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Science–policy data compact: use of environmental monitoring data for air quality policy

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Abstract

Environmental policies often strongly depend on environmental monitoring data, yet these increasing datasets are not always used effectively in enacting and implementing public policy. We propose a science–policy data model that defines the conditions that facilitate the use of environmental monitoring data for policy and which could help scientists and policymakers diagnose impediments in the link between science and policy and work more effectively together to use monitoring data in environmental policy. The model includes two parts: (1) criteria for scientific monitoring data to become useful information for public policy; (2) a "data compact," a relationship between senior scientists and midlevel policymakers that enables translation of environmental monitoring data into knowledge useful for public policy. We compare the model against two case studies in the air quality literature: ozone depleting substances and acid precipitation. Finally, we use the model to assess the potential of a newly developing area that we are researching, use of satellite remote sensing data for fine particulate matter transboundary policy.

Keywords: Policy model; Environmental policy; Data compact; Air quality; Satellite

1. Introduction: environmental policy and scientific data

Environmental policy, concerned with human health and the natural environment, depends on data that describe environmental conditions, such as air quality, water quality, hazardous chemical contamination, and land use. Fischer (2000) has proposed that environmental problems are different than other social policy issues, since they are argued more on scientific findings than on moral issues: "Although they are generally traceable to human agents, environmental problems have an imposing physicality compared to other social problems." Environmental politics in the U.S. began as conservation with President Theodore Roosevelt, but its modern political form began in the 1930s, when the Franklin Roosevelt administration addressed deforestation, soil erosion, flooding, protection of flora and fauna, and other areas that required information about the effects of human activity on the natural environment (Sussman et al., 2002). When modern environmental legislation, such as the Clean Air Act, Clean Water Act, and Endangered Species Act were passed, each required extensive scientific environmental monitoring to set standards and monitor progress. Environmental policy from the 1960s to the present has increasingly depended on environmental monitoring and the analysis of the monitoring data.

From agenda setting to implementation, environmental policies in areas as diverse as air quality, climate change, ozone depletion, water quality, land use, and environmental health all depend on environmental monitoring and research to set emission limits, establish safe levels of exposure, evaluate the fate of pollutants in the ecosystem, determine what land needs preservation, and many other decisions at the local, state, and federal level. The data that support this process are often complex, ambiguous, dispersed across

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multiple monitoring networks maintained by different organizations, provided piecemeal in many narrow technical papers, developed with competing theories, and presented with jargon that is not clearly understood by the policy analyst. The culture of science that generates and analyzes the data is very different from the culture of politics that uses the resulting information for decisionmaking.

The requirement for good environmental monitoring data for environmental policy has been noted in many fields, including ecological forecasting (Clark et al., 2001), common resources (Dietz et al., 2003), toxic chemicals (Susskind et al., 2001), and air quality (Alm, 2000). Dietz et al. (2003) state that ‘‘Environmental governance depends on good, trustworthy information about stocks, flows, and processes within the resource system being governed, as well as about the human–environment interactions affecting those systems.’’ The extent of monitoring these complex environmental processes has changed in the last 10 years due to the information revolution. With the advance of monitoring and communication technologies, such as handheld monitors, global positioning systems, real-time monitoring, and the Internet, data are available in significant quantities and can be provided rapidly and directly to a broad audience. The data-rich society we live in presents both challenges and opportunities, since we need the ability to translate all these data to useful information. Dale Jamieson (Sarewitz et al., 2000) notes that

I can now watch the ozone hole develop in (more or less) real time on my PC. Twenty years ago I didn't know that there was an ozone hole. My father didn't know that there was such a thing as ozone. Our ability to monitor global systems is increasing at high velocity, but that doesn't translate into 'solutions,' or even into understanding what constitutes a 'problem' or how one should be framed.

Environmental problems like climate change or urban air quality are not science problems or political problems alone, but interdisciplinary problems that require a unified science–policy solution. This requires collaboration between scientists and decisionmakers, working together to bridge the science–policy value gap by creating environmental monitoring information that is useful for public policy. In this section, we review the science–policy value gap, including various models proposed to define the connection of science to policy. We also discuss several participant models that describe the relationship of scientist to policymaker. In Section 2, we integrate these to develop a new model that defines the criteria and processes needed to make environmental monitoring data useful to policy decisionmakers. Section 3 discusses several examples where we apply the science–policy data compact model.

1.1. Environmental science policy value gap

The use of science in public policy has a history of mixed success and there are few clear standards or principles that guide the conversion of scientific data into an effective policy tool. The problem has been identified for nearly 50 years—from Snow's ‘‘two cultures’’ (1959) to Kai Lee's ‘‘civic science’’ (1993)—but the solutions have also had mixed results. Part of the problem seems to be the differences in perspectives, motivators, and values between the scientific and policy cultures—a science–policy value gap.

Policy theorists have attempted to define the relationship of science to policy through various policy models. Price (1965) proposed that after Benjamin Franklin and Thomas Jefferson, science and politics in the U.S. have been disconnected and the U.S. political system is not based on a scientific foundation. Yet, since the 1940s, research institutes and universities, which do not have a defined constitutional purpose, have become largely dependent on government funding. In parallel, government agencies have become dependent on scientific information. Price (1965) defines a spectrum of four estates in our current political system—scientists, professionals, administrators, and politicians—which he represents as a new system of checks and balances between freedom and responsibility. Price defines the scientific community as an ‘‘elite oligarchy’’ organized by discipline (e.g., chemistry and biology) that seeks truth through rational tests and the scientific method and requires freedom to explore theories, make discoveries, and compete for limited resources. The scientific community provides special knowledge for developing and implementing environmental policy. As opposed to the scientific estate, Price believes that democratic politics is based on action as a way to gain support from the electorate and is organized by purpose (e.g., commerce, war, and agriculture). Political decisions are based on reasoned argument, response to power centers (e.g., corporate, legal, and scientific organizations), and accountability for performance by the electorate. For environmental policy, this often involves acquisition and interpretation of scientific knowledge and application to social issues.

In his discussion of environmental policy, Lee (1993) proposed a similar spectrum as Price, stating, ‘‘Science and politics serve different purposes. Politics aims at the responsible use of power; in a democracy, 'responsible' means accountable, eventually to voters. Science aims at finding truths—results that withstand the scrutiny of one's fellow scientists.’’ Both Lee and Price feel that the culture of scientists and the culture of policymakers have fundamental differences, most notably in their objectives and their standard operating procedures. Scientists follow the scientific method, where a theory is proposed and tested, and then results published, allowing review, replication, and validation by their scientific peers. To put this in policy terminology, it is similar to the rational comprehensive method, building incrementally over many years toward a reasonable consensus within the scientific network. Policymakers, on the other hand, embrace less linear approaches, such as defined by Kingdon's (1995) garbage can model where problems, policies, and politics come together based