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JULY 2000

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Research as Policy

THE summer of 1988 was stultifyingly hot even by Washington, D.C., standards, and the Mississippi River basin was suffering a catastrophic drought. Hansen's proclamation that the greenhouse effect was "changing our climate now" generated a level of public concern sufficient to catch the attention of many politicians. George Bush, who promised to be "the environmental President" and to counter "the greenhouse effect with the White House effect," was elected that November. Despite his campaign rhetoric, the new President was unprepared to offer policies that would curtail fossil-fuel production and consumption or impose economic costs for uncertain political gains. Bush's advisers recognized that support for scientific research offered the best solution politically, because it would give the appearance of action with minimal political risk.

With little debate the Republican Administration and the Democratic Congress in 1990 created the U.S. Global

Change Research Program. The program's annual budget reached $1 billion in 1991 and $1.8 billion in 1995, making it one of the largest science initiatives ever undertaken by the U.S. government. Its goal, according to Bush Administration documents, was "to establish the scientific basis for national and international policymaking related to natural and human-induced changes in the global Earth system." A central scientific objective was to "support national and international policymaking by developing the ability to predict the nature and consequences of changes in the Earth system, particularly climate change." A decade and more than $16 billion later, scientific research remains the principal U.S. policy response to climate change.

Meanwhile, the marriage of environmentalism and science gave forth issue: diplomatic efforts to craft a global strategy to reduce carbon-dioxide emissions. Scientists, environmentalists, and government officials, in an attempt to replicate the apparently successful international response to stratospheric-ozone depletion that was mounted in the mid-1980s, created an institutional structure aimed at formalizing the connection between science and political action. The Intergovernmental Panel on Climate Change was established through the United Nations, to provide snapshots of the evolving state of scientific understanding. The IPCC issued major assessments in 1990 and 1996; a third is due early next year. These assessments provide the basis for action under a complementary mechanism, the United Nations Framework Convention on Climate Change. Signed by 154 nations at the 1992 "Earth Summit" in Rio de Janeiro, the convention calls for voluntary reductions in carbon-dioxide emissions. It came into force as an international treaty in March of 1994, and has been ratified by 181 nations. Signatories continue to meet in periodic Conferences of the Parties, of which the most significant to date occurred in Kyoto in 1997, when binding emissions reductions for industrialized countries were proposed under an agreement called the Kyoto Protocol.

The IPCC defines climate change as any sort of change in the earth's climate, no matter what the cause. But the Framework Convention restricts its definition to changes that result from the anthropogenic emission of greenhouse gases. This restriction has profound implications for the framing of the issue. It makes all action under the convention hostage to the ability of scientists not just to document global warming but to attribute it to human causes. An apparently simple question, Are we causing global warming or aren't we?, has become the obsessional focus of science -- and of policy.

Finally, if the reduction of carbon-dioxide emissions is an organizing principle for environmentalists, scientists, and environmental-policy makers, it is also an organizing principle for all those whose interests might be threatened by such a reduction. It's easy to be glib about who they might be -- greedy oil and coal companies, the rapacious logging industry, recalcitrant automobile manufacturers, corrupt foreign dictatorships -- and easy as well to document the excesses and absurdities propagated by some representatives of these groups. Consider, for example, the Greening Earth Society, which "promotes the optimistic scientific view that CO_2 is beneficial to humankind and all of nature," and happens to be funded by a coalition of coal-burning utility companies. One of the society's 1999 press releases reported that "there will only be sufficient food for the world's projected population in 2050 if atmospheric concentrations of carbon dioxide are permitted to increase, unchecked." Of course, neither side of the debate has a lock on excess or distortion. The point is simply that the climate-change problem has been framed in a way that catalyzes a determined and powerful opposition.

The Problem With Predictions

WHEN anthropogenic carbon-dioxide emissions became the defining fact for global environmentalism, scientific uncertainty about the causes and consequences of global warming emerged as the apparent central obstacle to action. As we have seen, the Bush Administration justified its huge climate-research initiative explicitly in terms of the need to reduce uncertainty before taking action. Al Gore, by then a senator, agreed, explaining that "more research and better research and better targeted research is absolutely essential if we are going to eliminate the remaining areas of uncertainty and build the broader and stronger political consensus necessary for the unprecedented actions required to address this problem." Thus did a Republican Administration and a Democratic Congress -- one side looking for reasons to do nothing, the other seeking justification for action -- converge on the need for more research.

How certain do we need to be before we take action? The answer depends, of course, on where our interests lie. Environmentalists can tolerate a good deal more uncertainty on this issue than can, say, the executives of utility or automobile companies. Science is unlikely to overcome such a divergence in interests. After all, science is not a fact or even a set of facts; rather, it is a process of inquiry that generates more questions than answers. The rise in anthropogenic greenhouse-gas emissions, once it was scientifically established, simply pointed to other questions. How rapidly might carbon-dioxide levels rise in the future? How might climate respond to this rise? What might be the effects of that response? Such questions are inestimably complex, their answers infinitely contestable and always uncertain, their implications for human action highly dependent on values and interests.

Having wedded themselves to science, environmentalists must now cleave to it through thick and thin. When research results do not support their cause, or are simply uncertain, they cannot resort to values-based arguments, because their political opponents can portray such arguments as an opportunistic abandonment of rationality. Environmentalists have tried to get out of this bind by invoking the "precautionary principle" -- a dandified version of "better safe than sorry" -- to advance the idea that action in the presence of uncertainty is justified if potential harm is great. Thus uncertainty itself becomes an argument for action. But nothing is gained by this tactic either, because just as attitudes toward uncertainty are rooted in individual values and interests, so are attitudes toward potential harm.

Charged by the Framework Convention to search for proof of harm, scientists have turned to computer models of the atmosphere and the oceans, called general circulation models, or GCMs. Carbon-dioxide levels and atmospheric temperatures are measures of the physical state of the atmosphere. GCMs, in contrast, are mathematical representations that scientists use to try to understand past climate conditions and predict future ones. With GCMs scientists seek to explore how climate might respond under different influences -- for example, different rates of carbon-dioxide increase. GCMs have calculated global average temperatures for the past century that closely match actual surface-temperature records; this gives climate modelers some confidence that they understand how climate behaves.

Computer models are a bit like Aladdin's lamp -- what comes out is very seductive, but few are privy to what goes on inside. Even the most complex models, however, have one crucial quality that non-experts can easily understand: their accuracy can be fully evaluated only after seeing what happens in the real world over time. In other words, predictions of how climate will behave in the future cannot be proved accurate today. There are other fundamental problems with relying on GCMs. The ability of many models to reproduce temperature records may in part reflect the fact that the scientists who designed them already "knew the answer." As John Firor, a former director of the National Center for Atmospheric Research, has observed, climate models "are made by humans who tend to shape or use their models in ways that mirror their own notion of what a desirable outcome would be." Although various models can reproduce past temperature records, and yield similar predictions of future temperatures, they are unable to replicate other observed aspects of climate, such as cloud behavior and atmospheric temperature, and they diverge widely in predicting specific regional climate phenomena, such as precipitation and the frequency of extreme weather events. Moreover, it is simply not possible to know far in advance if the models agree on future temperature because they are similarly right or similarly wrong.

In spite of such pitfalls, a fundamental assumption of both U.S. climate policy and the UN Framework Convention is that increasingly sophisticated models, run on faster computers and supported by more data, will yield predictions that can resolve political disputes and guide action. The promise of better predictions is irresistible to champions of carbon-dioxide reduction, who, after all, must base their advocacy on the claim that anthropogenic greenhouse-gas emissions will be harmful in the future. But regardless of the sophistication of such predictions, new findings will almost inevitably be accompanied by new uncertainties -- that's the nature of science -- and may therefore act to fuel, rather than to quench, political debate. Our own prediction is that increasingly complex mathematical models that delve ever more deeply into the intricacies and the uncertainties of climate will only hinder political action.

An example of how more scientific research fuels political debate came in 1998, when a group of prominent researchers released the results of a model analyzing carbon-dioxide absorption in North America. Their controversial findings, published in the prestigious journal Science, suggested that the amount of carbon dioxide absorbed by U.S. forests might be greater than the amount emitted by the nation's fossil-fuel combustion. This conclusion has two astonishing implications. First, the United States -- the world's most profligate energy consumer -- may not be directly contributing to rising atmospheric levels of carbon dioxide. Second, the atmosphere seems to be benefiting from young forests in the eastern United States that are particularly efficient at absorbing carbon dioxide. But these young forests exist only because old-growth forests were clear-cut in the eighteenth and nineteenth centuries to make way for farms that were later abandoned in favor of larger, more efficient midwestern farms. In other words, the possibility that the United States is a net carbon-dioxide sink does not reflect efforts to protect the environment; on the contrary, it reflects a history of deforestation and development.

Needless to say, these results quickly made their way into the political arena. At a hearing of the House Resources Committee, Representative John E. Peterson, of Pennsylvania, a Republican, asserted, "There are recent studies that show that in the Northeast, where we have continued to cut timber, and have a regenerating, younger forest, that the greenhouse gases are less when they leave the forest.... So a young, growing, vibrant forest is a whole lot better for clean air than an old dying forest." George Frampton, the director of the White

House Council on Environmental Quality, countered, "The science on this needs a lot of work.... we need more money for scientific research to undergird that point of view." How quickly the tables can turn: here was a conservative politician wielding (albeit with limited coherence) the latest scientific results to justify logging old-growth forests in the name of battling global warming, while a Clinton Administration official backpedaled in the manner more typically adopted by opponents of action on climate change -- invoking the need for more research.

That's a problem with science -- it can turn around and bite you. An even more surprising result has recently emerged from the study of Antarctic glaciers. A strong argument in favor of carbon-dioxide reduction has been the possibility that if temperatures rise owing to greenhouse-gas emissions, glaciers will melt, the sea level will rise, and populous coastal zones all over the world will be inundated. The West Antarctic Ice Sheet has been a subject of particular concern, both because of evidence that it is now retreating and because of geologic studies showing that it underwent catastrophic collapse at least once in the past million years or so. "Behind the reasoned scientific estimates," Greenpeace warns, "lies the possibility of ... the potential catastrophe of a six metre rise in sea level." But recent research from Antarctica shows that this ice sheet has been melting for thousands of years. Sea-level rise is a problem, but anthropogenic global warming is not the only culprit, and reducing emissions cannot be the only solution.

To make matters more difficult, some phenomena, especially those involving human behavior, are intrinsically unpredictable. Any calculation of future anthropogenic global warming must include an estimate of rates of fossil-fuel combustion in the coming decades. This means that scientists must be able to predict not only the amounts of coal, oil, and natural gas that will be consumed but also changes in the mixture of fossil fuels and other energy sources, such as nuclear, hydro-electric, and solar. These predictions rest on interdependent factors that include energy policies and prices, rates of economic growth, patterns of industrialization and technological innovation, changes in population, and even wars and other geopolitical events. Scientists have no history of being able to predict any of these things. For example, their inability to issue accurate population projections is "one of the best-kept secrets of demography," according to Joel Cohen, the director of the Laboratory of Populations at Rockefeller University. "Most professional demographers no longer believe they can predict precisely the future growth rate, size, composition and spatial distribution of populations," Cohen has observed.

Predicting the human influence on climate also requires an understanding of how climate behaved "normally," before there was any such influence. But what are normal climate patterns? In the absence of human influence, how stationary is climate? To answer such questions, researchers must document and explain the behavior of the pre-industrial climate, and they must also determine how the climate would have behaved over the past two centuries had human beings not been changing the composition of the atmosphere. However, despite the billions spent so far on climate research, Kevin Trenberth, a senior scientist at the National Center for Atmospheric Research, told the *Chicago Tribune* last year, "This may be a shock to many people who assume that we do know adequately what's going on with the climate, but we don't." The National Academy of Sciences reported last year that "deficiencies in the accuracy, quality, and continuity of the [climate] records ... place serious limitations on the confidence" of research results.

If the normal climate is non-stationary, then the task of identifying the human fingerprint in global climate change becomes immeasurably more difficult. And the idea of a naturally stationary climate may well be chimerical. Climate has changed often and dramatically in the recent past. In the 1940s and 1950s, for example, the East Coast was hammered by a spate of powerful hurricanes, whereas in the 1970s and 1980s hurricanes were much less common. What may appear to be "abnormal" hurricane activity in recent years is abnormal only in relation to this previous quiet period. As far as the ancient climate goes, paleoclimatologists have found evidence of rapid change, even over periods as short as several years. Numerous influences could account for these changes. Ash spewed high into the atmosphere by large volcanoes can reflect solar radiation back into space and result in short-term cooling, as occurred after the 1991 eruption of Mount Pinatubo. Variations in the energy emitted by the sun also affect climate, in ways that are not yet fully understood. Global ocean currents, which move huge volumes of warm and cold water around the world and have a profound influence on climate, can speed up, slow down, and maybe even die out over very short periods of time -- perhaps less than a decade. Were the Gulf Stream to shut down, the climate of Great Britain could come to resemble that of Labrador.

Finally, human beings have been changing the surface of the earth for millennia. Scientists increasingly realize that deforestation, agriculture, irrigation, urbanization, and other human activities can lead to major changes in climate on a regional or perhaps even a global scale. Thomas Stohlgren, of the U.S. Geological Survey, has written, "The effects of land use practices on regional climate may overshadow larger-scale temperature changes commonly associated with observed increases in carbon dioxide." The idea that climate may constantly be changing for a variety of reasons does not itself undercut the possibility that anthropogenic carbon dioxide could seriously affect the global climate, but it does confound scientific efforts to predict the consequences of carbon-dioxide emissions.

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(The online version of this article appears in three parts. Click here to go to part one or part three.)

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Illustration by James Steinberg.

The Atlantic Monthly; *July 2000; Breaking the Global-Warming Gridlock - 00.07 (Part Two); Volume 286, No. 1; page 54-64.*

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