Getting Warmer

Who knows what about climate change science

By Richard C. Rockwell

Many policy issues in our advanced industrial society demand from conscientious citizens some degree of scientific and technical knowledge. None better illustrates those demands than the issues arising from climate science. Climate scientists seek to understand the processes and feedbacks that regulate the global climate system. Climate is ultimately determined by the heat balance at the surface of the Earth—the absorption of incoming solar radiation and its loss as heat back into space. The entire Earth system—from its forests and oceans to the composition of its atmosphere and its clouds—is involved in this process, which regulates planetary heat balance and thus climate.

The Earth's heat balance is apparently changing. The lower atmosphere is estimated to have warmed globally by a little more than one degree Fahrenheit in the twentieth century, northern hemisphere springs have arrived earlier and autumns later in recent decades, and the hemisphere north of the fortieth parallel has seemingly been getting greener since 1981. However, it is not certain that all of this change is due to the human activities believed to cause the "enhanced greenhouse effect."

This enhanced greenhouse effect is caused by at least two kinds of human activities. Both affect the concentration of carbon dioxide gas and other so-called greenhouse gases, which absorb outgoing heat from the Earth's surface, retain it in the lower atmosphere, and thus raise the temperature near the Earth's surface. One human activity, which acts as the source of greenhouse gases, is the emission of carbon dioxide from the burning of fossil fuels, along with methane from rice paddies, ruminants, and natural gas usage, and manufactured chemicals such as Freon, nitrous oxide, and ozone. These gases slow the release of solar energy from the atmosphere.

The other human activity, which acts upon the sink of green house gases, primarily consists of widespread changes in terrestrial vegetation. Forests take up some carbon dioxide through photosynthesis and store the carbon away from the atmosphere for decades or centuries as woody material or in the soil, creating a "sink" for its storage, a process that is being affected by the deforestation that is happening in almost every part of the world.

Human-induced climate change interacts with natural climate fluctuations, such as the cycle of the Ice Ages (over hundreds of thousands of years), the 11-year cycle of sunspots, the brief cooling events caused by volcanic eruptions, and the interannual phenomena known as El Niño and La Niña. It also interacts with other human-caused environmental changes, such as the emissions of sulfate aerosols from power plants associated with cooling of the atmosphere.

The story gets yet more complex, because climate change does not exactly equate to "global warming"—it is a far broader concept. The most economically important climate changes are likely to be shifts in the quantities and annual patterns of precipitation. The enhanced greenhouse effect may even lead to cooler temperatures in some areas. "Lake effect" snowstorms may persist longer into the year, because lakes will freeze later in the winter.

So what do the American people understand and believe about this complex phenomenon of climate change? Pollsters can hardly administer pop quizzes to the public, so the available measures of the public's understanding are surrogates for direct test measures. They nevertheless reveal that the American public is growing increasingly aware of and knowledgeable about the possibility of climate change.

Using questions from five survey organizations (with slightly different question wording), we can approximate a trend in public awareness. In a Cambridge Reports Research International poll in 1982, only 41% of

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American adults claimed to have heard of the theory of climate change. Then the long heat wave of summer 1988 caused an estimated 5,000 to 10,000 deaths. That or something else got people's attention: in a 1990 Cambridge poll, 74% claimed to have heard about the greenhouse effect. By the end of the '90s, several surveys showed awareness levels above 80%. When asked in a March 2001 Gallup poll how well respondents felt they understood the issue, 69% replied "fairly well" or "very well."

Do most Americans really understand the issue, though? In 1994 the National Opinion Research Center asked whether it is true that every time we use coal or oil or gas, we contribute to the greenhouse effect; 61% said this was probably or definitely true. In a 1997 CBS News/*New York Times* poll, respondents who said they had heard or read about global warming were asked whether it is a result of normal fluctuations in the Earth's climate or of something else. Some 58% thought it was due to greenhouse gases, and another 10% thought both normal fluctuations and greenhouse gases were at work.

In a 1997 Gallup poll, 73% knew that carbon dioxide emissions are related to global warming. In March and April 2001, respectively, Gallup and *Los Angeles Times* polls asked whether "human activities," compared to "natural changes" or "natural causes," account for increases in the Earth's temperature over the last century. Both polls found about 60% of respondents attributing the increases to human activities, and the *Times* poll elicited the volunteered response of "both" from another 15%.

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Moreover, many Americans know that climate change involves more than carbon dioxide. Loss of rainforests was seen in a 1997 Gallup poll as a major cause of global warming by 60%, and another 17% saw it as a minor cause, as indeed it is. Aerosol sprays were also seen as a cause (36% major cause, 39% minor). Before their US reformulation in 1977, they contained propellant gases that are molecule for molecule more potent greenhouse gases than carbon dioxide. Refrigerators and air conditioners, seen by 21% as a major cause and 42% as a minor, do still contain as a refrigerant the same greenhouse gas once used in aerosol cans; in addition, both refrigerators and air conditioners are major consumers of electrical power.

Power plants burning coal or oil were indicted (correctly) by 56% as a major cause, and 17% as a minor cause. The automobile (65% major, 20% minor) emits greenhouse gases beyond carbon dioxide. [However, nuclear power plants were blamed as a major cause by 35% and a minor cause by another 23%, even though they are seen by some analysts as a useful part of the solution to climate change because of the low levels of greenhouse gases they emit.]

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Americans understand quite a lot about the possible impacts of climate change, as well. In a 1997 Gallup poll (asking questions only of the 86% of the sample that indicated at least a bit of familiarity with global warming), a rise in global temperature was correctly seen as related to global warming (by 83%), changes in global weather patterns (80%), melting of glaciers (74%), and rise in sea levels (65%). Sixty-six percent of the public also thought that skin cancer is related to global warming, when it is actually more related to another global-scale environment change, the depletion of the stratospheric ozone layer.

Asked to evaluate how harmful, if at all, global warming will be during the next 25 years, 43% of respondents in a 1997 Gallup poll anticipated that it would be very harmful to the survival of many animal and plant species, and to agricultural production (39%), human health (38%), the level of the oceans (27%), economic well-being (24%), and people's choices about where they live (21%). Scientists would take a more differentiated view of these impacts (e.g., negative agricultural impacts will be greater in developing countries outside the mid-latitude zone), but the public's list is a good start towards understanding them.

Do Americans *believe* the theory of climate change? In an August 2000 Harris Interactive poll, 72% said they "believe the theory that increased carbon dioxide and other gases released into the atmosphere will, if unchecked, lead to global warming and an increase in average temperatures." In a March 2001 Harris poll, 64% believed "that emissions of gases like carbon dioxide are causing global temperature increases." Note the subtle difference in the questions: the former asks about a change that "will... lead" to global warming, while the latter asks whether global temperature increases, due to greenhouse gas emissions, are occurring *now*.

Further insight into Americans' belief in climate change is afforded by asking them how serious a threat or problem global warming might be. From 1992 to April 2001 a series of polls by five different firms asked some variant of this question, with somewhere between 71% and 87% of the public viewing it as a "very serious" or "somewhat seri-

ous" problem. In an April 2001 *Los Angeles Times* poll, only 7% said it was "not at all serious." The time horizon matters when respondents answer questions about the possible impacts of climate change. In a 1997 CBS News/ *New York Times* poll, 28% thought that global warming is having a serious impact now, while 51% thought it would have such an impact in the future. When asked in a 1997 Gallup poll whether it would pose a threat to "your children or the next generation of Americans in their lifetime," 65% saw such a threat to their heirs.

Asked in the same poll to project when the effects of global warming will begin to happen, 48% said they already had begun, 3% thought "in a few years," 14% thought within their lifetimes, and 19% thought beyond their lifetimes, but that it "will affect future generations." Provided with a specific time horizon of 20 years, 45% of respondents to a 1997 Mellman Group poll saw a very serious threat and 27% a somewhat serious threat.

Americans are a rather optimistic people. Why are we so pessimistic about the environmental future of the planet? A great deal of environmental improvement and remediation has been accomplished in the United States and in most other industrialized nations over the past half century: air and water pollution are substantially down, smog is lessened in many cities, recycling and reuse programs are reducing solid waste, toxic dumps are being cleaned up, old farmland is returning to forest, substances that deplete the ozone layer are being phased out, many rivers and lakes are seeing the return of game fish, the Cuyahoga River no longer catches on fire. The rate of growth of the global human population has been declining since about 1964, putting less pressure on the planet than was once anticipated.

To be sure, emissions of carbon dioxide and other greenhouse gases are significantly greater than they were a half century ago. Nuclear waste is building up. Urban sprawl continues to change the landscape. But despite those serious remaining problems, the environmental record is generally good in the US.

Americans, however, do not see it that way: in a May 2001 poll by the Tarrance Group and Greenberg Quinlan Research, 42% said that they thought the environment had gotten worse in the past five years. Perhaps they got that impression because claims about the environment are frequently made, usually intense, and often dire. It may be these negative messages—many of them about the developing world, where environmental conditions are often far worse than in the US—to which Americans are attending to construct their pessimism.

That pessimism certainly extends to climate change, the data above show. Even so, no broad national consensus exists about appropriate policies and responses to potential climate change—unlike with many other environmental issues that have arisen since the 1970s. Some even see climate change as desirable, claiming that agricultural production in some regions of the US might increase because of higher temperatures and fertilization by carbon dioxide. Moreover, climate science sometimes elicits strong expressions of incredulity or even accusations of venal motives directed at those obtaining grants to research it.

Americans are not sure that scientists themselves have gotten their act together. A November 1997 Gallup poll found that 42% of Americans think scientists mostly believe global warming is a serious threat, while 44% thought the scientific community is generally divided on this issue. This is an overestimate of the division. As in most things, there are extremists in each direction; but most scientists are in the middle, looking for more evidence.

This misperception of a sharply divided scientific community prevails partly because media messages to the public about climate change often misrepresent scientists' views. In a search for "balanced" presentations, the media find scientists on either end of the issue and present them as offering equally valid and representative views.

In fact, a majority of the climate science community thinks that Arrhenius was right more than 100 years ago when he described the basic mechanism of the enhanced greenhouse effect. The theory makes sense to them. Most find a preponderance of empirical evidence that the Earth is warming, and many do think that climate change due to human activities has already begun.

This is evidenced by the remarkable agreement among scientists from more than 100 countries in the reports of the UN Intergovernmental Panel on Climate Change. There was diversity in their viewpoints on some issues and consensus on many others. In a small mail survey of US climate scientists undertaken in 1996 by the German Thyssen Foundation, 77% agreed, "We can say for certain that, without change in human behavior, global warming will definitely occur some time in the future." Yet scientists can be found who will question Arrhenius' mechanism or will claim that the Earth is cooling. The public is understandably somewhat confused.

The problem of global warming encompasses an enormously complex set of scientific questions and public policy issues. No one claims to understand climate change in its entirety. No one ever will. Yet the public in large part seems to understand enough about the topic to have a basis for formulating opinions. They seem to be ahead of their political leaders, in fact. What is now needed is public leadership that explains these complex issues in a calm and rational way to a public that seems willing to listen.