

# Degrees of Change

A Newsletter from the Global Change Integrated Assessment Program

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While they may draw very different policy conclusions, technically trained people share a common basic understanding, or "mental model," of the physical processes that could give rise to climate change. In discussing the subject, they usually assume that members of the general public share this same mental model. But do they? The question is important, because in a democracy like the United States, "the climate problem" is whatever voters and their elected representatives think it is.

## WHAT DO PEOPLE BELIEVE ABOUT CLIMATE CHANGE?<sup>†</sup>

In order to understand what the American public knows and thinks about the issues of climate change and global warming, we have undertaken a series of studies using methods developed in our previous work on risk communication (Morgan *et al.*, 1992; Bostrom *et al.*, 1992). Finding out what someone already knows about a topic like climate change is easier said than done. We could administer a questionnaire. But people aren't stupid. We have to ask questions *about* something. As soon as we start putting information in these questions, people are going to start using that information to make inferences and draw conclusions. Pretty soon we won't know whether the answers we are getting are telling us about the mental model that the person already had before we started quizzing them, or the new mental model that the person is building because of all the information we are supplying in our questions. Further, we can't be confident that our subjects understand basic words, such as "climate," in the same way that we do.

This suggests a different, more direct and open-ended approach. We can simply ask people, "Tell me about climate change" and see what they say. We first developed this technique in

1988, working on the topic of radon. The initial interviews that we conducted looked promising. In order to test the idea more broadly, we sent a number of graduate students out to interview their non-technical friends and neighbors. When we transcribed the tape recordings of the interviews, the results were hilarious. A few moments into most interviews the non-technical subject had figured out that here was someone who knew a lot about radon, and they had begun to subtly extract information from them. Since then, we have learned how to design interviews and train interviewers to avoid this, and a variety of other, problems.

After posing a question like "Tell me about climate change," most people can only talk for a few sentences before they run out of steam. However, those few sentences often contain five or ten different ideas or "concepts." If the interviewer has been trained to keep track of all the concepts that are mentioned, they can then go on to ask questions that follow-up on each one. For example, they might say "you mentioned that recently winters seem to have been warmer, tell me more about that..." By systematically following up on all the concepts that the subject introduces, a well trained interviewer can often sustain a conversation about a topic such as climate change for 10 to 20 minutes, introducing no new ideas of their own. Only in a later stage of the interview will the interviewer go on to ask questions about other key ideas which the subject did not bring up on their own. By conducting a number of interviews of this sort, we can begin to build up some sense of what people know and believe about a risk.

The people we have interviewed about climate change view global warming as undesirable, and highly likely (Bostrom *et al.*, 1994). Many believe that substantial warming has already occurred. They tend to confuse stratospheric ozone depletion with the greenhouse effect and weather with climate. Automobile use, industrial process heat and emissions, pollution in general, and aerosol spray cans are perceived as the main causes of global warming. Additionally, the "greenhouse effect" is often interpreted literally to mean a hot and steamy climate. Respondents described global climate change effects that included increased incidence of skin cancer and changes in agricultural yields. Mitigation and

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<sup>†</sup> An earlier version of this piece appeared in *The Bridge* published by the National Academy of Engineering.

control strategies proposed by interviewees ranged from alternative fuels for cars to the creation of a synthetic ozone layer. Many of the strategies proposed focused on general pollution control and regulation, with an emphasis on automobile and industrial emissions. Specific links to carbon dioxide and energy use were relatively infrequent. Respondents appeared to be relatively unfamiliar with recent regulatory developments regarding the environment, such as the ban on CFCs for spray cans and similar nonessential uses.

Several respondents thought that the space program was a contributor to climate change. The mechanism is that launch vehicles punch holes in the atmosphere which let heat in. One suggested that NASA might minimize the impact of this process by always launching through the same hole! We also encountered respondents who believe that the use of nuclear power directly contributes to climate change.

In addition to conducting mental model interviews, we have also run a variety of studies in which we asked people to define basic terms. One way we have analyzed the results of these studies is to give experts the terms along with the stack of definitions we have received from lay people, and ask them to match them up. We find that many people view the words weather and climate as meaning the same thing. Here are a few samples from interview transcripts: "Climate is the...is the weather;" "Climate is the weather conditions that are on the earth;" "What is climate change?...Anything out of the norm. In other words, having warm winters such as we've had. Extended summers. Hot, dry summers." We have also asked respondents to judge the correctness of statements that use key concepts such as climate. These statements included: "climate often changes from year to year," and "weather often changes from year to year." Forty-two percent erroneously said the first statement was true or probably true (11% erroneously disagreed with the second statement).

An important implication of the definitional confusions we have found between the words climate and weather is that one should be *very* leery of any results from national surveys that ask questions about climate or climate change. When the respondents answer such questions, there is a good chance they are thinking about weather.

Attractive as it is, the mental model interview process has one serious draw back. It is very time consuming. One typically can't afford to run more than 20 to 30 interviews (the climate results reported above involved 49 of which 44 were usable). Even then, when the tape recordings are transcribed, the resulting stack of

transcripts is typically the size of a city telephone book. Over the years we have conducted such interviews on a variety of different risks. We find that when we plot the number of new concepts encountered, as a function of the number of interviews conducted, the curves begins to reach an asymptote after about 10 to 15 interviews. Thus, if the interview subjects have been selected with care, the results should give an indication of most of the key concepts to be found in peoples' mental models. But, because of the small sample, we cannot say anything about the relative frequency with which these views are held, or even be certain that all the concepts we find are common, and not just the idiosyncratic views of one unusual subject.

In order to address this problem, we move to a second stage of study, in which we administer carefully designed true-false questionnaires in which most of the questions are based on the things that we have learned from the mental model interviews. By administering the questionnaire to many people we can make a statistical estimate of how frequently the various beliefs we have encountered in the interview results actually occur in the broader population.

Our climate questionnaire was designed to examine lay people's knowledge about the possible causes and effects of global warming, as well as the likely efficacy of possible interventions. This questionnaire was administered to two groups of fairly well-educated people in Pittsburgh (a total of 177 respondents). Our results (Read *et al.*, 1994), which are supported by similar findings by Kempton *et al.* (1991, 1995) and by McDaniels *et al.* (1995), suggest that lay people have a very non-specific mental model of climate change. Many appear to believe that *general pollution causes climate change and good green practice will prevent it*. Our respondents showed a poor appreciation of two key facts: 1) if significant global warming occurs, it will be primarily the result of an increase in the concentration of carbon dioxide in the earth's atmosphere; and 2) the single most important source of carbon dioxide additions to the atmosphere is the combustion of fossil fuels, most notably coal and oil. Our respondents' understanding of the climate issue was encumbered by a large number of secondary, irrelevant, and incorrect beliefs. Of these, the two most critical are confusion with the problems of stratospheric and tropospheric ozone, and difficulty in differentiating between causes and actions specific to climate and more general good environmental practice. Between 10 and 20% of our respondents believe that nuclear power and the space program are causal factors. Consistent with the model that general pollution is the cause, ozone in cities, toxic waste,

and ocean dumping are all seen as even more likely contributors.

In addition to true-false questions, we asked subjects a number of other questions, including "how likely do you think it is that human actions have changed global climate?" Thirty-seven percent of our subjects thought that such change had certainly occurred, while an additional 61% thought it was at least "somewhat likely" that it had occurred. We also asked questions about the magnitude of the change (in °F) that had already occurred, and might occur in the next 10 and 50 years. Few scientists believe that warming to date exceeds 0.5°C. Our subjects' median estimate was 2°C (mean = 2.7°C). If greenhouse gas emissions remain unchecked, the IPCC predicts (under their "business as usual" scenario) that warming on the order of 0.3°C will occur per decade. Our subjects' estimates were far larger. Their median estimated additional temperature increase in 10 years was 2°C (mean = 3.2°C) and in 50 years was 4°C (mean = 6.5°C). A few offered estimates of as much as 20 to 30°C!

Although respondents believed that climate change is a threat and favored mitigative action, their flawed mental models restricted their ability to distinguish between effective and ineffective strategies. This raises concern that lay people may waste their energies on ineffective actions, such as conscientiously refusing to use spray cans, while neglecting such critical strategies as energy conservation. It also suggests that they may fall easy prey to manipulation by special interests prepared to exploit incomplete lay understanding to achieve short-term political ends.

When the world is being asked to spend hundreds of billions of dollars on solutions to the problem of climate change, people need a more specific understanding than they now have if they are going to make informed private decisions and be informed participants in public debate about the issue of climate change. The clarifications needed to produce adequate public understanding are fairly simple, and well within the capabilities of modern risk communication. As one step toward improving the situation, we have recently developed a brochure on climate change for the general public (Morgan, 1994). It is hierarchically organized. An initial two-page spread discusses the problem in a nut shell and lists common misunderstandings. Then, three subsequent two-page spreads address the three broad questions: "What is climate change?" "If climate changes what might happen?" and "What can be done about climate change?" Longer "details brochures" are provided in pouches at the back of each of the three sections. This "paper hypertext" format is

designed to allow readers to explore the topic at varying level of detail depending on their interest and ability. Copies of the brochure are available, at cost, for bulk distribution.

### FURTHER READING

More detailed discussions of public perceptions of climate change can be found in:

- A. Bostrom, M.G. Morgan and B. Fischhoff, "What Do People Know About Climate Change?: Part 1: Mental Models," *Risk Analysis*, 14, pp. 959-970, 1994.
- A. Bostrom, B. Fischhoff and M.G. Morgan, "Characterizing Mental Models of Hazardous Processes: A methodology and an application to Radon," *Journal of Social Issues*, 48, pp. 85-100, 1992.
- W. Kempton, "Lay Perspectives on Global Climate Change," *Global Environmental Change*, pp. 183-208, June, 1991.
- W. Kempton, J.S. Boster, and J.A. Hartley, *Environmental Values in American Culture*, The MIT Press, Cambridge, MA, 1995.
- T. McDaniels, L.J. Axelrod, and P. Slovic, "Lay Perceptions of Ecological Risks from Global Change," Preprint, Westwater Research Center, University of British Columbia, 1995.
- M.G. Morgan, *Global Warming and Climate Change*, a hierarchically organized family of brochures published by the Department of Engineering and Public Policy, Carnegie Mellon University, 1994.
- M.G. Morgan, B. Fischhoff, A. Bostrom, L. Lave and C.J. Atman, "Communicating Risk to the Public," *Environmental Science and Technology*, 26, pp. 2048-2056, 1992.
- D. Read, A. Bostrom, M.G. Morgan, B. Fischhoff and T. Smuts, "What Do People Know About Climate Change?: Part 2: Survey Studies of Educated Lay People," *Risk Analysis*, 14, pp. 971-982, 1994.

An overview of the Global Change Integrated Assessment Program and our recent publications can be obtained by contacting us.

### PLEASE ENGAGE IN THE DIALOGUE

The motivation behind this newsletter is to enhance communication among global change researchers and decision-makers. This goal can be met by facilitating the distribution of findings at the Global Change Integrated Assessment Group and elsewhere to a broader audience. Of equal importance to us is the feedback from decision-makers and other researchers. Such a dialogue is needed in order to remain focused on policy-relevant research, and to bring pertinent research to the attention of policy decision-makers.

As such, we hope that this newsletter is the first stage of many dialogues. In each issue we will present a briefing on recent findings at CMU and elsewhere. We ask you, our readers, to send us your reactions. All of the reactions will be posted on an electronic bulletin board and summarized in subsequent issues of *Degrees of Change*.

#### QUESTIONS TO CONSIDER

- How should politicians combine pressures based on public perceptions with insights from scientific advisors?
- How can better public education on these matters be encouraged and supported?

#### RESPONSE TO DEGREES OF CHANGE 1(1&2)

Over 1260 copies of the first two issues of the newsletter were distributed by mid September. Over one hundred recipients wrote back asking to stay on the distribution list. Over twenty people read the electronic version posted at our Web site. We thought it prudent to distribute the newsletter to the full list once more and ask for the reply cards to be used if you would like to continue to receive *Degrees of Change*.

Among our readers, many had kind words of encouragement. The following was the only substantive comment. Don Macdonald, of the Alberta Department of Energy, wrote:

*"Your work on climate change in the technology/policy context serves an important niche. One concern policy makers face in sifting through scientific evidence prepared by groups such as yours is determining what sectoral biases may be reflected in research results (often a function of who is funding your research). Policy makers don't often have the detailed skills needed to sort this out and therefore are often left wondering... 'where the truth lies' between opposing points of view. While your newsletters suggest a fairly unbiased academic institution, you may want to give some thought to this. You may want to lay your 'bias cards' (if you have any) on the table in some location on your homepage or in subsequent newsletters. Alternatively, demonstrate how unbiased you are."*

Bias is a very important issue. Being an academic institution, we try to guard against it. Bias can arise from the source of funding, from where the research is done, and from the disciplinary expertise of investigators. So, Don, here are how we view ourselves — cards on the table!

♠ Our funding comes from: the National Science Foundation, the US Department of Energy, the Electric Power Research Institute, and the National Oceanographic & Atmospheric Agency. This may tend to give us a "research establishment" bias.

♥ CMU is located in Pennsylvania and this may give the impression that we have a US bias. However, many members of our team spent their formative years in Latin America, Europe, and Asia. So far, the ICAM models have not had a separate US region.

♦ The research is conducted in an engineering school. This could mean that we pay insufficient attention to the social and humanities aspects of the problem. This we have tried to deal with by having an interdisciplinary group of researchers drawn from the humanities and social and decision-sciences communities.

♣ The research is so difficult that what we study may be biased by what we know. This was one of the major concerns leading us to the development of the Integrated Assessment Approach. Our strategy is always to look for the weak links and doubtful assumptions in our work and make them the focus of our next round of research. We hope that our methodology helps us focus our research in the areas where dearth of knowledge most hampers informed decision-making.

#### HOW TO REACH US

Should you need to reach us in order to: record your reaction, request reprints or a copy of ICAM, you have a number of choices:

On the World Wide Web our URL is:  
[http://www.epp.cmu.edu/global\\_change](http://www.epp.cmu.edu/global_change)

Send e-mail to:  
[gc-degrees@andrew.cmu.edu](mailto:gc-degrees@andrew.cmu.edu)

Send faxes to:  
Hadi Dowlatabadi @ (412) 268 3757;  
or call him @ (412) 268 3031.

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Inquiries concerning application of these statements should be directed to the Provost, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone (412) 268-6684 or the Vice President for Enrollment, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone (412) 268-2056.

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