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Meeting the Challenges of Policy-Relevant Science: Bridging Theory and Practice

Ongoing public debate about the role of science in policy making signifies the importance of advancing theory and practice in the field. Indeed, assumptions about the science–policy nexus hold direct implications for how this interface is managed. A useful lens on contemporary themes is offered by the experience of a federal environmental science program that launched an ambitious effort to enhance capacity for policy relevance while protecting a commitment to sound, impartial scientific inquiry. This was achieved by developing an explicit conceptual model and implementing corresponding strategies that addressed critical gaps in capacity for policy-relevant research, analysis, and communication while supporting existing capacities. This article describes and evaluates the capacity-building effort from the dual perspectives of deepening an understanding of successful practice in the field and advancing a conceptual understanding of the science–policy nexus. It illustrates the challenges facing practitioners and the need for greater interaction between theory and practice.

Pressure is particularly great in the environmental and natural resources arena, where decisions about land use, competition for water, energy development, climate, natural hazards, public health, and species protection are widespread and may have multibillion-dollar implications, as well as consequences for human health, safety, and quality of life. There is a critical need to develop better theoretical understandings of the science–policy nexus and practical management strategies that are capable of enhancing the accountability and policy relevance of scientific research while preserving its core of independent inquiry.

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Frequent calls to craft science-based policy, enhance the societal relevance and accountability of science, and more clearly delineate the threshold between the use and misuse of science in policy making highlight the importance of the science–policy nexus. However, responses to these calls tend to be ad hoc and circumstantial. The relationship between science and policy is commonly assumed to be a linear one in which scientific "truths" are disseminated to policy makers who may or may not accept them, or as an incomprehensibly complex, highly charged interface where scientific and political cultures inevitably clash on epistemological or value-laden grounds. For practitioners, neither set of assumptions is a satisfactory guide for creating effective linkages between science and policy development. This article makes a contribution on both fronts by presenting a heuristic model of science–policy interaction and examining its practical value in the experience of a federal environmental science program that, responding to contemporary challenges, sought to enhance its capacity for policy relevance while protecting its commitment to sound, impartial science. When that effort began in the mid-1990s, it was experimental and innovative, with no known comparable precedents. The science–policy model that guided the effort was not previously available in the literature and demonstrated its value as a strategic management and diagnostic tool. Clearly, how the relationship between science and policy is conceptualized holds important implications for practice, and the critical importance of building stronger bridges between theory and practice to meet the challenges associated with meaningful pursuit of policy-relevant science and science-based policy cannot be overstated.

Background and Impetus for Change

The National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS) has the unique responsibility of undertaking comprehensive

monitoring of rivers, streams, aquatic ecology, and groundwater in about 50 major river basins nationwide. Initiated in 1991 in response to congressional inquiries as to whether water conditions were improving as a result of the Clean Water Act and related initiatives, the provision of useful information to resource managers and policy makers was considered an implicit but somewhat unarticulated part of the program's mission.

The primary mission of the USGS as a whole includes earth science investigations that emphasize data collection and environmental monitoring, with historically little direct involvement in national policy processes. Indeed, scientists are legally prohibited from making policy recommendations, and adherence to these constraints had resulted in a culture that discouraged scientists from responding to the information needs of policy makers except by providing technical documents and data sets.

A perception took hold among the senior USGS management during the mid-1990s that Congress was unwilling or unable to use scientific information as traditionally provided and that public concerns about the agency's relevance were growing. These perceptions were based partly on cautionary anecdotes and partly on a string of tight budgets that were seen as evidence of a decline in the status of public support for science. Closer to home, the so-called Contract with America, adopted by the Republican majority in Congress during 1994 (U.S. House 1995), involved a goal of shrinking the size of the federal government, and the USGS was one of several agencies suggested for elimination (Gauvin 1995; Miller 1995).

An additional factor in the overall impetus for change was the Government Performance Results Act of 1993, which elevated expectations regarding the results and accountability exhibited by all federal agencies. Defining goals for improving results and accountability in agencies offering direct services to citizens seemed straightforward, but that task was far less clear in a science agency whose historical mission was to provide high-quality data and reports that might indirectly affect the lives and livelihood of citizens but that had little direct service-related contact with them. As an initial response, the agency improved its dissemination of reports and statistical data sets, and the volume of postings to the Internet expanded dramatically in a trend that continues to the present time. This strategy proved to be valuable but insufficient for alleviating all concerns about relevance, and fresh examination of the complexities of the science–policy relationship led to the effort described in this article.

It is helpful to understand that while concerns about enhancing the policy relevance of science may have seemed to grow out of situational political pressures, they did not emerge suddenly or without a broader societal context. The societal trend for many decades had been a gradual shift from somewhat unquestioning public support for scientific inquiry that characterized the period after World War II to a respectful but more skeptical regard for science (Lewenstein 1992; Tarlock 2002; Yearley 1988). The idea that science was apart from and somehow above society became overtaken by a view of science as part of society, and questions of accountability correspondingly arose. By the 1990s, calls for scientists to engage more effectively with society had become quite common, from scientists who sensed a new dynamic emerging (Guston, Woodhouse, and Sarewitz 2001; Lubchenko 1998; National Research Council 1998; Toman 1998), from policy makers who saw the importance of scientific involvement in practical problem solving (Boehlert 2002; Ehlers 2002), and from civil society with its emphasis on participatory democracy (Addis and Lee 1996; Beierle and Cayford 2002; Ingram and Schneider 1998). These calls cited the need to improve the quality of public decisions by using more science, to increase the accountability of science to society and social values, or a mixture of the two. They reflected a heightened awareness of the unresolved normative and pragmatic tensions surrounding society's authority over and accountability to science, and science's authority over and accountability to society (Ingram and McDonald 2002; Moss 1982; Tarlock 2002).

The direct effects of these broader social trends on USGS water-quality science activities may have been delayed, possibly by insulating institutional factors or simply because the pertinent scientific capability that enabled interaction with the water policy domain was just emerging in the 1990s. Indeed, the NAWQA had to "create" much of the science on which the program's work was based (Miller 1995, 2003). In any case, the maturation of the program coincided with broader historical and political forces that may have magnified situational pressures, and the NAWQA program was under substantial pressure to demonstrate policy relevance. As the agency's flagship water-quality program, it was closely watched when it launched an effort in 1995 to increase the relevance of its scientific information to national policy making, confronting logistical, managerial, and cultural challenges along the way. Could policy relevance be enhanced without crossing the line into recommending policy? What were the goals for enhancing policy relevance? Could policy relevance occur without fundamentally undermining the scientific, independent culture of the agency?

Over six years, this effort demonstrated the feasibility of making monitoring, analysis, and communication more responsive to the needs of managers and policy

makers without sacrificing scientific credibility. Results suggested that the new strategies may even have helped sharpen scientific analysis while making findings more useful to nonscientists. The interplay between the conceptualization of the science–policy nexus and the strategies adopted by practitioners was illuminated as well because the strategies adopted flowed fairly directly from the heuristic model that guided the effort. Key choices made along the way would likely have been quite different if a different conceptual model had been adopted at the outset. At the same time, trust in the conceptual model was strengthened when reliance on it led to more effective practice. The realization of a recursive relationship between concepts and action leads to a greater appreciation of the need to link theory and practice more effectively in this field.

Methods and Approach

The experiment recounted in this article did not originate from academic inquiry but rather from a practical need to meet a program management challenge, and the methodological rigors associated with academic research are not always accepted as timely or entirely applicable in the dynamic atmosphere of practice. However, there is great interest among practitioners in discovering better ways to manage resources or solve problems. The methods used in this case were developed to satisfy the evaluation needs of practice but were rooted in styles of academic analysis in order to support fuller evaluation of the results and lessons learned.

When the effort began, little academic scholarship was available to serve as a direct guide, and no comparable cases from other agencies were available to use as role models. There was no consensus among the agency's senior management as to whether enhanced relevance would result from simply marketing existing scientific information better or whether it would require more profound institutional change. There was substantial confusion about the nature of the science–policy relationship, the cause behind the current challenge, and the potential solutions. Confronting this challenge, therefore, entailed several phases: developing a clearer concept about the nature of the science–policy nexus; assessing the contemporary challenge and corresponding goals and solutions; and initiating a plan that could move successfully from concept to action. Evaluation of results, while sometimes regarded as a luxury in the arena of practice, was a seminal aspect of this effort. Not only was it necessary to confirm whether stated goals were being achieved, but additional issues and observations that emerged during the effort and prompted interest in evaluating whether the concepts and techniques related to science-policy dynamics and organizational change could be replicated and generalized beyond the effort at hand.

Practitioners often speak of learning by doing, and the methods illustrated in this article go a step further by systematically linking doing and reflecting. Such an approach seeks to achieve a more holistic understanding and supports a mutually reinforcing, interactive relationship between theory and practice. Methods that encourage disciplined reflection on one's own practice in order to deepen theoretical understanding and inform future practice are found in several fields. In philosophical terms, an embeddedness of theory and practice is termed *praxis* (Dixon and Dogan 2003). In education, the process of integrating doing and reflecting is called *action research* (McCutcheon and Jung 1990, 148). In organization and management, *action science* connotes a process of critical reflection that can lead to changes in thought and action (Putnam 1999), and *practical theorist* denotes a scholar who can "span boundaries" between theory and practice, deliberately seeking to overcome alienation between them (Hoffman 2004). Similarly, the anthropological approach of ethnography is a method of immersion in the very social systems or organizations under analysis, relying heavily on personal observation, experience, and interviews (Humphreys, Brown, and Hatch 2003; Peterson et al. 2002).

These intellectual touchstones suggest the importance of firsthand participation, and yet a valid concern about such approaches may be the potential for participant bias. Indeed, in the present case, the author participated directly in, designed, and led core elements of the programmatic effort described. However, risks of bias may be mitigated by the suite of methods employed and outweighed by the value of gaining perspectives that would otherwise be impossible to obtain or without which improvements in theory and practice might be impeded or even impossible to achieve. In this case, the absence of guidance in the existing scholarly literature or in the experiences of other programs to meet the extant challenges suggested that a disciplined, reflective participant approach offered the greatest opportunity for learning.

To offset the risks of subjectivity, participant analysis and observation in this case were augmented by metrics that were designed to test achievement of program goals, surveys and focus groups to provide impartial feedback from external users, and a post hoc literature review to provide a context for deeper reflection and evaluation of results and lessons learned. Metrics were determined collaboratively within the NAWQA program's national management team based on the goals of the policy relevance plan; these will be described more fully later. Surveys were designed and conducted by the author and other management staff according to standards of professional practice, with the aim of obtaining standardized feedback from users about the credibility, understandability, and usefulness of scientific information developed during the effort. Focus groups were