

SCIENTIFIC INFORMATION AND GLOBAL CHANGE POLICYMAKING [1]

Editorial Essay

1. U.S. Global Change Research Program: What's the Problem?

The interdisciplinary, multiagency U.S. Global Change Research Program (USGCRP) was enacted by Congress in 1990 to provide policymakers with “usable information on which to base policy decisions relating to global change” [2]. The program has defined ‘usable information’ as a ‘predictive understanding of the Earth system’ to be achieved through observations, process research, integrative modeling, and assessments. The USGCRP currently addresses many aspects of global environmental change including: Climate change, stratospheric ozone depletion, and biodiversity and ecological change [3]. Through 1994 over \$5.7 billion dollars will have been spent on the program, representing one of the largest science programs ever conducted [4]. In 1993 the USGCRP consisted of 137 projects, among 31 federal bureaus, within 11 federal agencies.

The problem is that “although the results of the program, as currently structured, will provide valuable information for predicting climate change, they will not necessarily contribute to the information needed by public and private decisionmakers to respond to global change” [5]. In other words, the program will likely produce ‘good science’ but fail to provide ‘usable information’ on which policy decisions relating to global change can be based [6]. Therefore, a mismatch exists between information being supplied by the program and information needed by policymakers to respond to global change. Why is the USGCRP not producing ‘usable information’? What, then, is ‘usable information’? This essay addresses these questions.

1.1. FACTORS SHAPING THE SUPPLY OF INFORMATION

Two interrelated complexes of factors have given rise to the type of information produced in the USGCRP. First, the structure of the USGCRP has been shaped by its scientific and political contexts. When policymakers adopted the USGCRP from the science community in 1990 its content did not adjust to its changed mandate. The program evolved from NASA, NOAA, and NSF collaboration in the mid-1980s and was designed to be part of a broader international effort, the International Geosphere-Biosphere Program (IGBP) [7]. The IGBP was designed as a science program. Its policy relevance was a secondary consideration [8]. The

U.S. government, meanwhile, was embroiled in conflict over how to respond to 'global warming' that pitted members of Congress, including Senators Al Gore (D-TN) and Tim Wirth (D-CO), against President George Bush and members of his administration. The USGCRP provided the Bush Administration an opportunity to emphasize research over action, and gave some in Congress opportunity to link research to action [9]. When Congress established the USGCRP in statute it subordinated science to policy in the form of 'usable information'. The USGCRP has failed, however, to reconcile its scientific focus with its policy mandate.

Why is USGCRP scientific information not also 'usable'? Congress is inundated with information on global change, but "cannot be expected to interpret complex information which is not easily presented in an almost binary fashion" [10]. In other words, Congress needs 'a message, not data' [11]. The USGCRP is designed to provide reams and reams of data, but not necessarily a message. For instance, NASA's contribution to the USGCRP, the Earth Observing System, will generate annually enough information to fill 4 million 100-megabyte computer hard drives, so much that "no system in use to date has come close to handling this amount of data" [12]. However, even after 400 trillion bytes of global change data are reduced to a hundred odd journal articles, Congress will still need a message. The USGCRP contains much data on global changes, but few means of using the data to define or address policy problems posed by global change.

That Congress asks for information it cannot use is understandable: Decision theorists have learned that organizations systematically gather more information than they use, yet continually ask for more [13]. Why? In Congress the main reason is that policymakers, for the most part, do *not* want to make difficult decisions about global change. They seek information in hopes that science will provide 'the answer' to the various problems of global change so that they can avoid making difficult decisions [14].

A second complex of factors shaping the structure of the USGCRP are perspectives of scientists and policymakers about the role of scientific information in decision making. Although some scientists and policymakers have understood that scientific information is necessary, but not sufficient for making policies relating to global changes, the conception that scientific information is sufficient for policymaking persists. Perhaps because it is easy for policymakers to rationalize inaction in terms of the expectation of clarifying information, and for scientists to justify accepting substantial research funding [15]. Perspectives holding that science is sufficient for policymaking no doubt have their roots in the ideology of the enlightenment [16]. Policymaker perspectives have also been shaped by the post-war 'social contract' between science and the U.S. government, which promises that government support of science inevitably results in social benefits exceeding the initial investment [17]. From such perspectives, policymakers tend to view science as a panacea, instead of as a component to be integrated with the broader decision process.

The incongruity of science and policy in the program's fundamental structure has begun to be addressed, for example, through the addition of a 'policy relevant integrated assessment function' released with the president's fiscal year 1995 budget [18]. However, changing perspectives will be more difficult. The following section explores how barriers to usable information might be overcome.

1.2. WHAT, THEN, IS 'USABLE INFORMATION'?

Neither scientists nor policymakers know what usable information is in the context of global changes. Nor, however, do policy analysts or other academics. Instead, usable global change information must be discovered. In many cases policymakers have an undefined notion of what, exactly, the policy problems are in the context of global changes [19]. For policymakers, scientific information typically begs the question, "So what?" (or "What does global change mean in my district?"). Furthermore, policymakers generally have little conception of the range of alternatives at their disposal to deal with defined problems. To compensate for such limitations, usable information must be generated through the contextual integration of goals and action alternatives recursively over time.

The USGCRP could facilitate policy problem definition by distilling the practical significance of scientific information, and at the same time develop a wide range of action alternatives to address the range of problems. Scientific information is relevant to policy problem definition when it helps in the clarification of values (or goals), describes trends with respect to those goals, accounts for observed trends, or projects a realistic range of scenarios from which action alternatives might be developed [20]. For example, information about sea level rise would be associated with problem definition through the following series of questions: What do we value (and, who is we)? Has the sea been rising? If so, why? How does this affect our values? Is it likely to rise? If so, why? How does this affect our values? What response alternatives are most likely to achieve what we value? Clearly the present program will answer some of these questions. However many questions go unasked and unanswered, leaving for policymakers the task of integrating incomplete scientific information with other aspects of the decision making process.

Values, and consequently policy alternatives, change as science advances through the development of new knowledge [21]. (e.g., I did not know I preferred vitamin C until I learned that it wards off colds. Thus, I will choose an orange over an apple.) The USGCRP could help policymakers identify such changes and their significance by actively supporting experimental policy programs [22]. For example, to meet the goal of reducing carbon dioxide emissions, policymakers need a wide range of alternative means to choose from to implement that policy. The list of action alternatives to reduce carbon dioxide is inexhaustible and ranges from the centralized to the decentralized. Examples include experiments with carbon taxes in local municipalities to experiments with more efficient dishwashers or electric power lines. As data on projects comes in, policymakers will have a more solid

foundation for global change policymaking through bargaining, negotiation, and compromise [23]. The key to implementing experimental policy programs to provide usable information is to create a policy process that integrates policy problem definition with action alternatives.

2. Conclusion

Dealing with global environmental change through large programs such as the USGCRP will be difficult. It is impossible if the policy process depends solely upon scientific information gathered from the laboratory and the ivory tower to inform the legislative chamber. The USGCRP can fulfill its legislative mandate of providing 'usable information' to policymakers by setting up a process to define, in various contexts, what the policy problems of global change might be and to offer policymakers a wide range of alternative means to achieve their preferences. The process must be recursive so that the lessons of experience can be fruitfully applied to the evolving world. Edward Deming once observed that to be successful businesses must 'build quality in'. Likewise, if science programs are to provide usable information to policymakers, they must 'build policy in'. Policy relevance refers to a process not to information [24].

Notes

1. Environmental and Societal Impacts Group, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307-3000. The National Center for Atmospheric Research is sponsored by the National Science Foundation. Any opinions, findings, conclusions, or recommendations expressed in this paper are those of the author and do not reflect the views of the National Science Foundation.
2. P.L. 101-606, Sec. 104.b.1.
3. Committee on Earth and Environmental Science: 1993, *Our Changing Planet: The FY 1994 U.S. Global Change Research Program*, Office of Science and Technology Policy, p. 15.
4. The \$5.7 billion total includes funds for the program's focused elements. If contributing programs are included then the total is \$13.0 billion, which places the USGCRP among the largest science efforts of all time. See the *Our Changing Planet* series 1990-1994.
5. Office of Technology Assessment: 1993, *Preparing for an Uncertain Climate - Volume I*, OTA-O-567, (U.S. GPO: Washington, DC, October), p. 111.
6. See also Rayner, S.: 1993, 'Global Change Research: Science and Policy', statement before the Committee on Science, Space, and Technology, U.S. House of Representatives, May, 19, 12 pp., and R. Monastersky: 1993, 'The \$1.5 Billion Question: Can the U.S. Global Change Research Program Deliver on Its Promises?', *Science News* **144**, 158-159.
7. See, for example, Waldrop, M. M.: 1984, 'An Inquiry into the State of the Earth', *Science* **226**, 33-35, and Perry, J.: 1991, 'Global Change: From Rhetoric to Reality', *Rev. Geophys. Supplement*, April, 39-45.
8. International Council of Scientific Unions: 1986, 'The International Geosphere-Biosphere Programme: A Study of Global Change', report of the Ad Hoc Planning Group on Global Change, Prepared for the 21st General Assembly, September, p. 3.
9. On Bush Administration emphasis of research see Roberts, L.: 1990, 'Climate Extravaganza Bombs', *Science* **248**, 436.
10. Byerly, R.: 1989, 'The Policy Dynamics of Global Change', *EarthQuest* **3**, 11-13, 24, p. 12.
11. *Ibid.*

12. Office of Technology Assessment: 1993, *The Future of Remote Sensing from Space: Civilian Satellite Systems and Applications*, OTA-ISC-558 (US GPO: Washington, DC, July), p. 103.
13. Feldman, M. S. and March, J. G.: 1981, 'Information in Organizations as Signal and Sign', *Administr. Sci. Quart.* **26**, 171–186.
14. Cf. Clark, W. C. and Majone, G.: 1985, 'The Critical Appraisal of Scientific Inquiries with Political Implications', *Sci. Technol. Human Val.* **10**, 6–19.
15. Brunner, R. D. and Ascher, W.: 1992, 'Science and Social Responsibility', *Policy Sci.* **25**, 295–331.
16. White, L.: 1967, 'The Historical Roots of Our Ecologic Crisis', *Science* **155**, 1203–1207.
17. See, for example, Brown, G.: 1992, 'The Objectivity Crisis', *Amer. J. Phys.* **60**, 779–781.
18. It is unclear whether integrated assessments will provide usable information. They may be simply unusable information from the social sciences.
19. See, for example, Brunner, R.: 1991, 'Global Climate Change: Defining the Policy Problem', *Policy Sci.* **24**, 291–311, and Herrick, C. N. and Jamieson, D.: 1993, 'The Social Construction of Acid Rain: Some Implications for Science/Policy Assessment', paper presented at the 18th annual meeting of the Society for the Social Studies of Science, Nov. 19–21.
20. Lasswell, H. D.: 1971, *A Pre-View of Policy Sciences*, American Elsevier, New York.
21. Mesthene, E. G.: 1967, 'The Impacts of Science on Public Policy', *Public Administr. Rev.* June, 97–104.
22. A detailed proposal on how the USGCRP might be modified to make up for its policy shortfalls is presented in Brunner, R. D.: 1993, 'Policy and Global Change Research: A Modest Proposal', Prepared for the Fourteenth Annual Conference of the Association for Public Policy Analysis and Management, Washington, DC, October 30.
23. President Clinton's *Climate Change Action Plan* is a step in this direction. It is unclear, however, how the information generated by the USGCRP will be used to improve implementation of the Action Plan.
24. This paper is modified from an earlier version presented at the Creeping Environmental Phenomena Workshop, sponsored by the United Nations Environmental Program, the National Center for Atmospheric Research, and the Walter Orr Roberts Institute, and held in Boulder, CO 7–9 February 1994.

*Environmental and Societal Impact Group,
National Center for Atmospheric Research,
P.O. Box 3000, Boulder,
CO 80307–3000, U.S.A.*

Roger A. PIELKE Jr.