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Dependable dynamism: lessons for designing scientific assessment processes in consensus negotiations

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Abstract

Negotiations that involve the use and interpretation of scientific information and assessment are often particularly difficult, especially when the scientific input is uncertain or contested. Parties can exploit this uncertainty in order to stall progress, where they might prefer a very different policy outcome. In addition, scientific input often changes as new research is done and disseminated. In order to facilitate decision-making where science is involved, a number of international environmental agreements have established regimes, as well as assessment processes, that are designed to incorporate new information, review decisions, and modify judgments—that is, they are dynamic or adaptable. However, there is little systematic evaluation by policymakers or academic analysts of the type and qualities of such dynamism that might contribute to effective assessment and regulatory processes, or of whether this lesson is truly applicable across very different environmental issues. Examination of the recent protocol on persistent organic pollutants to the Convention on Long-Range Transboundary Air Pollution (LRTAP), in comparison to LRTAPs two previous protocols on sulfur emissions, offers a way to compare across different types of issues whether and how "adaptable" assessment processes influence consensus negotiations. The results of this comparison indicate that a type of adaptability likely to facilitate decision-making is "dependable dynamism"—the quality of assessment and decision-making processes that allows policymakers with ease to put off particular decisions for addressing in the future, with confidence that issues so put off will indeed be addressed later. The ability to modify such conclusions at a later time facilitates decision-making processes by offering a new dimension of compromise on both scientific assessment and policy decisions, and lowering the threshold of credibility necessary for decision-making.

1. Introduction

Establishing consensus on regulatory actions, where there are a large number of competing interests, is often a difficult process. Where there are significant scientific uncertainties and disagreements as well, controversies in scientific assessment processes that inform policy decisions can be a significant force in stalling policy progress. For environmental issues in particular, recent history has shown that making decisions informed by scientific knowledge, and managing interactions between scientific assessment processes and policy discussions, has been a challenge for both scientists and regulators. Compounding the problem of uncertainty and dissent over scientific issues is the rapidly changing state of the science in many relevant disciplines.

Those designing scientific assessment and negotiating processes often look to other agreements in an effort to learn lessons about how better to design such interactions. For example, "Modeled after the Montreal Protocol" was a saying among delegates to the Intergovernmental Negotiating Committee to develop a global legally binding agreement on persistent organic pollutants (POPs), in January 1999 (Earth Negotiations Bulletin, 1999). One of the lessons often drawn from the Montreal Protocol, as well as other existing agreements, is that scientific assessment processes informing decision makers—like negotiations themselves—should be designed as adaptable or dynamic. That is, decision-making that is informed by scientific assessments should be flexible enough to be modified based on future assessment and review.

Richard Benedick, in his attempt to delineate practical lessons from the Montreal Protocol experience, mentions the idea of "adaptability" as a property of decision-making and assessment processes that might

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help other agreements deal with the interactions of science and policy, and the challenge of changing and contentious science. In urging negotiators of other agreements to pay attention to the process, not just the outcome, of negotiations, he writes:

> The developments following the 1987 signing [of the Montreal Protocol] illustrated the wisdom of designing the treaty as a flexible instrument. By providing for periodic integrated assessments—the first of which was advanced ... in response to the rapidly changing science—the negotiators made the accord adaptable to evolving circumstances. In effect, the protocol became a dynamic process rather than a static solution (Benedick, 1998, p. 319).

The idea that negotiations, as well as the scientific assessment processes that inform them, should be somehow "adaptable" is a common one. Though policymakers draw lessons about "adaptability" from the successes of individual agreements such as the Montreal Protocol, it remains unclear exactly what adaptability is, how one might best promote this quality of a decision-making and/or scientific assessment process, or whether it indeed helps decision makers to deal with issues of scientific uncertainty and disagreements in consensus negotiations. Benedick's description indicates that he believes encouraging an adaptable process is a way to facilitate decision-making under these conditions; however, though dynamism or adaptability is frequently mentioned in this context, how adaptability contributes to decision-making is rarely spelled out. Few decision makers or academic analysts have systematically evaluated whether and how this quality might contribute to the effectiveness of scientific advice processes across different environmental issues. This paper is an attempt to add empirical analysis to this area of much policy action, by addressing the issue of adaptation in a more systematic way. With reference to specific assessment process on different environmental issues, it will first ask whether and what sort of "adaptability" contributes to the effectiveness of scientific advice processes, across issue areas. (In this paper, "adaptability" and/or dynamism are used to describe a quality of an assessment or negotiating process that allows modification, adjustment, and other changes over time.) The paper will then examine the mechanisms by which "adaptability" influences these processes, and analyze how an assessment process might promote this quality.

A difficulty of conducting analysis of assessment processes across issue areas is that often, the context, process, and institutional characteristics of assessment are unique to the particular issue. Therefore, it is difficult to find a case where the structure of a scientific advice process is sufficiently similar, such that it might be possible to compare the effectiveness of similar characteristics across issue variation. In one recent example, however, international negotiations addressed an environmental issue in a context and within a framework that has previously addressed very different sorts of issues. These negotiations, under the Convention on Long-Range Transboundary Air Pollution (LRTAP), resulted in the 1998 Århus Protocol on POPs.

The LRTAP convention is an agreement often cited for both its effective use of science in negotiations and its promotion of a particularly adaptable negotiating and assessment process (Levy, 1995). Countries of the United Nations Economic Commission for Europe (UN-ECE) signed the LRTAP convention in 1979. Over its 20-year history, LRTAP has addressed transboundary environmental concerns such as acidification, eutrophication, and photochemical oxidation. The LRTAP convention now includes protocols on sulfur emissions (1985 and 1994), nitrogen oxides (1988), and volatile organic compounds (1991). The most recent protocol addressed the interacting influences of multiple pollutants (1999). The signing in June 1998 of a LRTAP protocol on POPs, as well as a protocol on heavy metals, represented a departure for LRTAP from traditional air pollution issues, in addressing a problem of very different qualities from sulfur and nitrogen, and even from volatile organics. POPs are compounds whose properties of high toxicity, persistence in the environment, and bioaccumulation in living organisms make them a risk to the environment and human health at distances far from the locations of their use and emission (Eckley, 2001). In contrast to sulfur, which can be traced using relatively straightforward atmospheric models from emission to deposition, POPs can revolatilize from environmental reservoirs. Therefore, definitive links between the source of POPs pollution and the location of effects are very difficult to establish (AMAP, 1998). Where the effects of acidifying pollutants such as sulfur are relatively observable in the environment, POPs exert often unseen toxic effects on the environment and human health. And where previous LRTAP protocols addressed unwanted byproducts of industrial processes, several POPs are commercially produced chemicals—chemicals, such as pesticides, that were designed and produced for the very properties that make them of environmental concern (Eckley, 2001; Selin, 2000).

These differences, coupled with the addressing of POPs under the framework of the LRTAP convention, make examining the case of the POPs protocol to LRTAP a useful test for examining lessons about dynamism and adaptability across issue areas. This paper will look in depth at three protocols to the LRTAP convention: the 1998 POPs protocol, as well as the 1994 and 1985 protocols on sulfur emissions, and ask whether, how, and what sort of adaptability influenced the progress of negotiations across these cases. Data for this comparison is drawn primarily from personal interviews conducted in 1998–1999 with LRTAP scientific advisors and delegates involved in the POPs and sulfur protocol assessments and negotiations, as well as the examination and analysis of primary documents from the assessment and negotiating processes. Section 2 will first address the broader question of whether scientific assessment was effective in facilitating policy progress in negotiation of these three protocols (that is, whether scientific assessment contributed to making consensus decisions in this issue area, as opposed to stalling substantive decision-making with debate over scientific questions). Section 3 will explore whether adaptability contributed to effectiveness, examine the pathways by which adaptability influenced effectiveness in these cases, and address how these processes established themselves. Section 4 concludes by hypothesizing lessons that might be drawn across issue areas from these conclusions, and raises questions that policymakers might consider in designing assessment processes on a variety of environmental issues.

2. Effectiveness

On the whole, analysts of and participants in LRTAP are generally positive about its use of science in decision-making processes (e.g. Interview #2, 1998; Interview #8, 1998; Interview #21, 1998). Over the past 20 years, the LRTAP convention has developed a large scientific infrastructure for monitoring and evaluation, and has incorporated an increasing role for scientific assessment and information in negotiations. Levy (1995) notes, "The LRTAP process integrated knowledge-building exercises artfully with the task of negotiating international regulations." Participants in LRTAP negotiating processes often cite science as a strong basis for and one of the successes of their work. One delegate said of LRTAP, "Over the 20 years that the convention has existed, it has built up quite a network and support system to develop good scientific work" (Interview #2, 1998).

Defining what constitutes effectiveness of scientific input into the policymaking process is extremely difficult. Effectiveness can, in fact, be defined in many different ways. Different actors in the policy process often have very different conceptions of what they consider effective; analysts as well vary in what they mean by effectiveness. Even given a choice of what is meant by effectiveness, there is no easy way to measure what is effective, and what is ineffective, in a context in which issues are complex, difficult, and spread out over time. What is primarily important in drawing lessons from previous experience, however, is whether experienced negotiators and regulators saw the process as a particularly effective one—or, alternately, saw it as one that they might like to emulate in future—given their long experience in scientific assessment and decision-making processes. (In this case, these experienced negotiators represented governments.) In this paper, the term "effectiveness" is used consistently with the ways government negotiators used it in interviews—that is, an assessment process is effective where it helped negotiators reach a consensus decision (whatever the outcome), and is ineffective where it hindered the progress towards a decision.

In the negotiations of protocols, participants offer specific examples of how science contributed to the development of policy agendas and regulatory options. In negotiations of the 1985 sulfur protocol, though acidification science was often eclipsed by politics, participants considered science essential in setting the agenda and justifying decision-making. "When this convention came about, certainly it was scientific findings that were in the bottom," said one delegate of the lead-up to the sulfur negotiations. "It was a very long fight to get acceptance that emissions…had a spread that went hundreds and perhaps even thousands of miles, and in the European context at least that meant it was transboundary" (Interview #7, 1998). By the second sulfur protocol, the science of acidification and the institutions of scientific assessment had developed substantially. The protocol was based on the concept of "critical loads" and an effects-based approach to management—that is, emissions reductions are based on cuts relative to thresholds, or critical loads, set based on the effects of environmental pollutants (McCormick, 1998). In addition, in order to facilitate decision-making based on critical loads, negotiators made use of assessment tools such as integrated assessment models, the preeminent one being the regional acidification information and simulation (RAINS) model developed at the International Institute for Applied Systems Analysis (IIASA) (Hordijk, 1991). One delegate drew particular attention to the degree of scientific advancement and its applications to the policy process, noting that "by the time you got to the second [sulfur protocol] we were getting sophisticated in how…you design the protocol to take into account scientific things you knew" (Interview #10, 1998).

In the negotiations of the POPs protocol, delegates applied a strong scientific tradition to a relatively different subject. Though the assessment process involved the preparation of a "state-of-knowledge" report and investigations of emissions, transport, impacts, and abatement techniques, POPs cannot be modeled from source to impact as definitively as sulfur. Scientific assessment of POPs was conducted under LRTAP working groups and task forces. A North American delegate's assessment of the POPs protocol was that "in a very real sense science was the basis, and proved to us the need for us to go out and have a protocol for this"

(Interview #8). Particularly in the core scientific basis for conducting protocol negotiations, delegates cited science as an important influence on the progress towards consensual decisions during the POPs protocol negotiations.

Across the issues of POPs and sulfur emissions, therefore, delegates are generally positive about the way scientific assessment and decision-making were conducted in the LRTAP context. To an analyst hoping to draw lessons about assessment processes, it seems clear that there are certain features of the LRTAP process that make science-policy collaboration effective, in delegates' opinions, across a range of issue areas. Is one such aspect of LRTAP the quality of dynamism or adaptability?

3. Adaptability

As from the Montreal Protocol, the lesson that science-policy assessment processes and negotiations informed by science should be "adaptable" has been drawn from LRTAP. Is "adaptability" a quality that has contributed to the effectiveness of LRTAP's science-policy collaborations across different issues? If so, what sort of "adaptability" might be operable here?

The term "adaptability" is a contested one. Different analysts use the words "adaptability" and "adaptiveness" in different ways. For example, Kai Lee (1993) writes of "adaptive management"—a process by which experimental policymaking might be applied to ecosystem management. Haas and Haas (1995) distinguish "adaptation" from "learning" in their analysis of international institutions, defining adaptation as a means by which organizations alter the strategies they use to pursue their interests, without self-reflection in revisiting problem dynamics. The "adaptability" heralded by Benedick (1998) is different from these, emphasizing the responsiveness of an accord to changing circumstances and advances in science. The quality referred to by Benedick is what seems closest to the lessons drawn from LRTAP—an adaptability as dynamism, linking assessment and negotiating processes.

In analysis of the factors that might contribute to the effectiveness of LRTAP's assessment processes, the dynamism seen in the assessment and negotiating processes stands out. LRTAP's assessment and negotiating processes can respond quite actively to changes in science, or modify conclusions informed by scientific data at later times. For example, the negotiation of a second sulfur protocol, based on critical loads, after a first step had been taken, is an example of the LRTAP process responding to advancing science. Through LRTAP's Task Forces, new scientific information is gathered, and can be raised at the political level in the negotiating group. Assessment processes can be designed as more or less adaptable or dynamic. For example, they could range from virtually inadaptable or static—a process in which all decisions were final—to completely adaptable—in which any and all decisions could be changed at any time. It is clear that either of these extremes would likely signal an ineffective process: in the former case, changing information or preferences cannot be taken into account, and in the latter, policies have no measure of predictability, making rational efforts for compliance nearly impossible.

The LRTAP convention, however, is an instrument that seems to strike a balance between shortsighted rigidity and complete fluidity. The convention itself is an instrument that has been changed repeatedly over its 20-year history by the addition of successive, substantive protocols. In its assessment processes, it is clear that new scientific information can be incorporated into policy negotiations—for example, in the negotiation on subsequent protocols on the same topic, or the input of scientific information such as models during the negotiating process was it, to some extent, this dynamism that contributed to the effectiveness of LRTAP's assessment across different issues? If so, how did it operate?

All three protocols examined shared a sense of dynamism in their assessment processes. In negotiations of the first sulfur protocol, it was agreed that this protocol would be a first step, to be followed by further reductions of emissions in a subsequent protocol. The second sulfur protocol occurred in a history of iterative protocol negotiations, a second addressing of the sulfur issue with additional science and additional regulatory measures. In the context of the LRTAP convention, delegates often refer to the first protocol on a substance or substance category—such as the 1985 sulfur protocol—as a "first-generation" protocol. The second sulfur protocol is referred to as a "second-generation" protocol. The structure of the convention itself, the repetitive addressing of particular issues within it, and even the terminology of "generations" itself shows that adaptability, or dynamism, is an integral part of the LRTAP convention.

LRTAP's POPs protocol was envisioned and designed as a dynamic instrument in the context of the LRTAP convention, and embodied many of the convention's ideals of adaptiveness. Though the protocol regulates a list of 16 POPs,[1] LRTAP's Executive Body has set out criteria and a procedure for adding new substances to the agreement. The decision to incorporate this

[1] The 16 substances subject to the LRTAP POPs protocol are: aldrin, chlordane, chlordecone, DDT, dieldrin, endrin, heptachlor, hexabromobipheny, hexachlorobenzene, hexachlorocyclohexane (HCH), mirex, polychlorinated biphenyls (PCBs), toxaphene, polycyclic aromatic hydrocarbons (PAHs), dioxins, and furans.

dynamism into the POPs protocol was made early in the process, and means that further substances can be regulated in the future without the negotiation of an entirely new protocol.

The particular type of adaptation that contributed to effectiveness in the LRTAP assessment processes was a quality of "dependable dynamism"—the ability of the process to put off or agree to modify conclusions informed by scientific information later, with confidence that they would indeed eventually be addressed. This sort of process allowed parties to facilitate decision-making and consensus-building in two different ways. First, the fact that they believed a decision taken was not necessarily the final airing of a particular issue meant they were more willing to base further action on scientific information they considered less credible. Second, "dependable dynamism" allowed parties to make compromises along a temporal dimension—that is, to agree to keep options open for future revisions, in return for negotiating tradeoffs. These processes facilitated decision-making in all three LRTAP protocols examined.

3.1. Lowering the threshold of scientific credibility

In the first sulfur protocol, negotiations were largely based on political considerations, with limited scientific input. Negotiations aimed to set a target for sulfur reduction—a 30 percent decrease—that all parties would agree to. The decision to choose a 30 percent reduction was not based on science, and the negotiations stalled when some parties used this lack of science as justification for arguing against further action. Björkbom (1997) notes that the US and the UK cited inconclusive scientific evidence as reason for not joining the so-called "30-percent club" of countries that had agreed to the emissions cut. However, in the first sulfur protocol, the assumption that the sulfur issue would be revisited allowed parties to view the 30 percent reduction goal as a first step. One delegate observed that the countries opposed to regulation "were citing an unsatisfactory scientific base for such a thing, and of course they were right, but the function was to simply start the ball along." The science, in his opinion, did not have to be completely determinative because the process could, and would be, revisited later (Interview #7, 1998). Therefore, dynamism contributed to the effectiveness of the assessment process by lowering the threshold of scientific credibility[2] seen as necessary for further action.

In the case of the POPs protocol, a similar mechanism was at work when delegates were making final decisions about which substances would be included in, and which would be left out of, the final protocol list. The initial list of substances for negotiation was developed by a screening process conducted during the early assessment work under the LRTAP protocol. An initial POPs Task Force, during four meetings from 1991 to 1994, conducted much of the early assessment work on POPs and produced a State of Knowledge Report, which substantiated the state-of-the-art science on aspects of the POPs problem (United Nations Economic Commission for Europe, 1994). The assessment work was continued by an ad hoc Preparatory Working Group, which began development of a protocol. The initial list of substances selected for inclusion, identified by the screening process set up by the Task Force and the Preparatory Working Group, incorporated a clear methodology evaluating long-range atmospheric transport potential, environmental persistence, bioaccumulation potential, and toxicity for over 100 substances. The Preparatory Working Group presented 14 substances to negotiators for inclusion on the initial list, and recommended further evaluation and sought policy guidance for six others. The establishment of selection criteria for persistence, bioaccumulation, toxicity, and long-range transport put forth a clear framework by which substances were ranked and ordered. Though this ranking was certainly not purely "scientific," it was generally accepted by parties that a substance's inclusion should be based on scientific properties and not political tradeoffs (UNECE, 1998).

The most illuminating example of the effect of a confidently dynamic assessment process on influencing the progress of the negotiations occurred in the case of one of the 14 substances recommended for inclusion by the Preparatory Working Group: pentachlorophenol. Every delegate interviewed about the role that scientific assessment played in the progress of POPs protocol negotiations mentioned the debates over pentachlorophenol as an example of science influencing policy. Pentachlorophenol, a wood preservative, is a substance widely regulated in Europe, and to several European countries, it was clearly a substance that should have been included in the protocol (European Commission, 1999; Selin, 2000). Late in the negotiations of the protocol, in mid-1997, the United States, prompted by new data from industry, reexamined the initial data that had prompted pentachlorophenol's inclusion.[3] The US believed that the new data indicated that pentachlorophenol did not satisfy the criteria for inclusion. At a meeting of the Working Group on Strategies in September, 1997, technical experts from the US Environmental Protection Agency and the Chemical Manufacturers Association presented the new industry

[2] Credibility is intended to reflect the scientific and technical believability of the assessment to a defined user of that assessment, who is often in the scientific community (Clark, 1999; Eckley et al., 2001).

[3] Interestingly, the data in question had originally been provided by the US Environmental Protection Agency.

data on pentachlorophenol, and their interpretation that this data did not support its inclusion on the protocol.

The industry science presented by the US was greeted with skepticism by Europeans. A senior member of the US delegation observed that when the US raised questions about pentachlorophenol, basically all European countries "laughed at us," since the substance was so heavily regulated in Europe (Interview #1, 1998). Asked how credible he found the information presented by the US, a senior delegate from Sweden said, "We had some problems with that. I mean, our sincere opinion was that this substance should be in the protocol" (Interview #21, 1998). He noted, however, that the US had indicated that it would not sign the protocol if pentachlorophenol was included; the inclusion of the US in the agreement was seen as critical by certain key players in the negotiations, including Sweden.[4]

The outcome of this debate was that pentachlorophenol was left off the initial list of substances regulated under the POPs protocol. A key factor in negotiations that led to this agreement not to address pentachlorophenol was that the POPs protocol was envisioned and designed as a dynamic instrument in the context of the LRTAP convention. It was understood among negotiators that a substance left off the protocol in its first incarnation could later be added via a negotiated procedure relying on scientific criteria and political decision-making (UNECE, 1998). Because the protocol was dependably dynamic, a decision not to address a substance on the initial list did not mean that the substance would never be addressed. For this reason, countries favoring pentachlorophenol's inclusion could agree to put off a decision on the substance until further scientific work could be performed and more evidence could be employed, without agreeing that pentachlorophenol would never be regulated internationally. In fact, the issue of pentachlorophenol was addressed in the section of the protocol dealing with research, development, and monitoring. Parties agreed to encourage research on "levels of POPs generated during the life cycle of timber treated with pentachlorophenol."[5] The inclusion of pentachlorophenol in the research section of the protocol was an additional way that science helped to encourage countries' agreement.

In the case of the POPs protocol, it was the option to put off a decision that lowered the barrier to countries' accepting US science. One delegate mentioned that "we decided rather early that we tried to…find a solution, tried to find a compromise and a protocol, and then anticipate that there would be a second step" (Interview #4, 1998). A Swedish delegate made it clear that the adaptability of the protocol factored into his country's decision to forego action on certain controversial substances. After mentioning his difficulties with the science itself, and the political realities of the US not signing the protocol with pentachlorophenol included, he added:

> At the same time, we said, let's go and look upon this once more after the protocol….not only pentachlorophenol, but also other substances such as chlorinated paraffins that we wanted in. Further substances. So now the next step is once more to go back to science, and really look if there are loopholes that we have to some way or other try to close. If necessary, bring in further research to assess what's been going on. (Interview #21).

The option to put off a policy decision on certain substances facilitated the use of US science as sufficiently credible for moving along the policy process, and thereby contributed to scientific effectiveness in the POPs case.[6] If delegates had not had this option, in contrast, the science put forth by the US would likely have been questioned more rigorously by countries favoring regulation, because not addressing pentachlorophenol would have been a final decision; this would have stalled the negotiating process further.

3.2. *Offering a temporal dimension for compromises*

Dynamism in LRTAP assessment processes also offered a way for compromises, particularly on scientific issues, to be made along another dimension—that is, it added a temporal dimension for compromise on both science and policy options.[7] In the second sulfur protocol, the use of the concept of "critical loads"—and the corresponding concept of "critical levels"—represented a way in which this sort of dynamism facilitated decision-making. The critical loads approach represented an effort to incorporate assessment of the impacts of pollutants into decision-making on protocols. The idea of critical loads grew out of scientific work by impacted countries, particularly Sweden, and commitments to base further protocols on critical loads were elements of LRTAPs 1998 NO_x protocol and the 1991 VOC protocol (Levy et al., 2001). The 1994 sulfur protocol aimed to achieve a "60 percent gap closure" between sulfur deposition and critical loads in Europe

[4] One of the reasons why US participation was viewed as crucial was that the LRTAP POPs protocol was seen as setting a precedent for the global POPs agreement, which had yet to begin negotiations.

[5] A particular concern with pentachlorophenol is that it can be contaminated with dioxin; this clause is included in a section dealing with research on POPs contaminants. See LRTAP POPs protocol, Article 8(h).

[6] i.e. the Swedish delegation could accept the US science as credible enough for the decision that was taken—given that the decision could be modified at a later date.

[7] That is, delegates could not only compromise on actions they would take today, but they could compromise regarding whether decisions would be taken in the future, and what decisions would be on the table at what time.

(Thommessen, 1997). The "critical loads" approach—which set the maximum level of pollutants permitted in order to protect the most sensitive five percent of ecosystems—was generally accepted by at least the European negotiators. What was under negotiation was the degree to which parties would reduce emissions relative to critical loads—termed critical targets. The concept of setting "critical targets" relative to critical loads reinforced the adaptive nature of the agreement. Though the protocol only mandated reductions to critical targets, the critical load remained as a goal to be achieved eventually. By compromising on a critical target, parties were able to agree to reductions less than that target, with the idea that the critical load was still the goal. Parties were therefore able to compromise not only on what reductions were to be undertaken at present, but also what reductions might be undertaken in the future. The "critical load" itself, in addition to the history of repeated protocol negotiations, gave negotiators confidence in the goal of further reduction.

The facilitating of compromise over time was particularly evident in the POPs negotiation. Many issues of contention in the POPs negotiating process, particularly between North Americans and Europeans, were based on underlying differences about the nature of precaution and unacceptable risk. Where, for example, the US regulates substances based on calculated evidence of risk determination, Europeans tend to take a more precautionary approach (European Commission, 2000; Raffensperger and Tickner, 1999). A US negotiator expressed the difference between US and European regulatory policy as a difference between regulations based on hazard and risk. He defined hazard as the quality set that is inherent to a particular substance, and risk as going beyond hazard to say that the substance poses actual harm to the environment or human health, and said of the difference, "We regulate from the risk standpoint, the Europeans tend to regulate from the hazard standpoint" (Interview #1, 1998). The same US delegate noted of the difference in regulatory strategy, "The negotiation was in a sense for far too long a contest between these two systems to see which one would be the rule of the road" (Interview #1, 1998). This difference set up a dynamic in which one set of parties believed that science was sufficiently credible for including a certain set of substances, and another set of parties believed science was too uncertain. A compromise between the two sides would most likely result in some substances thought by the former group to be good candidates for the protocol being left unregulated. However, the dynamism built into the POPs process allowed this compromise to have another dimension—countries could agree to revisit those substances at a later time, a decision that satisfied both sides. Had negotiators in this case been forced to compromise by a process in which decisions could not be revisited, the negotiation would have faced the pitfall of possibly irresolvable debates about whether the science on these additional substances was credible enough to support inclusion on the protocol. This would have stalled negotiations by promoting debates on uncertainty, while other, more certain substances remained unaddressed.

That policymakers were able to put off certain decisions to future negotiations that they were confident would occur contributed to the effectiveness of assessment in negotiations on both sulfur and POPs. The sort of adaptability or dynamism seen in LRTAP is in the spirit of theories of international cooperation and bargaining, which emphasize the "shadow of the future" in determining how likely states are to cooperate (e.g. Fearon, 1998). Fearon (1998) argues that a longer "shadow of the future" can give states an incentive to bargain harder, delaying agreement in hope of getting a better deal. In the LRTAP case, the problem of international cooperation was complicated, among other reasons, by the fact that these negotiations involved scientific considerations, and that there was controversy over scientific uncertainty. The sort of adaptability inherent in the LRTAP process served to shorten the "shadow of the future" by convincing delegates that decisions informed by science could be revisited, facilitating bargaining by lowering the threshold of scientific credibility seen as necessary for decision-making and reducing the incentive for hard bargaining.

How, then, was LRTAP able to encourage "dependable dynamism"? One reason seems to be the existence of a history of repeated addressing of issues. In the first sulfur case, delegates had already reconvened to negotiate a substantive protocol under an existing framework agreement, which gave delegates confidence in the institutional longevity of LRTAP as a convention.

The POPs protocol was negotiated against a background of a long institutional history, that included one second-generation protocol and another, the multi-pollutant protocol, already in the pipeline. This history gave delegates the confidence that an issue put off would not be permanently shelved or forgotten. A related influence is the setup of LRTAP institutionally as a convention-protocol framework, which lowers the presumed barriers to collective action in the future.

4. Conclusions

Dependable or confident dynamism—here defined as the quality of assessment processes that allows policymakers to put off or agree to modify decisions that incorporated scientific information with assurance that they will be addressed in the future—emerged as a common element influencing effectiveness in both LRTAPs sulfur and POPs protocols. The results of this analysis suggest that when policymakers are able with confidence to assure that issues will be addressed later, the policy process can move forward by lowering the threshold of scientific credibility seen as necessary for decision-making, and by offering a new dimension of compromise. The existence of a history of repeated addressing of issues—as seen in LRTAPs convention-protocol framework—contributes to delegates' confidence that issues put off will indeed be addressed later. The LRTAP experience suggests the hypothesis that a more adaptable scientific assessment and negotiating process, in which every decision is not necessarily taken as final, is more likely to be effective than a less adaptable process—where "adaptability" is considered as "dependable dynamism."

If this hypothesis is correct, it might predict that in those cases where decision makers perceive that decisions that take into account scientific assessment will not be revisited, there will be more controversy over the credibility of scientific information used in decision-making, and parties will be less likely to compromise. In cases where assessment processes are more closely tied to ongoing decision-making processes, and decisions are revisited on a routine basis, this predicts that the credibility of science will be less contentious, and parties would be more likely to compromise. Such a hypothesis might be tested by comparing environmental agreements where assessment processes are routinely mandated, versus those in which assessments are ad hoc.

Future negotiations on transborder environmental issues are likely to differ from previous experience both in the issue area addressed and the context in which actions will be taken. Though the conclusions from this comparison cannot offer a concrete basis for both of these types of generalizations, it does suggest that policymakers should look carefully at how they design for dynamism in assessment processes. In designing processes as dynamic, analysis of LRTAP protocols also suggests that policymakers ought to take care to ensure that delegates have sufficient confidence in the process, such that they believe that decisions put off will indeed eventually be revisited.

In the particular case of the recently completed Stockholm Convention on POPs (UNEP, 2001), this analysis of the LRTAP protocols, particularly the POPs experience, raises several questions that those implementing this convention should consider. The global POPs convention is also envisioned as a dynamic convention, to which additional chemicals could be added in the future. This analysis of the POPs process should cause global policy makers to ask, in particular, whether the global POPs convention—without a framework convention or a longstanding institutional history—will succeed in making its dynamism dependable enough, and what sort of mechanisms they might institute to ensure that it will.

The conclusion of this paper certainly does not suggest that "dependable dynamism" is a magic bullet that ensures the effectiveness of assessment and decision-making. However, the comparison of LRTAPs sulfur and POPs protocol assessment processes does suggest that policymakers might want to look particularly at setting up a process that is *confidently* dynamic, in trying to draw parallels from existing assessment experience. If "Modeled after the Montreal Protocol"—or even "Modeled after the POPs Protocol"—is to be more than just a catchy saying among negotiators, this analysis can help to make such lesson-drawing more critical, more reflective, and, perhaps, more effective.

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