

FOLLOW-UP QUESTIONS, 3/13/02 HEARING ON THE ECONOMIC AND ENVIRONMENTAL RISKS ASSOCIATED WITH INCREASING GREENHOUSE GAS EMISSIONS

**To Dr. Roger A. Pielke, Jr., Associate Professor,
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Responses of 5-29-02**

From Senator Jeffords:

1. In your testimony, you provided some estimates of the costs of adapting our communities and infrastructure to a changing climate. Obviously, we need to do a much better job of discouraging development in vulnerable areas. How do your cost projections take into account the risks associated with abrupt climate changes described in the Academy's December 2001 report?

The sensitivity analyses reported in my testimony (based on Pielke et al. 2000) rely on the assumptions of the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) for both changes in climate and changes in society. Because the IPCC did not consider abrupt climate changes for the particular impacts we evaluated, neither does our analysis.

I served as a member of the Academy committee that prepared the Abrupt Climate Change report. We discussed at great length the topic of economic and ecological impacts associated with abrupt climate change, and Chapter 5 of our report focused on that topic. The Committee's main recommendation that focused on reducing risk associated with abrupt climate change is entirely consistent with the approach recommended in my testimony. I reproduce that particular recommendation (number 5 in the report, **Abrupt Climate Change: Inevitable Surprises**, National Research Council, 2002, pp. 164-165) in its entirety here:

“Recommendation 5. Research should be undertaken to identify “no-regrets” measures to reduce vulnerabilities and increase adaptive capacity at little or no cost. No-regrets measures may include low-cost steps to: slow climate change; improve climate forecasting; slow biodiversity loss; improve water, land, and air quality; and develop institutions that are more robust to major disruptions. Technological changes may increase the adaptability and resiliency of market and ecological systems faced by the prospect of damaging abrupt climate change. Research is particularly needed to assist poor countries, which lack both scientific resources and economic infrastructure to reduce the vulnerabilities to potential abrupt climate changes.”

Reference: Pielke, Jr., R. A., R. Klein, and D. Sarewitz, 2000: Turning the Big Knob: An Evaluation of the Use of Energy Policy to Modulate Future Climate Impacts. *Energy and Environment*, 11, 255-276.

2. How do those cost projections consider the impacts on intangible assets, such as cultural heritage, scenery, and other quality of life-related matters?

The sensitivity analysis presented in my testimony was based on three different analyses used by the IPCC for projecting tropical cyclone damage in 2050. Pielke et al. 2000 summarizes these projections as follows:

- Cline (1992) relied on Emanuel's (1987) estimate that the destructive potential of tropical cyclones could rise by 40-50% under a doubling of greenhouse gases. The study assumed U.S. annual average hurricane losses of \$1.5 billion and that damage would rise linearly with increased intensity. Cline thus multiplied \$1.5 billion by 50% to project an increase in annual U.S. hurricane-caused damages of \$750 million. Cline assumed that increased damage from global warming would be more than linear in relation to rising temperatures and estimated that annual hurricane-related damages from a 10° C warming could be as high as \$6.4 billion (Cline 1992).
- Fankhauser (1995) assumed worldwide annual average tropical cyclone damages of \$1.5 billion and loss of 15,000-23,000 lives. This study also relied on Emanuel's estimate of a 40-50% increase in tropical cyclone intensity resulting from a 4.2° C warming. It adjusted this to 28% for a 2.5° C warming and assumed storm damages increase exponentially with intensity. Thus, the study multiplied 28% by 1.5 by \$1.5 billion to arrive at an estimate of \$630 million in additional worldwide annual average hurricane-related damages due to a 2.5° C warming. It also estimated that an additional 8,000 deaths would occur, which were valued at \$2.1 billion, bringing total additional tropical cyclone-related worldwide losses to \$2.7 billion. Fankhauser estimated that the U.S. share of these damages would be \$223 million (\$115 million from destruction, \$108 million from lost lives).
- Tol (1995) assumed that tropical cyclone intensity will increase 50% due to a 2.5° C warming, and that a fraction of the damages are related quadratically to an increase in intensity. This study estimated that additional tropical cyclone-related damages from a doubling of greenhouse gases in 1988 dollars will be \$.3 billion in the U.S. and Canada and \$1.4 billion worldwide, but did not describe the baseline damage estimates.

Reference and source for references cited above: Pielke, Jr., R. A., R. Klein, and D. Sarewitz, 2000: Turning the Big Knob: An Evaluation of the Use of Energy Policy to Modulate Future Climate Impacts. *Energy and Environment*, **11**:255-276.

3. As you know, this Committee is very interested in the effects of disasters on public infrastructure. We have jurisdiction over FEMA, water supplies, highways, etc. What work is being done to quantify the costs of investments that could be made now to reduce the impacts of disasters and climate change on human-made and natural systems?

I suggested in my testimony “the possibility that the UN Framework Convention on Climate Change (FCCC) has a critical, but largely unrecognized flaw with profound implications for policy. Under the FCCC the term “climate change” is defined as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability over comparable time periods.” This definition stands in stark contrast to the broader definition used by the Intergovernmental Panel on Climate Change (IPCC) which states that climate change is “any change in climate over time whether due to natural variability or as a result of human activity.” As a consequence of the FCCC definition, “adaptation” refers to actions in response to climate changes attributable solely to greenhouse gas emissions. It does not refer to efforts to improve societal responses to “natural” climate variability. Consequently, adaptation has only “costs” because adaptive responses would by definition be unnecessary if climate change could be prevented. Hence, it is logical for many to conclude that preventative action is a better policy alternative and recommend adaptive responses only to the extent that proposed mitigation strategies will be unable prevent changes in climate in the near future. But this overlooks the fact that even if energy policy could be used intentionally to modulate future climate, other factors will play a much larger role in creating future impacts and are arguably more amenable to policy change.”

As a consequence, very little work (both in an absolute and relative sense) has been done to evaluate adaptation alternatives. In 1996 the IPCC wrote that adaptation offers a “very powerful option” for responding to climate change and ought to be viewed as a “complement” to mitigation efforts (IPCC 1996, 187-188). Yet, the IPCC also wrote “little attention has been paid to any possible tradeoff between both types of options.” (IPCC 1996, 250). These conclusions, in my view, remain current today.

Reference: Intergovernmental panel on Climate Change (IPCC), 1996. Climate Change 1995: Economic and Social Dimensions of Climate Change, J. P. Bruce et al. (eds.), Cambridge University Press.

4. You mention in your testimony that “decision making at local levels...can have a profound effect on the magnitude and significance of future damage.” Are local governments beginning to make the connection between urban and land use planning and vulnerabilities to climate change? Do you know of any efforts to disseminate academic research findings and recommendations regarding climate change adaptation techniques to local governments and communities?

If local governments are beginning to make the connection between urban and land use planning and vulnerabilities to climate change, they are doing so on an ad hoc and unsystematic basis. A considerable effort in government, academia and the private sector exists in the United States (and globally) to improve decision making with respect to “hazards.” However, this effort is largely separate in both research and action from the climate change community. In 1997 I wrote of this in an editorial (<http://sciencepolicy.colorado.edu/zine/archives/1-29/5.html>):

“The concept of “mitigation” is central to the natural disaster policy in the United States. At the same time, the concept of “mitigation” is also central to ongoing debate about global climate change. But as used by the natural disaster community and the climate change community, the term “mitigation” takes on almost exactly opposite meanings. Natural hazard mitigation is defined by the Federal Emergency Management Agency (FEMA) as “a sustained action taken to reduce or eliminate the long-term risk to people and property from natural hazards and their effects.” A recent FEMA report on Costs and Benefits of Natural Hazard Mitigation provides examples of mitigation, which include business interruption insurance, wind shutters, building codes, and community relocation. Climate change mitigation is defined by the Intergovernmental Panel on Climate Change (IPCC) as “actions that prevent or retard the increase of atmospheric greenhouse gas concentrations by limiting current and future emissions from sources of greenhouse gases and enhancing potential sinks.” What the natural hazards community calls mitigation, the climate change community calls “adaptation” which the IPCC defines as “any adjustment — whether passive, reactive, or anticipatory — that can respond to anticipated or actual consequences associated with climate change.” The different use of terminology creates a situation that is potentially confusing for policy makers and other practitioners. While academics often work in communities that are relatively isolated from one another, policy makers typically do not. And since natural hazards are one of the threats being associated with climate change, it is probably worth paying attention to the words used in this regard. At a minimum, the conflicting terminology is symptomatic of the general lack of interaction between the hazards and climate change communities. In the climate change world, there is a tension between those who seek to prevent climate change through energy policies (i.e., climate change mitigation) and those who emphasize adaptation (i.e., natural hazards mitigation). To date, the advocates of prevention have dominated the debate. This creates a disincentive for the natural hazards community to play a significant role in the development of climate policy, which is unfortunate, as without a doubt the knowledge gained by the hazards community has an important role to play in the climate policies of the future.”

5. You also state, “Many...human losses are preventable and economic losses are manageable with today’s knowledge and techniques....[C]osts of adaptation could easily be exceeded by the benefits of better dealing with the impacts of climate, irrespective of future changes in climate and their causes.” What are some specific examples of adaptation strategies or investments that you recommend vulnerable coastal communities implement today that could prove to be cost-effective in the long-term?

There is a considerable list of activities that might be considered under the label “adaptation” for reducing vulnerability to climate impacts along the coasts, including improving land use, insurance, evacuation, ecosystem management, and other policies. A starting point for understanding the breadth of such activities is the NOAA Coastal Services Center, <http://www.csc.noaa.gov/>. In collaboration with the H. John Heinz III Center for Science, Economics, and the Environment, the NOAA CSC contributed to the publication of a book that discusses a wide range of efforts that would address coastal vulnerability:

The Hidden Costs of Coastal Hazards: Implications for Risk Assessment and Mitigation. Washington, DC: Island Press, 2000. 220 pp. ISBN 1-55963-756-0 (paper).

6. As you and all the other witnesses indicated, it is not safe to continue increasing greenhouse gas emissions without limit. What needs to be done to assure that we can avert the point of no return or “dangerous levels” of greenhouse gas concentrations?

I reject the premise underlying this question. As I stated in my testimony, any policy designed to reduce risks and vulnerabilities to climate impacts on environment and society is necessarily incomplete if focused exclusively on energy policies. Consequently, any energy policy including instantaneous, magical abatement of emissions would be insufficient to address growing risks and vulnerability to future climate impacts. As I concluded in my testimony:

“It would be a misinterpretation of this work to imply that it supports either business-as-usual energy policies, or is contrary to climate mitigation. It does suggest that if a policy goal is to reduce the future impacts of climate on society, then energy policies are insufficient, and perhaps largely irrelevant, to achieving that goal. Of course, this does not preclude other sensible reasons for energy policy action related to climate (such as ecological impacts) and energy policy action independent of climate change (such as national security, air pollution reduction and energy efficiency). It does suggest that reduction of human impacts related to weather and climate are not among those reasons, and arguments and advocacy to the contrary are not in concert with research in this area.”

7. In an answer to a question from Senator Chafee regarding your opinion on achieving the 1990 level of emissions, our UNFCCC target, by the date (2007) set in the Clean Power Act, you said that “...full and comprehensive implementation of the Kyoto Protocol around the world...is not going to do much at all to address the environment and economic risks associated with climate change.” Does that mean you believe that the potential social, economic, and environmental costs associated with long-term global warming cannot or will not be reduced by reducing anthropogenic emissions? If so, how does that comport with the statement in question 5?

This question focuses on the issue raised in the sensitivity analysis presented in my testimony. Climate impacts are a joint result of climate events and the vulnerability to such impacts of human or natural systems. Both climate and human and natural systems are subject to change. The assertion presented in my testimony was, “The primary cause for the growth in impacts is the increasing vulnerability of human and environmental systems to climate variability and change, *not* changes in climate per se.” This is borne out by a growing body of research. If impacts are indeed the result of changes in climate and vulnerability, it would only make sense that policies designed to address climate-related risks would focus on both changes in climate and vulnerability. This is the essence of my proposal to recognize that climate policy has important and under-appreciated dimensions that are independent of energy policy. Such dimensions would include the sorts of adaptation strategies referred to in Question 5 above. Further, because there are important reasons to improve the nation’s energy policies other than climate change (e.g., for reasons of national security, human health, and economic efficiency), it may make pragmatic sense to expand national discussion of energy policy beyond a narrow focus on global warming to the exclusion of other, perhaps more compelling, reasons for improving national energy policies. The bottom line is that even if the Kyoto Protocol were fully and successfully implemented, it would do little to address “social, economic, and environmental costs associated with long-term global warming” and additional steps would be needed. Thus, whatever one’s perspective on the Kyoto Protocol, whether viewing it as a “first step” or a “dead end,” there is no controversy that additional efforts are needed.

8. What do you think is the greatest risk, in the next 30-50 years, of continuing to increase human-made greenhouse gas emissions? And, what is the most feasible way to reduce or eliminate that risk?

I see two risks. First, when humans alter the earth system, there are risks of unforeseen, unintended effects on that system. A second risk, which has largely gone unnoticed, is that in focusing primarily on the potential risks to the earth system resulting in changes to that system, we neglect to observe that (a) environmental and societal impacts associated with human-climate interactions can in many cases be addressed through a focus on reducing vulnerability to those impacts, and (b) that there are many “no-regrets” energy policy actions that make immediate sense irrespective of climate change. Both the science and policy communities appear to be neglecting the second type of risk and as a consequence there is a large opportunity cost in actions not taken to improve climate policies and energy policies. The most feasible way to address both types of risk is to follow a “no-regrets” strategy of reducing vulnerability to climate variability and change (i.e., to improve adaptation) and as well to improve the nation’s energy policies with respect to national security, human health, and economic efficiency.

On this, see:

Sarewitz, D., R. A. Pielke, Jr., 2000: Breaking the Global-Warming Gridlock. *The Atlantic Monthly*, 286(1), 55-64.

<http://www.theatlantic.com/cgi-bin/o/issues/2000/07/sarewitz.htm>

From Senator Smith:

1. Dr. Rowland testified that “during the 20th Century, the atmospheric concentrations of a number of greenhouse gasses have increased, mostly because of the actions of mankind.” Do you agree with that statement? Why or why not?

I agree with the IPCC conclusions.

2. Do you believe we should fully implement the Kyoto Protocol? Do you agree with the assertion that full implementation of the Kyoto Protocol would only avert the expected temperature change by 6/100 of a degree, Celsius? Why or why not?

See my answer to Question 7 from Senator Jeffords. There is no controversy that if the goal of the Kyoto Protocol is to reduce the risks of future climate impacts on the environment and society, even if fully implemented, it cannot meet this goal, for reasons discussed at length in my testimony. Consequently, whether or not Kyoto is fully implemented, considerable additional policy action will be needed to address climate impacts on society and the environment. However, as I noted in the question and answer period of the hearing, there are other reasons to implement the Kyoto Protocol, such as considerations of international relations, national security, environmental symbolism, etc. It may well be that such considerations lead to support for full implementation of the Kyoto Protocol, completely independent of risk associated with climate impacts. My testimony and this answer focus on the role of the Kyoto Protocol in reducing risk of climate impacts.

3. Since the hearing there has been much press attention paid to the breakup of the Antarctic Ice Sheet, especially a 500-billion ton iceberg known as “Larsen B,” that has been attributed to climate change. What specific evidence is there that climate change is the sole cause of this phenomenon? Is there any scientific evidence that anthropogenic influences bore any role in the breakup of Larsen B?

I have no special expertise to contribute to this subject.

4. Included in the hearing record as part of my opening statement was a Swiss Re report titled “Climate research does not remove the uncertainty; Coping with the risks of climate change” (copy attached). Please explain why you agree or disagree with the following assertions or conclusions from that report:
 - a. *“There is not one problem but two: natural climate variability and the influence of human activity on the climate system.”*

I would frame the problem a bit differently. There are changes in climate, caused by many reasons, including human activity. There are also changes in society and caused by society to the environment that result in increased vulnerability to climate

impacts. This definition of the problem underlies the recommendations presented in my testimony.

See Sarewitz, D., R. A. Pielke, Jr., 2000: Breaking the Global-Warming Gridlock. *The Atlantic Monthly*, 286(1), 55-64.

<http://www.theatlantic.com/cgi-bin/o/issues/2000/07/sarewitz.htm>

- b. *“...it is essential that new or at least wider-ranging concepts of protection are developed. These must take into account the fact that the maximum strength and frequency of extreme weather conditions at a given location cannot be predicted.”*

Agreed. Along with colleagues we have examined the role of prediction in decision making and arrive at substantially similar conclusions.

See: Sarewitz, D., R. A. Pielke, Jr., and R. Byerly, (eds.), 2000: **Prediction: Science, Decision-Making and the Future of Nature**. Island Press: Washington, DC.

- c. *“Swiss Re considers it very dangerous [1.] to put the case for a collapse of the climate system, as this will stir up fears which –if they are not confirmed- will in time turn to carefree relief; and [2.] to play down the climate problem for reasons of short-term expediency, since the demand for sustainable development requires that today’s generations take responsible measures to counter a threat of this kind.”*

Agreed and I point you to my answer to Question 1 from Senator Jeffords for elaboration.

5. Do you believe that our vulnerability to extreme weather conditions is increasing? Why or why not?

Vulnerability to extreme weather has increased as populations and wealth have grown and more people have located in exposed locations. This perspective is now well documented in the peer-reviewed literature. A 1999 review (Kunkel et al. 1999) concluded, “. . . increasing losses are primarily due to increasing vulnerability arising from a variety of societal changes, including a growing population in higher risk coastal areas and large cities, more property subject to damage, and lifestyle and demographic changes subjecting lives and property to greater exposure.” Numerous other references supporting this conclusion are provided in my testimony.

Reference: Kunkel, K., R. A. Pielke Jr., S. A. Changnon, 1999: Temporal Fluctuations in Weather and Climate Extremes That Cause Economic and Human Health Impacts: A Review. *Bulletin of the American Meteorological Society*, **80**:1077-1098.

From Senator Voinovich:

1. Advocates of the Kyoto Protocol expect aggressive reductions in emissions beyond 2012. Some advocate a global CO₂ concentration target of 550 ppm CO₂ by 2100

which will require substantial reductions in the emissions of developed countries (including the US).

- a. If a concentration target of 550 ppm by 2100 is adopted, what is your estimate of the caps on emissions for the US by 2050? By 2100?

I have no special expertise to contribute to this subject.

- b. Are you aware of any economic analysis of the impact of these reductions beyond the initial Kyoto target? If so, can you provide this analysis.

I have no special expertise to contribute to this subject.

2. Please provide an assessment of the approaches of various states to address normal beach erosion?

I have no special expertise to contribute to this subject.

3. How significant are the effects of land use changes versus other input to climate models?

I have no special expertise to contribute to this subject.

4. If the estimates that Kyoto would cost the U.S. between \$100 and \$400 billion per year to implement are true and the results would just be a change of 0.06 degrees Celsius; would money be better spent on programs like Project Impact (a program at FEMA which helps communities mitigate against future natural disasters by encouraging different building techniques in disaster-prone areas)? Are Kyoto-like reductions cost effective? Please explain.

The answer to this question is predicated upon the answer to a prior question, “Cost effective with respect to what criteria and outcomes?” If the goal of the Kyoto Protocol is to reduce future climate impacts, then it is clearly insufficient, and perhaps even irrelevant. However, there are other reasons why implementation of the Protocol might make sense, which would lead to different conclusions as to its cost effectiveness. See my answer to Question 2 from Senator Smith for discussion.

See Sarewitz, D., R. A. Pielke, Jr., 2000: Breaking the Global-Warming Gridlock. The Atlantic Monthly, 286(1), 55-64.

<http://www.theatlantic.com/cgi-bin/o/issues/2000/07/sarewitz.htm>

From Senator Campbell:

1. You mentioned in your testimony that, “The present research agenda is improperly focused on prediction of the distant climate future.” I am inclined to agree. What sorts

of research, in your expert opinion, would be of immediate benefit in relation to adaptation to climate change?

To answer this question I point you to the testimony at an April 17, 2002, House Science Committee hearing of my colleague Radford Byerly, who was asked by the Committee:

“How could a climate initiative yield information of greater relevance to end-users, people who make decisions related to climate?”

Dr. Byerly’s response is worth quoting at length.

“To assure that a research program generates information of great relevance to end-users, the users must be involved in planning and evaluating the research. That is, they must have a say in what research is done and in what counts as a success. Users must be able to ensure that research addresses their problems, and delivers usable results.

In the present program climate scientists typically develop information they want to develop, i.e., answers to scientific questions, and then try to get bewildered users to use it (the users may never have heard of the scientific question). Research results become a solution looking for a problem.

Sound research programs dedicated to problem solving typically have three phases: A beginning -- planning, a middle -- the research, and an end -- application and evaluation. The present program is almost all in the middle phase, that is, it is scientific research on scientific questions.

A better program, i.e., a program that would do more toward solving identified problems, would be conducted as follows: Research would be preceded by a planning phase in which users and scientists would identify and define specific problems to be attacked, as well as specific questions and information needs, and would look ahead to the application of the results. At this planning stage the primary sources of information about the problems are future users, the owners of the problems, not climate scientists. This planning process can be thought of as the researchers taking joint ownership of the problem with the users. The researchers do not relieve the users of responsibility, but together they take responsibility for solving the problem. Then in the middle the research is done, and new information is obtained and published. This second phase is often erroneously considered the entire project. Finally, in the third phase the results are applied in the field by the users on their problem and the research is evaluated in terms of how it helps solve the problems.

We hope that users will eagerly, fruitfully use the information, since they participated in planning the research. But such planning is hard and unfamiliar. Users may not express their needs clearly, or researchers may not hear them, and not every project will succeed. This is why the projects must be evaluated based on success in the field. Research projects unsuccessful in addressing the problem are terminated and successful ones are continued or replicated in a new context, as appropriate. That is, you correct and iterate.

Of course provision is made for projects that are making good progress in a demonstrably practical direction. In this way a program of projects solving real problems is grown. Along the way good science of a different kind is done.”

Dr. Byerly’s testimony can be view in its entirety at:

http://sciencepolicy.colorado.edu/homepages/rbyerly/house_testimony_apr_2002/index.html