

Scientists Say Earth's Warming Could Set Off Wide Disruptions

By WILLIAM K. STEVENS

The earth has entered a period of climatic change that is likely to cause widespread economic, social and environmental dislocation over the next century if emissions of heat-trapping gases are not reduced, according to experts advising the world's governments.

The picture of probable disruption, including adverse changes and some that are beneficial, emerges from draft sections of a new assessment of the climate problem by the Intergovernmental Panel on Climate Change and from interviews with scientists involved in the assessment. The panel, a United Nations group of 2,500 scientists from around the world, advises parties to a 1992 treaty that are negotiating reductions in heat-trapping greenhouse gases like carbon dioxide.

The new feature of the assessment — the first in five years by the intergovernmental panel — is that the experts are now more confident than before that global climate change is indeed in progress and

that at least some of the warming is due to human action, specifically the burning of coal, oil and wood, which releases carbon dioxide into the atmosphere. Like its predecessors, the forecast depends heavily on uncertain computer simulations of the atmosphere's response to heat-trapping gases.

While some environmentalists and their allies have long believed potentially catastrophic human-induced climate change to be a fact, and some political conservatives and industry groups have been skeptical, experts in the mainstream of climate science have never confirmed either view.

So far, most governments have taken small steps to rein in emissions of greenhouse gases, with the hope of at least avoiding further contribution to the warming problem. But even before the current reassessment, parties to the 1992 treaty had agreed that these steps were inadequate and had opened talks aimed at stronger measures.

According to draft sections of the new forecast, some of the predicted effects of climate change may now be emerging for the first time or with increasing clarity. The possible early effects include these:

¶ A continuing rise in average global sea level, which is likely to amount to more than a foot and a half by the year 2100. This, say the scientists, would inundate parts of many heavily populated river deltas

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and the cities on them, making them uninhabitable, and would destroy many beaches around the world. At the most likely rate of rise, some experts say, most of the beaches on the East Coast of the United States would be gone in 25 years. They are already disappearing at an average of 2 to 3 feet a year.

An increase in extremes of temperature, dryness and precipitation in some regions. A United States Government study conducted by one of the panel's scientists has shown that these extremes are increasing in America. There is a 90 to 95 percent chance, the study concluded, that climate change caused by the emission of greenhouse gases like carbon dioxide is responsible. The intergovernmental panel forecasts an increase in droughts like the current one in the Northeastern United States, heat waves like the one in Chicago this summer, and more fires and floods in some regions.

A "striking" retreat of mountain glaciers around the world, accompanied in the Northern Hemisphere by a shrinking snow cover in winter. In some semi-arid regions, the panel says, runoff from melting glaciers may increase water resources. But in most places, rivers and streams could be diminished in the summer.

"While there will be some beneficial effects of climate change, there will be many adverse effects, with some being potentially irreversible," says one of the panel's draft sum-

maries.

Beneficial effects, if the panel's forecast is right, would include, for instance, milder winters in northern climes, an increase in rainfall in some regions that need it, and faster crop growth. Grain belts of North America and Russia could expand. Agricultural production worldwide is not expected to decrease much.

But some regions — especially sub-Saharan Africa, South and Southeast Asia and tropical Latin America — could suffer losses in their harvests. Deserts are expected to expand, and the heartlands of continents to become drier. There would be more rain throughout the world. Northern temperate regions would experience more rain and less snow in winter. In summer, water would evaporate faster, drying the soil.

Natural ecosystems, being untended, would be even more vulnerable than cropland. Forest trees could not migrate northward fast enough to keep up with shifting climatic zones, and some forests would disappear, the panel says.

Computerized models indicated that if atmospheric carbon dioxide levels double, "one-third of all the forest area of the earth will change," said Dr. Steven P. Hamburg, a forest ecologist at Brown University who is a member of the intergovernmental panel. "But we still don't have a good grasp of what it will look like," he added. Carbon dioxide concentrations are expected to double late in the next century if no further action is taken to limit emissions.

Climate forecasting is a difficult

and often controversial science. One major subject of dissension are the computer models on which the intergovernmental panel's report largely depends. The climate experts on the panel believe their models have become increasingly reliable. But skeptics continue to assert that the models fail to simulate the present climate realistically and hence are an unsure guide to future climates.

There is wide agreement among scientists that the average surface

temperature of the globe has already risen by about 1 degree Fahrenheit during the last century, with the steepest rise taking place in the last 40 years. But given the natural variability of the earth's climate and the wide fluctuations in temperature known to have occurred in the distant past, climate experts have until now been almost unanimous in saying they could not prove that human emission of greenhouse gases was playing in part in the warming.

Scientific opinion among climatologists is now shifting, and more are prepared to say that human activity is a likely cause of at least part of the climatic change experienced so far.

The human contribution to global warming could range from highly significant to trivial. The scientists say it is not yet possible to measure how much of the warming has been caused by human activity and how much is a result of natural causes.

Computer models are the principal basis for the draft report's forecast that the world's average surface temperature will rise by about 1.5 to 6 degrees Fahrenheit by the year 2100 if no further action is taken to rein in greenhouse gas emissions. Further warming — 50 to 70 percent more than what took place by 2100 — would take place after that year, the report says. The warming would be somewhat larger if, as appears possible, industry stops emitting sulfate aerosols, which exert a cooling effect by reflecting sunlight and are air pollutants in their own right.

Even if atmospheric concentrations of greenhouse gases were stabilized immediately, the report says, the world would still warm by about 1 to 3.5 degrees, resulting in some degree of climatic dislocation.

The panel's draft report has yet to undergo review by governments but its members say they expect few if any substantial changes in the findings. Members of the panel said in interviews that there was a range of views among their group as to the impacts of the predicted warming. The draft reports, they said, repre-

sent a reconciliation of these views. They said further that in the case of agriculture, one competing school of thought held that farmers would adapt with new crops and methods, while another said that food production might plummet in some regions.

Sea-level rise is one of the clearer consequences expected of the predicted warming. Measurement of the rise is "the dipstick of climate change" said Dr. Stephen P. Leatherman, director of the Laboratory for Coastal Research at the University of Maryland and a reviewer of the panel's chapter on the subject.

Since its last full assessment in 1990, the panel has cut its estimate of expected average sea-level rise between now and 2100 from a "best estimate" of 26 inches to a little less than 20 inches, with a possible range of 10 to 31 inches. A further rise is expected after 2100. The best estimate for 2100, the draft report says, would be then put at risk tens of millions of people in low-lying areas and on oceanic islands. Many low areas, like parts of the Maldives, Egypt and Bangladesh, would be inundated, and many of their inhabitants would be cast on the world's mercies as environmental refugees.

At present, the draft report says, an estimated 46 million people experience flooding because of storm surges each year. Under the best estimate for 2100, 92 million to 118 million would be so affected. Rich countries might be able to adapt, but at the cost of spending \$521 million a year on sea walls and other protection, the panelists estimate. Even then, many coastal wetlands and sandy beaches would have to be sacrificed. Poorer countries would find it more difficult to protect themselves, the report says.

"The incidence of floods, droughts, fires and pest outbreaks is expected to increase in some regions," the draft report says. One region in which the climate has already become more variable is North America, according to a study headed by Thomas M. Karl of the National Climatic Data Center, a Federal agency in Asheville, N.C. The report concluded that from 1980 through 1994, the greenhouse effect increased the incidence of drought, above-normal temperatures, summertime precipitation and heavy rainstorms in many areas of the United States.

The current drought in the Northeast and the lethal midsummer heat wave in Chicago would probably have happened anyway, but the greenhouse effect may have made them worse, said Mr. Karl, who is a member of the panel.

The global impact of climate change on agriculture is likely to be "small to moderate" if measures are taken, the panel says. But regional effects are expected to vary widely.

For instance, the semi-arid croplands of sub-Saharan Africa, already vulnerable, would be even more so, said Dr. Cynthia Rosenzweig, a research agronomist at the NASA Goddard Institute for Space Studies in New York and a co-author of the report's agriculture chapter.

In North America, Dr. Rosenzweig said, "it's really quite an opposite picture of vulnerability." Carbon dioxide promotes plant growth, and this may outweigh negative changes, which may be less severe in temperate zones in any case.

Still, she said, the United States would probably not escape agricultural dislocation. A change in climatic zones would force farmers to change crops — growing citrus fruits farther north, for instance.

"There's no doubt we in the U.S. can adapt, but we shouldn't think those adaptations are cost-free," she said.

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