Apocalypse Not

Predictions that global warming will spark epidemics have little basis, say infectious-disease specialists, who argue that public health measures will inevitably outweigh effects of climate

The story of global climate change and disease is what a newspaper reporter would call great copy. It has dire predictions of pestilence and death, with the imprimatur of topnotch science. The plague is coming, and it's coming home to the developed world. The idea, as proposed by a handful of public health researchers, is that global warming and the attendant climatic extremes of floods and droughts, storms and heat waves, may play havoc with public health. As the heat rises, hundreds of thousands may die yearly from heat-related ailments, while disease vectors and their pathogens may be redistributed far and wide with apocalyptic results. "To the layman," wrote Harvard physician Paul Epstein in *The Washington Post*, "it means a global spread of infections."

Epstein and others have predicted that deaths from malaria may increase by a million a year; that malaria, dengue, and yellow fever may move north into the United States and Europe; that cholera epidemics may intensify; and that emerging diseases such as hantavirus and Ebola may run rampant. Already, they say, bursts of warming from short-lived climate shifts like the Pacific warming called El Niño may have triggered disease outbreaks that offer an ominous preview of what is to come. If it is not the beginning of the end, it has certainly read like it: "Global Fever" was just one of the headlines, from the 8 July 1996 *Time*. It continued: "Climate change threatens more than megastorms, floods and droughts. The real peril may be disease." Even *Science* was suitably concerned: "If the Mercury Soars, So May Health Hazards" (17 February 1995, p. 957).

The salient word in all these stories, however, was "may." These predictions are getting renewed attention with the approach of the December climate change summit in Kyoto, Japan, and leading infectious-disease experts have taken to criticizing them sharply. Duane Gubler, for instance, director of the division of vector-borne infectious diseases at the Centers for Disease Control and Prevention (CDC), calls the prognostications "gloom and doom" speculations based on "soft data." Johns Hopkins epidemiologist D. A. Henderson, who led the international smallpox eradication program from 1966 to 1977, says they are based on "a lot of simplistic thinking, which seems to ignore the fact that as climate changes, man changes as well." Henderson, Gubler, and others argue that breakdowns in public health rather than climate shifts are to blame for the recent disease outbreaks—and that public health measures will be far more important than climate in future disease patterns.

Many of the researchers behind the dire predictions concede that the scenarios are speculative. But they say their projections play a useful role in consciousness raising. "What it does is serve notice on us; we need to be aware we're tinkering with fundamentals, and there could be a range of consequences for human health," says Anthony McMichael of the London School of Hygiene and Tropical Medicine.

The increasingly heated tone of the debate has prompted the CDC and the National Research Council (NRC) to begin putting together an expert panel that will try to set the discussion on a footing of solid science. Says Henderson, who has been chosen as a co-chair, "What's worrying is the question of credibility when sweeping predictions like these are being made." The panel will also set an agenda for further research, he says: "Fundamentally, we would like to have a better understanding of the transmission of disease under different circumstances of temperature and climate, not necessarily because of global warming, but because it can be of value to us whenever we have climate fluctuations."

Heat or light?

The current controversy has been building for at least 6 years, since climatologists began agreeing that the planet's temperature is rising (although they still do not agree on the cause of the warming to date, or on how much warmer the planet will get). In 1991, virologist Robert Shope, then director of the Yale Arbovirus Research Unit, pointed out in *Environmental Health Perspectives* that with rising heat, the *Aedes aegypti* mosquito, which transmits dengue fever and yellow fever, might move northward, while the life cycles of the mosquito and the virus might accelerate, which "could lead to epidemics in North America." Cholera could also become epidemic in North America, Shope said, as changes in marine ecology favor the growth and transmission of the pathogen, which is "harbored persistently in the estuaries of the U.S. Gulf Coast."

In 1992, microbiologist Rita Colwell of the University of Maryland, College Park, with Epstein and Harvard biologist Timothy Ford, took that idea further. They suggested in a *Lancet* article that an El Niño warming of the tropical Pacific was at least partially responsible for a 1991 cholera epidemic in Latin America that affected a half-million people and killed nearly 5000. Over the next 3 years, the tide of concern rose inexorably. In January 1996, the predictions erupted into the press when *The Journal of the American Medical Association* published a paper by Epstein, Jonathan Patz, an expert in occupational and environmental medicine at Johns Hopkins, and collaborators, speculating about the effects of a 4-degree warming over the next century on a range of public health threats from malaria and arboviral encephalitis to cholera and toxic algae.

The last step toward turning these speculations into what Gubler calls "gospel" came last year, when the United Nations' Intergovernmental Panel on Climate Change (IPCC), which is meant to offer scientists' consensus voice on climate change and its effects, included a chapter on public health impacts in an update of its landmark 1990 assessment. The public health chapter, written by a team led by McMichael and including Patz and Epstein, concluded that "climate change is likely to have wide-ranging and mostly adverse impacts on human health, with significant loss of life."

The growing official acceptance of these predictions has irritated some other public health experts. "What I find astounding," says epidemiologist Mark L. Wilson of the University of Michigan, Ann Arbor, "is how little

research is actually being done in this whole thing." As a case in point, Henderson cites the IPCC's suggestion that by 2050, summer heat waves in the United States will regularly kill 3000 to 6000 persons each year. "They say, 'Look at what happened in Chicago a year or two ago. We had all these deaths due to heat stroke. If the temperature rises, there will be an even greater problem.' Well, good heavens, people adapt. One doesn't see large numbers of cases of heat stroke in New Orleans or Phoenix, even though they are much warmer than Chicago."

STOCK MONTAGE, INC.

Effective measures. Clean water for a 19th century cholera outbreak in Hamburg, Germany.

As for infectious diseases, says Wilson, the predictions suffer from many levels of uncertainty. No one disputes the influence of weather patterns: "There's reason to believe that if it's an extremely rainy spring, summer mosquito populations will increase, or if it's an extremely snowy winter, the tick populations in the spring might benefit." But Wilson and his colleagues point out that no one knows just how patterns of temperature and rainfall will change in a warmer world, or how these changes will affect the biology of diseases and their vectors. Then there are variations in public health practices and lifestyles, which can easily outweigh any change in disease biology. Says Wilson, "What's biologically possible isn't necessarily epidemiologically likely or important."

Behind the fears about the spread of cholera, for example, is an untested hypothesis about the biology of the disease. Cholera is known to spread directly from humans to other humans through feces and through food and water; that's why cholera epidemics appear when public health and sanitation break down. The global warming predictions, on the other hand, are based on a transmission scenario that R. Bradley Sack, a Johns Hopkins cholera expert who is collaborating with Colwell, admits is speculative. It is at best, he says, "a highly attractive hypothesis."

Seawater temperatures are known to affect the spread of bacteria similar to the cholera agent, and the cholera organism is known to live in sea-borne plankton. Putting those two facts together, Colwell and Epstein argue that the potential dosage of cholera in seawater and hence in shellfish increases during plankton blooms, which in turn become more likely as the sea surface warms. The 1991 Peruvian outbreak is then cited as circumstantial evidence for this chain of events, because it spread extremely quickly and took place when an El Niño had warmed Peru's coastal waters.

But experts at the CDC say that the Peruvian outbreak doesn't require any explanation beyond the conventional ones. "We had a powder keg ready to explode," says CDC medical epidemiologist Fred Angulo, "an entire continent in which the sanitation and public water supplies and everything was primed for transmission of this organism once it was introduced," probably by ships emptying their bilge water near fishing areas. Angulo adds that cholera has been introduced into the United States several times in the last few years; it did not spread, simply "because we have a public health and sanitation infrastructure that prevents it."

A lifestyle question

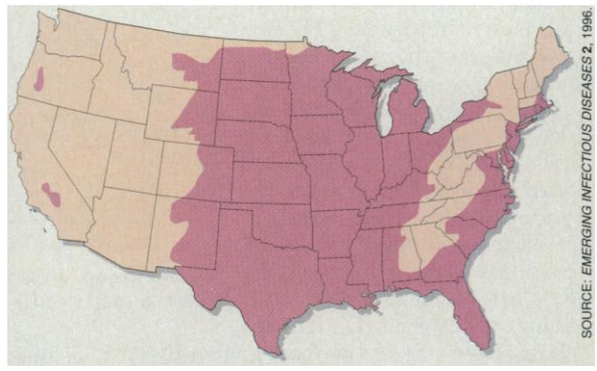
For mosquito-borne diseases such as dengue, yellow fever, and malaria, the assumption that warming will foster the spread of the vector is simplistic, says Bob Zimmerman, an entomologist with the Pan American Health Organization (PAHO). Zimmerman points out that in the Amazon basin, over 20 species of *Anopheles* mosquitoes can transmit malaria, and all are adapted to different habitats: "All of these are going to be impacted by rainfall, temperature, and humidity in different ways. There could actually be decreases in malaria in certain regions, depending on what happens."

Similarly, in Sri Lanka, says CDC entomologist Paul Reiter, malaria outbreaks are associated with arid periods, when rivers dry up and leave pools and puddles in which the mosquitoes breed. "Heavy rainfall is just what's needed to get rid of their malaria," he says, because the puddles become torrents and mosquitoes don't breed in running water. "It's so easy to be simplistic and intuitive in these things, and to miss the boat altogether."

Gubler adds that the evidence to date suggests that lifestyle and public health measures such as mosquito control far outweigh any effects of climate. Epstein, for instance, attributes Latin America dengue epidemics in 1994 and 1995 in part to El Niño and the more gradual rise in global temperatures, both of which might have favored the spread of the mosquito. But dengue experts at PAHO and the CDC say the epidemics resulted from the breakdown of eradication programs aimed at *Aedes aegypti* in the 1970s, and the subsequent return of the mosquito. Once the mosquito was back, they say, the dengue followed.

Gubler is even more dismissive of claims by Epstein and others that these diseases may spread into the United States. He calls such predictions "probably the most blatant disregard for other factors that influence disease transmission." The mosquito vectors of malaria, dengue, and yellow fever have been in the United States for centuries, but the epidemics they once caused have vanished due to mosquito control, eradication programs, piped-water systems, and changing lifestyle. "We have good housing, air conditioning, and screens that keep the mosquitoes outside, and we have television that keeps us inside," says Gubler. "All of these decrease the probability that humans will be bitten by these mosquitoes." Gubler and Reiter point to the 1995 dengue pandemic that rolled through Mexico only to die at the Rio Grande. There were more than 2000 confirmed cases in Reynosa, Mexico, and only seven across the river in Texas.

Gubler adds that the Gulf states of the United States are several degrees warmer than the Caribbean during the summer. Both regions have the dengue vector, and yet the Caribbean has the disease and the Gulf states don't. "If temperature was the main factor, we would see epidemics in the Southern U.S. We have the mosquito; we have higher temperatures and constant introduction of viruses, which means we should have epidemics, but we don't," he says.



SOURCE: *EMERGING INFECTIOUS DISEASES* 2, 1996.

Fever in a temperate climate. Areas of the United States where malaria was endemic in 1882.

Neither McMichael nor Epstein dispute Gubler's argument that climate shifts have had minimal impact on disease patterns so far. Gubler "is on very sound ground when he says that if you look at shifts of dengue fever and malaria over the last decade, most if not all have to do with things other than climate," says McMichael. "There is no clear signal from any of recent past data that cli-

mate has been an important influence."

But Epstein says that Gubler's critique overlooks some worrisome signs. When Epstein and others feed data on the global warming that has taken place so far into their computer models of disease spread, he says, they find that the results match trends that are already apparent, such as the spread of mosquito vectors at higher latitudes. Gubler and others are "mixing up the present with the future," McMichael adds. "What we're saying is if climatic changes do occur, given what we think we know about the influences of changing temperature and humidity on the distribution and biological behavior of mosquitoes, vectors, and infectious organisms, it's a perfectly reasonable prediction that there will be change in the potential transmissibility of these things."

The NRC panel will not be the only body trying to make sense of these disputes. Nancy Maynard, deputy director of science for NASA's Mission to Planet Earth program, says NASA has just started a subcommittee on global change and human health, hoping to "provide the strongest scientific basis for these relationships. We want to know the science underlying this." PAHO, says Zimmerman, is also hoping to "establish a scientific agenda to define what studies are necessary to show the impact of changing climate and weather patterns on tropical diseases."

Still, Gubler worries that all the attention to global warming as a public health problem will distract the public from other priorities. "We should definitely do what we can" to reverse global warming, he says, "but we should also be thinking about directing resources toward public health measures to prevent the spread of disease—immunization, mosquito control, improved water systems, waste management systems. The most cost-effective way to mitigate the effect of climate change on infectious disease is to rebuild our public health infrastructure and implement better disease-prevention strategies."

Virologist Barry Beaty of Colorado State University in Fort Collins agrees: "You don't have to be a rocket scientist to say we've got a problem," he says. "But global warming is not the current problem. It is a collapse in public health measures, an increase in drug resistance in parasites, and an increase in pesticide resistance in vector populations. Mosquitoes and parasites are efficiently exploiting these problems."

–Gary Taubes

YOUNG INVESTIGATORS

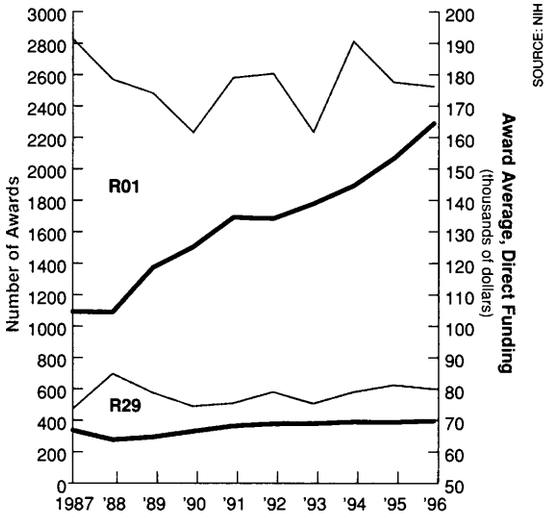
NIH Plans One Grant for All Sizes

You've finished your postdoc, and now you are ready to apply for your own grant from the National Institutes of Health (NIH). But first, you have a decision to make: Do you want an R29 grant, a type custom-designed for new applicants, or a standard R01, which puts you in a competitive pool that includes Nobel Prize winners? It may sound like a no-brainer, but many young investigators are finding that the easier option can be a frustrating trap.

Take cell biologist Kenneth Dunn of Indiana University in Indianapolis. He applied for an R29 because an adviser told him it was the surest route to success. But now that he's won the grant, Dunn is beginning to wonder. The R29's top payout of $70,000 a year means that, after salaries, Dunn will have at best $10,000 a year for supplies. "And I'm lucky," he says, because reagents in his field are cheap.

Next week, NIH's leaders are considering ending the agonizing R29-R01 dilemma simply by abolishing the R29 grant. The R29 was created 10 years ago as a low-budget alternative to the standard R01. It was designed to give new researchers easier access to the funding system, but NIH thinks the experiment has been a failure. The $70,000 per year it provides in direct costs over 5 years, NIH staffers say, is saddling good ideas with impossible budgets.

Under the NIH's new proposal, everyone would compete for R01s, which have a $500,000 limit per year and pay on average more than $160,000 a year (see graph). New applicants would still get special status, however: They would be identified as newcomers on the cover of their application, and peer reviewers would be asked to give them a break. And, to ensure that the number of new entrants into the funding system at least remains steady, NIH may add more than $300 million to the budget for grants.



Widening gap. While the average annual value of an R01 has increased steadily, R29s have fallen behind.

The additional money will be needed, says Marvin Cassman, director of the National Institute of General Medical Sciences, because institutes would have to fund new grantees at the rate that veterans drop out—8% to 9% a year. Over a 5-year period, in effect, all the R29s would be converted to more expensive R01s. Using 1995 data, Cassman estimates that the added cost would be $55 million the first year, rising to $370 million in the fifth year.

This plan was proposed last summer by a working group chaired by Cassman and Elvera Ehrenfeld, director of NIH's Center for Scientific Review, formerly the Division of Research Grants. It has been treated gingerly by NIH's top brass, however. The working group presented its report to NIH institute directors in July, and according to Ehrenfeld and Cassman, it was received favorably. But NIH made no decision.

The proposal is "very sensitive," explains working group member John Krystal, a Yale psychiatrist who strongly supports it, as does the other outsider on the panel, cell biologist Trina Schroer of Johns Hopkins University. But the NIH staff is wary that the plan will "increase everyone's anxiety," says Krystal. As Dunn observes, "this may look awful at first blush" to postdocs who are leery of competing with senior investigators. And senior scientists who don't understand why winning an R29 is a kind of curse may also be confused. Dunn recalls, for example, that one senior colleague was dismissive of younger researchers' concerns about funding, noting that he himself had three R01s. As for Dunn, he fears it may sound ungrateful, but he agrees that the R29 is so stingy that ending it "sounds like a good idea."

Cassman is aware that this proposal "is not a trivial change," in part because "it would require a significant increase in funding to new investigators" from all the institutes. The institutes seem to be inching toward making that commitment, however. A peer-review oversight group that advises Wendy Baldwin, NIH deputy director for extramural research, is hearing Cassman present the case for this change on 3 November, and the NIH institute chiefs will review it a second, and perhaps final, time at a meeting on 13 November.

"This isn't a done deal," says Baldwin. But she adds, "if I were betting, I would bet that it will be approved."

–Eliot Marshall