CONNECTING SCIENTIFIC RESEARCH AGENDAS TO SOCIAL NEEDS: SOME REFLECTIONS

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"Basic research…provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn."[2]

"So we discover in the administrative service one official who knows all that can be known about the control of water-borne diseases, another who has at his fingertips the substance of all available information on wheat rust, and another who cannot be 'stumped' on appropriations for the national park service. These men are not merely useful to legislators overwhelmed by the increasing flood of bills; they are simply indispensable. They are the government."[3]

The second of these quotes seems almost quaint to a late 20th century reader familiar with the limited influence of technological experts on the thinking of decisionmakers who are concerned with a myriad of social and political factors as well as basic scientific "facts." The first quote, however, still resonates with many scientists and policymakers. We look to science for answers to deal with problems that seem ever more complex and threatening: environmental threats, global competitiveness, crime, health hazards, education failures, and so forth. At the same time, however, we have become cynical about scientific prescriptions for social ills, especially when rival prescriptions are presented in highly politicized public debates.

In this paper I offer some brief reflections on how scientists and science program managers can better take account of social priorities in the design of science research agendas and the allocation of research budgets.[4] For reasons discussed below, I think that more attention to social priorities in the subject areas pursued and the specific questions investigated is crucial for addressing both scientific interests and social interests, though scientific activities should not be entirely subordinate to current perceptions of social needs. I attempt to sketch ways in which scientific methods can be used to inform the setting of scientific priorities against the backdrop of broader social concerns.[5]

THE CHALLENGE

Many observers would agree that social problems are growing in both scale and complexity.[6] Scale issues arise because some potential threats, such as those stemming from human impacts on the biosphere, now arise over larger geographical areas (e.g., widespread deforestation in some tropical areas, regional or global scale air pollution) and have longer time durations (e.g., threats to global biodiversity, persistent pollutants). Complexity grows as systemic concerns involve more interdependent factors and require the attention of multiple disciplines. A prime example is the evaluation of how human activities affect biodiversity and other "ecosystem services," and how changes in these services in turn affect human interests.[7]

The growing scale and complexity of social concerns increase the demand for scientific input to devising solutions, at least in largely technocratic societies like the United States. However, these same factors handicap the application of scientific information to devising solutions. Increases in the scale and complexity of social problems pose a challenge to the articulation and consistent application of social criteria for action (e.g., economic efficiency, social equity, ecological integrity). In short, the determination of priorities for scientific inquiry logically should be intimately connected to the determination of social priorities. In practice, this connection arises if only because social priorities influence the allocation of financial resources for scientific activities. However, the nature of this connection is often not well understood or articulated. In this situation, science increasingly is dragged into policy debates which turn at least as much on competing value systems as on scientific findings. Scientific inquiry itself becomes unavoidably politicized in this process, as inevitable scientific uncertainties are exploited in attempts for partisan gain.[8]

The other key element of the challenge is the increased demand by the public for a more utilitarian accounting of the fruits of scientific inquiry. Faith in the view expressed by the second quote at the beginning of the paper, that the accumulation of scientific knowledge inexorably will benefit humankind, has been shaken by the failures of science to consistently deliver on this promise and by the acceleration of competing demands for public and private financial resources that might otherwise support scientific activity. Even when the right subject areas are being investigated, the kinds of scientific questions pursued may not fully address society's relative needs for knowledge. For example, a better understanding of climate change risks and response options may be a priority, but responding to this priority requires a better understanding of the potential impacts of climate change and the possibilities for adaptation to these impacts, not just a refined understanding of atmospheric dynamics.

Byerly and Pielke (1995) discuss the growing social distrust of the "reservoir of knowledge" theory of scientific benefits and the growing demand by the public for increased accountability on the part of the scientific establishment.[9] They conclude that the social contract between the scientific establishment and the broader public, as represented by society's political institutions, must be renegotiated. In their view, science must demonstrate greater democratic accountability to social goals, which in turn will help win more sustained political support for expenditures on scientific activity. They recommend a national debate on the future of science, addressing two key questions (Byerly and Pielke 1995, p. 1532):

1. In what ways does science contribute to the national welfare?

2. How can science best be marshaled to assist in addressing specific societal problems?

These two questions lead to two related corollary issues. The first concerns the assessment of how science contributes to social welfare. The second is how scientists and science leaders can interact with broader processes through which social interests are articulated and acted upon to make their own activities more aligned with social interests, without giving up on the idea that there is something distinctive about the pursuit of scientific understanding.

SCIENCE, KNOWLEDGE, AND POLICY

In responding to the first of Byerly and Pielke's questions, determining what science has contributed to the nation's welfare, we immediately confront two dilemmas. First, there is no universal agreement on how to assess national welfare. Different definitions will have implications for how science is valued. Second, assessing the contribution of science requires that we have some measure of the input of science as well as the output, and defining this input raises philosophical as well as technical issues.

The common answer to the first dilemma, as Byerly and Pielke suggest, is democratic accountability. Granted that we have no unambiguous, definitive measures of well-being; in a democratic society we have processes to make social determinations of the extent to which things are satisfactory or wanting. In practice, the process is less simple. The ongoing debate among social groups that put different values on technical advance and maintenance of pristine natural landscapes illustrates the point. But these debates reside within the larger society, not just within the science establishment. Scientists need to be aware of the elements of these debates so that they can articulate how they think scientific advance does contribute to the achievement of different goals,[10] but the resolution of debates over values is not itself a scientific endeavor.

Regarding measuring the input of science, critics of traditional ideas about the objectivity of scientific knowledge, such as Jasinoff (1990) and Funtowicz and Ravetz (1994), argue that what we call knowledge is in fact an artifact of the various institutions society establishes for legitimating assertions about what is an acceptable description of "reality." In this view, even peer review is a legitimating institution subject to various kinds of manipulation, not an Olympian process for deducing ultimate truth. Following this line of argument makes answering Byerly and Pielke's question difficult, since it is impossible to divorce what is defined as scientific knowledge from social values and conventions.

The critics have a point in arguing that there is no such thing as ultimately objective reality – any attempt we make to define our view of the world must rest on some basic axioms that are themselves not testable. But the criticism of the traditional view of scientific knowledge risks going too far in the other direction, denying that there is anything special about what emerges from peer-reviewed scientific inquiry and seeing the result of such activity as just one more expression of a particular social perspective. It seems important to conceive of subjectivity being a matter of degree. Moreover, the processes of scientific inquiry and expert peer review, even though imperfect, do provide increased confidence in the identification and explanation of observed patterns.

ESTABLISHING A STRONGER SCIENCE-SOCIETY CONNECTION

I have argued that science can be seen as a specialized skill that can generate a better understanding of social problems for all parties to debates over social priorities and values. I also have argued that to function well in practice, science needs to recognize and respond to those debates rather than defining an independent agenda in a vacuum. To conclude the paper I turn to the other question by Byerly and Pielke posed above, namely assessing how science can best be marshaled to meet social needs while still seeking to expand more fundamental knowledge.

A key element, as those authors note, is a process of *social interaction* between scientists and the broader society that examines what science has contributed from a number of perspectives. Stakeholder peer review of scientific accomplishments and agendas is a useful complement to expert peer review. Diverse groups increasingly are involved in policy debates through multi-criteria as well as multi-stakeholder processes, especially with the devolution of some regulatory functions to states and increased emphasis on public participation and information activities. One way stakeholder review of scientific programs can be provided is for science agencies and programs to have separate advisory bodies that reflect stakeholder interests, as well as technically oriented bodies capable of providing disciplinary or multidisciplinary review. The obverse of this process is the need for scientists to increase their efforts toward forthright education of stakeholders regarding the value of their science mission, especially in the case of more fundamental research.

A second key element is *diversification* of activities to increase expected returns and reduce risks. Just as investing in only one security is imprudent, even if the security seems to have an extraordinary return, society should pursue a portfolio of diverse scientific activities including more fundamental as well as applied research rather than just picking a few apparent winners. Who precisely should make these investments (industry, government, academia, and others) remains a complex and much-debated question, one that ultimately will be settled through a resolution of competing stakeholder interests like any other policy issue, but this does not alter the basic conclusion about the value of diversification. The argument in favor of social interaction in the previous paragraph implies that both scientific experts and the broader public have a role to play in these determinations.

A third key element in more strongly connecting science to social interests involves an internal discipline for *setting priorities*. Just as scientists must make choices in what types of knowledge they may pursue, scientific agencies and programs face difficult tradeoffs in directing attention to different social goals (for example, among environmental concerns or between economic and environmental objectives). Selectivity is needed in dealing with currently pressing issues without losing track of the importance of supporting more fundamental research that may have a less evident payoff.

To choose how to focus resources, science program managers can use a model based on the *value of information.* This model directs attention to where increased knowledge would have the greatest potential impacts on decisions. Examples of the questions brought to the fore by this approach include: How is a proposed analysis of scientific phenomena linked to social values and incentives? Are the areas of greatest scientific uncertainty also those areas where the value of improved knowledge is highest? What do decisionmakers need – better facts, better knowledge of mechanisms, better knowledge of behavioral levers? How are the risks, benefits, and costs distributed among different groups and across time?

An example of this kind of inquiry, as already suggested, is in the area of climate change. It is not enough to better understand atmospheric dynamics. It may be more valuable to increase understanding of how climate change could affect human health, and even more valuable still, to better understand how an improved public health and social service infrastructure might reduce these risks. To serve an increasingly diverse set of constituencies interested in such complex problems, there is a growing need for a capacity to conduct scientifically respectable but relatively quick "what if" scenario analyses as well as more complex multifaceted assessments.

A final crucial element in the process of connecting science and social values is *iterative shared learning*. Social values extant at any moment in time depend on the vast and idiosyncratic pools of knowledge and experience possessed by different members of society. I have argued that scientific inquiry should be informed by this knowledge and experience in responding to social priorities. At the same time, scientific inquiry alters knowledge and changes our experience of the world, thereby altering values and priorities.[11] This interdependence heightens the apparent tension between science as a world apart and science as a tool for social problem-solving, and it underscores the importance for both science and the public at large that scientific endeavors be better connected to the society in which the endeavors are carried out.

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ENDNOTES:

1. I am grateful to Terry Davies and Elisa Graffy for helpful comments on an earlier draft. Responsibility for the paper's content is mine alone.

2. Vannevar Bush (1945), quoted in Byerly and Pielke (1995, p. 1531).

3. Leonard White (1926), quoted in Jasanoff (1990, p. 10).

4. In this paper I use the term "science" very broadly to refer to physical, biological, and social science fields.

5. In this paper I do not attempt to address the question of how scientific knowledge is or should be used to help resolve specific social policy controversies involving complex and uncertain cause-effect relationships, such as those arising in the regulation of environmental hazards. Essentially I believe that scientific analysis (in the broad sense, including the social sciences) should play a vital part in these processes, but that scientific analysis alone cannot provide definitive answers. For further discussion of this issue see National Research Council (1994, 1996) and (specifically on the role of economic analysis) Kopp, Krupnick, and Toman (1997) and Toman (1998).

6. For further discussion of this see Norton and Toman (1997) and references therein.

7. The papers in Simpson and Christensen (1997) discuss these complications in detail.

8. For a summary of these aspects of the science/policy nexus, see for example Jasanoff (1990) and references cited therein.

9. Byerly and Pielke note that the reservoir of knowledge concept largely is a post-World War II idea; prior to that, government policy expected more in the way of immediately tangible benefits from science.

10. In practice this task is itself extremely difficult, given the uncertainty surrounding any contemporaneous cause-effect relationships involving specific scientific advances and social progress.

11. See Norton and Toman (1997) and references therein for discussion of this approach in the context of environmental impacts.