

naive to assume that people living in impoverished Third World countries will constrain energy growth (i.e., economic growth) or stop cutting down trees just because Americans are forced to get rid of large cars or replace their existing refrigerators with more efficient but more costly units.

These two policy statements demonstrate that expertise in geophysics does not automatically qualify one to make public policy recommendations. At the very least, some economic thinking must be added, as well as a certain amount of political sophistication.

Kaula and Anderson exhibit their biases by criticizing the Marshall Institute report on the greenhouse effect (authored by Fred Seitz, Robert Jastrow, and William Nierenberg), and by posing the rhetorical question: "Is it all right that these three individuals have more influence [with the White House] than the 25,000-member AGU, which presumably has more of the relevant expertise?" Yet they mention with approval the politically motivated Union of Concerned Scientists, without criticizing that organization's open letter of February 1990, which expressed a wildly alarmist view about greenhouse warming and was signed by many scientists with no discernable expertise in climatology!

The Forum article demonstrates the danger inherent in moving outside of geophysics when it criticizes "some economists" for advocating tax cuts and deregulation. There are many economists who would argue that the economic growth of the 1980s was directly related to the 1981 tax cuts and that the troubles of the savings and loan industry had much to do with the actions of Congress, including the passage of a higher limit on federal deposit insurance, which in turn encouraged savings and loans to take unreasonable financial risks.

Finally, the article asks us to debate the "proper definition of caution in the face of uncertainty." Well, this is a bit like asking how much we should spend on an insurance policy when the risks are poorly understood. Robert M. White, cited in the article, recommends buying an essentially costless insurance policy against greenhouse warming. But if the insurance policy is costless, or nearly so, then we need not worry about the magnitude of the risk or whether indeed there is a risk. Obviously, any action that advances energy conservation and energy efficiency, and results in an economic gain, should be encouraged regardless of any possible greenhouse warming.

With respect to the risk of greenhouse warming, Kaula and Anderson assume implicitly that there will be a disbenefit—or even a global calamity. Many scientists would disagree, arguing that if there is a modest warming and resultant increase in precipitation, as the newer global circulation models now suggest, then the overall impact will be positive; that is, there will be more winners than losers. Certainly, the evidence of agriculturalists is that increased CO₂ levels lead to more rapid plant growth. A higher average temperature—less nocturnal cooling

and a longer growing season—and more rainfall will further benefit food crops. Many climatologists, taking the long view, also regard a modest global warming as possibly delaying the impending onset of the next ice age.

It is useful here to recall that only 20 years ago, opinions on climate trends were also sharply divided, with many distinguished climatologists fearing an imminent global cooling and U.S. government studies forecasting frightening numbers about economic damage. Perhaps I will be forgiven for immodestly quoting from an article in the premier issue of the journal *Cosmos*, which I co-authored with Roger Revelle and Chauncey Starr: "The scientific base for a greenhouse warming is too uncertain to justify drastic action at this time. . . . Yet there is hope that research, including satellite observations and ocean data, will provide many of the answers within this decade."

The proper and important role of AGU is to point out areas of research that are crucial to a better understanding of the mechanisms of the greenhouse effect and thereby improve the specification of the global circulation models used to predict future climate. Perhaps even more important is that AGU remain a forum for free and open scientific debate in an increasingly poisonous atmosphere of coercion and intimidation in environmental affairs.

I would value the opinions of other AGU members and ask that they communicate with me.—*S. Fred Singer, University of Virginia, currently at the Woodrow Wilson International Center for Scholars at the Smithsonian, Washington, DC 20560; fax 202-357-4439.*

Response

Singer's comments appear to misinterpret, or miss the emphasis of, several points in our article.

1) He infers that we advocate "raising energy taxes or . . . directly enforcing conservation." There are no explicit statements thereof in our article. The main thrust of the criticized item was that the public should be *more aware* and have a *greater spirit of cooperation*. We do feel that it is desirable that the public be better informed—something to which the AGU can contribute—entirely aside from governmental compulsion, something which is not AGU's business.

2) Singer states that we "mention with approval the politically motivated Union of Concerned Scientists." What we said was "There are also other organizations more focused on political issues, such as the Union of Concerned Scientists." This phrase was not intended to connote approval. Ironically, we suggested that the AGU should discuss public implications of geophysics in part *because* of the excessive alarmism of the Union of Concerned Scientists.

3) Singer states that many economists argue that the economic growth of the United States in the 1980s was directly related to the 1981 tax cuts, and that the savings and loan deregulation was the work of

Congress. We recall that there were economists who advocated both measures and think that it is a "debated benefit" when measures are followed by an increase in national debt of 43 to 60% of GNP, an increase in adverse foreign trade balance of 0.7 to 2.5% of GNP, and a percent rate of growth in GNP less than two-thirds the rates of some other developed countries with higher taxation.

4) Singer says Robert White suggested "an essentially costless insurance policy." What we understand White suggested were changes that would cause appreciable dislocations, and hence expense, but which were desirable on more grounds than ameliorating climate evolution.

5) Singer states: "With respect to the risk of greenhouse warming, Kaula and Anderson assume *implicitly* that there will be a disbenefit or even a global calamity." We are unsure what it was that stimulated this remark. Perhaps it was the statement regarding "unmistakable trends that, in the long run, will be detrimental." By this we meant an extreme end, such as further increase of CO₂ in a world completely cloud covered. In any case, the main emphasis we intended was the *uncertainty*: "the most unlikely scenario of all is 'no significant change at all in geographic distribution of insolation and rainfall'." Such a redistribution *may* be beneficial to the whole of mankind in the long run, but it is very unlikely that such shifts could occur without economic impacts, hurting some while helping others.

We feel that our suggestion of a possible revision of the 1982 policy is quite consistent with the opinions of leaders in scientific policy making. For example, from the presidential address of Frank Press to the National Academy of Sciences on April 30, 1991: "The case for the support of science will not sell as an entitlement program for scientists, or solely on intellectual grounds. Rather, it must be justified in terms of what science can contribute to the betterment of the country. Scientists are in a zero-sum game with those who would spend public monies to help society in other ways. Presidential science adviser Allan Bromley, Congressman George Brown (chairman of the House Science, Space, and Technology Committee), and others here in Washington have exhorted our community to make its case in these terms of societal benefits."

But perhaps a more active role for AGU is inappropriate because it is too sluggish an organization; it is now two years since Frank Press urged us to do so at a meeting of AGU's Planet Earth Committee. Meanwhile, matters are moving on elsewhere. For example, from a recent *New York Times* article titled "NRC Policy Implications of Greenhouse Warming" (April 11, 1991):

" . . . despite great uncertainties, greenhouse warming is a potential threat sufficient to justify action now. [We] call for these measures:

"Adopt nationwide energy-efficient building codes.

"Improve the efficiency of the U.S. automotive fleet through the use of an appropri-

ate combination of regulation and tax incentives.

"Strengthen federal and state support of mass transit.

"Improve appliance efficiency standards.

"Encourage public education and information programs for conservation and recycling.

"Reform state public utility regulation to encourage electrical utilities to promote efficiency and conservation.

"Sharply increase the emphasis on efficiency and conservation in the federal energy research and development budget.

"Utilize federal and state purchases of goods and services to demonstrate best-practice technologies and energy conservation programs."

The panel of 14 that generated these recommendations included only two AGU members; and was chaired by a former Republican governor and senator. We are pleased to see this evidence that our opinions are apparently central to the informed mainstream.—*William M. Kaula, University of California, Los Angeles, 213-825-4363; Don L. Anderson, California Institute of Technology, Pasadena, 818-356-6901*

extensively on questions that involve watershed research. The uptake of water and nutrients by vegetation, the exudation of chemicals through leaf surfaces and roots, and the microbially mediated reduction of iron, sulfate, and other oxidized species in wetlands are examples of processes that have been the focus of ecological studies on watersheds. Clearly, furthering the critical study of hydrochemical response of watersheds will require communication among hydrologists, geochemists, and ecologists.

Each of the fields of inquiry discussed above has its own series of professional societies and annual meetings. It is extremely rare, however, for key scientists within the disciplines to gather in an informal meeting dedicated to integration among the disciplines. The watershed concept serves to focus the subjects at hand; the Gordon Conference structure and format are designed to promote discussions and the exchange of ideas.

The purpose of the upcoming Gordon Conference, "Hydrological-Geochemical-Biological Interactions in Forested Catchments," scheduled for July 1-5 in Plymouth, N.H., is to get on with the work of addressing these newly emerging questions, to bring to the fore the most recent advances in data and understanding in watershed science, to bring biologists more completely into the discussions of integrated watershed effects, and to identify and develop new questions that go to the heart of integrated watershed response.

At the conference, morning and evening sessions will seek to maximize open discussion on the subjects of the conference. Of special interest will be synthesis and integration among the disciplines. A field trip to the nearby Hubbard Brook Experimental Forest is planned. The last half-day of the conference will be devoted to further integrating the previous discussions and organizing subsequent Gordon Conferences along the theme of integrative watershed studies.

Attendance at the conference is limited to 135. If interested, contact M. Robbins Church, U.S. EPA, ERL-C, 200 S.W. 35th St., Corvallis, OR 97333; tel. 503-757-4666; fax 503-757-4335. Organizers hope that this will be the first in a continuing sequence of Gordon Conferences dedicated to the general theme of integrating hydrological, geochemical, and biological studies in forested ecosystems.—*M. Robbins Church, U.S. Environmental Protection Agency, Corvallis, Oreg.*

SECTION NEWS

HYDROLOGY



Editor: W. Berry Lyons, University of Nevada, Mackay School of Mines, Hydrology/Hydrogeology Program, Reno, NV 89557; tel. 702-784-6465

Geochemical Studies in Watersheds Expanded

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In the past, geochemical research in forested watersheds has focused on understanding the basic processes that occur in soils and rocks. Watershed geochemical processes, however, are greatly influenced by, and in turn, greatly influence, both organisms and biological process in soils, and hydrologic responses of catchments. To date, geochemical research has dealt principally with basic chemical processes in soils and rocks, and much less with questions concerning hydrologic routing through catchments and the effects such routing has on temporal variation in chemical composition of surface waters.

Research on flow generation in catchments has focused on intensive field studies on plots, hillslope sections, and small catch-

ments, with extension to larger scales necessarily involving the application of conceptual models that might (or might not) be valid. The acquisition of direct experimental evidence (for example, verifying flow generation mechanisms) on larger-scale watersheds has always been problematic. Although geochemists understand that the explanation of some geochemical observations requires that flow pathways be explicitly identified, and hydrologists understand that flow generation can be better elucidated if the geochemical history of waters is known, critical integrated communication between the disciplines is often lacking. In turn, biologists require physical and geochemical information to interpret biological effects in watersheds, and hydrologists and geochemists need to be aware of the effects of biological processes on hydrochemical response of catchments.

Currently, advances in watershed hydrology, geochemistry, and biology are hindered by a lack of communication and flow of ideas and information among the disciplines. An AGU Chapman Conference was convened in September 1989, which brought together geochemists and hydrologists for a series of discussions of watershed biogeochemistry. As interesting, useful, and enjoyable as the conference was, it still left unexplored a number of topics linking the disciplines. Also, the conference did not explicitly encourage the involvement of watershed biologists. Ecologists, as well as geochemists and hydrologists, have worked