

# If Climate Changes, Who Is Vulnerable? Panels Offer Some Local Projections

---

By WILLIAM K. STEVENS

---

**I**F mainstream scientists are right in their forecast that the earth will warm up substantially in the decades ahead, what will happen to a place like, say, New England? Will its brilliant fall foliage fade? Its sugar maples migrate to Canada? Its ski slopes turn to slush? Its tourists vanish?

As negotiators from around the world struggle to agree on cuts in emissions of heat-trapping greenhouse gases, scientists are trying to bring the issue of global warming and attendant changes in climate down out of the stratosphere of scientific debate and global diplomacy into the everyday world, where some local officials and citizens are starting to think more about how the predicted changes might affect them.

It is not an easy task. Experts find it difficult enough to predict how temperature and climate will change globally if industrial society continues to emit greenhouse gases like carbon dioxide. This is mainly because of imperfections in

computer models of the atmosphere on which global predictions are based.

Forecasting the re-

**THE WARMING WORLD**  
*Coping With Climate Change*

---

gional and local impact of climate change is even harder because the global models do not deal with climatic change on a regional and local scale very well. To make matters even more difficult, the global environment and human economy interact in complex and often unfathomable ways, creating environmental stresses that could be either worsened or mitigated by alterations in climate.

But nothing prevents scientists from zeroing in on areas and activities that could be vulnerable to the predicted alterations in climate, and they are doing so more intensively.

In the case of New England (and upstate New York), for instance, experts meeting at a federally sponsored workshop at the University of New Hampshire this month said that the predicted changes do indeed pose a substantial, though still potential, threat in coming decades to the region's forests, its winters, its trout fisheries and shoreline developments — many of the features, in fact, that together largely define the region's character. In some future autumn, the experts said, the landscape might be dominated not by the bright oranges, reds and yellows of maples, but by the duller brown of oaks and hickories that have migrated up from the South.

New England's very "sense of place" may be at risk, said Dr. Steven P. Hamburg, an ecologist at the University of Rhode Island.

But there will probably be gain as well as pain, winners as

*Continued on Page 6*

# Some Local Projections on Climate Changes

*Continued From First Science Page*

well as losers, and no country or region is likely to be affected in the same way. This point has been made again and again in the workshops held by the Government's Global Change Research Program. The meetings this year and next are designed to produce in 1999 a national assessment of the impact of climate change.

State and local officials, natural resource managers, businessmen and others who might have to deal with the effects of a changing climate have also been attending the meetings, watching and listening to scientists' slide presentations, and meeting in discussion groups, in the hallways and at the lunch table to exchange thoughts about what it all might mean.

In another forum, the Intergovernmental Panel on Climate Change, an international group of scientists that advises the climate negotiators under United Nations auspices, issued a report on Sunday at a meeting in the Maldives identifying potential losses, gains and widely varying effects from climate change in different regions of the world.

On the negative side in North America, for instance, the panel found that forests and their wild inhabitants in the East and parts of the mountain West might not be able to migrate northward or upward fast enough or far enough to adjust to the warming climate. The group further concluded that water shortages in the southern plains could be made worse, that agriculture in the Southeast and southern plains could be at risk, that deaths from extreme heat in Northern cities could increase and that coastal development could be threatened by rising seas.

On the positive side, the panel found that, for example, agriculture in the Northern United States and southern Canada, on the West Coast and in parts of the interior West could benefit, as could the magnificent evergreen forests of the West Coast; that milder winters could cut the number of cold-weather deaths and the cost of heating and snow clearance; and that northern waters

could be open for navigation longer. In fact, the report said, the Arctic Ocean might become ice-free, opening a new trade route between Europe and Asia.

American society might be able to cope relatively easily with any single effect of climate change, said Dr. David S. Shriner, an ecologist at the Oak Ridge National Laboratory in Tennessee who was a lead author of the North American chapter of the intergovernmental panel's report. But he said that because there were likely to be several effects, all occurring at the same time, they would pose "increasing challenges" for policy makers, resource managers and citizens, especially because any changes would be difficult to predict.

One measure of the difficulty is that the intergovernmental panel's forecast of global warming specifies a wide range of possible increases in average surface temperature over the next century, from 2 to 6 degrees Fahrenheit; the panel's best estimate is about 3.5 degrees if greenhouse gas emissions are not reduced. Moreover, while the earth's surface has warmed by about 1 degree over the last century, scientists are not sure how much of that is natural and how much has been caused by greenhouse emissions.

Still, there are some early signs of actual climate change, and in some respects they appear in line with experts' admittedly very general notions of what is vulnerable and what is not. A case in point is Alaska, where, scientists at the University of Alaska said, the average warm-season temperature at Fairbanks has risen by nearly 3 degrees Fahrenheit in the last half-century. While the temperature reached 80 degrees for about a week in the early 1950's, it now does so for nearly three weeks. These figures were typical for central Alaska and much of the western North American Arctic, the scientists said.

It is possible that this warming could be an expression of the climate system's natural variability. But it is just the kind of temperature change the intergovernmental panel predicted; the Arctic is expected to warm more than the global average (while the tropics are expected to warm

less).

Alaska is already experiencing the low range of the warming the panel predicted for the globe as a whole by the year 2100, Dr. Glenn P. Juday, a forest ecologist at the university in Fairbanks, said at the recent New England workshop. While only time will tell whether the Alaskan warm-up has been caused by greenhouse gases, he said, "the kinds of change you might expect from global warming are happening" in the state right now.

The evidence of Alaskan climate change is substantial, the scientists said: Glaciers have generally receded and typically become about 30

## Weather shifts are expected to create winners and losers.

feet thinner in the last 40 years. There is about 5 percent less sea ice in the Bering Sea now than in the 1950's. Permafrost is thawing, and as it does, the ground is subsiding and holes are opening in roads. The thawing has also led to landslides and erosion, threatening roads and bridges and causing local floods.

Traditional ice cellars in northern villages have thawed and become useless. Melting sea ice has made hunting more dangerous for native people. More precipitation falls as rain than snow. But where it remains cold enough to snow, annual snowfall has increased, as would be expected in a generally warmer and therefore moister global atmosphere. The snow also melts faster, at least at low altitudes, and the intergovernmental panel forecasts more running and standing water.

The state's vast evergreen forests, called taiga, are under climatic siege, and Dr. Juday said their growth rate has gone "into the tank," in lock step with the temperature rise.

The new report of the intergovernmental panel said that tundra and taiga in North America may be reduced by two-thirds in the next century and that the southern boundary of the area covered by permafrost should shift northward by about 300 miles over the next 50 years, threatening roads, buildings, pipelines and other structures.

But there is good news for the Arctic, too, and there may be more if the warming is a long-term one. With less snow and more rain in coastal areas, for instance, there are fewer avalanches. The growing season is longer, and the intergovernmental panel says that some of the arctic may eventually open up to farming. Less ice offshore could aid oil and gas production, and warmer water could help fisheries. Heating costs could fall. Tourists could have easier access to the region. Once the permafrost is finished melting, construction should be easier than before.

The Arctic is among the regions most vulnerable to climate change, according to the panel's report. Other highly vulnerable places, it said, include small islands, many of which could be all but inundated by rising seas caused by heat-induced expansion of ocean water and melting ice sheets. The report specifically cited the Bahamas, the Maldives and the Pacific states of Kiribati and the Marshall Islands as examples of the most threatened spots. It said that as

much as 80 percent of the Marshalls' territory could be drowned by a one-meter, or 3.28-foot, rise in sea level, which is in the high end of the range predicted by the panel by 2100. (The best estimate is a rise of about a foot and a half by then, with a continuing rise after that.)

Some 70 million people in low-lying areas of Bangladesh could be displaced by a one-meter rise, the panel said. Such a rise would also threaten the coastal zone on which Tokyo, Osaka and Nagoya sit in Japan, not to mention China and the Atlantic and Gulf Coasts of the United States, according to the panel, and salt water could intrude on inland rivers, threatening some supplies of fresh water.

The opposite problem, too little water, could be worsened in arid areas like the Middle East and parts of Africa, according to the intergovernmental panel. Global warming is expected to make droughts more frequent and severe in areas prone to them. Largely for this reason, according to the panel, Africa may be the continent most vulnerable to climate change, because its economy consists largely of rain-fed agriculture and many of its farmers are too poor and ill equipped to adapt.

Australia and parts of Latin America, too, were judged vulnerable to drought, and the panel projected falling agricultural production for some major crops in Mexico, Central America and parts of South America.

On the other hand, increased rainfall in temperate zones, combined with a warmer climate, longer growing seasons and the fertilizing properties of atmospheric carbon dioxide, might spur agriculture there. Much of the increase in precipitation is expected to come not from the steady, gentle rains favored by farmers, however, but from heavy storms that could increase flooding. Evidence of an increase in these heavy storms has already been detected in North America. Northern Europe, according to the panel, may be hit by more floods, while southern Europe is more vulnerable to drought.

In southern Asia, where hundreds of millions of rural dwellers depend on the seasonal flow of water from melting snow and ice in the Himalayas, there might be more water in the short term but less in the long run as glaciers and snow cover shrink.

As many of these examples suggest, much of the potential impact of climate change has to do with changes in the distribution of water around the world; that is, the planetary hydrological cycle involving evaporation of water from the earth's surface, precipitation, freezing and melting. In North America, for instance, water is the common factor tying together many impacts across many regions, the intergov-

Blocked due to copyright.  
See full page image or  
microfilm.

ernmental panel found. A warmer climate is expected to affect not only the kinds of weather people experience — more severe rainstorms and also more severe droughts — but also the availability of water in many regions. Some are likely to get more, others less.

Climate change may have serious repercussions for human health, said the intergovernmental panel. The ranges of mosquito-borne tropical diseases like malaria, dengue fever and encephalitis and waterborne diarrheal diseases could expand, for instance. And in a more direct effect, heat-related summertime deaths are expected to increase in northern American and European cities, and cold-related deaths to decrease.

The intergovernmental report said the expected net effect on total deaths is unclear in Europe, but a leading American expert on the subject said that in this country, the increase in heat deaths was likely to

outweigh the reduction in deaths from cold. The reason, said Dr. Lawrence S. Kalkstein of the University of Delaware, is that many cold-season deaths are related to diseases like flu, which are transmitted in closely confined winter quarters. Climate change is not likely to alter that picture of confinement very much in Northern cities, he said.

On the other hand, he told another recent Federal workshop at Pennsylvania State University, summertime heat deaths in Northern cities are almost certain to rise substantially if the climate warms as predicted. First, he said, Northerners are not as acclimatized to heat as Southerners are. Second, Northern buildings, especially in crowded cities, are not constructed to promote cooling. Even air-conditioning is no automatic fix, he said, because many inner-city dwellers cannot afford it. "There is no doubt in my mind that we have a problem," he said.