11

Information and Influence

Ronald B. Mitchell, William C. Clark, and David W. Cash

Introduction

Scientific assessments have become increasingly common in the landscape of global environmental affairs, at least in part, due to the tantalizing prospect that better and more widely shared information fosters better management of complex, transnational interactions between humans and nature. According to proponents, global environmental assessments (GEAs) can evaluate the state of knowledge about the world, improve our understanding of the probabilities and risks of various scenarios, and illuminate the expected costs and benefits of alternative policies. The hope has been that better understanding of the environmental impact of human actions, decisions, policies, and behaviors, and of the options for mitigating those impacts, will help political, social, and economic decision makers discern and pursue their own self-interest in a more enlightened manner. More ambitiously, scientific assessments can foster collective efforts to address global environmental problems, providing tools scientists, stakeholders, or policymakers can use to persuade others (Benedick 1998; Watson 1994; Walsh 2004; Harrison and Bryner 2004; Wilkening 2004).

These hopes for scientific assessment are not without foundation. Internationally shared scientific and technical knowledge—developed at least in part through GEAs—has clearly facilitated progress in managing environmental risks such as acid rain and stratospheric ozone depletion. Other assessments, however, have had few discernible impacts. Indeed, scholars have identified many reasons that scientific research that seeks to influence policy fails to do so (see, for example, Pulwarty and

Melis 2001; Pulwarty and Redmond 1997; Pielke and Conant 2003; Lemos and Morehouse 2005). It is precisely the question of "Why do some assessments have more influence than others?" that this book seeks to address. Here, we delineate findings and conclusions derived from the range of cases analyzed in the preceding chapters.

The first section of this chapter reviews major findings regarding the sources of GEA influence that are supported by evidence from most or all of our cases. As noted in the introduction, our initial research led to two propositions that we sought to evaluate systematically across our cases, namely that (1) GEAs are better conceptualized as social processes rather than published products, and (2) to be influential, potential users must view a GEA as salient and legitimate as well as credible. In addition, this section delineates other, more detailed, propositions that were evident when looking across our chapters but that were not propositions that chapter authors systematically sought to evaluate. By identifying such patterns of GEA influence that emerge from most or all of our cases, we hope to help guide those interested in GEA influence toward promising areas for future research.

The next section of this chapter looks across our cases for other, less expected, insights into the conditions, factors, and processes by which GEAs wield influence. Unlike the insights supported by most of our cases, we believe it is worth reporting several insights that are supported by only a few of our chapters and in which we, therefore, have less confidence. We believe such insights also provide interesting clues regarding new questions and new trajectories for research.

We end with a short set of "considerations for practitioners." Other research related to the larger project of which this book was a part, much more directly and explicitly sought to identify what design choices assessors can make to improve assessment influence—including initial choices regarding what issues to address, what types of actors to involve in assessments, how to bridge the science-policy interface, and how to treat uncertainty and dissent (Farrell and Jäger 2005). Yet our efforts to determine when assessments have influence also identified several insights that can help make the many currently underway or upcoming GEAs be more effective and influential. We do not intend these considerations as specific design principles for assessment but as broader, higher-level

recommendations regarding how assessors should think about assessments in order to enhance their influence. We delineate those lessons here in the hope that our efforts can inform future global environmental assessments.

Major Findings

Our study leads to five major conclusions. First, assessments vary both in what type of influence they have and in how much influence they have. Second, assessment influence is relational—we cannot evaluate an assessment's influence in general but only its influence with different potential audiences. Third, assessment influence with any audience depends on that audience seeing the assessment as salient, credible, and legitimate. Fourth, audiences tend to see those assessments as salient, credible, and legitimate in which they have been able to participate, a process of coproduction of knowledge. Fifth, assessments gain influence by addressing incapacity problems, whether those are incapacities that inhibit full participation as a producer of assessments or incapacities that inhibit full understanding as a user of assessments.

Assessments Vary in Type, as Well as Amount, of Influence

As expected, we found considerable evidence that people are more responsive to some assessments than to others. But, less expectedly, we found that assessments prompt many changes that both differ from—and are sometimes contrary to—those that assessment producers sought. In part, this finding reflects our initial choice to look for assessment influence in an expansively defined issue domain rather than only in policy and behavior changes (see the introductory chapter). One important result of our research has been to identify, verify, and document the variety of intended and unintended ways in which audiences respond to assessments and thus alter an issue domain. Thus, we have come to replace our earlier sense that some assessments have an influence and others do not with a more subtle understanding of the variation in the type and amount of influence assessments may have.

The impact of an assessment depends at least partly on when they are conducted, relative to an issue domain's development. Those conducted

at early stages are unlikely to lead to immediate and direct policy change; those conducted at more mature stages in an issue's development are unlikely to transform fundamentally the ways in which various audiences conceptualize an environmental problem. Early on, different audiences can use an assessment to prompt scientific, public, and political debate about a previously undiscussed environmental problem. Audiences are more likely to accept an assessment's framing of an issue that has received little previous attention. As an issue develops, however, various stakeholders may succeed in promoting alternative framings that highlight different environmental, economic, social, or political facets of the problem, perhaps doing so through assessments. As discussion of an issue shifts from identifying and defining the problem to developing and debating possible responses, some societal actors may respond to assessment processes by seeing how their interests are (or are not) at stake, becoming correspondingly more (or less) engaged. At later stages, policymakers and stakeholders may see assessments as useful resources in identifying, evaluating, or supporting particular policy options. Assessments can have these and many other influences on an issue domain. And, as our cases show, assessments may also fail to have any influence or may have influence that is difficult to discern because it is small or because of the researcher's limited ability to detect subtle changes in the issue domain and/or to demonstrate such changes to an assessment convincingly.

Assessments sometimes directly influence behaviors that affect the environment. Parson's (2003) account of how scientific assessments fostered global action that slowed ozone-layer depletion provides a powerful example. Policymakers in the Convention on Long-Range Transboundary Air Pollution (LRTAP) used improved scientific understandings not only to shift acid precipitation regulation from flat-rate emission standards to "critical-load" criteria but also from common obligations to politically more challenging differentiated ones (VanDeveer, chapter 5, this volume). Polish electricity producers negotiated industry-government agreements on how to achieve sulfur emission reductions in response to participatory assessments of alternative policies (Andonova, chapter 6, this volume). Global negotiators of rules regarding persistent organic pollutants (POPs) would have moved more slowly

and would have been unlikely to select those chemicals and criteria that they did were it not for earlier LRTAP-related assessments of POPs (Selin, chapter 7, this volume). Commercial farmers in Zimbabwe and farmers in Nebraska adopted practices that would have been unlikely in the absence of processes for gaining their acceptance of drought forecasts and information on methods for mitigating aquifer depletion (Patt, chapter 9, this volume; Cash, chapter 10, this volume).

Assessments often influence issue development in more subtle or time-delayed ways that make their effects harder to isolate. Many political, economic, and other forces influence policy choice, directly or indirectly (Andonova, chapter 6, this volume). The Villach climate assessment did not lead directly and immediately to negotiation of a climate change convention and the boost it gave to international policy actors promoting global action on climate change was highly contingent on other factors, most notably success on ozone loss, having created receptive audiences for its claims (Torrance, chapter 2, this volume). Assessments may influence an issue domain by engaging scientists in ways that make them both more interested in and more capable of studying particular issues.

Both our work and that of other researchers has identified numerous cases in which assessments had no discernible or immediate influence. The lack of influence of some assessment processes seems virtually global in extent, as in the Swedish assessment of acid rain presented at the 1972 Stockholm Conference on Human Environment, the 1975 assessment of supersonic-transport threats to the ozone layer, the various pre-Villach assessments of climate change, and the 1995 Global Biodiversity Assessment (Social Learning Group 2001a, 2001b; Torrance, chapter 2, this volume; Cash and Clark 2001). In other cases, assessments that some actors have readily accepted have been ignored or rejected by others. In India, not only the generally uninfluential Global Biodiversity Assessment but also the Villach and subsequent climate assessments had little influence (Biermann, chapter 4, this volume). Aquifer-related science was quite influential in some American counties but had almost no influence in many parts of Texas (Cash, chapter 10, this volume).

Because different actors respond to assessments in ways that reflect their concerns, interests, and policy preferences, assessments may

influence an issue domain by evoking counterintuitive, skeptical, or oppositional responses. Skepticism that assessments of POPs conducted in Europe and North America would have findings applicable to other regions prompted new assessment efforts in those regions (Selin, chapter 7, this volume). Similarly, scientists in developing countries responded to climate change and biodiversity assessments by initiating "counterassessments" that identified inaccuracies in the science of prior assessments and rejected their policy implications (Biermann, chapter 4, this volume). Our findings that assessments often influence issue development without leading directly to behavior change are consistent with evidence that society's attention to, and management of, most issues typically exhibits long periods of relative stability punctuated by shorter episodes of rapid change (Baumgartner and Jones 1993), and that new ideas must often "incubate" for a decade or more before they have much influence on behavior (Weiss 1975; Sabatier 1993).

We were also struck by cases in which an assessment induced little if any response even from actors we would have expected to be receptive to it. Assessments of climate change and sea-level rise had no immediately discernible influence on coastal zone managers in Maine and Hawai'i, who used it simply to justify previous policy choices that had nothing to do with sea-level rise (Moser, chapter 8, this volume). Many assessments of acid rain, including one by the International Institute for Applied Systems Analysis (IIASA)—whose assessments have frequently been central to acid rain politics in Western Europe—have been ignored in public discussions and negotiation of policy changes in Poland and Bulgaria (Andonova, chapter 6, this volume).

We should not be surprised that assessments differ in the type of influence they have or whether they have any readily discernible influence at all. Indeed, it would be naive to think that scientific findings can replace or be divorced from the fundamentally political and normative conflicts whose resolution they seek to promote (Jasanoff 1990, 2004). As Gupta demonstrates with respect to biosafety negotiations, fundamentally normative and political conflicts regarding the nature of an environmental problem and its appropriate resolution cannot be resolved by reference to science that is merely technically credible (Gupta, chapter 3, this volume). In contrast, in such areas, perceptions of technical credibility

are themselves closely intertwined with the normative conflicts. To be influential, assessments must grapple with this complex reality, balancing the need for getting the science right with the need for "political engagement" (Andonova, chapter 6, this volume; Herrick and Jamieson 1995; Lemos and Morehouse 2005; Pielke 1995).

Influence Depends on the Assessment-Audience Relationship

A second insight of our cases is that assessment influence is relational. Since multiple audiences evaluate any given assessment, a claim that an assessment is influential can only be understood if we know "with whom." Some assessments tend to be accepted by a wide range of audiences; others are given little credence even by those who produced them. Most assessments have influence with some audiences but not others. Thus, the Commercial Farmers' Union (CFU) helped large-scale farmers in Zimbabwe make use of drought forecasts in ways that small-scale and communal farmers could not (Patt, chapter 9, this volume). Publics and policymakers were far more interested in and receptive to climate change assessments in Europe than they were in India (Biermann, chapter 4, this volume). Assessments that convinced many European and North American policymakers of the value of global POPs regulations had to be carefully adapted to convince Asian, African, and Latin American policymakers (Selin, chapter 7, this volume).

The relational character of assessment influence poses a special challenge for assessments intended for use in transnational or global contexts. The concerns, perspectives, knowledges, data, and assumptions of groups (e.g., nations) initiating a global environmental assessment often differ markedly from those of other groups whose cooperation is needed to address an environmental problem. The power and interests of the countries and substate actors involved in any environmental problem affect both the policy agenda and the assessment agenda. The responses of Central and Eastern European states on acid precipitation issues, of India on biodiversity and climate issues, of developing states on biosafety issues, and of Hawaiian industry on reports of sea-level rise all demonstrate that whether findings from an assessment are accepted by a given audience depends on a range of "nonscientific" political, social, and economic factors.

The Attributions That Determine Influence

Our study found considerable evidence of our second proposition, that GEAs have influence with audiences that see them as salient and legitimate as well as credible. As noted in the introduction, salience, credibility, and legitimacy are attributions that potential users make about the assessment. Audiences or potential users of an assessment that differ in their goals, interests, beliefs, strategies, and resources are also likely to differ in whether they perceive an assessment as salient, credible, and legitimate and, therefore, to differ in whether and how they respond to the assessment. As the more detailed results below attest, an assessment's failure to influence particular audiences most often reflects a failure to address salience, credibility, and legitimacy in ways that are convincing to those on the other side of the North-South divide, the scientist-policymaker divide, or the global-local divide.

Salience The notion that an assessment must be salient—that is, relevant—to potential users in order to be influential with them seems obvious. Yet many assessments lack influence with potential users because they fail to produce information with an eye toward "what decisions might be affected by the information" (Patt, chapter 9, this volume). Information must be responsive to local conditions and concerns, must link to issues on which decision makers focus and over which they have control, and must be timely, coming before—but not too long before—relevant decisions get made.

Even audiences who we would expect to find a particular assessment salient may ignore or reject it if it fails to define a problem or discuss its impacts in ways that resonate with that audience or fails to identify actions that that audience can take to mitigate or adapt to the problem. Sea-level rise has important implications in Hawai'i and Maine, yet assessments of sea-level rise related to climate change have generally been ignored because they failed to identify erosion or flood information in ways that coastal zone managers could incorporate in their regular management decisions (Moser, chapter 8, this volume). Small-scale farmers in Zimbabwe have often been unresponsive to drought predictions, not because droughts are not salient, but because these farmers are risk averse and tend to plant drought-tolerant crops. Forecasts would be

more influential if they predicted abnormally wet years in which farmers would face minimal risk from planting crops that provide higher-than-average yields in wet years but do poorly in dry years (Patt, chapter 9, this volume). Options for minimizing acid rain reduction costs in Bulgaria were ignored because those conducting the assessment misunderstood the decisions faced by, and circumstances of, electricity producers (Andonova, chapter 6, this volume).

Ensuring an assessment's salience proves particularly challenging when an assessment seeks to influence multiple audiences. Many of our cases lacked salience with "additional" audiences that were not initially demanding, involved in, or an intended audience of the assessment. International assessments often are initiated by "leader" states concerned about an issue (Sprinz and Vaahtoranta 1994; DeSombre 2000). Not surprisingly, such assessments tend to define and frame the problem, undertake science, and propose solutions in ways that are salient for people in those states but are inattentive to the concerns of states that subsequently become involved. Scandinavians saw acid rain as a "chemical war" against the Scandinavians, and states like Germany became more invested in assessments only after they recognized acid rain's impacts on their own forests (VanDeveer, chapter 5, this volume). People in India (and presumably other developing countries) failed to be persuaded by the Global Biodiversity Assessment (GBA) because it framed the problem as one of flora-and-fauna protection, overlooking developing countries' concerns with equity and development and the dramatic ways in which preservation policies influence the lives and livelihoods of "people living in the centers of biodiversity" (Biermann, chapter 4, this volume). Negotiations over what information to exchange regarding genetically modified organisms demonstrate how much what is salient varies across audiences: GMO-exporting countries were concerned about trade restrictions on GMOs, European states wanted to control imports to address domestic political concerns, and developing countries sought to prevent the spread of novel hazards (Gupta, chapter 3, this volume).

Salience depends on "framing"—that is, in defining an environmental problem, its impacts, and its potential solutions in ways that highlight certain aspects and downplay others. This is clearly evident in the

biosafety negotiations, where conflicts over problem framing were center stage. As Gupta shows, how the problem is framed in this global arena is key to the perceived salience of the biosafety assessments to be shared via this global regime (Gupta, chapter 3, this volume). Efforts to mobilize international action on POPs because of problems of long-range transport and bioaccumulation resonated in developed countries; developing countries became more engaged only after regional assessments helped identify the local health impacts of POPs (Selin, chapter 7, this volume). Efforts to help Zimbabwean farmers understand drought forecasts, to produce regional assessments of POPs salient to developing countries, or to identify a wide range of impacts in a climate assessment all reflect assessors finding aspects of an environmental problem that make it salient to new audiences.

Salience also depends on decision matching: ensuring that the scale and timing of information meets the needs of decision makers. Potential users are apt to ignore assessments that get the scale of informational resolution wrong. Global-scale data, knowledge, and models relevant to international and national decisions are often simply not useful to the day-to-day decisions of farmers, aquifer users, or coastal zone managers. Assessments gain influence with lower-scale decision makers by "localizing" their knowledge, reframing findings in terms that are more relevant to national and/or local decision makers (Jasanoff and Martello 2004). National food planners need long-term, national rainfall forecasts to plan crop purchases far enough in advance to avert famine; farmers need local-scale, shorter-term forecasts regarding where, how much, and when rain will fall (Patt, chapter 9, this volume). Decision matching also requires information that is responsive to "decision calendars" (Pulwarty and Melis 2001; Pulwarty and Redmond 1997). Initial workshops conducted by agricultural extension services in Zimbabwe had little impact because they occurred only after farmers had purchased their seed and finished their early plantings (Patt, chapter 9, this volume).

Salience can be fostered through different mechanisms. Ongoing, explicit, and self-conscious processes that encourage participation by, and are responsive to, decision makers are particularly important to fostering salience (Farrell and Jäger 2005). Acid rain assessments by IIASA

are "explicitly linked to state-controlled policymaking authority" and are often responses to specific requests from LRTAP policymaking bodies (VanDeveer, chapter 5, this volume). Water networks in Nebraska involve farmers and other local-level actors in setting research agendas so that research findings address the questions and concerns of water users (Cash, chapter 10, this volume). Salience can also be fostered by explicit efforts to bring in local knowledge and concerns, as illustrated by the greater influence of regional and subregional assessments of POPs (Selin, chapter 7, this volume). Salience can also be promoted by information brokers who self-consciously recognize and redress the disconnect between large-scale assessments and local-level decisions, as evident in the Zimbabwean Commercial Farmers' Union translating national drought forecasts into place-based information on what crops to plant and why (Patt, chapter 9, this volume).

Finally, salience often depends on factors and conditions beyond the assessment's control. Assessments have an inherently more difficult task if they address environmental problems whose impacts are gradual, diffuse, off in the future, uncertain, or have unclear causes. Environmental assessments are less likely to be salient to developing countries and economies in transition (Biermann, chapter 4, this volume; Gupta, chapter 3, this volume; VanDeveer, chapter 5, this volume). Assessments can fall victim to bad timing, arriving "too early" or "too late." The Villach climate change assessment had little new scientific content but was looked to by more policy advocates and policymakers than earlier assessments because of the "window of opportunity" opened by recent governance successes on ozone-depleting substances (Torrance, chapter 2, this volume). Likewise, LRTAP assessments regarding acid rain controls became salient to Central and Eastern European states only after EU accession became a possibility.

Credibility Assessment influence also depends on credibility—that is, on convincing actors that the facts, theories, ideas, models, causal beliefs, and options contained in an assessment are "true," or at least a better guide to how the world works than competing information. Assessors usually expend considerable effort to make GEAs credible—at least with other scientists "like" those performing the assessment (Jäger et al.

2001). But, as noted above, assessments address multiple audiences and those audiences often evaluate credibility using quite different criteria than do the community of scientists from which assessment participants are drawn.

Before incorporating an assessment's findings and claims into their decisions, potential users seek assurance that the assessment reflects an unbiased effort to determine how the world is, rather than how self-interested actors would like the world to be. Technical credibility might seem the easiest of our three attributions to achieve. But assessments are usually undertaken in arenas of uncertainty in which most audiences cannot independently judge the information and claims being made (Haas 1992). Some countries have the capacity to evaluate international assessments independently before accepting their results. Thus, the administration of President George W. Bush requested that the U.S. National Academy of Sciences review the results of the Intergovernmental Panel on Climate Change's (IPCC) Third Assessment. More often, however, policymakers and other audiences cannot evaluate message content and must assess credibility through the proxies of credentials and process (Slater and Rouner 1996; Osgood and Tannenbaum 1955). Audiences differ in their views of what constitute "credible" credentials but tend to trust sources that have provided accurate information in the past and that have expertise (i.e., the training to identify accurate information) and are trustworthy (i.e., will report that information honestly) (Hurwitz, Miron, and Johnson 1992).

Our cases illustrate the need for "local credibility" that comes from ensuring that higher-scale findings fit the local context (Jasanoff and Martello 2004). Audiences frequently dismiss scientists and scientific groups with the best scientific credentials because those individuals or groups lack local expertise, in the sense of understanding local concerns and decisions and being able to integrate local knowledge and data into larger-scale analyses. Many of our case authors independently identified the importance of tapping into existing networks of expertise. Assessments of sea-level rise and of aquifer depletion had more influence when they tapped into "well-established, well-functioning networks . . . among information providers and users" (Moser, chapter 8, this volume; Cash, chapter 10, this volume). Commercial farmers in Zimbabwe found

El Niño–Southern Oscillation (ENSO) forecasts more credible because they were both interpreted by and vouched for through trusted, local scientists working with the CFU (Patt, chapter 9, this volume). Polish policymakers accepted findings regarding sulfur reduction options (even those conducted by Americans) more readily than did Bulgarian policymakers because those assessments involved and cited respected Polish scientists in "domestic expertise establishments" who already had credibility with those policymakers (Andonova, chapter 6, this volume).

For local audiences to view an assessment as credible, it also must take into account, and be seen as taking into account, local conditions. Developing countries often assume that "data from the North are easily misleading if merely extrapolated to the South" (Biermann, chapter 4, this volume), as evident in tropical countries questioning findings in POPs assessments that derived exclusively from research in temperate and Arctic climes (Selin, chapter 7, this volume). Even involving partisan stakeholders in assessment processes can increase credibility if those stakeholders bring with them otherwise-unavailable data. Central and Eastern European scientists and policymakers gave little credence to early acid rain assessments because they estimated emissions rather than requesting data (VanDeveer, chapter 5, this volume). They saw later assessments as more credible because they involved Eastern European industry representatives who brought better data to the table (Andonova, chapter 6, this volume).

The availability of alternative sources of information also affects the credibility that various audiences give to an assessment. The nongovernmental Villach assessments lost credibility rapidly once governments established the intergovernmental IPCC—even though many of the same scientists contributed to both assessments (Torrance, chapter 2, this volume). LRTAP's influence on acid precipitants in Eastern Europe (VanDeveer, chapter 5, this volume) and on POPs in global negotiations (Selin, chapter 7, this volume) appears to have depended considerably on the absence of other sources of information on these problems. One unintended influence of assessments that appears not uncommon is to prompt audiences with which a given assessment has little credibility to fill the informational gap with a "counterassessment" (Franz 1998)—a

1990 U.S. Environmental Protection Agency (EPA) study that attributed one-third of global methane emissions to India prompted an Indian assessment that showed these estimates to be off by a factor of ten (Biermann, chapter 4, this volume). What was an initially reactive assessment has promoted a more general increase in "communication and cooperation among Indian scientists on climate-related issues" (Biermann, chapter 4, this volume).

Lastly, our cases confirm the importance of assessment processes, with credibility having to be developed over time. IIASA's assessments and models gained credibility slowly and steadily over time by doing careful science that involves relevant stakeholders who contribute local data and insights while gaining better understandings of "the science" (VanDeveer, chapter 5, this volume). Although not examined in this volume, the four IPCC assessments have gained credibility with increasing numbers of audiences as the IPCC process has become more inclusive and transparent and as their findings have gained support from other independent studies. As Patt (chapter 9, this volume) notes, communicators that build a track record of honesty can gain credibility as audiences develop the habit of listening to and relying on the information they provide, but such track records are difficult to build. Assessment credibility is fostered by ensuring that potential users understand underlying data, methods, and models sufficiently well to replace "credibility by proxy" with "credibility through understanding" (Moser, chapter 8, this volume). This type of understanding often entails building local capacity, a point developed below.

Legitimacy An unexpected finding of our study has been the importance of legitimacy to assessment influence. Legitimacy involves the perception by relevant audiences of an assessment process as "fair," having considered the values, concerns, and perspectives of that audience. Environmental problems often embody highly complex biophysical and human-environment interactions, and assessments cannot analyze the large variety of causes, impacts, and policy options relevant to their resolution. The choices that must be made regarding what to analyze and what to omit—and the implications of those choices—are inherently, if

not always explicitly, political. Not surprisingly, then, audiences evaluate an assessment's legitimacy before accepting its claims.

Central to legitimacy is the notion that if assessments are conducted in support of policy, then those affected by those policies should be involved in the assessment process. Relevant stakeholders that are not included view such assessments as illegitimate, since such assessments tend to ignore or misidentify core concerns and tend to define problems, their causes, and responsibility for their resolution in ways that such audiences are unwilling to accept. Climate change assessments that imputed lower values to human life in developing than developed countries; that equated emissions from automobiles, airplane travel, and air-conditioners with emissions from food production; and that saw developing countries as equally responsible for climate change were, not surprisingly, viewed as illegitimate by those in developing countries (Biermann, chapter 4, this volume). Precisely because assessments identify and categorize the causes of problems and options for resolution, they also, if often implicitly, allocate blame and responsibility in a way that raises political issues of legitimacy.

Audiences judge legitimacy based on who participated and who did not, the processes for making choices, and how information was produced, vetted, and disseminated. Potential users often reject assessments that lack legitimacy as "not invented here." As noted with respect to salience and credibility, "localizing" knowledge is important (Jasanoff and Martello 2004). Unlike their Polish counterparts, Bulgarians rejected assessments of sulfur-reduction alternatives that were credible but lacked legitimacy because consultants and international institutions conducted them (Andonova, chapter 6, this volume). Proponents of global POPs regulations used LRTAP values and criteria but were extremely careful not to reference their LRTAP origins, so as to avoid resistance from countries that would have questioned the legitimacy of findings from assessments that had not included their representatives, concerns, or perspectives (Selin, chapter 7, this volume). As with salience, audiences frequently question the legitimacy of assessments originally undertaken by leaders to address their own concerns. Precisely because those actors not initially concerned about a problem are unlikely to want to be

involved in early assessments, their concerns and perspectives on the problem are unlikely to be reflected in those assessments, and they will, therefore, tend to question the legitimacy of those assessments. Including representatives of different audiences promotes legitimacy by ensuring that the assessment incorporates those audience's views, goals, interests, and concerns and that those audiences perceive it as having done so.

An assessment's legitimacy can also founder because of deep, preexisting distrust between assessment producers and potential users. The historical context of North-South relations leads many developing countries to be skeptical that GEAs reflect their interests and perspectives, whether they relate to climate change, GMOs, or POPs (Biermann, chapter 4, this volume; Gupta, chapter 3, this volume; Selin, chapter 7, this volume). Hawaiian policymakers have a "basic distrust" of federal assessments of sea-level rise due to the "political history of Hawai'i . . . [and] the magnitude of the military's presence and influence in local politics" (Moser, chapter 8, this volume). Similar dynamics—related to the Cold War rather than colonialism and development—affect the legitimacy that Eastern European audiences give to many GEAs (Andonova, chapter 6, this volume; VanDeveer, chapter 5, this volume).

For an assessment to overcome such distrust and mistrust requires considerable time, attention, and effort. Building trust requires extended interactions with assessment producers that reassure potential users that the assessment process is not simply the "continuation of policy by other means" (Clausewitz 1982, 119). Particularly in highly contested arenas, as in North-South negotiations over biosafety, climate change, or biodiversity, legitimacy is simultaneously crucial yet hard to achieve. The biosafety negotiations on GMOs were dominated not by questions of credibility but by normative conflicts over whether the information to be exchanged would reflect the socioeconomic and human health risks that concerned developing countries (Gupta, chapter 3, this volume). Governments established the IPCC as an alternative to the Advisory Group on Greenhouse Gases (AGGG), presumably because they felt an intergovernmental assessment process would reflect their views and concerns more accurately than a nongovernmental one (Torrance, chapter 2, this volume).

The Trade-Offs among Attributions Our two final findings about salience, credibility, and legitimacy were that tactics adopted to promote one attribution often undermine another but that opportunities to promote different attributions simultaneously do exist. Assessments, particularly those organized by scientists, often try to maximize credibility by involving only the most respected scientists and attempting to isolate the process from political influence. Such an approach, predictably, will have little influence since it will have ignored the questions most salient to policymakers and stakeholders. The reverse can occur when efforts to answer salient questions require that the scientific community provide tentative or premature results, thereby bringing the assessment's credibility into question. Efforts by the initial Climatic Impact Assessment Program (CIAP) to estimate the global costs and benefits of protecting the ozone layer lacked influence because they promised more than they could deliver (U.S. Department of Transportation 1975; Social Learning Group 2001a, 292; Glantz, Robinson, and Krenz 1982; Clark and Dickson 2001). Similarly, some assessments seek to foster legitimacy by including stakeholders or scientists who are brought in because they can represent the views and concerns of audiences that assessors hope to influence; in so doing, however, they may decrease the scientific credibility of the assessment, at least with other scientists and potentially with other decision makers.

Efforts to design assessments to promote their influence do not always involve such trade-offs in fostering attributions of salience, credibility, and legitimacy with different audiences. Efforts to "downscale" global climate models to support local decision makers have sometimes proved successful, as evident in the case of Zimbabwean farmers presented by Patt (chapter 9, this volume) and in Indonesia rice production (Naylor et al. 2001). As evidence from the acid rain (Andonova, chapter 6, this volume) and POPs cases (Selin, chapter 7, this volume) illustrates, increasing participation that is intended to increase salience and legitimacy can also increase credibility by providing access to local knowledge and to anecdotal and systematic data that would otherwise be unavailable. If stakeholders are involved, scientists can ensure that their models of environmental problems and human-environment interactions better represent local conditions. Equally important, participation helps

stakeholders better understand the foundations of assessment findings, thereby increasing the extent to which they find them to be credible.

Assessments as a Process of Coproduction of Knowledge through Participation

The research presented in the foregoing chapters strongly supports our initial finding (see chapter 1) that has suggested an assessment's influence flows from the process by which it creates knowledge rather than from the reports it may produce. The content and form of assessment reports are poor predictors of their influence. What matters is how the assessment process was conducted, from initial efforts to define the problem and the questions to ask to ongoing efforts to help users understand and incorporate new information into their decisions. The effectiveness of assessment processes depends on a process of coproduction of knowledge between assessment producers and potential assessment user groups in which the boundaries among these groups are bridged so that they can develop reciprocal understandings of what salient, credible, and legitimate mean to the others involved (Jasanoff and Martello 2004; Jasanoff and Wynne 1998).

A traditional model of assessment sees scientists as generating the "best" possible science and communicating it to decision makers. Assessments lack influence because scientists do not communicate their findings clearly or policymakers do not pay attention to the science that is done. Our study suggests that a more accurate model recognizes that assessments have influence to the extent that they involve long-term dialogues and interactions in which potential users of an assessment educate scientists about their concerns, values, priorities, resources, and knowledge of the problem while scientists educate potential users about the nature, causes, consequences, and alternatives for resolution of the problem at hand as well as the ways such knowledge is arrived at. Coproduction implies that assessments are influential to the extent that they are bidirectional, with science shaping politics but also politics shaping science.

Decision makers tend to listen to the findings of assessments in which they were involved and that they therefore find salient, credible, and legitimate. Stakeholder participation creates a sense of informational

"ownership" (Patt, chapter 9, this volume). At a deeper level, who participates in the coproduction of an assessment shapes what knowledge gets produced. As scientists better understand decision makers' concerns, they can conduct and communicate research in ways that fit into the day-to-day decisions of policymakers, coastal zone managers, power plant operators, or farmers. As laypeople better understand scientific procedures (such as confidence intervals and peer review), their mistrust of science declines and their capacity to comprehend findings deepens. Scientists gain access to local knowledge that ensures that models and analyses reflect local conditions. By involving stakeholders with competing interests and reassuring nonparticipants that competing views were listened to, participatory assessments can reduce the chances that those divergent interests simply ignore assessment findings (Andonova, chapter 6, this volume; Gupta, chapter 3, this volume).

Influential assessments are those that eschew one-way communication from scientists to decision makers in favor of coproduction of knowledge—that is, when producers and potential users of an assessment have long-term interactions that foster communication and mutual understanding (Cash, chapter 10, this volume). Scientists can simply conduct research on topics they view as important and present the results to policymakers, but such exercises are unlikely to be persuasive. Stakeholder participation fosters salience, since decision-maker participation is crucial to matching the information assessments produced to the decisions being faced (Patt, chapter 9, this volume). Stakeholder participation fosters credibility, since assessments often must involve those responsible for a problem because they have data and evidence needed to understand it and because their involvement fosters their understanding, and reduces their distrust, of the knowledge the assessment produces. Stakeholder participation fosters legitimacy, since ongoing interactions among scientists and potential users reassure the latter that their perspectives and concerns are fully understood and accounted for in the models and analyses that scientists undertake.

Ongoing and iterative relationships between those "doing the science" and those "using the science" provide a way to incorporate stakeholder views into an assessment and to demonstrate that scientists have been to stakeholders who did not participate (thereby fostering legitimacy).

These relationships also help scientists understand users' needs and decisions so they can frame and answer questions in ways that are relevant to potential users (thereby fostering salience). Further, a collaborative approach helps users gain an understanding of assessment methods and models sufficiently to believe in them and helps scientists gain access to users' knowledge of local conditions (thereby fostering credibility). Participation explains much of the variation in the influence of our assessments. Initial biodiversity and climate assessments had few immediate, visible, or intended affects on policymaking in India in no small part because they failed to involve Southern participants. IPCC assessments have slowly gained influence in India as initially token participation by developing-country scientists has become more substantive and substantial (Biermann, chapter 4, this volume). Involving Polish academics and electricity companies in cost-assessment processes garnered Western-initiated assessments far more influence than similar assessments in Bulgaria that lacked such stakeholder involvement (Andonova, chapter 6, this volume). In relation to American aquifer depletion, state and federal scientists became "legitimate sources of information" when they worked with local scientists and local farmers in "on-farm demonstration trials" and other joint efforts that fostered scientists' understanding of farmer concerns and constraints and farmers' understanding of scientific conclusions and recommendations (Cash, chapter 10, this volume).

When successful, relationships and networks can bridge across scale as in the polyarchic networks in the American Midwest (Cash, chapter 10, this volume) and the CFU's communication of drought forecasts to commercial farmers (Patt, chapter 9, this volume), across regions as in the LRTAP POPs and acid rain cases (Selin, chapter 7, this volume; Andonova, chapter 6, this volume; VanDeveer, chapter 5, this volume), or between scientists and policymakers as in the climate case (Torrance, chapter 2, this volume). When such relationships are absent or do not function well, they can inhibit assessment influence as evident in global biosafety negotiations (Gupta, chapter 3, this volume), Indian responses to climate change and biodiversity assessments (Biermann, chapter 4, this volume), and Hawaiian responses to sea-level rise assessments (Moser, chapter 8, this volume).

Understanding assessments as processes also highlights that the assessment process does not end once scientists have reached some set of conclusions. It may take considerable effort to help decision makers and stakeholders understand and accept the validity and relevance of scientific findings to their decisions. Commercial and smallholder farmers in Zimbabwe needed help in converting weather forecasts into planting guidance (Patt, chapter 9, this volume). Global acceptance of LRTAP POPs assessments depended on conducting subsequent regional assessments that developed further knowledge and fostered acceptance of that knowledge (Selin, chapter 7, this volume). Educating potential users is rarely effective when viewed as "dissemination" to be undertaken once an assessment is complete but works best when viewed as integral to the assessment process.

Of course, participation is not a panacea. As noted above, trade-offs exist among salience, credibility, and legitimacy. Indeed, many scientists believe that assessment processes should be kept relatively, or even completely, free of nonscientist policymakers, stakeholders, and interested parties. For these scientists, promoting legitimacy and salience eviscerates credibility. And, certainly, participation by self-interested actors can lead audiences to question the expertise and trustworthiness on which credibility with those audiences depend.

This study, however, confirms the view of the "social studies of science" literature that science rarely achieves the impartial detachment from politics that many consider crucial to the influence of scientific information (Jasanoff and Wynne 1998). But our research goes further and demonstrates that efforts to achieve such objectivity and neutrality often inhibits informational influence. Stakeholder involvement is not antithetical to credibility and it is almost essential for stakeholders to incorporate information from assessments into their decisions. Effective participation requires involving stakeholders in ways that shape what questions get asked and how the answers to those questions are framed, delivered, and understood without allowing that involvement to dictate the answers produced. As the unwillingness of various audiences to accept initial IPCC reports, LRTAP POPs assessments, proposals regarding GMO information exchanges, or federal assessments of sea-level rise illustrates, focusing on credibility alone all but ensures that the

assessment will have less influence than it might. Equally important, our cases show how assessors have involved stakeholders and relevant decision makers in ways and at points that have increased salience and legitimacy while either not undermining or actually increasing credibility (on these issues of assessment design, see Farrell and Jäger 2005; Farrell, VanDeveer, and Jäger 2001).

Capacity Building

A final finding in many of our cases was the value of building the capacity of various actors to be involved in producing assessments and to understand the findings of assessments. Because scientific infrastructures and expertise tend to be concentrated in developed countries, developing-country scientists have often participated only in token ways, if at all. Assessment processes have gained influence with wider audiences, however, by establishing a long-term goal and process to enhance the capacity of a range of scientists to participate substantively in assessments, thereby mitigating trade-offs among credibility, salience, and legitimacy. Building capacity among assessment producers and assessment users expands the group of people who see and know the world in similar ways and fosters the coproduction just mentioned by developing common ways to interpret information about the environment, politics, economics, and the other factors involved in resolving environmental problems (for recent reviews of capacity building, see Sagar and VanDeveer 2005; VanDeveer and Sagar 2005).

Investments in building scientific capacity expand the range of scientists involved in scientific research on a given environmental problem, increasing the legitimacy of assessments among stakeholder groups that view themselves as represented by those scientists but also increasing the credibility of assessments by bringing in knowledge, data, and perspectives that would not otherwise be available. As Andonova notes, an important way that assessments gain influence comes from involving participants and thereby helping "strengthen domestic capacity and the institutional linkages between experts and policy establishments" (Andonova, chapter 6, this volume). The IPCC made such efforts and, after fifteen years, that investment is evident in developing-country

scientists having considerably more influence on IPCC analyses, and in those analyses having increasing influence in developing countries (Biermann, chapter 4, this volume). For decades, IIASA ran workshops and training sessions for Central and Eastern European scientists and policymakers and ensured that computer models could run on less capable computers (VanDeveer, chapter 5, this volume). Beyond allowing researchers to contribute meaningfully to IIASA research, these efforts produced a network of IIASA and RAINS alumni that helps IIASA assessments gain acceptance because members of that network can understand and vouch for their credibility and legitimacy and because those members have credibility and legitimacy with their own policymakers (VanDeveer, chapter 5, this volume; Andonova, chapter 6, this volume).

As the IIASA case illustrates, capacity building among potential users is as important as among assessment producers. The ability to understand and interpret scientific information may be lacking in countries that are most likely to be affected by particular problems. In the biosafety negotiations, significant and ongoing capacity building will be needed to help GMO-importing countries access, process, and understand the information on the risks of such imports that will be provided through the clearinghouse mechanism (Gupta, chapter 3, this volume). Poland had "a great deal of scientific expertise but little experience in environmental management or in the open use of information as a basis of decision making," and involving government and corporate stakeholders in acid rain cost assessments helped "facilitate the adoption of European acid rain standards in Eastern Europe" (Andonova, chapter 6, this volume). Both commercial and smallholder farmers in Zimbabwe required training, whether by the CFU or Agritex, in how to understand drought forecasts as well as the implications of those forecasts for their planting decisions (Patt, chapter 9, this volume). In Maine, geologists expended considerable effort to help local decision makers understand coastal processes, slowly building a management and policymaking network that is knowledgeable about, and in the future may become willing to address, sea-level rise directly (Moser, chapter 8, this volume). By directly involving stakeholders in assessment processes—whether it involves farmers conducting experiments on their farms or

policymakers and industry representatives helping scientists develop scenarios for acid precipitation models—stakeholders build the capacity to understand and trust the results of those assessments.

Areas for Future Research

Our research has uncovered several additional insights that were evident in only one or a few of our cases but that deserve further study by those interested in the influence of GEAs.

First, the characteristics of the institution that sponsors or undertakes an assessment affect how much influence that assessment will have. Undertaking initial assessments on acid precipitation through the Organization for Economic Cooperation and Development (OECD) helped increase attention to those issues among Western European states but inhibited those assessments' influence among Central and Eastern European states that were not OECD members (VanDeveer, chapter 5, this volume). Much of the variation in the use made of information about aquifer depletion and water use in the American Midwest can be explained by looking at which institutions conducted those assessments, particularly their preexisting linkages with water managers and farmers (Cash, chapter 10, this volume). Climate change assessments conducted by the intergovernmental IPCC have been much more influential among the world's governments than nongovernmental efforts, even when many of the same scientists have been involved (Torrance, chapter 2, this volume).

Second, attributions of salience, credibility, and legitimacy have particular difficulty traveling across scales. Assessments that various national- or international-level audiences view as salient, credible, and legitimate are often viewed differently by local-level audiences. In assessments, "one size does not fit all" and disconnects often emerge between the aggregate, large-scale, low-resolution data needed by those trying to understand the environmental problem and the disaggregated, small-scale, high-resolution analyses needed by those making decisions among the options available to them. Various scenarios of average global temperature that motivate international climate negotiators frustrate those

national policymakers concerned about the impacts on their country under each scenario. Careful management can, however, help convince audiences at one scale to accept assessments that were conducted to support decisions at another scale. Ideas from European assessments had influence in global POPs negotiations only because promoters of those negotiations recognized the need to keep the European provenance of the assessments in the background (Selin, chapter 7, this volume). In Zimbabwe, regional rain forecasts were used by farmers only because the CFU translated these forecasts into knowledge that matched their day-to-day decisions (Patt, chapter 9, this volume).

Third, an assessment's influence depends on the informational environment into which it enters, particularly the degree of informational competition. One source of the influence of IIASA's assessment and modeling of acid precipitation in Europe or the POPs assessments internationally is the absence of alternative sources of information on these issues (Andonova, chapter 6, this volume; VanDeveer, chapter 5, this volume; Selin, chapter 7, this volume). The nongovernmental Villach assessment's influence declined precipitously once the IPCC was established (Torrance, chapter 2, this volume). Nor is the informational environment static: as noted, assessments can generate their own competition by prompting counterassessments such as the responses of Indian scientists to American assessments of methane emissions (Biermann, chapter 4, this volume) and of climate skeptics to IPCC reports (Franz 1998).

Finally, and fortunately, our cases demonstrate that assessors can improve assessments over time. The IPCC has gained increasing acceptance by more audiences by ensuring that developing-country scientists are increasingly, if still under-, represented in the IPCC process (Biermann, chapter 4, this volume). The Millennium Ecosystem Assessment has learned from the failures of the Global Biodiversity Assessment and invited a more geographically diverse set of scientists and located their headquarters in Malaysia (Biermann, chapter 4, this volume). The Zimbabwean agriculture extension service (Agritex), recognizing prior mistakes, has increased public participation and stakeholder education and has redesigned drought forecasts to make them more timely and

more useful to farmers (Patt, chapter 9, this volume). The influence of LRTAP assessments on acidification and POPs reflects years of using past experience to refine assessment processes (VanDeveer, chapter 5, this volume; Andonova, chapter 6, this volume).

The foregoing chapters present many other insights into when and how assessments gain influence with different audiences as well as into the many obstacles to such influence. We hope that those undertaking further research on GEAs will use the wealth of ideas identified in those chapters to shape that research.

Considerations for Practitioners

Our findings suggest several lessons for those actually involved in designing and carrying out global environmental assessments. Although many more, and more refined, lessons are delineated in the associated volume by Farrell and Jäger (2005), we delineate those most closely related to our findings here.

Focus on the Process, Not the Report

Our most important lesson for practitioners is that the conduct of an assessment determines its influence more than its conclusions do. Decision makers are more likely to incorporate the knowledge of assessments if that knowledge comes through iterative, two-way communication with assessment producers rather than from reading a report. Equally important, assessments prove more effective when assessment producers also see them as involving mutual education and coproduction of knowledge rather than as scientists aggregating and disseminating information to policymakers and decision makers.

Focus on Salience and Legitimacy as Well as Credibility

Assessors too often focus exclusively on ensuring an assessment's scientific credibility. Credibility is important but assessment influence also depends on audiences viewing the assessment process and products as salient and legitimate. Accurate information that is irrelevant to decision makers' needs or that disregards their concerns, perspectives, and values is as likely to be dismissed as inaccurate information is. Fostering assess-

ment influence requires promoting attributions of salience, credibility, and legitimacy through assessment processes that mitigate the frequent trade-offs among these attributions while taking advantage of potential synergies among them.

Assess with Multiple Audiences in Mind

Assessment influence declines the greater the "distance" of assessment producers from potential users. For GEAs to contribute to the resolution of the problems they address, they must influence numerous, diverse audiences. Each audience will evaluate the salience, credibility, and legitimacy of an assessment on terms that reflect that audience's unique set of interests, perceptions, knowledge, and beliefs. People in different countries, at different scales, or with different training or values will not all accept an assessment's findings unless assessors make conscious efforts to make the assessment salient, credible, and legitimate to all of those audiences.

Involve Stakeholders and Connect with Existing Networks

It is tempting to identify rules of thumb by which assessments can promote salience, credibility, and legitimacy with multiple audiences. Yet our study shows that the most effective path to influence involves promoting substantive and substantial participation by potential users. Participation fosters salience by ensuring that the problem definition, the research agenda, the menu of options, and the criteria for choosing among options match the concerns and decision needs of potential users. Participation fosters credibility by ensuring that no single stakeholder dominates the assessment process, by maximizing access to relevant data, and by helping potential users understand and trust the methods by which assessment conclusions are derived. Participation fosters legitimacy by ensuring that the interests and values of affected actors are taken into account and addressed in the assessment. Engaging existing networks of scientists, decision makers, and policymakers allows assessments to bring the expertise, knowledge, and data of these actors into the assessment while taking advantage of the preexisting salience, credibility, and legitimacy that actors in these networks have with important audiences.

Develop Influence over Time

Assessments rarely gain significant influence with multiple audiences overnight. Understandably, most audiences will not change their policies and practices immediately in response to new information. Influence often takes time to develop, varies over time, and may take time to reveal itself. The influence that IIASA assessments have had on acid rain and POPs regulation owes much to sustained and conscious efforts to engage stakeholders (Andonova, chapter 6, this volume; VanDeveer, chapter 5, this volume; Selin, chapter 7, this volume). IIASA, the IPCC, and other assessment processes become salient, credible, and legitimate with various audiences not only by getting particular assessments "right" but through an extended effort to build a reputation for producing assessments that audiences believe they should take into account in their decisions. Investments in building capacity, both of scientists and stakeholders to participate and of potential users to understand assessment findings, take time to pay dividends (Biermann, chapter 4, this volume; Patt, chapter 9, this volume; Andonova, chapter 6, this volume). Finally, assessments also may benefit from independent changes in how interested governments and decision makers are in an environmental problem—the influence of the Villach climate assessment and the LRTAP acidification assessments increased due to the success of ozone negotiations and the possibility of EU accession, respectively (Torrance, chapter 2, this volume; VanDeveer, chapter 5, this volume). It takes time to build a reputation for understanding the decisions and constraints that stakeholders face; for providing unbiased, reliable, and understandable information; and for taking account of the values, interests, and views of stakeholders—and through that reputation to gain influence.

Conclusion

Global environmental assessments can and do change how many people consider human impacts on the environment to be a problem, how and how well they understood those problems, and whether and what action is warranted to address it. However, achieving these impacts poses challenging tasks that require overcoming numerous obstacles. This book has

demonstrated that an assessment's influence depends far more on its conduct than its content and that significant influence requires using assessment processes to convince not one but multiple audiences of the salience, credibility, and legitimacy of the information in an assessment. Those producing GEAs are usually separated from potential users by numerous boundaries to effective communication, including those dividing science from policy, those isolating certain nations and groups of nations from others, and those conducting science and those making decisions at different scales on the international-regional-national-local spectrums. Overcoming these boundaries to the uptake of scientific ideas requires avoiding the assumption that assessment influence depends only on scientific credibility. Those conducting assessments are most successful when they recognize assessments as social processes aimed at the coproduction of knowledge, foster the participation of a wide range of stakeholders, and build the capacity of scientists to participate in assessments and of potential users to understand and trust those assessments. We hope our research helps scholars and practitioners learn from the experiences of the assessments analyzed here so that future assessments can make greater contributions to the resolution of the myriad global environmental problems we face.

Acknowledgments

We would like to thank Frank Alcock and Lisa Martin for major efforts in developing this chapter. We would also like to thank Frank Biermann, Susanne Moser, Noelle Eckley Selin, and Stacy VanDeveer for helpful comments on earlier drafts of the chapter.

References

Baumgartner, F. R., and B. D. Jones. 1993. *Agendas and Instability in American Politics*. Chicago: University of Chicago Press.

Benedick, Richard Elliot. 1998. *Ozone Diplomacy: New Directions in Safeguarding the Planet*. Cambridge, MA: Harvard University Press.

Cash, David W., and William Clark. 2001. *From Science to Policy: Assessing the Assessment Process*. John F. Kennedy School of Government Faculty Research Working Papers Series RWP01-045. Cambridge, MA: Harvard University.

Clark, William C., and Nancy M. Dickson. 2001. Civic science: America's encounter with global environmental risks. In Social Learning Group, ed., *Learning to Manage Global Environmental Risks, Volume 1: A Comparative History of Social Responses to Climate Change, Ozone Depletion, and Acid Rain*, 259–294. Cambridge, MA: MIT Press.

Clausewitz, Carl von. 1982. *On War.* New York: Penguin Books.

DeSombre, Elizabeth R. 2000. *Domestic Sources of International Environmental Policy: Industry, Environmentalists, and U.S. Power.* Cambridge, MA: MIT Press.

Farrell, Alex, Stacy VanDeveer, and Jill Jäger. 2001. Environmental assessment: Four under-appreciated elements of design. *Global Environmental Change* 11: 311–333.

Farrell, Alexander E., and Jill Jäger, eds. 2005. *Assessments of Regional and Global Environmental Risks: Designing Processes for the Effective Use of Science in Decisionmaking.* Washington, DC: Resources for the Future.

Franz, Wendy. 1998. *Science, Skeptics, and Non-State Actors in the Greenhouse.* Discussion Paper E-98-18. Cambridge, MA: Belfer Center for Science and International Affairs, Harvard University.

Freudenburg, W. 1996. Risky thinking: Irrational fears about risk and society. *Annals of the American Academy of Political and Social Science* 545: 44–53.

Glantz, M. H., J. Robinson, and M. E. Krenz. 1982. Climate-related impact studies: A review of past experiences. In William C. Clark, ed., *Carbon Dioxide Review: 1982*, 55–92. New York: Oxford University Press.

Haas, Peter M., ed. 1992. *Knowledge, Power, and International Policy Coordination.* Columbia: University of South Carolina Press.

Harrison, Neil E., and Gary C. Bryner. 2004. *Science and Politics in the International Environment.* Lanham, MD: Rowman & Littlefield.

Herrick, C., and Dale Jamieson. 1995. The social construction of acid rain: Some implications for policy assessment. *Global Environmental Change* 5: 105–112.

Hurwitz, Steven D., Murray S. Miron, and Blair T. Johnson. 1992. Source credibility and the language of expert testimony. *Journal of Applied Social Psychology* 22(24): 1909–1939.

Jäger, Jill, with Jeannine Cavender-Bares, Nancy M. Dickson, Adam Fenech, Edward A. Parson, Vassily Sokolov, Ferenc L. Tóth, Claire Waterton, Jeroen van der Sluijs, and Josee van Eijndhoven. 2001. Risk assessment in the management of global environmental risks. In Social Learning Group, ed., *Learning to Manage Global Environmental Risks, Volume 2: A Functional Analysis of Social Responses to Climate Change, Ozone Depletion, and Acid Rain.* Cambridge, MA: MIT Press.

Jasanoff, Sheila. 1990. *The Fifth Branch: Science Advisers as Policy-Makers.* Cambridge, MA: Harvard University Press.

Jasanoff, Sheila. 2004. *States of Knowledge: The Co-production of Science and Social Order.* New York: Routledge.

Jasanoff, Sheila, and Marybeth Long Martello, eds. 2004. *Earthly Politics: Local and Global in Environmental Governance.* Cambridge, MA: MIT Press.

Jasanoff, Sheila, and Brian Wynne. 1998. Science and Decisionmaking. In S. Rayner and E. Malone, eds., *Human Choice and Climate Change: The Societal Framework*. Columbus, OH: Battelle Press.

Lemos, Maria Carmen, and B. J. Morehouse. 2005. The co-production of science and policy in integrated climate assessments. *Global Environmental Change* 15: 57–68.

Naylor, Rosamond L., Walter P. Falcon, Daniel Rochberg, and Nikolas Wada. 2001. Using El Niño/Southern Oscillation climate data to predict rice production in Indonesia. *Climate Change* 50: 255–265.

Osgood, C. E., and Percy H. Tannenbaum. 1955. The principle of congruity in the prediction of attitude change. *Psychological Review* 62: 42–55.

Parson, Edward A. 2003. *Protecting the Ozone Layer: Science and Strategy.* Oxford: Oxford University Press.

Pielke, Robert Jr. 1995. Usable information for policy: An appraisal of the U. S. Global Change Research Program. *Policy Sciences* 28: 39–77.

Pielke, Robert Jr., and R. T. Conant. 2003. Best practices in prediction for decision-making: Lessons from the atmospheric and earth sciences. *Ecology* 84: 1351–1358.

Pulwarty, Roger S., and Ted Melis. 2001. Climate extremes and adaptive management on the Colorado River: Lessons from the 1997–1998 ENSO event. *Journal of Environmental Management* 63: 307–324.

Pulwarty, Roger S., and Kelly Redmond. 1997. Climate and salmon restoration in the Columbia River basin: The role and usability of seasonal forecasts. *Bulletin of the American Meteorological Society* 78(3): 381–397.

Sabatier, Paul A. 1993. Policy change over a decade or more. In P. A. Sabatier and H. C. Jenkins-Smith, eds., *Policy Change and Learning: An Advocacy Coalition Approach*. Boulder, CO: Westview Press.

Sagar, Ambuj D., and Stacy D. VanDeveer. 2005. Capacity development for the environment: Broadening the focus. *Global Environmental Politics* 5(3): 14–22.

Slater, Michael D., and Donna Rouner. 1996. How message evaluation and source attributes may influence credibility assessment and belief change. *Journalism and Mass Communication Quarterly* 73(4): 974–991.

Slovic, P. 1993. Perceived risk, trust, and democracy. *Risk Analysis* 13(6): 675–682.

Social Learning Group, ed. 2001a. *Learning to Manage Global Environmental Risks, Volume 1: A Comparative History of Social Responses to Climate Change, Ozone Depletion, and Acid Rain.* Cambridge, MA: MIT Press.

Social Learning Group, ed. 2001b. *Learning to Manage Global Environmental Risks, Volume 2: A Functional Analysis of Social Responses to Climate Change, Ozone Depletion, and Acid Rain.* Cambridge, MA: MIT Press.

Sprinz, Detlef, and Tapani Vaahtoranta. 1994. The interest-based explanation of international environmental policy. *International Organization* 48(1): 77–105.

U.S. Department of Transportation, Climatic Impact Assessment Program. 1975. *Impacts of Climatic Change on the Biosphere, Final Report.* Washington, DC: U.S. Department of Transportation.

VanDeveer, Stacy, and Ambuj Sagar. 2005. Capacity building for the environment: North and south. In A. C. Kallhauge and G. Sjöstedt, eds., *Furthering Consensus: Meeting the Challenges of Sustainable Development Beyond 2002.* London: Greenleaf.

Walsh, Virginia M. 2004. *Global Institutions and Social Knowledge: Generating Research at the Scripps Institution and the Inter-American Tropical Tuna Commission 1900s–1990s.* Cambridge, MA: MIT Press.

Watson, Robert T. 1994. The stratospheric ozone debate: Global research that led to achieving scientific consensus. *Abstracts of Papers of the American Chemical Society* 208, part 1: 172.

Weiss, Carol H. 1975. Evaluation research in the political context. In E. S. Struening and M. Gutentag, eds., *Handbook of Evaluation Research*. London: Sage.

Wilkening, Kenneth E. 2004. *Acid Rain Science and Politics in Japan: A History of Knowledge and Action toward Sustainability.* Cambridge, MA: MIT Press.