International Studies Quarterly (2003) **47**, 123–150

Knowledge, Power, and Interests in Environmental Regime Formation

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Knowledge-based approaches to the study of international environmental cooperation tend to treat knowledge as a single variable. It is more useful to distinguish between different types of information and to analyze their roles in policy formation separately. Disaggregating knowledge reveals important aspects of the interplay between knowledge, interests, and power which otherwise remain hidden, and helps solve empirical puzzles and theoretical contradictions. Its utility is illustrated in a comparison between two prominent cases of regime-making efforts: deforestation (non-regime) and ozone depletion (regime). The study relies on analysis of multilateral scientific assessments, observation of UN meetings, and interviews with scientists and policymakers. The evidence suggests that reliable information about the cross-border consequences of a problem is of critical importance in regime formation as it facilitates utility calculations and the formation of interests. By contrast, other types of seemingly relevant scientific knowledge appear to be of far lesser importance. Moreover, contrary to power-over-knowledge theorizing, the state of knowledge cannot be easily explained with reference to political power.

In environmental politics, natural scientific information is widely believed to be a key prerequisite for policymaking. A growing number of studies explore the interface between science and politics in the international arena (Andresen and Østreng, 1989; Jasanoff, 1990; Haas, 1992a; Litfin, 1994; Andresen et al., 2000; Social Learning Group (SLG), 2001). These works have made major advances in understanding the relationship between knowledge and action, and the conditions under which information influences policy processes. However, an apparent contradiction between theoretical expectations and empirical findings creates a major puzzle that begs explanation. Namely, our intuitive expectations that knowledge should be at least necessary for policy action are repeatedly contradicted by empirical findings that states form policy regimes in spite of significant scientific uncertainty and gaps of information.[1] This contradiction has contributed to

Author's note: Research for this study was funded by the Institute for the Study of World Politics, the MacArthur Foundation, and the Department of Political Science at the University of Minnesota whose support I gratefully acknowledge. I also wish to thank Martin Sampson, Richard Price, and Robert Holt for their astute guidance, as well as Peter Haas, Frank Alcock, and two anonymous reviewers for their useful comments. An earlier version of this study received the 2001 Lawrence S. Finkelstein award of the International Studies Association.

[1] The underlying definition of regime here is: a legal treaty or a series of treaties that involve international commitments for specific policy action to address a problem. This is one way to operationalize Stephen Krasner's classical definition of regimes as "implicit or explicit principles, norms, rules, and decision-making procedures around which actors' expectations converge in a given area" (Krasner, 1983:2).

Published by Blackwell Publishing, 350 Main Street, Malden, MA 02148, USA, and 9600 Garsington Road, Oxford OX4 2DQ, UK.

skepticism about the idea that scientific knowledge can help explain international environmental cooperation. At the very least, it has made it difficult to move beyond the recognition that the relationship between science and policy is complex and precarious (Andresen et al., 2000; SLG, 2001; Harrison and Bryner, 2003).

This apparent puzzle is relevant to both rationalist and constructivist agendas. If reliable information is not even necessary for collective action, rational choice theorizing would lose one of its major premises. For constructivists, who see politics as a process of social learning and who focus on the mechanisms for constructing and diffusing ideas, the implications of the puzzle are equally considerable. If consensual knowledge is not required for institutional development, why care who and how constructs, frames, and diffuses knowledge? In other words, if shared knowledge is not an important independent variable, why study it as a dependent variable? Thus the puzzle addressed in this study presents a challenge to theorists of various persuasions that they cannot afford to ignore.

This article seeks to reduce tensions in the relevant literature on regime formation. It attempts to do so by applying a new analytical framework that leads to findings that are more consistent with theoretical expectations and that increase confidence in the proposition that reliable information is necessary for policy regime formation. Existing knowledge-based approaches to the study of international cooperation have delivered less than consistent or persuasive accounts of the impact of shared scientific knowledge. One reason for this is that they generally tend to treat science as a single variable ("knowledge about the problem") and do not give sufficient scrutiny to the impacts of different *types* of shared knowledge.

The study on regime formation presented here advances the argument for a differentiated concept of knowledge that allows for the possibility that different types of research-derived information play uneven roles in international policy-making.[2] I draw a distinction between three aspects of an ecological problem and the corresponding sectors of knowledge about them: (1) the extent of a problem, (2) its causes, and (3) its transboundary consequences. The utility of this analytical approach is demonstrated in a comparison of regime-making efforts on two prominent ecological issues: ozone depletion and deforestation. The formation of a legal policy regime on ozone depletion has been hailed as a triumph of multilateral diplomacy and international cooperation, and a clear confirmation that chronic discord among nations can be overcome. By contrast, after eight rounds of negotiations over ten years, states have not reached agreement on the need for a global forest convention.

Evidence from the two cases strongly suggests that the dynamics and general outcomes of these policy processes correspond with the state of knowledge on the shared *consequences* of a problem. Reliable information on this makes utility calculations possible and facilitates decisions regarding collective action. Conversely, uncertainty and gaps of information in this sector reduce incentives for policy coordination. By contrast, the state of knowledge on the *extent* and *causes* of the problem does not appear to critically affect the general outcome, although it may affect other stages and aspects of the policy process.

Whereas the chief purpose of this article is to contribute to theory development, the case study on deforestation also makes important contributions to data collection. To my knowledge, no one in the study of IR has subjected to scrutiny the impressive array of recent initiatives to introduce comprehensive global policy on forest management. Published work on this prominent ecological issue is ostensibly missing from the burgeoning literature on international cooperation in environmental management.

[2] It is possible and necessary to study the influence of information on various stages of national and international policy processes: agenda setting, policy formation, regime design, and implementation. This study focuses on international regime formation in particular.

At the same time, the study also introduces a non-regime into the regime literature. Students of global environmental politics typically focus on happy-ending stories of successful efforts to reach legal agreements, and ignore both failed state efforts to commit to a common agenda and environmental issues that governments have not addressed through policy agreements. The absence of non-regime cases has been described as a major gap in the literature on regime formation (Hasenclever, Mayer, and Rittberger, 1997; Zürn, 1998; and Sprinz, 1999). Indeed, if we try to understand the conditions under which cooperation occurs, it is important to examine collective decisions *not* to cooperate. The second case study presented here seeks to throw light on some of the reasons why a legal regime on forest policy has not come into being.

The analysis suggests that a specific type of research-derived knowledge provides part of an explanation of why some global ecological problems are addressed in a coordinated manner while others may be subject to discussion but do not lead to international treaties. Some may question whether I am proposing a causal explanation. The notion of causality is the subject of major disputes in the social sciences. As Peter Railton (1989) points out in his brilliant essay, much of the difference among particular views of causation and explanation lies in fundamental metaphysical disagreements that have no definitive resolution. These intractable controversies need not hinder studies on either side of the fence.[3]

What the article does not attempt to do is ascribe strict causality to the impact of science. The two cases do display variance on research-derived information that could possibly be treated as a causal variable. Yet they also vary along a number of other axes, including levels of externalities, opportunity costs, the distribution of power across coalitions, and the distribution of costs and benefits among domestic actors. Given such multidimensionality, no single-variable explanation can be exhaustive. These important factors offer ground for various alternative explanations of either of the two cases, and the account offered here is not intended to refute those. It advances not a competing but a complementary explanation and illuminates the impact of a certain type of information that, in conjunction with other factors, has made regime formation easier in one case and overwhelmingly difficult in the other.

Second, this is not an exploration of the micro-dynamic process of interaction between scientists and policymakers as political actors. As the review of literature will show, others have given thorough treatment of this important topic (Haas, 1990, 1992a; Sabatier and Jenkins-Smith, 1993; SLG, 2001). The epistemic communities approach could be applied successfully to explain *how* knowledge is diffused. The focus here is on the substantive *content* of research-derived information and how the state of knowledge on various aspects of a problem affects the formation of converging interests regarding regime formation.

The article proceeds as follows: the first section offers a review of previous work on the science–policy interface, and elaborates its achievements and unresolved tensions. It introduces an alternative analytical framework that relies on a typology of knowledge. In the second section, this framework is applied in a structured comparison between the ozone regime and the forest non-regime. Based on inventories of multilateral scientific assessments and interviews, I evaluate the state of knowledge on various aspects of each problem, and observe how it relates to the dynamics of regime-making efforts. The third section discusses the interplay between power, knowledge, and state interests in the two cases. The concluding section offers suggestions for future research.

[3] My personal view on explanation follows closely Philip Kitcher's unification approach. Its essence is captured in the following: "The growth of science is driven in part by the desire for explanation, and to explain is to fit the phenomena into a unified picture in so far as we can.… Proponents of the unification approach are committed to viewing factors as explanatorily relevant if they figure in a unified treatment of the phenomena" (1989:495, 500).

Existing Knowledge-based Regime Theory: A Critique

Social scientists are cautious about suggestions that natural scientific information affects social dynamics and outcomes. With our tradition of dwelling on the subjectivity of human thought, the complexity of human behavior, and the mystery of history, we are conditioned to be reserved about the notion that scientific input could shape social output in critical ways. Such reservations are based on two principal objections. One of them stems from the recognition that scientific information is not objective but a product of subjective cognitive processes. A number of important works have examined the production of knowledge as a sociological phenomenon, and the unifying theme among them is the claim that knowledge is socially constructed (Kuhn, 1970; Mulkay, 1978; Latour and Woolgar, 1979). The second grand caveat is that science cannot dictate policy since politics intervenes between knowledge and action, and the transition from information to interest formation is shaped by values, power, and institutions (E. Haas, 1975; Douglas and Wildavsky, 1982). These two stipulations have together strongly inclined scholars to doubt that scientifically derived information could determine social processes or outcomes. While all agree that the science and policy realms are in a dialectic relationship, and that knowledge can be studied as both dependent and independent variable, many scholars choose to focus on knowledge as a dependent variable shaped by political, social, and cultural factors. Most projects in this line of research study factors that influence the generation, selection, diffusion, and persistence of ideas (Jasanoff, 1986, 1990; GEA, 1997; Haas, 1997; Andresen et al., 2000; SLG, 2001).[4]

The above caveats are to be taken seriously indeed, but they do not preclude studying the impact of scientific knowledge on policy formation. It does not necessarily follow from these objections that science-based knowledge does not affect decision-making and collective action in important ways. It has not been shown, for instance, whether social processes of knowledge production affect the *content* of scientific output. Indeed, a recent comparative study found that the influence of scientific input in decision-making is not affected either by the malignancy of political conflicts or by the way the science-policy dialogue is organized (Andresen et al., 2000). As Ernst Haas (1975:874) points out, we cannot "write off science as a willing handmaid, to be used or ignored as our moral commitments dictate." Yet studies that do examine the impact of information on policymaking are constrained by the analytical assumptions they rely upon—a point that the following critique elaborates.

Knowledge-based accounts of international regime formation constitute a rich and productive body of literature.[5] For our analytical purposes, three points merit particular attention. First, these works reach highly contradictory and sometimes antithetical conclusions that create a major puzzle. Despite an entire literature built upon the assumption that policy-relevant information matters in important ways, several major empirical studies conclude that scientific information cannot help explain international policy (Douglas and Wildavsky, 1982; Andresen and Østreng, 1989; Litfin, 1994; Munton, 2001). A recent collaborative project found that reliable information is not even necessary for collective action since decisionmakers took regulatory action on ecological problems in the absence of conclusive evidence (Andresen et al., 2000). With regard to the regime on ozone depletion, other analysts point to considerable scientific uncertainties that existed and claim that "the treaty was not fundamentally rooted in consensual knowledge" (Litfin, 1994:79). Even Peter Haas, whose work is emblematic of the knowledge-policy literature, notes: "Analytically, the ozone case is revealing because international

[4] For excellent surveys of this literature consult Haas (2001) and The Social Learning Group (2001: ch. 1).

[5] An inventory of regime theories is provided in Hasenclever, Mayer, and Rittberger (1997).

cooperation on a highly technical issue was reached before complete scientific consensus emerged" (1993:152).[6] Thus, results from knowledge-oriented studies in fact cast doubt on the proposition that scientific data can account for environmental policy.

Such counter-intuitive conclusions are particularly bewildering in relation to environmental politics. What makes this issue area distinct is the strong biophysical component of ecological problems, which makes natural scientific research indispensable in obtaining information about these issues. "Environmental management necessarily has a high scientific and technical component at its core; indeed, policy-makers would often not be aware that certain scientific problems existed unless those problems had first been identified by scientific research" (Weale and Williams, 1998:84). For such reasons, the claim that research-derived knowledge is not part of the foundation for policy is puzzling. Moreover, it runs against other empirical findings, namely, that overall policy development does correlate with scientific research and that global responses to environmental issues display a high measure of rationality over the long run (Andresen et al., 2000; SLG, 2001). Such contradictions are a source of tension that needs to be addressed.

The second drawback of knowledge-based accounts of international cooperation is that, strictly speaking, there are hardly any. All accounts of global environmental policy that are deemed to emphasize knowledge in fact focus on factors other than the available information per se, partly because of their own appraisal that such information was incomplete. Some shift the emphasis to social discourse and give reflectivist accounts of how knowledge is framed (Litfin, 1994). Others focus on agency and political participation. For instance, the literature on epistemic communities, which has gained well-deserved prominence in the study of IR during the last decade, focuses on the role of transnational networks of scientists with an authoritative claim to policy-relevant knowledge, who share beliefs and values, and who are politically empowered by their governments. They seep into the decision-making apparatus and can bring their governments to agreements that lead to the adoption of institutional frameworks for relevant policies (Haas, 1990, 1992a, 1992b).

The epistemic communities literature is concerned mostly with agency and explains international cooperation not with information per se but with the political participation of groups who have been described as "coalitions of believers" (Sebenius, 1992:364) and whose political power derives from their social status as experts.[7] Scholars in the epistemic communities tradition are concerned less with the content of knowledge and more with the mechanisms for transmitting it, and they explain outcomes not with science but with scientists. The latter distinction is of critical importance: it implies that scientists can critically influence the policy process even if the existing research-derived information is not reliable or does not fully justify policy action. By shifting the focus from science onto scientists as political agents, the analysis is back into the realm of power and interests, and this takes us away from the original proposition that *information* matters.

The third and cardinal limitation of previous explorations of the role of science in politics stems from their analytical assumption that scientific knowledge is a single entity. Most, although not all, of those who consider the impact of scientific knowledge typically treat it as a single, dichotomous variable, "knowledge about the

[6] It is important to keep in mind the distinction between scientific information and the authoritative knowledge claimants who convey it to the policymakers. One may study the state of knowledge, or, alternatively, whether knowledge claimants were politically representative. Conclusions about the role of science could be based on either type of argument, or on both. In this study, the analytical focus is on the content of scientific knowledge, rather than on the participation of scientists in the policy process.

[7] While epistemic communities are a social group whose input affects the policy process, they are distinguished from other interest groups. Peter Haas (2001, 1992a) writes that they differ by a measure of neutrality by providing information that is less likely to be politically tainted.

problem," which can be either certain or uncertain. In two prominent compendiums of studies on the topic (Andresen and Østreng, 1989; Andresen et al., 2000), among other works, knowledge is in the singular, both grammatically and conceptually. The variable under examination is defined as the "state of knowledge; in particular the conclusiveness of available scientific evidence.... The general assumption is that other things being equal, the less conclusive the evidence, the less likely that it will be utilized as a basis for joint policy decisions" (Andresen et al., 2000:15). As in the broader literature, evidence *about what*? is under-specified.

In important recent work, other scholars are mindful of various aspects of a problem and are attentive to questions of what kind of knowledge matters to whom and for what reasons. In a major comprehensive study, the Social Learning Group (2001) considers such aspects in the context of issue framing, and explores how ideas about a problem's causes, effects, and policy solutions figure in elite public discourse. Yet they do not study the state of scientific knowledge on each of these aspects, nor do they attempt to establish patterns between policy responses and levels of scientific certainty.[8] In sum, those who seek to explain policy with knowledge treat the latter as a lump entity; and those who do differentiate between aspects of a problem do not focus on information as an independent variable. Absent from the literature is a systematic analysis of how different types of information affect the likelihood for a collective policy response.

An Alternative Approach: Disaggregating Knowledge

Clearly, we need to calibrate our analytical tools more finely, and consider the possibility that different types of shared knowledge play uneven roles in influencing collective decisions. What kinds of things are important to know in order to introduce an international legal regime? Conversely, what types of uncertainty hamper cooperative action to protect the environment? Is one type of information more important than other types? Knowledge about which aspect of the problem is most influential in decision-making?

There are a number of possible ways to categorize knowledge. Here research-derived shared knowledge is broken up into three basic sectors: (1) knowledge about the *extent* of the problem, (2) knowledge about the *causes* of the problem, and (3) knowledge about its *consequences*. The first sector comprises data relevant to the identification of an ecological development and the appraisal of its extent: whether ozone concentrations are declining and how much ozone is depleted; or whether forested lands are shrinking and what area of forests is being degraded. The second sector contains information about what causes such changes and about the relative contributions of different human activities and/or natural factors. Finally, the third sector is a pool of knowledge about the socioeconomic consequences of the ecological trends.[9]

Why should we differentiate between different types of information? The primary value of disaggregating knowledge is this: it helps us solve theoretical puzzles that previous approaches have not been able to address effectively. As the subsequent analysis will show, the new analytical premise leads us to findings that are more consistent with theoretical expectations and thus extricates us from the

[8] The SLG study is conceptually sophisticated and explicitly atheoretical. It refrains from making causal inferences, and is described by the authors as a "preliminary historical reconnaissance" to document patterns of potentially important variables (see chapters 1 and 22).

[9] There are other types of relevant information as well, such as knowledge about policy options and the ecological changes they are likely to induce. Whether scientists can tell policymakers what a particular policy measure would lead to in ecological and socioeconomic terms is likely to be an important factor in policy formulation. Examining the role of this and other types of knowledge would be a useful continuation of the research agenda.

apparent contradictions in the literature. This alone would justify the exercise. In addition, there are conceptual and methodological reasons for distinguishing between types of information. Ecological research in the natural sciences is an enormously complex, multi-component endeavor that involves various academic disciplines: chemistry, physics, biology, meteorology, medicine, and atmospheric chemistry. Conceptually, it is not realistic to assume a singularity of science. Moreover, the state of knowledge in different areas does not progress evenly or simultaneously. Variance in data on the extent of a development is not necessarily reciprocated by variance in information about its causes or consequences. There is no reason to assume, for instance, that advances in atmospheric chemistry on measurements of ozone concentrations would entail progress in medical research on the health effects of ozone depletion.

This complexity has significant methodological implications for social research on the impact of information in policy. If the states of knowledge on different aspects of a problem vary independently from each other, then literally speaking, they are discrete variables and should be examined separately. By treating knowledge holistically as a lump entity, we would be grouping several variables together and remain unable to isolate the independent role of each in the political process. Suppose, for instance, that we investigate the role of science in the successful formation of a policy regime on a problem. If we implicitly treat "knowledge about the problem" as a single variable, as soon as we find scientific uncertainty about any given aspect of the problem, we may be led to conclude that information could not explain the outcome. In the meantime, we may be overlooking other areas of knowledge where information is reliable! Indeed, previous analysts of the ozone regime are preoccupied with the uncertainty about the extent of depletion and bypass the reliable information and scientific consensus on the shared consequences of the problem—and that provided an important zone of agreement.

As an alternative analytical premise, disaggregating knowledge allows us to make more precise observations on the relationship between science and politics. I illustrate this by probing into two crucial cases of global environmental politics that involve prominent ecological problems: ozone depletion and forest degradation. Neither of the two cases can be adequately explained by existing knowledge-based approaches. In the many studies of the ozone case, scholars see the gaps of information on the extent of depletion but overlook the complete scientific consensus on the consequences of depletion; thus, their conclusion that "science" could not explain the story is premature. While no previous accounts of the forest case exist, the scholarly tradition of the epistemic communities would be amiss in interpreting the case. Various scientific assessments turn up on a regular basis solid data about the extent and causes of deforestation; and research is deeply institutionalized at both national and international levels. In view of these factors, previous knowledge-based approaches would have difficulty explaining the persistent failure of states to form a regime on forest management. Disaggregating scientific information allows us to see clearer pictures.

The Ozone Regime

The formation of the international legal regime on protection of the ozone layer has been well-documented elsewhere (Roan, 1989; Haas, 1992b; Cagin and Dray, 1993; Parson, 1993; Litfin, 1994; Benedick, 1998), and a brief sketch should suffice here. The regime consists of several legal instruments: the Vienna Convention for the Protection of the Ozone Layer (1985), the Montreal Protocol on Substances that Deplete the Ozone Layer (1987), and a series of amendments made in 1990, 1992, and 1997. In the early 1970s a scientific theory implicated certain human-made industrial substances in the destruction of stratospheric ozone which shields living

creatures from detrimental ultraviolet solar radiation. These substances had been used since the 1930s in aerosols, refrigerants, propellants in the production of plastic foams, fire-fighting agents, and solvents for cleaning computer microchips. The theory spurred academic conferences, further scientific research, and public debate. Despite business opposition, several countries, including the U.S., introduced domestic legislature to limit or ban the use of CFCs.

At the formal request of Scandinavian countries, UNEP convened in 1982 the first meeting of a committee to negotiate an international treaty on ozone depletion. Western European countries were strongly opposed to control measures, whereas Scandinavian countries, Canada, Austria, and Switzerland (the Toronto group) supported regulation. The U.S. was inclined to endorse policy measures but its position was not consistent until the mid-1980s. Its domestic regulations placed its producers at an international market disadvantage. DuPont, accounting for one-fourth of world production, launched programs to develop substitutes, and when it succeeded the company joined the U.S. government in advocating a treaty in which it saw an opportunity for a market advantage.

Because disagreements could not be resolved, negotiations produced only a general agreement to cooperate on further research and data exchange. Talks resumed in December 1986, to negotiate a protocol to the Vienna Convention. The proposed policy options were widely different, and as late as April 1987, countries of the European Community would not agree on more than a cap on production capacity. A compromise was reached and twenty-four countries signed the Montreal Protocol in September 1987, agreeing on 50 percent cuts of ozone depleting substances (ODSs), and three years later on their complete elimination. The Protocol entered into force on January 1, 1989, with ratification from twenty-nine countries that accounted for 83 percent of global consumption of CFCs and halons. The regime was further strengthened by amendments that provided for complete elimination of all major ODSs by 1996. Today virtually all states are parties to the agreements.

The case is by no means idiosyncratic in its political dimensions since it displayed all of the usual obstacles to cooperation in environmental politics: a conflict between environmental concerns and economic interests and sharp disagreements among nations. The final outcome is even more astonishing, given that it was the largest producer of CFCs (the U.S.) who became a leader in the move to phase them out, despite initial opposition from its corporate sectors. Similarly, Germany was the largest producer in the European Community and yet became one of the first European countries to support international regulations. And the treaty set up deadlines for specified reductions in emissions before alternative technologies were widely available (Benedick, 1998). One background factor that helps explain the case is the reliable scientific knowledge about detrimental and globally shared consequences of ozone depletion.

Ozone Science

Following articles in scientific journals suggesting that human-made compounds destroy stratospheric ozone (Johnston, 1971; Molina and Rowland, 1974; Stolarski and Cicerone, 1974), there was an explosion of research efforts to determine how the stratosphere reacts to an influx of pollutants of anthropogenic sources. A Coordinating Committee on the Ozone Layer (CCOL) was established in 1977 to coordinate national and international research and to take stock of all existing information on ozone. In 1984, the World Meteorological Organization (WMO) and NASA launched a research program that involved 150 scientists from eleven countries and began to produce regular reports on their findings. And the 1985 Vienna Convention established an advisory body, the Meeting of Ozone Research

Managers, which consisted of government experts on atmospheric research and on effects of ozone depletion (Wettestäd, 1999:151–153).

Sector 1. Extent of Depletion. Problems with measuring ozone changes and attributing them to specific sources haunted research from the beginning and were never quite dispelled, despite significant improvements made over the first decade. Monitoring indicated increased quantity of substances that were believed to facilitate ozone depletion (WMO, 1986). There was also general agreement that less ozone would mean more UV radiation (NRC, 1979:6), but whether there was actual ozone change remained a question with no certain answers until after the Montreal Protocol was signed. As late as the early 1990s, measurements of ozone depletion were considered unreliable (Parson, 1993:72). There were also significant discrepancies between model predictions and actual measurements. In 1986 it was acknowledged that the actual quantities of ozone turned out to be 30 to 50 percent higher than the models estimated (WMO, 1986:14). "In general, analyses for the trends in the total column of ozone show no statistically significant trend since 1970 in agreement with model predictions for the same period" (NASA, 1986:xi). Just prior to the making of the Montreal Protocol, a comprehensive international study concluded: "We are still data limited … the measurements are not adequate for critically testing the photochemical models" (WMO, 1986:13). NASA was even more explicit in its conclusions: "The question still remains concerning our ability to predict future concentrations of ozone and other atmospheric species" (NASA, 1986:xii).

The first conclusive evidence of an ozone hole over the Antarctic appeared *after* the protocol was signed in Montreal. Despite publicity in popular mass media, no one used a possible Antarctic hole as an argument in deliberations of the Protocol: at the time, the scientific evidence was unreliable and the hole was considered an inexplicable anomaly (Bakken, 1989:201; Benedick, 1998:18–20). In the executive summary of the WMO 1986 report, there was only a passing remark about a decrease in Antarctic ozone but no figure was given (WMO, 1986:20). In 1987 NASA undertook an operation whose findings were termed by the *Washington Post* (October 1, 1987) "the first hard evidence that the critical environmental loss can be blamed on a man-made gas." This proof that CFCs were causing severe depletion over Antarctica was brought two weeks after the Protocol was signed on September 14, 1987. And scientists came to a consensus at a workshop that took place in Berlin in early November (Cagin and Dray, 1993:352–354). Since these conclusions were made after the signing of the Protocol, such information could not have supported decision-making in the making of the Montreal Protocol. The ozone hole did play a role but only in the subsequent evolution of the regime.

Sector 2. Causes of Depletion. There was not sufficient confidence about the causes of the problem and their relative contributions. Stratospheric ozone is under the simultaneous influences of a number of substances of human and natural origin, and there were several alternative explanations of ozone depletion that focused on natural phenomena. Sea spray constantly ejects chlorine atoms from the oceans into the atmosphere, and chlorine acts as a catalyst for converting ozone into oxygen. Another theory drew attention to the role of ice particles on the surface of polar stratospheric clouds. And solar cycles cause radiation to vacillate and ozone levels to fluctuate (Stolarski, 1988). Scientists found it impossible to determine the precise contribution of anthropogenic sources relative to natural factors. One major review of several groups of theories on the causes of depletion concluded that none of them could

explain the Antarctic hole satisfactorily (Solomon, 1988). As late as 1989, two years after the Protocol was signed, an international report explicitly stated that "the current record is too short to differentiate the effects of natural and human-induced processes on ozone" and that no attempt to do so was made (WMO, 1990:ix). And into the 1990s, new suggestions about additional mechanisms that deplete ozone kept appearing (Cagin and Dray, 1993:360).

Sector 3. Consequences of Depletion. By contrast, the potential consequences of ozone depletion were known with certainty and were never disputed by either scientists or policymakers. The detrimental effects of higher UV light were known from the very beginning and did not change essentially over the years of research. They were acknowledged in the first report on the issue (NRC, 1975) and can be classified in three main categories: health effects on humans, effects on terrestrial plants and bacteria, and effects on marine life. These effects were well documented at an early stage, even before multilateral talks on ozone depletion began; and the reliability of such knowledge only grew further over the years. The bibliography of an official 1982 report on biological effects ran thirteen pages (NRC, 1982:116–133). In 1986 UNEP published in three volumes the proceedings of the International Conference on Health and Environmental Effects of Ozone Modification and Climate Change, and each article presented a comprehensive review of existing knowledge.

The effects of excessive UV exposure on skin cancers result from a well-known mechanism through which UV-B solar radiation incurs damage to the DNA that becomes irreversible beyond certain critical levels. By the turn of the decade, ultraviolet damage to the DNA had been extensively documented (Rahn, 1979). A number of nonmelanoma skin cancers have been "unequivocally associated with sun exposure," including premalignant actinic keratosis, basal cell carcinomas, and squamous cell carcinomas (Emmett, 1986). Sun-induced skin diseases constitute more than half of all skin diseases among fair-skinned people and include nonmelanoma and possibly melanoma cancers.[10] It was also known that, in combination with UV exposure, some chemicals in paints, dyes, and antibacterial products commonly used in households produced cancer. In addition, a number of other, non-cancer diseases are either triggered or exacerbated by UV exposure: albinism, herpes simplex, and nutrition deficiencies such as pellagra and porphyrias (Emmett, 1986:143, 138).

Ultraviolet radiation can also damage several parts of the eye: the retina, the crystalline lens, the cornea, and the photoreceptors. The results include cataracts, visual aging, impaired visual development in children, and retinal degeneration—especially in infants and the elderly whose eyes are particularly vulnerable. A long list of studies from the late 1970s and early 1980s demonstrate an association between cataracts and exposure to UV light (Waxler, 1986). The UNEP/EPA report submitted that "depletion of the ozone layer increases the ambient level of UV-B radiation and therefore also increases the risk of eye damage" (Waxler, 1986: 152).

In 1986, the EPA issued a report of 1,600 pages organized in five volumes, entitled *Assessing the Risks of Trace Gases That Can Modify the Stratosphere*. It estimated that increased UV would cause 40 million additional cancers over the next 88 years, 800,000 of them fatal, 12 million more eye cataracts, and a growing number of immune system disorders (Cagin and Dray, 1993:310). Eminent scientific authorities confirmed health effects. The report was peer reviewed and at a

[10] Most research was done on white populations because fair-skinned people are more vulnerable to UV radiation.

congressional hearing the chair of the reviewing panel, Margaret Kripke, graded it as "an up-to-date document that accurately and fairly assessed the state of knowledge." And only between 1975 and 1985, cases of melanoma in the southwestern United States had increased by 340 percent.

Information on the negative effects of excessive UV radiation on plants was equally abundant. Between 1975 and 1985, several hundred studies documented such effects (Teramura, 1986b:255). Two out of every three plants that were tested showed sensitivity to UV (NRC, 1982:339). The resultant changes include reduction in leaf size, decrease in total dry weight, and decrease in the efficiency of water use by the plant. In addition, photosynthesis in some plants was decreased (Teramura, 1986a:170). Eventually, these alterations lead to stunting of plant growth and a decline in plant productivity. The implications for agriculture are significant because the plant species that were found to be most sensitive to UV were crop species: members of the bean, pea, cabbage, and squash families. Studies at the University of Maryland showed a direct correlation between the rates of depletion and yield decline in soybean (Teramura, 1986a:167).

Finally, scientists agreed on the impacts of ozone depletion on marine life. Scores of studies converge on the conclusion that increased ultraviolet light inflicts damage to plankton and marine plants which are essential to aquatic food webs. As early as the 1930s, a number of experiments had shown detrimental impact of UV on aquatic organisms (NRC, 1984). The ramifications of this impact on phytoplankton are particularly sweeping because phytoplankton is at the bottom of the food chain. There are also serious direct effects on zooplankton whose larvae and eggs are translucent and allow deep penetration of UV into the tissues. For some species, such as the bay oyster, a 15 percent decrease of ozone could lead to a 30 percent increase in the number of abnormal larvae (Thompson, 1986).

Shared Knowledge and Collective Action on Ozone Depletion

Throughout the scientific trials and errors in ozone measurements, no one doubted the detrimental potential effects of ozone depletion. Because there was reliable knowledge about the consequences of the problem, this aspect of science was not debated. The chief negotiator for the U.S. notes:

> All of these possible effects were known to the negotiators of the Montreal Protocol, *and they were never seriously contested*. It was generally accepted that changes in the ozone layer pose serious risks to human health and the environment. The point of contention among participating governments was the extent of international action necessary to provide a reasonable degree of protection. (Benedick, 1998:22; emphasis added)

Reliable information about cross-border consequences was significant in two ways. First, it testified to the level of externalities involved: because the consequences of depletion were shared, the problem involved significant elements of interdependence among states. All countries would suffer the effects, regardless of the point of origin of ODSs. Therefore, if regulatory action was to be taken, externalities required an international system of mutual obligations rather than unilateral action that would leave the possibility of damage from emissions abroad.

Second, reliable information about consequences made possible cost-benefit calculations. Data about the detrimental impact of ozone depletion implied that the cost of inaction would be considerable as human health and food production would suffer from the thinning of stratospheric ozone. At the same time, action to ameliorate ozone depletion would not be very costly, for two reasons. First, the consumption of ODSs was of relatively low social value. Industrial uses such as dyes, solvents, and coolants are not negligible, yet none of them served basic social needs

such as food, energy production, or transportation. Second, production of these substances was a negligible part of national economies. CFCs accounted for only 2 percent of the revenues of the largest producer, DuPont (Wettestäd, 1999:135). Moreover, by 1981 it was clear that substantial cuts could be achieved at low costs (Parson, 1993:73). In a risk assessment, the U.S. Environmental Protection Agency (EPA, 1986) estimated the global costs of 50 percent cuts in ODS to be $27 billion, whereas their benefits would be $6.4 trillion in the U.S. alone! Clearly, even rough cost-benefit calculations were in favor of regulations; and they were made possible by undisputed information about the consequences of the problem.

Information about the extent of depletion does not appear to have critically affected the general outcome (regime formation) since uncertainty in this sector of knowledge did not prevent the making of the treaties. This does not mean that such information is irrelevant or unimportant. Knowledge about consequences alone would not be sufficient since the anticipated impact of a problem is a function also of its magnitude, and consequences with no probability that they would take place do not provide reasons to worry about them. The point here is that uncertainty and the lack of conclusive evidence regarding this aspect of the problem did not hamper regime formation. Moreover, this type of knowledge influenced the subsequent evolution of the regime. After evidence of depletion became reliable and widely accepted, countries significantly strengthened the regime. At the first meeting of the parties to the Montreal Protocol in Helsinki in May 1989, 123 countries, including members of the EC, called for complete elimination of ODSs before the end of the century. The London Amendments of 1990 redefined the target as a complete phase-out of most ODSs by the year 2000; and the amendments adopted in Copenhagen in 1992 moved this deadline to 1996.

The Forests Non-Regime

In contrast to the ozone case, efforts to create an international legal regime on forest management have been a resounding failure. Back in the late 1980s, a forester described the international forest agenda as "a series of loudly trumpeted non-events" (Westoby, 1989:165). Today it can be described as a series of loudly trumpeted events with few consequences. Despite an impressive spate of multilateral initiatives and the widely shared view of governments that the destruction of forests worldwide continues at unsustainable rates, states have not created a comprehensive international treaty on forest management. At the same time, existing legally binding agreements that bear tangential relevance to forest issues have not been utilized to introduce international forest policy.

Failed Efforts at Regime Formation

The international agenda of forest policy deliberations is greatly fragmented. It consists of a large number of local, bilateral, and regional initiatives that involve a variety of actors: NGOs, states, and IGOs such as the Food and Agriculture Organization (FAO), the United Nations Environmental Programme (UNEP), and the UN Developmental Programme, and a number of developmental banks including the World Bank. In addition, innumerable NGOs such as the Forest Stewardship Council and the International Union of Forest Research Organizations fund forestry projects and actively engage in forest-related research, education, and training.

The global institution that is most directly relevant to forests is the International Tropical Trade Agreement (ITTA), established in 1983 and renegotiated in 1994.[11]

[11] The text of the agreement can be found in a database of Tufts University, available at ⟨http://www.tufts.edu/departments/fletcher/multi/texts/BH837.txt⟩ (July 2002).

The design of the ITTA makes it far from adequate for protection of forests, for three reasons. First, the agreement is limited in geographic scope: it covers only tropical forests even though 80 percent of industrial wood comes from temperate and boreal forests (VanderZwaag and MacKinlay, 1996:12). Second, the ITTA is narrow in thematic scope: it is a commodity agreement that regulates trade in timber and largely disregards the ecological functions of forests. Member states have rejected a proposal for certification of tropical timber from sustainably managed forests (ibid.). Finally, the agreement has no monitoring and compliance mechanisms, and the ITTA has no authority to conduct independent reviews of national forest policies (Rawson interview, 1999).

The political movement toward a global forest convention emerged in the late 1980s. A report on the effectiveness of existing tropical forest policies stated that a comprehensive treaty on all types of forests is desirable (Ullsten, Nor, and Yudelman, 1990). At a 1990 meeting of the group of industrialized countries, U.S. president George Bush proposed to start negotiations on a global forest convention (Kolk, 1996:145). International talks on a forest treaty have taken place within three high-profile institutional settings: at the 1992 UN Conference on the Environment and Development (UNCED) in Rio de Janeiro; in four sessions of the Intergovernmental Panel on Forests (IPF) between 1995 and 1997; and during four rounds of the Intergovernmental Forum on Forests (IFF) between 1997 and 2000.

Forest Discords at Rio. The plan to include negotiations of a forest convention in the agenda for UNCED was abandoned at the preparatory stage due to sharp disagreements among states on the need for such a treaty. The group of developing countries (G-77) opposed the proposal from the very beginning, viewing it as a method to raise trade barriers.[12] The Rio conference generated neither new funds for forestry nor a new legal instrument on forests. The only output was a set of nonbinding "Forest Principles"[13] whose insignificance as a legal instrument is reflected in the fact that a very small group of states were interested enough to engage in negotiating the text (Kolk, 1996:158).

After Rio, parties to the ITTA considered expanding the scope of the treaty to include boreal and temperate forests. The U.S. and the European Union firmly objected, stressing that they considered changes in the character of the treaty unacceptable: it would alter the membership and voting procedures, and would shift the responsibilities to the North as producing countries (Kolk, 1996:161). Such a position was considered by developing countries as a double standard: the North was pressing them to take costly action to protect tropical forests while refusing to reciprocate with temperate and boreal forests.

Interim Initiatives. A number of other initiatives were launched in the 1990s. A ministerial conference for forest protection in Europe in June 1993 set off the "Helsinki process" by issuing a set of nonbinding guidelines for forest management. In October the same year, the Conference on Security and Cooperation in Europe convened a workshop on temperate and boreal forests and began what came to be known as the Montreal Process, whose main goal is the development of criteria and indicators for sustainable forest management (SFM), without establishing institutional structures. Apart from multilateral initiatives, at least thirteen unilateral and bilateral state initiatives were begun in

[12] Earth Negotiation Bulletin, available at ⟨www.iisd.ca/linkages⟩ (July 2002). ENB documents are available only in electronic form.

[13] The full text of the Forest Principles can be found in Appendix A in the Canadian Council of International Law 1996:353–359.

the mid-1990s that pertain to various aspects of forestry (Grayson and Maynard, 1997).

Forest Negotiations at IPF and IFF. During the third session of the UN Commission for Sustainable Development in April 1995, countries recognized a need for an international mechanism that is dedicated exclusively to forests. To this end, they established a two-year, ad hoc forum for discussion called the Intergovernmental Panel on Forests (IPF). The IPF met four times between 1995 and 1997 but delegates could not agree on major issues such as financial assistance or the need for a global forest convention.[14] States decided to continue the policy dialogue and Resolution 1997/65 of ECOSOC established another ad hoc Intergovernmental Forum on Forests (IFF). At this point, in order to rally support for a global convention, Canada and Costa Rica initiated a series of expert meetings that involved more than forty countries and organizations.

The bargaining process at IPF and IFF was characterized by stagnation. Throughout seven rounds of talks, the positions of individual countries as well as the arguments offered on each side remained essentially unchanged. Scandinavian countries, France, Canada, Switzerland, the Russian Federation, Poland, the Czech Republic, Malaysia, and others supported the idea of a legally binding agreement. The United States and Brazil were leaders of the anti-treaty coalition which included Australia, New Zealand, Japan, Mexico, India, Indonesia, and the group of developing countries, including China.[15] These countries advocated a nonbinding arrangement. The division between the two camps was based neither along North-South lines nor on types of forests. Each camp included rich and poor countries, some with tropical and others with boreal forests.

The denouement of the IPF/IFF process came at IFF's last, fourth session (IFF-4) in early February 2000, where the most difficult issue was the need for a convention.[16] After long hours spent trying to reconcile opposing positions, consensus could not be reached and the final decision amounted to rejecting the idea of a treaty. The IFF decided on an international arrangement that would include two principal elements: a permanent UN Forum on Forests (UNFF), and a collaborative partnership among relevant international and regional organizations and secretariats of existing treaties to enhance cooperation and coordination among its members. In order to appease the disappointed treaty supporters, the plenary agreed that after five years UNFF would "consider with a view to recommending the parameters of a mandate for developing a legal framework on all types of forests."[17] NGOs dubbed this the "Monty Python paragraph," and one delegate remarked, "In five years' time, a vast array of lawyers will spend large amounts of public money trying to interpret what the negotiators meant."

There was a widespread sentiment among delegates that no substantive progress was made during the IFF sessions. Some delegates said in consternation that the sole reason for producing a final text with recommendations was to justify to their publics and governments the expensive three-year process. Thus, every single international initiative on forests produced a last-minute agreement to keep talking. At UNCED, countries adopted the Forest Principles; IPF ended with the idea to

[14] Coverage and analyses of IPF and IFF meetings are available at ⟨www.iisd.ca/linkages/vol.13⟩ and ⟨www.iisd.ca/linkages/forestry⟩, respectively. The final text of the IPF report is available in electronic form at ⟨www.un.org/documents/ecosoc/cn17/ipf/1997/ecn17ipf1997-12.htm⟩ (July 2002).

[15] China is not a member of the G-77 but often chooses to be represented by its statements.

[16] All information about IFF-4 is based on personal observation of the meeting where the author was employed as a rapporteur for the *Earth Negotiation Bulletin*.

[17] E/CN.17/IFF/2000, available at IFF's webpage at ⟨http://www.un.org/esa/sustdev/ecn17iff2000-sprep.htm⟩ (July 2002).

turn it into IFF; and IFF produced a recommendation to establish a permanent forum for discussion. After years of research, inter-sessional meetings, and formal debate, there remains strong resistance to the extension of international forest policy to include a legal treaty.

There are many stumbling blocks in international debates on forest issues: the large number of actors involved, business interests in exploiting forest resources, concerns with relative gains, the unwillingness of rich countries to offer funds for a treaty. Each of these factors helps explain the failure to conclude a forest treaty. One fundamental obstacle to regime formation, however, is posed by the insufficient information about key aspects of the problem of deforestation. In particular, gaps in existing scientific knowledge about the consequences of the problem create uncertainty about the benefits that would accrue from an international policy agreement.

Forest Science

Comprehensive global forest assessments began recently. While the literature on local and national forest resources has been extensive, it was not until 1990 that a study was carried out on a global scale, by the Food and Agriculture Organization (FAO, 1995a). At present, several multilateral scientific programs are under way for assessing and monitoring forest resources in order to provide the international community with appropriate information: FAO's Forest Resources Assessment (FRA); the LANDSAT Pathfinder Tropical Deforestation Project;[18] and Project TREES by the Joint Research Committee of the Commission of the European Community. While each of them is rigorously pursued, only the FAO's projects provide truly global assessments of all types of forests.

The resulting series of international reports provides plentiful data about the extent of changes in forest cover as well as their causes. However, multilateral reports submit remarkably little information about the consequences of the problem. While there is general discussion of the effects of deforestation, reports do not provide specific estimates of damage. They explicitly acknowledge that global effects on climate change and biodiversity cannot be measured with any degree of precision.

Sector 1. Extent of Deforestation. Knowledge about global rates of deforestation and the extent of the problem is generally considered reliable. Assessments provide extensive data with a high degree of precision and there is general agreement among scientists and policymakers alike that deforestation proceeds at a rapid rate. FRA 1990 consisted of two phases that used different methods: analysis of existing information from national inventories, and a statistical sample survey that used new multi-date data from high-resolution satellite imaging. The results from the two phases of the assessment turned out to be highly consistent. The correlation coefficient of the two estimates of forest cover was 0.96, a correlation "so high to be almost identical" (FAO, 1993:78). The study concluded that between 1980 and 1990 global forests and other wooded lands had decreased at an annual rate of 0.02 percent (FAO, 1995a:7–8). Apart from the global level, the study found strong regional characteristics in the process of change. The rate of change over the decade was 6.6 percent in Africa, 5.9 percent in Latin America, and a much higher 11.3 percent in tropical Asia (FAO, 1993:24). In Europe, there was a net gain in forest area of almost 2 million

[18] The project is a collaborative research effort under the auspices of the NASA Goddard Space Flight Center, the University of New Hampshire, and the University of Maryland.

hectares, a continuation of a trend that had lasted for forty years (FAO, 1995b:30).

Sector 2. Causes of Deforestation. There is general agreement that the main causes of forest degradation are human activities: commercial logging, agriculture, pasture, colonization programs, mining, hydroelectricity projects such as the construction of dams, and military activities.[19] These are conditioned by a large complex of broader socioeconomic factors: rapid population growth, poverty, unemployment, and government policies. At an international expert meeting on forests, no one mentioned natural causes such as fires and disease.[20] And different studies arrive at comparable estimates of the role of particular human-induced causes. For instance, according to a World Bank study, agricultural settlement is responsible for 60 percent of the loss of tropical moist forests (World Bank, 1991:31), and another study found that clearing land for agriculture accounts for nearly two-thirds of tropical deforestation worldwide (cited in FAO, 1995a:29).

Sector 3. Consequences of Deforestation. The negative consequences of deforestation derive from the ecological functions that forests play. Most of these functions are local in character. Forests improve air quality, serve as habitats for biological species, stabilize microclimates, control erosion, and prevent landslides. Trees cool cities and protect them against sand and winds in arid and semi-arid areas, mitigate air pollution, buffer noise, and provide psychological benefits to people. Maintaining forest cover on critical watersheds is essential for safeguarding water supplies for irrigation systems. Forests are also sustainable sources of a number of "minor forest products" such as fruit, seeds, mushrooms, fibers (rattan, bamboo, and reeds), rubber, gums, resins, waxes, pharmaceutical and cosmetic products, and ornaments (FAO, 1982:64). With deforestation and forest degradation, these benefits are lost or diminished and negative consequences are endured.

Yet there is a marked paucity of data on non-wood benefits of forests. One review of existing research unequivocally concludes that information about the *non*-wood products and functions of forests is at a primitive level and that the problems with their estimate and quantification are overwhelming (Nilsson, 1996). The FAO, too, submits that there is no inventory of non-wood forest products (FAO, 1995c). And in its official final report, the Intergovernmental Panel on Forests notes:

> Much attention is still given to timber and forest cover, whereas other goods and services provided by forests, such as fuelwood, the sustainable use and conservation and the fair and equitable sharing of benefits of biological diversity, soil and water protection functions, and carbon sequestration and sinks, as well as other social, cultural and economic aspects, are rarely covered and need to be considered. (E/CN.17/1997/12)

To take one local effect of deforestation, multilateral assessments do not quantify the connection between the loss of soil and deforestation, even though there is information on the extent of soil erosion. According to one estimate, 10 million hectares of arable land are lost because of erosion (Pimentel et al., 1997:106), which

[19] A stark example of this is the Vietnam war during which 1.25 million hectares of forests were spread with defoliants and more than 4 million hectares were damaged by shells (FAO, 1982:90).

[20] A meeting of the Costa Rica–Canada Initiative, Ottawa, Canada, December 6–10, 1999. Personal observation.

hurts agriculture and is related to numerous other problems: siltation of harbors, disruption of sewage because of siltation, eutrophication of waterways, flooding, and increased water treatment costs. Deforestation is known to increase erosion, yet there are few estimates of how much they contribute to it. One of FAO's reports includes a scant two-paragraph comment on soil erosion as a result of timber harvesting and offers no data or discussion of the socioeconomic consequences of such changes (FAO, 1993:54).

The most uncertainty is over the global effects of deforestation: biodiversity and climate change. This is where scientific knowledge is considered to be the least reliable, by both scientists and policymakers. Forests are rich in biodiversity. Tropical forests in particular cover only 7 percent of the land surface but are believed to provide habitat for half of all known species. The general recognition of the importance of forests contrasts with the absence of more specific and reliable data on the impact of deforestation on biodiversity. FRA 1990 provides surprisingly little information and gives only "semi-quantitative evaluation" of the loss of trees but not other species that reside in forests. Furthermore, we do not know the significance of loss of species for human communities. "On a scale of 0 to 10, we are somewhere between 0 and 1.5. That's how poorly we understand biodiversity." As to the impact of changes in biodiversity on societies, "They can only speculate on that" (Trines, 1999 interview). The FAO reports explicitly recognize uncertainty: "the magnitude of such losses or the extent of degradation of biodiversity is unknown" (FAO, 1997:41). Thus, the ecological role of forests as habitats of species has not been considered.

Because forests are both sinks and sources of carbon, they can either mitigate or contribute to climate change. On the one hand, when forests grow, they withdraw carbon dioxide from the atmosphere. On the other hand, the burning of forests releases carbon dioxide and other greenhouse gases such as methane, nitrous oxides, and carbon monoxide (FAO, 1995a). In its second comprehensive report, the IPCC concluded that deforestation and forest degradation accounts for 23 percent of human induced CO_2 emissions (IPCC, 1996). FRA 1990 assessment did not generate data on its own but cited an independent study that found that between 1980 and 1990, deforestation and degradation caused a release of 900 million tons of carbon (FAO, 1995a:11).

A strong connection between forests and climate change would offer a good reason for coordinated state action on deforestation, but two caveats prevent it from being a formative factor. First, there is already a separate climate change regime in the making, and this introduces ambiguity about the need for a separate forest treaty. Second, the science on forests and climate change is still considered incomplete. "The link between forests and climate change is somewhat weak, the knowledge is very much under construction" (Goodale, 1999 interview).[21] Ironically, global warming is expected to have a highly positive impact on the productivity and volume of forests: middle scenarios predict a 20–25 percent increase in net primary production, with a benefit to the forest sector of $10 to $15 billion (Nilsson, 1996:34).

Eventually, assessments conclude that it is hard to draw conclusions from the available data. The FAO recognizes that "the essential needs of researchers and policy makers cannot be met satisfactorily" (1995a:41). Broad reviews of the state of knowledge conducted by the International Union of Forest Research Organizations also reveal a serious lack of data. One overview of existing research concludes that, in view of efforts to set international forest policy,

[21] Decision-makers from Finland, France, the U.S., and the U.K. stated similar views. For instance, Mike Dudley, Head of International Division, U.K. Forestry Commission, said, "The connection between forests and carbon still has to be clarified" (interview December 10, 1999); and Bernard Chevalier of France remarked, "Biodiversity and climate change are not so sure."

> [i]t is rather astonishing that so much data and knowledge are still missing. International organizations such as the FAO and the World Bank and aid organizations such as USAID, CIDA, SIDA, and Finnida [*sic*] have pumped billions of dollars into forestry activities over the decades, and yet we cannot answer some of the most basic questions concerning global forest resources and their functions. (Nilsson, 1996:55)

Moreover, multilateral assessments explicitly state that "it is highly unlikely that it will be possible, in the near future, to make comprehensive inventories of non-wood goods and services on a global basis" (FAO, 1995a:30).

From Information to Knowledge: What Do Decision-Makers Know? Interviews with policymakers and negotiators reveal that their own perceptions closely reflect the state of existing scientific knowledge. Government officials and negotiators tend to think of forests in terms of their local and national benefits and are dubious about cross-border effects of forest degradation. Both advocates and opponents of a forest treaty point out that their global roles in climate change and biodiversity are uncertain. Many of them question the link between forests and climate change. The United Kingdom's senior forest official for international policy commented, "Deforestation is seen as an international problem but in fact the links are not so easy to establish.... The connection between deforestation and carbon [emissions] still has to be confirmed and clarified" (Dudley, 1999 interview). Even leaders of environmental NGOs openly state: "The impacts [of deforestation] are not global, there is no threat to health and human well-being. The consequences are local and national. Both the causes and the consequences are in the locale" (Mankin, 1999 interview).

Most remarkably, even political actors who advocate strong international policy openly recognize existing uncertainties. Canada ardently advocates a forest treaty. Yet, when asked about the scientific knowledge about the shared consequences of deforestation, a Canadian negotiator and policymaker said: "Oh, it is all speculative. To my knowledge, there is no government that tries to ascertain them" (Fullerton, 1999 interview). Another noted, "The link between forests and climate change is somewhat weak, the knowledge is very much under construction" (Goodale, 1999 interview). High-level officers in international forest institutions also acknowledge gaps of knowledge. The head of the IFF Secretariat commented, "There is a lot of mythology in [discussions of] biodiversity, a lot of fiction and few facts" (Maini, 1999 interview). And the coordinator of NGO activity at forest negotiations remarked: "With forests, science is all conjecture. Both the causes and consequences of deforestation are debatable" (Mankin, 1999 interview). Clearly, such shared knowledge cannot easily serve as a basis for, or as justification of, international commitments for costly policies.

Shared Knowledge and Collective (In)Action on Deforestation

In summary, international assessments provide reasonably good information about global forest cover and the rate of deforestation, as well as undisputed principal understanding of the causes of deforestation. However, there is a marked paucity of information about the non-wood benefits of forests and about the consequences of deforestation. Moreover, most of the socioeconomic and ecological benefits of forests are local and national in character. The greatest gap of information is on the shared, cross-border effects of deforestation, and this is reflected in perceptions of decision-makers.

The gaps in information about the cross-border consequences of the problem hamper international policy action in two ways. First, they impede cost-benefit

calculations regarding the protection of forests. While the costs of forest protection are high due to the economic importance of activities that cause deforestation, the benefits from such policies are unclear. Even experienced and concerned foresters note "a lack of clarity about which tropical forests should be saved, how much, *and for what reason*" (Westoby, 1989:167; emphasis added). The shortage of reliable scientific information about the environmental benefits of intact forests does not permit evaluation of the benefits that can be expected from policies of protection.

At the same time, information about the causes of forest degradation implies that the social and economic costs of policy innovations would be high. Deforestation is a conglomeration of cross-sectoral issues in which many socioeconomic interests meet. The utilization of forest products and services extends into different realms such as agriculture and industrial exports, and effective policies for forest management would impinge upon various interests. The economic value of wood products is $400 billion per year, or 2 percent of global GDP (FAO, 1995b:21–25). Consequently, undertaking international obligations for sustainable forest management would have wide social and economic ramifications.

Second, missing knowledge about transboundary impact deprives the issue of elements of interdependence. Because the proven effects of forest degradation are local, they do not easily justify the need for state-to-state obligations. A fundamental obstacle to an international treaty has been the failure of proponents to make a strong case for the need for such a treaty. In private conversations, some delegates at IFF shared the belief that "there are no serious reasons to have a forest treaty" and that "if someone comes up with a really good reason to have a treaty, we would consider it" (Rawson, 1999 interview). Few dispute that forests are important, and all agree that action should be taken; they are not convinced, however, that this action should be coordinated. Even ardent proponents of a treaty acknowledge that forest issues could be handled effectively through unilateral action (Fullerton, 1999, Mankin, 1999 interviews).

Eventually, existing knowledge about deforestation portrays a problem with weak elements of interdependence, and this has affected international debates at various stages. At the Rio conference, the G-77, including China, Brazil, and India, have maintained that because the problem is essentially local, it is subject to national policy and legislation and is not to be considered a matter of international obligations (Grayson and Maynard, 1997:27). The Brazilian Minister of the Environment, José Goldemberg, stated that Brazil saw no need for an international convention unless the uncertainty about greenhouse gas emissions was dispelled (Kolk, 1996:156). Consequently, the text of the Forest Principles omitted references to global or regional benefits of forests. Previous references to the interests of the world community were replaced with "values to local communities" (ibid., 159).

Many countries continue to reject the idea of forests as a public good. Everton Vargas, principal negotiator for Brazil at IFF-4, curtly stated: "Forests are not global commons, they are national resources." Notably, no delegate objected to this statement. The U.S. delegate to the expert meeting in Ottawa, and later a negotiator at IFF-4, stated as a matter of fact, "Forests are inherently local, they are not global commons. The net effects [of deforestation] are too disaggregated" (MacAlpine, 1999 interview).

Uncertainty about the cross-border benefits of forest policy also helps explain states' unwillingness to commit financial resources for implementing a treaty. At IFF-4, all industrialized countries, with the exception of Canada, were adamant in their position that additional financial resources are not justifiable. Even the strongest supporters of a treaty, such as the Scandinavian countries, said there is money already provided on bilateral and multilateral bases, but, they argue, this money is not used properly and efficiently. Such refusal to create a global forest fund makes developing countries oppose a treaty—because they see no other benefit that could accrue from a legally binding agreement.

Knowledge, Power, and Interests in Regime Formation

The exploration of regime making efforts on ozone depletion and deforestation suggests that different types of information carry different weights in decision-making. Reliable information about the cross-border effects of a problem appears to be a particularly important requirement in policy deliberations, and to play a critical role in international policymaking. Conversely, when good information about negative cross-border effects is missing (as in the case of forests), this gap severely hampers the process and may preclude the formation of international agreements. In the case of successful regime formation there was a strong knowledge base regarding the detrimental transboundary consequences of environmental degrading, while such base was missing in the failed case of deforestation. The reasons for the presence and absence of such knowledge appear to be scientific rather than political, a point that is elaborated below. An equally important finding is that other types of information that are seemingly highly relevant in fact are not very important. In particular, conclusive data about the extent of a problem appear to be neither necessary nor sufficient for regime formation. On the one hand, states created a strong policy regime to address ozone depletion despite the lack of conclusive evidence of the extent of depletion. On the other hand, countries have failed to form a regime on forests despite solid data about the high rates of deforestation. Thus, the state of this type of knowledge did not have decisive influence on the international policymaking process in either of the cases.

To summarize the empirical results, the successful formation of the ozone regime was accompanied by significant scientific uncertainty about the extent of ozone depletion, and, to a lesser extent, its causes. There was, however, reliable information and consensus about the consequences of depletion—if and when it occurred. The mechanisms through which increased UV radiation damages human health, terrestrial plants, and aquatic life were well understood and never disputed by either scientists or negotiators. This widely accepted knowledge was a focal point, to use the language of a classic work (Goldstein and Keohane, 1993); it served as a constant background to discussions and created a zone of agreement. It was significant not by itself but in conjunction with other factors, namely, it made possible utility calculations that were in favor of regulations also because of the relatively low socioeconomic value of ODSs.

In contrast, multilateral assessments of forest resources produce solid information about the extent and causes of forest degradation, but there are gaps in knowledge about its transboundary effects. Most of the known impact is confined to the local and national level while information about the cross-border consequences of the problem is extremely scant and incomplete. Furthermore, the perception of policymakers is consistent with research-derived information. Consequently, the benefits that a country would reap from forest protection in other countries remain unclear. This limits incentives for policy coordination under a treaty and diminishes countries' willingness to compromise.

Knowledge and Power

Why was consensual knowledge about consequences available in the ozone case, but not in the forestry case? It is possible to consider the state of knowledge as a dependent variable and to study the impact of interests and power on agenda setting in scientific research, what information is sought and produced, and what knowledge becomes a broadly accepted basis for decision-making. Although this is not the chief subject of study here, for the purposes of our analysis we need to consider that one possible explanation of the observed pattern between the state of knowledge and outcomes would draw on the theme "power and knowledge." According to that line of argument, knowledge is epiphenomenal: it is constructed

by powerful political actors who generate and mold information to buttress their preferences. Hence, the argument would proceed, what really helps interpret the two cases is not the available information but the exercise of power that shaped such information.

The problem with this good theory, too, is that facts and logic get in the way. When the theory is operationalized and its logical derivatives are tested, they do not find full support in the empirical cases. If knowledge were a puppet in the hands of powerful actors, one would logically expect such actors to "produce" information that suits their interests and to contest information that undermines their negotiating positions. This did not happen in either of the cases examined here. Powerful actors were not able to suppress information that runs counter to their preferences, and do not even attempt to do so.

In the ozone case, the United States wanted a treaty and took the political and entrepreneurial leadership in the negotiating process. Furthermore, U.S. research institutions were the prime makers of ozone science and that should have provided good opportunity to massage information. Yet, the U.S. was not able to fabricate evidence about the *extent* of ozone depletion: the uncertainties were blatant and never dispersed until after the key agreement was signed. Moreover, American negotiators and policymakers did not deny the significant information gaps in that particular sector of knowledge. If power shaped knowledge, why was the U.S. unable to "produce" reliable information on this important aspect of the problem?

Similarly, in the forest case, even the most ardent proponents of a treaty, such as Canada, the Scandinavian countries, and Switzerland, readily acknowledged the significant scientific uncertainty about the cross-border consequences of deforestation. In other words, these political actors did not even attempt to manipulate existing knowledge about the problem in order to strengthen their negotiating positions and to further their interests. Hence, the facts of the two cases do not allow us to interpret existing shared knowledge as a function of power, or as a contrivance in its exercise. Certainly, we cannot dismiss altogether the political manipulation of science: powerful political actors can and do affect which scientific projects are funded, who conducts them, and how the results are used. At the very least, however, the empirical evidence presented here should serve as a reminder about the limits to which information is malleable and knowledge volatile.

Knowledge and Interests

Knowledge about consequences exerts influence on the formation of interests along two main pathways: by making utility calculations possible, and by portraying the degree of interdependence involved in the issue. Interests are future-oriented ideas: they are preferences for a particular future. The consideration of alternative futures is therefore intrinsic in the formation of interests. Even critics of rational choice theory agree that actors seek to benefit from their own actions. Therefore, according to the most basic notion of rationality, expected utility is necessary for action.[22] Assuming that a policy regime is at least in part a response to a perceived problem, its expected utility is in preventing or ameliorating this problem's impact. In order to assess the stakes in an ecological development, actors seek to know what consequences this development may have. Reliable information about the impact of a problem plays an integral role in this process, by allowing actors to make utility calculations.

The role of such knowledge is by no means deterministic; data do not dictate the outcome of decision-making. Many political, economic, and personal considerations

[22] On the widely used concept of utility, consult Bruce Bueno de Mesquita's expected utility theory of conflict as well as the work of James Fearon, Duncan Snidal, Kenneth Oye, and James Morrow, among others.

as well as the dynamics of interaction among actors affect collective decisions. The socioeconomic costs of forest protection, for instance, are very high since forest utilization is a cross-sectoral issue that involves a number of economic and broader social interests. It is therefore dubious whether the policy outcome would have been different even if there had been solid information about the impact of deforestation. Yet reliable knowledge about the consequences of a problem is an important permissive condition because it allows a meaningful discussion of the problem, of actors' interests in addressing it, and of the overall policy options.

The second pathway through which this type of knowledge affects interests is by supplying elements of interdependence. A premise of regime theory is that international policy regimes are collective responses to transnational problems that cannot be managed effectively in a unilateral manner. Yet the notion of "transnational" is impossible without reference to available information about the problem: what makes a problem transnational is defined by its cross-border consequences. Hence, the formation of common interests that stem from perceived interdependence depends upon reliable information about the transboundary impact of an alleged problem. How this connection plays out in the two cases was already elaborated in the case studies but some additional observations would be useful.

Elements of interdependence, implied by cross-border impact, strongly affect collective decision-making, and their relevance is clearly reflected in perceptions of policymakers. In comparing deforestation to ozone depletion, U.K.'s senior forestry official for international policy commented, "Ozone depletion was a case where national actions create an international problem. Deforestation is seen as an international problem but in fact the links are not so easy to establish" (Dudley, 1999 interview). And an Indian negotiator noted, "Transboundary issues are more easily addressed by a treaty than localized problems. For example, climate change is a transboundary issue but forests are not. What happens to one's forests will not affect other countries" (Oberai, 1999 interview).

In the case of ozone depletion, multilateral research provided solid and undisputed evidence that the shared consequences of the problem would be grave. Correspondingly, the benefits from preventing depletion were compelling and were seen as such by all actors–even by those for whom the costs of action were greatest. This perception did not form automatically or quickly: techniques of persuasion, individual leadership, trade-offs and other efforts to achieve equity, and many other factors that affect the dynamics of the political process all played their part. Consensual scientific knowledge was an important enabling condition in this process.

In the case of forestry, on the other hand, policymakers do not have solid information about the cross-border consequences of deforestation, and are therefore not convinced about the benefits of introducing an international system of obligations under a treaty. Even treaty advocates admit that the problems can be effectively addressed through unilateral policies. Few see a clear reason to commit their countries to international obligations, particularly given the high socio-economic costs involved in policies to protect forests. Most remarkably, even Canadian negotiators who strongly support a treaty recognize that "for an issue to trigger an international (policy) response, there have to be global dimensions, there has to be a problem that is shared ... common impacts.... Forests don't affect everyone in the same sense" (Fullerton, 1999 interview).[23]

The findings presented here support neoliberal institutionalist claims about the importance of common interests, as well as recent studies that posit that high

[23] Also confirmed by Richard Ballhorn, Chief negotiator for Canada at IFF-4. Interviewed December 1999.

externalities are likely to lead to convergence in state behavior (Sprinz and Vaahtoranta, 1994; Botcheva and Martin, 2001). Thus, the apparent match between perceived interests and knowledge about shared consequences of a problem should not come as a surprise. None of these findings, however, should be regarded as self-evident since they are made possible only by distinguishing between types of information. Previous knowledge-based explanations cannot help us understand the cases because they use an undifferentiated concept of knowledge. From the perspective of the epistemic communities tradition, the failure of regime formation in the forest case would be puzzling, given the impressive array of research efforts that are highly institutionalized in the policymaking structures, and the steady stream of reports that provide solid information about the extent and causes of deforestation. The puzzle dissolves only when we distinguish between types of information, which enables us to see gaps in data about the shared consequences of deforestation. In the ozone case, previous accounts overemphasize the scientific uncertainty about the extent of depletion and overlook the reliable and undisputed data about the detrimental *impact* of potential ozone depletion. Thus, it is not possible to provide an adequate knowledge-based explanation of the two cases unless we distinguish between different areas of knowledge.

None of this analysis implies a single-variable explanation or attribution of causation. The two cases are characterized by different levels of externalities and policy costs. In the ozone case, we have a relatively certain, global externality that accrues to present generations, and relatively low opportunity cost of environmental protection. In the forestry case, on the other hand, externalities accrue disproportionately to future generations, and the opportunity cost of environmental protection is high. These differences could also help explain the weaker cooperation on forestry as well as the more limited role of scientific assessments. The state of knowledge on cross-border consequences is one element of a much broader picture, albeit a very important element. It is worth considering, however, that the state of knowledge is an integral part of other alternative explanations as well. For instance, if one wishes to focus on the externalities involved in each case or the type of good, one cannot discuss these dimensions without discussing negative impacts. Is not the level of externality defined by socioeconomic consequences? Similarly, we cannot explain the cases exclusively with the position of the U.S. Why did the U.S. want an ozone treaty, and how did knowledge about negative consequences help shape its national position? The state of knowledge on consequences helps shape other factors that come to characterize a case, and therefore provides the basis for a complementary rather than a competing explanation.

Concluding Remarks

As long as we treat scientific knowledge as a single variable, we may not be in a good position to adequately assess its role in decision-making or to fully understand the connection between science and politics. This study illustrates the utility of disaggregating knowledge and demonstrates that accurate identification of the role of science in international policymaking requires that we distinguish between different types of scientific information. Instead of asking, "Does science matter?" it is more constructive to ask what kind of scientific information matters. Preliminary evidence from two prominent cases in environmental politics suggests that different types of shared information carry uneven weight in international regime formation. Reliable information about the shared *consequences* of a problem appears to be particularly important in efforts to introduce regimes on deforestation and ozone depletion. In contrast, other types of seemingly relevant

knowledge does not appear to be a critical requirement for international policy coordination.

Moreover, the state of knowledge itself cannot be easily explained as a function of power. While it has not been the focus of this project to study information as a dependent variable, the cases offer important insights regarding the interplay between knowledge and power. Some basic facts in the two stories do not support the power-knowledge hypothesis. Even powerful political actors do not always manage to produce information that suits their interests, and do not even attempt to contest information that undermines their preferences. This finding is yet another benefit of analytically dividing types of knowledge.

The analytical framework advanced here is a useful addition to the research agenda of knowledge-based approaches to the study of international cooperation. Disaggregating knowledge enables us to arrive at findings that are more consistent with theoretical expectations about the importance of information and shared knowledge. Eventually, it helps reduce tensions that have haunted previous work on science and politics. The results throw light on what constitutes usable knowledge and when natural scientific input is likely to affect policy processes. Evidence from two cases cannot be taken as proof of validity or as a conclusive test of propositions but it is a useful start. The centrality of these cases in global environmental politics warrants that these propositions be taken seriously and further tested. Their validity is supported also in studies on international coral reef management and acid rain policies (Dimitrov, 2002a, 2002b) but we clearly need more cases. It would be important to try the framework against the climate change case and to explore the role of shared knowledge about the extent, causes, and consequences of global warming in the dramatic collective decision made recently by most industrialized countries to enter a legally binding regime despite the abstention of the United States. We could also differentiate kinds of shared knowledge in studying other failures at regime formation such as the non-regime on Arctic air pollution, or a variety of existing regimes such as the nuclear test ban regime, the regime on global trade with hazardous waste, or any regional binding agreement such as the Black Sea policy program.

The research agenda can be extended in a number of other directions as well. It is possible to study the role of other types of knowledge such as knowledge about policy options. Or, to change the dependent variable and study the impact of shared knowledge not on regime formation but on regime design or policy implementation. It does appear, for example, that better understanding of the extent of ozone depletion and its causes later on contributed to strengthening the already existing regime. Thus, while complete information about the extent of a problem does not appear necessary for regime formation, the state of such knowledge may relate to regime strength. These and other questions merit further research.

A number of caveats warrant caution in making conclusions about the role of science. First, while some types of information may be necessary, neither type is likely to be sufficient for undertaking collective action because a number of other obstacles can thwart efforts at cooperation. Even if science brings states to a consensus about an ecological problem, collective action problems may prevent cooperation. How these problems are solved remains a major question about which knowledge-based explanations may have little to say. Second, the ideas supported here may not be capable of explaining the national differences in positions of countries at the negotiation tables (Skolnikoff, 1997). In this respect, we have to resort to other existing studies for help (Sprinz and Vaahtoranta, 1994; SLG, 2001). Furthermore, the transition from science to policy is structured by social relations between scientific and policy communities that vary across countries (Jasanoff, 1986). Organizational and cultural differences between political systems may affect the use of information. Such caveats warrant analytical rigor and methodological

discipline in studying the interface between science and politics but they are not sufficient reasons to dismiss the importance of science. What we need are comparative studies that examine the differential role of types of shared knowledge in international environmental politics, and that will establish whether the conclusions from this study are generalizable.

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