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The theory of boundary organizations was developed to address an important group of institutions in American society neglected by scholarship in science studies and political science. The long-term stability of scientific and political institutions in the United States has enabled a new class of institutions to grow and thrive as mediators between the two. As originally developed, this structural feature of these new institutions—that is, their location on the boundary between science and politics—dominated theoretical frameworks for explaining their behavior. Applying the theory of boundary organizations to international society requires a refocusing of some of the theory's central features, however. In this article, I introduce a new framework—hybrid management—to explain the activities of boundary organizations in the more complex, contingent, and contested settings of global politics. I develop the framework of hybrid management using the specific example of the U.N. Framework Convention on Climate Change's Subsidiary Body for Scientific and Technological Advice.

This article stems from a long-standing interest in the articulation, negotiation, and construction of new expert advisory institutions in global governance. As people have sought to adapt the institutional framework of international politics to address the challenges of globalization, they have increasingly accorded science a central role in the making of global policy.[1] However, the mobilization of science to serve the global public good is neither simple nor straightforward. Incorporating expertise into the making of

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public policy raises the same kind of deep-seated, normative questions for international society that it has raised over the past century in domestic settings (Jasanoff 1996b; cf. Jasanoff 1990, Ezrahi 1990, and Porter 1995 for accounts of the political dimensions of expert institutions in domestic governance). What counts as legitimate knowledge? Who speaks for nature? How much power and authority should be accorded to science relative to other modes of knowing and deciding? Such questions may cut across geopolitical divides (e.g., Jasanoff 1993). More mundanely, they may get caught up in conflicts between distinct national approaches to the production, dissemination, and use of expert knowledge.[2] Regardless, finding institutional arrangements that can command credibility, legitimacy, and authority among the many, diverse publics, officials, and experts around the world with a stake in global decision making is an exceedingly complex and difficult task (Miller 2001).

A good example of the efforts of scientists, diplomats, and other policy makers to construct new institutional arrangements for mobilizing science in support of global policy making is the creation of the climate regime.[3] Participants in the climate regime have turned to science in a wide array of decisions such as apportioning blame for greenhouse gas emissions, assessing the need for regulatory intervention in the global economy, finding policy and technological solutions, and compensating victims of climatic changes already under way. Indeed, science has become such a significant component of the climate regime that countries have established a separate forum—the Subsidiary Body for Scientific and Technological Advice (SBSTA)—for the explicit purpose of establishing new expert advisory arrangements. Created in 1992 by the U.N. Framework Convention on Climate Change (UNFCCC), the SBSTA has emerged as

> the principal forum in which regime participants have articulated and negotiated among competing models of institutional design for providing expert advice about climate change. It has served, in other words, as a space where governments (and to a lesser extent [nongovernmental organizations]) can deliberate the ground rules by which scientific experts and knowledge claims receive accreditation within the institutions of the climate regime. Settlements arrived at in SBSTA have thus created an important part of the normative and institutional contexts that will mediate future interpretations of climate change and choices about human responses to it within the climate regime. (Miller 2001)

Understanding institutions like the SBSTA, which are not exactly scientific but which help interpret and manage the production of scientific knowledge

and its incorporation into policy making, will provide important insights into the emergence and consolidation of global governance over the next few decades. In this article, I analyze the SBSTA using the newly developed theory of boundary organizations, so named because they lie on the boundary between politics and science (Guston 1999, 2000). Originally developed in the context of U.S. politics, however, the theory focuses on features of these organizations and the broader institutional landscape that are not applicable to international relations. Neither science nor politics are as cleanly distinct from one another in international contexts as they are in the hyperdifferentiated atmosphere of U.S. political culture, leaving space for a broader array of institutional types inhabiting the institutional landscape between, say, the scientific laboratory and the U.N. General Assembly. Hence, the theory of boundary organizations needs to be expanded to examine what types of new organizations are emerging and how they differ from and relate to one another. Likewise, the original theory of boundary organizations is too static to cope with the rapid changes associated with contemporary processes of globalization. International boundary organizations do not exist between two well-defined, deeply embedded (and hence slowly changing) institutions like politics and science in the United States. Rather, international science and politics, as well as the institutions linking them, exhibit considerable fluctuations, requiring a theoretical approach that addresses issues of process and dynamics, rather than structure, as its central focus.

To reorient the theory of boundary organizations for international contexts, I develop the concept of *hybrid management*. Hybrids are social constructs that contain both scientific and political elements, often sufficiently intertwined to render separation a practical impossibility. They can include conceptual or material artifacts (e.g., the climate system or a nuclear power plant), techniques or practices (e.g., methods for attributing greenhouse gas emissions to particular countries), or organizations (e.g., the SBSTA or the Intergovernmental Panel on Climate Change). By examining in detail the management of these hybrids—that is, the processes by which they are constructed, taken apart, and ordered in relation to one another—I argue that analysts can develop an understanding of how boundary organizations function in international politics and thus contribute to a deeper appreciation of emerging patters of global governance. In the first half of this article, I describe in greater detail the concept of boundary organizations and the attendant modifications necessary to make it fit international contexts, developing as I go the concept of hybrid management. In the second half, I explore the processes of hybrid management in the climate regime and their relation to broader questions of global governance.

Rethinking Boundary Organizations

The goal of this special issue of *Science, Technology, & Human Values* is to illuminate an important aspect of the ways in which science and politics are brought into a dynamic, mutually constraining relationship in modern societies. Namely, the issue focuses on those organizations that lie, as David Guston (2000), the originator of the theory of boundary organizations, puts it, "between politics and science." As science has emerged over the course of the twentieth century as a powerful social institution, a considerable variety of organizations has arisen for the purposes of trying to maintain a productive tension between science and other forms of life in modern society. Surprisingly, these organizations have received little attention from scholars either in science studies—where research has focused on laboratories, disciplines, and what Harry Collins terms "core sets"—or in political science—where research has focused on what are considered mainstream political institutions, for example, legislatures, executives, and the courts. Yet, as several authors have begun to demonstrate, institutions that are neither laboratories nor conventional political organizations are increasingly prevalent features of the institutional landscape of modern society and play key roles in managing the interactions between science and politics, economics, and culture (see, e.g., Agrawala, Broad, and Guston 2001 [this issue]; Keating 2001 [this issue]; Cash 2001 [this issue]; Guston 1999, 2000, 2001 [this issue]; Jasanoff 1990).

To argue that these institutions lie on the "boundary . . . between science and politics" is, to be sure, to risk conceptual confusion. Historically, science and politics have been understood as distinct realms of human activity, one oriented toward the search for knowledge, truth, and objectivity, the other toward the accumulation and distribution of power (thus the famous phrase "speaking truth to power"). However, as scholars have pursued detailed, empirical investigations of scientific culture and practice, this distinction has come to appear less and less meaningful. Viewed up close, science turns out to look a lot like other social institutions, full of norms, beliefs, ideologies, practices, networks, and power and deeply engaged in the production and management of social order. The modern research university, for example, quite clearly ties together a variety of social, political, and economic networks and institutions, in addition to their cognitive and disciplinary components (Dennis 1994; Leslie 1993).

Similarly, post-Enlightenment political institutions rely deeply on the production of matters of fact to acquire and retain legitimacy. Authors such as Yaron Ezrahi, Sheila Jasanoff, and Theodore Porter have highlighted the extent to which modern political institutions not only enroll but also help

construct science in the day-to-day activities of policy making. Informed by science, concepts of objectivity, practices of knowledge making, objects of discourse, and embodied expertise pervade the hallways, offices, and courtrooms of Congress, executive agencies, and the legal system, helping to make up the constitutional foundations of contemporary democracy (Ezrahi 1990; Jasanoff 1990, 1996a; Porter 1995).

The recognition that the laboratory and the legislature both mix ideas and beliefs with values, norms, and institutions should not blind us, however, to the very real differences in social practice and organization that exist between the two settings. Congress does not select committee chairmen on the basis of the number of articles candidates have published in *Nature*, just as scientists do not vote on the speed of light. A culture or moral economy of credibility may operate in each context, but we would not expect the cultures of the laboratory and the legislature to necessarily exhibit the same characteristics (Shapin 1996). Following Wittgenstein, what most people outside of the field of science studies persist in labeling "science" and "politics" clearly constitute distinct forms of life. Each contains its own unique ordering and amalgamation of human norms, practices, discourses, and knowledges. These distinctions are important, for they reflect critical differences in the credibility, legitimacy, and authority accorded to different forms of life for making choices and conducting business in different spheres of human activity. For all their differences, however, both institutions incorporate knowledge making and social ordering as central, integrated components of their activities. Each participates in the production of knowledge and order.

The practice of treating both science and politics as distinct forms of life (as opposed to viewing them as ideal forms of activity) can help avoid the trap of imagining that activities taking place in those domains labeled as "scientific" are somehow free of concerns about values, power, and order, while activities taking place in domains labeled as "political" are somehow not involved in the production of knowledge (see, especially, Jasanoff 1996a, 1996b). Science is surely political—in the sense that its activities shape the distribution of power in modern societies. We should not, however, fall into the logical fallacy of thereby assuming that the same models we use for explaining Congress and the presidency will necessarily work to explain the laboratory and the discipline.

Where, then, does that leave boundary organizations? I use the phrase *boundary organizations* to refer to those social arrangements, networks, and institutions that increasingly mediate between the institutions of "science" and the institutions of "politics"—understood as labels for distinct forms of life in modern society. In the 1950s, relationships between science and politics were frequently quite direct. Today, they are rarely so. A range of

institutions, including expert advisory committees, scientific assessments, research management agencies, consensus conferences, and so on, populate the social landscape of the United States and, to a growing degree, international governance. Moreover, a significant feature of these new institutional forms is their reliance, when examined in detail, on amalgamations of social practice drawn from the worlds of both science and politics. They might include, for example, a managerial committee appointed by government officials combined with working groups selected from the scientific community. They are, in other words, hybrids—mixing scientific and political elements—a point to which I will return below.

Before proceeding to discuss the implications of their hybrid character, I need to expand on the original theory of boundary organizations to make it relevant to international relations. Conventionally, boundary organizations have been analyzed in terms of their relations with the domains of science and politics (Guston 1999, 2000). In his analyses of boundary organizations in the United States, Guston has identified their proximity to powerful scientific and political institutions as defining their character and functions. Boundary organizations appear to need the approval of science for the credibility of their knowledge claims as well as the approval of political institutions for the legitimacy of their policy orientations. These relationships create a context in the United States in which boundary organizations constantly appear to serve two distinct and potentially conflicting sets of goals.

When we begin to examine international contexts, however, it quickly becomes apparent that the conventional model of boundary organizations contains a number of weak assumptions. The first weakness of the conventional model is that it tends to overuniversalize science and politics. While boundary organization theory recognizes that science and politics constitute distinct forms of life, it tends to elide differences that occur between institutions within the separate domains of science of politics. These differences stand out more distinctly in international settings, however, where the scientific and political institutions of myriad countries are brought into immediate contact with one another. Even in domestic contexts, however, investigators may need to pay greater attention to differences between, say, biology, physics, and agriculture (or, equally, state and federal institutions or legislatures, executive agencies, and courts) in explaining the behavior of particular boundary organizations. The norms, practices, ideas, and discourses of distinct forms of life may differ considerably from one another, even if they are encompassed within the domain of either science or politics. Scientific assessments, for example, frequently operate under very different standards and procedures of peer review than do, say, scientific journals or grant competitions (Edwards and Schneider 2001). More generally, the science studies

literature provides numerous examples wherein scientific disciplines differ from one another and through history in the norms and practices they exhibit and the ideas and representations of nature they develop (Galison 1997; Kohler 1994; Kay 1993; Mitman 1992).

Likewise, boundary organization theory has not fully escaped conventional patterns of thought that circumscribe the institutional landscape inhabited by these institutions to a "fine, bright line" (Guston 2000, xv).[4] This depiction perpetuates discursive tendencies (at least in the United States) to seek out pure forms of science and politics and thus to overlook the diverse array of hybrid institutional types that relate to one another as well as to scientific and political institutions (see Latour 1993 for a longer discussion of the concept of purification). In many cases, however, the institutional landscape inhabited by boundary organizations is more expansive, and boundary organizations' differences and interactions with each other may be just as important as their interactions with science and politics, per se. In his description of agricultural extension, for example, David Cash (2001) illustrates the rich array of institutional forms inhabiting the thick boundary-lands between agricultural science and farmers in the United States. Another way of emphasizing this same point would be to highlight recent research on boundary work, which indicates that while the distinction of what is and what is not science (or politics) is often asserted to be quite sharp, it turns out, in practice, to be quite fuzzy (Gieryn 1995, 1999).

As Figure 1 illustrates, the variety of boundary organizations that exists in contemporary society is also easily visible in international relations. The climate regime contains numerous institutions that mix scientific and political elements in remarkably different ways.[5] The U.N. Intergovernmental Panel on Climate Change (IPCC), the UNFCCC's SBSTA, the World Meteorological Organization, the U.N. Environment Programme, the International Research Institute for Climate Prediction, the International Geosphere-Biosphere Programme, the U.S. Global Change Research Program, and numerous others are neither scientific nor political according to conventional categorizations. Rather, they combine elements of both, albeit each in a unique manner. Moreover, in addition to these formal institutions, the climate regime contains a host of equally important but less formalized networks that link people and ideas around the globe. These networks and institutions are essential components of the climate regime, whose actions and interrelations must be understood if we are to make sense of the globalization of environmental governance.

Finally, the third weakness of conventional boundary organization theory when viewed with respect to international relations is that it presents an overly static view of science and politics. Within the U.S. context, the

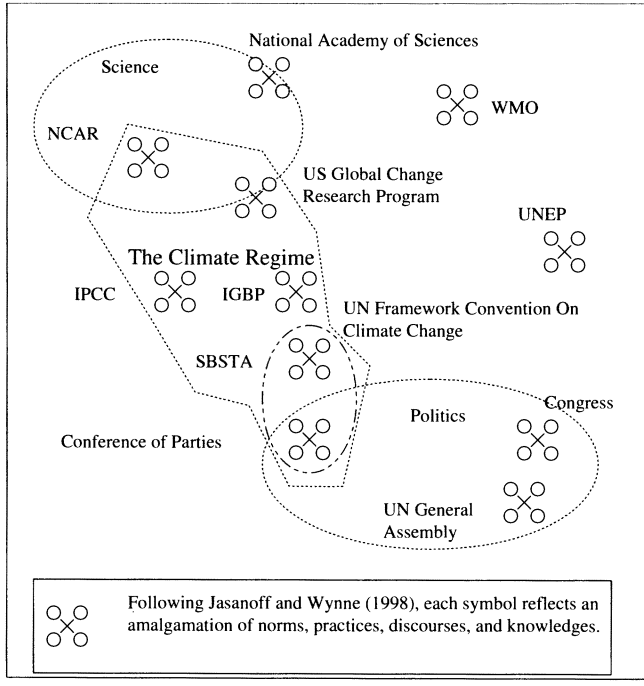

Figure 1. The institutional landscape of the climate regime.
NOTE: NCAR = National Center for Atmospheric Research; WMO = World Meteorological Organization; UNEP = U.N. Environment Programme; IPCC = U.N. Intergovernmental Panel on Climate Change; IGBP = International Geosphere-Biosphere Programme; SBSTA = U.N. Framework Convention on Climate Change's Subsidiary Body for Scientific and Technological Advice.

durability and relatively slow pace of change of the modern research university, Congress, the Constitution, and other institutions sometimes lends an aura of timelessness to discussions of science policy, overlooking the vast changes in these institutions and their interrelations that have marked the twentieth century. Especially now, however, the very real changes taking place in global governing arrangements make clear the flexibility of categories like "science" and "politics" in international contexts. Definitions and standards for expertise are deeply contested across cultural and geopolitical divides, as are notions of appropriate political institutions for carrying out public sector management for the planet as a whole. Perhaps the most widely recognized example of this in contemporary environmental politics is the long-running debate over whether issues of risk associated with genetically

modified crops should be dealt with under the auspices of the World Trade Organization, the Food and Agriculture Organization, or the U.N. Convention on Biological Diversity—each of which offers a very different model of how global science and global politics should be organized, how they should relate to one another, and how global policy making should be prioritized.

Hybrid Management

To rectify the weaknesses of the original theory of boundary organizations for application to international settings, I introduce in this section the concept of hybrid management. Use of the term *hybrid* to refer to people, artifacts, and institutions that mix elements from scientific and political forms of life has a long history in science studies. Most recently, and profligately, it has been adopted by French philosopher Bruno Latour, who explicitly theorizes modernity as the "proliferation of hybrids," by which he means the mixing up of facts and values, knowledge and identity, nature and culture, science and politics in our conceptual frameworks, material technologies, and social networks and institutions. His book *We Have Never Been Modern* (1993) opens by describing a newspaper article that exemplifies the hybrid character of the "ozone hole":

> On page four of my daily newspaper, I learn that the measurements taken above the Antarctic are not good this year: the hole in the ozone layer is growing ominously larger. Reading on, I turn from upper-atmosphere chemists to Chief Executive Officers of Atochem and Monsanto, companies that are modifying their assembly lines in order to replace the innocent chlorofluorocarbons, accused of crimes against the ecosphere. A few paragraphs later, I come across heads of state of major industrialized countries who are getting involved with chemistry, refrigerators, aerosols, and inert gases. But at the end of the article, I discover that the meteorologists don't agree with the chemists; they're talking about cyclical fluctuations unrelated to human activity. So now the industrialists don't know what to do. The heads of state are also holding back. Should we wait? Is it already too late? Toward the bottom of the page, Third World countries and ecologists add their grain of salt and talk about international treaties, moratoriums, the rights of future generations and the right to development. (P. 1)

The ozone hole is clearly an object of scientific study. Instrumented airplanes and satellites are flown into the polar atmosphere to detail its chemistry and physics. Yet, it also contains elements of political symbolism. Calling it a hole, rather than a region of lowered density, is something of a political act. Scientists, government officials, and representatives of many industry

and nongovernmental organizations have considerable stakes in how the ozone hole gets represented.

For Latour (1993), the basic drive of modernity has been to purify hybrids into science or politics, facts or values. A more careful reading would suggest, however, that many institutions, and particularly the boundary organizations of interest in this special issue, exist instead to establish and maintain a productive tension between the multiple, diverse forms of life in contemporary societies. This may take the form of managing the relationship between laboratories and legislative bodies to enable them, as the subtitle of Guston's (2000) *Between Politics and Science* suggests, to assure "the integrity and productivity of research." Or, it may take the more complex form of trying to create effective global policies for reducing human threats to the climate system. In either case, ways need to be found for institutions, networks, and even cultures that put together order and knowledge in very different ways to each successfully sustain its own internal processes while forming productive relationships with one another.

To maintain these productive and dynamic relationships, boundary organizations need to be able to manage hybrids—that is, to put scientific and political elements together, take them apart, establish and maintain boundaries between different forms of life, and coordinate activities taking place in multiple domains. These four elements—hybridization, deconstruction, boundary work, and cross-domain orchestration—make up what I term "hybrid management." Previous work on boundary organizations has discussed many of these activities in the course of descriptions of particular institutions. By foregrounding hybrid management as theoretically important, however, I hope to accomplish a number of goals, including placing new emphasis on the social arrangements and practices internal to boundary organizations and the dynamics of their relationship with a diverse array of other organizations.

It is important to recognize, however, that hybrid management activities are not carried out exclusively in boundary organizations. As we will see, boundary organizations and the other forms of life with which they interact are enmeshed in a web of mutually constraining activities and practices. Consider, for example, recent, comparative analyses of regulatory systems in different countries. These studies demonstrate that the framing of risk, the norms and practices of expert advisory committees, and even the kinds of scientific evidence that predominate in policy deliberations differ from country to country in ways that reflect broader patterns of difference in political culture. Moreover, these differences also reflect back into the scientific institutions of the countries, shaping their organization and the kinds of knowledge

produced. Together, these observations indicate the extent to which science and politics further fit together in larger, mutually constraining forms of life characteristic of particular nation states (Jasanoff 1986, 1991, 1995, 1997a; Brickman et al. 1985). Hybrid management, I suggest, is the glue that links scientific, political, and other institutions together in modern political economies.

Hybrid Management in the Climate Regime

To more fully explain what is meant by hybrid management and how the concept relates to the activities of boundary organizations, this section examines an institution within the climate regime that has received relatively little attention, despite its importance to the regime: the SBSTA. The SBSTA's legal mandate is established in Article 9 of the 1992 UNFCCC. Article 9 asserts two basic principles concerning the SBSTA. First, its basic mission is to "provide the Conference of the Parties [of the UNFCCC] and, as appropriate, its other subsidiary bodies with timely information and advice on scientific and technological matters relating to the Convention." Second, its members "shall comprise government representatives competent in the relevant field of expertise." The first of these principles is spelled out in somewhat greater detail through a list of tasks the SBSTA shall undertake. The second is left to stand without further specification (Mintzer and Leonard 1993).

Subsequent to its formal inauguration in 1995, however, the SBSTA has taken a somewhat different path than these two principles might at first suggest. Consequently, although the original treaty language seemed to cast the SBSTA as science to the Conference of Parties' politics, the SBSTA's actual organization entails a melange of elements. The principal body is a legislative assembly composed of representatives of those countries that have signed and ratified the Framework Convention. In addition, nongovernmental organizations may register for (nonvoting) observer status, and other intergovernmental organizations may also send observers. Although the language of the SBSTA's authorizing text says that SBSTA members will be government experts, most countries send the same or similar delegations to the SBSTA that they send to the Framework Convention's Conference of Parties (the legislative assembly for the regime as a whole). Some of these delegations include scientists and other experts as members, and some are composed solely of scientists. Many, however, are diplomats. The SBSTA's legislative assembly frequently draws on the services of the Framework Convention's secretariat (a bureaucratic support organization) to carry out routine tasks such as organizing meetings. After long debates, the SBSTA has also

compiled a roster of experts for its use in seeking expert advice. National governments nominate experts to this list. The SBSTA's legislative assembly may request that a panel of experts from the roster be set up to address a specific issue or question. At that point, the secretariat will select appropriate experts from the roster, constitute a panel, and solicit a report. Once the report is complete, the panel is disbanded. To date, the SBSTA has received five such reports. Finally, delegates to the SBSTA have constituted two informal working groups to provide assistance to the body on the development of standard methodologies for the regime and on technology transfer. These working groups are composed of representatives from those governments that wish to participate.[6]

In carrying out its activities, the SBSTA has been the site of widespread debate and disagreement over just how expert advisory arrangements should be constituted under the auspices of the climate regime and just what role experts and expert knowledge should play in the formulation of global climate policy. At times, these controversies have reflected competing interpretations of scientific evidence and theories. At other times, they have reflected deep-seated conflicts between competing models of democracy, within the Western liberal states, or geopolitics, between North and South. Frequently, the scientific and political aspects of these conflicts have been indistinguishable. From an analysis of the content of these debates, however, it is possible to begin to derive an analytical framework to describe the efforts of SBSTA participants to manage the hybrids within its domain of authority.

As indicated by the creation of an informal working group on methodologies, one of the SBSTA's most challenging tasks has been to help create and stabilize standard methods for carrying out a variety of knowledge production activities within the climate regime. Of these, by far the most important work to date has involved the measurement of greenhouse gas emissions. Measures of national emissions of greenhouse gases have become the accepted means within the climate regime for assigning blame for changes in the climate and therefore for assigning responsibility for undertaking action to help stabilize the atmosphere. Such measures thus have enormously high political significance within the regime, as does their perceived objectivity as a scientifically sound accounting of each country's responsibility. At the same time, the construction of these measures also raises numerous value-laden questions. For example, who should be responsible for a given emission? Should survival emissions and luxury emissions be differentiated? Which emissions should count as natural and which as anthropogenic?

A key hybrid management function performed in part by the SBSTA involves putting together these kinds of hybrid, policy-relevant standards and measures. Within the hybrid management model, I term this function

n *hybridization*. Standardizing accounting procedures and other methods and practices in international regimes involves establishing what must be measured and also how best to measure it. Each of these choices embeds both normative and technical judgments. Successfully integrating these kind of judgments so that they meet the epistemological and normative criteria of multiple expert, policy, and public audiences frequently involves a great deal of work in a multiplicity of institutional forums. Boundary organizations like the SBSTA can provide a site for doing the additional work necessary to integrate these multiple threads of activity.

In the case of measuring greenhouse gas emissions, for example, key diplomatic acts, such as the 1992 Framework Convention and the 1997 Kyoto Protocol, provide some normative guidance for what kind of information emissions inventories should contain. The Framework Convention directs the accounting methods to assign responsibility to countries (as opposed to individuals or firms), to differentiate natural from anthropogenic emissions, and to make several other key normative choices. Likewise, since 1989, groups of scientists from ecology, animal science, atmospheric chemistry, and other disciplines have been working with the Organization for Economic Cooperation and Development (OECD) and the IPCC to provide expert input into the definition of standard guidelines for emissions inventories. These expert groups have worked to develop a set of standard, default methods for the climate regime that meet the requirements laid out in the two treaties, as well as a host of narrower requirements developed formally and informally within the regime (see, e.g., IPCC 1991, 1997; van Amstel 1993).[7]

Since its creation in 1995, the SBSTA has operated as the primary forum for integrating these two threads of activity. This work has involved facilitating communication between experts and political officials, formal and informal efforts to clarify both technical requirements and value choices, and negotiating compromise settlements between regime participants. Scientists, diplomats, and others have worked together in the SBSTA to coordinate the process of producing and approving default standards among various institutions, identify critical design choices, solicit expert and political input on these choices, and resolve conflicts. This work resulted in the submission and approval of an initial set of default standards in 1997 and the creation of an ongoing program of work to update and refine these standards in response to scientific and political change within the climate regime. Subsequently, numerous countries have submitted national inventories of greenhouse gas emissions in accordance with these standards, and the standards have served as the baseline for efforts to develop a monitoring system for the Kyoto Protocol's emissions-trading program.

Within the process of integrating new hybrid, policy-relevant standards and measures from diverse streams of activity, a second key hybrid management function is that of *deconstruction*—the opening up of hybrids to reveal the tacit and often value-laden assumptions embedded in their construction. In her detailed studies of public controversies over science and technology, Dorothy Nelkin (1992) describes the frequent deconstruction of scientific facts, evidence, and theories that takes place in American politics. The deconstruction of science that takes place in the American media, in legislative and administrative hearings, and in the courts is often rightly viewed as a major hurdle to the effective use of science to shape policies. By rendering tacit and value-laden assumptions visible to participants in policy debates, however, critical examinations of scientific claims can help increase the transparency of the policy process and may help prevent subsequent controversies and enhance policy effectiveness (Jasanoff 1997b).[8]

The ability of participants in the climate regime to deconstruct scientific knowledge claims rests significantly on their ability to mobilize competing interpretations of scientific evidence and theories. This ability is, not surprisingly, quite limited for many countries, given the almost complete absence of climatological research (particularly involving climate models—the principle tool of expert advice within the climate regime) outside of a handful of major research institutions in the United States, Europe, and Japan. The structure of decision making within the SBSTA significantly strengthens the ability of participants to deconstruct science within the climate regime, however, most notably through its consensus voting rules. Although few if any issues ever come to a formal vote, the tacit ability of any country to halt progress on a given issue helps to guarantee that even small voices of skepticism have an opportunity to be heard.

For example, during the development of the initial default standards for measuring greenhouse gas emissions, two competing methods were put forward to account for carbon dioxide emissions from deforestation. Initial discussions within the IPCC focused on the accuracy of the two methods in accounting for carbon emissions. During these discussions, however, several participants indicated that value-laden differences between the two methods might be of sufficient magnitude to matter to governments calculating their emissions. These differences stemmed from how the two methods distributed carbon emissions between countries, in one case to countries in which deforestation was occurring and in the other case to countries in which wood products (manufactured from the wood taken from the forests) were decaying and releasing stored carbon into the atmosphere. These differences affected not only the distribution of accountability but also incentives for undertaking sustainable forestry policies, raising significant (and unexpected) questions

about just what principles the accounting system should be based on. Should the methods be designed to strictly account for only those emissions actually released from a particular country's territory? Should they try to account for underlying activities that ultimately result in emissions? Or should they be designed to foster sustainable policy making? Each potential goal corresponds best to a different method of accounting.

The SBSTA's role as a boundary organization has helped facilitate discussion of this issue, containing the conflict and moving it toward resolution. Two features of the SBSTA's organization have been particularly important. First, the flexibility and responsiveness of the SBSTA in creating new expert advisory institutions and developing extensive relations with a variety of governmental, intergovernmental, and nongovernmental institutions enabled participants to rapidly solicit diplomatic and expert views on the questions raised in the dispute from myriad interested parties. SBSTA participants asked the secretariat to create a special expert panel to report on the issue and, once completed, to solicit official governmental responses (Brown, Lim, and Schlamadinger 1998). Governments are now in the process of submitting their views on how these value choices should be resolved (Methodological issues 1999). Second, the SBSTA's voting rules enable any participating country to veto SBSTA resolutions. Consequently, different viewpoints cannot simply be ignored but must be carefully accommodated. Settlements are thus frequently delayed but, when ultimately resolved, tend to defuse potential fault lines that could subsequently emerge in more damaging controversies if not adequately addressed. It is certainly plausible, for example, that had the original methodology been adopted without discussion, later discovery of its implications could have led developing countries to denounce the default standards as biased against their interests, creating a deeper and more difficult to resolve conflict.

As the SBSTA and other boundary organizations seek ways to productively integrate strands of activity from diverse forms of life to create new, hybrid entities, a third key management function involves the creation and maintenance of appropriate boundaries and jurisdictions between interacting organizations. This boundary demarcation and maintenance is important because, as authors such as Thomas Gieryn and Sheila Jasanoff have demonstrated, the boundaries between different hybrids often become extremely fuzzy and even disappear completely in actual practice—creating a need for boundary work to form clean distinctions (Gieryn 1995, 1999; Jasanoff 1990). The rhetorical assertion of well-marked boundaries separating science from politics (and other forms of nonscientific activity) plays important roles not only in maintaining social discipline within each form of life but also in establishing the authority of each vis-à-vis each other. Indeed, the

legitimacy of science and politics in modern societies depends in a very important sense on each being seen to act wholly within its appropriate jurisdiction even when, in practice, there is very little a priori distinction between the two at the margin.

Developing standard methods for measuring greenhouse gas emissions used in the climate regime provides a good example of the wide array of expert and political institutions involved in the construction of policy-relevant knowledges, including national governments, universities, laboratories, the SBSTA, the OECD, the International Energy Agency, the IPCC, and numerous other organizations. The SBSTA has been deeply involved in dividing up responsibilities between these various hybrids and, in this way, in helping to construct appropriate boundaries around the jurisdiction of each. The goal has been to allocate responsibility for various aspects in a way that is perceived to be legitimate by those participating and by those observing in broader society. This process is inevitably dynamic in that boundaries are constantly being delineated, criticized, defended, and adjusted over time as participants respond to events.

As part of their boundary work on emissions inventories, SBSTA participants have adopted the explicit designation of certain choices or activities as scientific and others as political, relegating them to appropriate agencies such as the IPCC or the Conference of Parties. For example, deciding how to differentiate various categories of emissions into "natural" and "anthropogenic" inevitably involves making judgments of fact and value. Under current practices, methane emissions from cattle are counted as anthropogenic, while those from deer are counted as natural, despite the fact that cattle and deer populations are ultimately both decided by human policies. Are choices like this scientific or political? They are hybrid. Yet choices like this are constantly being made (sometimes explicitly, often tacitly) by both scientific and political institutions in their routine operations. The choice to treat deer as "natural" for purposes of the climate regime, for example, was made tacitly by scientists when constructing the default standards. An important role for the SBSTA has been to identify occasions when this kind of choice involves sufficiently important or contentious value dimensions that it needs to be addressed by the regime's political bodies (e.g., in the case discussed earlier of how to account for emissions from deforestation).

Even if successful, however, the differentiation and demarcation of relevant domains of authority for science and politics do not obviate the fact that activities taking place in one form of life are nonetheless relevant and important to people participating in other forms of life. Scientists care a great deal about how science and scientific knowledge are portrayed and used in political institutions, while politicians, lawyers, and judges care deeply about what

goes on in laboratories and universities (witness the rapid responses by world leaders to the cloning of Dolly). Thus, although the activities taking place in the two domains must appear separate, for purposes of legitimacy, they must also be coordinated. *Cross-domain orchestration* constitutes the fourth aspect of hybrid management.

Precisely because the work of scientists and other policy makers involves considerations of both facts and values of interest to all concerned, the activities of each domain are not independent. Within the climate regime, delegates to the Conference of Parties frequently express concerns over the rules and procedures by which organizations such as the IPCC operate. Likewise, scientists frequently express concerns about how scientific knowledge is interpreted and used by institutions like the Conference of Parties. The SBSTA has played a critical role in helping to coordinate across the various domains of decision-making and knowledge-making authority within the climate regime to resolve such issues. This coordination has taken a variety of forms, including the development of rules for new expert advisory arrangements created under its authority, the negotiation of joint programs of work with the IPCC, and the provision of a forum to which the IPCC can offer its advice for formal, collective evaluation and certification by the regime in addition to its interpretation and use by individual governments.

One of the principle challenges of cross-domain orchestration, particularly in global contexts, is the multiplicity of audiences to which knowledge must ultimately appear credible—and the multiplicity of expectations and procedures for assessing truthfulness that may therefore be in play.[9] Certainly, this is the case with methods for measuring greenhouse gas emissions as they have emerged in different national contexts. The United States, for example, employs a consulting firm to research the relevant scientific literature and to produce, in conjunction with one individual at the Environmental Protection Agency and another at the Department of Energy, a national inventory. In Germany, by contrast, the emissions inventory process has been assigned to the same agency that measures all other forms of air pollution—and the extensive norms and procedures of this activity have been expanded to greenhouse gases. Along other lines, considerable conflict has emerged between U.S. and Indian scientists regarding whether the best way to measure methane emissions from rice agriculture is to extensively measure a small number of sites and extrapolate or to make only a small number of measurements at any given site but to measure large numbers of sites.

SBSTA participants have sought to find ways to warrant the credibility of emissions inventories across multiple audiences and so to enhance the likelihood that they will be able to help develop shared understandings and expectations of global environmental governance. One approach has been to leave

specific methodological choices up to individual countries that presumably know best the requirements for establishing credible statistical information within their own domestic political cultures. Another approach has been to establish an informal working group in which government delegates can negotiate, behind closed doors, with each other and with representatives of expert groups, a wide variety of issues concerning measurement standards. A third approach has been to establish the formal authority of the SBSTA to make rules regarding measurement standards through consensus voting. In this manner, the normative weight of collective agreement helps buttress the credibility of value-laden choices. Still another has been to regularly seek the advice of IPCC expert working groups regarding the construction of default measurement standards against which countries are asked to explicitly compare their own methods to enhance the transparency of their choices (see Miller 2001).

Conclusion

The relationship between science and politics has become increasingly sophisticated over the past half-century. Three features of this growing sophistication stand out. First, the relatively simple institutional landscape of earlier eras, in which scientists inhabited the laboratory and public officials the legislature and bureaucracy, has grown increasingly complex as a wide variety of novel institutional forms—what we have termed boundary organizations in this special issue—has emerged, each of which mixes elements of science and politics. Second, it has become increasingly obvious that neither science nor politics has a monopoly on truth or power. Rather, the construction of objective knowledge and authoritative orderings of society require increasingly nuanced arrangements that orchestrate activities in the worlds of both science and politics. Finally, the discourses, material artifacts, and institutions that increasingly populate all three domains are hybrids, complex mixtures of facts and values.

I have argued in this article that a promising approach for analyzing the increasingly sophisticated relationship between science and politics is to view it as a process of hybrid management—the work of putting together and taking apart these hybrids, orchestrating their use across multiple forms of life, and bounding and demarcating their relevant domains of authority. By helping to manage hybrids—like the methods for counting greenhouse gas emissions that I discussed above—boundary organizations contribute, I believe, to the maintenance of a productive tension between science and politics in modern society.

Exploring processes of hybrid management offers three important advantages in the analysis of science policy. First, it offers a descriptive language that explicitly confronts and emphasizes the value-laden character of policy-relevant scientific knowledge and expertise.[10] The work of scholars of science studies over the past three decades has provided thick descriptions of the rich, textured landscape of science in practice. To date, however, these depictions have largely remained absent from discussions of science policy, not because scientists and public officials do not also recognize the complexity of their own practices but because of a lack of appropriate vocabulary for making sense of those activities.

Second, it offers a new avenue for exploring power relationships in contemporary society, especially in the rapidly changing and informal worlds of global diplomacy and governance. Power, as we know from the work of Foucault and others, derives as much from the ability to classify and characterize nature as it does from the ability to order human relations. Indeed, the two frequently go hand-in-hand. What emerges from this study is that the classification of national responsibility for greenhouse gas emissions is not simply the product of some hegemonic agent. Neither scientists nor government officials monopolized the production of inventory methods. Nor, for that matter, did any single country, such as the United States. Indeed, on several occasions, representatives from small countries with little in the way of economic, military, or scientific might made significant contributions to methodological innovations. Power, then, is something that is located within the SBSTA's activities but in more complex arrangements than theorists of international relations generally recognize.

Finally, it offers important insights into the moral economy of emerging structures of global governance, particularly as they relate to issues of trust and credibility. As Shapin (1994) has eloquently observed, credibility is dynamically constituted as people and institutions develop new forms of social relationships. As global governing regimes implicate ever more central features of modern economies—such as the production of energy and food and the transportation of goods and people—they will need to build increasingly strong ties to the publics of many nations. Differences in political culture from country to country seem likely to complicate these relationships even further.

What processes of hybrid management, like the construction of methods for measuring emissions of greenhouse gases in the SBSTA, offer are sites for investigating what works and what does not work as government officials, scientists, and others search for ways of bridging national differences to create globally credible governing regimes.

Notes

1. Sheila Jasanoff (1996b) has eloquently argued this point:

> With the growing saliency of issues such as hunger, disease, environmental decay, and international security, the world community appears increasingly to have pinned its hopes for the future on the accumulation of technical information. Experts play an ever more influential role in defining and controlling fundamental social problems. Not only are their knowledge and know-how deemed essential for managing our most pressing problems, but science, because of its claims to value-neutrality, seems to provide the only forum where nations can set aside their differences in favor of a common, rationalistic approach to problem solving. To "scientize" an issue is at once to assert that there are systematic, discoverable methods for coping with it and to suggest that these approaches can be worked out independently of national or sectarian interests. Science represents for many the only universal discourse available in a multiply fragmented world. (P. 173)

2. Comparative studies of regulatory politics illustrate that even Western democracies differ dramatically in how they institutionalize expert advice. Cultural specificity in the incorporation of science into policy often reflects, in such cases, constitutional aspects of social order, including the distribution of power between legislative, executive, judicial, and scientific institutions as well as norms and practices for assessing such questions as to what constitutes legitimate knowledge, who is entitled to speak for nature, and how much deference science commands relative to other ways of knowing (Jasanoff 1986, 1995, 1997a; Brickman, Jasanoff, and Ilgen 1985).

3. The climate regime has emerged in recent years as an important focus of geopolitical conflict in the arena of environment and development, with competing interpretations of climate science playing key roles in many of the disputes. In this article, I use the term *climate regime* to refer to the suite of social, political, scientific, and economic networks and institutions (both formal and informal) that have emerged in response to human threats to the earth's climate system (see Miller and Edwards 2001).

4. Guston (2000) notes that the goal of boundary organization theory is "to examine that boundary between politics and science and, at least intellectually, expand it into a space that can be explored and explained." Nonetheless, much of the book's treatment of science policy continues to focus on boundaries—almost by definition, relatively narrow lines that differentiate neighboring entities (see, e.g., pp. 30, 58-59, 70, 149). I would suggest that the continued use of the language and imagery of boundaries serves to undermine rather than reinforce efforts to construct alternative geographies and to more accurately describe the social and institutional landscape of modern societies.

5. Jasanoff and Wynne (1998) offer a theoretically informed discussion of the role of science in the climate regime. See also the contributions to Miller and Edwards (2001).

6. For a deeper discussion of this argument, see Miller (2001).

7. For further information about the U.N. Intergovernmental Panel on Climate Change, see Miller (forthcoming), Shackley and Wynne (1995), and Boehmer-Christiansen (1994).

8. To be sure, facts and values cannot be separated. What deconstruction offers is the possibility of making value choices explicit in the production of scientific knowledge and its use to inform policy making.

9. For enlightening discussions of credibility, see particularly Shapin (1994, 1996) and Jasanoff (1991).

10. I am indebted to an anonymous reviewer for this point.

References

Agrawala, Shardul, Kenneth Broad, and David H. Guston. 2001. Integrating climate forecasts and societal decision making: Challenges to an emergent boundary organization. *Science, Technology, & Human Values* 26:454-477.

Boehmer-Christiansen, Sonja. 1994. Global climate protection policy: The limits of scientific advice. *Global Environmental Change* 4 (2):140-59 and 4(3):185-200.

Brickman, Ronald, Sheila Jasanoff, and Thomas Ilgen. 1985. *Controlling chemicals: The politics of regulation in Europe and the United States*. Ithaca, NY: Cornell University Press.

Brown, Sandra, Bo Lim, and Bernhard Schlamadinger. 1998. Evaluating approaches for estimating net emissions of carbon dioxide from forest harvesting and wood products. Meeting report, IPCC/OECD/IEA Programme on National Greenhouse Gas Inventories, Dakar, Senegal, 5-7 May.

Cash, David W. 2001. "In order to aid in diffusing useful and practical information": Agricultural extension and boundary organizations. *Science, Technology, & Human Values* 26:431-453.

Dennis, Michael. 1994. "Our first line of defense": Two university laboratories in the postwar American state. *Isis* 85 (3): 427-55.

Edwards, Paul, and Stephen Schneider. 2001. Self-Governance and peer review in science-for-policy. In *Changing the atmosphere: Expert knowledge and environmental governance*, edited by Clark A. Miller and Paul N. Edwards. Cambridge, MA: MIT Press.

Ezrahi, Yaron. 1990. *The descent of Icarus: Science and the transformation of contemporary democracy*. Cambridge, MA: Harvard University Press.

Galison, Peter. 1997. *Image and logic: A material culture of microphysics*. Chicago: University of Chicago Press.

Gieryn, Thomas F. 1995. Boundaries of science. In *The handbook of science and technology studies*, edited by Sheila Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor Pinch. Thousand Oaks, CA: Sage.

———. 1999. *Cultural boundaries of science: Credibility on the line*. Chicago: University of Chicago Press.

Guston, David H. 1999. Stabilizing the boundary between U.S. politics and science: The role of the Office of Technology Transfer as a boundary organization. *Social Studies of Science* 29 (1): 87-112.

———. 2000. *Between politics and science: Assuring the integrity and productivity of research*. Cambridge, UK: Cambridge University Press.

———. 2001. Boundary organizations in environmental policy and science: An introduction. *Science, Technology, & Human Values* 26:399-408.

Intergovernmental Panel on Climate Change. 1991. Proceedings of the Workshop on National Inventories of Greenhouse Gas Emissions and Sinks, 5-6 December, Geneva, Switzerland.

———. 1997. *IPCC guidelines for national greenhouse gas inventories*. Bracknell, UK: IPCC.

Jasanoff, Sheila. 1986. *Risk management and political culture*. New York: Russell Sage Foundation.

———. 1990. *The fifth branch: Science advisers as policymakers*. Cambridge, MA: Harvard University Press.

———. 1991. Acceptable evidence in a pluralistic society. In *Acceptable evidence*, edited by Deborah Mayo and Rachelle Hollander. Oxford, UK: Oxford University Press.

———. 1993. India at the crossroads. *Global Environmental Change*, March, 32-51.

———. 1995. Product, process, or programme: Three cultures and the regulation of biotechnology. In *Resistance to new technology*, edited by M. Bauer. Cambridge, UK: Cambridge University Press.

———. 1996a. *Science at the bar: Law, science and technology in America*. Cambridge, MA: Harvard University Press.

———. 1996b. Science and norms in global environmental regimes. In *Earthly goods: Environmental change and social justice*, edited by Fen O. Hamson and Judith Reppy, 173-97. Ithaca, NY: Cornell University Press.

———, ed. 1997a. *Comparative science and technology policy*. Cheltenham, UK: E. Elgar.

———. 1997b. Compelling knowledge in public decisions. In *Saving the seas: Values, scientists, and international governance*, edited by L. Anathea Brooks and Stacy VanDeveer, 229-54. Silver Spring: University of Maryland Press.

Jasanoff, Sheila, and Brian Wynne. 1998. Science and decisionmaking. In *Human choice and climate change: The societal framework*, edited by Steve Rayner and Elizabeth Malone. Columbus, OH: Battelle.

Kay, Lily. 1993. *The molecular vision of life: Caltech, the Rockefeller Foundation, and the Rise of the new biology*. Oxford, UK: Oxford University Press.

Keating, Terry J. 2001. Lessons from the recent history of the Health Effects Institute. *Science, Technology, & Human Values* 26:409-430.

Kohler, Robert E. 1994. *Lords of the fly: Drosophila genetics and the experimental life*. Chicago: University of Chicago Press.

Latour, Bruno. 1993. *We have never been modern*. Cambridge, MA: Harvard University Press.

Leslie, Stuart W. 1993. *The Cold War and American science: The military-industrial-academic complex at MIT and Stanford*. New York: Columbia University Press.

Methodological issues: Other matters, estimation of emissions of carbon dioxide from forest harvesting and wood products. Draft conclusions by the chairman. 1999. U.N. document FCCC/SBSTA/1999/CRP.06, November 1. United Nations, Geneva, Switzerland.

Miller, Clark A. 2001. Challenges to the application of science to global affairs: Contingency, trust, and moral order. In *Changing the atmosphere: Expert knowledge and environmental governance*, edited by Clark A. Miller and Paul N. Edwards. Cambridge, MA: MIT Press.

———. Forthcoming. Undermining the postwar settlement: Climate science and the reconstruction of global order. In *States of knowledge: Science, power, and political culture*, edited by Sheila S. Jasanoff.

Miller, Clark A., and Paul N. Edwards, eds. 2001. *Changing the atmosphere: Expert knowledge and environmental governance*. Cambridge, MA: MIT Press.

Mintzer, Irving, and J. A. Leonard, eds. 1993. *Negotiating climate change: The inside story of the framework convention*. Cambridge, UK: Cambridge University Press.

Mitman, Greg. 1992. *The state of nature: Ecology, community, and American social thought, 1900-1950*. Chicago: University of Chicago Press.

Nelkin, Dorothy. 1992. *Controversy: Politics of technical decisions*. 3rd ed. Newbury Park, CA: Sage.

Porter, Theodore. 1995. *Trust in numbers: The pursuit of objectivity in science and public life*. Princeton, NJ: Princeton University Press.

Shackley, Simon, and Brian Wynne. 1995. Global climate change: The mutual construction of an emergent science-policy domain. *Science and Public Policy* 22 (4): 218-30.

Shapin, Steven. 1994. *A social history of truth: Civility and science in seventeenth century England*. Chicago: University of Chicago Press, 1994.

———. 1996. Cordelia's love: Credibility and the social studies of science. *Perspectives on Science: Historical, Philosophical, Social* 3 (3): 255-75.

van Amstel, A. R., ed. 1993. *Methane and nitrous oxide: Methods in national emissions inventories and options for control, an international IPCC workshop*. Bilthoven, Netherlands: RIVM.

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