

**DESIGNING AN EFFECTIVE CLIMATE REGIME:
ADAPTATION, INFORMATION AND FLEXIBILITY**

Alexander Thompson

Assistant Professor
Department of Political Science
Ohio State University
Columbus, Ohio, USA
Email: thompson.1191@osu.edu

For presentation at the 2005 Berlin Conference on “International Organizations and Global Environmental Governance,” Berlin-Potsdam, 2-3 December, Panel 1.E

Acknowledgements

I would like to thank Joe Arvai, Tom Koontz, Ronald Mitchell, Paul Robbins, Brent Sohngen, David Victor and participants in the Adaptive Research and Governance in Climate Change conference at Ohio State University for useful discussion and insights. I also thank the Mershon Center at Ohio State for financial support.

1. Introduction

This paper analyzes climate change policy from the perspective of international politics. I identify various collective action problems that plague the formation of a global climate regime in general, and assess the promise of an adaptive management approach to climate facilitated by United Nations-based institutions. In the absence of an overarching government—that is, in a state of anarchy—states pursuing international cooperation over climate face difficulties at three stages, the bargaining stage, the transition stage, and the implementation stage. Even if international obstacles can be overcome during these three stages, national leaders may still be undermined by domestic politics at various points in the regime formation process.

Aggravating these political challenges is the uncertainty that characterizes the climate challenge. Like many environment and resource issues facing policymakers, the problem of global climate change is plagued with uncertainty regarding its precise causes and impacts and its long-term implications for humans. This makes the formulation of effective responses—in terms of both mitigation (reduction of greenhouse gas concentrations) and adaptation (responses to climate changes)¹—difficult and necessarily based on educated guesses. Feeding this lack of information is the sheer complexity of the climate change phenomenon, with manifold causes and consequences that range from the local to the regional and global levels. Uncertainty and complexity also make it difficult to estimate the relative costs and benefits—and distributive consequences—of alternative policy options. The thirst for increased certainty strengthens the political temptation for inaction.

I argue that the adoption of a more gradual policy strategy informed by ‘adaptive management’ principles may help overcome these cooperation problems. In studies of local and

regional environment and natural resource policy, proponents of adaptive management, an approach involving policy experimentation to systematically gather information on successive management treatments, have provided a theoretically appealing method and a growing set of apparent success cases (Holling, 1978; Walters, 2002; Lee, 1993; Gunderson et al., 1995).

Adaptive management is indeed a reasonable response to uncertainty and to the bounded rationality of policymakers, allowing them to learn and improve policies over time. It has been recommended for improving management even in large-scale and complex systems (Holling 1993; Johnson 1999), including climate change itself (Dowlatabadi 2002).

The anarchy of the international system presents problems, however, that domestic regulators do not confront. I conclude that *in principle* an adaptive management approach has much to offer in the area of global warming policy but that *in practice* various political barriers militate against its use in an active, centralized manner. Nevertheless, existing institutions and practices at the international level could be redirected toward more systematic gathering of information and more efficient learning, thereby allowing policymakers to capture some of the benefits of an adaptive management approach. The spirit of adaptive management is indeed a useful guide for the creation of a global climate regime under UN auspices.

In the next section I provide an analysis of the international politics of creating a climate change regime. The third section discusses both the appeal and the problems associated with applying adaptive management principles to global climate change and makes policy recommendations that follow from the discussion. The final section concludes.

2. Climate Cooperation under Anarchy

International relations theorists commonly describe the international system as anarchic in the sense that there is no government above the level of states to manage world affairs and enforce international agreements. This condition breeds competition and mistrust (Waltz, 1979) and implies that solutions to international problems must come through decentralized, self-help mechanisms. This has been conceptualized as the problem of “cooperation under anarchy” (Oye, 1986). Anarchy implies that the most frequently advocated solutions to commons management at the domestic level, a coercive Leviathan and the establishment of stable property rights (Hardin, 1968), are usually unrealistic at the international level.

Climate cooperation can be thought of as taking place over three stages: the bargaining stage, where agreements are reached and institutions designed; the transition stage, whereby agreements are ratified and the regime is launched; and the implementation phase, when the agreements are (or are not) carried out. Each stage is characterized by particular strategic dilemmas that make concerted action difficult. The stages overlap and are not strictly sequential in practice since anticipation of issues at future stages can affect cooperation in a current stage—for example, anticipation of enforcement problems will affect bargaining over the initial agreement (Fearon 1998). Nonetheless, it is useful analytically to treat them as somewhat distinct. I focus particularly on the transition stage since it has received less attention in the theoretical literature on international cooperation and since it has been unusually important in the evolution of the climate regime.

The cooperation problems exhibited during these three stages illustrate many pitfalls of applying an adaptive management approach to global environmental problems. Ironically, however, the solutions necessitated by these political obstacles have, as a largely unintended

consequence, laid the foundation for employing an adaptive strategy, as I outline in the next section.

2.1. THE BARGAINING STAGE

The first and formative phase of international cooperation in any issue area involves bargaining over the objectives and specific means for addressing a particular problem, including the design of any rules and institutions that will be created.² At a minimum, a common understanding of the problem, agreement on at least some basic goals, and the establishment of standards—including issues as mundane as a uniform lexicon for discussion and common measurements for emissions—must be agreed upon to serve as building blocks for regime formation. Such minimal aspects of cooperation at the bargaining stage make take the form of simple coordination and standard setting. This is not a difficult cooperation problem: With minimal communication, actors should be able to achieve their goal of coordinating policies and the resulting outcome should be stable (Stein, 1982). Thus, for example, the 1992 UN Framework Convention on Climate Change (FCCC) embodies various coordination points: global warming is indeed a potential threat to humans, a multilateral approach is needed to address the problem, the UN is the proper political forum for negotiation and treaty-building, atmospheric concentrations of greenhouse gas should be reduced, developed countries should pay a higher proportion of the mitigation costs, etc. The treaty has been almost universally embraced by states (187 have ratified it) and none of these basic principles has been fundamentally challenged.

Most subjects of international regime formation, however, raise concerns regarding the distribution of costs and benefits across countries—that is, there are winners and loser as a result

of the choices made. Even when all parties could be made better off by an international agreement, sensitivity to *relative* gains is sometimes an important obstacle to international cooperation (Grieco, 1988). Distributive implications are especially stark in the area of climate change.

The most notable example in the case of the current regime was the initial establishment of baselines and the allocation of “assigned amounts”, or emissions reduction targets, for the 2008-2012 commitment period. In effect, this process establishes the size of the carbon pie and each state’s share of that pie. For much of 1996 and early 1997, climate negotiations were stalemated over precisely this issue (Bodansky 2001, 36) and targets were not agreed to until the final night of Kyoto negotiations. Most fundamentally, the choice among basic criteria used to assign emissions quotas—overall emissions, per capita emissions, emissions compared to GNP, emissions per land area, historical emissions, etc.—creates obvious winners and losers. The decision to ignore population will ultimately hurt large developing countries, though the decision to take past emissions into account (by initially imposing commitments only on industrialized countries) will benefit them once Kyoto is implemented. The creation of the market mechanism for trading carbon permits, combined with uncertainty regarding the future value of permits, has exacerbated distributive concerns over allocation, as David Victor (2003, p. 215) argues: “Allocation of emission permits is particularly difficult not only because the assets at stake are extremely valuable but also because the future demand for permits is highly uncertain....In the case of global warming, [countries] will focus on the downside danger that future emissions and abatement costs will be higher than anticipated, and they will demand additional permits accordingly.” Precisely as this logic would predict, the post-Kyoto Conferences of the Parties (COPs), especially those in The Hague (COP 6, 2000) and Marrakesh (COP 7, 2001), became

mired in negotiations over carbon credits and additional allowances for sinks created since, and in some cases before, Kyoto.

Countless other issues have distributive implications because of their differential impact on nations' economies. The extent to which emissions reductions efforts can be supplemented by carbon trading and other flexibility mechanisms, such as the Clean Development Mechanism (CDM) and Joint Implementation (JI) (which allow states to acquire emission reduction credits through projects in developing and developed countries, respectively), has been an ongoing subject of heated debate at the climate conferences. Limits on "supplementarity"—a terms used in negotiations to refer to the allowable share of international versus domestic measures to achieve targets—would not be felt evenly across states. Rather, they would disproportionately hurt states with high domestic abatement costs, who would like to use the market mechanism to buy their way to meeting commitments, and those who will have carbon credits to export once implementation begins, such as Russia and the Ukraine (Brander 2003, pp. 31-2). The balance struck between emissions reductions and carbon sinks as means to reduce greenhouse gas concentration also creates differential impacts. A focus on reduced emissions hurts economies that rely on fossil fuels for energy, such as the United States with its abundant coal reserves, and would also harm oil-exporting nations. By contrast, a reduced emissions approach benefits European countries that have already invested in alternative energy sources and those, like Germany, that substantially subsidize coal production. A focus on sinks, on the other hand, could disproportionately burden nations with dense populations (and therefore little room for new forests) and that rely on timber exports—Brazil would like to continue clearing the Amazon forest, for example, and has fought against expansive sink use. Finally, the speed at which mitigation efforts are mandated can affect economies differently. In particular, relatively rapid

mitigation efforts would affect capital intensive and fixed-investment industries more, leading to more disruption in some economies than others (Edmonds and Sands 2003).

When states bargain over distributive issues, political power rather than effectiveness or efficiency tends to determine the shape of resulting institutions and rules (Krasner 1991). This is precisely what we have seen in the case of climate negotiations, where the United States has had disproportionate influence over the nature of the evolving regime. For example, the United States successfully fought to remove any mention of specific targets and timetables in the 1992 FCCC and later, over European objections, pushed for the inclusion of flexibility mechanisms in Kyoto, which were prominently featured in the form of emissions trading, JI and the CDM (Rowlands 2001, p. 46).

Once the United States rejected Kyoto in March of 2001, more reluctant participants such as Canada, Japan, and especially Russia acquired immense bargaining power since their participation was now required for the treaty to enter into force (i.e., to reach the 55% of Annex I emissions threshold). They were therefore able to extract enormous concessions from more enthusiastic participants—namely the European Union. By the end of the Marrakesh meetings in 2001, new rules for counting sinks and new credits for forest and farmland management practices left these three countries with tens of million of tons in additional carbon credits that will count towards their reduction targets or be traded. On the other hand, those states for which the costs of no international agreement are the highest—i.e., those who are most exposed and vulnerable to climate change, such as small island nations and developing countries dependent on marginal agriculture (Luterbacher and Sprinz 2001, p. 6)—have had relatively little bargaining power. The adage that “beggars can’t be choosers” applies. The result is that those who favor a strong and proactive regime are precisely those with the least influence over

bargaining outcomes. Those who are indifferent (because they view the costs of inaction as low) or who have longer time horizons for addressing climate change are advantaged in the bargaining process and have incentives to hold up the process.

In theory, side-payments can be used to alleviate distributive barriers to bargaining; cooperative winners can pay the losers, rendering aggregate gains Pareto efficient (and thus appealing to a wider range of actors). This apparent political solution, however, is complicated by uncertainty: there is no consensus on how exactly alternative policies will harm and benefit given groups over time. Nevertheless, efforts such as the CDM, by transferring clean technology from the developed to the developing world, can be seen as a form of side-payment from North to South (Wiegandt, 2001, p. 138), as can the flexibility concessions granted by the EU to the United States and fossil fuel exporting states.

Finally, even if national leaders or their representatives could reach an agreement at the international level, their efforts are ultimately dependent on sufficient domestic support. Bargaining at the international level is linked to bargaining at the domestic level, thereby constraining the range of international agreements that can be reached. This is commonly referred to as the problem of “two-level games” (Putnam 1988). President George W. Bush promised during his presidential campaign to establish mandatory reduction targets for industrial emissions. Once in office, however, pressure from business interests was too great and voluntary emissions reductions were favored by his administration, making adherence to Kyoto untenable. Since both the impact of climate change and the costs of addressing it will vary so much by region and economic sector within countries, two-level politics have and will continue to complicate international bargaining.

2.2. THE TRANSITION STAGE

While international relations scholars have conceptualized the bargaining and implementation phases of cooperation at length (e.g., Fearon 1998 and Drezner 2000), the political complications of the intervening stage are often overlooked. As a practical matter with treaty-based cooperation, there is often a lag between negotiations and signature, on the one hand, and ratification and entry into force, on the other. In the case of climate, the period between the signing of Kyoto in 1997 and the treaty's entry into force in 2005 was an awkward phase of regime formation due to problems—both substantive and strategic—with ratification, competitiveness concerns if some states move forward while others do not, and unresolved conflicts with international trade rules.

Domestic ratification can be hard to achieve after heads of state have signed international treaties. While international negotiators often anticipate domestic obstacles during the bargaining stage, they may or may not be successful in forging an agreement that reflects the interests of important domestic interest groups. There are two explanations for such an outcome. First, leaders may miscalculate the reactions of constituents or lack information during the bargaining phase, believing they have a sufficient coalition for ratification when they do not. Second, leaders may sign an international agreement in the absence of sufficient domestic support as part of a strategy to overcome domestic opposition and to rally public opinion. The presence of new international commitments can influence domestic politics even if they are not binding, creating incentives for leaders to negotiate and sign agreements before they have mobilized support behind them.

Problems with ratification have plagued the climate regime. Going into COP 6 in The Hague, three years after Kyoto was negotiated, 84 countries had signed but only 30 had ratified

the treaty, none of which was among the industrialized nations subject to binding commitments. While the Clinton administration was a leader in pushing for Kyoto, the U.S. Congress and subsequent Bush administration have rebuffed multilateral efforts. Canada's Prime Minister, Jean Chrétien, signed Kyoto but spent almost five years struggling with domestic opposition from certain regions and sectors of the economy before he achieved ratification. In Australia, several large companies in oil, power and mining lobbied hard to delay ratification (*International Environment Reporter*, March 26, 2003). Thus even if leaders or their negotiators commit to an international agreement they cannot guarantee that they will have sufficient domestic support to achieve ratification. This is the problem of "involuntary defection" discussed by Putnam (1988).

The international politics of ratification may also create strategic incentives to delay participation. Because leaders may not be able to deliver on their international promise, and because they know this is true of other leaders as well, they will be wary of pushing for ratification too quickly unless they are confident it will be reciprocated abroad. Waiting for others to ratify first may be advantageous since it leads to increased bargaining power, as outlined above. We should therefore expect some signatory states to cynically commit to ratification with public statements, in order to convince others that it is safe to do so, but then to delay their own efforts. This is one explanation for Russia's behavior.³ Some states may even seek to "free ride" altogether, hoping that enough other states participate for the regime to move forward while they reap the benefits of mitigation from the sidelines. Indeed, the temptation to free ride at this stage is enormous. Global warming has been called the "grand-daddy of all public goods" (Nordhaus 1991); those who do not participate in the regime will nevertheless benefit from reduced greenhouse gas concentrations and increased climate stability.

The transition from negotiated agreements to a functioning regime also presents potential roadblocks in the form of competitiveness concerns. Fearful that their own economies will be at a competitive disadvantage if they act in isolation, states must be confident that a sufficient number of other states will move forward at the same time in order for the regime to be set in motion. For example, a carbon tax or regulatory burden on energy-intensive industries domestically would favor imports of energy-intensive products from countries that are not burdened by Kyoto commitments. Kyoto's framers recognized this and built in a fairly high threshold for the treaty to become law: 55 states must ratify it, and enough Annex I states must ratify to account for 55% of that group's total emissions. The requirements delayed Kyoto's entry into force but are stringent for a reason: a regime with too few participants would place more pro-active states at a competitive disadvantage economically. It would also render the treaty meaningless if it were binding but only covered a minority of industrialized world emissions.

The Australian example is again instructive. In a March 2003 speech explaining why ratification would not be prudent for Australia, Environment and Heritage Minister David Kemp argued that participation in the regime would pose trade and investment competition disadvantages for Australian business. "If Australia were to ratify," he argued, "Kyoto would create obligations for Australia that are not imposed on many of our regional trading competitors. If these arrangements continued over the longer term, industries could be driven overseas by competitive pressure to countries that might not have as stringent environmental standards as Australia" (*International Environment Reporter*, March 12, 2003). Explaining Russia's hesitation to ratify, an advisor to Vladimir Putin argued that "it would be unfair to Russia to curb emissions and stymie its own growth while the United States and other nations

which account for the bulk of global emissions refuse to join the pact” (*Washington Post*, December 2, 2003). EU leaders were also worried that their alacrity vis-à-vis Kyoto would place their producers at a disadvantage. As one European Commission official informed me, “competitiveness was a major concern for us” (Lars-Olof Hollner, personal communication).

Finally, the transition stage has been characterized by concerns over potential conflicts between the emerging climate regime and existing trade rules embodied in the World Trade Organization (WTO). Trade law issues that had not been considered at length during the FCCC and Kyoto negotiations must now be taken seriously under the specter of binding commitments and a trading scheme. While there are many potential conflicts between the two regimes (Luterbacher and Norrlof, 2001; Brack 1999), I highlight three. First, WTO rules outlaw most subsidies, which many national governments will want to use to promote the adoption of cleaner technologies and fuels, especially in factories and transportation. Updated and more efficient, subsidized producers may have a competitive advantage over producers in countries without subsidies programs. Second, governments may impose regulatory standards (on energy efficiency, fuel use, emissions levels, etc.) that have a discriminatory affect on imported goods if the same standards are applied to foreign products. Alternatively, the burden of such regulations for domestic industry could prompt the use of import duties designed to offset the lower cost of production for foreigners. Such taxes could lead to WTO-based challenges on the grounds of protectionism. Third, government procurement rules designed to favor environmentally friendly products could violate the Uruguay Round’s Agreement on Government Procurement if they are used to discriminate against foreign products and services. In general, WTO dispute panels have favored free trade over environmental regulation when the two conflict—the shrimp-turtle and

beef hormones cases are notable examples. It will be difficult to implement the Kyoto regime if these legal issues remain unresolved.

Despite these political obstacles during the transition stage, many of the most important details of the regime were agreed to during the years between the signing of Kyoto and its entry into force. By the end of COP 7 in 2001, negotiators had agreed to more than 200 pages of agreements designed to flesh out the 23-page Kyoto Protocol and make ratification more politically appealing through compromise. Avoiding stagnation during the transition stage, in the absence of binding commitments, is an important strategy for tackling complex environmental problems at the international level (Victor, Chayes and Skolnikoff 1993).

2.3. THE IMPLEMENTATION STAGE

Problems with monitoring and compliance will bedevil Kyoto's implementation. Two types of noncompliance are of concern to states: noncompliance motivated by opportunism on the part of governments (i.e., cheating) and inadvertent noncompliance due to lack of implementation by private parties or lack of capacity by governments (Chayes and Chayes, 1995).

Theoretically, the problem of cheating with international agreements is often linked to the Prisoners' Dilemma model: lacking enforceable promises, states face short-term incentives to cheat since they cannot be sure others will not do the same. Such incentives are evident since compliance with Kyoto commitments will require costly domestic regulation in most cases. Moreover, the public good properties of the Earth's atmosphere make incentives to defect from the regime, or to avoid participation in the first place, all the more severe. Since no state can be excluded from the benefits of a stable climate, the incentives to free ride—that is, to benefit from other countries' sacrifices without contributing—are great. This stands in contrast to many

issues over which successful international regime creation and implementation occur. Those who choose not to cooperate in a regional trade agreement, for example, are denied the benefits of reduced tariffs, and those who opt out of a military alliance forego the additional security. These goods are excludable, generating incentives to participate (Grundig et al., 2001, p. 167).

The most commonly advocated solution to such cheating problems at the international level is the creation of institutions that can promote iteration—that is, the need to cooperate repeatedly over time—and monitor compliance (Keohane, 1984; Oye 1986). Monitoring behavior under the climate regime will be very difficult, however, since emissions, sinks and market transactions will have to be verified across much of the globe. The institutions of the climate regime will never have the capacity to thoroughly verify emissions and sinks and will never have the authority to engage in centralized punishment of violators. Nevertheless, the evolving climate regime has already begun to implement an impressive program for monitoring and verification, which may indeed succeed in minimizing cheating. It begins with national reporting on implementation efforts under Article 12 of the FCCC and Articles 7 and 8 of the Kyoto Protocol, which are supplemented by periodic verification by “expert review teams” and dissemination of information by the FCCC Secretariat. It remains to be seen whether this system will reliably detect noncompliance and, more fundamentally, whether there is sufficient political will among states to provide the necessary resources and access. As David Victor (2001, p. 57) points out, U.S. regulators monitoring sulfur dioxide emissions—the most common domestic analogy to greenhouse gas emissions—have the benefit of continuous monitoring as well as enforcement capabilities backed up by courts. There are no such luxuries in the anarchy of the international political system.

When cheating occurs repeatedly or egregiously, some sort of enforcement mechanism is necessary. Enforcement is an especially difficult prospect in climate since there is little incentive for an individual nation to pay the costs of enforcing international rules. Due again to the public good nature of the global climate, the benefits of enforcement are distributed roughly equally throughout the globe and the harm of a violation to any given nation is small (Victor, 2001, pp. 66-67). As Daniel Bodansky (2001, p. 216) points out, violations “implicate community interests, rather than injure a particular state.” Enforcement itself thus faces the classic collection action problem and temptations to free ride (Olson, 1965). Contrast this with violations of other types of international agreements, such as those in trade and disarmament. Violations—higher tariffs, retention of weapons—have direct implications for certain nations, giving them an incentive to pay the costs of enforcement.

In any case, even if the international problem of cheating can be solved, domestic politics may intervene again at this stage. Even when governments are able to overcome domestic political barriers to ratification of an international agreement, implementation of that agreement may still be undermined by sub-state actors. Industries, interest groups, individuals, and even courts “often find sufficient leeway to delay and, potentially, circumvent the implementation of international [climate] obligations at the domestic level” (Sprinz and Weiss, 2001, p. 67). EU officials, for example, doubt whether Russia has the institutional capacity and resources to carefully track the behavior of relevant actors at the domestic level and to generate thorough national reports (Anonymous European Commission official, personal interview).

The three stages of climate cooperation and their associated cooperation problems are summarized in Figure 1. In the next section, I discuss how decisions already made in response to the political obstacles confronted during the bargaining and transition stage (the implementation

stage has yet to unfold in earnest) have provided a partial foundation for applying adaptive management principles to climate change.

Figure 1. The Stages and Obstacles of Climate Cooperation

Stage 1 Bargaining	Stage 2 Transition	Stage 3 Implementation
Cooperation obstacles: <ul style="list-style-type: none"> - coordination/standards - distributive conflict - two-level politics - bargaining power v. efficiency - variable costs of action and inaction 	Cooperation obstacles: <ul style="list-style-type: none"> - domestic opposition - strategic ratification politics - free riding temptations - competitiveness concerns - conflicts with trade rules 	Cooperation obstacles: <ul style="list-style-type: none"> - incentives to cheat - monitoring - collective action of enforcement - domestic implementation - lack of capacity

3. Adaptive Management and Climate Change

In light of these political difficulties, the best chance for creating effective policies and institutions to tackle climate change could lie in an approach inspired by adaptive management principles. In its purist form, adaptive management treats management policies as experiments designed to “test clearly formulated hypotheses about the behavior of an ecosystem being changed by human use” (Lee, 1993, p. 53). This experimentation goes beyond normal trial and error and casual observation; it is structured and theoretically driven, designed to elicit specific information to be incorporated systematically into future treatments and decisions. Good adaptive managers, like good experimenters, should be open to surprises in the form of

unanticipated information. The approach's appeal rests on its ability to inform environment and resource managers even in the face of complex problems and high levels of uncertainty, allowing them to learn over time and move toward better—if not optimal—management strategies.

Since management typically must proceed despite uncertainty, the only option is some form of “learning by doing” (Walters and Holling, 1990). Adaptive management provides a framework for such an approach. While its experimental focus might be especially appealing to scientists, it is not an effort to develop abstract scientific models divorced from real people; on the contrary, adaptive management seeks to understand the continual interaction between human behavior and natural systems. As C.S. Holling (1993, pp. 553-4) indicates, it is often the case that “the system itself is a moving target, evolving because of the impacts of management and the progressive expansion of the scale of human influences on the planet.” Its concern with the human dimensions of environmental problems makes adaptive management more appealing to social scientists and policymakers than many traditional scientific approaches.

In the remainder of this section I outline the appeal of an adaptive management approach to climate change, address some of the limitations of a top-down experimental approach at the international level, and then discuss how existing practices and institutions at the international level could be restructured to facilitate more efficient learning regarding climate policy.

3.1. THE APPEAL OF ADAPTIVE MANAGEMENT

There are at least three reasons to believe *a priori* that adaptive management is a useful way to approach the problem of global climate change. First, following from the discussion above, any policy approach to global warming must incorporate the interaction of human behavior with the atmosphere, and vice versa. This point is obvious insofar as global warming is anthropogenic,

but, more profoundly, it is also true that mitigation and adaptation strategies themselves will interact with each other and with natural variables, creating a complicated dynamic of cause and effect where most important variables are both exogenous and endogenous. Adaptive management is well suited to incorporating this concern with the constantly shifting human-environment nexus.

Second, adaptive management is inclusive and flexible in terms of the precise goals of climate change policy and the means used to achieve those goals. By definition, the approach seeks to apply a variety of policy treatments to a problem. Moreover, it could be used to pursue a range of policy goals in the areas of both mitigation and adaptation. This flexibility and inclusiveness is appealing from a political and practical standpoint insofar as nation-states have different goals when it comes to climate change policy depending on their distinct values and incentives.

Finally, and most importantly, the sheer complexity of the climate change problem makes an adaptive approach appealing. “[T]he very concept of complexity,” notes one climate scientist (Rind 1999, p. 105), “arose in concert with atmospheric processes.” This complexity results in a high degree of scientific uncertainty,⁴ leaving policymakers unsure of how serious a problem it will be, who will be most affected by its impact, what mitigation and adaptation schemes will be most effective, and how costly such schemes will be. Dealing with uncertainty, ever changing circumstances and incomplete science is, of course, the specialty of an adaptive management approach. In theory, applying adaptive management to climate policy would allow policymakers to proceed and to learn over time, a preferable alternative to the current stalemate in many countries whereby uncertainty leads to inaction. This may be especially valuable since regulators have no past experiences with climate change and its consequences from which to

draw analogies and lessons. In an excellent paper advising policy-makers on how to cope with the uncertainty they face in designing climate policies, Hadi Dowlatabadi (2003, p. 21) argues that “it would be good to have an adaptive learning strategy generating the information necessary to improve policy design at each successive step.”

An adaptive management approach therefore has considerable appeal in the context of climate change policy at the international level. However, many assumptions underlying adaptive management at the domestic level are inapplicable at the international level, with its unique political dynamics. We should be wary about transferring lessons across domains.⁵

3.2. OBSTACLES TO ADAPTIVE MANAGEMENT

Even those who advocate adaptive management recognize that its actual implementation poses various practical and political challenges (Lee, 2001; Walters, 1997; McLain and Lee, 1996). Many of these challenges are exacerbated at the international level, where it is difficult to meet the requirements of an adaptive management approach. An “active” (Walters and Holling, 1990) adaptive management approach requires policies that are “deliberately experimental” (Walters 1986, vii), chosen to as a part of a coherent plan. Returning to Dowlatabadi’s paper (2003, p. 23) on applying adaptive management to climate policy, he advocates “a clear timetable of regulatory experiments,” with specific experiments designed to address specific unknowns. Kai Lee (2001, p. 11) argues that, because centralized coordination is necessary to guide policy treatments and gather information, adaptive management is most likely to be successful when there is some sort of leader in the form of a manager or a public official.

At the domestic level, such an approach is possible with direction and funding from the government. At international level, for many of the specific reasons outlined in Section 2 above,

an adaptive management approach with a coherent framework across space and time is simply unrealistic. The top-down nature of an experimental approach is not viable under anarchy and would be seen as a threat to the sovereignty of nation-states. National leaders always prefer to retain as much policy autonomy and control as possible. This is natural in the face of both international competition and domestic demands on the government, which interact to shape the ever-changing incentives of states. The distributive conflicts of Stage 1 and the free riding temptations and competitiveness concerns of Stage 2 would likely thwart the formulation of a coherent management plan. In the end, whatever policies are chosen at the national level will necessarily reflect a judgment about the risks of climate change and the political tradeoffs associated with different policy options.

Aside from these general problems of international cooperation and sovereignty, adaptive management raises equity concerns and requires a long time horizon, both of which clash with the incentives of elected leaders. Under experimental adaptive management states would be compelled to adopt policies that may or may not be beneficial for them. Indeed, by definition some governments will be asked to pursue strategies that are expected to produce unknown or even harmful effects on their constituents. This may be especially risky in areas where the ecosystem is fragile and the local community vulnerable (van Eeten & Roe 2002). Imposing potentially harmful treatments on countries or communities within them makes sense from the perspective of a grand, controlled experiment that produces national- and international-scale gains in the form of new information, but it may not accord with norms of equity and will often be undesirable politically. Such concerns mean that the complications of two-level politics, important during all three stages of cooperation, will militate against the viability of an adaptive management scheme.

Even if an objective and collectively useful set of policies can be selected by overcoming problems of bargaining and transition, national-level politicians may or may not pursue the goal consistently or faithfully during the implementation stage. In particular, elected officials are notorious for their short time horizons and their concern with personal gain (votes and “rents”) over effective policy, and this works directly against an adaptive management approach. For adaptive management to work, it requires a long-term commitment and a willingness to suffer some short-term losses for the sake of gathering information and improving policy in the long run. This conflicts with the incentives of politicians, who always prefer to choose the policy expected to provide the most benefits to constituents (and, ultimately, the most votes and contributions). Shifting power and coalitions at the domestic level mean that the influence of constituencies may also change over time, influencing policy outcomes. As Lee (2001, p. 13) concedes, “[Adaptive management’s] requirements for patient record keeping and clear-headed assessment turn out to be difficult to muster where there is conflict—that is, in all the important cases” (Lee 2001, 13). We thus face the problem of time-inconsistency: preferences may align for the adoption of an adaptive management plan today but tomorrow there will be incentives to deviate.

For experimental version of adaptive management to be applied to climate change, national and local level management practices would become the object of experimentation on a larger spatial scale. For example, national (or state or provincial) governments would require different localities to apply different treatments—controlling for some factors and varying others—and would then compare the results across these areas and internationally. Imposing from above a structured experimental plan on national governments and communities is seen by proponents of adaptive management as one of its virtues when it comes to large-scale systems,

since this is regarded as the best way to gather relevant information. Applied to large-scale problems, adaptive management allows policymakers to proceed “free from local constraints” (Holling, 1993, p. 554). Politically, however, such an approach to climate policy at the international level—where “local constraints” are jealously guarded national interests—is not feasible.

Finally, adaptive management can be hampered by path dependence and the constraints imposed by existing institutional choices. For example, the rules and incentives created by extant regimes can limit options available for another (I have already discussed potential conflicts between WTO rules and Kyoto). And prior decisions can limit future freedom of action in terms of institutional design and implementation strategies. In the climate case, Kyoto negotiators agreed early on to binding targets as a way to give “teeth” to the Framework Convention. While bindingness clearly has its virtues, this decision may well have limited the willingness of states to engage in “learning by doing”, to involve a wide variety of stakeholders, including both industry and NGOs, and to launch bold but unproven initiatives—practices consistent with an adaptive management approach. Nonbinding instruments are often useful for tackling complex problems for precisely these reasons (Raustiala and Victor 1998).

3.3. TOWARDS ADAPTIVE MANAGEMENT IN CLIMATE POLICY

I advocate a more passive and decentralized management framework inspired by the insights of adaptive management but designed to be more politically realistic. While international organizations can never be quasi-governments and are rarely effective regulators, they can facilitate information sharing and learning among states if properly designed.

In many ways, the logic and practical foundations of an adaptive approach are already evident in the international legal texts. Largely as a consequence of the myriad political obstacles encountered and anticipated during the three stages of cooperation outlined in Section 2, the only way to generate sufficient support for Kyoto was to build substantial *flexibility* into the regime. This flexibility came in two forms: the ability to alter commitments and treaty rules over time, and the ability to select from a variety of policy tools in order to meet commitments. This built-in flexibility has the virtue of allowing for considerable institutional and policy adaptation over time.

The Kyoto Protocol recognizes the need to improve the global management system for climate as new information is gathered and as circumstances change. Article 9 calls on the COP to “periodically review this Protocol in the light of the best available scientific information and assessments on climate change and its impacts, as well as relevant technical, social and economic information.” During the negotiations leading up to Kyoto, even the European Union, which favored an aggressive approach to tackling climate change, recognized the need for “creating a dynamic instrument that can develop over time” (International Institute for Sustainable Development, 1996, p. 2). The Chair of the Ad Hoc Group on the Berlin Mandate (AGBM), charged with negotiating a treaty with binding commitments (a process that resulted in the Kyoto Protocol) warned of “infinite studies that would delay the AGBM’s work” (International Institute for Sustainable Development, 1996, p. 3). In other words, he advocated a principle central to adaptive management: uncertainty should not delay management efforts.

Another virtue of the Kyoto framework from the perspective of adaptive management is that it places few strict limits on the choice of policy instruments at the domestic level, which may include both emissions reductions and sinks, variations of cap-and-trade, taxation schemes

for business, grants to homeowners to improve energy efficiency, command-and-control style regulation, and other tools deemed appropriate by governments. These are complemented by various international options, namely emissions trading, CDM and JI. This means that a wide variety of management techniques will be used and can serve as case studies for comparison and adaptive learning over time. Since so many sectors and actors are potentially implicated by this wide-ranging policy tool-kit, governments will have incentives to solicit feedback from a variety of stakeholders, including industrial emitters, the agriculture, energy and transportation sectors, and consumer groups and environmental NGOs. A key finding of the adaptive management literature is that management is most successful when it is participatory and when knowledge from stakeholders is integrated into policies (McLain and Lee 1996; Shindler and Cheek 1999). While the policy flexibility of the Kyoto regime does not guarantee that such inputs will be sought by governments, it also does not constraint such practices. And since domestic actors are so important during all three stages of climate cooperation—consider the two-level politics of bargaining, the support necessary for ratification, and the requirements of domestic implementation—there have been ongoing incentives for national governments to encourage input from a variety of stakeholders in designing management policies.

Moreover, the climate regime already has a substantial reporting mechanism and thus the potential for information sharing. Among the few requirements of the FCCC is the submission of national reports on greenhouse gas inventories and efforts to implement the treaty and, for developed countries, additional information on specific measures to limit emissions and enhance sinks along with estimates of their effectiveness (Article 12). As early as 1995, climate negotiators understood the importance of mechanism to facilitate “the exchange of experiences on national activities” (International Institute for Sustainable Development, 1995, p. 1), clearly a

precursor to adaptive management. This nationally reported information is coordinated centrally by the Climate Change Secretariat, creating the possibility of an information clearinghouse on climate policies at the global level.

However, to facilitate efficient learning, a requirement for adaptive management, the system for information gathering and dissemination will have to be improved in three ways. First, the nature of the information produced must be modified to include more data on policies and their effectiveness. Most extant reporting and reviews have focused on national activities related to compliance and international credit transactions, information that is not necessarily helpful for improving management. Gathering information on policy experiences is very difficult because the information demands are so intensive. A successful adaptive management regime will have to gather information on both human behavior (i.e., policies) and environmental outcomes, and also evidence that the two are linked (that is, that outcomes would have been different absent the given policy) (Mitchell, 2001). As many relevant variables as possible will need to be reported. Information on the success of policies and measures is scant, partly because there are no agreed guidelines for evaluating policies. As the Secretariat has noted, “In those cases where information on the effects of policies and measures was presented in national communications, it was not always possible to see how these estimates had been arrived at. In spite of their best efforts, few Parties have in place monitoring mechanisms or procedures which they feel are adequate to evaluate progress...” (FCCC/CP/1998/4, p. 4).⁶

Second, in addition to the re-orientation of reports to focus on policy experiences, the quality of information must be improved and standardized for comparison. National reporting systems tend to produce reports that are incomplete and that do not use uniform or even comparable standards. The “in-depth review” process in climate has confronted problems of

comparability across national communications—indeed, reports from the *same* country have not always been consistent over time in terms of the information provided and the procedures used (FCCC/CP/1998/4, p. 3). This led to attempts in Marrakesh in 2002 to clarify technical standards for data exchange among the parties and encourage cooperation among the administrators of national registries (see Decision 24/CP.8). More recently, efforts to improve national reporting were discussed during the December 2003 meetings of the Subsidiary Body for Implementation (SBI) in Milan. In general, national reporting varies widely among Parties (FCCC/SBI/2003/7/Add.4), and some FCCC member states, including Japan and the United States, have called for more specific guidance and agreement with regard to standard formatting and content (FCCC/SBI/2003/MISC.11). The United States’ contribution to the SBI discussions in Milan complains of “individualized reporting approaches” and calls for “uniform terms” and “standardized reporting” (FCCC/SBI/2003/MISC.11, p. 13).

Though higher quality information begins with improved national reports, that information must be coordinated and structured effectively so that it is easily accessible and so that appropriate lessons can be derived. Evidence from other areas of environmental cooperation demonstrate that even modest coordination of national reporting by a centralized institution can greatly enhance the quality and value of that information. For example, European efforts to combat acid rain have been facilitated by the Long-Range Transboundary Air Pollution Convention, whose secretariat, while very weak, is able to serve as an information clearinghouse at the supranational level. As Marc Levy (1993, p. 87-8) notes, “One reason coordination is important is that it ensures comparability of results across Europe. Without standardization of data collection, measurement, and analysis procedures, even those countries with an active interest in acidification would be unable to pool their results. With harmonized research

methods it is possible to make comparative assessments of changes over time. It also enhances the credibility of national research in foreign capitals.” The dual components of comparability and credibility of information are prerequisites for an adaptive approach.

Third and finally, the various institutions at the international level will need to be rationalized and adjusted to facilitate learning through information sharing. The good news is that robust institutions already exist, including the Climate Change Secretariat and the Intergovernmental Panel on Climate Change (IPCC), as well as the World Meteorological Organization (WMO) and the UN Environment Program, which predate the first two. While the WMO is more oriented toward providing information on climate science rather than on policy successes and failures, it already has substantial experience with exchange of data among national meteorological services. A program similar to this but managed by the Secretariat could be very useful. Another innovation could be a periodic report on policies and measures, compiled by the Secretariat or perhaps by an independent group somewhat smaller than the IPCC and that includes policymakers. The IPCC reports on scientific research are almost universally viewed by researchers and policymakers as the most credible and neutral source of scientific information; this bodes well for the possibility of an international effort to produce reports on policy experiences.

For international information sharing to be effective, governments will need to establish structures at the domestic level to make sure relevant information is conveyed. The United States, though not a participant in Kyoto, is a model in the area of information sharing. The U.S. Climate Technology Cooperation Gateway, a joint effort among the Agency for International Development, the Environmental Protection Agency, and the Global Environment and Technology Foundation, an NGO, provides “case studies” of efforts to implement bilateral clean

energy projects, especially in the developing world and economies in transition. Within the EU, sharing on policy experiences is quite well developed. The Commission's Climate Action Program requires governments to report policy successes and failures, and there are frequent multilateral discussions on these matters among the EU membership. Among the Program's stated goals is to identify and analyze policies and measures across sectors (energy, transport, agriculture, forestry and research) and to incorporate "stakeholder consultation" with government, business and NGOs (European Commission, 2003). Indeed, within the EU an approach very similar to adaptive management is being implemented. As one Commission official put it, governments must "fine-tune their policies as new science comes in" (Lars-Olaf Hollner, personal communication). Important lessons can be learned from these efforts by the United States and Europe in order to universalize information sharing on policy experiences.

Returning to the theme of management *under anarchy*, the key virtue of this information-sharing approach is that it respects state sovereignty and should not be viewed as a competitive or distributive activity. While intrusive reviews may be ideal (and may be required for assessing compliance in certain cases), they are neither politically attractive nor necessary for the purpose sharing policy and technical information. The most difficult challenge will be to grant an international body enough autonomy and resources to serve not only as a transnational clearinghouse for information, but to offer independent analysis and assessments of policy experiments around the world and to make recommendations accordingly. (Existing international organizations, including the International Labor Organization, the World Bank, and the Organization for Economic Cooperation and Development, demonstrate that this function is performed in other issue areas.) Improved information sharing with modest centralization to

coordinate and assess would provide the institutional foundation for a politically realistic adaptive management approach.

4. Conclusion

Transnational environmental problems must be managed interdependently among states, and any complete analysis of potential barriers and solutions must include a focus on international politics and foreign policy (Thompson 2000). States grappling with climate change face cooperation problems—stemming from both the anarchy of the international system and the political exigencies of domestic politics—at three stages of regime development: the bargaining stage, the transition stage, and the implementation stage. I have provided a taxonomy of these cooperation problems, many of which characterize regime formation across issue areas, and offered examples from the ongoing politics of climate cooperation.

Adaptive management in the active sense is an unrealistic approach to climate change at the international level because of its emphasis on top-down, structured, and controlled experimentation. Nevertheless, an approach informed by the spirit of adaptive management is the best way to proceed. Uncertainty regarding climate science and the impact of climate change on humans means that treaties must be designed as very incomplete contracts, and a viable regime will have to be flexible and able to evolve over time. This will help counteract the tendency to use uncertainty as an excuse for inaction and will facilitate learning and the improvement of policies as new information—in terms of both science and policy experiences—is gained.

To improve the efficiency of such learning, I have recommended three changes to existing institutions of the climate regime. First, national reporting in the climate regime must

shift its focus toward information on successes and failures of various policies and measures implemented at the domestic level. Data on implementation and compliance will still be important, to be sure, but more information on policy experiences must be gathered and assessed. Second, the quality of national reporting must be improved and the information standardized. Only with credible and comparable information can lessons be drawn and policies adapted accordingly. Finally, the existing institutions of the climate regime must be rationalized to reduce bureaucratic redundancies and re-oriented toward the types of information provision that facilitate adaptive management by national governments. These politically viable modifications of the regime will allow national experiences to be compared at the international level, with lessons applied to future climate policies.

An active, regulatory response to climate change with strict national commitments is simply not realistic in the anarchy of the international system. We should rather devote our energies to the creation of a decentralized regime that is sensitive to state sovereignty and the need to learn over time. In some ways, the UN-based efforts to tackle global warming have placed the cart before the horse. Rather than allow trials with different policies and comparisons of experiences across countries, and then to use some of the knowledge gained to inform the design of a binding regime with specific targets, negotiators began with burdensome commitments fairly early on, before governments had a sense of the costs of compliance and the policy options available to them. National policy experiences could serve as “case studies” to reveal effective policy mechanisms and to guide the design of an ever-improving regime (Hahn, 1998).

Economically, a more gradual approach has cost advantages insofar as it minimizes premature retirement of capital stocks, increases the likelihood of benefits from new

technologies (Edmonds and Sands 2003, p. 177), allows research and development to come to fruition, and permits behavioral changes within societies that lead to emissions reductions, such as new consumption habits and farming techniques. Politically, a gradual approach to cooperation—both in the sense of making the rules “deeper” over time and in the sense of admitting new members sequentially over time—is often necessary and even desirable at the international level (Downs et al., 1998; Abbott and Snidal, 2002). In complex issue areas, the most effective international regimes take decades to develop.

Endnotes

¹ Climate change policy has traditionally focused on mitigation, however slow political progress in this area has placed adaptation squarely on the agenda. For the first time, adaptation was given equal status at the latest Conference of the Parties to the UN Framework Convention on Climate Change in New Delhi, and the most recent White House report urges researchers to focus more on adaptation strategies.

² Of course, bargaining is ubiquitous and occurs at later stages of cooperation as well. Nevertheless, I retain the ‘bargaining stage’ label to maintain consistency with the international relations literature and because bargaining is most central to the early phases of cooperation.

³ Another factor for Russia is it may actually benefit from global warming in some respects. Warmer and shorter winters are appealing. The fact that some countries and regions will likely benefit from global warming (see, e.g., Mendelsohn et al., 1994) implies that some states may actually prefer inaction in the area of climate change. This clearly complicates international climate negotiations.

⁴ The sources of uncertainty are outlined in the most recent National Research Council (2001) assessment.

⁵ On the potential problems of transferring models from the domestic to the international level, see Thompson, 2001.

⁶ This and all other COP documents referred to below are available online at <<http://maindb.unfccc.int/library>>.

References

- Abbott, K., and Snidal, D.: 2002, 'Filling in the Folk Theorem: The Role of Gradualism and Legalization in International Cooperation to Combat Corruption', Presented at the Annual Meeting of the American Political Science Association, Boston, August 30.
- Arrow, K.: 1951, *Social Choice and Individual Values*, John Wiley & Sons, New York.
- Bodansky, D.: 2001, 'International Law and the Design of a Climate Change Regime', In Luterbacher, U. and Sprinz, D.F. (eds.), *International Relations and Global Climate Change*, MIT Press, Cambridge, pp. 201-19.
- Brander, L.: 2003, 'The Kyoto Mechanisms and the Economics of Their Design', Faure, M., Gupta, J. and Nentjes, A., (eds.), *Climate Change and the Kyoto Protocol*, Edward Elgar, Northampton, pp. 25-44.
- Chayes, A., and Chayes, A.: 1995, *The New Sovereignty*, Harvard University Press, Cambridge.
- Dowlatabadi, H.: 2003, 'What Do We Know about Climate Policy Costs and How Can We Learn More?', *OECD Workshop on the Benefits of Climate Policy: Improving Information for Policy Makers* (ENV/EPOC/GSP(2003)11/FINAL), OECD, Paris.
- Downs, G.W., Rocke, D.M., and Barsoom, P.N.: 1998, 'Managing the Evolution of Multilateralism', *International Organization*, 52, pp. 397-419.
- Drezner, D.W.: 2000, 'Bargaining, Enforcement, and Multilateral Sanctions', *International Organization*, 54, pp. 73-102.
- Duncan B., Windram, C., and Grubb, M.: 1999, *International Trade and Climate Change Policies*, Earthscan Publications, London.
- Edmonds, J.A. and Sands, R.D.: 2003, 'What Are the Costs of Limiting CO₂ Concentrations?', in Griffin, J.E. (ed.), *Global Climate Change: The Science, Economics and Politics*, Edward Elgar, Cheltenham, pp. 140-86.
- European Commission.: 2003, 'Climate Change: How the European Union Implements the Kyoto Commitment', Statement of Jos Delbeke, Director of the Environment DG, Before the Committee on Commerce, Science and Transportation, U.S. Senate, October 1. Available online at < http://europa.eu.int/comm/environment/climat/statement_delbeke.pdf>.
- Grieco, J.: 1988, 'Anarchy and the Limits of Cooperation', *International Organization*, 42, pp. 485-507.
- Grundig, F., Ward, H., and Zorick. E.R.: 2001, 'Modeling Global Climate Negotiations', in Luterbacher, U. and Sprinz, D.F. (eds.), *International Relations and Global Climate Change*, MIT Press, Cambridge, pp. 153-81.

- Gunderson, L., Holling, C.S. and Light, S.S.: 1995, *Barriers and Bridges to Renewal of Ecosystems and Institutions*, Columbia University Press, New York.
- Hahn, R. W.: 1998, *The Economics and Politics of Climate Change*, American Enterprise Institute Press, Washington.
- Hardin, G.: 1968, 'The Tragedy of the Commons', *Science*, 162, pp. 1243-1248.
- Holling, C.S.: 1978, *Adaptive Environmental Assessment and Management*, John Wiley & Sons, New York.
- Holling, C.S.: 1993, 'Investing in Research for Sustainability', *Ecological Applications*, 3(4), pp. 552-555.
- International Environment Reporter* (BNA): 2003, 'Handful of Large Companies Lobbied Against Kyoto Protocol, Greenpeace Says', March 26.
- International Institute for Sustainable Development: 1996. 'A Summary of the Third Session of the Ad Hoc Group on the Berlin Mandate of the UNFCCC', *Earth Negotiations Bulletin*, 12(27).
- International Institute for Sustainable Development: 1995. 'A Summary of the First Session of the Ad Hoc Group on the Berlin Mandate of the UNFCCC', *Earth Negotiations Bulletin*, 12(22).
- Johnson, B.L.: 1999, 'The Role of Adaptive Management as an Operational Approach for Resource Management Agencies', *Conservation Ecology* 3(2), 8, [online] URL: <http://www.consecol.org/vol3/iss2/art8>.
- Keohane, R.: 1984. *After Hegemony*, Princeton University Press, Princeton.
- Lee, K.: 1993, *Compass and Gyroscope: Integrating science and politics for the environment*, Island Press, Washington.
- Lee, K.N.: 2001, 'Appraising Adaptive Management', in Buck, L.E. et al., (eds.), *Biological Diversity: Balancing Interests through Adaptive Collaborative Management*, pp. 1-26.
- Levy, M.A.: 1993, 'European Acid Rain: The Power of Tote-Board Diplomacy', in Haas, P.M., Keohane, R.O. and Levy, M.A. (eds.), *Institutions for the Earth*, MIT Press, Cambridge, pp. 75-132.
- Luterbacher, U. and Norrlöf, C.: 2001, 'The Organization of World Trade and the Climate Regime', in Luterbacher U. and Sprinz, D.F. (eds.), *International Relations and Global Climate Change*, MIT Press, Cambridge, pp. 279-95.

Luterbacher, U. and Sprinz, D.F.: 2001, 'Problems of Global Environmental Cooperation', in Luterbacher U. and Sprinz, D.F. (eds.), *International Relations and Global Climate Change*, MIT Press, Cambridge, pp. 1-22.

McLain, R. J., and Lee, R.G.: 1996, 'Adaptive management: promises and pitfalls', *Environmental Management*, 20, pp. 437-448.

Mendelsohn, R., Nordhaus, W.D. and Shaw, D.: 1994, 'The Impact of Global Warming on Agriculture: A Ricardian Analysis', *American Economic Review*, 84(4), pp. 753-71.

Mitchell, R.B.: 2001, 'Institutional Aspects of Implementation, Compliance, and Effectiveness', in Luterbacher U. and Sprinz, D.F. (eds.), *International Relations and Global Climate Change*, MIT Press, Cambridge, pp. 221-44.

National Research Council: 2001, *Climate Change Science: An Analysis of Some Key Questions*, National Academy Press, Washington.

Nordhaus, W. D.: 1991, 'A Sketch of the Economics of the Greenhouse Effect', *American Economic Review*, 81(2), pp. 146-50.

Olson, M.: 1965, *The Logic of Collective Action*, Harvard University Press, Cambridge.

Oye, K.: 1986, *Cooperation under Anarchy*. Princeton University Press, Princeton.

Putnam, R.: 1988, 'Diplomacy and Domestic Politics: The Logic of Two-Level Games', *International Organization*, 42(3), pp. 427-460.

Raustiala, K. and Victor, D.G.: 1998, 'Conclusions', in Victor, D.G., Raustiala, K. and Skolnikoff, E.B. (eds.), *The Implementation and Effectiveness of International Environmental Commitments: Theory and Practice*, MIT Press, Cambridge, pp. 659-707.

Rind, D.: 1999, 'Complexity and Climate', *Science*, 284 (April 2), pp.105-107.

Rowlands, I.H.: 2001, 'Classical Theories of International Relations', in Luterbacher U. and Sprinz, D.F. (eds.), *International Relations and Global Climate Change*, MIT Press, Cambridge , pp. 43-65.

Shindler, B., and Aldred Cheek, K.: 1999, 'Integrating citizens in adaptive management: a propositional analysis', *Conservation Ecology*, 3(1), 9, [online] URL: <http://www.consecol.org/vol3/iss1/art9>.

Sohngen, B., Mendelsohn, R., Sedjo, R.: 1998, 'Valuing the Market Impact of Large Scale Ecological Change: The Effect of Climate Change in U.S. Timber', *American Economic Review*, 88(4), pp. 689-710.

- Sprinz, D. F. and Weiss, M.: 2001, 'Domestic Politics and Global Climate Policy', in Luterbacher U. and Sprinz, D.F. (eds.), *International Relations and Global Climate Change*, MIT Press, Cambridge, pp. 67-94.
- Stein, A.: 1982, 'Coordination and Collaboration: Regimes in an Anarchic World', *International Organization*, 36, pp. 304-24.
- Thompson, A.: 2000, 'Canadian Foreign Policy and Straddling Stocks: Sustainability in an Interdependent World', *Policy Studies Journal*, 28(1), pp. 219-35.
- Van Eeten, M. and Roe, E.: 2002, *Ecology, Engineering, and Management: Reconciling Ecosystem Rehabilitation and Service Reliability*, Oxford University Press, Oxford.
- Victor, D.G.: 2001, *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming*. Princeton University Press, Princeton.
- Victor, D.G.: 2003, 'International Agreements and the Struggle to Tame Carbon', in Griffin, J.M. (ed.), *Global Climate Change: The Science, Economics and Politics*, Edward Elgar, Northampton, pp. 204-29.
- Victor, D.G., Chayes, A. and Skolnikoff, E.B.: 1993, 'Pragmatic Approaches to Regime Building for Complex International Problems', in Choucri, N. (ed.), *Global Accord: Environmental Challenges and International Responses*, MIT Press, Cambridge, pp. 453-74.
- Walters, C.: 1997, 'Challenges in adaptive management of riparian and coastal ecosystems', *Conservation Ecology*, 1(2), 1, [online] URL: <http://www.consecol.org/vol1/iss2/art1>.
- Walters, C.J.: 1986, *Adaptive Management of Renewable Resources*, McGraw-Hill, New York.
- Walters, C. J., and Holling, C.S.: 1990, 'Large-scale management experiments and learning by doing', *Ecology*, 71, pp. 2060-2068.
- Wiegandt, E.: 2001, 'Climate Change, Equity, and International Negotiations' in Luterbacher U. and Sprinz, D.F. (eds.), *International Relations and Global Climate Change*, MIT Press, Cambridge, pp. 127-50.