

AMERICAN LAY CONCEPTIONS OF GLOBAL WARMING

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Ethnographic interviews were conducted with Americans from all walks of life in order to understand how ordinary citizens conceptualize global climate change and make value judgments about it. Most informants had heard of the greenhouse effect, but they held fundamental misconceptions that were shared across individuals. Many of these misconceptions derive from the process of fitting a new concept, global warming, into four preexisting categories: stratospheric ozone depletion, plant photosynthesis, tropospheric pollution, and personally-experienced seasonal and geographic temperature variation. Informants readily accepted that human activities could change climate and weather patterns. Indeed, most reported they had already observed changes in weather patterns, some citing space shots or atomic bomb testing as causes. Few informants connected the greenhouse effect to energy or fuel consumption, although the connection was easily understood when explained by the interviewers.

INTRODUCTION

Despite extensive media attention since the Summer of 1988, global climate change remains a challenge to lay comprehension. The scientific issues are staggeringly complex, with major predictions still disputed within the scientific community. The lay person directly observes daily weather and does generalize from it, but recent local weather is many statistical procedures distant from accurate climate generalizations.

A social consensus will be required on climate change policy, because the costs of either prevention or adaptation are very large, and preventive responses are inherently collective. The citizen's comprehension and value judgments are therefore significant in the political decision-making process. Yet lay thinking is made inaccessible and foreign to those most active in the policy debate, due to the very jargon and established scientific models that experts must internalize to understand the climate and policy issues.

This paper attempts to document current lay thinking on global climate change. It is based on extensive, open-ended interviews with ordinary Americans from various walks of life. The interviews covered the environment and global warming. One goal of this paper is to make this information accessible to those working in the field, whether atmospheric scientists, policy makers, educators, or science journalists. Another audience is the anthropologist or cognitive scientist concerned with how people assimilate new concepts, by adjusting them to fit preexisting ones.

Of course it would be silly to expect members of the public to think about this topic like atmospheric scientists or policy analysts. It is nevertheless useful to document systematic distortions, since this information can be used to design more effective public communication. And when public support or rejection of a proposed policy is founded on misconceptions, it should be of concern to interests on all sides of the policy debate.

INTERVIEWS

The interviews use ethnographic methods, which are designed for areas in which the interviewer initially has little understanding of native concepts (see Agar 1980; Spradley 1979). These methods can be contrasted with survey research, in which the questions and range of possible answers are already known and the study measures precise answer frequencies. Ethnographic interviewing methods use open-ended questions, follow-up probes on topics raised by informants, and paraphrases for verification. Interviewers must be highly experienced for a successful outcome. Probe questions are essential to understand what answers really mean and to discover unfamiliar concepts, but these methods do mean that some answers are not comparable across informants. Ethnographic methods were developed by anthropologists to study foreign cultures, but the author has found in prior work that an equally important application is in bridging the gap between the layman and the scientist in understanding science policy issues.¹

The interview had three parts. First, the informant's present recall of information on global warming was assessed, along with questions concerning the environment in general and the weather. Second, the interviewer gave a short presentation on global warming to provide background information. In length and depth, the presentation was intended to be comparable to an in-depth article in a weekly news magazine. Third, informants were asked for reactions to the presentation and to a set of policy proposals we gave. Since it followed our presentation, the third part of the interview provided a rough gauge of how people assimilate new knowledge about global warming, and how they may react in the future if the phenomena become better

¹ *The difference between survey and ethnographic methods are clearly seen by comparing the present report with a survey of 1200 respondents (RSM, Inc. 1989). The survey was conducted at approximately the same time (October - November 1989) by Vince Breglio, former chief pollster for the Bush-Quayle campaign. The survey did not ask about three-quarters of the points made here, and thus did not find out about those issues. On the other hand, when answers overlap, the RSM survey provides far more reliable national percentages. I will cite it periodically to check the representativeness of my small sample.*

known. The interview protocol is included in an expanded version of the present paper (Kempton 1990).

A total of 14 interviews were conducted, the first two of which were used to test the interview protocol. They were typically conducted jointly by Kempton and a research assistant. Most interviews were conducted in Hamilton Township, a demographically diverse community bordering on Trenton, New Jersey. Four informants were approached in public places (park, shopping center), eight were asked at their homes. Houses were picked for a diversity in neighborhoods and housing cost, then we just rang doorbells. We warned prospects that the interview might take 45 minutes, and our refusal rate was approximately two-thirds of those approached. Most refusals cited an appointment or chore that had to be done within 45 minutes.

The sample is evenly split by sex. Household income ranges from \$13,000 to \$62,000 and educational levels range from ninth grade to college graduate (the second pilot informant holds a PhD). Sixty percent voted for the Republican candidate (George Bush) in the last presidential election. All informant names are pseudonyms.

The first two interviews were intended to pilot test the interview protocol and were conducted in Princeton with a married couple, called Ellen and Eddie here, who were acquaintances of a research assistant. Data from these two informants were not initially planned to be analyzed, but are occasionally discussed here. Eddie gave answers in the form of analysis and policy recommendations, a form very similar to what one might read in a scientific or policy journal. Data from his interview are used to contrast with lay thinking rather than to make inferences about lay thinking.

All interviews were taped, excepting the first (Ellen). This paper draws its data from our verbatim transcripts, occasionally supplemented by field notes, totalling 98 single-spaced pages (60,000 words). Quotations presented here use the following conventions. Quotes are word-for-word transcriptions from tapes, except that in this publication version (not the transcripts) the redundant "Uh"s,

repetitions, and false starts have been removed. Non-standard grammar and word choice are preserved, marked with "(sic)" when they might otherwise cause confusion. (Readers unfamiliar with verbatim transcripts should be warned that spoken sentences are rarely as complete and syntactically well-formed as written text.) Italics indicate emphasis by the informant, and ellipsis ("...") indicates material I have deleted. Parentheses bracket my added clarification, as deduced from the context, prior statements, intonation, etc. Square brackets [] are used for our questions.

GLOBAL WARMING INCORPORATED INTO EXISTING CONCEPTS

After several questions about perceptions of weather, we asked "Have you heard of the greenhouse effect?" We chose this term over "global warming" as more commonly used by the media and more widely recognized by the public. Ten of our 12 informants had heard of it, along with both pilot informants.² This suggests that our sample did not over-represent those familiar with the phenomenon, since our 10 of 12 is virtually identical to the proportion found in a national probability sample: 79% had heard of the greenhouse effect (RSM 1979).

We next asked those who had heard of the greenhouse effect, "What have you heard about that?" The responses were seriously at variance with the scientific models of global warming. When looking at one or two interviews, the responses seem idiosyncratic. Inspection of the entire corpus shows repeated and systematic transformations from scientific models. As described below, I propose that new information on global warming is being fitted into four prior concepts: stratospheric ozone depletion, tropospheric (near surface) air pollution, plant photosynthesis, and seasonal and geographic temperature variation. This process is of interest both theoretically, as an example of how cultures

assimilate new information, and practically, since it has a significant effect on public support for various policy options.

Stratospheric Ozone Depletion

The most widely shared transformation from scientific to lay knowledge is caused by categorizing global warming as a subset of, or effect of, ozone depletion. For example:

[Have you heard about the greenhouse effect?] Is that what they're talking about the ozone layer? ... They had last year for a, create the hot spell? ... But I couldn't understand that, last year we had it, what made it change this year? We don't have it quite as severe ... [... what other things can you remember ...?] Well that was about the only thing... through the gases and that in the cans, you know, pressurized cans. - Wilbur, p 3

While the man quoted above had only a ninth-grade education, the same confusion is seen in the following quote from a college graduate, who expresses an interest in environmental and health news, and who warned us that she was atypical because she talks with scientists about the greenhouse effect:

Most people say burning fossil fuels is changing the climate because we are making the ozone layer disappear, that's the layer that protects us from the sun's harmful rays. This will greatly affect the climate over the next 100 years. - Ellen

We were able to observe the collapse of ozone and greenhouse right before our eyes during one interview, with John. Since John initially said he had heard nothing of the greenhouse effect or of a warming trend, his subsequent discussion of these topics was presumably derived from what we said. Shortly after our presentation, we asked about automobile technology that did not cause the "greenhouse effect". He replied that they had already changed the formulation of gasoline to "cut down the ozone effect" (John, p 5).

Why did he respond to our question about "greenhouse effect" with "ozone effect"? We had mentioned the greenhouse effect about eight times

² Nine recognized the specific term "greenhouse effect". A tenth did not recognize that term but had heard that, as he put it, "in the 21st century it's going to be unbearably warm".

by this point in the interview, whereas we mentioned ozone depletion only once, and that once only to note that we were not going to discuss it.³ I conclude that, even in this semi-controlled environment, any talk about pollution affecting the stratosphere makes most people think "ozone" no matter how much you mention CO₂ and the greenhouse effect. Their knowledge of ozone depletion is imperfect: Assigning the blame to aerosol cans is a decade out of date (in the U.S.) and some confuse stratospheric ozone with urban tropospheric ozone. Nevertheless, it appears that the ozone hole has arrived as a core concept in the American public's consciousness, but the greenhouse effect has arrived primarily as a subset of the ozone hole phenomenon, the closest model available.

Tropospheric Air Pollution

The second confounding prior concept is tropospheric pollution. "Air pollution" is a well-established concept which greenhouse gas emissions get plugged into, resulting in misconceptions like adverse health effects:

Well, I like warm weather, personally, *but* I think it's wrong for what humans are doing to the atmosphere. [In what way?] With all the aerosols and the ozone and so forth ... that's being projected up into the atmosphere. ... [(If you like warm weather, why do you say the greenhouse effect would be wrong?)] Well, I think it's wrong because at the same time, we are ingesting and breathing in all these different chemicals that are being *put* into the atmosphere. - Susan, p 3

One consequence of regarding greenhouse gases as pollution is that traditional pollution controls seem a solution:

We're just going to have to probably ... find out where most of the pollution is coming from. (For the sources that are) industrial, have an *incredibly* fine filter .. where you prevent most of this excess CO₂ from going into the atmosphere. - Doug, p 8

³ This explicit distinction was added to the presentation after we found confusion of ozone depletion and the greenhouse effect in our first pilot interviews.

[Do you think the United States should do anything about (the greenhouse effect)?] Yes, ... trying to find non-polluting fuels. There should be more money poured into mass transit. There should be strong controls on industrial pollution. [Like today's pollution controls but stricter?] Oh, much stricter. - Ellen, p 2

The above suggestions are traditional solutions to pollution, but measures such as filters and strengthening today's "pollution controls" would not solve the global warming problem.

A terrifying, if idiosyncratic (only reported by one person) interpretation is that descending stratospheric ozone would force out fresh air. This may derive from a confusion with urban (tropospheric) ozone pollution:

[What have you heard about the greenhouse effect?] I really don't understand that much, but I know that the ozone is getting, coming down more on account of, you know, the exhaust and all that kind of stuff. (later) [Do you remember hearing about what kind of effects the greenhouse effect might have?] Well, I know it wouldn't be a good effect, I don't know how (pause) It makes me think we're going to be, not have any air to breathe if it keeps gettin' closer into our air. That's the way I understand it. - Jane, p 3

Of the nine informants who provided enough detail to discern, six carried inappropriate pollution concepts into their inferences about global warming. (Two of the three who did not--Eddie and Doug--were the two who read scientific journals on the subject.) In many cases the distinction does not matter, since many measures simultaneously reduce CO₂ and pollution. The point is that the pollution model is a source of many misconceptions about both global warming and possible policy responses.

Photosynthesis

New information about the greenhouse effect is also incorporated into prior knowledge of plant photosynthesis, taught early in school and thus widely shared. Many informants understood and could recite the idea that trees absorb CO₂ and produce

oxygen. From this foundation, many of them had reinterpreted the media descriptions of forest destruction increasing CO₂ levels into the idea that we would exhaust all atmospheric oxygen--a terrifying prospect:

Uh, well it has to do, I think with the climate changing as a result of the atmosphere, atmospheric changes that are presently going, and cutting down all of our woods takes away a certain chem, the oxygen, or something, that is required for us to have good air quality, and uh, it's kind of scary. - Tara, p 3

That's what scares me. [What?] When they cut all the forests down, they say, pretty soon we're not going to have any oxygen to breathe. Why do they let them do that? - Cindy, p 3

Science educators deserve credit for successfully imparting the concept of photosynthesis to generations of students, but here it misleads. It misleads both because the anticipated increase in CO₂ is very small, and because--school textbook illustrations notwithstanding--even without any terrestrial plants whatsoever, we would not perish for lack of oxygen.⁴

Experienced Temperature Variation

The fourth source of differences between lay and scientist perspectives is preexisting lay knowledge of seasonal and geographical temperature variation. Informants are familiar with winter-summer temperature swings of 100° F, frequent daily temperature swings of 20° F, and major temperature differences within the US. From this experience, an average temperature rise of less than 10° F does not seem very harmful. This was seen by reactions to our presentation like:

That doesn't sound so bad, does it? Three to nine degrees (warming in 100 years). - Cindy, p 3

⁴ There are two levels of explaining why this is so. Biologists note that oceanic phytoplankton alone can produce sufficient oxygen to balance all breathing animals. More fundamentally, the chemist or physicist notes that plants store only enough carbon (about 700 x 10⁹ tC) to react with far less than 1% of atmospheric oxygen.

One person argued that future generations would acclimate to the new temperatures:

I wouldn't want to live in that, from what I am accustomed to. But it relates, I'm sure, to what you're accustomed to. If you live in *Alaska*, or you live at the *North Pole*, and you like it, (then) you like it. - Tara, p 4

Similarly, there is anecdotal evidence from a climatologist that people underestimate the temperature change needed for major climate-induced effects: "Many people are surprised to find out that the ice age was only about 9°F colder than the present average Earth temperature." (Schneider 1988: 31). This observation was based on reactions and questions during his own public lectures and testimony (Schneider, personal communication), presumably a subpopulation more informed than the average citizen.

Unlike the former three sources of misconceptions, seasonal and geographic temperature variation distorts only in scale, not by applying concepts inappropriately. Nevertheless, it is clearly more difficult to understand what the public fuss is about when one's direct experience, from travel as well as seasonal and daily cycles, is that 3° to 9°F is "not much" temperature change.

In summary, the four lay models affecting beliefs about global warming illustrate the difficulties in putting a new concept on the layman's cognitive map. Global warming is not caused by ozone depletion, and it differs greatly from traditional "pollution" in effects and solutions. CO₂ increases do not threaten to suffocate terrestrial mammals, and major environmental and biological change would result from average temperature changes far smaller than seasonal swings. In time, given continued media coverage, school lessons on this topic, and public discussion, American citizens' understanding will surely improve. We can take heart in my evidence that the public has assimilated the aerosol-ozone link. But in the meantime, the scientific content of media discussions, no matter how accurate the words and graphs in the presentation, will continue to be distorted as citizens try to fit this strange new phenomenon into their known world.

PERCEPTIONS OF WEATHER

People directly perceive weather, not climate. In the context of global warming, this raises a cognitive and a political question. The cognitive question is, how do people integrate casual weather observations and draw conclusions from them? The related political question is, if the climate begins to change, would the average citizen personally observe it and demand action? An additional question is whether ordinary people would find plausible the claim that climatic warming was caused by anthropogenic gases. To address these questions, the interview protocol briefly covered informants' personal observations about weather patterns. These questions were the very first on the protocol so that the questions concerning environmental pollution and the greenhouse effect would not contaminate them. My data suggest that people overemphasize both the human effects on climate and the extent to which climate is already changing.

Human Effects on Weather

We began our interview asking "What factors would you say affect the weather?" This was intended as a quick check on the informant's knowledge of meteorology; and we got some expected answers such as:

Sunspots, volcanic activity, earth movements - Ellen, p 1

The jet stream is the biggest factor concerning the weather... - Jenny, p 1

A more common type of answer was totally unexpected. People saw diverse non-natural causes of weather change. Several informants mentioned "pollution" as the primary factor:

Pollution affects the weather. That's all I can think of. - Paige, p 1

Well, burning, like these rainforests, and these Western forest fires. Spraying for insecticides and stuff like that. [Mmm-hum.] And, herbicides, like on the farms, to prevent weeds from growing' ... But the main thing is burning and auto pollution, stuff like that. - Walt, p 1

One man thought the weather had become more violent or erratic, a change he attributed to atomic bomb testing:

I have an answer, but it's (pause) I don't know, I've always felt that when they had that bomb I think it had an awful bearing on the change of our weather. The A-bomb. They had those tests. ... just seemed like here things have changed ever since, it's become more *torrent*, the weather here in the past few years. [...When you say more *torrent*, you mean like more changing?] Violent, violent, yea. The weather is very changeable. They say that didn't have nothing to do with it, but I still feel that it did somewhere along the line. - Wilbur, p 1

Lay attribution of weather change to atomic bomb testing was in fact widespread in the early 1960's, during the period of intense U.S. testing (Kimble 1962; U.S. News & World Report 1963).⁵

Three people mentioned space shots as affecting the weather (20% of our sample), for example:

I have my own private theory (pause) [What's that?] That every time they shoot something up in space it disturbs things up there! [There could be something to that.⁶] I've been told I have no foundation for that, but it just seems every time something happens we get this *strange* type of weather. ... [Like what? ...] Well, for instance, tornadoes were very rare in this section of the country... violent-type storms ... - Susan, p 1

Well, I don't know what the hell they're doin' up on the moon and shooting those things up there. I think they're disturbing the atmosphere. So much rain we've had, so much rain. (Stated in response to a request for ideas as to what could be done about the greenhouse effect.) - John, p 4

⁵ David Hart of the MIT Political Science Department reports a similar public reaction to earlier technology of destruction: Extensive shelling during World War I was also believed to have affected the weather (personal communication).

⁶ This follow-up comment violates my interviewing ethics because I stated something I do not believe to be true. The reason was that I was dumbfounded, yet I needed to respond quickly and positively to encourage the informant to expand on her "private theory".

These quotes suggest a propensity for people to believe that the weather is affected by human activities, especially human activities that occur in the atmosphere and are regarded as unnatural or immoral (space shots, atomic bombs, pollution).⁷ Although no one specifically mentioned greenhouse gases ("burning" and "pollution" were closest), the concept of human activities changing the weather would seem to be readily assimilable, especially if those activities are seen as unnatural or immoral. In this sense, American culture seems to already be "pre-wired" to believe in anthropogenic global climate change.

There is a corollary to my finding that unnatural or immoral human activities are seen as changing the weather. That is, the cultural belief system would be consistent if the same people also considered it improper for humans to attempt to change the weather. I find evidence that some Americans do believe this, based on an earlier set of surveys. In non-urban areas of four states, the surveys asked whether respondents believed "Cloud seeding probably violated God's plans for man and the weather." Agreement ranged from 30% to 48% (Farhar 1977: 289). An organized religion framework was not essential to this perspective, since the answer covaried with two secular statements: "Man should take the weather as it comes and not try to alter it to suit his needs or wishes" and "... cloud seeding programs are very likely to upset the balance of nature" (Farhar 1976). Would similar concerns be cited in reaction to polluting a river or paving a meadow for a shopping center? Surely fewer would express their objections to such non-weather modifications in terms of "God's plans" or the "balance of nature". Although I don't have the ideal direct and

⁷ Overall, when asked "What factors affect the weather?", five mentioned exclusively human activities, three mentioned both human and natural phenomena, and only four listed exclusively natural phenomena. (Two didn't answer the question.) In part, the pollution answer may have been enhanced because we initially described the interview topic as "weather and the environment." There is also an unintended ambiguity in the question word "affect", as indicated by one informant's paraphrase of our question as "things that could change the natural weather patterns". It may be worth asking about this topic again with a reworded question. Nevertheless, these potential objections do not alter my judgement from the existing data that people have a tendency to believe that human activities affect the weather.

explicit data from either my own interviews or the cited surveys, I am arguing that the weather (and hence climate) is a culturally special natural system, and that there are tendencies, even in our technologically-based society, to feel that it is wrong for man to tamper with it.

Belief that the Weather Has Changed

I also found that many people believe that the weather has *already* changed. Some reported personal observations of warming:

I know out in Wisconsin it's much more warm than it was years ago. Yes, 'cause a couple of years ago they (her son's family) took up cross-county (sic) skiing, and the man said they had to close down (for lack of snow) ... They don't have snow at all like they used to. It is much warmer.
- Jane, p 4

We used to have snow drifts all the way up the telephone poles, all the way up the side of the house. Now, you get a couple of inches and they close the schools. [When do you think that changed...] I guess in the last ten years, there was a big change. [(Are you thinking about this now for the first time?)] No, I've thought about it, we've discussed that. (Mother indicates agreement.) You know when we look at old pictures and stuff we say, "Look at all that snow." -Cindy, p 5

As the above quotes indicate, milder winters are one common observation. In the following case, I suspected that a warming trend was reported in part because the informant had heard that it was expected:

... what I've noticed in the weather patterns around *here* is that we seem to be having *hotter summers*, actually, it seems to be much more hotter (mentions a television show on the greenhouse effect) [And you're saying that you noticed *yourself* that it's gotten hotter, besides what you heard on the TV.] Yeah, [You *personally*, is that?] I think that the number of hot days we've *had* has been significantly increasing. ... I've noticed the amount of days. And it seems that also as far as the *winters* are concerned, we don't seem to be having *cold* winters as we used to,

used to get when I was younger, it seems. So it actually seems, we seem to be having *mild* winters, and *hotter* summers. - Doug, p 2.

In contrast to Doug's quote above, two informants explicitly mentioned that they had not yet observed any greenhouse-induced warming. Given the impossibility of laymen accurately computing climate trends from casual weather observation, Doug's quote (and another like it from Tara) suggests that lay climate generalizations are like a Rorschach inkblot test--one sees that patterns that one is predisposed to see.

Another common observation was that weather patterns were becoming less predictable:

Well your springs are unpredictable any more, you can't really tell. As far as, you know, especially if you tried to plant a garden and that. ... Now you can't really go by it. What was it? Somewhere in the middle, fifteenth of April when you could pretty near predict that frost was done. And you go ahead and plant. But now ... you could have a cold spot, you know, it can seem like anytime you turn right around, it's snowing. - Wilbur, p 2

I think our weather is more unpredictable now, uh, we've got more, *modern, satellites* and all to predict the weather and I think they're worse at predictin' it now than when they *didn't* have them. So, your *seasons* don't seem to run the same. I mean, they're less *predictable* for *patterns*. ... Like now in the spring you get real hot weather like the summer, and then when the summer comes you got weather that's like the spring, and then in the middle of winter sometimes you get weather that's almost like *summer*. Uh, it isn't an even, *even pattern*. [When would you say you started noticing that...?] Uh, I don't know, it's come on gradual. - Walt, p 4

In addition to warmer winters and more unpredictability, people who believed that unnatural or immoral human activity was influencing the weather often perceived an increase in storms or violent weather, as mentioned in the previous section.

My finding that a majority reported noticing a change in the weather is consistent with what little historical and survey research I have found on

perceived weather changes. For example, during the American colonial period there was a widespread, publicly articulated belief that the American climate had grown warmer. Ludlum (1987) cites people's accounts that winters did not seem as harsh as those described by their grandparents. One early published explanation (Williamson 1771) attributed the warming to human alteration of the New World: felling trees allowed temperate marine winds to penetrate from the East more deeply into the country, and bared soil to receive and store some solar heat. Another popular explanation was that "the rise of urban communities with heated buildings and smokepots was leading to a milder climate, as they claimed had occurred in Europe" (Ludlum 1987: 257). The attribution of a warming trend to deforestation, heated buildings, and smokepots rings curiously familiar in the present, but my point is that we have a historical propensity to perceive weather change, whether or not it is occurring, and to attribute it to human perturbations.

For a more contemporary example, a 1977 survey in Illinois asked: "Have you noticed any particular changes in the weather during the time that you've lived here?" Sixty-two percent answered yes (Farhar *et al* 1979: Tables B17, B18).⁸ Asked how they observed this change, the overwhelming response was direct personal observation of the weather (55% direct observation, 16% talking to others, 16% TV/radio, 9% newspaper/magazine, and all others 1% or fewer).

Climate is long-term and manifested in many instances of weather. It's not surprising that lay people do not compute accurate statistical trend lines based on personal observation. What is surprising is that the majority claim to have personally observed weather changes during their lifetimes. In the case of my present data (but not

⁸ The study concerned a local weather change that actually had occurred in the St. Louis area over the prior 25 years, increases in growing season precipitation, thunderstorms, and hail. However, actual weather change does not explain the finding, since only 11% reported the changes that actually did occur. The most commonly reported change was less rain, perhaps due to the immediately prior summer being unusually dry. Also, answers were not significantly different in the control area where the weather change had not occurred (Farhar *et al* 1979: D3).

the Illinois study) the frequently-reported observation of warming may in fact be accurate, since the majority of my informants, and the majority of Americans, live in areas that have experienced ambient temperature increases due to urban growth. This "urban heat island" effect is carefully factored out by climatologists studying the weather record, but it is the strongest signal present in casual personal observations.

In sum, these data do not provide any basis for the concern expressed by some climatologists (e.g. Schneider 1990) that people would not notice global warming, or would not attribute it to human activities. On the contrary, the evidence presented here suggests that at any given historical moment, the majority of the population believes that they have observed a change in the weather. Warmer winters and more variable and more violent weather seem to be common observations. The current publicity about global warming simply gives people an appropriate framework with which they can interpret their own observations. Further, many people are predisposed to attribute changes in weather to unnatural human activities. These factors together clarify why a potentially implausible hypothesis, that human activities will warm the entire planet, has been so readily picked up by the public.

CONCLUSION

While large proportions of the US public have heard of the greenhouse effect, lay understanding of

the phenomenon, its causes and effects are quite different from the understanding of scientists and energy analysts. Table 1 offers a brief and simplified summary of many of the differences, concentrating on aspects that relate to policy: current evidence for global warming, and potential policies to reduce it. The background data for some entries is discussed in more detail in Kempton 1990. This summary table cannot be regarded as definitive, both because of the small sample and because evidence for some entries draws only on the minority who happened to mention that topic.

Some would argue that the public does not need to understand all the details of global warming--as long as citizens express concern, let the scientific, political, and industrial leaders put together appropriate responses. I would argue against this perspective for two reasons. First, some citizen knowledge is needed to keep leaders honest. This can be seen clearly in recent US Federal government policy: a massive (if underfunded) tree-planting program but essentially no action on energy policy. A glance at Table 1 shows this to be a beautiful policy combination from the perspective of a political consultant, if not from that of a scientist. My second objection to today's state of public knowledge is that, if the world needs to reduce greenhouse-gas emissions by one-half to three-quarters (as has been estimated by EPA), this reduction will require both consumer/worker involvement and citizen understanding of why large changes are necessary.

Table 1. Comparison of Scientist and Lay Views of Anthropogenic Global Climate Change

| | <u>Scientists' Perspective</u> | <u>Lay Perspective</u> |
|-----------------------------|--------------------------------|------------------------|
| <u>Evidence</u> | | |
| CO ₂ increases | Clearest evidence | Not known |
| CFC increases | Yes | Yes |
| Temperature increases | No/maybe | Already apparent |
| More extreme weather | No | Already apparent |
| <u>Policies</u> | | |
| Energy efficiency | Yes, very important | No, irrelevant |
| Stop using aerosol sprays | Irrelevant in U.S. | Yes! |
| Halt deforestation | Helpful | Extremely important |
| Reforestation | Limited potential | Yes! |
| Stricter pollution controls | No | Yes |
| Carbon tax or fuel tax | Yes | Ineffective and unfair |

What to do? This problem of public understanding would probably eventually work itself out through media coverage and science education in schools. This process could be accelerated greatly if those who communicate with the public (science journalists, environmental groups, etc.) specifically target some of the gaps and misleading prior models. For example, even if people are not ready to memorize the chemical names of greenhouse gasses, they can relate to the idea that cars and home heating have more to do with global warming than do aerosol spray cans.

Despite gaps in factual knowledge and inappropriate application of existing models, this and other surveys show strong public support for environmental protection (discussed in more detail in Kempton 1990). In particular, Americans place strong value on keeping the environment intact for their descendants. In this I see hope, and the possibility of support for politicians ready to take a leadership position in the environmental area.

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REFERENCES CITED

Agar, Michael H., 1980, *The Professional Stranger: An Informal Introduction to Ethnography*. New York: Academic Press.

Farhar, Barbara C., Jack A. Clark, Lynn A. Sherretz, Jerry Horton, and Sigmund Krane, 1979, Social Impacts of the St. Louis Urban Weather Anomaly. Final Report, Vol II, Boulder, CO: Institute of Behavioral Science, U. Colorado.

Farhar, Barbara C. 1976 The Impact of the Rapid City Flood on Public Opinion About Weather Modification. *Pacific Sociological Review* 19(1): 117 - 144.

Farhar, Barbara C., 1977, The Public Decides about Weather Modification, *Environment and Behavior* 9(3): 279-310.

Kempton, Willett, 1990, Lay Perspectives on Global Climate Change, PU/CEES Report, available from Center for Energy and Environmental Studies, Princeton University, Princeton, NJ.

Kimble, George, 1963, But Somebody Does Something About It, *New York Times Magazine*, p 11 *et seq*, 8 July 1962.

Koppel, Ted, 1988, ABC News Nightline, "The Greenhouse Effect". Broadcast on 7 Sep 1988. Transcript available from Journal Graphics, NY.

Ludlum, David M., 1987, The Climythology of America, *Weatherwise* 40: 255 - 259, October 1987.

Newsweek, 1988, Special report titled "Inside the Greenhouse" (three articles), 11 July 1988.

RSM, Inc. (Research/Strategy/Management, Inc.), 1989, "Global Warming and Energy Priorities: A National Perspective". (Survey commissioned by the Union of Concerned Scientists). Washington, DC. November 1989. Unpublished manuscript available from UCS.

Schneider, Stephen H., "The Greenhouse Effect: Science and Policy" *Science* Vol 243, 10 Feb 1989, pp 771-781.

Schneider, Stephen H., 1990 Talk at Princeton University, 1 March 1990.

Spradley, James P., 1979, *The Ethnographic Interview*. New York: Holt, Rinehart and Winston.

U.S. News & World Report, 1963, Is Man Upsetting the Weather?, 46-48, 11 Nov 1963.

Williamson, Hugh, 1771, An attempt to account for the change observed in the Middle Colonies in North America, *Transactions of the American Philosophical Society*, First Edition. (Cited in Ludlum 1987).