ADAPTIVE MANAGEMENT OF THE GLOBAL CLIMATE PROBLEM: BRIDGING THE GAP BETWEEN CLIMATE RESEARCH AND CLIMATE POLICY

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Abstract. To date the Intergovernmental Panel on Climate Change (IPCC) has concerned itself with gathering a state of the art review of the science of climate change. While significant progress has been made in enhancing our integrated understanding of the climate system and the dynamics of the social systems that produce an array of potential greenhouse gases, it is also clear from the panel's reports how far the science community is from being able to present a dynamic and synoptic view of the climate system as a whole. Clear evidence of these complexities and uncertainties inherent in the climate system is evident in efforts aimed at designing robust policy interventions. In this paper, we argue that the adaptive management framework in ecosystem management may be a useful model for guiding how the IPCC can continue to be relevant both as a scientific establishment and as a policy-relevant scientific endeavor.

1. The Global Climate Problem: A Role for Adaptive Management?

Like many environment and resource issues facing policymakers, the problem of climate change is plagued with uncertainty regarding the magnitude of its severity and long-term implications. Feeding this uncertainty is the sheer complexity of the climate change challenge, with manifold causes and consequences that range from the individual and local to the regional and global levels. Effective policy responses – in terms of both mitigation (reduction of greenhouse gas concentrations) and adaptation (both reactive responses to climate change impacts and anticipatory interventions aimed at enhancing the resilience of social and natural systems)[1] – are therefore difficult to formulate, and at best are often based on educated guesses.

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The way in which climate scientists and policy makers have traditionally viewed the relationship between these three issues – uncertainty, adaptation, and mitigation – is quite clear. Uncertainty in the context of the climate problem falls within the domain of scientific research, and efforts aimed at reducing it have focused on the oceans (e.g., the development of large-scale ocean circulation models), atmosphere (e.g., models of atmospheric circulation), and land (e.g., measuring the carbon storage capacity of agricultural and forested land). Adaptation and mitigation, on the other hand, have been within the purview of the climate policy community and are largely reactive in nature to an ever widening, often conflicting, and difficult to interpret (from a policy-relevance perspective) array of scientific studies. Viewing the relationship between uncertainty, adaptation, and mitigation in this way is problematic because it discounts the importance of climate policies as means of reducing uncertainty about the overall climate system. Just as laboratory research in biology complements field studies in ecology, so too can the comparative assessment of climate policies and their outcomes complement more traditional research being conducted by climate scientists.

The concept of "adaptive management" (Holling, 1978; Walters, 1986) provides a theoretically appealing framework for strengthening the relationship between climate policy and climate science. It proceeds based on "experimentation" by simultaneously implementing varied policy treatments and then comparing their results to test clearly formulated hypotheses about the behavior of complex systems. Experimentation in this sense goes beyond management through trial and error and casual observation; it is structured and theoretically driven, designed to elicit specific responses from systems under study such that new knowledge can be incorporated systematically into future treatments.

While this experimental focus is especially appealing to scientists, adaptive management reaches beyond the goal of simply enhancing traditional scientific understanding of natural systems independent of human systems. The approach also recognizes that managed systems present moving targets influenced largely by human drivers and, therefore, explicitly incorporates these human factors into management experiments (Holling, 1993). By linking science and policy in this way, the objectives of adaptive management go beyond maximizing utility (from an environmental or human standpoint) relative to a previous baseline under a given management option to also include learning over time about complex and uncertain systems. The added appeal of adaptive management, therefore, lies in its ability to help inform the judgments of policy makers who must address complex problems with high levels of uncertainty.

Implementing adaptive management takes place in two phases: the challenging task of institutionalizing a framework in which intentional and varied policies may be implemented, and the relatively easier task of learning over time by monitoring the responses of the system on which the varied experimental policy "probes" have been enacted.

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, 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 importantly, 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 human-environment nexus.

Second, adaptive management is appealing because of the sheer complexity of the climate change problem coupled with the need to make management decisions under uncertainty. Even after over a quarter century of intense research, questions linger regarding the magnitude of human disturbance, climate sensitivity, impacts of realized climate change, and what mitigation and adaptation schemes will be most effective. Applying adaptive management to climate policy could provide policymakers with the flexibility needed to proceed and to learn over time, a preferable alternative to the current stalemate in many countries and localities where uncertainty leads to incrementalism or inaction. Adaptive management may be especially valuable since many planners and decision makers – particularly those in North America – have reported little direct experience with climate change and its consequences from which to draw analogies and lessons.[2]

Finally, adaptive management is inclusive and flexible in terms of the precise goals of climate change policy and the means used to achieve them. By definition, the approach seeks to apply a variety of policy treatments to a problem. As such, it could be used to pursue a range of policy goals in the areas of both mitigation (e.g., emissions reductions, farming practices and forestry) and adaptation (e.g., accommodating changes in temperature and precipitation patterns, planting new crops and protecting biodiversity, building seawalls to protect coastal areas from flooding). Likewise, the approach also possesses the flexibility to include policy treatments that address climate indirectly; indeed, it is hard to imagine a policy intervention that *only* achieves goals related to climate change. Conversely, there are many interventions that may be pursued and justified on the basis that they help to achieve other goals and address climate change only via a secondary pathway. An example of one such 'no regrets' intervention is the effort to enhance the efficiency of motor vehicles in order to reduce dependence on fossil fuel imports and improve local air quality. In sum, the flexibility and inclusiveness that is inherent to adaptive management is appealing from a political and practical standpoint insofar as it allows different managers – at the international, national, sub-national, and individual levels – to pursue different objectives and options when it comes to climate change policy depending on the values and incentives that are specific to their regions.

2. Challenges to Adaptive Management

Despite its theoretical potential, even those who advocate adaptive management in principle recognize that its actual implementation, irrespective of context, poses considerable practical and political challenges (Lee, 1999; McLain and Lee, 1996; Walters, 1997). Beyond the fundamental obstacle to adaptive management that deals with the requirements that policy makers both learn to fail *and* learn from their failures (Gunderson and Holling, 2002), other challenges stem from potentially high costs associated with developing initial global, regional, and local frameworks for the implementation of adaptive management and take three fundamental forms: spatial variability in political, social, and economic systems; political inertia; and the implications of inequitably distributing the costs and benefits of alternative management efforts.

First, successfully implementing adaptive management involves overcoming the tendency in more traditional resource management to focus on temporal rather than spatial variation in policy treatments. Most resource management efforts tend to be remarkably similar over broad temporal scales, which are punctuated by relatively rapid paradigm shifts. These shifts are accompanied by relatively little or no attention to monitoring and comparison across both spatial and temporal scales. Subsequently, future changes in management occur only with the arrival of additional crises. For example, the policy agenda of the World Bank has evolved from an initial neglect of forest issues to front lining them in the early 1990s (Wade, 1997), only to neglect them again in more recent years. While adaptive management requires spatially diverse to long-lived objectives, most lending and planning strategies are biased towards implementation of fairly specific and sometimes fad-driven management options. In the climate change debate, this tendency is manifested in the widespread call for mitigation via no-till agriculture despite concerns about its long-range effectiveness as the climate continues to grow warmer or as soils erode, and questions regarding the magnitude of the sequestration effect in agricultural soils (Lal et al., 2004a,b; Renwick et al., 2004; Van Oost et al., 2004). Similarly, current incentives in the Kyoto Protocol aim to initiate weakly defined "clean" growth and forestry projects in the developing world. However, the existing treaty – or even more localized efforts – does not provide clear direction for incorporating the learning that can occur over space, as policies adopted today reveal diverse results in differing areas. For example, while individual countries are developing national level emissions monitoring systems, and numerous governments and non-government organizations are developing methodologies to measure carbon abatement and mitigation, few have set up a system whereby they can adapt policies based on a systematic analysis of alternative (sometime similar) approaches that have been implemented in other areas.

In contrast, adaptive management requires simultaneous implementation of varied treatments in different places over long periods of time (Walters, 1986). Reorganizing the institutions of resource management from an emphasis on

temporal, rapidly changing strategies to those which emphasize spatial variability over a longer time period requires a retooling of an entrenched management ethos and bureaucratic structure. While climate change policy in general, and the Kyoto Protocol process specifically, could embrace and potentially benefit from applying the principles of adaptive management, the structure of Kyoto provides no inherent incentive for nations to adopt it them.

From a political perspective, concerted action – and by extension adaptive management – on a global scale is made virtually impossible by the fact that national political leaders are naturally protective of their sovereignty, preferring to maintain as much policy autonomy and control as possible. This is natural in the face of both international competition and domestic demands on the state, which interact to shape the ever-changing incentives of state leaders (Putnam, 1988). So too, the long-term nature of consistent policy treatments in adaptive management exceeds the typical terms of most political regimes. In sum, elected officials and by default, bureaucrats are notorious for their short time horizons and their greater concern with personal gain (votes and "rents") than with effective policy, thereby limiting the potential for implementing adaptive management (Lee, 1993).

Distributive and ethical issues also inhibit the transition from ad hoc policy making to a framework for adaptive management. By implementing intentionally varied management practices, local communities may be compelled to adopt policies that may or may not be beneficial for them. Indeed, by the strict definition of an actively adaptive management framework, some would be asked to pursue strategies that are designed to produce unknown or even harmful effects (or such strategies may be imposed upon them). This is especially risky in areas where local communities are fragile and vulnerable (Van Eeten and Roe, 2002). Imposing potentially detrimental policies on communities makes sense from the perspective of a grand, controlled experiment that produces national- and international-scale gains, but does not accord with norms of social justice.

3. Climate Change: An Ideal Testbed for Adaptive Management

Although the obstacles to implementing adaptive climate management appear to be significant, current climate policy has already overcome many of the most difficult of barriers. Spatially varied management "probes," or experiments, are already underway as a result of the multitude of competing and overlapping sovereign political actors and institutions. Likewise, the global economy in combination with regional variability in climate already distributes costs and vulnerability across communities and places. For example, different types of climate mitigation projects have already been undertaken in different regions of the world (i.e. forestry projects in the tropics versus energy projects in China). In contrast to the active implementation of experimental treatments called for by adaptive management purists, these spatially varied experimental probes are not the result of thoughtful and intentional

manipulation. Instead, the experiments have been stumbled into quite by accident. Still climate scientists and policy-makers ought to take advantage of the happenstance that has created the wide-ranging series of global experiments on climate policy by instituting an intentional, international effort aimed at learning from these experiments.

This effort, we argue, is the easier component of adaptive management to implement: a way of thinking that proceeds based on the imaginative synthesis of information obtained by studying the effects – across appropriately similar scales – of existing, quasi-experimental climate policy probes. Despite the widely cited appeal of adaptive management in a variety of policy sectors, however, such imaginative syntheses are lacking. Take Canada, for example, where in December 2002 the Parliament ratified the Kyoto Protocol. Rather than designing innovative and experimental policies that may help to advance knowledge gleaned from similar global systems, a view from within Canada's climate change plan (Government of Canada, 2002) reveals what amounts to little more than incremental – some would say trial and error – changes to existing Canadian climate policies. Viewing the Canadian plan from the outside does reveal policy treatments that differ substantially from other nations with several similar social, geographic, and physical features (namely the United States); comparing the outcomes stemming from these different policy treatments – and building the findings into subsequent policy decisions – via the framework of adaptive management can enhance social learning.[3]

Likewise, varying community vulnerabilities, both to climate change and climate policy, have led to a range of locally developed responses and practices. What remains absent is a responsive information network that would allow policy communities to track and communicate their experiences – especially with distant, equally vulnerable groups – and to defend such local experimental decisions in national and international arenas. The results of carbon sequestration experiments in Indian social forestry, for example, championed precisely because of local community vulnerabilities (Poffenberger, 2002), are unknown to those conducting similar efforts elsewhere or even to those coordinating national and international climate governance regimes. As a result, such experiments are more vulnerable to elimination and change in an ad hoc national context, despite calls in the scientific literature for just these sorts of interventions (Niles et al., 2002).

Viewed in this light, the adoption of a large scale but passive adaptive management framework (in that the "experimental" probes come in the form of pre-existing policies that vary across scales) works to undercut concerns about the need to implement potentially painful and socially unacceptable polices. Despite this benefit, however, the key to adaptive management in a climate – and indeed any other – context rests on overcoming the tendency to defer difficult decisions and radical departures from existing policies until either more information is available or people simply grow accustomed to a worsening environment. Climate managers and policy makers must develop new ideas by explicitly seeking out analogies or similarities between problems of current concern and others where advances have

been possible (Walters, 1986). It is not the goal of this paper to make this seem like an easy task; quite clearly, it is not. The challenges are varied and include tracking the wide range of polices over both space and time, and clarifying management objectives so as to be able to monitor and draw conclusions in a consistent and defensible manner.

We do believe, however, that a coordinating body working at the international level could facilitate this process by – at minimum – playing the role of an information clearing-house, advisory board, and monitor for climate management. Such an institution would foster long-term consistency and help translate varying experiences with climate management into new policy recommendations. To this end, the Intergovernmental Panel on Climate Change holds considerable promise as the reporting body for assessing the wide range of experiments that have occurred around the world. The IPCC and the Secretariat of the UN Framework Convention on Climate Change should both be strengthened to provide concrete guidance on methods and approaches for adaptation and management. Currently, the IPCC essentially mimics the non-adaptive policy world by concentrating huge amounts of effort from key scientists around state of the science reports every 5 years, and special reports that react to current issues are deemed important. Instead, the IPCC should re-tool to provide a continuous stream of interpretation of adaptive management experiments that are occurring. Beyond specific IPCC and UN initiatives, what is called for at a minimum is a new and more adaptive approach to decision-making amidst climatic uncertainty. Since the nations of the world have long since paid the bulk of the steep initiation fee for implementing adaptive management, the opportunity to learn from it can and should be seized.

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Notes

[1] Climate change policy has traditionally focused on mitigation, however slow 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 (2002) report urges researches to focus more on adaptation strategies.

[2]Our work, particularly in a North American context, has shown that while planners and decision makers in at-risk areas are undertaking adaptive measures, few are doing it with climate change in mind. Much of the adaptation is being undertaken in response to political and social pressures, and to a lesser extent environmental drivers. While many of these pressures and drivers are linked to climate, few of the adaptive policies are linked to climatic change explicitly.

[3]For example, U.S. policy has not adopted the Kyoto Protocol, and has instead focused on voluntary programs aimed at reducing carbon intensity in the economy (CO_2 emissions per $ GDP), and on large research projects aimed at clean energy technologies coupled with biological and geological sequestration. In contrast, Canada has adopted Kyoto, accepts regulations intended to reduce carbon emissions (i.e. through gas taxes and efficiency standards), and also focuses on biological sequestration.

References

Government of Canada: 2002, *Climate Change Plan for Canada*, Queens Printer, Ottawa.

Gunderson, L. and Holling, C. S.: 2002, *Panarchy*, Island Press, Washington, DC.

Holling, C. S. (ed.): 1978, *Adaptive Environmental Assessment and Management*, John Wiley & Sons, New York.

Holling, C. S.: 1993, 'Investing in research for sustainability', *Ecological Applications* **3**, 552–555.

Lal, R., Griffin, M., Apt, J., Lave, L., and Morgan, G.: 2004a, 'Response to comments on "Managing Soil Carbon"', *Science* **305**, 1567d-.

Lal, R., Griffin, M., Apt, J., Lave, L., and Morgan, M. G.: 2004b, 'Managing Soil Carbon', *Science* **304**, 393.

Lee, K. N.: 1993, *Compass and Gyroscope: Integrating Science and Politics for the Environment*, Island Press, Washington, DC.

Lee, K. N.: 1999, 'Appraising adaptive management', *Conservation Ecology* **3**, 2.

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

Niles, J. O., Brown, S., Pretty, J., Ball, A. S., and Fay, J.: 2002, 'Potential carbon mitigation and income in developing countries from changes in use and management of agricultural and forest lands', *Philosophical Transactions of the Royal Society of London Series A – Mathematical Physical and Engineering Sciences* **360**, 1621–1639.

Poffenberger, M.: 2002, Communities and Climate Change: The Clean Development Mechanism and Village-Based Forest Restoration in Central India. Community Forestry International, Santa Barbara.

Putnam, R.: 1988, 'Diplomacy and domestic politics: The logic of two-level games', *International Organization* **42**, 427–460.

Renwick, W. H., Smith, S. V., Sleezer, R. O., and Buddemeier, R. W.: 2004, 'Comment on "Managing Soil Carbon" (II)', *Science* **305**, 1567.

Van Eeten, M. and Roe, E.: 2002, *Ecology, Engineering, and Management: Reconciling Ecosystem Rehabilitation and Service Reliability*, Oxford University Press, London.

Van Oost, K., Govers, G., Quine, T. A., and Heckrath, G.: 2004, 'Comment on "Managing Soil Carbon" (I)'. *Science* **305**, 1567b.

Wade, R.: 1997, 'Greening the bank: The struggle over the environment, 1970–1995, in Kapur, D., Lewis, J., and Webb, R. (eds.), *The World Bank: Its First Half Century*, Vol. 2, Perspectives. Brookings Institution, Washington, pp. 611–734

Walters, C. J.: 1986, *Adaptive Management of Renewable Resources*, The Blackburn Press, Caldwell, NJ.

Walters, C. J.: 1997, 'Challenges in adaptive management of riparian and coastal ecosystems', *Conservation Ecology* **1**, 1.

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