne Tropical Diseases

Disease	Number of People Now Infected (millions)	Possibility that Climate Change Will Alter Distribution
Malaria	300–500	extremely likely
Schistosomiasis	200	very likely
Lymphatic filariasis	117	likely
Leishmaniasis	12	likely
Onchocerciasis (river blindness)	17.5	very likely
American trypanosomiasis (Chagas' disease)	18	likely
Dengue	10–30 new cases per year	very likely
Yellow fever	<0.005 new cases per year	very likely

that climate change is real, we know that there are going to be shifts in the distribution of many diseases."

In the Jan. 17 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, Patz, Epstein, and their colleagues reviewed how global warming could encourage emerging infectious diseases to spread. Malaria, they note, generally does not afflict regions with annual average temperatures below 16°C, because lower temperatures inhibit the parasite. As minimum temperatures climb, the disease could spread into previously malariafree regions.

At present, 45 percent of the world has conditions that permit malaria transmission. The IPCC estimates that warming of 3° to 5°C could expand the zone of potential transmission to include 60 percent of the globe. Temperatures will reach this point sometime in the 22nd century, according to model forecasts. The IPCC predictions call for global average temperatures to rise 1° to 3.5°C by 2100.

Although malaria has the potential to envelop large parts of the world, the IPCC panel found it unlikely that the disease will run rampant through the United States and other developed countries. These nations have the infrastructure to combat malaria, both by eliminating mosquito breeding sites and by treating cases. Although many parts of the United States and Europe already have climates that could support malaria, the disease was wiped out in these areas in the 19th century.

The predicted consequences of global warming would fall most heavily on tropical regions, where malaria could spread in both latitude and altitude. "A relatively small increase in winter (minimum) temperature would likely facilitate the spread of malaria into large urban highland populations that are currently malariafree and immunologically naive, such as Nairobi, Kenya, and Harare, Zimbabwe," Patz and his colleagues contend in their recent article. Because residents of Nairobi and Harare have little immunity to the disease, malaria would claim an inordinately large number of people in such cities.

One study by researchers in the Netherlands estimates that climate change will cause 1 million extra malaria deaths per year by the middle of the next century. But such numbers represent little more than a guess, warn researchers. Epstein points out that the ongoing spread of drug-resistant malarial strains is likely to make the situation worse than current expectations.

Other vectorborne diseases also have the potential to expand their ranges in a warmer world. Dengue fever has already shown its ability to respond to changing conditions. In Mexico during a heat wave in 1988, the mosquito species *Aedes aegypti* carried dengue fever from an altitude of 1,000 meters up to 1,700 meters.

Recent warming helped spark an outbreak of dengue that burned through Latin America this summer. By the end of September, the disease had infected 140,000 people from Argentina all the way through South and Central America, eventually reaching into Texas. More than 4,000 people died. "This was a hell of a summer. It was quite a massive epidemic," says Epstein.

Waterborne scourges

Future trouble will also come from the seas. According to the IPCC, global warming should make the oceans a more hospitable home for cholera and harmful algal blooms.

In 1991, cholera emerged in Peru for the first time this century. The waterborne illness spread through coastal cities and waterways, eventually reaching most countries in South America. In its first 18 months, the epidemic infected 500,000 people and caused 5,000 deaths.

The cholera plague struck while an El Niño was warming the waters of the equatorial Pacific, a correlation not lost on researchers interested in health and climate change.

Scientists know that water temperature affects the spread of cholera. The bacterium that causes the disease often hitches a ride inside tiny marine animals called copepods, which feed on algae. When the water warms, algae bloom and copepod populations soar. The whole chain leads to an outbreak of cholera. In Bangladesh, for instance, the incidence of cholera tends to rise when water temperatures do.

Scientists can't prove that the 1991 El Niño triggered the South American cholera outbreak, but climate change is likely to encourage epidemics in the next century, says Epstein.

Harmful algae also find favor in warmer seas. In the past few years, scientists have tracked a global epidemic in coastal blooms of toxic plankton that can afflict humans who consume fish or shellfish.

"Given that many of these harmful algae [thrive at higher temperatures], warming trends and global climate change will promote increased activity and also cause them to continue to expand and extend their ranges," says JoAnn Burkholder of North Carolina State University in Raleigh.

Greenhouse warming will work together with other factors that are currently contributing to the algal invasion. Sewage and agricultural fertilizers abet these plankton by pouring nitrogen into coastal waters, stimulating the growth of plants. Overharvesting reduces the fish populations that keep algae in check.

Threats such as cholera and malaria, however, may pale in comparison to the risk of food shortages caused by global warming. Although increasing concentrations of carbon dioxide might actually boost global food production in the near future, prolonged warming and precipitation shifts will probably lower agricultural yields in many developing countries, according to the IPCC. Such countries have fewer resources to adapt to changing conditions, and their climates are already marginal for certain crops.

One recent study predicted that climate change will put 40 million to 300 million extra people at risk of hunger in 2060. This population would join the 640 million others expected to face food shortages by that date even without climate change.

Beyond climate concerns

As the vast range in hunger estimates demonstrates, scientists are only taking their first steps toward assessing how greenhouse warming will actually affect people. In its report, the IPCC admits that its health forecasts are fraught with uncertainty, notably, how much the climate will change, exactly how diseases will respond, and to what extent various countries will be able to protect against future risks.

Complicating the picture even further are the myriad other threats to health, especially in developing countries. Increasingly crowded cities, poor sanitation, limited supplies of potable water, and violence all cause major harm today and will continue to do so for the foreseeable future.

In fact, some public health researchers worry that the growing emphasis on global warming could dilute appreciation of some more important, but perhaps less provocative, factors currently eroding health around the world.

"My concern is that you can be distracted by what is in fashion," says Vilma Santana, an epidemiologist at the Federal University of Bahia in Salvador, Brazil. "I think *the* major issue is poverty. One of the most consistent findings of epidemiological research is that poverty is positively associated with disease."

Others echo Santana's concern. "Most of my colleagues in Africa feel that in the face of populations without water, toilets, basic access to education, and jobs, global warming is the least threat," says epidemiologist Carolyn Stephens, a colleague of McMichael's.

Those concerned about global warming counter that climate will interact with and exacerbate many of these seemingly unrelated problems. For instance, shifts in rainfall may displace rural populations, thus squeezing even more people into crowded cities, where infectious diseases thrive. More frequent droughts would make water even scarcer than it is today.

"My argument is that climate change is making a bad situation even worse," says Patz.

He and Stephens agree, however, that climate change will disproportionately burden developing countries. In this way, warming will exact the greatest price from populations that can afford it least. □